THE IMPACT OF INTERNATIONAL MIGRATION ON INTERNATIONAL TRADE:
AN EMPIRICAL STUDY OF AUSTRALIAN MIGRANT INTAKE FROM ASIAN COUNTRIES

Sidney Mankit LUNG

B. Bus. (Hons.) International Trade, Victoria University

This thesis is submitted in total fulfilment

of the requirements of the degree of

Doctor of Philosophy

School of Applied Economics

Faculty of Business and Law

Victoria University

Melbourne

Australia

May 2008

ABSTRACT

In the context of established international economic theory, it is well known that international trade of commodities is effectively trading factors of production such as labour and capital. It follows that if factors of production can be moved internationally, then the need for commodity trade is eased, and trade of commodities and movements of factors of production can be substituted for each other. From this, the conclusion can be reached that factor movement is a substitute for commodity trade.

Allowing people to migrate from one country to another country involves migration of labour – the movement of a factor of production. The conclusion that factor flows are a substitute for commodity-trade can be re-stated as international immigration is a substitute for international trade.

However, this conclusion does not explain the real world in which both international trade and international immigration have increased over time. Thus, established theory of immigration and trade may not be a reliable policy guide for formulating immigration and/or trade policy. It is the purpose of this thesis to formulate an alternative theory, which more effectively explains the relationship between immigration and trade.

For the purpose of distinguishing the impact of immigrants on trade from the impact of other factors on trade, this thesis employs a two-step approach. The first step lays down the theoretical foundations by arguing that immigrants contribute to the economy of the immigrant receiving country in two areas: Firstly, immigrants supply labour to the immigrant receiving country and increase demand for goods and services, hence increase the size of the economy in the immigrant receiving country. Secondly, immigrants bring in intangible social capital and human capital with them (in addition to any tangible capital they bring with them). Both contributions have impacts on international trade. The increasing labour supply could reduce trade, but increasing the market size, and bringing in social capital, in the form of foreign market information, could facilitate trade.

The second step employs the latest econometric techniques to test empirically the theory that is developed in the first step, using real world data. The main empirical technique employed in this thesis to analyse the effect of immigration on trade is the gravity model that is estimated using cross-section and time series (panel) data. The case of Australia's immigration and trade with ten major Asian trade partner countries is selected for the study. The panel cointegration test is conducted to investigate the possible long run equilibrium relation between immigration and trade. The short-run relation between immigration and trade is also examined.

This thesis successfully distinguishes between the impact of immigrants on trade and the impact of other influential factors on trade. A strong long run relation between immigration and exports is established. Within a certain range of immigrant intakes, immigrants have positive and significant impact on Australia's exports to the immigrant home countries. The long run impact is found to be double the strength of the short run impact.

However, a long run relation between immigration and imports cannot be clearly established by the panel cointegration test, and the impact of immigrant intake on imports is not strong.

Since the long run relation between migrant intake and exports can be established, it is possible that an underlining causation exists. Therefore, a panel causality test on immigration and exports is conducted. The results show that migrant intake "Granger causes" exports, but exports do not Granger cause immigration.

This thesis demonstrates that international labour immigration, unlike the movement of other factors of production, is not necessarily a substitute for international trade in the manner described by established international economic theory. In the case of Australia's immigration and trade with Asian immigrant home countries, immigrants have long run and short run positive impacts on exports, although immigrants do not have a strong impact on Australia's imports from Asian migrant home countries. Moreover, migrant intake "causes" exports.

The main policy implication of these findings is that Australia can use immigration as a long-term strategy to promote exports to Asian countries.

ACKNOWLEDGMENTS

Encouragement, assistance, and support from my family and friends and guidance from academic community motivated me to continue my efforts to achieve my dream of completing this thesis. Every piece of help I received during this long haul of study is significant to the successful completion of the thesis.

I thank Dr. Lindsay Smyrk, since my idea to enrol in the Ph. D. research programme was sparked by a casual conversation with Dr Smyrk, at the School of Applied Economics of Victoria University.

I am grateful to my principal supervisor, Dr. P. J. Gunawardana, who also supervised me to achieve a first-class honour in my honours year studies, leading to my success in winning the competitive, prestigious APA scholarship from Australia Federal Government. I am deeply indebted to Dr. Gunawardana for his guidance throughout the whole period of candidature, his patience about my progress, his comments on my drafts and his understanding of my personal and family circumstances. His encouragement and support in motivating me to continue this study are unforgettable. Thanks are also extended to the Victoria University Scholarship Committee and the Australian Federal Government for the financial assistance. Without the APA scholarship, this research would not have started in the first place.

Help was also received from many staff members of the School of Applied Economics. Among them, my co-supervisor, Dr. Segu Zuhair, offered time for discussions in modelling issues and econometric issues, Dr. K. Jegasothy shared his mathematics knowledge in matrix algebra and his econometric knowledge in panel cointegration and commenting on my drafts regarding the panel cointegration test. My knowledge of productivity diversity from immigration is sharpened by Associate Professor Dr. Santina Bertone. General advice was received from Associate Professor Alan Morris. My mathematical knowledge in derivatives and integration was sharpened by Mr. Jim Bates. Advice on thesis formatting and

EndNote experience were received from Dr. Inka Havrila. Computer support was promptly provided by Mr. Coskun Susoy and the IT support team.

I am also grateful to instructions from Academia in the United States. Professor Chihwa Kao of Syracuse University offered time for numerous discussions regarding his expertise in panel cointegration test as well as the GAUSS codes for Brownian motion simulation. Professor Bruce E. Hansen of University of Wisconsin-Madison provided advice regarding the long run covariance process and his GAUSS codes. Associate Professor Peter Pedroni of Williams College offered his articles on his groundbreaking panel cointegration test techniques.

My sincere thanks are also extended to Associate Professor David Harris of the University of Melbourne for his emails regarding the Brownian motion simulation and Associate Professor Brett Inder of Monash University for his willingness to assist in regression estimation.

The greatest sacrifice was by my wife Polly (Sau Wah) who bore the greatest burden to look after the family and to keep the children away in order to help my studies. I feel sorry for imposing such difficult tasks on her for several years and I am grateful to her for tireless support and encouragement throughout my candidature period. I am also thankful to my children, my elder son Dominic, my twin boys Frederick and Benjamin and my sweet little girl Naomi for being their understanding and being patient, as I could not pay sufficient attention to them.

I am also grateful to our good neighbour and good friend, Ms. Mary Fisher for her long support. Her love like our mother and like our children’s grandmother is unforgettable.

I would like to dedicate this thesis to my father, brother and sisters who love me the most and are proud of me, and in memorial to my late mother and late brother who suffered illnesses and were unable to see the completion of this thesis, but they will exist in my memory for ever.

Sidney Mankit Lung

2008

DECLARATION

"I, Sidney Mankit LUNG, declare that the PhD thesis entitled **The Impact of International Migration on International Trade: An Empirical Study of Australian Migrant Intake from Asian Countries** is no more than 100,000 words in length, exclusive of tables, figures, appendices, references and footnotes. This thesis contains no material that has been submitted previously, in whole or in part, for the award of any other academic degree or diploma. Except where otherwise indicated, this thesis is my own work".

Signature Date

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

ABBREVIATIONS

ABS	Australian Bureau of Statistics
ADF	Augmented Dickey-Fuller
AIC	Akaike information criterion
AR(1)	First order autoregressive process
ANZCERTA	Australia New Zealand Closer Economic Relations Trade Agreement
ASEAN	The Association of Southeast Asian Nations
BCOLS	Bias-corrected OLS
BIMPR	Bureau of Immigration, Multicultural and Population Research
c.i.f.	Cost, Insurance and Freight
CES	Constant Elasticity of Substitution
CET	Constant Elasticity of Transformation
CMEA	Council of Mutual Economic Assistance
CRDW	Cointegrating regression Durbin-Watson test
DGLS	Dynamic Generalised Least Squares
ECM	Error Correction Mechanism
ECOM	Error Components Model
EEC	European Economic Community
f.o.b.	Free On Board
FEM	Fixed Effect Model
FGLS	Feasible Generalised Least Squares
FMOLS	Fully-modified Ordinary Least Squares
GLS	Generalised Least Squares
H-O	Heckscher - Ohlin
H-O-S	Heckscher – Ohlin - Samuelson
$I(0)$	Stationary time series
$I(1)$	Non-stationary time series, which can be converted into stationary time series by taking the first difference of the series
i.i.d.	independent and identically distributed
IIT	Intra-Industry Trade

ITU	Indirect Trade Utility
LBI	Locally Best Invariant
LBUI	Locally Best Unbiased Invariant
LSDV	Least Squares Dummy Variables
NAFTA	The North American Free Trade Agreement
OECD	Organisation for Economic Co-Operation and Development
OLS	Ordinary Least Squares
PCSE	Panel-Corrected Standard Errors
PPC	Production Possibility Curve
PRC	People's Republic of China
PWT	Penn World Tables
REM	Random Effect Model
SAFTA	Singapore-Australia Free Trade Agreement
SC	Schwarz criterion
SITC	Standard International Trade Classification
SUR	Seemingly Unrelated Regression
TAFTA	Thailand-Australia Free Trade Agreement
TOT	Term of Trade
UN	The United Nations
US	United States
VAR	Vector Autoregression
VEC	Vector Error Correction
WBWT	World Bank World Tables
WWII	World War II

Chapter 1 INTRODUCTION

"We must populate this country or we will lose it."
Arthur A. Calwell, Minister of Immigration, Australia 1945 – 1949.

1.1 Introduction to the Context of Research

Immediately after the end of the Second World War, the popular slogan "populate or perish" encapsulated the shortcoming of how vulnerable the under-populated Australia was to war. The slogan became the rationale to support a new immigration policy of the day, which was designed to boost population by a program of massive immigrant recruitment from Europe.

Half a century later, Australia is confronted with a new challenge of population ageing, and a new immigration[1] policy is needed. Population ageing can be defined as the increase of average age of the population as a result of decreasing mortality rate and birth rate. The decrease in mortality rate and birth rate is a by-product of stages of economic development and a better healthcare system. Population ageing implies a shrinking of the proportion of the working age group in the society and rising of the proportion of the retiree group. The consequence of population ageing is a higher tax burden for the working age group to support the non-working age group. As a result, it reduces the incentive for and the ability to invest for future economic growth and development. The "populate or perish" slogan might be changed to read as "make the population younger or face poverty".

Bowing to the pressure of population ageing, the Australian governments provide economic incentives to its citizens and residents to increase the birth rate while preparing to accept more young-and-skilled immigrants as a two-pronged policy to alleviate the population-ageing problem. The economic incentive to raise birth rate has a profound effect to combat population ageing. However, this policy involves a considerable time

[1] In this study, the term "migration" refers to the movement of people across national border. The term "immigration" refers to the movement of people into a country.

lag. On the other hand, the immigration policy of increasing young-and-skilled immigrants can make the population younger within a shorter time period.

Immigration policy has always been an issue subject to public debate in major migrant receiving countries such as Australia, Canada and the USA. The major impact of immigration on the economy has long been perceived by the general public in the immigrant [2] receiving countries as immigrants replacing native workers. Massive immigrant intake will raise the supply of labour in the immigrant receiving countries, hence lowering the wages of workers in the migrant receiving countries if demand for labour did not increase. However, academic research on the impact of immigration on immigrant receiving country labour replacement has found no evidence to support such a perception (see, for example, Shan, Morris, & Sun, 1999). Evidence from Addison and Worswick (1999) shows that recent immigrants did not affect real wages of native Australians. In turn, the arrival of immigrants increased the chance of a "representative" Australian individual being employed – simply the working of Say's Law, "supply creates its own demand".

An economic theory widely accepted by economists, which is not in favour of immigration, is the commodity price equalisation of factor movement theorem of Mundell (1957). This theorem follows the labour substitution argument above. If the supply of new immigrants lowers the native workers' wages, with new lower wages, the migrant receiving country is able to produce the commodities, which previously imported from a lower labour cost countries – the situation of rising local production replacing imports. As a result, the demand for imports will decrease. On the other hand, some resources, which were previously employed to produce commodities for exports, are now shifted to produce import competing commodities. The export supplies will then decrease. The theory is advanced from labour substitution effect of immigration to trade substitution effect of immigration. The theory concludes that increased immigrant intake will alter a country's comparative advantage and will force the countries to divert resources away from its comparative advantage sectors of production and hence depressing international trade.

---

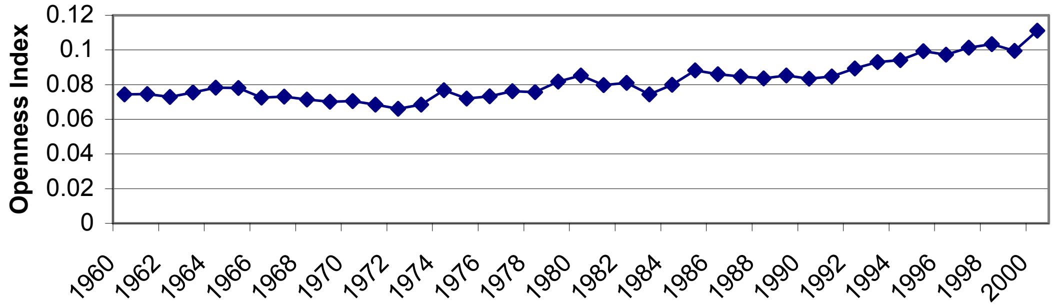
[2] In this study, the term "migrant(s)" refers to people who move across national border, while the term "immigrant(s)" refers to people who move into a country.

The conclusion of the theory outlined above is that international migration is a substitute for international trade. However, the following evidence shows that international migration does not have to be a substitute for international trade.

Over the past 30 years, the Australian economy has become more integrated into the global economy to become competitive in the world market in order to sustain economic growth. The Commonwealth and state governments and business communities have raised their efforts to develop an export culture. The effort has led to some success in increasing trade as evidenced by the improvement of Australia's trade openness (the Openness Index[3] increased from 0.07 in 1975 to 0.11 in 2000, see Figure 1.1).

Despite the improvement in integrating into the world economy, the growth of Australian exports is relatively slower than many other OECD (the Organisation for Economic Co-Operation and Development) countries. Australia was ranked the 15th exporter in the OECD in 1998, dropping three places from the rank of 12th exporter in twenty-five years ago. Some authors have suggested increasing overseas contacts, in order to improve Australia's export performance (see, for example, Mahmood, 2001).

Figure 1.1 Trade Openness, Australia, 1960 - 2000



Source: The graph is constructed using the data obtained from DX EconData, 2001, RBA Bulletin database, Table H.03 Exports and Imports of Goods and Services and OECD Main Economic Indicators and Table AUS.01 Australia, National Accounts.

[3] Openness Index is calculated as the sum of total exports and imports as a percentage of the country's GDP. Openness Index is a measure of the degree of economic integration into the world economy.

Overseas contacts can be facilitated by visiting and networking. Business travellers, international students and immigrants are possible sources of overseas contact. Kulendran and Wilson (2000), inspired by the history of Marco Polo in the Thirteenth Century, investigated the relationship between trade and business travel. They found that business travel creates trade. They advanced the hypothesis that successful business trips encourage other entrepreneurs to "try their luck".

Looking back to the history of European – Asian trade, the contribution of Marco Polo to this part of the history was his knowledge about the East at the time. Marco Polo stayed in China for 17 years before he travelled back to Europe. During this 17-year period of residence and participation in governmental administration in China, Marco Polo had a chance to travel around in China. His knowledge about the Far East, as a form of information, was passed on to the Europeans after his return to Europe, which significantly influenced the development of European - Asian trade. Nowadays, of course, business information is more readily accessible with speed of light travelling across continents through electronic devices. However, correct interpretation of culture related market information is significant to the success of international business. Rauch (1999) refers to language differences as a search barrier, and found that common language and colonial ties reduce the search barrier to trade in differentiated products.

When mismatches exist in the market, entrepreneurs can profit from bringing sellers and buyers together, and when cultural differences distort trade, 'cross-culture brokers' thrive by reducing the search cost (Curtin, 1984). Chu (1995) demonstrated the significant role a 'cross-cultural broker' plays in identifying the impediments to international business transactions. 'Cross-cultural brokers' can be viewed as communities who have knowledge or insight into at least two different national cultures, and can bridge the cultural differences for business transactions. People who have substantial periods of residence in two countries could fit into these communities.

Returning to the Marco Polo example, he can be seen as a cross-cultural broker as he resided overseas for an extended period of time and acquired the language of the host country, and his information about the East influenced the trade between the West and the East.[4] Skeldon (1996) found that the existence of cross-cultural brokers facilitates the circulation of goods. McCrohan and Lung (2001) found that tertiary education exports lead to commodity exports as the overseas students played the role of 'cross-cultural brokers'.[5] The hypothesis developed from this can be phrased as "In the international market for goods and services, where information is distorted by cultural differences, the existence of 'cross-cultural brokers' can reduce the information gap, and increase international trade".

It can be further argued that Marco Polo was a European immigrant to China.[6] His 'immigration' made him a cross-cultural broker. If this argument has merit, it suggests that international immigrants tend to have the advantage to assume the cross-cultural brokers' role. A logical development then follows that, holding other factors constant, international immigrants can increase trade between their host country and their home country by bridging the cultural differences.[7]

According to the Australian Bureau of Statistics (ABS) census data, immigrant stock (the proportion of immigrant to total population) was 20 percent in 1971 and had increased to 23 percent in 1996, while total exports of goods increased from $4,891 million to $75,951 million.[8] In addition, the total import of goods increased from $4,009 million to $77,833 million for the corresponding periods.[9] It can be observed that, the proportion of Asian immigrants to the total immigrant intakes has subsequently increased after the abolition of the White Australia Policy in 1973 (see Table 1.1). The striking feature of Table 1.1 is that Asian countries have become important trading partners of Australia since 1973. Asia was the destination for 60% of Australia's total exports during 1994/1995.

---

[4] The 'host country' is the immigration country, also called the 'country of destination' or the 'receiving country'.

[5] An empirical study investigated the links between Thai overseas students in Australia and Australian exports to Thailand.

[6] This argument is supported by his prolonged residence and official appointments in China. His return was urged by potential political unrest in China.

[7] The 'home country' is the emigration country and may be called the 'country of origin' or the 'sending country'.

[8] RBA Australia Economic Statistics, Table 1.4 Exports of Goods by Countries, dX EconData, 2001.

[9] RBA Australia Economic Statistics, Table 1.6 Imports of Goods by Countries, dX EconData, 2001.

We observe that increasing volumes and varieties of Asian products on the Australian market and Australian products on Asian markets have coincided with the increasing arrivals of Asian immigrants in Australia. However, the question of what contribution the immigrants make to the trade performance of Australia has not been addressed by empirical studies so far. The purpose of this thesis is to explore and answer this question.

Table 1.1 The Proportion of Asian Immigrants in Australia and the Proportion of Australian Trade with Asian Countries, 1959/60 to 2005/06

	Asian Immigrants (as % to total immigrants)	Exports to Asia (as % to total exports)	Imports from Asia (as % to total imports)
1959/60	2.7	22.8	15.8
1964/65	3.3	27.2	16.7
1969/70	9.6	38.8	18.2
1974/75	18.1	43.0	25.7
1979/80	29.6	44.3	29.0
1984/85	39.4	47.5	37.3
1989/90	41.8	50.7	35.3
1994/95	37.0	60.6	38.0
2003/04	38.0	46.6	44.2
2004/05	39.2	53.0	45.5
2005/06	39.6	52.9	47.5

Source: The export and import data were obtained from Reserve Bank of Australia (RBA) Australian Economic Statistics, dX EconData, 1995-2000, Table 1.4 and Table 1.6. Asian immigrants' data are from the Bureau of Immigration, Multicultural and Population Research (BIMPR) M10, June 1996. Asian Immigrants data from 2004 to 2006 are collected from Department of Immigration and Citizenship website: http://www.immi.gov.au/media/publications/statistics/immigration-update/Settler_Arrivals0506.pdf, accessed, 03/04/2008. Exports and Imports data are collected from the Department of Foreign Affair and Trade website: http://www.dfat.gov.au/publications/stats-pubs/downloads/EA_2006.pdf, accessed, 03/04/2008. Exports and Imports data after 2003/04 are not compatible with Exports and Imports data before.

1.2 The Issue and Problem Definition

There is a contradiction between the fact of more immigrants and more trade, and the conventional economic theory of migrants replacing trade. In this section, we examine the following questions: whether the economic theory of migrants replacing trade is universally applied or are there any exceptions to the theory? If there are certain circumstances contributing to the exceptions to the theory, what are those circumstances? We first look at where the argument of "migrants replacing trade" comes from and where it was mainly applied.

Theory of "migrant replacing trade" comes from the implication of the Heckscher-Ohlin (H-O) theory for international trade. According to Ohlin (1933), with different resource endowments, countries are better off to shift production composition toward the commodities, which intensively use the inputs, which are abundantly available within the country and export the commodities in exchange (import) of the commodities, which rely heavily on the inputs, which are scarce in the country. The benefit of this shift of production composition comes from specialisation and trade. If all countries realise this benefit of specialisation and trade, then after free trade, the effect of trade on the resource price is to reduce the difference in the prices of resources between countries or even equalise prices of resources in all trading countries. Commodity trade between countries, in a nutshell, is trading resources or factors of production.

Labour is one of the factors of production. According to the (H-O) theorem, international trade in labour-intensive commodities is effectively trading labour factor or moving labour factor across national borders without physically migrating the persons. The theory of "increasing trade between countries in order to reduce the wage gap, and to achieve the objective of reducing the incentive for migration", leads to the theory that international trade is a substitute for international migration. This theory is specifically developed to apply to the situation of illegal immigration pressure on the US-Mexico border from the Mexico side. The policy implication of this theory is to increase US-Mexican trade or to form the US-Mexico Free Trade Agreement because trade is a substitute for immigration (Samuelson, 1949).

Following the same chain of logic and working backward, the H-O theorem is interpreted in the following way: Provided that international trade is a substitute for international migration, international migration is also a substitute for international trade. When migrant is measured as a unit of labour, then international migration is effectively the movement of labour across countries. When migrants leave their home countries, supply of labour will decrease. The decrease of supply will put upward pressure on wages in the migrant home countries. When migrants enter into the migrant receiving country, the supply of labour will increase. The increase of supply will put downward pressure on wages in the migrant receiving countries. The wage rate converges between migrant home countries and migrant receiving countries as a result of migration. This wage convergence wipes out the pre-migration comparative advantages of countries and makes trade unattractive. This theory of migration being a substitute for trade follows similar logic of Mundell's (1957) commodity price equalisation of factor movement theorem.

The contradiction between the established economic theory of migrants substituting trade and the reality of more immigrants and more trade (illustrated in Table 1.1) has led to the conjecture about the exceptions to the theory. Recent studies (David M. Gould, 1996; Rauch, 1999) started questioning the way of measuring migrants as mere units of labour.

The conventional migrant-trade substitution argument was criticised by Gould (1996) and Rauch (1999) for failing to acknowledge that immigrants also bring in intangible human capital in the form of foreign languages, cultural diversities, education, human networks and foreign market information. This intangible capital is liquid, is secure against loss and theft, and is hardly used up. It is even more valuable than any other form of assets that immigrants can bring with them into the host countries. Unlike physical capital, which sometimes could be stolen, destroyed or lost, intangible human and social capital are stored in the brain and is secure, although they may fade over a long period of time. Human capital and social capital are liquid because they can be carried around without incurring additional transportation cost, and are valuable because their proper use gives unlimited commercial potential. In particular, the social capital of human networks and foreign market information strengthens the commercial links, and facilitates trade between migrants' home and host countries.

Broadening the measure of migrants by including human capital and social capital, increased immigrant intakes may not strictly replace international trade but may enhance trade. The issue addressed in this study is the following assertion: although increasing trade would reduce the pressure of migration, increasing migrants may increase trade to some extent.

1.3 Objectives of the Study

The objective of this study is to examine the impact of immigration on international trade by developing and estimating an international trade model that incorporates immigrant foreign market information. To this end, the specific objectives are:

- To theoretically explain trade enhancement effect of migration incorporating the theory of information economics.
- To develop a gravity model specifically to explain international trade between one country with a group of trade-partner countries (the country specific gravity model).
- To empirically test the theoretical country specific gravity model using panel data. Specific reference is made to Australia's trade with Australia's major Asian trade partner countries.
- To investigate and to apply panel cointegration tests and panel cointegration estimation techniques to the empirical analysis.
- To conduct panel causality tests to investigate the possible "causal" relations between immigrant intakes and exports to and imports from the migrant source countries.

1.4 Scope of the Study

This study evaluates the effects of Asian immigration on Australia's trade with Asia, employing the following framework. Firstly, this thesis focuses on the economics of immigration and its effect on international trade. Limited relevant non-economic arguments may be borrowed to assist the logical development of economic arguments. Secondly, the analysis of this thesis focuses on Australia as an immigrant receiving country and investigates the likely trade enhancement effect with immigrant home countries. The economic welfare effects on the immigrant source countries are not investigated in this study, rather, a brief review of the literature on the economics of migration will be provided in the literature review chapter. Thirdly, the thesis limits its scope to international trade between Australia and its Asian immigrant home countries. Fourth, this study concentrates on the time frame from the 1960s to the end of the 1990s, which is the period in which immigrant intakes from Asian countries increased while the White Australia Policy was relaxed.

1.5 Significance of the Study

The several areas of contribution to knowledge as presented in Section 1.4 show that the significance of the study rests on the investigation of the impact of immigration on Australia's trade. The results of the analysis could be used to benefit immigration policy developments, particularly in formulating long-term immigration strategies. Immigration policy has been used as a vehicle for short-term economic solution for labour and skill shortage, as well as for long-term strategy for increasing population size to provide economies of scale in the domestic market and for tackling the population-ageing problem. This thesis is significant in providing quantitative research on how immigrants can help Australia's exporters to expand their overseas markets, the optimal level of immigration, the time period that will take a typical immigrant to translate effectively his/her foreign market information as a trade benefit to Australia.

1.6 Outline of the Thesis

With the objective of investigating whether migrants replace or enhance trade in mind, Chapter 2 reviews the literature on the theories and empirical studies relating to international trade, immigration, immigrant entrepreneurship and welfare effects of immigration, in an attempt to find support for our arguments. We find that a substantial volume of literature pointing to the fact that immigrants do not replace trade (the volume of immigrants may be too insignificant relative to the volume of trade in order to trigger the substitution effect). Chapter 3 provides an overview of Australia's immigration history with the focus on the eleven major Asian immigrant source countries and Australia's trade history with those countries. In Chapter 4, the theory of information economics is applied to model the relations between immigration and trade, and to provide a theoretical foundation for incorporating the immigrant variable into the gravity model.

Chapter 5 provides a comprehensive review of literature on the gravity model. Following the development from Chapters 4 and 5, Chapter 6 develops and justifies a new gravity model to analyse trade with immigrant information and discusses the econometric issues confronted by this study in order to determine the appropriate econometric techniques that should be applied to the panel data gravity model. Chapter 7 documents the data sources and explains the appropriate treatment of the data set in order to prepare for the preliminary analysis of the data.

Chapter 8 employs the latest, advanced econometric techniques available for panel data cointegration tests and panel data cointegration estimation. The long run relation between immigration information and exports is established by the panel cointegration test, and the optimal level of immigrant intake to allow the immigrant information to have the optimal effect on exports is also calculated from the panel cointegration estimation. The short run relations are also obtained through the panel error correction mechanism. Following the findings of Chapter 8, Chapter 9 investigates whether possible causality relations between immigration and trade can be established. Chapter 10 summarises the findings and policy implications of the study, acknowledges the limitations of the study and suggests some further research directions.

Chapter 2 TRADE AND MIGRATION: A REVIEW OF LITERATURE

2.1 Introduction

The purpose of this chapter is to explain the theoretical and empirical foundations on which this thesis is based, by reviewing the literature on the economics of immigration, social capital and immigration, immigrant entrepreneurs, and immigration and trade. Section 2.2 reviews the literature on the development of the theory of free trade. Section 2.3 surveys the literature on the theoretical connection between immigration and trade. Special attention is paid to the arguments on the substitutability of trade and factor movements. In order to put forward arguments to support the notion that immigration benefits trade, Section 2.4 starts by looking at immigrants as part of the society where they originally belong, and that such belonging is still maintained after they migrate to a new country. Section 2.5 discusses possible information flow between migration source countries and immigrant receiving countries, which is facilitated by immigrants. Section 2.6 provides a review of literature on immigrant entrepreneurial activities. Section 2.7 concentrates on the national economic welfare effects associated with immigration. Section 2.8 summarises the theoretical arguments developed in this chapter.

2.2 The Development of the Theory of Free Trade

International trade has always been an important issue throughout the history of human civilisation. According to Irwin (Irwin, 1996), in ancient Europe the European's attitude toward trade with foreigners was a mixed attitude. Some viewed that opening trade with foreigners led to national moral contamination by foreigners. Others were more positive towards trade with the view that ideas can be exchanged with foreigners through trade.

A more structured international economic literature emerged in the sixteenth-century England – the mercantilist's views. The mercantilists advocated aggressive trade policy of export promotion and import restriction. By forcing a favourable trade balance, a nation achieves a net inflow of precious metals to finance the expansion of the nation's armed forces and strengthen the King's power. However, the wealth of the nation was measured by the stock of resources, which can be utilised to produce goods and services for its citizens. The well being of its citizens is measured by the satisfaction from consuming goods and services. The mercantilist's "favourable balance of trade doctrine" was eroded by the objections put forward by free trade advocates. Roger Coke (1670), (quoted in Irwin (1996)) observed a contradiction that the Dutch thrived even though their imports were more than their exports while, the Irish were getting poorer even though their exports were eight times more than their imports. David Hume's price-specie-flow mechanism theory cast doubt on the mercantilist's monetary doctrine. Hume's idea was that, a country with initial cost advantage might undersell its competitors in the foreign market, but the repatriation of precious metals would raise the price level of that country, eroding the competitive power and reducing the trade surplus. The price-specie flow functioned as a self-correction mechanism of the trade imbalance.

There were numerous essays and pamphlets advocating free trade by a number of eminent scholars and philosophers. However, it was Adam Smith (1937),[10] who collated the existing free trade thoughts, exploited the flaws of mercantilist doctrine and developed a systematic framework of economic analysis for the case of free trade. In Adam Smith's view, foreign trade, like domestic trade, should be free from government intervention. Free trade would allow merchants to move goods from abundant market to scarcity market for the incentive of profit at the level of risks assumed. By acting for self-interest, individuals perform beneficial services to society. The abundant market benefits from increasing demand and the scarcity market benefits from increasing supply. The "invisible hand" facilitates the allocation of resources to be utilised most efficiently and would maximise world welfare. Restrictions on imports will divert resources away from the sector of the economy with absolute cost advantage hence reducing the nation's ability to sell its products abroad. Adam Smith's free trade analysis warranted national wealth creation and irrevocably changed the way of commercial policy analysis.

To Smith, free trade takes place if a country has absolute cost advantage on one product and absolute cost disadvantage on the other product. A number of economists (for example Mill, 1995; Ricardo, 1971; Torrens, 1829), stepped further and viewed that free trade can take place and be beneficial even if a country has no absolute cost advantage. The crux of their argument is the opportunity cost of production in autarky. The sector of the economy

[10] Originally published in 1776.

in a country with lower relative cost of production has lower opportunity cost, hence a comparative cost advantage.

The example of comparative cost advantage used by Ricardo was a one-factor model in terms of labour cost differences between countries.[11] It was in 1919, Heckscher (1949) who asked the question why should factor costs be different between countries. [12] He proposed that, if factors of production are immobile across nations, a factor is not rewarded by production efficiency but is rewarded by the scarcity of supply relative to the demand. If a factor of production has an abundant supply but in relatively low demand, the factor price will be relatively lower. In contrast, if a factor of production has scarce supply but in relatively high demand, the factor price is relatively higher.[13] In other words, factor-price differences come from factor endowment differences between countries. Heckscher then reasoned that the commodity that intensively uses the abundant factor would incur a lower cost. In a competitive environment, the price for the commodity would be lower if the cost is lower. This initial lower commodity price formed the basis of comparative cost advantage and the basis for international trade – that is, the country exports the commodity, which intensively uses the country's abundant factor. For example, China has relatively abundant labour supply. According to Heckscher's theory, China exports labour intensive commodities.

When international trade takes place, consumers will buy the commodity from the lower priced country. As a result, demand for the lower priced commodity increases and demand for higher priced commodity decreases. The derived demand for the factor intensively used to produce the commodities increases in the lower priced country, while the derived demand for the same factor in the higher priced country decreases. If the supply is constant, the right

---

[11] Ricardo received almost all the credit in developing the comparative advantage theory of trade. In his example of exchange of cloth for wine between England and Portugal, Ricardo reasoned that England benefits from trade with Portugal, even though England has absolute cost disadvantage in production of both wine and cloth. However, Ricardo was criticised for failing to "bring out the essence of the theory"(Irwin, 1996) and not really understand his own statement (Chipman, 1965).

[12] Heckscher's article was first published in Swedish *Ekonomisk Tidskrift*, Vol. XXI, 1919, pp 497-512.

[13] When the factor prices are compared across countries, they are measured in a relative sense, that is, the price of one production factor in relation to the price of another production factor. The relative price is also the measure of opportunity cost of using alternative resources. For example, the relative price of labour to the price of capital (P_L/P_C) is the opportunity costs of using labour in terms of using capital. This opportunity costs are then compared across countries. The country has lower opportunity cost for a factor means that the country has relatively abundant supply of that factor. The other country, which has higher opportunity cost means that the factor is scare in supply in that country.

shift of the demand curve raises the equilibrium price for the abundant factor in the lower priced country, while the left shift of the demand curve lowers the equilibrium price for the same factor in the higher priced country.

If trade continues, the price for the abundant factor continues to rise in the lower priced (exporter) country while the price for the scarce factor continually decreases in the higher priced (importer) country. Heckscher's theory leads to the conclusion that factor prices (the relative price or the opportunity cost) between trading nations will converge through international trade. In a broader sense, after opening up trade, the relative scarcity of the various factors of production for the whole economy is readjusted.

Heckscher's reasoning revolutionised the existing trade theory at the time by his insight into the relations between foreign trade and distribution of income, and the development of the concept of factor price equalisation through commodity trade. His main concern was the influence of foreign trade on the distribution of income and the changes in factor prices. To this end, international trade in commodities is effectively the exchange of factors of production across nations. By allowing factor mobility across countries and assuming equal labour quality, Heckscher reasoned that all international trade would cease because factor price differences between nations induce factor movement across boarders into the nations where there will be better returns. Heckscher's reasoning was the basis of economists' claim that commodity trade and factor movement are substitutes.

Ohlin (1933) extended the theory of interregional trade into international trade. The advancement of international trade theory by Heckscher and Ohlin is known as the Heckscher - Ohlin theorem (or the H-O model). The H-O model became the orthodox theory for explaining the source of comparative advantage. The basic idea of the H-O model established the theoretical foundation for trade based on factor endowments and factor proportions. It has also several significant implications on the relations between trade with specialisation, trade with distribution of factor incomes and trade with international factor movements.

The factor proportions theory of the H-O theorem suggests that trading countries should specialise in the production of commodities, which utilise intensively the factor which is in abundant supply and exchange for the commodities that intensively use the country's scarce factor. It predicts that when trade is opened and continued, return on all factors of productions will converge between countries. To the extent that international factor movement is motivated by international differences in factor returns, the factor price convergence effect of commodity trade reduces the incentive for factors of production to move across countries. Hence trade is a substitute for factor migration.

One of the limitations of the factor endowment theory lies in the time frame the theorem was developed. In the context of world trade conditions of the early 1900s, Ohlin's factor price convergence theory was developed for the evaluation of trade policy, which protected labour income and labour intensive industries in the U.S. The theory predicts that international trade will benefit capital but hurt labour in the U.S. However, Ruffin (1999) found that the negative impact of international trade on the U.S. labour force between 1972 and 1997 was small and insignificant. A major reason that the impact of international trade on income distribution did not follow the prediction of the H-O model was that the direction of trade did not follow nicely the prediction of the H-O model.

In the 1960s, economists noticed that most of the world trade took place between capital abundant industrialised countries, in capital-intensive commodities. For example, the U.S. traded cars with Germany. In this instance, U.S. consumers or German consumers do not perceive U.S. cars as identical to German cars. Since commodities and services have a variety of forms and characteristics which provide slightly different utilities to consumers, according to Lanscaster (1966), there are no commodities that can be perfect substitutes for each other in regard to all those characteristics.

Balassa (1966; 1967) noticed that when the European Economic Community (EEC) bloc reduced tariffs levied between its member nations, the trade pattern changed to increasing trade in differentiated products within broad industrial classifications. Balassa called this phenomenon 'intra-industry' trade (IIT). Grubel and Lloyd (1975) estimated that about one-half of the trade amongst developed countries was intra-industry trade. To a large extent, intra-industry trade arises from the fact that products are differentiated. Focusing on product differentiation allows firms to gain economies of scale in production and facilitates the growth of monopolistic competitive markets. Firms in a monopolistic competitive market continuously improve existing products or develop new products in order to stay away from fierce competition, resulting in the growth of intra-industry trade. According to

Ruffin (1999), 57 percent of U.S. trade was intra-industry trade within four-digit Standard International Trade Classification (SITC) industries, over 60 percent in Europe and 20 percent in Japan. Sharma (2000) found that in the Australian case, the industries which experienced the sharpest fall in protection are the ones with the highest levels of IIT. The incorporation of intra-industry trade in the theory of international trade provides a fruitful alternative for the basis of trade in the microeconomic, industry specific level.

While Balassa noticed the peculiar characteristics of intra-industry trade, Vernon (1966) had an insight in the product life cycle theory of international trade, which was also concerned at the industry specific level, based on the U.S. experience after the Second World War. According to Vernon, manufactured goods tend to go through a product life cycle in four stages – the new product introduction stage, the growth stage, the maturity stage and the decline stage. Innovative products are developed for the high-income market in order to satisfy the consumers' desire for convenience. Because the initial demand for the product is uncertain, and there is a need to retain the technology within the firm, the innovative firm would keep production volume at a low level. They produce and market the product in the home country. When the domestic market becomes fully aware of the existence of the product, the product life cycle moves into the growth stage, and foreign demand could follow. The company begins to export the product and subsequently the product is modified to suit foreign markets. After the patent on the product lapses, the production technology for the innovative product becomes public knowledge. The continuing growth of the market provides an incentive to attract imitators to enter the market. The increasing supply of the product to the market moves the product into the maturity stage. At this stage, the need to standardise the production and searching for lower cost production centre become important issues for the firm, hence production moves to the lower cost centre and/or proximity to the market in relatively lower income countries. Foreign demand then decreases and trade will slow down. Eventually, standardisation of production in the low cost centre gains competitive advantage, and the product is then imported back to the initial innovative country. The innovative country becomes a net importer of the product. To the innovative country, the product is in its decline stage of the product life cycle and will be overtaken by a new innovative product. Then a new product life cycle starts again. The length of the product life cycle varies from product to product and could be influenced by the time lag of technology diffusion in the low cost countries and the frequency of new products development in the innovative countries.

The limitation of the international product life cycle trade theory, similar to one of the limitations of the H-O model, lies in the historical time frame the trade pattern was observed. The U.S. dominated the world trade in the 1960s because European countries were focusing on rebuilding their economies after the WWII devastation. On the other hand, the U.S. gained economies of scale on R&D and production on war supplies. Those technologies were shifted to produce innovative consumer goods such as televisions, computers, microwave ovens and refrigerators. After a period of growth in the domestic market, those innovative products started to be exported into the European market in the 1960s. The theory seemed to explain the trade pattern quite well at that time. However, the explanatory power of the theory was jeopardised after the economic recovery of Europe and Japan from the war, innovations sprung up everywhere at a quicker pace rendering a shorter product life cycle. The trend of globalisation also plays a role in weakening the product life cycle theory. The time frame for a product life cycle will not be widely apart in different markets and the trade pattern between those markets will not follow the prediction of the product life cycle theory. However, empirical studies by Lutz and Green (1983), Mullor-Sebastián (1983) and Schneeweis (1985) found supporting evidence that product life cycle has an impact on international trade, and government assistance may be justified to promote exports of products in the growth stage of the product life cycle.

A new development in the theory of international trade is the strategic trade theory (also called the New Trade Theory), which was pioneered by Brander and Spencer in the 1980s. Brander and Spencer (1981) identified the shortcomings of traditional trade theories that explain international trade only in the context of aggregate, and that ignore the roles of individual industries and firms in the world market. Brander and Spencer (1981) developed the New Trade Theory within industrial economic arena by considering the effect of market structure, and acknowledging the fact that most international businesses are operating in non-competitive (e.g. oligopoly) markets in industrialised countries. In the market where a few firms producing homogenous goods, the action of one firm will affect the market shares of all other firms. Since there are not many competitors in the market, firms make strategic moves based on their conjecture about rival firms' actions. In the case of a new market opportunity, the timing of the entry or the credible threat of building up of excessive production capacity can be the strategies to deter potential entry of competitors. In the international market arena, the benefit gained by self-interested, rent-seeking firms by deterring foreign competitors sharing the market will improve the national well being of its home country at the expenses of foreigners. It suggests that the government can play a role to improve national wellbeing by changing the payoff in the oligopoly game in favour of the local firm, using tariff policy on imports (Brander & Spencer, 1981), subsidy policies on research and development (Spencer & Brander, 1983), and subsidies on exports (Brander & Spencer, 1985).

Brander and Spencer's sophisticated strategic trade policy arguments for government intervention attracted a great deal of attention amongst economists. Dixit and Kyle (1985) extended the Brander and Spencer analysis into more general strategic games played by governments and competing firms. Krugman (1986) called it the "new thinking" and further argued that the dominant traditional free trade theory needed to be rethought in the context of the challenge offered by the New Theory (Krugman, 1987).

In line with the strategic trade theory and the theory of international product life cycle, Chandler (1994) advocates a more general government support to innovative local firms to take up the first-mover advantages in the international market. Being the innovator of the new product and first player in the market, firms gain the first-mover advantage by establishing consumer loyalty with relatively lower costs when the concept of the product is still fresh to the consumers. Imitators find that it is harder to attract consumers away from the established market. Higher costs could be incurred on mass communication to gain a position in the consumers' mind or by substantially lowering the price to expand the market and lure consumers to change their consumption habits (see, for example Ries & Trout, 1986). Innovators also have the first-mover advantages over imitators by gaining early experience about the market and in the area of improvements of the new products, which become additional barriers against new comers.[14]

Although the conclusion from the strategic trade theory analysis strongly supports targeted industry and trade policy, the new theory attracted sharp criticisms on the economic foundation of the theory, on its assumptions, on its practicality and the political response from foreign countries. First, the government support to an industry will use up some

[14] First-mover advantage is a concept in game theory (see, for example A. Dixit & Skeath, 1999; Gardner, 1995). Chandler (1994) relates the first-mover advantages to international trade.

government funding as well as attracting resources into the inefficient industry, where the resources would otherwise be used in a more efficient alternative industry.

Second, the new theory assumes that oligopoly firms select output quantity as the strategy for competition. For any reason, if the firms choose to compete in price, according to Grossman (1986), the industry policy implication will be opposite to what the strategic trade theory would suggest. We do know that firms behave strategically, but we do not know how exactly they behave. What strategy firms would pursue largely depends on the nature of the product, the cost structure of production and the legal environment the firms are operating. There are different models that can be applied to the situation of oligopoly market structure. It is difficult to generalise the strategic trade theory.

Third, to implement the strategic trade policy, government needs to pick the "winning industry" and "winning firm(s)". Because market conditions in the future are unforeseen, there is no guarantee the firm can pay off the government supports today and can earn an excessive profit in the future. It is even harder to pick the winning firm due to the difficulty in identifying a "local" firm in the increasing globalisation of business environment. The policy could open up industries or firms lobbying the government or even bribe government officials for government support. Even though some "winners" have been legitimately identified, the time required by the firm to gain economic profit at the cost of government support would be undefined in the face of potential entry attracted by the excessive profit enjoyed by the winner firm. In order to defend the winner firm's position, the government has to assume the relentless role to police the industry. In the content of these uncertainties, policy makers find themselves difficult to implement the strategic trade policy.

Fourth, the strategic trade policy is often criticised as "beggar-thy-neighbour' policy (Krugman & Obstfeld, 1994), which is welfare gained at the expenses of foreigners. The use of strategic trade policy could attract retaliation by foreign governments and could initiate trade wars or provide a platform for countervailing duties.

2.3 Economic Theories of Labour Migration and International Trade

International trade theories evolved from the dominant classical free trade theory into so-call neoclassical school – free trade is still the theory of the first best, although anti-free trade arguments popped up from time to time, targeting some very narrowly defined situations.[15] The neoclassical trade theory has three significant theorems. According to the first theorem, free trade improves national welfare. The worse scenario of free trade will be no improvement of welfare but will not make a country worse off from free trade. The second theorem asserts that free trade equalises factor returns. The third theorem states that small economies gain more from trade than large economies. It is the interest of this study to focus on the second theorem of the neoclassical trade theory.

Ohlin (1933) asserted that international commodity trade leads to partial equalisation of factor returns and serves as a partial substitute to international factor immigration. On the other hand, free factor movements lead to a full equalisation factor returns. One commonly used example for the substitutability argument for factor movement and commodity trade in the H-O model is that labour migration from a labour abundant country into a labour scarce country could alter the capital to labour ratios of both migrant sending and migrant receiving countries. It changes the comparative advantages of both migrant sending and migrant receiving countries in the opposite direction. In the labour scarce migrant receiving countries, increasing labour supply, while demand for labour remains constant, will have a downward pressure on the equilibrium wage. The new lower equilibrium wage will induce the use of labour on the production of labour intensive goods. Hence, the immigrant-receiving nation will be less reliant on imports of labour intensive goods. On the other hand, emigration of labour in the labour abundant countries would result in a reduction of labour supply and an upward pressure on the equilibrium wage. Higher wage would lower the use of labour, hence a reduction on supply and export of labour intensive commodities. As the result of wage convergence and the changes in composition of production, increasing the volume of labour migration decreases the volume of commodity trade. This theorem can be valid if the volume of immigration is large enough to affect a wage convergence.

---

[15] Some of the anti-free trade arguments are terms of trade and optimal tariff argument, infant industry argument, wage differential argument, increasing returns argument, national security argument and diversification argument. Root (1990) categorises anti-free trade arguments into fallacious arguments, questionable arguments, qualified arguments and sophisticated arguments. Irwin (1996) provides a comprehensive review of the development of the anti-free trade arguments.

By criticising Ohlin's assertion of trade being a partial substitute for factor movement as a weak argument,[16] Samuelson (1948; 1949) rigorously proved that free trade inevitably and unambiguously equalises the return on factors in a simplified two-countries, two-goods, and two-factors (2 x 2 x 2) model (it is known as the factor-price equalisation theorem or the H-O-S theorem). Complete factor-price equalisation via commodity trade implies that commodity trade serves as a perfect substitute for factor movement. Mundell (1957) worked along the same line of reasoning as Samuelson and explicitly stated that, under certain rigorous assumptions, the rise of trade barriers encourages factor movements, and on the other hand, restricting factor movements stimulates trade. Mundell called it the commodity price equalisation of factor movement.

According to Wong (1986), Ohlin's approach is in "quantitative-relationship sense" and Mundell's approach is in "price-equalisation sense" of substitutions between commodity trade factor movement. The corollary of these analyses leads to the commonly accepted theorem that commodity trade and factor movement are complete or near complete substitutes. However, as widely criticised (e.g. by Gould 1996 and Rauch 1999), one of the drawbacks of these theorems is the treatment of people in both sending and receiving countries as units of homogenous labour which are perfect substitutes for each other.

Nevertheless, the factor-price equalisation theorem exerted a strong influence in trade and immigration policy formation in developed countries. For example, one of the objectives the North American Free Trade Agreement (NAFTA) intended to achieve was to increase trade with Mexico in order to reduce the real wage gap between the U.S. and Mexico. It is expected that the wage convergence resulting from free trade between the U.S. and Mexico can lower the incentive for Mexican labour to migrate to the U.S. However, in spite of the endeavours to reduce trade barriers with Mexico and the establishment of border industries in Mexico along the U.S. border for the purpose of reducing the wage gap between the both sides, illegal immigration from Mexico to the U.S. is still continuing (Hashemzadeh, 1997; Martin, 1996; Rivera-Batiz, 1986). This could be reflecting the fact that immigration is not motivated purely by higher wages in the host country.

[16] Ohlin was criticised as being unclear of his position on the issue of incomplete factor-price equalisation (see Samuelson, 1948).

However, empirical tests of the theorem have produced mixed results. Leontief's attempt to test the H-O theorem with the U.S. data has given rise to the well-known Leontief paradox (Leontief, 1954). In a weaker test of the H-O model by Leamer (1984), the model performed quite well. But in a more restricted test by Bowen, Leamer and Sveikauskas (1987), the model performed poorly. A more recent study by O'Rourke and Williamson (1999) found evidence of factor price convergence after 1800 when transportation cost of international trade was substantially lowered, but found no evidence of factor price convergence before 1800. These mixed results show that the H-O model failed to predict a significant proportion of international trade in the real world. These defects of the H-O model carry forward into the H-O-S model. Furthermore, controversies arise about the realism of the factor price equalisation theorem if some of the explicit and implicit stringent assumptions are relaxed or overturned. For example, trade in non-import competing, non-substitute commodities has no effect on commodity price convergence and factor price convergence (O'Rourke & Williamson, 1999).

If the assumption of trade based on inequality of factor endowments is removed, and replaced by economies of scale differential (see, for example Dixit & Norman, 1980; Krugman, 1979), or by product differentiations (Grubel, 1967; Grubel & Lloyd, 1975; Helpman, 1975; Krugman, 1980) or by technological differences (Gruber, Mehta, & Vernon, 1967; Markusen & Svensson, 1985; Purvis, 1972; Vernon, 1966), free trade renders factor price divergence rather than factor price convergence. Ironically, economies of scale, product differentiation and technological differences were assumed to be constant across trading countries in the H-O model. Moreover, Jones (1975), Jones and Scheinkman (1977) stressed the weakness of the theorems of the factor endowment trade theory when the number of factors are different from the number of goods and when joint products are produced. Ethier and Svensson (1986) argue that the factor intensity theorem only holds when there is an equal number of factors and goods. The theorems will be slightly weakened if goods outnumber factors. If factors outnumber goods, the theorems will be significantly weakened. They concluded that factor price equalisation depends on the relative number of international markets and factors rather than the relative number of goods and factors.

If the factor price equalisation theorem is not generally applicable, then the conclusion of complete substitutability between commodity trade and factor movement requires qualification. Some research has branched off from this point, and their conclusions tend to reject the substitution and even point to a complementary effect. By holding constant the factor endowments and relaxing some of the assumptions, such as allowing technology differences between countries, in the H-O model, Purvis (1972) concluded that factor movement and trade in final goods could be complementary. Markusen (1983) innovatively demonstrate that, by assuming that the basis of trade is the inequality of technology between countries, commodity trade and factor movements are complements in the 2x2 model. The intuition is straightforward: if two countries are identical in all aspects except technology differences, opening trade leads to the high-tech country specialising in and exporting technology intensive commodities in exchange for labour intensive goods. The rise in export of technology intensive products raises the demand for capital (the demand curve for capital shifts to the right) in the high-tech country. In conjunction with the initial capital supply curve, the right shift of the demand curve raises the equilibrium price of capital in the high-tech country. The rise of capital price provides incentive to supply and attract inflow of capital. Hence, exporting capital-intensive product attracts inflow of capital – trade and factor movement are complements. The same mechanism applies in the low-tech country in the labour intensive sector. If initial labour endowment is the same across two countries, the increasing export of labour intensive goods expands the demand for labour and drives up wages. The rise of wages attracts labour immigration into the low-tech country. As a result, the export of labour intensive product and labour immigration are complements. Markusen (1983) views that the complementarities between factor movement and goods trade is rather general, and the H-O view on the substitution of goods and factor trade is rather a restricted case only when all the H-O assumptions hold at the same time.

Studies by Svensson (1984) and then Markusen and Svensson (1985) show that factor trade and commodity trade can be substitutes or complements, depending on the traded factor (defined as capital) and the non-traded factor (defined as labour) are "cooperative" or "non-cooperative", [17] and also depending on whether the demand for factors are elastic or inelastic. They conclude that if capital demand is elastic and labour and capital are non-

[17] Svensson (1984) defined that labour and capital are cooperative if the labour endowment has positive effect on capital input; labour and capital are non-cooperative if the labour endowment has negative effect on capital input.

cooperative, factor movement and goods trade are complements. If capital demand is inelastic and capital and labour are cooperative, then factor movement and goods trade are substitutes. Markusen and Svensson (1985) acknowledged that Markusen's (1983) approach may not obtain satisfactory results if technology differences are arbitrarily selected, and demonstrated that factor movement and commodity trade are complements by focusing on product augmented technology differences.

Ethier (1996) noted that the answer to the question of whether international labour immigration and commodity trade are substitutes or complements is ambiguous. He distinguished the "substitutability" into three concepts of quantity, price, and equilibrium substitutability.[18] He examined trade and immigration for models based on comparative advantage and for models based on economies of scale and imperfect competition. He argued that trade and immigration are substitutes if trading nations have different factor endowments, or heterogeneous preferences, or competition distortion. Trade and immigration are complements in all other situations including different technologies, different internal and external economies of scale and monopolistic competition market structure that gives rise to intra-industry trade. Furthermore, Gould (1996) pointed out that, when non-homogeneity of factors, such as human capital variation, different qualities of land, or different taxation polices existing across nations is considered, factor movement and goods trade may be complementary even if the other assumptions of the H-O model are maintained.

Wong (1986) modelled the relationship between international trade and factor mobility, and established the necessary and sufficient conditions for substitutability. Wong (1988) empirically tested the substitutability in a general equilibrium indirect trade utility (ITU) function using the U.S. data. He focused on the consumption effect of trade and assuming that the difference between production and consumption equals net exports. By differentiating the ITU, the net export function and the factor-price function were estimated. Wong found a general positive effect of growth in factor endowment on the growth of exports and imports. The growth of labour will encourage exports in non-durable goods and services, while the growth of capital and land will stimulate exports in durable goods. Wong

[18] Ethier's approach is similar to Wong's (1986) approach. In Appendix A, Wong grouped the existing literature at the time about substitutability into four categories: *Quantitative- sense, price-equalisation sense, world-efficiency sense and national-welfare sense*.

also found that factor movement and goods trade are complementary. The inflow of labour encourages both exports and imports, leaving the net exports unchanged. The inflow of capital stimulates exports and imports, leaving net trade unchanged over time. In Gould (1996), immigrants are modelled as a source of foreign market information for trade cost reduction. Gould (1996) performed an empirical study on the relations between immigration and trade for the U.S. Gould found that trade and immigration is generally complementary.

However, some studies support the factor price equalisation theorem. For example, empirical studies conducted by Horiba and Kirkpatrick (1983) found supportive evidence for the substitution within the USA when they disaggregated labour into age, education and race categories. Doroodian and Jung (1995) considered the issue of simultaneous relationship existing among the prices of different countries, and their empirical results provided support for the factor price equalisation. They found a long run equilibrium relationship among factor prices for trading nations. On the other hand, Aislabie, Lee and Stanton (1994) found no relationship between Australian cultural diversity and Australian export growth, but Head and Ries (1998) found that immigration worsened Canada's trade balance.

The complementary relationship between international factor immigration and international trade is now well established and is being accepted by the profession. The question that is of interest in this study is whether immigrants play a role in reducing search cost of business information and whether lower information costs stimulate international trade. In order to pursue this research question, the remaining sections in this chapter intend to establish the linkage between immigrants and international trade by reviewing the relevant literature. By reviewing the sociological literatures in the field, Section 2.4 investigates the arguments that immigrants have emotional connections with their home countries. Section 2.5 suggests that immigrants have social contacts with friends and relatives in their home countries and perform the function of passing information between the home and host countries. Section 2.6 examines the entrepreneurial drive of immigrants and their possible involvement in business activities with their home countries through their personal connections. Section 2.7 discusses the welfare effects of immigration.

2.4 Social Capital and Immigration

This section makes use of the concept of social capital from social economists' view and presents the argument that immigrants bring in social capital to the immigrant receiving countries. Before we explore the concept of social capital, we look at the individual in the economic system.

Economists have followed the doctrine of self-interest of individuals as laid down by Adam Smith.[19] In regarding to economic modelling, economic agents are predominantly assumed to be rationally acting for their own best interest – utility maximisation. However, it is not uncommon for altruistic behaviour to be observed. For example, social security system of a country to help the poor is an altruistic act of the society. Parents' invest in children's education is the altruistic act of the parents. Volunteer fire fighting is also altruistic. Altruistic acts benefit others at altruists' own costs, sometimes even detrimental to themselves. Even Adam Smith acknowledged the existence of altruism seventeen years before the publication of *The Wealth of Nations*.[20] The selfish assumption for a rational economic agent is sometimes criticised as empirically inaccurate (Quiggin, 1987). An altruist does not necessarily reduce personal wellbeing (Becker, 1974), or even has greater consumption than egoist (Becker, 1976). Pareto optimality in public finance might be achieved through income redistribution if one agent is altruistic (Hochman & Rodgers, 1969).

Some generosity or altruistic behaviour was unintentionally revealed in the economic experiments for structured Ultimatum Bargaining Games by Güth, Schmittberger and Schwarze (1982). Similar results were also observed by Kahneman, Knetsch and Thaler (1986). In Kurz (1978), altruism is viewed as an outcome of social interaction.

Social interaction with altruistic agents generates the basis for the concept of social capital, which was introduced by Coleman (1988). The essence of the social capital concept

[19] According to Adam Smith, (1937) butchers, brewers and bakers who provide supplies for our dinner do so not because they intend to look after us, but for their own interest.
[20] In his opening sentence of The Theory of Moral Sentiments (first published in 1759), Adam Smith (1976, p. 47) said, "How selfish soever man be supposed, there are evidently some principles in his nature, which interest him in the fortune of others, and render their happiness necessary to him, though he derives nothing from it, except the pleasure of seeing it." Later economists considered "the pleasure of seeing it" as part of the person's utility.

consists of trust, cooperation and association within a group (Knack & Keefer, 1997), and the value of social obligations or contacts is formed through social networks (Johnson, 2000). The necessary conditions for the creation of social capital are social network connection and social interaction.

Social capital can be an asset, which generates other forms of capital and economic benefits. Coleman (1988) presented an example of social capital in the creation of human capital. Rauch (1996) investigated the effects of social capital on the success of Japanese trading houses in a close-tie network system. Rauch (1999) found that less standardised products or differentiated products are traded better in a network system. It is well recognised that trust (as a form of social capital), can raise economic benefits by facilitating economic activities. As Arrow (1972) stated, every commercial transaction has the element of trust. For example, the use of fiat money as a national currency is the trust of the nation's general public place on their government. The issue of credit cards is the trust the financial institutions place on their clients. The credit terms a supplier awards to its buyer is the trust of the business relationship. Employees are paid at the end of the pay period because of the trust employees place on their employer. A society with lack of trust renders a backlash on economic activities and hinders economic development. Trust is stronger in a society with closed ties within family or religious affiliations.

The accumulation of social capital, like the accumulation of any other form of capital, requires a considerable time and cost. A person who has accumulated social capital is like the person who has accumulated "credit slips". Social capital accumulated by individuals in the group creates a pool of social obligations for cooperation and for mutual benefit. The "credit slips" provide their owners the right to draw social obligations from the "pool" upon request. The "credit slips" are geographically boundless and can be "carried" by the owner and are honoured as long as the social network connections are maintained. Since social capital is intangible and is only associated with its owners, it will be carried away when the owner moves from one social circle to another.

Schiff (1998) argued that immigrants take away social capital from their country of origin and "deposit" social capital in the immigrant receiving country. The stock of social capital accumulates in the immigrant receiving country as the stock of a particular ethnic immigrants increase. However, Schiff asserted that social capital associated with immigration in the immigrant receiving country is affected by two opposing forces: immigrant social capital increases at a decreasing rate; natives become less hospitable due to native social capital diluted by foreign social capital. As a result, social capital in the immigrant receiving country initially increases but will decrease as immigrant stock increases. The opposing forces on immigrant social capital in the immigrant receiving country also affect the immigration pattern. Immigrant inflows initially increase as social capital built-up, and then immigrant inflows will decrease as average social capital declines. This decline of immigration due to social capital reduction can be viewed as a crowding out effect; the growing immigrant stock crowds out the incentive for further new immigration. The time pattern of immigration which refers to the initial increase in immigration, then followed by a decrease in immigration, is called a "migration hump" by Martin (1996).[21] The immigration hump could be the result of the pattern of immigrant social capital hump. Schiff explained the result of the 1993 Latino National Political Survey, which revealed that 65 percent of Hispanics living in the US prefer a reduction of further Hispanic immigration. Schiff's argument can partly explain the phenomenon of waves of immigrants from ethnic groups, for example, Italian, Vietnamese and African immigrant waves in Australia. However, it raises the questions of what determines the turning point of the "hump" and when the hump occurs.

We argue in this thesis that if immigrants maintain social connections with their home countries, the social capital they bring to the host country could provide economic benefits in the form of raising business activities between the host country and the home country. In order to establish the argument that immigrants maintain contact with their country of origin, Section 2.5 reviews the literature on immigrant networks.

2.5 Immigrant Networks and Information Flows

The study of immigration involves the study of three components: the sending community that is the community that remains behind in the migrant sending countries, the receiving community that is the community in the migrant receiving countries, and the immigration

[21] Martin (1996) explained the migration hump as a result of the difference between countries in the following factors: technology differences, productivity differences and economies of scale differences. The migration hump is also attributed to the slow adjustments to the changes by countries, imperfect competition and the financial risk strategies pursued by migrants.

units that are the migrants themselves. The three components are often studied in isolation, with a substantial concentration on the immigration motivation of the immigration units and the effect of immigration units on the receiving community. The effect of immigration on the sending communities have received relatively less attention, however, the issue of "brain drain" often attracts discussions on the topic.[22] Nevertheless, it may be more useful to conceptualise the study of immigration as the study of a single network system, in which the sending community and the receiving communities are connected by the immigrant units (Taylor, 1979). Mabogunje (1970) viewed that immigration is a dynamic network engaging the sending and receiving communities simultaneously. It has been observed that many ethnic groups who are living outside their countries of origin create formal or informal associations (Rauch & Trindade, 2002). According to Massey (1988), immigrant networks are sets of interpersonal ties formed by kinship, friendship and shared community of origin, which are connecting the immigrants settled in the receiving countries, the prospective immigrants and the community left-behind in the sending country.

Portes (1995) described immigrant networks as an important source of social capital. The input of social capital in the network system performs the important functions of short-term adaptive assistance such as providing low-cost information about housing, employment, and survival strategies to potential immigrants as well as emotional support to newly arrived immigrants. The networks serve as mechanisms for interpreting data and feeding information and other resources in both directions (Gurak & Caces, 1992) and for the flow of the reciprocal exchange of goods, services and economically valuable information (Lomnitz, 1976).

The strength of the immigrant networks is associated with the timing of immigration and the type of immigrants. According to Campbell (1992), the immigrant networks are stronger if the immigrants came at a time when few public services were available and immigrants access to capital was limited in the receiving country. The harsh environment urges immigrants to form organizations to cope with unemployment and discrimination. If

[22] Grubel and Scott (1966) refer "brain drain" as the emigration of the country's highly skilled persons that lowers the country's total per capita endowment of human and physical capital. Adams (1968) described "brain drain" as the loss of a vital resource without compensation. The "loss" not only refers to the loss imposed on the sending country, but in a broader sense, the loss of efficiency of the total human capital. The loss of human capital efficiency is due to the movement of the human capital from a low capital-labour ratio country where human capital can make greater contribution to human welfare, to a high capital-labour ratio country where human capital is already well supplied.

immigration is predominately the movement of individuals and the immigrant stock grows at a slow pace, the immigrant networks tend to be weaker than in the situation where immigration is based on the movement of social units such as the whole family. According to Grieco (1998), immigration of social units, such as family or chain immigration, would encourage so called "strong ties" in the immigrant networks.[23] However, family immigrant networks and community immigrant networks are substitutes. Once community immigration networks are well established, family immigrant networks become less important (Winters, De Janvry, & Sadoulet, 2001).

Networks provide an informal information channel for the flow of certain types of information. Information can be classified into source information and interactive information (Poot, 1996; Ralston, 1983). Source information is often one-way mass communication, targeting a specific audience by the information source. The matter of what message is communicated and who are the target audience are controlled by the information source. Source information reaches the target audience through the formation of information channels. On the other hand, interactive information is multi-dimensional, non-audience specific and uncontrollable by the information source and often communicated through informal channels such as networks. For example, word of mouth spreads around through a "grape vine" serving the purpose of the person who spreads the information, which is uncontrollable. Persons who do not have the network connection to the "grape vine" are not likely to receive the information. In the marketing literature, it is often argued that world of mouth from opinion leaders is a powerful and cost effective way of communication. Information is even better absorbed and retained when vocabulary and dialects are close to everyday language (Fawcett, 1989). The power from the effective information flown through the networks is known "the strength of weak ties" (Granovetter, 1973).

The strength of the effect of weak ties on international trade in differentiated products are investigated by Rauch (1999) and Casella and Rauch (2002). In the situation where the source information about product characteristics and quality is cumbersome for buyers to process, their prices become ineffective and insufficient to signal relative scarcity, and the trading of those products on organised exchanges (such as the stock exchange) becomes

[23] Granovetter (1973) described family networks as "strong ties" and community networks as "weak ties".

inefficient. They are more likely traded through distribution channels where middlemen match sellers and buyers to reduce the information barrier and search costs, resulting in trading through networks rather than on organised markets. Rauch's study profoundly supports the argument of the importance of networks in international trade. However, the effects of networks will be even more significant for trade if services such as tourism and education are considered.

2.6 Immigrant Entrepreneurship

Sociological studies of both social capital and immigrant networks acknowledge the role of immigrants in linking host and home countries through information flows. It can be assumed that market information can also be exchanged via such links. This section focuses on the issue of whether immigrants are astute enough to realise their peculiar position in bridging the information gap and be able to capture the opportunities.

Casson (1982) showed that, to be successful, it is essential that an entrepreneur has the characteristics of constant information alert, willing to take risks and be able to put a business plan into action to capture the benefits when opportunities arise. In relating immigrants to entrepreneurship, it can be argued that, compared to non-immigrants in their home country, immigrants are relatively more willing to take risks as they demonstrate that they are prepared to live in an unfamiliar country. They are also more active in searching new opportunities to locate their ideal destination. Once immigrants settle in the host country, they could compare the differences between the host country and the home country. Those differences could represent business opportunities for immigrant entrepreneurs. However, the business opportunities may not be identified by non-immigrants and hence the presence of the information gap. By identifying the information gap, immigrant entrepreneurs are in a better position to discover new business opportunities.

The questions that may arise here are that whether the characteristics of risk bearing and information seeking in relating to immigration decision are also carried over to entrepreneurial drive for business success, and whether immigrants are more astute in putting business plans into action. It is difficult to establish a direct link between risk taking and information seeking for immigrant decision and risk taking and information seeking in business activities since it is largely attributed to the difficulties of unveiling immigrant individual's internal information. It is also difficult to prove that immigrants are more astute in running a business than non-immigrants. However, we can speculate that since immigrants can identify the information gap, and immigrant networks can facilitate the flow of goods and services, immigrants would have certain advantages over non-immigrants for a head start in certain areas of business.

In Australia, immigrant entrepreneur literature often presents the cases of Asian immigrants establishing trading activities with their home countries, or immigrants representing their Australian employers to develop overseas markets (see Lever-Tracy, Ip, Kitay, Phillips, & Tracy, 1991; Rod & Webster, 1995; Strahan, 1990; Strahan & Williams, 1988). The nation-wide survey in Johns *et al* (1974) reviewed that immigrants are more entrepreneurial than Australian born.[24] The business survival rate of immigrants was also higher (Strahan, 1990). In the U.S., for every decennial census between 1880 and 1980, the data revealed a higher rate of immigrant self-employment than natives (Light & Rosenstein, 1995). Razin (1993) and Razin and Light (1998) found that immigrant entrepreneurs view trading activities as their labour market niche. Chin *et al* (1996) presents the case of the Korean immigrant import-export business in the U. S. wig industry. The success of the wig trade for the Korean immigrants in the U.S. is characterised as opportunities seized by Korean immigrants and their strong connection with the wig manufacturers in Korea. The connection provides strength to Korean immigrants with initial business opportunities, trading experience and financial advantage for competing against wig imports from other countries. The strength also equips Korean immigrants to operate in relating industries and remain in the trade activities even after the wig market declined. Most of those trading activities take place within the family, between siblings and relatives, amongst people from the same region of origin and on personal recommendations. Those trade links are largely non-contractual relationships based on trust. Trust is even more important in overseas Chinese business networks (East Asia Analytical Unit, 1995; Rauch & Trindade, 2002; Redding, 1995; Weidenbaum & Hughes, 1996).

[24] The survey in Johns *et al* (1974, p.74) reveals that 21% of the respondents are foreign-born chief executives. Comparing 20% immigrant stocks in Australia at the time, we can infer that immigrants are more entrepreneurial.

Castles (1991) observed the growth of ethnic small business in Australia and studied the entrepreneur drives of immigrants. According to Castles, the major factor leading to immigrant entrepreneurship is employment disadvantage. This disadvantage arises from labour market segmentation by ethnic origin and gender. It was reinforced by the selection mechanisms based on language proficiency. Immigrants are further disadvantaged in the labour market by non-recognition of credentials and employers' unwillingness to provide training. Castles (1991) concluded that the growing number of immigrant entrepreneurs in Australia are more relating to outside factors, such the environment immigrants live in, than the intrinsic entrepreneur drives of immigrants.

2.7 The Welfare Effects of Immigration

The welfare effects of labour immigration on the immigration source country, the destination country and the world as a whole were not explicitly shown in Heckscher (see Flam & Flanders, 1991), Ohlin's Ph. D. dissertation (see Flam & Flanders, 1991) and Samuelson (1948; 1949). They limited their analysis to factor price equalisation resulting from factor movement. According to Heckscher, complete factor mobility inevitably equalises the absolute factor prices throughout the world. Any factor price difference would present an incentive to move production factors from a low priced to a high priced region. Heckscher did not distinguish capital and labour, and viewed that all factors of production would behave in the same way if perfect mobility were assumed. However, Ohlin was less straightforward in this issue. Ohlin viewed that factor movement, at most, only achieves a tendency to equalise factor return. To support his view, Ohlin discussed the mobility of labour and the mobility of capital separately, and put forward the argument of so-called "psychic cost" as an impediment to free labour immigration.[25] Although Samuelson fiercely attacked Ohlin's use of the words of "tendency", "partial" and incomplete" in factor price equalisation of trade as a flaw of the innovative theory, Samuelson (1948) agreed that even if factors of production are mobile, immigration occurs only up to a certain degree. To achieve full factor price equalisation, free trade of goods is required.

[25] Similar to his incomplete factor price equalisation of trade (which was attacked by Samuelson (1948)), Ohlin has never been able to free himself from the reality of the cost associated with goods movement and the costs associated with factor movement. This constraint has shown up on his conclusion that factor price equalisation of trade is only a "tendency" rather than an "inevitable".

In the HOS framework, factor movement alters the factor proportion of production inputs for both countries in the opposite direction, resulting in the optimal output combination moving along the production possibility curve (PPC). Gould's (1996, p.18) insight in this issue led him to conclude that as long as countries are not completely specialised in production of one good, factor movements between countries will affect the composition of products produced without affecting the welfare of the factor owners. Immigration will not create winners and losers because the marginal products of all factors are assumed constant if both countries are not completely specialised in production. Constant marginal product implies no factor prices change when immigration takes place.

However, in a study focussing on the effects of factor movement on trade in the HOS framework by Mundell (1957), factor immigration not only has the effect on the change of product composition of both countries but also shifts out the PPC in favour of the sector of the economy that intensively uses the growing factor of production from immigration. Although Mundell made no reference to the welfare effects of factor immigration, the shifting out of the PPC in his model implies welfare gained from factor immigration to fuel economic growth.

Labour immigration contributes to population growth. In natural resource rich counties like Australia, according to Barro (1990, p. 239), population growth has an uplifting effect on the aggregates of capital, output, consumption and work effort. The steady state of the economy, when capital, output and consumption are assumed constant, does not hold with immigration. Economic growth becomes dynamic and the steady-state growth could be reached[26].

One of the earliest works on the economic welfare effects of labour immigration was Berry and Soligo (1969) neoclassical partial equilibrium analysis on short-run effects of emigration. In the presence of diminishing returns on marginal product of labour, Berry and Soligo compared the incomes before and after emigration in an oversimplified model and found that there is a net income triangle loss. Clarke and Ng (1993) and Peter and Verikios (1996) extended the Berry and Soligo model of emigration into the welfare effects of

---

[26] A steady state of the economy is the situation where the growth rate of the economy delined over time and then settled at zero rate of growth. A steady state growth of the economy is the situation where the growth rate is constant (without approaching zero).

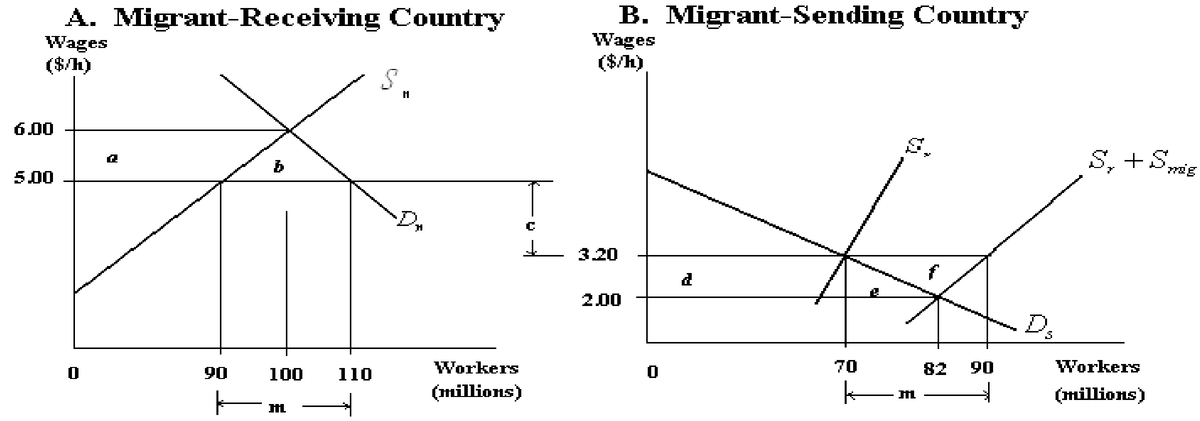
immigration (see, for example, Clarke & Ng, 1993; Oslington, 2001; Peter & Verikios, 1996). Applying the same assumption as in Berry and Soligo, with allowing immigration of labour but capital is fixed in a short run, increasing labour supply will reduce the marginal product of labour. In a competitive economy, if labour is paid the value of their marginal product, then wages will decline in line with the decline of the marginal product of labour. Non-immigrant workers (suppliers of the labour service) in the immigrant receiving country are hurt by the decline of "supplier surplus" due to wage reduction, while employers (users of the labour service) will gain a greater "consumer surplus". Since the consumer surplus gain is greater than the supplier surplus loss, a net welfare triangle gain is generated for the economy.

However, the above models only analyse the welfare effects on immigrant sending country and immigrant receiving country in isolation. A more comprehensive analysis is presented in Pugel and Lindert (Pugel & Lindert, 2000, pp.583-584) where they model the labour market and the welfare effects for both countries simultaneously. Their model is reproduced in Figure 2.1 below (Figure 2.1 consists of Graph A on the left and Graph B on the right).

In the Pugel and Lindert model, labour is homogenous with upward sloping supply curves for both countries. In the receiving country (refers to Figure 2.1 A), the arriving of immigrants increases the quantity of labour stock *m* workers and bids down the wage rate from \$6.00 to \$5.00. Facing a decline of wages, some workers in the immigrant receiving country drop out of the labour force and the vacancies can be filled by new immigrants. The dropped out workers incur a welfare loss that is equal to the amount shown by area *a* in Figure 2.1A. Employers gain from a greater supply of labour at a lower wage cost. Their gain consists of the areas of *a* and *b*. The employers' gain is unambiguously greater than the workers loss and the immigrant receiving country experiences a net welfare gain of *b*. The net gain of *b* which Pugel and Lindert have identified is greater than the welfare triangle which was described in Clarke and Ng (1993) and Oslington (2001).

On the other hand, in the sending country (refer to Figure 2.1 B), the departure of immigrants reduces the labour stock of *m* workers. The labour supply curve shifts inward and become less elastic. This change raises the wage rate for the remaining workers from \$2.00 to \$3.20. Those workers experience a welfare gain, which is equal to *d*. However, employers lose as they suffer from a shrunk labour force and a wage rise. The welfare loss to the employers is the areas of *d* and *e*. The employers' loss is unambiguously greater than the workers' gain, resulting in a net loss to the immigrant sending country.

Figure 2.1 Labour Market and Welfare Effects of Immigration



Source: Pugel, Thomas A. & Lindert, Peter H., (2000), *International Economics*, 11th edn, McGraw-Hill, Boston, p.584.

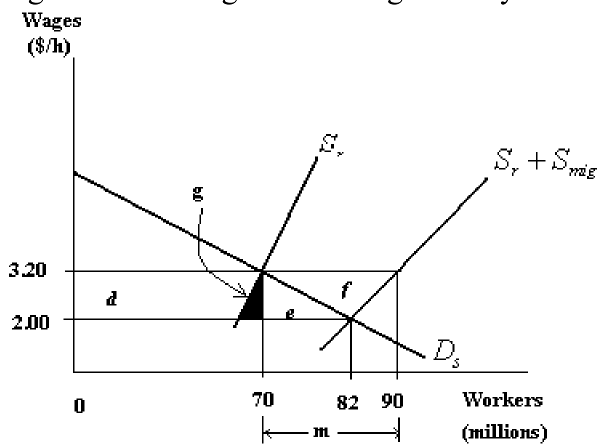
For immigrant workers themselves, the attraction to leave the sending country is the wage rate of \$6.00 in the receiving country comparing to their current wage rate of \$2.00. They actually get \$5.00 per hour of wage once they reach the receiving country because the increasing supply of labour exerts downward pressure on the wage. The \$5.00 wage rate they get is worth only \$3.20 to them. The difference of \$1.80 represents the "psychic cost" of moving them from one country to another. The welfare gains for the immigrant workers by the wage rise from \$2.00 to \$3.20 sum up to areas *e* and *f*. However, the areas of gain by the immigrant workers of *e* and *f* are presented in Figure 2.1 B, but the gains do not accrue to the immigrant sending country since the immigrant workers have already left the country.

The welfare effects on the receiving country, the sending country and the immigrant workers can be summed up as: a net gain of *b* for the receiving country, a net loss of *e* for the sending country, and a gain of *e* and *f* for immigrant workers. For the world as a whole, the gain of *e* for immigrant workers is cancelled out by the loss of *e* to the sending country and hence a net gain of *b* and *f* for the world. Since *b* and *f* are non-negative, the Pugel and

Lindert model of labour immigration warrants monotonic welfare improvements for the receiving country and for the world at large.

However, the model in Pugel and Lindert only considers the change of elasticity of supply of labour in the immigrant home country after emigration but did not consider the shift and the change of elasticity of the labour supply curve in the immigrant receiving country after immigration. The model also fails to recognise an area of dead-weight loss in the immigrant sending country under the new labour supply curve (S_r) after emigration. The deadweight loss represents the increasing labour costs to the employers in the immigrant-sending country in order to attract the additional labour supply after migrants left the country. The area of dead-weight loss is the shaded triangle in Figure 2.2 below. If the shaded triangle is labelled *g*, then the world welfare improvement due to free immigration is the amount equivalent to area $b + f - g$. Although the immigrant receiving country still obtains the same gain from free immigration, the impact on world welfare become ambiguous which depends on the relative magnitudes of $(b + f)$ and $(- g)$.

Figure 2.2 Immigrant-Sending Country's Dead-Weight Loss



Policy makers are more concerned with the net economic well-being improvement of the existing population in the country as a result of new immigrants, since the welfare effects on the immigrants themselves can be self-explanatory from their intention to migrate (Clarke & Ng, 1993; Peter & Verikios, 1996). The welfare improvement of area *b* in Figure 2.1A provides a case of free immigration to the policy makers. Withers (2003), and Clarke and Ng (1993), among others, are the strong advocates of net welfare improvement as a result of immigration. Jolley (1971), and Tian and Shan (1999) found that Australia's aggregate income was raised by post-war immigrants.

If immigrants benefit the receiving country, another issue of concern for policy makers is whether they should be more interested in aggregate welfare improvement or the per capita welfare improvement (Clarke & Ng, 1993; Jolley, 1971; Peter & Verikios, 1996). The fear of depletion of resources as a result of population growth leading to the decline of standards of living becomes a stronger argument against immigration. As Clarke and Ng (1993) criticise, such fears are the revisit of the pessimistic ancient theories of population growth of Malthus, Ricardo and Marx. The pessimistic views of population growth do not stand up empirically (Barro, 1990) since they fail to consider technological progress and productivity improvement. For the last two hundred years, the world population has increased but the overall standard of living has been improving rather than declining – life expectancy increased, death rate declined and per capita food production grew faster than population growth (Clarke & Ng, 1993). The empirical evidence supports the "steady-state growth" theory in which a good combination of growing labour and capital maintains the growth rate from declining (Barro, 1990). The steady-state growth in the long run could be an explanation why a number of empirical studies did not find a negative statistical relation between immigration and unemployment (see Pope & Withers, 1993; Shan et al., 1999; Tian & Shan, 1999; Withers & Pope, 1985) and between immigration and wage decline (see Addison & Worswick, 2002; Pope & Withers, 1993; Withers, 1986). Chao and Yu (2002) and Oslington (2001) found that certain types of immigrants can achieve *Pareto-superior* welfare improvement for the receiving countries.

2.8 Conclusion

The development of the international trade theory gravitates to free trade and the mainstream trade economists believe that free trade in goods and services is the "first best" to improve the welfare of trading nations. However, free trade in factors of production is viewed as a substitute to free trade of goods and hence it is less preferred, although this view is not shared by some economists.

There is no shortage of models advocating welfare improvements as a result of immigration by those who question the orthodox view of Heckscher-Ohlin-Samuelson. However, as Gould (1996) pointed out, the studies in this area had been causal speculations. Gould (1996) provides a general model that shows that the existence of immigrants in a country can reduce the gap for foreign market information, and trade between immigrant host country and the immigrant home country can be facilitated by immigrants. However, the model is *ex-post*, that is, the model demonstrates the existence of the effects of information facilitation by immigrants while it assumes that the effects exist.

The question of how the information gap can be reduced by immigrants remains unanswered and it is the task that this study expects to carry forward. Before we investigate the role of immigrants in bridging the gap between buyers and sellers in the international market (in Chapter 4), we briefly review the history of Australia's immigration in the next chapter (Chapter 3) with a focus on the East Asian immigration and Australia's trade with Asian countries. We intended to search for evidences to support the notion advocated in Chapter 2 that labour immigration and trade are not necessarily substitutes.

Chapter 3 EAST ASIAN IMMIGRANT INFLOWS INTO AUSTRALIA AND AUSTRALIA - EAST ASIA TRADE: AN HISTORICAL OVERVIEW

3.1 Introduction

In Chapter 2, we reviewed the literature, which holds the novel view that immigration complements trade to a certain extent. In this chapter, we intend to look into the historical evidence to investigate whether this novel view can be supported by the case of Australia's immigration history.

Australia has been an immigrant country and is one of the four major immigrant-receiving countries. The other three are the U.S., Canada and New Zealand. Australia's immigration history dates back from the first White settlement in 1788 and has continued up to the present. Waves of immigration flowed into the country coinciding with the changes in its economic conditions as well as the immigrant sending countries' economic and political conditions. Australia's major immigrant source countries gradually shifted from Western Europe to East Asia. Coinciding with this shift of the significance of immigrant source, Australia's major trading partners also gradually shifted from Western Europe to East Asia. By the year 2001, six of the top ten Australian trading partners were Asian countries (Department of Foreign Affairs and Trade, 2002).

In order to understand the history of Australia-Asia immigration and trade relations, Chapter 3 is organised in the following way: Section 3.2 discusses Australia's Asian immigration policy and the overall Asian immigration history. Section 3.3 presents a brief immigration history for the major East Asian immigrant source countries. Immigrants' demographic patterns are also included to provide some primary information. The trade data with those East Asian countries are paired with their immigrant intake data to illustrate the relations between the two sets of data. Section 3.4 concludes the chapter.

3.2 An Overview of Australian Immigration History and Policy

3.2.1 Pre-Federation Immigration Policies

The background of colonising Australia can be traced back to the conditions in the UK in the 1780's. England then was characterised with a mountain of national debt and severe economic depression as a result of the end of the Seven Years War against France in 1763 and then the war to bring down the American Revolution (1775-1783). Hyper-unemployment bred criminals in the UK. Stiff laws and severe penalty systems (even those who found guilt of stealing a loaf of bread were sentenced), caused convict congestion in jails. By the time the British considered the need for peace and to end the war in 1783, America was no longer the place to exile convicts. King George III looked to Australia as an alternative to solve the convict problems. With that mindset, the initial Australian immigration policy set by the British government was to treat Australia as a "jail" or a "convict colony".

Starting in 1778, convicts sentenced to transportation, guarded by soldiers, were the first immigrants to arrive in Australia, at the British government's expense. The practice of transporting convicts to Australia lasted for 65 years and the last shipment of convicts arrived in Tasmania in 1853. Within those 65-years, the immigration policy had gradually shifted away from convict colonisation to systematic colonisation.

In 1819, Commissioner John Thomas Bigge was appointed to investigate the possible changes of the colony to serve the British interests better. Bigge's vision for the colony was a free enterprise society rather than a jail. The success of the enterprise can be achieved by combining the capital brought in by free settlers and the cheap convict labour force. In the 1820's, the immigration policy changed to adapt Bigge's suggestion. Free immigrants, mainly men, were attracted to the colony by the British government's free land grants, provided that immigrants need to bring their own capital to develop the land. A few years after, the free land for free immigrants[27] program was modified to land sold to free immigrants at a very low cost.[28]

[27] The term "free immigrants" means immigrants with free status, in contrast to convicts.
[28] The source of information for this section is from the World Book Encyclopaedia, 1999 CD-ROM.

The slow but steadily increasing inflow of free immigrants with capital soon absorbed the convict labour. The momentum of free immigration was accelerated by the vast opportunity provided by the cheap land. The farm sector grew rapidly. The down side was that the rapid growth of the farming sector of the economy soon drew away the labour supply from all other sectors of the economy. The growth of the farming sector caused the decline of the other sectors, which can be described by the Rybczynski effect. Experiencing severe labour shortage, employers turned to recruit labourers from Britain under the indenture system. This created another class of free immigrants in Australia.

3.2.1.1 Systematic Colonisation

In addition to the problem of labour shortage, high proportion of convicts and severe imbalance of gender with males greatly outnumbering females in the society was also a major concern for the moral standard of the colony.

In 1829, Edward Gibbon Wakefield introduced the concept of *systematic colonisation* in his *Letter from Sydney* pamphlet and then another pamphlet *England and America* in 1833 (Atkinson, 2001). Wakefield proposed that instead of allowing the colonies gradually developed by convicts labour with free immigrant capital, Britain should actively assist free immigrants to provide labour supply. The assisted immigration program could be funded by money collected from selling land rather than granting land almost for free. He agreed that a perfect community could be established by proper management of the immigration program (Atkinson, 2001).

In 1831, the British government introduced the system of assisted immigration to the colonies by adopting Wakefield's model. South Australia that was created by free immigrants in 1836 was an example of the Wakefield model of systematic colonisation.

3.2.1.2 Free Female Immigrants

In addition to assisted free immigration policy, the colonial governments also actively recruited young, unmarried women to Australia since there was a severe shortage of farm and domestic servants and severe shortage of wives. Up until the 1830's, the colony was mainly formed by convicts, soldiers, explorers and free men. It was natural that there were fewer female criminals than male criminals. According to Oxley (2001), there were 162,000 male prisoners transported to Australia, in contrast to 25,327 female prisoners. It was also natural for more risk-taking men than women to migrate to an extremely harsh, undeveloped new colony. The 1828 census of New South Wales showed that there were four men to one woman (age 12 and above) (Atkinson, 2001). Due to the shortage of women in Australia, many men remained single. In Australia, women were married younger and bearing more children than women in England. Convicts tended to be less inclined to be bound by the standard tradition of family life. There was a high rate of illegitimate children born to parents who were not legally married ("The World Book : Multimedia Encyclopedia," 1999).

In addition to the moral standard concern in the colony, the importance of women in the success of colonisation was also expressed by Wakefield. He wrote that 'in colonization, women have a part so important that all depends on their participation in the work. If only men emigrate, there is no colonization; if only a few emigrate in proportion to men, the colonization is slow and most unsatisfactory in other respects: an equal emigration of the sexes is one essential condition of the best emigration' (Oxley & Richards, 2001).

In order to attract women to migrate to Australia, the colony provided free passage to those who matched the criteria set by the colonial governments, that is, they are young, single English women, they are trained in domestic and/or farm service and are 'respectable' persons. Despite the efforts of the English government and the colonial governments to recruit single women, the quotas remained less than full. The standard, however, had been compromised to include non-English girls. Irish girls who could speak English also recruited. However, the gender imbalance was yet to be corrected. Then, the immigration policy shifted to those who were from the remote and poorer areas of Ireland, and those who have not been trained in farm or domestic service was also recruited. At some stage, even those girls who could not speak English were also shipped to Australia.

With the rapid expansion of the colonies in Australia the labour force experienced hunger. The promising opportunities continued to attract more men than women to the colony. The gender imbalance problem persisted. By the time of the gold rush in the 1850's, there were still about three men to one woman in the colony of Victoria.

Throughout Australia's immigration history, this pattern of shifting immigration policy from the more restricted measures to less restricted measures, repeated in different waves of immigration.

3.2.1.3 Labour Force Recruitment

In a closed economy, the growth of the sector of the economy that intensively uses its abundant resource endowments will negatively impact on the other sectors of the economy by attracting scarce resources into the growing sector to work with the abundant resource. Australia in the early settlement period was a good example of the well-known Rybczynski effect with farm sector's growth drying up labour supply for the other sectors. However, in an open economy, the pressure can be relieved by importing labour from overseas.

The growth of the farm sector contributed by the free immigrants with capital soon saw an inadequate supply of convict labour. After searching for a new source of labour supply, Wakefield suggested to source labour from the over populated China to provide indentured labour to develop the colony of South Australia. Although this suggestion was rejected by the British and colonial governments, some New South Wales employers managed to bring in several shiploads of labourers from India, China and the Pacific Islands for termed contracts at very low wages (an early version of modern guest workers). However, since those Asian labourers were paid extremely low wages, employers were soon met hostility from settler workers. The best permanent solution appeared to be the recruiting of non-convict labour from the UK. It opened up a new page of assisted immigration in Australia's history.

A large scale of free, assisted immigrants poured into the colony from the early 1830's. There were two administrative systems for recruiting assisted immigrants, the government system and the bounty system. Under the government system, respectable potential immigrants were attracted by governments' incentives such as free passage and organising the transporting of family belongings. In order to ensure that the assisted immigrant program was recruiting workers for Australian employers, land was no longer granted for free immigrants. Government was responsible for recruiting, screening, and bringing the immigrants to Australia. Under the bounty system, money was granted as a bounty by the governor of the colonies to any settlers who assisted in the immigration of a skilled person to the Australian colonies (Delbrdige *et al.*, 1999). Recruiting under the bounty system was largely conducted by British ship owners. Employers preferred the bounty system than the government system because the government was accused for carelessly recruiting immigrants who did not meet the required standards.

British ship owners stepped into the business of finding workers for Australian employers. When the supply of immigrant workers from England was lower, ship owners moved to Asian countries for the cheaper supply of workers. They were responsible for bringing in massive shiploads of Indian and Chinese coolies as slave labourers for Australian employers. Driven by poverty, uneducated peasants in Southern East China were lured by false promises, indentured under unfair contracts with Australian squatters and mining companies. Some of those coolies were even kidnapped by their own countrymen, and then sold to the ship owners for transporting to Australia (Evans, 2001; Godley, 1992). Those shipowners got around the legal loopholes in both the labour source countries and in Australia. They opened up a new page of immoral slavery coolie trade in Australia's immigration history and laid down the foundation for potential ethnic conflicts in Australia.

Mass protests in China and also by Australian workers, in conjunction of the negotiation British and Chinese governments brought the end of the coolie trade. However, the influx of Chinese into Australia had not been slowed, and coolies were replaced by free immigrant workers.

The presence of cheaper coloured workers triggered the anti-Asiatic campaign, and led to a broader discrimination against all non-white people in Australia. It took five decades (1850's – 1901) for the growth of ethnocentricity against non-white to the historical milestone of White Australia Policy at the birth of the Australian Federation.

3.2.1.4 The Rise of the White Australia Policy

The scale of Asian immigration was insignificant until the late 1840's when the rapid expansion of the farming activities caused severe shortage of labour. Squatters and employers were forced to turn to over populated Asian countries for labour supply. British colonist James Mario Matra in 1783 suggested to the British government to use Chinese labour to develop the Colony of Australia. Edward Gibbon Wakefield (1796-1862) suggested that instead of allowing squatters to develop pastoral freely, the New South Wales colonial government should sell the land to squatters for development. The income from selling land will be used to assist people in England who would like to migrate to New South Wales. He also suggested pairing Australia with over-populated China to provide labour resource for the nation's development (Wang, 2001). However, the Chinese (the Qing) government had closed the border for trade and emigration. Any Chinese who left the country unauthorised could attract capital punishment when they returned home.

New opportunities opened up for the squatters and employers soon after signing of the Sino-British Treaty of Nanking in 1842 when the Qing was forced to open up Chinese inner ports for trade and also to allow free labour movement. The first shipload of Chinese coolies arrived in Sydney in 1848. Within three years, the Chinese population steadily climbed up to 1742 (Wang, 2001). Then, it was the gold rush that sought a massive influx of Chinese labour in Australia and hence promoted racial conflicts between white settlers and the Chinese "guest workers".

The first shipload of Chinese miners arrived in the newly separated colony of Victoria in 1853 (Knott, 2001). The rapid growth of Victoria during the gold rush caused the Victorian colonial government to conduct three censuses between 1851 and 1861. The 1854 census showed that there were 2,373 Chinese in Victoria. By 1857, the census recoded 25,421 Chinese (Jupp & York, 1995). The number of Chinese miners was at its peak in 1856, when there were about 34,000 of those in Victoria alone, which made up 20 percent of all Victorian gold miners (Knott, 2001). In the colony of New South Wales the government statistician, T. A. Coghlan noticed that between 1856 and 1889, 61,245 Chinese entered the colony of New South Wales, and 31,850 departed (Wang, 2001).

The mass influx of Chinese miners, as well as the presence of Pacific Islanders and Indians in Queensland and northern New South Wales' sugar cane fields was perceived as strong competitors against white workers. Although the anti-foreigner feeling against any non-British gold diggers were already under way, coloured people became the main target of racial discrimination.

Asiatic people were often described as filthy, opium addicts, gamblers, with immoral sexual behaviour and are inferior races. They were also accused of wanting to get married with white women. The allegation of “stealing” white woman attracted rather serious reaction amongst the white settlers, since there was a severe gender imbalance.

The anti non-white feeling infused the belief of racial superiority of whites and provided the rationale for restrictive non-white immigration legislations in the colonies of Western Australia, New South Wales and Tasmania before the federation. These colonial legislations created an environment to breed the idea of forming a pure white society in Australia that was later known as the White Australia policy, and was adopted by the first Federal Government with the formation of the Australian Federation in 1901. The White Australia Policy became one of the legislative foundation stones and ideological lodestar for the Australian federation (Evans, 2001), and it produced the Immigration Restriction Act 1901. The Immigration Restriction Act 1901 effectively restricted the entry of non-white immigrants regardless their nationality, in favour of the European race. Under this Act, not only Asian people, but also non-white British ex-soldiers who fought for the empire in the First World War and non-white American subjects were denied entry, while non-English speaking German, Russian and Italian immigrants were allowed to stay.

3.2.2 The Effect of the White Australia Policy

The White Australia Policy was in place for seven decades. The effect of the White Australia policy is concisely summarised by Evans (2001, p. 45):

> “…it would, over time, afford a basis for naturalisation, citizenship and the franchise; for health, welfare and occupational policies; for foreign policy, diplomacy and defence. It would be used to discriminate against, to segregate, confine and deport certain individuals upon consideration of their skin colour, phenotype or genetic background. Its domain extended across the lives of Aboriginal and Torres Strait Islander people and, at times, European immigrants, as well as those of non-white incomers, sojourners and subjects. It affected certain British citizens because they were not white and certain white foreigners because they were not British. It carried the power of sunder families and limit reproduction as well as to magnify racial arrogance and quash dissent.”

The White Australia policy also partly contributed to the Japanese aggression towards Australia during the World War II. With the implementation of all the harsh measures on Asian immigrants and also the denying of the basic rights of coloured people, the White Australia policy effectively expelled Asians out of Australia. The Chinese population in Australia declined from just under 30,000 at Federation to about 6,000 forty-five years after, while the Japanese population fell from 3,500 to 330 over the same period of time.

The newly formed Chinese republic government and the Japanese government protested strongly against the way their subjects were treated in Australia. The Japanese, backed by its rising economic and military power in Asia, saw itself as a leader and a “better race” over other Asian countries, had long standing and vigorously fighting against the racial discrimination against Japanese by Westerners. However, the Australian and New Zealand governments viewed that the Japanese were even “worse” than the Chinese and the US is ready to exclude Japanese from their immigrant lists. The ambition of Japan to enter the club of great powers was constrained by it being oriental and its racial difference from the other great powers. It turned Japan into a more inward looking nation and to adopt the policy of “Asia for the Asiatic” and drifted away from the League of Nations. The Japanese decided to fight for its status at all costs and prepared to resolve the matter by war. It made the World War II (WWII) a racial war (Bennett, 1992).

3.2.3 The Politics of Asian Immigration after the WWII

The end of the WWII brought great changes to the world powers. The colonial rules in Asia and Africa were weakened by the War. A new demand for national self-determination resulted India, Pakistan, Sri Lanka (then Ceylon) and Singapore gaining independence. National policies based on racial prejudice and discrimination based on skin colour became unpopular in the Western world. In responding to the world trend, the term “White Australia” policy was discarded in the 1950s, but no substantial changes took place in the policy.

Meanwhile, the famous “Populate or Perish” statement made by Arthur Calwell provided the rationale for massive immigration from Europe to consolidate Australia against the “yellow peril”. The immigration policy of the day was rested on the solid racial discrimination heartland. Although the global political environment changed, placing external pressure on

Australia to end the White Australia policy, this pure-White society mindset persisted for another twenty years in the political arena.

On the other hand, the general public's attitude toward maintaining a monotonic White society was slowly relaxing over this period of time. Opinion polls showed that the general public gradually shifted to be in favour of a small number of non-European intakes. The younger generation politicians grew up with more liberal views on this subject. With the influence of the Immigration Reform Group's recommendation, [29] and responding to international criticism and concerning Australia's image in the world, voices urging to reform the racial discrimination policy grew stronger within both the major parties. However, then Liberal Prime Minster Sir Robert Menzies and the opposition leader Author Calwell stood firm against the changes.

In the mid-1960s, following the retirement of Sir Robert Menzies, his leadership was replaced by the more open successor Harold Holt, and Author Calwell was also replaced by Gough Whitlam who was sympathetic to immigration reform, and the Australian people were given the opportunity for well-informed public discussions on the subject. Public opinion changed gradually and the policies of political parties changed progressively, reflecting the public preferences. Both parties gradually moved away from the "White Australia" party platform. A bipartisan approach to non-discrimination immigration policies was emerged. In anticipation of the UK joining the European Economic Community (EEC) and the UK trade with Australia would be diverted to trade with the EEC member nations, Australia needed to redefine its position in Asia. The offensive "White Australia" policy was an insult to its potential trade partners. The new Whitlam labour government formally abolished the White Australia policy in 1973 as a good gesture to its Asian neighbours. The changes were slow, but progressive, and with context. The public was well informed and the debates were in an open manner. Abolishing the White Australia policy attracted no major political objection.

---

[29] The task of the Immigration Reform Group was to find the optimal solution to guide the immigration policy for the objective of (1) to enhance Australia's international image, (2) to avoid destabilising social harmony. The Immigration Reform Group recommended that the volume of non-white immigrants should be absorbable by the society. The occupation of the non-white immigrants should be balanced to avoid clustering to low-income group. Non-white immigrants also should not be resided around cheap housing areas. This strategy avoided disrupting social harmony.

The successive Liberal and Labour governments committed against racism. A multicultural society emerged under Hawke and Keating Labour governments and was honoured and developing under the current Howard government. However, a “race debate” was sparked by Pauline Hanson, the Independent Member for Oxley in October 1996. The formation of Pauline Hanson’s One Nation Party attracted considerable publicity. Public opinions were persuaded to swing to question the wisdom of accepting Asian immigrants by alleged facts and figures that were later found false and manipulated. The debate also fuelled a massive nation-wide protest against racism, which marked the dramatic slide of support to the One Nation Party.

3.3 History of Australian Immigration from its Major Trade Partners in East Asia

Before the removal of the White Australia policy, Asian countries were not the major countries of immigrant sources and exports destinations. After the removal of the White Australia policy, both the trade volume and immigrant arrival rose rapidly over the last thirty years and surpassed the significance of the European countries. For example, in the year of 1990, Australia’s major trade partners were the UK and the USA. Germany, France and South Africa were also on the top of the list. By the year 2000, six of the top ten trade partners were located in East Asia. Although the UK was still a major trade partner for Australia, its rank dropped to the sixth. While Germany struggled to retain its rank as the ninth, its trade with Australia was slightly greater than Malaysia’s trade with Australia. France and South Africa became insignificant to Australia (Department of Foreign Affairs and Trade, 2002).

The ensuing discussion is focused upon eleven major trade partner countries and/or areas in East Asia. Their immigrant demographic characteristics are briefly examined to provide an overall picture for the immigrants’ cultural broker function, in order to explain whether the links between immigration and trade development with those countries are significant or not. We are interested in finding the answers to the questions of who the immigrants to Australia from those countries are or where and when their immigration took place. The question of “who” is to find out whether the immigrants were business people, professionals or labourers. The question of “when” is to find out how long a time it takes for the immigrants to establish trade links with their home countries.

3.3.1 China

As previously mentioned, Chinese immigrants from Mainland China were among the earliest non-white immigrants to Australia. They came to Australia as early as in the 1840s. Massive number of coolies and free uneducated labourers arrived during the 1850s and the 1860s. These were followed by a decline in immigrant numbers when the gold fields became exhausted. However, trade between Australia and China has been established by some of the early immigrant entrepreneurs such as celebrated Mui Quong Tart (known as Quong Tart) in tea trade with China and the Wings (Wing On, Wing Sang and Wing Tiy) in fruit and greengrocery exports to Hong Kong. The history of immigration from China in Section 3.3.1 is as quoted in Jupp (2001), pp.197-224.

Following the anti-Chinese (and then anti-non-White) movement, the Chinese population dropped from just under 30,000 in the 1901 Census to 6,500 in the 1947 Census. Business environment for the Chinese in Australia was also severely limited, trading companies such as Wing On and Sincere moved their operations to Hong Kong and are still thriving today.

From the early 1970s, China-born population in Australia started to increase, however, this group came to Australia from the countries in South East Asia where the communists claimed victory, such as Vietnam, Laos and Cambodia. This group of Chinese had enough resources to flee themselves from the wars before the wars were concluded. Some of them have established firm businesses in Australia. A small proportion of this group of China-born immigrants came from Singapore, Hong Kong, Malaysia and Indonesia.

A common characteristic of this group of Chinese is that although they were born in China, their places of residence before arriving in Australia were other countries rather than China. There is a conflicting role in this group of Chinese. They considered themselves “Chinese” as a race but little emotional attachment to China as their motherland. When searching for business opportunities, they looked for their place of last residence. However, trade links to the countries they fled were not established until those countries became ready to do business with the Western world.

With abolition of the White Australia policy, the recognition of the People’s Republic of China (PRC) by the Whitlam government, the Chinese government relaxing its control of overseas studies, and the introduction of the 'Australian-Chinese Family Reunion Agreement', immigrants from China Mainland started to come to Australia slowly. By 1981, the Chinese born population in Australia was coming back to the level in 1901.

In the mid-1980s, following the improvement of diplomatic relations between the Hawke Labour government and the Chinese government and the relaxation of its control over Chinese students studying overseas, the Australian government was actively marketing education service exports to China. The marketing campaign was successful and it opened up a huge Chinese student market to Australia education institutions. As a result, the China-born population grew more than two fold from 37,000 in 1986 census to 78,000 in 1991 census. The 2001 census showed that the Chinese born population in Australia doubled again to 140,000. This wave of growth in Chinese population is largely the responsibility of family member reunion program sponsored by their close family members who were Chinese students, and who gained permanent resident status after the "Tiananmen Square Incident" in China in 1989.[30]

This group of China-born mainly came from Mainland China. They maintain connection with their family and friends in China. It provides opportunity for them to establish trade links with China either as their own business or working for their employers. According to ABS statistics, in 1991, Australia's merchandise exports to China expanded more than two fold of its export level in 1981. Within the next decade, from 1991 to 2001, exports to China were rapidly grown five times. Over the same period, imports grew six times from 1981 to 1991, and grew another six times again during the next decade. In the financial year 200-01, China was Australia's fifth major trade partner. Table 3.1 below illustrates the Chinese population in Australia and Australian trade with China.

Chinese immigrants, who particularly arrived in the mid-1980 to the 1990s, were predominantly international students, studying in English courses in Australia. Most of them financed their studies by heavily borrowing from their relatives and friends back home. Their visa status restricted their ability to work in Australia. The inability to access to

[30] The Australian Labour government decision of granting temporary resident status (later converted into permanent resident status) to Chinese students who came to Australia before the 4th June 1989 did not have the impact on raising the China-born population in Australia. However, it had the impact on immigration "category jump" from student visa to permanent resident visa.

finance also limited them from engaging in international trade. Their permanent residence status in Australia was certain in 1994. There would be a considerable lag time between the arrivals of those students to their effect on Australian trade with China.

Table 3.1 China-born Population in Australia and Australian Trade with China (Selected Years)

Year	China-born[a] (Selected Census Years)	Year	Trade with China[b] (A$'000) Exports	Imports
1901	29,907	1901	258	319
1911	20,775	1910	228	159
1921	15,244	1920	656	2,069
1933	8,579	1930	6,702	695
1947	2,759	1940	7,028	1,118
1954	2,954	1950	1,700	5,314
1961	14,488	1960	79,714	7,948
1971	17,601	1970	63,277	31,584
1981	26,760	1980	670,878	219,486
1991	77,799	1990	1,347,502	1,502,784
1996	110,987	2000	6,842,539	9,881,097
2001	156,996	2001	7,581,000	10,313,000
2005	191,194	2005	19,156,000	22,570,000

Source: a – The birthplace data for censuses of 1901 to 1996 are from Department of Immigration and Multicultural Affairs (2001). The birthplace data for 2001 and 2005 are from ABS publication: cat. no. 3105.0.65.001 Australian Historical Population Statistics, TABLE 87. Estimated resident population, sex and country of birth, Australia, 30 June, 1996 onwards. b – Trade with China data for 1901 to 2000 are from Department of Foreign Affairs and Trade (2002). Trade data for year 2001 are from ABS publication cat. no. 5368.0 International Merchandise Exports, Australia and cat. no. 5439.0 International Merchandise Imports, Australia. Trade data for 2005 are from Department of Foreign Affairs and Trade (2006). All trade data are recorded in current dollar values at each year.

Strong economic growth in China during the last two decades has reformed the social structure in China. A new middle class appeared for the first time over the last fifty years. One strategy to secure their newly accumulated wealth is to seek an overseas haven. Business and investment immigration become a current trend. Some of those business immigrants established businesses in Australia and some of them travel frequently between Australia and China to pursue their business opportunities in China while leaving their families in Australia.

3.3.2 Hong Kong

Hong Kong became a British dependency from 1842 as part of the Treaty of Nanking. It returned to China as a Special Administrative Region from 1 July 1997. In the early 1900s, Hong Kong mainly served as a port for the British to trade with China. After WWII, Hong Kong has developed as a centre of international trade and finance. It also developed its own industries and became world famous for its filming, electronic and garment industries.

Before the 1980s, very few people migrated to Australia from Hong Kong. The favoured immigration destinations for the Hong Kong people were the UK and the USA. In the late 1970s, the UK government anticipated the return of Hong Kong to China and legislated to prevent Hong Kong Chinese British subjects to "flood" the UK. Then the favourable immigration destination for Hong Kong people shifted from the UK to Canada and Australia because those countries' images for clean environment, low crime rate and friendly people.

The Sino-British joint declaration in 1984 for returning Hong Kong to China triggered a new wave of emigration. Hong Kong Chinese community in Australia has grown rapidly since then. This group of immigrants were skilled, vibrant and had sufficient resources to satisfy Australian government's requirements as independent immigrants. They were more prepared for the job market or ready to set up businesses. Exports to Hong Kong expanded five fold between 1980 and 1990, and imports doubled within the same period, with a favourable trade balance for Australia (refer Table 3.2). Hong Kong absorbed 1.6% of Australia's exports in 1980-81, 3.0% in 1990-01 and 3.3% in 2000-01. It was Australia's ninth major trade partner.

Since there are a considerable proportion of Hong Kong immigrants born in China but gained residence status in Hong Kong later in their life, the statistics for Hong Kong born would underestimate the stock of Hong Kong immigrants in Australia. By the same token, it also over-estimates the stock of immigrants from Mainland Chinese.

Table 3.2 Hong Kong-born Population in Australia and Australian Trade with Hong Kong (Selected Years)

Year	Hong Kong-born[a] (Selected Census Years)	Year	Trade with Hong Kong[b] (A$'000) Exports	Imports
1901	167	1901	827	570
1911	413	1910	1,388	489
1921	337	1920	1,734	88
1933	236	1930	765	29
1947	762	1940	2,265	218
1954	1,554	1950	11,936	3,830
1961	3,544	1960	37,578	12,486
1971	5,583	1970	90,403	61,116
1981	15,717	1980	306,726	394,106
1991	57,510	1990	1,559,805	740,559
1996	68,437	2000	3,910,347	1,362,528
2001	75,180	2001	4,191,000	1,418,000
2005	76,218	2005	4,228,000	2,941,000

Source: a – The birthplace data for 1901 to 1996 are from Department of Immigration and Multicultural Affairs (2001). The birthplace data for 2001 and 2005 are from ABS publication: cat. no. 3105.0.65.001 Australian Historical Population Statistics, TABLE 87. Estimated resident population, sex and country of birth, Australia, 30 June, 1996 onwards. b – Trade with Hong Kong data for 1901 to 2000 are from Department of Foreign Affairs and Trade (2002). Trade data for year 2001are from ABS publication cat. no. 5368.0 International Merchandise Exports, Australia and cat. no. 5439.0 International Merchandise Imports, Australia. Trade data for 2005 are from Department of Foreign Affairs and Trade (2006). All trade data are recorded in current dollar values at each year.

3.3.3 Indonesia

The modern nation of Indonesia was founded in December 1949. It consists of more than 13,600 islands and stretches over 5,000 kilometres along the Equator. In historical times, it consisted of hundreds of small states, which ruled by their own rulers. Its spice trade was forced in favourable terms to the Portuguese's traders in the 1500s and then was controlled by the Dutch East Indies Company from the 1600s to the early 1800s when the control was passed on to the Dutch government. By 1910, the Dutch government gained administration of the whole of Indonesia, which was known as Netherlands East Indies. The Portuguese and the Dutch made huge profits from monopolising spice trade. They also made the Indonesian too poor to buy foreign goods. The trade was almost one-way exporting from Indonesia to the Netherlands.

Because of Indonesia's proximity to Australia, the visits by Indonesians to Australia had been as early as the visits of White people. However, the Indonesians were seasonal fishermen and their visits were limited to the Australia's northern coasts. They built processing facilities on shore and processed their catchments and then sold their products mainly to the Chinese market for Chinese cuisine. They usually left at the end of the fishing season and returned in the next year. They had contacts with aboriginal people and had certain influence on aboriginal language, culture and religion in the region. With the implementation of the White Australia policy, the South Australia government banned this kind of fishery activities, and the Indonesian visits subsided.

However, a group of Indonesians were immune from the White Australia policy. They were the pearl divers working in the north and northwestern coastal regions. Exemption was granted to Indonesian pearl divers because there was a lack of supply of skilled White workers who do this kind of dangerous jobs.

During WWII, following the attack by the Japanese on Indonesia, the Dutch colonial government retreated into Australia. It brought with them about 10,000 Indonesian military, civil and domestic servants into Australia along with 500 political prisoners (Penny & Gunawan, 2001). They all returned to Indonesia after the war.

After the war, a new development to bring Australia closer to its Asian neighbouring countries and increasing Australia's involvement in the economic and social development in Asia was proposed by Australia's foreign minister Sir Percy Spencer at a Commonwealth foreign ministers' meeting in Colombo, Sri Lanka (Ceylon) in 1950 (known as the Colombo Plan). As part of the plan, some Indonesian students received scholarship aid to study engineering in Australia. Australia also recruited Indonesian language teachers and radio broadcasters. Some of them got married with Australians and settled in Australia. In the 1960s, increasing contacts between Australia and Asian countries eased the restriction on non-White immigration and a small number of Indonesian immigrants were allowed to enter into Australia.

In the 1970s, the economic take-off in Indonesia made travelling more affordable to the middle class Indonesians. With the introduction of the non-discriminatory immigration policy in Australia, Indonesian immigrant stock grew since then.

Indonesian-Australians were moving between Australia and Indonesia in the 1980s and the 1990s to pursue economic opportunities between these two countries. In the 1980s, the economic growth in Indonesia attracted some Indonesians back and they traded with Australia. Since the 1997 Asian economic melt down, some of these families moved back to Australia. Although a high proportion of Indonesian immigrants are ethnic Chinese, their contacts remain in Indonesia. Indonesia would be the first choice for their business activities. About 2.6% of Australia's exports was sold to Indonesia in 2000-2001 and Indonesia ranked the tenth major trade partner. Table 3.3 below presents Indonesian immigrant stock in Australia and Australia's international trade with Indonesia.

Table 3.3 Indonesia-born Population in Australia and Australian Trade with Indonesia (Selected Years)

Year	Indonesia-born[a] (Selected Census Years)	Year	Trade with Indonesia[b] (A$'000)	
			Exports	Imports
		1901	409	1,876
		1910	795	1,163
		1920	5,137	17,598
1947	918	1930	2,873	8,022
1954	3,631	1940	6,113	16,347
1961	6,018	1950	6,486	43,576
1971	7,981	1960	11,814	57,525
1981	12,463	1970	39,076	22,523
1991	32,688	1980	356,158	416,791
1996	44,157	1990	1,462,287	783,742
2001	51,829	2000	3,112,125	3,278476
2005	65,914	2005	4,436,000	4,540,000

Source: a –The birthplace data for 1947 and 1954 are from ABS publication: cat. no. 3105.0.65.001 Australian Historical Population Statistics, TABLE 76. Population, sex and country of birth, states and territories, 1947 census. The birthplace data for 1961 to 1996 are from Department of Immigration and Multicultural Affairs (2001). The birthplace data for 2001 and 2005 are from ABS publication: cat. no. 3105.0.65.001 Australian Historical Population Statistics, TABLE 87. Estimated resident population, sex and country of birth, Australia, 30 June, 1996 onwards. b – Trade data are from Department of Foreign Affairs and Trade (2002 and 2006). All trade data are recorded in current dollar values at each year.

3.3.4 Japan

Japan had virtually closed borders to shield foreign influence for more than two hundred years from the 1630s to the 1850s. During that period, Japan pursued its own pace of economic and social development. It laid the foundation for economic take-off and then was flying high for the next 150 years. During this two hundred year period, foreigners were not welcome and Japanese people were not allowed to leave the country. The Japanese missed out the opportunity to work in the gold fields during the gold rush in Australia.

Following the Europeans' success to force China to sign an unequal treaty in 1842 and open up trade in the Europeans' terms, the U.S. decided to open up Japan. A series of struggles and negotiations between the U.S. and Japan from 1853 led to the treaty of commerce in 1858 allowing the U.S. to trade with Japan and also to give the privilege to the U.S. citizens over the Japanese. The Japanese viewed this treaty as unequal as well. It bred strong nationalism for self-strength to compete against Westerners. The Meiji emperor adopted an ambitious economic and military development strategy.

The Japanese found that the treaty of commerce with the U.S. did give them some benefits; Japanese labourers and sex workers would work in the U.S., although under unfavourable conditions. They earned a handsome foreign reserve to fuel Japan's development. This lucrative market shifted Japan's immigration policy from no emigration to fighting for the right to export workers. Unlike the Chinese Chin government who were more interested in exploiting its overseas subjects, the Japanese government refused to become the source of coolie workers. It took an active role to supervise its immigrant workers' welfare.

By that time, the Japanese started to look at Australia as a favourable immigration destination, since Australia was having problems with the Chinese gold miners. Although the Japanese insisted that they were the superior race over the Chinese, in the Australian dominions' view, the Japanese were as bad as the Chinese or even worse because they were suspected to colonise Australia, and at least the increasing Japanese naval power in the region supported this suspicion. Thus, the Japanese were brought under the umbrella of the Immigration Restriction Act.

Although Japan was a major buyer of Australia's natural resources exports, up to the WWII, there were only a few thousands of Japanese resided in Australia in the occupations of pearl divers (replacing the Indonesian pearl divers), sugar cane field workers, menservants, laundrymen, international firm staff and a number of business people.

During the Pacific war, all Japanese, regardless of age, sex and place of birth, were locked up in camps and later deported because they were known to be loyal to their emperor.

Japanese assets were confiscated. By 1949, there were only 50 Japanese left in Australia (Oliver, 2001).

After the war and until the mid-1960s, when the White Australia policy was still having a stronghold, Japanese entries were bitterly restricted. Even those "war brides" (Japanese wives of Australian service men as the occupation force in Japan) were not allowed to be admitted until 1952. Business visas were also restricted to 3-6 months only in 1951. It was gradually relaxed up to four years in 1962. Some pre-war long-term residents were allowed to return in 1963. After the abolition of the White Australia policy in 1973, Japanese immigrant stocks in Australia grew slowly. However, it was relatively smaller than other Asian immigrants stocks. Today, there are large inflows of Japanese tourists but the permanent resident community is still relatively small. However, Japan's trade with Australia grew faster than its immigrant stock (refer to Table 3.4).

Table 3.4 Japan-born Population in Australia and Australian Trade with Japan (Selected Years)

Year	Japan-born [a] (Selected Census Year)	Year	Trade with Japan [b] (A$'000) Exports	Imports
		1901	247	576
		1910	1,314	1,437
		1920	6,235	10,460
		1930	19,001	4,759
1947	330	1940	10,728	7,201
1954	966	1950	123,100	31,190
1961	2,306	1960	322,976	130,890
1971	4,006	1970	1,197145	574,032
1981	6,818	1980	5,221647	3,623,188
1991	18,485	1990	14,378,460	8,849,250
1996	23,015	2000	23,502,609	15,370,569
2001	25,472	2001	23,723,000	15,259,000
2005	28,717	2005	31,825,000	19,192,000

Source: a – The birthplace data: From1947 to 1996 are from ABS cat. no. 3105.0.65.001 Australian Historical Population Statistics, varies years, from 2001 to 2005 are from ABS publication: cat. no. 3105.0.65.001 Australian Historical Population Statistics, TABLE 87. Estimated resident population, sex and country of birth, Australia, 30 June, 1996 onwards. b – Trade data with Japan for 1901 to 2000 are from Department of Foreign Affairs and Trade (2002). Trade data for year 2001 are from dX EconData, ABS Time Series Statistics Plus, Table 5432-03 and Table 5439-03. Trade data for 2005 are from Department of Foreign Affairs and Trade (2006). All trade data are recorded in current dollar values at each year.

Australia enjoyed a trade surplus over Japan throughout the history and still it is the case today. Japan bought 27.6% of Australia's total exports in 1980-01, 27.4% in 1990-01 and

19.7% in 2000-01. Although the lion's share that Japan took from Australia's exports declined, Japan is still the number one trade partner of Australia. Japan bought almost three times greater imports from Australia than did the U.S. (the second major buyer of Australia's goods).

3.3.5 Korea

The Korean peninsula is governed by two administrations. The Northern Korea is called the Democratic People's Republic of Korea, often referred to as North Korea. The Southern Korea is called the Republic of Korea, known as South Korea. Since there is very little trade data collected/published about the North Korea, this study focuses on the immigration and trade with South Korea. The term "Korea" solely refers to South Korea.

Australia had very little trade with Korea up until the 1960s. Since the 1970s, Australia's trade with Korea has been soaring. Korea became the third largest market for Australia's exports (after Japan and the U.S.) in 2000-01.

Korean immigration to Australia also had a similar pattern to its trade pattern with Australia. The 1971 Census recorded a total of only 379 Korean born in Australia, and this census was the first time the Korean were listed in its own category.

There is very little published work on the Korean immigration history in Australia. Kim (1988), Coughlan (1997) and Han (2001) are the only useful material found. The early ethnic Koreans in Australia could be the orphans in the Korean War and "war brides" of the Australian service men in Korea. Voluntary Korean immigration started in the 1970s, and a few hundred of Koreans benefited from the Whitlam government's easy tourist visa scheme. Because the economic and political situations in Korea were not favourable to them, they overstayed after their tourist visas were expired and turned into illegal immigrants. As the White Australian policy died down and the Australian government became more Asian friendly, this group of Koreans gained amnesty and became legal residents.

This group of Korean immigrants was from lower socio-economic background. Most of them had been working in Southeast Asian countries or the Middle East as contract labourers before they reached Australia. Their economic background and being unable to access Australian government social services forced them to grab whichever work opportunities available. After their residence status became clear, they earned sufficient income to payoff their houses and sponsor their children and other family members to Australia. By 1981, there were 4,104 Koreans in Australia (Table 3.5). The early Korean businesses were started by this group of immigrants.

The chain immigration feedback to Korea serving as immigrant information network triggered the second waves of Korean immigration – the middle class immigrants. The second wave of Korean immigration started in the 1980s, accompanying with the rapid economic development in Korea. The economic success in the 1970s by former Korean immigrants in Australia served as an indicator for business opportunities in Australia for the newly grown middle class in Korea. The tension between North Korea and South Korea laid the threat of war, also serving as a force to push the middle class to emigrate. The 2001 Census recorded 38,899 Koreans (Table 3.5). During the last two decades, Korean population in Australia grew by approximately 15,000 per decade.

Table 3.5 Korea Population in Australia and Australian Trade with Korea (Selected Years)

Year	Korea-born [a] (Selected Census Year)	Year	Trade with Korea [b] (A$'000)	
			Exports	Imports
		1960	3,442	150
1971	349	1970	9,685	5,762
1981	4,104	1980	537,798	203,545
1991	2,0513	1990	3,237,017	1,254,349
1996	32,602	2000	9,207,737	4,709,579
2001	41,814	2001	9,530,000	4,636,000
2005	46,532	2005	12,378,000	5,514,000

Source: a – The birthplace data are from ABS cat. no. 3105.0.65.001 Australian Historical Population Statistics, varies years. b – Trade with Korea data for 1960 to 2000 are from Department of Foreign Affairs and Trade (2002). Trade data for year 2001 are from dX EconData, ABS Time Series Statistics Plus, Table 5432-03 and Table 5439-03. Trade data for 2005 are from Department of Foreign Affairs and Trade (2006). All trade data are recorded in current dollar values at each year.

3.3.6 Malaysia

Initially, the Federation of Malaysia was formed in 1963 by uniting Malaya, Singapore, Sarawak and Sabah. Before the Federation, Malaya was an independent state in the form of British protectorate. Singapore, Sarawak and Sabah were separate British crown colonies. Singapore withdrew from the Federation of Malaysia in 1965. Malaysia is a multi-race community with 50% Malays, 35% Chinese and 10% Indians. The political power is controlled by Malays but the Chinese control the economy.

Immigration from Malaysia to Australia recalls the similar stories as the Indonesian immigration in Australia because they are closely related people living in the region, but divided by two different Western powers. Malaysia was a British colony and a member of Commonwealth nations, while Indonesia was a Dutch colony. Thus, for Malaysians, it was relatively easier to migrate to Australia than for Indonesians. Throughout the history, there has been about twice the Malaysians in Australia than the Indonesians. Malaysian immigrant stock in Australia grew rapidly in the 1980s and 1990s. Since the Malaysian Chinese are generally wealthier and held better skills, a great proportion of Malaysian immigrants were ethnic Chinese who were born in Malaysia.

Australia's trade with Malaysia has generally been greater than trade with Indonesia. A comparison of Table 3.6 with Table 3.3 reveals the differences. In the middle of 2004, Australia and Malaysia agree to conduct a preliminary study to help both governments to decide whether it is possible to negotiate a free trade agreement.

Table 3.6 Malaysia-born Population in Australia and Australian Trade with Malaysia (Selected Years)

Year	Malaysia-born [a] (Selected Census Year)	Year	Trade with Malaysia [b] (A$'000) Exports	Imports
1954	2,279			
1961	5,793	1950	16,428	41,294
1971	14,945	1960	23,986	30,390
1981	31,598	1970	66,494	32,740
1991	71,665	1980	437,177	186,554
1996	76,221	1990	984,990	731,503
2001	87,153	2000	2,498,697	4,176,681
2005	100,287	2005	3,729,000	6,883,000

Source: a – The birthplace data are from Department of Immigration and Multicultural Affairs (2001). The birthplace data for 2001 and 2005 are from ABS publication: cat. no. 3105.0.65.001 Australian Historical Population Statistics, TABLE 87. Estimated resident population, sex and country of birth, Australia, 30 June, 1996 onwards. b – Trade with Malaysia data are from Department of Foreign Affairs and Trade (2002 and 2006) and are recorded in current dollar values at each year.

3.3.7 The Philippines

The Philippines is an Island-nation consisting more than 7,000 islands and islets. It had been a Spanish colony for over 300 years from 1565 to 1898. After the U. S. won the war against the Spanish in the Philippines in 1898, the U. S. bought the Philippine islands from Spain for $20 million and the Philippines became a part of the U. S. In 1935, the Philippines became self-governing commonwealth and then fully independent in 1946.

Filipino immigration to Australia started in the second part of the 19th century when Asian pearl divers were in high demand. They survived the White Australia policy as a special group of workers who were granted exemptions. However, the widespread racial discrimination resulting from the White Australia policy turned the living conditions unfavourable for the Filipinos. Therefore, Filipino population declined from 689 at the time the Immigration Restriction Act introduced at Federation to 141 in 1947 (Table 3.7).

Table 3.7 Gender Balance of the Filipino Immigrants in Australia (Selected Census Years)

Census Years	Male	Female	Total
1947	92	49	141
1954	117	100	217
1961	243	187	430
1971	1028	1304	2332
1976	2247	3258	5505
1981	5102	9714	14816
1986	9923	22834	32757
1991	25432	47575	73007
1996	32326	60623	92949
2001	35807	68135	103942

Source: ABS statistics, cat. no. 3105.0.65.001Astralian Historical Population Statistics, various years.

Filipino population in Australia grew along with other Asian nations when the immigration restrictions on the coloured immigrants were relaxed. Continuous political unrest, social instability and economic under-development served as factors pushing the Filipinos to leave their country. Bride immigration is a unique feature of Filipino emigration. For Filipino women, it was easier to emigrate than for Filipino men simply by getting married to foreign men. Australia is one of the favoured destinations for Filipino brides. Compared to the other Asian women, Filipino women were more ready to become brides of Western men and more ready to blend into the Western culture because the Philippines are predominately a

Christian country. Christianity was successfully spread by the Spanish. The Filipinos were educated in the American education system and are fluent in English. Australian Census data showed that from 1970, female Filipinos exceeded males for the first time. The subsequent Censuses revealed a rapid growth of the female Filipino population in Australia. Since the 1981 Census, the female group of Filipino immigrants exceeded the male group by almost two times.

In trading with the Philippines, Australia enjoys a huge trade surplus over the Philippines throughout the data collection years (see Table 3.8).

Table 3.8 Philippine-born Population in Australia and Australian Trade with Philippines (Selected Years)

Year	Philippines-born [a] (Selected Census Year)	Year	Trade with Philippines [b] (A$'000)	
			Exports	Imports
1901	689			
1911	444	1901	604	193
1921	329	1910	947	213
1933	234	1920	842	418
1947	141	1930	666	80
1954	217	1940	977	187
1961	430	1950	956	104
1971	2,550	1960	7,392	812
1981	15,431	1970	40,935	4,962
1991	73,144	1980	168,776	91,710
1996	92,933	1990	436,904	129,021
2001	112,205	2000	1,500,580	512,688
2005	129,401	2005	1,020,000	1,011,000

Source: a – The birthplace data for 1901 to 1996 are from Department of Immigration and Multicultural Affairs (2001). The birthplace data for 2001 and 2005 are from ABS publication: cat. no. 3105.0.65.001 Australian Historical Population Statistics, TABLE 87. Estimated resident population, sex and country of birth, Australia, 30 June, 1996 onwards. b – Trade with Philippines data are from Department of Foreign Affairs and Trade (2002 and 2006) and are recorded in current dollar values.

3.3.8 Singapore

Singapore is a small island country located on the southern tip of the Malay Peninsula, and north of Indonesia. It consists of a large island and about 50 small islands or islets. Its total territory is about 640 square kilometres, which is almost half the size of Hong Kong. Singapore is an independent city-state where the city makes up the majority of the nation. Singapore gained independence from Britain in 1959. In September 1963, Singapore jointed the Federation of Malaysia. In August 1965, Singapore broke away from the Federation and became independent.

The location of Singapore plays an important *entrepôt* for trade between Europe and the Far East as well as an important port for Malaya trades. Since the birth of the nation, its economy evolved from relying on *entrepôt* to a well-balanced economy with manufacturing of highly skilled products. Singapore became an important financial and transportation centre. Tourism is also an important industry in Singapore, income generated from tourism industry ranks the third highest export income. Singapore enjoyed about 8% economic growth rate per annum since independence and is amongst the nations with highest per capita income in Asia. Singapore is a multi-racial society with 75% of the population being Chinese, 15% Malay and 7% Indian. Singapore uses four official languages – English, Mandarin Chinese, Malay and Tamil.

As it is an immigrant nation, it has not played a major role in Australia's immigration. The 1961 Census showed that 2,759 persons in Australia reported born in the new Singapore nation (Table 3.9). Due to its rapid economic growth, emigration was not attractive until the 1980s when a lot of Singaporeans moved up to the middle class and had the resources to emigrate. Singaporean immigrants are generally wealthier than their other Asian counterparts. The job prospects for Singaporeans in Australia are also brighter than for most other Asian immigrants who encounter English language difficulties.

Table 3.9 Singapore-born Population in Australia and Australian Trade with Singapore (Selected Years)

Year	Singapore-born[a] (Selected Census Year)	Year	Trade with Singapore[b] (A$'000)	
			Exports	Imports
1961	2,759	1950	21,750	21,004
1971	5,532	1960	24,370	3,712
1981	11,990	1970	118,397	23,303
1991	24,021	1980	498,042	506,396
1996	29,503	1990	2,768,737	1,271,038
2001	35,919	2000	5,998,075	3,898,047
2005	46,318	2005	6,472,000	12,179,000

Source: a – The birthplace data are from Department of Immigration and Multicultural Affairs (2001). The birthplace data for 2001 and 2005 are from ABS publication: cat. no. 3105.0.65.001 Australian Historical Population Statistics, TABLE 87. Estimated resident population, sex and country of birth, Australia, 30 June, 1996 onwards. b – Trade with Singapore data are from Department of Foreign Affairs and Trade (2002 and 2006) are recorded in current dollar values at each year.

In trade with Singapore, Australia has benefited from Singapore's forty-year long economic boom. Over the forty years period from 1959 to 1997, Australia has enjoyed a substantial trade surplus over Singapore (Table 3.9). Although Singapore is a city-state, the amount of commodities Singapore bought from Australia is greater than the sum of Australian exports to Malaysia and Indonesia over the same period of time. Singapore is viewed by many multinational enterprises as a trading post for their expansion into other Asian countries. Its position became even more important after Hong Kong returned to China in 1997. In the APEC Leaders' Meeting in November 2000, a joint announcement was made by Australian Prime Minister and Singapore Prime Minister to commence negotiation on Singapore-Australia Free Trade Agreement (SAFTA). The negotiation started in April 2001. By October 2002, ten rounds of negotiations were held. The SAFTA came into force on 28 July 2003. It is the first free trade agreement Australia ever entered into with an Asian country.[31]

3.3.9 Taiwan

Taiwan is an island province in South East China, located about 140 kilometres off the Chinese coast. During 1624 to 1661, Taiwan was influenced by the Dutch. After the first Sino-Japanese war, Japan annexed Taiwan in 1895. Taiwan was returned to China in 1945 when the WWII ended. In 1949, the communist force in China claimed victory over the Mainland China and the Nationalist Party (the Kuomintang) moved their government to Taiwan. Taiwan was ruled by martial law from 1949 until the end in 1987.

The Taiwanese immigration to Australia was not recorded as a separate region until the 1971 Census. Before the Japanese took control of Taiwan in 1895, Taiwanese were counted as Chinese. In the gold rush period, Chinese coolies were collected, kept and embarked from the major seaport of Amoy that is located on the mainland side of the Taiwan Strait. It is reasonable to infer that some Taiwanese could be amongst the coolies. For the period that the Japanese annexed Taiwan, it was under tight control of the Japanese. The martial law introduced by the Kuomintang since 1949 also restricted Taiwanese emigration. The post-

[31] The first Free Trade Agreement Australia entered into is the Australia New Zealand Closer Economic Relations Trade Agreement (known as ANZCERTA or the CER) in 1983.

war rapid economic growth led by free trade also attracted the Taiwanese to remain in Taiwan.

Taiwanese immigrants in the late 1980s were amongst the affluent immigrants in the Asian countries. Most of them were selected by Australia on the basis of their experience in international trade and business as well as the "amount of funds" they could bring with them (N. Chiang, 2001). They were mainly business and skilled immigrants. However, majority of the Taiwanese immigrants were not fluent in English. Their overseas qualifications were not well recognised by Australian governments and large organizations. Their employment prospects were not as bright as their Singaporean counterparts.

The Taiwanese, without experiencing major cultural revolutions such as their Mainland Chinese counterparts had gone through, Taiwanese still maintain the similar family and cultural values as those Chinese gold miners in the mid-1800s. Most Taiwanese Australians maintain strong political and cultural bonds with Taiwan. When things do not work out in Australia, they turn to seek support from their community back home.

For the last forty years, Australia's trade with Taiwan (both exports and imports) has increased rapidly with exports growing faster than imports (Table 3.10). The immigrant stock has also grown in a similar pattern as the trade growth.

Table 3.10 Taiwan-born Population in Australia and Australian Trade with Taiwan (Selected Years)

Year	Taiwan-born [a] (Selected Census Year)	Year	Trade with Taiwan [b] (A$'000) Exports	Imports
1976	364	1960	4,016	448
1981	743	1970	40,009	22,854
1986	1,949	1980	393,912	507,664
1991	12,565	1990	1,962,381	1,752,161
1996	19,547	2000	5,874,881	3,326,652
2001	26,534	2001	5,377,000	3,023,000
2005	30,783	2005	5,995,000	3,860,000

Source: a – The birthplace data are from ABS Statistics, cat. no. 3105.0.65.001 Australian Historical Population Statistics, varies years. b – Trade with Taiwan data for 1960 to 2000 are from Department of Foreign Affairs and Trade (2002). For year 2001, trade data are from the dX EconData, ABS Time Series Statistics Plus, Table 5432-03 and Table 5439-03. Trade data for 2005 are from Department of Foreign Affairs and Trade (2006). All trade data are recorded in current dollar values at each year.

3.3.10 Thailand

Thailand is the only nation in Southeast Asia that had never been colonised by a Western Power. With relatively politically stable and healthy economic growth, Thailand has not had any major waves of emigration. It explains why the Thai community in Australia is relatively small (only 23,600 Thais in Australia at the 2001 Census) compared to other Asian nations (See Table 3.11).

According to Taneerananon (2001), the earliest Thai visit was a delegate whose mission was to buy horses on behalf of the Thai King Rama VI in the early 1920s. The first group of Thai international students came to study in Australia in 1950 under the Colombo Plan. Since then, Thai population in Australia expanded at the rate of almost doubling every five years. Similar to the Filipinos, Thai immigrants are female dominated with women being almost two times than men. Most female Thai immigrants are wives of Australian men.

Trade between Australia and Thailand grew very rapidly over the last four decades. Thailand climbed up to the 14th top Australia trade partner for Australia in 2001. Australia has been having positive trade balances over Thailand in most of the selected years shown in Table 3.11. However, Imports from Thailand exceeded exports to Thailand in 2001.

Table 3.11 Thai-born Population in Australia and Australian Trade with Thailand (Selected Years)

Year	Thailand-born [a] (Selected Census Year)	Year	Trade with Thailand [b] (A$'000) Exports	Imports
		1920	50	10
1961	371	1930	121	4
1971	891	1940	386	6
1976	1,450	1950	1,754	206
1981	3,102	1960	3,774	886
1986	6,739	1970	32,290	3,918
1991	13,702	1980	128,362	64,443
1996	18,936	1990	665,479	505,009
2001	23,600	2000	2,221,300	2,779,883
2005	30,885	2005	4,770,000	3,770,000

Source: a – The birthplace data for censuses are cited from ABS Statistics, cat. no. 3105.0.65.001 Australian Historical Population Statistics, varies years. b – Trade with Taiwan data are from Department of Foreign Affairs and Trade (2002 and 2006) and are recorded in current dollar values at each year.

Thailand-Australia Free Trade Agreement (TAFTA) came into force on 1 January 2005. Under the agreement, all Thai tariffs levied on imported goods from Australia will be eliminated by 1 January 2010. It is a significant breakthrough for Australian exporters since some Thai tariffs levied on Australian goods were as high as 200 per cent.

3.3.11 Vietnam

The end of Vietnam War in 1975 marked the beginning of a massive people outflow from Vietnam. In the ensuing decade, an estimated two million people left Vietnam and resettled in western countries including Australia. The Vietnamese community in Australia was unnoticeable prior to 1975. By 1981, almost 50,000 Vietnamese had been resettled in Australia (Department of Immigration and Multicultural and Indigenous Affairs, 2004).

The massive influx of Vietnamese marked the greatest ever-Asian immigration into Australia. This wave of Asian immigration is even greater in number than the first wave of Asian immigration in the gold rush period which triggered the White Australia policy. Just two years after the formal abolition of the White Australia policy, Australia's commitment to "colour blind" immigration policy was under a serious test. The Australian government stroke a balance between maintaining its international reputation in South Eastern Asian nations by admitting the Vietnamese and educating its citizens to avoid major racist backlash within the country.

The outflow of Vietnamese "boat people" peaked in 1978-79 and slowed down by 1982. Instead, the family reunion program replaced the "boat people" and the rate of growth of the Vietnamese community in Australia had not been slowed down. In the next decade, the Vietnamese community grew almost three fold. By 1991, there were more than 120,000 Vietnamese-born in Australia. The 2001 Census recorded 154,830 Vietnamese-born, and it became the largest Asian community in Australia (Table 3.12).

Vietnam has not been a major Australian trade partner. Trade was even distorted by the embargo against the newly formed communist Vietnam. Following the reorientation of its economy, which deviated from the Soviet style of central planning economic system after the collapse of the Soviet Union and steered toward the ASEAN and the East Asian "tiger economy", some former Vietnamese made their return visits fifteen years after they left the country. Those return-visits planted seeds for the tremendous trade opportunities. As soon as Vietnam normalised relations with the West in 1995, Australian trade with Vietnam has grown twenty times within ten years from 1990 to 2000. Imports from Vietnam grew even faster – 140 times from AU$17 million to AU$2,431 million (see Table 3.12).

Table 3.12 Vietnam-born Population in Australia and Australian Trade with Vietnam (Selected Years)

Year	Vietnam-born [a] (Selected Census Year)	Year	Trade with Vietnam[b] (A$'000) Exports	Imports
1976	2373			
1981	40,725	1960	444	34
1986	82,705	1970	15,117	98
1991	121,811	1980	27,782	49
1996	151,053	1990	24,800	17,788
2001	154,830	2000	498,996	2,431,638
2005	177,728	2005	931,000	3,770,000

Source: a – The birthplace data are from ABS Statistics, cat. no. 5105.0.65.001 Australian Historical Population Statistics, varies years. b – Trade with Vietnam data are from Department of Foreign Affairs and Trade (2002 and 2006) and are recorded in current dollar values at each year.

3.4 Conclusion

This chapter briefly reviewed Australia's immigration history, the characteristics of its Asian immigration and its commodity trade with its Asian immigrant source countries. The immigrant stocks data and trade data presented in Table 3.1 through to Table 3.12 exhibited the general pattern of positive relations between immigration and trade. The data does not support the conclusion derived from the H-O model, that is, trade and labour immigration are substitutes. With this information at hand, the reasons for why immigration is not necessarily a substitute to trade, but rather a complement to trade deserve investigation.

In order to support the argument that immigration is not necessarily a substitute for trade, this study will establish a theoretical foundation to explain the complementarities between immigration and trade, based on the role of information played in the economy. The study then tests the complementarities between immigration and trade by considering the other impacts on trade such as economic growth of trading partners and the global trend towards freer trade. The theoretical foundation for complementarities will be provided in Chapter 4 and the empirical tests will be conducted in Chapter 8.

Chapter 4 A THEORETICAL MODEL OF IMMIGRATION AND TRADE

4.1 Introduction

In the traditional H-O model, it is assumed that the imported commodities are perceived by buyers as homogeneous as the same commodities produced at home. Goods can be imported because they are at a lower price. In a free trade environment, only those goods bearing a lower production cost are traded at a lower price. Thus the base of trade lies on the relative scarcity of resources supplied for production. Traded commodities are competing at the perfectly competitive market on the basis of relative costs. For example, if the U.S. has a lower cost of rice production and Japan has a lower cost of car production, then the U.S. car buyers will see no difference between American cars and the Japanese cars. With perfect price information, only those American cars that can match the Japanese car prices can remain in the American car market. The same situation applies for the Japanese rice producers. Only those Japanese rice producers who can match the American rice prices can survive. The product homogeneity assumption means that there is no need for buyers to search for information.

The development of the theory of Intra-Industry Trade shows that no commodities are homogenous, but they have some degree of homogeneity. Using the above example, by owning a car, consumers gain satisfaction from both the car's core utilities, which is transporting people from one place to another place on ground travel for the people's convenience, and the peripheral utilities of safety and comfort feature provided by the cars. The core utilities provided by the car attract consumers to the car industry as a whole, but the peripheral utilities of the car persuade consumers to a particular make and model of a car against the other cars within the car industry. If the degree of homogeneity amongst competing cars is high, for a representative buyer, the searching for a uniquely satisfactory car is less intense. The intensity of search by buyers will increase for the product with a lower degree of homogeneity, which satisfies the same basic needs.

On the suppliers' side, in order to "make it easy" for buyers, a representative supplier would conduct market research for an optimal marketing mix of product, price, place and promotion. The more unique marketing mixes the firms in the industry would adopt, the greater the differentiation of the commodities would be in the industry. For a firm that serves the international market, the extent of international market research would be greater than domestic market research. For example, culture and language differences and taste and preference differences could distinguish the international market from the domestic market.

By both forces of buyers and sellers being in place, there are feedback effects on the market to the equilibrium price and quantity. The greater the product varieties available in the market, the greater the tendency for buyers to search for the uniquely satisfactory product and price, and hence the intense the search will be. Buyers continue to revise their expectations on products and sellers continue to refine their products to attract buyers. This process is dynamic and it forms a virtues cycle on continuous improvement on new products, better product quality and greater varieties of products.

This chapter intends to demonstrate that immigration reduces buyer and seller search costs and business transaction costs. In order to present the connection from immigration to business transaction cost reduction, first, Section 4.2 discusses the demand side of the economy, and it represents the negative relation between the volumes of information the buyers possess and the selling prices that the sellers prepare to charge. Then, in Section 4.3, we discuss the production side of the economy, and it represents the negative relation between information and business transaction costs. In both sections, it can be seen that information plays a similar role to reduce prices and costs. In international trade, the information gap is wider than domestic trade, thus the marginal benefit of information would be greater than domestic trade. Section 4.4 follows the development in Section 4.2 and Section 4.3, and presents the links from immigrant information to transaction cost reduction for international trade, and proposes an alternative general equilibrium model for immigration and trade. Section 4.5 concludes this chapter.

4.2 Effects of Asymmetric Information on Price

In the real world of business, information is never perfect. It is always the case that some parties hold more information than other parties or some parties know what the other parties do not know. Since information is not evenly spread or distributed across the population, we face the situation of asymmetric information. Commonly cited examples are: potential employees know about their merits and abilities but employers cannot find those out before recruiting; the management of a firm knows more about the perspective of the business than potential investor; the insured know more about their health than the health insurance company which insures them; car owners know about the quality of their cars than potential buyers.

The role of information in economics has long been recognised. The *Law of Demand* acknowledges that if the price of a commodity increased, quantity demanded would decrease. Those consumers who are unwilling to pay a higher price either due to their inability to afford the higher price (the income effect) and/or the possession of the information on substitute goods (the substitution effect) would leave the market. If the firm knows about its customers and can discriminate them into the categories for those who are willing to absorb the higher price and those who are not, then the firm can design a multiple pricing system, charging different consumers at their highest expected (affordable) prices without compromising the quantity sold. On the other hand, if consumers possess perfect information about substitute or competing products, rational individuals would not allow the firm to charge them the higher price even if they can afford it. They can simply switch to another supplier.

However, information is not meant to be a free good. Buyers face a distribution of asking prices and a distribution of quality grades. It costs time and effort to find out which firm charges the right price for the right quality. The opportunity cost for the time and effort spent on searching can be expressed as a reduction of buyer utility. Among the buyers, there is also a distribution of buyers who hold different attitudes toward the need and the cost to find more product information. The uneven spread of buyer information renders no perfectly informed buyers but more or less informed buyers.

Traditional economic modelling based on perfect information would argue that the better informed could serve as surrogates to the less informed in the model since the less informed can mimic the better informed, then an economy with less than perfect information would look like an economy with perfect information. In contrast, Salop and Stiglitz (1977) argued that, with even a small amount of information imperfection, there is no reason why the economy has to reach a competitive equilibrium.

The process starts with a product at a competitive price. Assuming that buyers have less than perfect information, a representative firm would charge a slightly higher price than the competitive price. As long as the price difference is not higher than the search cost, it does not trigger the buyer to invest into searching for a new supplier. If this strategy works for the representative firm, it works for all other firms in the industry. Thus all firms in the industry charge a price higher than the competitive price. Since all firms charging the same above-competitive price, the process will replicate itself. A representative firm amongst those firms who are charging the same above-competitive prices would be better off to charge an even higher price without losing a significant number of customers, then, all other firms could do the same thing again. This process could continue up to a point where, as Diamond (1971) asserts, each firm could charge the monopoly price over their current customers. As a result, imperfect buyer information can create niche markets for sellers to exploit.

In addition, Salop and Stiglitz (1977) argued that although the competitive price is unstable under less than perfect information, the monopoly price proposed by Diamond is also unstable. Since the "niche" prices earn excessive profit for firms, it may attract new firms to enter or some incumbent firms may attempt to lower their prices to a noticeable difference level in order to gain a bigger slice of the market. The action of lowering prices provides incentive for buyer search, hence working in favour of the lower price firm. If one firm earns profits by lowering the price, all other firms can follow. At this point, the price will start to cycle down. In this kind or model, price could become permanently unstable and fluctuate in a pattern of a "price cycle". As a result, there would be a range of price equilibriums. The competitive price equilibrium described in the model of perfect competition with perfect information becomes one of the range of equilibrium prices, but not "the only price".

The above argument suggests that, holding all other factors constant, price is a function of information. It can be elaborated that price for buyers is a negative function of information. We would expect that the function would decrease in a decreasing rate due to diminishing return on information.

However, the above argument is only concerned with the situation where buyers do not have perfect information about sellers, but sellers have perfect information about buyers. That is, searches are conducted by the buyer's side only. However, there are un-answered questions: if buyer searches forced firms to lower their prices in the down turn of the price cycle, what is the lowest price the buyer search can achieve? Why the lowest price is unstable? Why this lowest price is not the equilibrium but eventually will cycle up? What causes the price to cycle up, even if some buyers become informed?

To answer these questions, we have to discard the assumption that firms have perfect information about consumers. There is no reason to claim that firm's managements are born with perfect buyer information, otherwise universities would not offer courses to teach market research skills and quantitative analysis. Insurance companies offering high wages to attract actuary graduates demonstrate that information is so important for the insurance firms' pricing strategy. One possible explanation for the cycling up or cycling down processes could be that firms also conduct search to find buyers. The motive for firms to search for buyers is to find out whom the firms can charge a higher price from. The force that keeps the firms continuously searching for buyers is the market dynamics. Market dynamics, in marketing concept, means a continuous changing of buyer population in the market over time. The buyer population in the market consists of new buyers, repeat buyers, and one-off buyers who leave the market after purchase and those who re-enter the market after being absent for a period of time. The exit of current buyers who possess market information could reduce the information pool in the buyer population; however, the entry of new buyers who has little market information into the market could dilute the information pool. The former buyers' re-entry into the market, they find themselves holding onto obsolete information. The market dynamics guarantee buyer information imperfection and the need for sellers to search for buyers who are willing to pay more. It follows that the price the sellers can charge is a positive function of better information. However, due to the diminishing return on greater volume of information, price changes in respect to the volume of information changes would be an increasing function with a decreasing rate.

It can be concluded that the fluctuation of price equilibriums between the competitive price and monopoly price can be attributed to two forces: buyers' search for sellers due to a distribution of sellers' asking prices (Stigler, 1961; 1962), and sellers' search for buyers due to uneven distribution of information among buyers and also due to market dynamics.

4.3 Effects of Price Spread on Information Search Cost

We have argued in Section 4.2, that price spread is a function of buyers and sellers information imperfection. However, this argument only tells one side of the story. On the other side, the information search costs, which cause the buyers and sellers information imperfection, are affected by the price spread asked (quoted) by the sellers. It can be demonstrated that the greater the quoted price spread among sellers, the higher the search costs the buyers are willing to incur, although the relation between price spread and search costs does not have to be linear. By holding quality constant, the greater the quoted price spread, the higher the chance to find a very low quoted price, that is, the greater incentive for search converts into a greater search cost. The sequential buyer search model (Rothschild, 1973, 1974; Silberberg & Suen, 2001) supports this point.

A number of suggestions the sequential search model has made are relevant to study the impact of immigrant information to international trade. Silberberg and Suen (2001, p.476-478) demonstrated that (1) a buyer with high search costs sets a higher reservation price; (2) frequent buyers or bulk buyers tend to set a lower reserve price; (3) buyers who set lower reserve price and who expect greater gain from search will exert higher search efforts; (4) an increase in search costs will shorten the search duration or the number of search attempts, (5) an increase in quoted price spread or an increase in the volume of purchase will increase the search duration.

In international trade, asymmetric information is generally stronger than domestic trade due to geographical separation, cultural diversification and language impediment. The greater the information disequilibrium, the greater the spread of asking prices by firms and also the greater the spread of willingness to pay by the buyers. International trade also involves a greater volume of transactions resulting in the economies of scale to justify the transportation costs. Thus, buyers and sellers who engage in international trade face greater variation in prices and incur greater search costs, which contribute to greater total cost and a lower volume of trade.

By acknowledging the negative relation between information gap and international trade, any reduction in the information gap will help to stimulate trade. There are numerous ways to increase information flow and reduce the information gap. For example, improving diplomatic relations between countries can facilitate the information flow and improving telecommunication technology such as the Internet will increase information flow. Human networking through immigrant links to their home countries is another way to facility information flow. The next section will present how migrant information influences transaction costs.

4.4 Effect of Immigration on Trade

Based on the modelling approach developed by Dixit and Norman (1980), Gould (1996) constructed a general equilibrium international trade model with three goods and two factors of production to investigate the effect of business cost reduction subject to immigrant information.[32] With the assumption of perfect competition (perfect information is implied) within the domestic market and imperfect information for international trade market, Gould concluded that the changes in trade due to immigrant information is ambiguous; the changes in the price ratio of un-traded goods to exportable goods due to immigration is also ambiguous; the impact of immigration on the welfare of the immigrant receiving country is unambiguously positive if there is no factor market distortions.

We propose an alternative approach, taking into account of information imperfection and the effects of immigrant information on the reduction of search costs and transaction costs. As stated in the previous sections of this chapter, under imperfect information, price of a commodity does not have to be a single equilibrium price. A commodity could be traded at a range of prices between the perfect competitive price and monopoly price depending on who is buying from whom in the market. Since both sellers and buyers are not perfectly

---

[32] The general equilibrium model of a system of equations is:

$$E(1,p,q,u) = R(1,p,q,V) \quad \text{(i)}$$

$$E_q(1,p,q,u) = R_q(1,p,q,V) \quad \text{(ii)}$$

$$p = p^* + I(Z) \quad \text{(iii)}$$

Equation (i) is for trade balance. E is total expenditure of an economy; R is total revenue of the economy; p is the domestic price ratio of importable goods to exportable goods; q is the domestic price ratio of non-traded goods to exportable goods. The price ratio of exportable goods to exportable goods is denoted by 1. u is the utility function of the economy and V is the vector of inputs. The left hand side of Equation (i) denotes maximising utility subject to income constraint; the right hand side denotes maximising profit subject to cost constraint. Equation (ii) is for domestic market clearing condition for non-tradable goods with constraint maximisations. Equation (iii) is for the price gap between domestic market and international market: p^* is the price ratio of importable goods to exportable goods in the international market; $I(Z)$ is the information cost function and $I(Z) \geq 0$, $I(.)$ is a negative function of Z , that is, the greater the Z, the lower the $I(.)$. Z is for immigrant and is also a subset of V. For further explanation on variables, see Gould (1996).

informed, price is a function of information held by individual sellers and buyers. Instead of assuming that the price gap between international price and the domestic price is the cost of information, the model we propose explicitly considers price as a function of information.

The following is for an open economy, allowing for free trade and free labour movement. The economy produces three goods: exportable (*X*), importable (*M*) and non-tradeable (*D*) by using two factors of production: capital (*K*) and labour (*L*). All three goods are produced by the three factors. The economy is land abundant and labour scarcity. We assume that the economy is a small country without market power over both resources market and goods market, i.e. it has no influence on the world prices of goods and world prices of factors. The economy uses standard technology and produces at least costs.

For a typical consumer,[33] the utility maximisation function subject to budget constraint is:

$$\begin{aligned} &\max : U(C_d, C_m, C_x), \\ &\text{s.t.} \quad q(I_F)C_d + p(I_F)C_m + C_x \leq Y \end{aligned} \tag{4.1}$$

where *U*(.) is the utility function. *C* is the quantity of consumption. Subscripts of *d*, *m* and *x* represent exportable, importable and non-tradeable goods respectively. Prices for the goods are $q(I_F)$, $p(I_F)$ and 1. Let $p(.)$ be the price ratio of importable goods to exportable goods. This model also assumes that perfect competition in the domestic market and imperfect information for the international market. As argued in Section 4.2 and Section 4.3, price is modelled as a function of foreign market information, $p(I_F)$ where (I_F) stands for foreign market information. Let $q(I_F)$ be the price ratio of non-tradeable goods to exportable goods. Although prices for non-tradable goods are independent from foreign market information, the price ratio of non-tradable to exportable is influenced by foreign market information (I_F) due to the impact of (I_F) on the price of the exportable. The value of 1 is the price ratio of exportable goods to exportable goods. *Y* is the total income. Equation (4.1) can be rearranged into the indirect utility function of:

[33] For simplicity, Dixit and Norman (A. K. Dixit & Norman, 1980) used one consumer in the model and the result can be generalised to more than one consumers.

$$E = E(q(I_F), p(I_F), 1, u) \tag{4.2}$$

On the supply side of the economy, producers' profit maximisation objective can be represented by,

$$\max : \Pi = q(I_F)Q_d + p(I_F)Q_m + Q_x - wV \tag{4.3}$$

where Q_d is the quantity of non-tradeable goods produced, Q_m is quantity of importable goods produced and Q_x is the quantity of exportable goods produced. w is the vector of factor prices and V is the vector of factors of production. This profit maximisation function of Equation (4.3) can be represented by the indirect profit function of:

$$R = R(q(I_F), p(I_F), 1, V) \tag{4.4}$$

For a circular flow of an economy, expenditure equals revenue, that is $E = R$. Equates (4.3) and (4.4) to get,

$$E(q(I_F), p(I_F), 1, u) = R(q(I_F), p(I_F), 1, V) \tag{4.5}$$

Equation (4.5) depicts the function of foreign market information in the external (trade balance) equilibrium in a single period model. Since the prices are defined as the ratio that is denominated by the price of exportable goods, we are more interested in the direction of change than the magnitude of the price. This equality can be supported by the argument that foreign market information can lower the prices of imports and raise the prices of exports in the course of trade. By reducing the price gap, the saving comes from lower transaction cost.

We are interested in finding out whether prices are affected by foreign market information. Total differentiate and rearrange Equation (4.5) to yield,[34]

---

[34] $E(q(I_F), p(I_F), 1, u) = R(q(I_F), p(I_F), 1, V)$

from total differentiation of the equation, to get

$$(E_q - R_q)\frac{dq}{dI_F} + (E_p - R_p)\frac{dp}{dI_F} = R_V dV - E_u du \qquad (4.6)$$

Since supply of and demand for non-tradeable goods are equal, thus $(E_q - R_q) = 0$. The solution for Equation (4.6) is,

$$(E_p - R_p)\frac{dp}{dI_F} = R_V dV - E_u du \qquad (4.7)$$

$$\frac{dp}{dI_F} = \frac{R_V dV - E_u du}{E_p - R_p} \qquad (4.8)$$

Equation (4.8) shows that the changes in ratio of importable price to exportable price, with respect to the changes in foreign market information depend on the four components: $R_V dV$, $E_u du$, E_p and R_p.

In the numerator in the right hand side of Equation (4.8), the term R_V is the marginal product with respect to production factors. In this model, we hold other production factors constant and only allow labour to move. R_V is the marginal product of labour from immigration, and is positive. dV is the change in quantity of production factor (labour) and is positive for immigrant intake. Thus $R_V dV$ represents the change in revenue from labour immigration, and is also positive. The term E_u is the marginal expenditure with respect to changes in consumer utility. It changes in the same direction as *du* changes. That is, if *du* increases, E_u also increases and vice versa. Hence $E_u du$ is positive and it represents the expenditure change from utility changes. In this model, in which borrowing is not allowed, the additional expenditure is only be met by additional revenue. That is $R_V dV - E_u du \geq 0$.

$$\frac{\partial E}{\partial q}\frac{dq}{dI_F} + \frac{\partial E}{\partial p}\frac{dp}{dI_F} + \frac{\partial E}{\partial u}du = \frac{\partial R}{\partial q}\frac{dq}{dI_F} + \frac{\partial R}{\partial p}\frac{dp}{dI_F} + \frac{\partial R}{\partial V}dV$$

$$E_q\frac{dq}{dI_F} + E_p\frac{dp}{dI_F} + E_u du = R_q\frac{dq}{dI_F} + R_p\frac{dp}{dI_F} + R_V dV$$

rearrange the equation, thus

$$(E_q - R_q)\frac{dq}{dI_F} + (E_p - R_p)\frac{dp}{dI_F} = R_V dV - E_u du$$

In the denominator, the term E_p is the price effect on expenditure, and is negative. The term R_p is the price effect on production, and is positive. That is $E_p - R_p < 0$.

For a positive numerator and a negative denominator, the right hand side of Equation (4.8) is negative, thus $dp/dI_F < 0$. It means that the price ratio (p) of importable to exportable decreases with respect to the increase in foreign market information (I_F). The decreasing ratio could be attributed to a reduction of importable price, or an increase in exportable price, or both. Since immigrant information is a subset of foreign market information, we conclude that immigrant bridges the information gap in international trade, by reducing the transaction cost, and by "negotiating" a higher export price and a lower import price. As a result, immigrant produces welfare gain for the immigrant host country through increases in both producer surplus and consumer surplus.

The terms of trade (TOT) of a country is defined as the ratio of its export price to its import price, which is the inverse of p. Since the price ratio (p) of importable to exportable decreases with respect to the increase in foreign market information (I_F), and the term of trade (TOT) increases with respect to the increase in foreign market information, hence, we can conclude that increasing foreign market information improves the country's TOT.

To model the relationship between immigrant information and trade, we can first consider a more general model of foreign market information (I_F) and trade, and then immigrant information (I_Z) can be considered as a part (or an element) of foreign market information, i.e. $I_Z \in I_F$. If foreign market information can reduce the transaction cost, which in turn lowers the price of importable and raises the price of exportable, then we can claim that immigrant information as an element of foreign market information also reduces the price of importable goods and raises the price of exportable goods by reducing transaction costs and search costs. We can also infer that immigrant information helps improve host country's trade with immigrant home country.

4.5 Conclusion

This chapter presented the link between the lack of foreign market information and a higher price of trade, leading to a higher search cost and lower volume of trade. The function of foreign market information and immigrant information on lowering the price of importable and raising the price of exportable is represented in the proposed model. From the impact of immigrant information on prices, we conclude that immigrant information facilitates trade between immigrant home and host countries.

The solution of the proposed model is promising. However, more rigorous proof would make the model more convincing. Since this research focuses more on the empirical testing on the effects of immigration on Australia's trade, more rigorous proof will be left to future research with a different focus.

In order to test the effect of immigrant information on Australia's trade with immigrant home countries, this study will develop empirical gravity models. However, before developing the gravity model, the literature on gravity model is reviewed in Chapter 5.

Chapter 5 A REVIEW OF THE GRAVITY MODEL AND ITS APPLICATION

5.1 Introduction

In Chapter 3, we reviewed the history of Australia's immigrant intakes from and Australia's trade with eleven immigrant source countries of Asia. The data in Chapter 3 showed that both immigrant stocks and the volume of goods traded increased over time for all the countries. The data do not support the H-O model's claim that increasing labour immigration will reduce commodity trade, but tends to support the opposite. In Chapter 4, we have seen that the inflow of immigrant information reduces international business transaction costs, and reduces both buyers' and sellers' search costs. As lower costs pass onto lower price under competition, the volume of international trade would increases. The results from Chapter 3 and Chapter 4 provide preliminary hypotheses for more in-depth econometric tests using empirical data.

However, the model in Chapter 4 could not demonstrate the cultural broker function of immigrants, which is the non-price effect on total trade. The non-price effect is more profound than the price effect. For instance, the variety of tradeable goods increases due to immigrant information raising the nation's total utility, but it may not show up in the price changes. In addition, although the data in Chapter 3 have shown a strong positive association between the data on immigration stocks and the trade volume, it will be naive to attribute immigration information as the major factor contributing to the volume of trade. A country's exports are still largely determined by the economic conditions of its trade partner(s), while the country's imports are mainly affected by its own economic conditions, which can be quantified by real gross domestic product (RGDP). Other important factors influencing a country's trade performance are the stage of economic development, the price level of the traded goods, the trading partners' population, and whether they are in the same trade bloc, and so on. Here, we attempt to find out whether immigrant information provides a significant contribution to international trade using the gravity model of international trade.

In this study, it is intended to apply the gravity model to perform an analysis of the contributions of immigrant information to international trade. The gravity model has been very successful in explaining international trade in many studies. Before we build a workable model in Chapter 6, we will conduct a comprehensive literature review on the gravity model in the rest of Chapter 5.

In Section 5.2, we will justify the application of gravity model in this study. Section 5.3 reviews the origins of the gravity model. Section 5.4 shows how the gravity model branched into the economics field. Section 5.5 discusses the growing diversified uses of the Gravity model in economics to explain trade flows. Section 5.6 investigates the popular variables used in the gravity model. Section 5.7 reviews the theoretical support to the gravity model presented by a number of studies. Section 5.8 concludes the current chapter.

5.2 Justification of the Use of the Gravity Model in this Study

Gravity models (in many forms for different studies) have been the most successful empirical tools used to explain international trade flows. The gravity models have been applied to a wide variety of goods trade and factors moving between regions and across national borders, and the estimations produce good fit to the data. The models were developed during the 1950s and 1960s, and specifically sought to explain the volume of trade. The models predict that trade flows are proportional to the size of the economy of both trading partners and are inversely associated with the trade impediments between them. The models can be derived from very different trade theories: the Ricardo's comparative advantage theory; the Heckscher-Ohlin's factor endowment and factor intensity theory; and monopolistic competitive theory with increasing return to scale. The gravity models are consistent with the Heckscher-Ohlin-Vanek factor service trade prediction, one of the most important results of trade flows (Evenett & Keller, 2002). The gravity models are useful tools in analysing the determinants of international trade flows, identifying and estimating export market potential and identifying "natural" trade blocs (Lung & Gunawardana, 2000). The gravity models can determine the normal or standard bilateral trade pattern that would prevail in the absence of trade impediments (Gunawardana, 2005), and also can determine the magnitude of the trade impediments. In addition, the gravity models are also consistent with Helpman-Krugman-Markusen theory of intra-industry trade (Bergstrand, 1989).

This study focuses on the marginal effect of immigrant information on the volume of trade with immigrant home countries. By using gravity equation, which is derived as a reduced form from a four-equation partial equilibrium model of export supply and import demand as in Linnemann (1966), is the best approach to investigate whether immigrant information impacts on export supply and import demand simultaneously.

5.3 The Foundations of the Gravity Model

The use of the gravity model for explaining spatial interaction and flows of all kinds appeared in the late 19th Century. It has been successful in explaining human flows from one centre to another, such as immigration flows, shopper flows to shopping centres, patient flows to hospitals, commuting traffics, and so on (for example, see Karemera, Oguledo, & Davis, 2000; Zipf, 1946). The model assumed that there is a hidden force to draw the flow. The force is formed by the attraction of the two centres. The attraction of the two centres can be attributed to their sizes. The force is weakened by the distance between two centres. This formulation is by the use of Newton's Law of Universal Gravitation:[35]

$$F = \frac{GM_1M_2}{r^2} \tag{5.1}$$

where F is attraction force, M_1 and M_2 are masses of two objects, r is the distance between M_1 and M_2, and G is the constant proportion. Newton's theory of gravitation says that the force of attraction between the objects is proportionally related to the size of their masses and inversely related to the square of the distance between them.

Stewart (1947) used the gravity model to study the distribution and equilibrium of population. Hua and Porell (1979), Kau and Sirmans (1979) and Oguledo and Macphee (1994) identified some other applications of the gravity model which analysed the flows of buyers to shopping centres, patient flows to hospitals, recreation traffic, commuting, immigration, communication, household relocation, regional planning, transportation and tourism.

[35] The formula is cited from Grolier Encyclopaedia CD-ROM, published by Grolier Electronic Publishing, Inc., 1995. See also Ramsey (Ramsey, 1964).

5.4 The Application of the Gravity Model in International Trade Flow Analysis

The application of the gravity model in international trade was pioneered independently by the Dutch economist Tinbergen (1962) and Finnish economists Pulliainen (1963) and Pöyhönen (1963). Their studies were presented as preliminary results to be tested further in future studies. The simplest form of the gravity trade model as used by Tinbergen (1962) was:

$$E_{ij} = \alpha_0 Y_i^{\alpha_1} Y_j^{\alpha_2} D_{ij}^{\alpha_3} \tag{5.2}$$

where: E_{ij} = Exports from country *i* to country *j*

Y_i = GNP of country *i*

Y_j = GNP of country *j*

D_{ij} = Distance between country *i* and country *j*

α = Scaling factors

Tinbergen made an analogy of a country's exports E_{ij} with Newtonian's Universal Gravitation force *F* in Equation (5.1). The masses of M_1 and M_2 were replaced by Y_i and Y_j, which are the income levels or the sizes of economies of the trading partner countries. Tinbergen believed that the size of exporting country's economy positively influences its ability to supply to the world market; and the importer's income level is positively related to the market size for imported goods. He reasoned that transportation costs and other natural trade impediments create a price wedge between the exporting country and the importing country. This price wedge raised the relative price of traded goods to non-traded goods, and hence inversely (negatively) affected the volume of trade. Due to the complexity of those natural trade impediments, it is difficult to quantify those individually. Tinbergen used the proxy of distance variable D_{ij} to capture the essence of those natural trade impediments.

To capture the artificial trade enhancing and trade discrimination effects, Tinbergen (1962) modified the basic gravity model of Equation (5.2) by introducing three dummy variables: the common border effect dummy, the Commonwealth preferential dummy and the Benelux preferential dummy. The gravity model in Equation (5.2) was then expanded as:

$$E_{ij} = \alpha_0 Y_i^{\alpha_1} Y_j^{\alpha_2} D_{ij}^{\alpha_4} N^{\alpha_4} P_c^{\alpha_5} P_b^{\alpha_6} \quad (5.3)$$

where N is common border dummy variable, P_c is Commonwealth preference dummy variable and P_b is Benelux preference dummy variable. The dummy variables were assigned positive values if the arguments of the dummies are satisfied and zero otherwise[36]. Equation (5.3) was then estimated in the double-log form of:

$$\log E_{ij} = \alpha_1 \log Y_i + \alpha_2 \log Y_j + \alpha_3 \log D_{ij} + \alpha_4 \log N + \alpha_5 \log P_c + \alpha_6 \log P_b + \alpha_0' \quad (5.4)$$

where $\alpha_0' = \log \alpha_0$. However, the logarithm of dummy variables, which consist of zeros and ones, would result in the regression being inoperative. Linnemann (1966) rectified this problem by using the values of ones and twos for the dummy variables.

The model with trading countries' income variables and the distance variable is viewed as the basic gravity model in the analysis of international trade flows. Any trade obeying this rule is regarded as the expected trade or as the standard trade level. The purpose of Tinbergen (1962) was to develop a model to determine the standard pattern of international trade in the absence of discriminatory trade impediments. An expected- or standard-trade between countries can be revealed by the "average" trade estimated from the model, and the trade impediments are of a stochastic nature. By comparing the actual exports with the expected exports, a positive deviation between them means that actual exports are greater than the expected exports. Any countries whose actual exports are greater than their expected exports are receiving preferential treatment by the importing countries. In contrast, a negative deviation shows that actual exports are less than the expected exports. Any negative deviations indicate that exports of the given countries are discriminated against by the importing countries. For policy makers who are looking at trade expansion the negative deviations are of greater interest as they indicate the existence of untapped trade potential in the importing countries, and attention could be focused on any existing trade barriers or resistances to trade, for trade negotiation purposes.

---

[36] Tinbergen (1962) did not indicate what the positive value was, but presumably, the 'positive value' means '+1'.

5.5 Diverse Approaches to Gravity Models

In Linnemann (1966), the actual trade is regarded as a joint force of two major components: the potential trade factor and the trade resistance factor. Both income and population determine a country's potential trade. The trade resistance factor can be divided into natural trade obstacles and artificial trade impediments. The major components of the natural trade obstacles are transportation costs, transportation time and the psychic distance. The transportation costs and transportation time component of the natural trade obstacles are self-explanatory, but the term of psychic distance requires further explanation. According to Linnemann (1966), the psychic distance relates to imperfect market information due to different languages, different cultures, unfamiliar laws and institutions in the partner country, and so on. The psychic distance and physical distance are related, as people could be relatively familiar with neighbouring countries compared to a country located far away. Linnemann argued that these three components of natural trade obstacles could be represented by the physical distance variable as a proxy.

Artificial trade impediments are government-created, such as quotas, tariffs, exchange controls, voluntary export restrictions, embargoes and trade diverting custom unions. The effects of these artificial trade impediments on trade were the focus in Linnemann (1966). By taking into consideration the trade potential, natural trade impediments and artificial trade impediments, Linnemann firmly established the empirical base of the gravity model to explain international trade flows as:

$$\begin{aligned}\log X_{ij} &= \varphi_1 \log Y_i + \varphi_2 \log N_i + \varphi_3 \log Y_j + \varphi_4 \log N_j + \varphi_5 \log D_{ij} \\ &+ \varphi_6 \log P_{ij}^{UUC} + \varphi_7 \log P_{ij}^{FFC} + \varphi_8 \log P_{ij}^{PB} + \varphi_0^{'}\end{aligned} \tag{5.5}$$

where: X_{ij} = Total exports of country *i* to country *j*

Y = GNP

N = Population

D_{ij} = Distance between country *i* and country *j*

P_{ij}^{UUC} = Dummy variable for British Commonwealth preference

P_{ij}^{FFC} = Dummy variable for French Community preference

P_{ij}^{PB} = Dummy variable for Belgian and Portuguese colonial preference

The major difference between Linnemann's model (Equation (5.5)) and Tinbergen's model (Equation (5.4)) was that Linnemann excluded the country border dummy variable and introduced the population variables of the trading nations. In addition, Linnemann used the values of twos and ones in the dummy variables.

The studies of Tinbergen (1962) and Linnemann (1966) stimulated a vast research interest on the gravity model. The role of the gravity model as a popular instrument in explaining world trade and its empirical success was soon recognised by the economics profession. Substantial amount of research on international trade flows was conducted using different forms of the gravity model. For example, Aitken (1973), Aitken and Obutelewicz (1976), Bikker (1987), Baldwin (1993), Frankel *et al* (1995), Greenaway and Milner (2002) and Rajapakse and Arunatilake (1997) identified the preferential trade effects of trade blocs on international trade flows. Trade potential was the focus of Egger (2002), and Al-Atrash and Yousef (2000). Martinez-Zarzoso (2003), Tang (2003), and Martinez-Zarzoso and Nowak-Lehmann (2002), applied the gravity models to study the trade effects between trade blocs. Yu and Zietlow (1995) investigated the determinants of bilateral trade in Asia-Pacific. Gunawardana and Hewarathna (2000), Blomqvist (2004) and Gunawardana (2005) investigated the impact of Asian economic crisis on Australia's trade flow with East Asian countries. Bergstrand (1989; 1990) modified the gravity model to explain intra-industry trade flows. McCrohan and Lung (2001) studied the potential trade links between Australia and Thailand generated by Thai tertiary students graduated in Australia. Gould (1994; 1996) and Rauch (1996; 1999) explored the link between immigration and trade in the US. Koo and Karemera (1991), Dascal (2002), Christerson (1994) and Lung (1998) studied the trade flow in specific commodities between a number of countries.

5.5.1 The Impact of Costs on Trade Flows

Unlike most of the earlier studies with primary concern of the artificial trade impediments and preferential treatments of trade blocs, which lumped all the natural trade obstacles into the distance variable, Geraci and Prewo (1977) took the lead to model the transportation costs explicitly. They justified their approach by three arguments: First, the transportation costs varying according to the commodities being transported, such as bulky and heavy but low valued goods versus light and compact in size but high valued goods. It is the proportion of transportation cost to the value of the goods that negatively affecting trade. Second, following the previous argument, as long as inter-industry trade is involved between a pair of countries, transportation costs will not be the same for both directions of moving goods since the commodity composition of trade differ, transportation costs differ even though the distance between the pair of countries remains the same. Third, the use of distance as a proxy for transportation costs is not helpful for policy analysis since between any pair of countries, distance does not change.

In order to model the transportation costs, Geraci and Prewo (1977) distinguished trade resistance into those that can be quantified and those that cannot be quantified. They quantified the transportation costs of the natural trade obstacles T_{ij}^* and quantified tariff Z_j by using an average nominal tariff rate.[37] Their model is:

$$X_{ij} = f(Y_i, Y_j, Z_j, G_{ij}, L_{ij}, B_{ij}, T_{ij}^*) \qquad (5.6)$$

where X_{ij} is total exports from country *i* to country *j*. The variables *G, L* and *B* are dummy variables to capture the effects of preferential trading groups, common language and common borders respectively. T_{ij}^* is unobservable and can be obtained in two ways. According to Geraci and Prewo, T_{ij}^* is a proxy of T_{ij} which is the ratio of true c.i.f. value to true f.o.b. value,[38] and as in Equation (5.7) below:

$$T_{ij}^* = g(T_{ij}) \qquad (5.7)$$

[37] Geraci and Prewo (1977) used average nominal tariff rate weighted by each country's most-favoured-nation imports of industrial goods.

[38] Both c.i.f. and f.o.b. are Incoterms - the official International Chamber of Commerce rules for the interpretation of trade terms. c.i.f. stands for Cost, Insurance and Freight. The cost of carriage and insurance cover up to the named port of destination are borne to the sellers. f.o.b stands for Free on Board. Seller's responsibility to the goods is up to the named port of shipment. After the goods pass the ship's rial, all costs associated with moving the goods are borne by the buyer.

alternatively, T_{ij}^* is a function of distance D_{ij} and the average unit value (V_i)[39] of exports from country i, as in Equation (5.8) below:

$$T_{ij}^* = h(D_{ij}, V_i) \qquad (5.8)$$

Geraci and Prewo (1977) found that both the tariff variable and the transport cost variable were statistically significant with a negative impact on a country's total exports.

A number of studies were also interested in the negative impact of transaction costs on the volume of trade. For example, Loungani *et al* (2002) focused on the impact of physical distance and information distance on capital flow, while Hutchinson (2002) was interested in the effects of costs of inefficient communication and language barriers on trade.

5.5.2 Commodity Based Gravity Models

The gravity model was invented to analyse the determinants of total exports from one country to another. Leamer (1974), in focusing on the impact of tariffs on trade, used the gravity model for disaggregated commodity imports. The dependant variable was M_{ik}. Where M is imports, i is country subscript and k is commodity subscript. The study used one period cross-sectional data.

A number of studies applied a similar technique as Leamer (1974) by focusing on disaggregate commodities. For example, Gould (1996) studied the trade flow pattern of consumer goods between the U.S. and its immigrant home countries. Dascal *et al* (2002) used full panel data to analyse the EU wine trade.

Bergstrand (1989) opened up a new front of research by using the gravity model to explain international trade flows in differentiated products rather than for total trade of a country. His model can be presented as:

[39] Geraci and Prewo (1977) calculated the average unit value (V_i) by using the weight and value figures for each country's exports as reported in the Country Table 3 of the U. N. *Yearbook of International Trade Statistics, 1970 – 1971.*

$$PX_{aij} = f(Y_i, \frac{Y_i}{N_i}, Y_j, \frac{Y_j}{N_j}, D_{ij}, A_{ij}, EEC, EFTA, C_j, WPI_i, WPI_j) \quad (5.9)$$

where PX_{aij} is the value of exports of commodity *a* from *i* to *j*, and *i* is the exporter country and *j* is the importer country. *Y* is the aggregate income. Y/N is per-capita income. *D* is distance between countries. *A* is the dummy variable for common border effect. *EEC* and *EFTA* are the dummy variables for custom union effects of EEC and EFTA, respectively. C_j is the change in the importing country's exchange rate. *WPI* are average wholesale price indices.

By the use of the variable of Y/N, Bergstrand (1989) explained that, in addition to the basic gravity model, the volume of trade for a commodity is also affected by the consumers' buying power (per capita income) in both countries. If the buying power of consumers in the exporting countries increased, domestic demand for the exporting goods is stronger (assuming the goods are normal goods), hence it might reduce the quantity of the commodity exported, thus reducing trade flow. On the other hand, an improvement of the importer's per capita income would increase the demand for imported goods (assuming marginal propensity to import remains unchanged), and as a result, trade flow will increase. The variable C_j was used to capture the impact of change in the importing country's exchange rate. An appreciation of the importer's currency would increase the demand for imported goods.

Following Bergstrand's innovative use of the gravity model to explain bilateral trade flows for a particular commodity, several other analysts used a similar approach. For example, Koo and Karemera (1991) used the gravity model to analyse the determinants of world wheat trade flows. Christerson (1994) employed the gravity model to analyse world trade in apparel. Lung (1998) used the gravity model to analyse trade flows of alcoholic beverages between Australia and APEC countries as well as between Australia and some non-APEC countries. Vido and Prentice (2003) used the gravity model to study Canadian lentil and pork trade.

Feenstra *et al* (1998) ventured into a study for homogenous goods. Feenstra *et al* claimed that trade for homogenous products with free market entry also exhibits the home market effect as in the case of trade for differentiated products. By modelling the homogenous goods as in a Cournot-Nash competition market structure and applying the "reciprocal dumping" model of trade of Brander (Brander, 1981), Feenstra *et al* developed a new approach to apply the gravity model.

5.5.3 Combining Cross Sectional Data and Time Series Data

Traditionally, the gravity model was set up to explain economic interaction (international trade) between country *i* and country *j* at a point in time. The majority of gravity models on empirical studies have been for comparison across countries, holding time constant at a particular point. Usually the dependent variable X_{ij} is for exports from country *i* to country *j*. Where $i = 1,...,I$, $j = 1,...,i-1,i+1,...,J$ (it means $i \neq j$ and $J = I - 1$). The number of observations in the regression is $I \times J$ or $I \times (I-1)$.

Leamer (1974) acknowledged the shortcoming of a single cross-section study which could fail to capture the effect of policies since policy decisions operates over time rather than across countries. He suggested a fruitful direction of research for gravity models, that is, using cross-section and time-series data.

In order to compare the changes over time, some researches used the method of conducting several cross-sectional econometric analyses at different times across a number of years. The changes of the coefficients for the same variables in the gravity model from those analyses can capture the changes of the factors affecting trade over the same period of time (see, for example Blavy, 2001; Blomqvist, 1993; Frankel et al., 1995; Helliwell, 1996; Yu & Zietlow, 1995).

Pelzman (1976; 1977) carried on the research suggested by Leamer (1974), combining into one gravity model from a full set of cross-section data on trade development within the Soviet bloc of the Council of Mutual Economic Assistance (CMEA) over a 16-years period. Pelzman's studies used a full panel of cross-section and time-series with the dependant variable of X_{ij}^{t} , where X_{ij}^{t} represents the exports from country *i* to country *j* at time *t*.

$i=1,...,I$, $j=1,...,i-1,i+1,...,J$ and $t=1,...T$. The number of observations in Pelzman's regression was $I\times(I-1)\times T$. The gravity models using panel data are suitable for the situation where trade development between countries is also of interest in the studies since it can capture the dynamic time effect. Although Anderson (1979) believed that the use of pooled cross-section and time series data technique in the gravity model required theoretical justification, a number of studies (see, for example Mátyás, 1997; Tang, 2003; Vido & Prentice, 2003; Zhang & Kristersen, 1995) employed the full panel data with the dependent variable of X_{ij}^t .

Some researchers paid particular attention to the econometric issues of the model. Zhang and Kristersen (1995) specified their pooled cross-sectional and time-series gravity model, allowing coefficients for the explanatory variables across countries to vary. Mátyás (1997) commented on the issue of model specification for the use of a full panel data set, based on the study of Mátyás *et al* (1997). It is demonstrated that when the fixed effect is appropriate for a full panel gravity model which has the data structure like Pelzman (1976; 1977), it is necessary to incorporate dummy variables for the home country effect, the target country effects and the time effect. The model developed by Mátyás *et al* (1997) is:

$$\begin{aligned}\ln Exp_{ijt} = \alpha_i + \gamma_j + \lambda_t + \beta_1 \ln Y_{it} + \beta_2 \ln Y_{it} + \beta_3 \ln POP_{it} + \\ \beta_4 \ln POP_{jt} + \beta_5 \ln FCR_{jt} + \beta_6 \ln RER_{ijt} + u_{ijt}\end{aligned} \tag{5.10}$$

where: ln = Logarithm

EXP = The volume of exports

Y = GDP

POP = Population

FCR = Foreign currency reserves

RER = Real exchange rate

i = Exporting country, $i = 1,\ldots, N$,

j = Importing country, $j = 1,\ldots,i-1, i+1,\ldots N + 1$,

t = Time, $t = 1,\ldots,T$

α_i = Dummy for local country effect,

γ_j = Dummy for target country effect,

λ_t = Dummy for time (business cycle) effect, and

u_{ijt} = White noise (error term).

Mátyás *et al* (1997) point out that when using cross section dummy variables only, some previous researchers automatically restricted the time effect arising from business cycles. When only time series dummies were used, the local (exporting) country and target (importing) country effects are restricted. By only using pooled (time series-cross section) data and explicitly considering the exporting country, importing country and time effects, the gravity model will be complete. The gravity model proposed by Mátyás *et al* (1997) is called Least Square Dummy Variables (LSDV) model for pooled data with fixed effects for which the intercept vectors α_i, γ_j and λ_t are treated as fixed parameters. Mátyás (1997) argued that all studies which failed to incorporate the three sets of dummy variables for the fixed effect had produced misleading results. However, Mátyás *et al* (1997) does not provide a theoretical justification for the omission of the distance variable and the inclusion of variables for real exchange rate and foreign currency reserves in their model.

5.5.4 Country Specific Gravity Models

The gravity model was set up to explain trade between countries. Initially, the model used cross-section trade data among trading partners in the sample in a particular year. A form of deviation of the initial model focused on trade of one country with a pool of other countries in the sample over a number of years. It is a form of the pooled cross-section and time series model, but represents a reduced form of the full panel gravity model to focus on a particular country only. This practice is sometimes referred to as using the country specific gravity model.

Thursby and Thursby (1987), pioneered the use of country specific models. Their study aimed to test the Linder hypothesis[40] and the effect of exchange rate variability on trade flows. In their model, the dependant variable was X^i_{jt} with *i* the exporting country that remains unchanged for one regression equation, and *j* the set of trade partners (1,…,*J*) and *t* is the period of time (1,…,*T*) the study is concerned with. The number of observations in their model was $J \times T$.[41] There were seventeen countries in Thursby and Thursby (1987)'s sample. They generated seventeen regression equations. Each equation modelled the

[40] Linder (1961) hypothesised that trade of manufactured goods between two countries will be inversely related to the difference in their per capita incomes (Thursby and Thursby, 1987). That is, trading in manufactured goods will be higher among countries with similar taste and income levels (Salvatore, 1990, p.151).

[41] Compared to the full panel data gravity model, which has the number of observations $I \times J \times T$, where $J = I - 1$, the country specific gravity models have *J* times observations less.

exports of a particular country i $(i = 1, 2, 3, ..., 17)$ to the rest of sixteen countries j $(j = 1, 2, 3, ..., 16)$ over nine years t $(t = 1, 2, 3, ...9)$ with a total of 144 observations for each equation.[42]

Similar to Thursby and Thursby's approach, which focuses on a single country in each regression equation in a pooled cross-section and time series gravity model, Gould (1996) used a country specific gravity model and focused on one country's (the U.S.) trade with all trade partner countries. The dependent variables in Gould's models were EX_{jt}^{us} for exports and IM_{jt}^{us} for imports. No separate equations were estimated for each of the U.S.' trade partners.

The use of cross-section and time series (panel) data on a country specific basis represents another new direction in the use of the gravity model. For Australia, Lung (1998), Kalirjan (1999) and Gunawardana (2005) also used the country specific model to investigate Australian trade with its trade partners. Vido and Prentice (2003) applied the country specific model to analyse Canadian trade with other countries.

5.6 Core Explanatory Variables in the Gravity Model

The common feature of the gravity model is that it attempts to attribute flows from one region to another region depending on the relative attractiveness of the two regions. In relation to international trade, the model proposes that flow of goods from one country to another is a function of a positive product of the size of economies of the two trading countries and an inverse function of trade resistance factors. The model attempts to explain the volume of trade as a result of the trading countries' ability to supply and demand tradeable goods when the trade resistance factors are removed. It appears as a reduced form of simultaneous equations of supply and demand in which prices are endogenous. The ability to supply and demand by trading nations is characterised by the trading countries' wealth (GDP), market sizes (population), and their average living standard (per capita GDP). Trade resistances can be quantitative and/or qualitative. Quantitative resistances are

---

[42] Section 5.4.4 is more interested in the way the gravity model is set up. The explanatory variables used by Thursby and Thursby to test the Linder hypothesis and the foreign exchange risk could be of great interest to some readers, who are recommended to refer to the Thursby and Thursby's article.

captured by transportation costs (proxy by the geographical distance between trading nations) and tariff. Qualitative measures are non-tariff barriers (proxy by preferential treatment and trade bloc dummy variables). The use of these explanatory variables in the gravity model attracted a great deal of attention. The ensuing sub-sections focus on the core explanatory variables.

5.6.1 The GDP Variables

The empirical relationship between GDP variables and the total exports is not clear. Most studies found that the GDP variables are positive and significant. These studies include Tinbergen (1962), Pöyhönen (1963), Linnemann (1966), Aitken (1973), Aitken and Obutelewicz (1976), Geraci and Prewo (1977; 1982), Frankel and Wei (1993), Frankel *et al*(1995), Bergstrand (1985; 1989; 1990), Thursby and Thursby (1987), Le, Nguyen and Bandara (1997) and Christerson (1994). However, Glejser (1968, cited in Oguledo and MacPhee, 1994) found that exporter's GDP has a negative and significant impact on total trade.

While home country's GDP partially determines total exports, total exports also contribute a portion of home country's GDP. GDP is measured as the sum of aggregate consumption (C), aggregate investment (I), government expenditure (G) and net exports (NX), which are total exports (X) minus total imports (IM). Total exports contribute a portion of GDP either by increasing the GDP if net exports are positive or by reducing the GDP if net exports are negative. Under the very rare situation where the country has a balanced trade (a very special case of zero net export), the GDP is independent from the net exports. Whenever net exports are not zero, the dependent variable of total exports in the gravity model is not independent from the explanatory variable of GDP. As a result, the GDP variable is contemporaneously correlated[43] with the error term in the regression through the dependent variable, thus the ordinary least squares (OLS) estimators are inconsistent and hence the estimates are biased. For the same reasoning, foreign country's GDP is also correlated with home country's total exports as they constitute a proportion of the foreign country' total imports, but the endogeneity is to a lesser extent.

---

[43] Contemporaneous correlation, in econometric terminology, means that one or more explanatory variable(s) correlate(s) with the error term in the same time period (Griffiths, Hill, & Judge, 1993, p.450).

A number of studies acknowledged that the dependent variable in the gravity model has endogenous problem with the GDP variable and attempted to replace the GDP variables by instrument variables. For example, Wei (1996) uses a quadratic function of population as an instrument for GDP. Cyrus (2002) used factor-accumulation-variables as instruments for GDP. These factor-accumulation-variables are physical capital accumulation rate (the average share of investment in income), human capital accumulation rate (the average share of the working-age population in secondary schools) and the growth rate of the working-age population.

However, the impact of the endogenous problem on the OLS estimates might be less significant when the gravity model is applied on commodity specific trade rather than total trade and if the commodity in study does not make up a significant share of the country's total trade.

5.6.2 Population

The impact of the population variable is not clear. Linnemann (1966), Aitken (1976), Blomqvist (1994), Oguledo and MacPhee (1994), Christin (1996) and Mátyás *et al* (1997) found that populations of the trading countries have a negative and statistically significant impact on the trade flows. However, Brada and Méndez (1983) found population size to have a positive and significant impact on trade flows. In the study of Asian countries, Frankel, Romer and Cyrus (1996) found that the populations of exporting countries have negative and significant impact on trade flows, while the populations of importing courtiers have positive and significant impacts.

5.6.3 Per Capita GDP

Per capita GDP is not a common variable used across gravity models applying cross-section data. However, a number of studies incorporated per capita GDP in the models, by taking into consideration of the stages of economic development on the influence of trade. When per capita GDP is used, either population variable (Le *et al*, 1997; Bergstrand, 1989; Frankel and Wei, 1993; Frankel *et al*, 1995) or GDP variable (Frankel *et al*, 1996) was omitted. All of the per capita GDP variables, except some in Bergstrand's model [44], have a positive and significant impact on trade flows.

5.6.4 The Distance Variable

The distance variable in the gravity model is a proxy variable for transportation costs. The common practice is to use direct distance (so called "bird-view") between major economic centres of the two trading partners, and often these economic centres are selected arbitrarily. Some studies replaced the economic centres by major seaports.

However, a number of studies investigated the influence of transportation costs on trade. They argue that transportation cost is not a linear function of distance and volume, but are subject to the influence of economies of scale. In addition, shipments in opposite direction between a pair of countries may not incur the same costs because the ocean currents affect the shipping route used. Land transportation between seaports and economic centres may vary substantially for the same distance depending on the road conditions and landscape. A comprehensive discussion of the deficiency in using direct distance as a proxy for transportation costs is provided in Vido and Prentice (2003).

Linnemann (1966, p.180-88) recognised the deficiency of the distance variable and provided an alternative measure. Linnemann calculated a location index to measure the "advantage" of a country for international trade in terms of physical location. The index was calculated based on the country's trade share in value to the total world trade. Polak (1996) applied the location index in his study for APEC trade bloc with some improvement in efficiency. However, the calculation of the location index is quite complicated. If the efficiency improvement is weighted against the cumbersome working out of the location index, the benefit will be reduced. On the other hand, the location indices for each country are subject to changes if either the number of countries involved or the trade shares or both change over time. Its use is limited to one period cross-section analysis.

---

[44] Bergstrand (1989), by studying one-digit SITC (from SITC 0 to SITC 8) trade flows and using variables of exporter per capita income and importer per capita income, found that in 1976 importer per capita income had positive impact on trade flow of six out of nine categories of tradeable goods. However, three of the six coefficients are statistically significant. Importer per capita income also had positive sign for six categories. Four of them were statistically significant. Of the nine categories, three had the positive sign for importer per capita income and for exporter per capita income. Six of them had opposite signs.

5.6.5 Export and Import Prices in the Gravity Equation

Linnemann (1966) believed that prices of commodities have no role to play in the gravity model since in the world market, supply equals demand. If a particular country has long term "too high" or "too low" prices, there would be a permanent disequilibrium of the balance of payment and the adjustment of the exchange rate will take place to correct the disequilibrium.

In the 1970's, a number of authors started to pay attention to the missing price components in the gravity model and their effects on trade. Anderson (1979) argued that the gravity model should include the price variables. Bergstrand (1985) was more explicit to tackle the problem of missing price variables in the gravity model in his general equilibrium approach. Thursby and Thursby (1987), Gould (1996) and Bikker (1987) among others, found that the price variables were significant in explaining international trade. Oguledo and MacPhee (1994) made a successful extension to Anderson's approach by placing the price variables in the gravity model and fully justifying the price variable in the gravity model.

5.6.6 The Tariff Variables

Tariff is an artificial trade barrier. Linnemann (1966) discussed the difficulty of using tariff as a variable. To overcome the difficulty, he assumed that commodities faced the same average tariff across all trading nations with some deviations. The deviations were classified as positive if deviations are higher than average and as negative if deviations are lower than average. An example of positive deviation is an embargo and an example of negative deviation is preferential treatment. He used dummy variables to capture these deviations.

Instead of using dummy variables as a proxy for the impact of tariffs on trade flows, Geraci and Prewo (1977) and Oguledo and Macphee (1994) explicitly used a tariff variable in their gravity models. Although their approaches to tariff variables are different[45] and the bias[46]

---

[45] Geraci and Prewo (1977, p.69) use average nominal tariff weighted by each country's most-favoured-nation imports of industrial products. Oguledo and Macphee (1994, p.115) use actual trade-weighted *ad valorem* rate assessed.

[46] The bias was the result of the weighting process. The weighted tariff rates underestimate the protective effect due to tariffs. It is because they assign small weights to high tariffs and large weights to low tariffs, and effective rate may be expected to be higher than nominal rates.

has been pointed out by Geraci and Prewo (1977, p.69), their results confirm that tariffs have a negative effect on trade flows.

Many economists constructed their models adding different variables to the basic gravity model and produced quite satisfactory results. However, the remaining important issue is the theoretical foundation of the model itself. Since Tinbergen's approach was rather intuitive, and Linnemann's Walrasian general equilibrium approach is not satisfactory in explaining the theory behind the model, Anderson (1979), Bergstrand (1985, 1989), Helpman and Krugman (1985) and Deardorff (1995) searched for theoretical foundations of the gravity model. Theoretical foundations of the gravity model are discussed in the ensuing section.

5.7 Theoretical Foundations of the Gravity Model of Trade

Tinbergen borrowed the gravity model from physics, and intuitively applied it to analyse international trade flows without providing firm theoretical justifications. Nevertheless, his gravity model was empirically successful in modelling trade flows. However, while the physics gravity model was invented to explain the universal gravitation, the economic gravity model is intended to explain international trade flows. Thus, there is a need to provide a theoretical justification for the economic model. Moreover, it is the theory that guides the development of an economic model, not the other way round. Without theoretical support, the econometric results could not be strongly persuasive.

Linnemann (1966) justified the theoretical foundation of the gravity model by using a Walrasian general equilibrium system. He argued that the gravity model is a reduced form of a four-equation partial equilibrium model of export supply and import demand (see also Bergstrand, 1985). The same approach was used by Aitken (1973) to examine the trade bloc effect, and by Geraci and Prewo (1977) to analyse bilateral trade flows. Frankel *et al* (1995) and Le *et al* (1997) also used similar theory to support their models.

Anderson (1979) criticised the approach as not useful for policy purposes because of its "unidentified" properties. He offered a solution by using the property of the expenditure system, while maintaining the hypothesis of identical homothetic preferences across regions.

He formally derived the gravity model by assuming Cobb-Douglas preferences or Constant Elasticity of Substitution (CES) with the Armington assumption[47] of product differentiation by place of origin. However, as Deardorff (1995) pointed out, Anderson (1979) modelled preferences over traded goods only; his primary concern was to examine the econometric properties of the resulting equation, rather than to extract easily interpretable theoretical implications. As Anderson realised, his model can make the best case for the aggregate, but not for commodity specific, gravity equation.

Bergstrand (1985 and 1989) provided a theoretical foundation for bilateral trade in differentiated products. He derived a 'generalised' gravity equation including price index variables from partial equilibrium, which is the general equilibrium model plus small market assumption and the assumptions of identical utility and production functions across countries. He pointed out that the gravity model is a reduced form of a partial equilibrium sub-system of a general equilibrium trade model with nationally differentiated products. After considerable mathematical transformation[48], his model of aggregate trade flow was written as:

$$PX_{ij} = f(Y_i, Y_j, D_{ij}, A_{ij}, EEC, EFTA, E_{ij}, U_i, U_j, p_i, p_j) \qquad (5.11)$$

where PX_{ij} is the value of aggregate trade flow from i to j. The special feature of this model is the additional variables of E_{ij}, U_i, U_j, p_i, and p_j. E_{ij} is exchange rate variable. U_i is unit value index. p is price index. The subscripts i and j are exporting country i and importing country j. The use of cross-country differences in price indices is viewed as a major turning point for the gravity model. Bergstrand (1985) used exporter's GDP deflator to proxy the exporter's price index and the importer's GDP deflator to proxy the importer's price index. In Bergstrand (1989), a new gravity model was introduced by incorporating his 'generalised' gravity equation (5.11) with relative factor endowment differences and non-homothetic tastes, and by assuming monopolistic competition. The non-homothetic preference assumption provided the theoretical foundation for the gravity model to be applied to intra-industry trade.

---

[47] Armington (1969) assumed that goods are differentiated by country of origin. Each country is completely specialised in the production of its own good. Thus there is one good for each country.
[48] The mathematical transformation is complex. It is presented in Bergstrand (1985).

Bergstrand's model in Equation (5.9) included per capita incomes of exporter and importer countries, which are proxies for relative factor endowments of the trading countries. Based on product differentiation among firms rather than among countries, he examined the model for each one-digit SITC category in a multi-industry world and made the point that the gravity equation is consistent with modern theories of inter-industry and intra-industry trade.

5.8 Conclusion

Chapter 5 reviewed the development of the gravity model, its applications in international trade flow analysis, and its theoretical foundations. In relation to international trade, the gravity model was used by Tinbergen, and others following him, to study total trade (exports and imports) for the countries in the sample for a specific time period (one year), that is they used cross section data. Pelzman (1976; 1977) pioneered the use of pooled time series - cross section data to estimate the gravity model. Thursby and Thursby (1987) pioneered the modelling of trade using country specific gravity models. Zhang and Kristersen (1995) revived the use of time series – cross section data, believing that the use of only cross section data or solely time series data has a limitation in explaining the evolvement of trade patterns over time. However, Zhang and Kristersen were criticised by Mátyás *et al* (1997) for failing to take into account the intercepts for the effects of time, the local country, and target country.

The application of the gravity model has been successful in most of the empirical studies in analysing the determinants of international trade flows, identifying and estimating trade potential among countries and regions, and identifying 'natural' trading blocs. Thus, when applied correctly with accurate data and appropriate econometric procedures, the gravity model could provide an instrument of multiple uses in the analytical tool kit of international trade flow analyst.

The next chapter (Chapter 6) will focus on constructing a theoretical gravity model that is specific to a country's trade with its trade partner countries by taking into the account of the business information brought in by immigrants. We then extend this model to develop empirical models to analyse the impact of Australia's immigration on trade with Australia's immigrant source countries in East Asia.

Chapter 6 A Country Specific Gravity Model Using Panel Data

6.1 Introduction

In Chapter 4, the general equilibrium model established that the price gap between exporters and importers decreases in the presence of immigrant information. In Chapter 5, we reviewed the application of the gravity models. In this chapter, we will concentrate on constructing a theoretical gravity model, which incorporates the immigrant cultural broker effects on international trade to analyse a specific country's trade with its trade partners.

Since this study focuses on the relationship between Australia's immigration and trade with its Asian trading partners, a gravity model with immigrant information will be developed for the use in the country specific case. The country specific gravity model represents a reduced form of the full version of the gravity model.

Section 6.2 discusses conventional theoretical arguments for the country specific model. Section 6.3 proposes a new model for country specific studies. Section 6.4 develops an empirical gravity equation for panel data, selects the fixed effect model for the panel data regression and makes adjustments of the empirical gravity model for estimation. The conclusion of the Chapter is in Section 6.5.

6.2 Theoretical Arguments for the Country Specific Model

The gravity trade model was initially used for the study of trade between all trading partner countries. That is, a gravity model for international trade among and between all of the trade-partner countries. The theoretical foundations of the gravity model developed by Bergstrand (1985) was also with all the trading countries in mind. Some studies (e.g. David M. Gould, 1996) carried Bergstrand's technique for developing the theory for country specific studies, which only focuses on the export and import of a particular country with its trade partners. If we treat the full version of the gravity model is like a study on the population, then the country specific model can be viewed as a study on a sample with the sample size of $1/N$ of the population size, since the full version of gravity model uses $N(N-1)$ observations while the country specific model utilises only $N-1$ observations. N

is the number of countries in the study. Thus, we can say that the country specific model is a reduced form of the full version gravity model, in the sense that the country specific model utilises a reduced set of data.

There are two forms of country specific gravity models, either in the format for one country trading with all its trading partners or one country trading with a selected group of trading partners. Either way, the country specific studies focus on a single country's trade with its trade partners. Trade between other countries are not the concern in such studies, and it does not form part of the dependent variable in the gravity model. However, Bergstrand's theory, which is appropriate for the inter-trade between all trading partner countries in the population, may not be appropriate for a study, which focuses only on one country. An alternative theoretical gravity model for country specific studies is necessary. Before we develop theoretical arguments for the country specific gravity model, we elaborate the problems associated with borrowing Bergstrand's (1985) model for a country specific study.

To derive the theoretical foundations of the gravity model, Bergstrand's (1985) used the world trade equilibrium system. That is, the total exports by all countries exporting the goods in the world should equal the total imports by all countries importing the goods in the world. This equilibrium was to be equally true for both total trade of all commodities and trade for any specific commodity. Then, Bergstrand developed the gravity model by looking into the behaviour of the exporters and the importers. He assumed that both exporters (supply side) and importers (demand side) are benefit maximising economic agents. On the export side, suppliers maximise their profits subject to the constraints of constant-elasticity-of-transformation (CET) in the use of immobile resources. On the import side of the world trade, buyers maximise their constant-elasticity-of-substitution (CES) utilities subject to incomes constraint. Income comes only from the exports sold in the foreign market since the outputs of all countries are assumed to be sold only in the foreign market. This system produces $N(N-1)$ bilateral export supply equations and $N(N-1)$ bilateral import demand equations for each point in time. N is the number of countries trading the goods (the sum of N countries' trade makes the world total trade). $N-1$ is the number of trade partners (that is, a particular country i does not trade with itself). By equating the supply equations and demand equations, in equilibrium, the gravity model was derived.[49]

[49] The process of deriving the gravity model can be found in Bergstrand (1985) and Gould (1996).

In using the Bergstrand's (1985) model, we need to assume that all exports by the exporting countries in the study have to be imported by all the importing countries in the study within the same data set to be able to satisfy the equilibrium requirement. In the country specific gravity model, it is difficulty to satisfy such equilibrium requirement. We can use Gould's (1996) approach as an example to illustrate this point. Gould extended Bergstrand's (1985) model and applied it to the study on the US trade with its trading partners. The problem with this approach is, while the total US exports to all of its trade partners represents the total US exports, its trade partners also import goods from countries other than the US, that is, the total US's exports do not equal to the total imports of its trade partners. Then, the world trade equilibrium fundamental in Bergstrand's (1985) model is not satisfied when it is applied to the country specific study.

We can now see that the world trade equilibrium foundation of Bergstrand's theory for the gravity model is restricted to use in the full version of gravity equation, and the foundation collapses in the case of the country specific gravity model. The direct application of Bergstrand's model to provide theoretical support for country specific case (as in Gould's (1996) study) will not be appropriate. An alternative theory is needed for the country specific model. In the next section, we develop the analytical framework for the country specific gravity model.

6.3 Theoretical Framework for the Country Specific Gravity Model

This Section develops a gravity model, which can be applied for a study focusing on trade of a single country with its trade partners. The model is derived from a Cobb-Douglas linear expenditure system. It modifies the gravity model developed by Oguledo and MacPhee (1994). The advantage of Oguledo and MacPhee model is that it does not rely on the balanced total trade between all countries. It can be modified to suit the situation, which focuses on a specific country's trade.

To logically develop a country specific gravity model, it is necessary to restate some of the steps used by Anderson (1979) and Oguledo and MacPhee (1994). We start with a very simple model, and then extend the simple model into a model that can be applied to the country specific situation. For the simple model, exporter countries i trade with importer countries j. The share of traded goods in national expenditure b_i or b_j is small for all countries. That is, the pressure on domestic price adjustment is small should changes of b_i or b_j arise. Assume identical unity Cobb-Douglas utility function across countries. Countries specialise in the production of its own goods, thus one good for each country. With no natural and artificial trade impediment, imports (*IM*) of goods from country i by country j could be represented as:

$$IM_{ij} = b_j Y_j \tag{6.1}$$

where b_j is the share of country j's importable goods in its national expenditure, and Y_j is country j's total income. Equation (6.1) represents the imports of country j from country i as a share of country j's total income. In the complete specialisation case with exportation of its total production, country i's income is derived from its total exports to country j, thus

$$Y_i = b_j \sum Y_j \tag{6.2}$$

It is assumed non-traded goods have zero value, from Equation (6.2),

$$b_j = \frac{Y_i}{\sum_j Y_j} \tag{6.3}$$

Substituting Equation (6.3) into Equation (6.1), yields

$$IM_{ij} = \frac{Y_j Y_i}{\sum_j Y_j} \tag{6.4}$$

Equation (6.4) is the simplest form of gravity equation with the denominator as a constant. By taking logarithm of both sides of the equation, the mathematical equation can be converted into a statistical model by adding an error term. The model can be estimated by OLS technique. However, as Anderson (1979) pointed out, this setting is absurd in econometrics standpoint since the only parameter b_j has been substituted away. In addition, the model is over simplified and too restricted. As pointed out by Oguledo and MacPhee (1994), the model assumes restricted identical preferences and unit income elasticity of demand across all countries.

To avoid this restriction, Anderson (1979) relaxed the complete specialisation assumption by introducing non-traded goods into the model. The new utility comes partially from traded goods *TG* and partially from the non-traded goods *NTG*, that is, $u = u(g(TG), NTG)$. At a certain level of expenditure on traded goods and non-traded goods, utility is a function of the traded goods $g(\cdot)$ alone, which is maximised subject to a budget constraint involving the level of expenditure on traded goods. The share of individual traded goods to total traded goods Θ_i and Θ_j, with homotheticity, are functions of traded goods' price only (Anderson, 1979; Oguledo & MacPhee, 1994):

$$\Theta_i = f_i(P_i, P_j) \tag{6.5}$$

$$\Theta_j = f_j(P_j, P_i) \tag{6.6}$$

In addition, let Φ_i be the share of traded goods to total expenditure in country *i* and Φ_j be the share of traded goods to total expenditure in country *j*, Chenery (1960), Kuznets (1966) and Maizels (1968) found that the share to total expenditure is well explained by income *Y* and population *N*, thus $\Phi_i = F_i(Y_i, N_i)$ and $\Phi_j = F_j(Y_j, N_j)$. Oguledo and MacPhee (1994) specified that the share of traded good to total expenditure is a function of income *Y*, population *N* and general price level *P*.

$$\Phi_i = F_i(Y_i, N_i, P_i) \tag{6.7}$$

$$\Phi_j = F_j(Y_j, N_j, P_j) \tag{6.8}$$

By assuming Φ_i and Φ_j to be constant over time, the approximation of $\frac{\Phi_k}{Y_k} \approx F_k(\frac{N_k}{Y_k}, \frac{P_k}{Y_k})$ for *K* = *i*, *j*, will be satisfied. To be able to use the linear expenditure function with homogenous degree of zero in income and prices, this approximation is necessary. The role of price in this approximation is that the change of the relative price level has an income effect on the composition of the share of traded goods to total expenditure. If the restriction of linear expenditure is relaxed, the share of traded goods can vary over time, and Equations (6.7) and (6.8) can be estimated (Oguledo & MacPhee, 1994).

Following Oguledo and MacPhee (1994)'s specification, we focus on the trade of a particular country (Country i) with all of its trade partners (Country js). Each Country j purchases a portion (Π) of Country i's total exports. That is:

$$\Pi_{ij} = \frac{EX_{ij}}{EX_i} \tag{6.9}$$

where EX_{ij} is the exports of Country i to Country j, and EX_i is Country i's total exports. Thus $\sum\left(EX_{ij}\right) = EX_i$, equivalently, $\sum\Pi_{ij} = 1$. The share of Country i's export to Country j depends on Country j's income Y_j, population N_j, price level P_j, and M_{ji} which is the foreign market information contributed to Country i by immigrants who came from Country j. Thus Π_{ij} can be defined as:

$$\Pi_{ij} = \pi_{ij}\left(Y_j, N_j, P_j, M_{ji}\right). \tag{6.10}$$

Equation (6.10) means that income and the stage of economic developments vary across the buyer countries (Country j) and will have an impact on the volume of export from the seller Country i, hence the share of exports.[50] Different price levels across buyer countries indicate where the markets are and also provide incentives to sellers to supply to the highest priced country. If exporters in Country i have perfect price information about all their export destination countries, then the higher the price the buyer country offers to Country i's tradable goods, the greater the export volume (hence the export values) from Country i to Country j, holding other factors constant. The foreign market information and price information can be improved by the availability of immigrants M_{ji} to the seller country from the buyer countries. All these factors influence the trade shares Π_{ij}.

On the other hand, Country j purchases goods from all of its import supplier countries including Country i. The amount of Country j purchases from Country i represents a portion Π_{ji} of Country j's total imports. The factors that determine the proportion Π_{ji} are

[50] The marginal propensity to import of GDP can be used to support this argument.

mainly the exporter Country i's price level P_i and the foreign market information brought by immigrants M_{ji}. Thus Π_{ji} can be defined as:

$$\Pi_{ji} = \varphi_{ji}(P_i, M_{ji}) \tag{6.11}$$

It follows that import expenditure of Country j, which is the same as the export income of Country i can be expressed as the proportion of Country j's income Y_j:

$$IM_{ij} = \Pi_{ji}\Theta_j\Phi_j Y_j \tag{6.12}$$

where $\Pi_{ji} \leq 1$, $\Theta_j \leq 1$ and $\Phi_j \leq 1$. Since Country i's exports to Country j makes up a portion of its total exports which in turn is the export income that represents a portion of the total income, thus

$$EX_{ij} = \Pi_{ij}\Phi_i Y_i \tag{6.13}$$

where EX_{ij} is Country i's export income from exporting goods to Country j. , $\Pi_{ij} \leq 1$ and $\Phi_i < 1$. Given that the value of exports from Country i to Country j equals the value of all country js' imports from Country i, thus:

$$\Phi_i Y_i = \Theta_j \Sigma_j (\Pi_{ji}\Phi_j Y_j) \tag{6.14}$$

Rearranging Equation (6.14) we obtain:

$$\Theta_j = \frac{\Phi_i Y_i}{\Sigma_j (\Pi_{ji}\Phi_j Y_j)} \tag{6.15}$$

Substituting Equation (6.15) into Equation (6.12), we obtain

$$IM_{ij} = \frac{\Pi_{ji}\Phi_i Y_i \Phi_j Y_j}{\Sigma_j (\Pi_{ji}\Phi_j Y_j)} \tag{6.16}$$

The denominator of the right hand side of Equation (6.16) equals total exports by Country i. It is a constant in every point in time. Let $k = \Sigma_j \Pi_{ji} \Phi_j Y_i$, and substitute Equations (6.11), (6.7) and (6.8) into Equation (6.16), to get

$$IM_{ij} = \frac{1}{k} \varphi_j (P_i, M_{ji}) F_i (Y_i, N_i, P_i) Y_i F_j (Y_j, N_j, P_j) Y_j \qquad (6.17)$$

Linearization of Equation (6.17) and adding a constant γ, a tariff levied by Country *j* (T_j) as a proxy for artificial trade impediment, a distance from *i* to *j* ($Dist_{ij}$) as a proxy for natural trade impediment, and the error term (U_{ij}) to the model in the fashion of Oguledo and MacPhee (1994), Equation (6.17) can be written as:

$$IM_{ij} = \frac{\gamma}{k} Y_i^{\beta_1}, Y_j^{\beta_2} N_i^{\beta_3}, N_j^{\beta_4}, P_i^{\beta_5}, P_j^{\beta_6}, T_j^{\beta_7}, M_{ji}^{\beta_8}, Dist_{ij}^{\beta_9}, U_{ij} \qquad (6.18)$$

Taking logarithm on both sides of Equation (6.18), we generate the empirical gravity equation, which can be estimated:

$$\begin{aligned} \ln IM_{ij} = \beta_0 + \beta_1 \ln Y_i + \beta_2 \ln Y_j + \beta_3 \ln N_i + \beta_4 \ln N_j \\ + \beta_5 \ln P_i + \beta_6 \ln P_j + \beta_7 \ln T_j + \beta_8 \ln M_{ji} + \beta_9 \ln Dist_{ij} + \varepsilon_{ij} \end{aligned} \qquad (6.19)$$

where $\beta_0 = \ln\left(\gamma/k\right)$ and the error term $\varepsilon_{ij} = \ln\left(U_{ij}\right)$. *IM* is imports. i is for the exporter country, and *j* is for the importer courtiers. β stands for parameter. *Y* stands for aggregate income. *N* stands for population, and *P* stands for price. T_j is tariff levied by the importer Country j on Country i's exports. M_{ji} is for immigrants from Country j to Country i. $Dist_{ij}$ is for the distance from Country i to Country *j*. Equation (6.19) is the gravity equation, which shows that, in addition to all the usual explanatory variables in the model such as GDP, population, price, distance and tariff, the level of immigrant intake is also a factor to determine the trade flows. That is, Country *j*'s imports from Country i can be explained by the emigrants (M_{ji}) who left the Country *j* and entered into Country i. Since Country *j*'s imports from Country i is the same as Country i's exports to Country *j*, and

Country j's emigrants migrated to Country i is the same as Country i's immigrants from Country j, Equation (6.19) can be written as:

$$\begin{aligned}\ln EX_{ij} &= \beta_0 + \beta_1 \ln Y_i + \beta_2 \ln Y_j + \beta_3 \ln N_i + \beta_4 \ln N_j \\ &+ \beta_5 \ln P_i + \beta_6 \ln P_j + \beta_7 \ln T_j + \beta_8 \ln M_{ji} + \beta_9 \ln Dist_{ij} + \varepsilon_{ij}\end{aligned} \tag{6.20}$$

where EX_{it} is the value of exports from Country i to Country j.

6.4 Empirical Models Using Panel Data

Panel data in the context of the gravity model means the pooling of observations of cross-section units of countries over a period of time. However, the gravity model developed in Section 6.3 is best suited to explain trade between countries at a particular point in time and it is suitable for a cross-sectional data set. We need to incorporate the time dimension t into Equations (6.20) and (6.19) to convert the cross-section gravity equations into panel gravity equations for exports (EX) and for imports (IM) of Australia.

$$\begin{aligned}\ln EX_{ijt} &= \beta_0 + \beta_1 \ln Y_{it} + \beta_2 \ln Y_{jt} + \beta_3 \ln N_{it} + \beta_4 \ln N_{jt} \\ &+ \beta_5 \ln P_{it} + \beta_6 \ln P_{jt} + \beta_7 \ln T_{jt} + \beta_8 \ln M_{jit} + \beta_9 \ln Dist_{ij} + \varepsilon_{it}\end{aligned} \tag{6.21}$$

$$\begin{aligned}\ln IM_{jit} &= \beta_0 + \beta_1 \ln Y_{it} + \beta_2 \ln Y_{jt} + \beta_3 \ln N_{it} + \beta_4 \ln N_{jt} \\ &+ \beta_5 \ln P_{it} + \beta_6 \ln P_{jt} + \beta_7 \ln T_{it} + \beta_8 \ln M_{jit} + \beta_9 \ln Dist_{ij} + \varepsilon_{it}\end{aligned} \tag{6.22}$$

where i now stands for the cross-section unit, j is for the importer country and t is the time dimension. The term D_{ij} has no t subscript because the distances between countries are time invariant. For convenience, we use the exports gravity equation (Equation (6.21)) only through out the rest of this chapter, although our empirical test will be conducted for both exports and imports gravity equations.

There are certain advantages of using panel data over cross-section data alone or time series data alone. These advantages are well documented in Baltagi (2005), Gujarati (2003) and Hsiao (1986), among others. Some of the advantages relevant to our study area: (1) Panel data give more observations and more informative data. By pooling cross-sections and time series, the number of observations is significantly greater than cross-section data alone or time-series data only. The degree of freedom will hence be higher. As a result, panel data enhance the efficiency of the estimation. (2) Panel data utilise more variables, for which cross-section alone or time series only models unable to utilise. Some variables change over time but do not vary at each point in time across cross-section. Those variables are cross-section invariant and cannot be used in cross-section regressions. However, by pooling cross-section and time series, such variables can add variation and can raise the explanatory power of the regression. Examples of such variables in our study are Australia's GDP and Australia's per capita GDP. Some variables do not change over time but vary across cross-section. Those variables are time invariant and do not contribute to time series regression but can be utilised in panel regression. In our study, the distance between countries (variable D_{ij}) is a good example. The distances between Australia and each of its trading partners are different but do not change over the period of time. Panel data can incorporate these variables into the analysis. (3) Panel data increase the variability of the variables in the data set due to cross-section variation within each variable. (4) Panel data are better in a study of dynamics of adjustment of international trade to the changing economic environment and globalisation. (5) Panel data reduce the collinearity among explanatory variables. This is also due to the cross-section variation within each variable.

However, some drawbacks are associated with the use of panel data: (1) the use of panel data increases the complexity in data collection. Missing data, unbalanced panels and dropping some cross-sections due to poor availability of data are often the rules rather than exceptions that researchers encounter. (2) Following the problems in (1), another drawback is the selectivity bias in that the sample is not drawn randomly from the population.

6.4.1 The Fixed Effect Panel Gravity Model

How to estimate a panel gravity equation depends on the assumptions we make about the intercept, the slope coefficients and the error term of the model. That is, the subscripts of the parameters (β_s) indicate the ways to estimate the panel gravity equation. If we assume that all cross-sections and all time periods have their own intercepts and slopes, then the panel gravity equation becomes:[51]

$$\begin{aligned}\ln EX_{ijt} &= \beta_{0it} + \beta_{1it}\ln Y_{it} + \beta_{2it}\ln Y_{jt} + \beta_{3it}\ln N_{it} + \beta_{4it}\ln N_{jt} \\ &\quad + \beta_{5it}\ln P_{it} + \beta_{6it}\ln P_{jt} + \beta_{7it}\ln T_{jt} + \beta_{8it}\ln M_{jit} + \beta_{9i}\ln Dist_{ij} + \varepsilon_{it}\end{aligned} \qquad (6.23)$$

In Equation (6.23), all parameters (β_s) have the subscripts of i and t, except for the parameter of β_9, which only has the subscript of i (since distance $Dist_{ij}$ does not change over time). This specification is the most unrestricted since it has unknown parameters for each cross-section as well as for each period of time. In fact, it is intractable as there are more unknown parameters than data points (Griffiths et al., 1993, p.574). To make the model estimable, a number of simplifications can be applied. We can assume that all cross-sections have their own parameters, but common parameters for each cross-section throughout the whole period of time in the study. That is:

$$\begin{aligned}\ln EX_{ijt} &= \beta_{0i} + \beta_{1i}\ln Y_{it} + \beta_{2i}\ln Y_{jt} + \beta_{3i}\ln N_{it} + \beta_{4i}\ln N_{jt} \\ &\quad + \beta_{5i}\ln P_{it} + \beta_{6i}\ln P_{jt} + \beta_{7i}\ln T_{jt} + \beta_{8i}\ln M_{jit} + \beta_{9i}\ln Dist_{ij} + \varepsilon_{it}\end{aligned} \qquad (6.24)$$

Hence, the t subscripts for all parameters βs are dropped. Estimating a pooled model like Equation (6.24) requires the assumption of some common elements that bind all the cross-section units together. One way to do that is to assume the error term ε_{it} in Equation (6.24) is contemporary correlated. That is, the errors of the same period of time are correlated across cross-section units, but are not correlated over time. The estimate obtained by the regression with this assumption is called the Zellner's seemingly unrelated regression (SUR) estimators.[52]

The SUR model recognises the individuality of the cross-section units, but fails to take advantage of greater explanatory power given by the increasing variation from the data pool. For this study, the SUR model is not a suitable model since one of the core variables of the gravity model – the distance between trading partners, is a time-invariant regressor, which

---

[51] For convenience, the subscript j is dropped from ε_{ij}.

[52] More details of the SUR are given in to the original work of Zellner (1962).

plays no role in explaining the dependent variable in the SUR model.[53] An assumption totally opposite to the SUR model, which can take advantage of using time invariant variable is to assume one common parameter for all cross-section countries throughout the whole period of time, which is Equation (6.22). All the βs have no subscripts i and t. We can obtain the estimates of the βs simply by the OLS regression procedure. It is the simplest form of estimation, but it is rather naive.

To utilise the benefits provided by the increasing variation from the panel data while more realistically recognising the difference between cross-sections, we could use the following model:

$$\begin{aligned}\ln EX_{ijt} &= \beta_{0i} + \beta_1 \ln Y_{it} + \beta_2 \ln Y_{jt} + \beta_3 \ln N_{it} + \beta_4 \ln N_{jt} \\ &+ \beta_5 \ln P_{it} + \beta_6 \ln P_{jt} + \beta_7 \ln T_{jt} + \beta_8 \ln M_{jit} + \beta_9 \ln Dist_{ij} + \varepsilon_{it}\end{aligned} \qquad (6.25)$$

Now, the subscript i for all the βs is dropped except for β_0. Put it differently, Equation (6.25) differs from Equation (6.22) by the subscript i for β_0. That is, only the intercept parameter varies across individual cross-sections, but not over time. All other parameters in the model are common across the cross-sections and over time. The variation of intercepts across the cross-sections captures the behavioural difference between individual countries and over time. This model is known as the fixed-effect model (FEM) or the Least Squares Dummy Variables (LSDV) model. We can test whether the dummy intercept variables capture the individual differences, or, put differently, whether the panel data model does have the cross-section variation, by performing a Chow F-test, treating the pooled OLS as the restricted model and FEM as the unrestricted model.

$$F = \frac{(R_{UR}^2 - R_R^2)/(N-1)}{(1-R_{UR}^2)/(NT-N-K^{'})} \qquad (6.26)$$

where R_{UR}^2 is the coefficient of determination R^2 for the unrestricted (UR) model. R_R^2 is the restricted (R) model's R^2. N is the number of the cross-section countries (not the N for population in Equation (6.25)). T is the number of time periods (not the T for tariff in Equation (6.25)). $K^{'}$ is the number of slope parameters.

[53] Although the SUR model will not be the one we will use to analysis the immigrant impact on trade, we will still compare the SUR model with the OLS model to test whether pooling the data are more efficient than the individual OLS model.

However, the FEM may suffer from the drawback of too many dummy variables if *N* is large, and even worse if $N > T$, a dramatic loss of degrees of freedom, and hence the power for the test of significance. An alternative to the FEM is to treat the number of cross-sections *N* as a random sample of the larger cross-section population. If this was the case, we can assume that the intercept is a random variable with the mean as β_0, so the individual intercepts in the FEM can be viewed as randomly different from the mean intercept β_0.

$$\beta_{0i} = \beta_0 + u_i \tag{6.27}$$

where u_i differ across the cross-section *N* but constant over time *T*. Substituting (6.27) into (6.25), we get:

$$\begin{aligned} \ln EX_{ijt} &= \beta_0 + \beta_1 \ln Y_{it} + \beta_2 \ln Y_{jt} + \beta_3 \ln N_{it} + \beta_4 \ln N_{jt} \\ &+ \beta_5 \ln P_{it} + \beta_6 \ln P_{jt} + \beta_7 \ln T_{jt} + \beta_8 \ln M_{jit} + \beta_9 \ln Dist_{ij} + \varepsilon_{it} + u_i \end{aligned} \tag{6.28}$$

Let $\omega_{it} = \varepsilon_{it} + u_i$, then Equation (6.28) becomes:

$$\begin{aligned} \ln EX_{ijt} &= \beta_0 + \beta_1 \ln Y_{it} + \beta_2 \ln Y_{jt} + \beta_3 \ln N_{it} + \beta_4 \ln N_{jt} \\ &+ \beta_5 \ln P_{it} + \beta_6 \ln P_{jt} + \beta_7 \ln T_{jt} + \beta_8 \ln M_{jit} + \beta_9 \ln Dist_{ij} + \omega_{it} \end{aligned} \tag{6.29}$$

Equation (6.29) is called the error components model (ECOM) because of $\omega_{it} = \varepsilon_{it} + u_i$, or the random effect model (REM) because it treats the intercept as a random variable. However, estimating Equation (6.29) by OLS will result in inefficient estimators rendering the estimated coefficients less significant. Usually, the generalised least squares (GLS) or the feasible generalised least squares (FGLS) can achieve asymptotically efficient estimates.[54]

In selecting the FEM or the REM, advice is provided by Baltagi (2005), Gujarati (2003) and Hsiao (1986), among others. Here we discuss some of them, which are relevant to out data set.

1. If *N* (the number of cross-sections in the data set) is large relative to *T* (the number of time periods in the data set), the FEM will suffer a loss of degree of freedom and the

---

[54] The GLS and FGLS procedures are explained in Baltagi (2005) and Greene (2000).

REM would be more efficient. However, if T is large and N is small, it would not make much difference between the FEM and the REM. In our data set, $T = 38$ and $N = 10$, making T is substantially greater than N, the FEM and the REM are likely to achieve similar outcomes.

2. If the data are not collected from random sampling, the inference of the sample will be biased and the REM would not provide the population estimates efficiently, and then the FEM would be a better approach. Our data set for the eleven Asian countries is not from a random sample of all the Asian countries. They are selected because they are the major Asian trade partners of Australia and major immigrant source countries in Asia. Data collected from this sampling procedure is suitable for the FEM because the estimates from the data are primarily related to those countries in the sample. The estimates are not to be generalised to the whole population of countries, not even for the population of all Asian countries.
3. The benefits of straightforward econometric procedure of OLS, when using the FEM versus the complexity of the GLS for the REM, are not the major issues in choosing the FEM over the REM, because many standard econometric computer softwares have routine procedures to perform FEM and REM analysis. The Hausman test for efficiency improvement of REM over the FEM is also available in standard packages such as Eviews, LIMDEP and TSP.
4. An issue of a more technical nature in the regression procedure is that, to be able to estimate the coefficients, the number of cross-sections N should be greater than the number of coefficients βs. From the discussion in Chapter 7, it can be seen that our empirical model will have ten explanatory variables and ten cross-section countries (Vietnam was eventually dropped due to a considerable number of missing data points which are beyond extrapolation).

In summary, the fixed effect model (FEM) would be the appropriate model to carryout the econometric analysis in this study. In the next section, we will make necessary adjustments to the variables in Equation (6.25) to tailor the data set that will be used in the estimation.

6.4.2 Adjustment to the Empirical Model

We make a number of adjustments to the empirical model to suit the estimation of the gravity equation. The population variables are replaced by per capita GDP variables. The volume of immigrant intakes is used to proxy the immigrant information effects on trade. The openness variable is used to proxy the tariff level. More details of these changes are discussed in the ensuing sections.

6.4.2.1 Per Capita Income Variables

Although the per capita income variables are not among the conventional variables included in gravity models, there are some advantages of using per capita income variables over population variables. The per capita income variables are not only valuable in revealing economic capacity of the trading partners but also valuable in revealing information about the stage of economic development of the trading partners and the wealth of the population. While the aggregate income variables in the gravity model relate to the production capacity, the per capita income variables relate to the consumption capacity. This in turn can be transformed into the purchasing power and the ability to demand goods and services. Unlike the population variables, which relate to the quantitative side of the market size, the per capita income variables relate to the intensity of the market which is the qualitative side or value side of the market size. Another advantage is that the coefficient of the per capita income variable in the gravity model with log-log transformation of the data would indicate the average income elasticity of demand for traded goods across the population.

The per capita income variable will not be highly correlated with the aggregate income variable in the model because the two variables are collected from two different data sources and the data collection methods used by the data collectors are different.[55] The per capita income data are not obtained by simply dividing the total income by the population (if this was the case, the two variables will be highly correlated).

For the expected impact of per capita income on trade, a number of previous studies (refer to Section 5.6.3) found a positive relationship. However, we should be more cautious if we

---

[55] The data and data sources are discussed in Chapter 7.

want to keep our expectation in line with the results of some previous studies. They should be viewed as *ad hoc* results rather than universally applicable theory. We make the following assumptions about the impact of the per capita income variable on foreign trade: It is acceptable that the importing countries' per capita income would have a positive impact on imports because it affects the demand on the demand side of the global economy. The exporter countries' per capita income may not necessarily have a positive impact on exports since it affects the demand on the supply side of the global economy. It could depend on the marginal rate of transformation between exportable goods and the non-tradable goods and the marginal rate of transformation between all type of goods, e.g. inferior goods, normal goods and luxury goods in the exporter countries' production sector. If the transformations are elastic or flexible, a rise in domestic per capita income would channel the former exportable goods into the domestic market, and exports will decline. If the transformations are not flexible, the now wealthier population will be unsatisfied by the domestic supply and could turn to imports, freeing more domestic goods available for exports. Following this argument, we expect that the importer countries' per capita income would have a positive impact on imports, whereas the impact of exporter countries' per capita income on exports is uncertain.

6.4.2.2 Immigrant Information Variables

Since it is impossible to quantify the amount of foreign market information carried over by immigrants, we use the volume of immigrant intake to proxy the immigrant effect on trade. However, by using the immigrant intake as the proxy, we encounter a contradictory impact on trade by the immigrant intake variables. On one hand, the immigration represents the movement of labour across countries. Its effect on trade follows the standard argument relating to the H-O model of factor price equalisation of inter-industry trade, and commodity price equalisation of factor movement (refer to Section 2.3 in Chapter 2). Thus, immigrant intake level variable is expected to have a negative impact on trade variable. On the other hand, we expect that immigrant information will facilitate trade, thus the impact would be positive (refer to Sections 2.4 to 2.6 in Chapter 2). We cannot separate the two contradictory effects that immigrants have on trade. However, at least we can have some idea about the magnitudes of each from the combined effect that we obtain from the estimation. We can model the combined effect by using M_{jit} variable and M_{jit}^2 variable (the square term of the M_{jit}) in the regression. If the combined estimated coefficients (from

M_{jit} and M_{jit}^2) is negative, then we know that the labour effect of trade substitution is stronger than the foreign market information effect of immigration on enhancing trade. On the other hand, if the estimated coefficient is positive, the market information effect of immigrants enhancing trade offsets the trade substitution effect of labour.

The immigrant intake level influences the relative strength of both effects. Up to a certain level of immigrant intake, the foreign market information effect is stronger and the impact of immigration on trade is positive. The impact of immigration on trade will become negative if the immigrant intake level is higher than that level. Since we are unsure about which effect is stronger so we cannot assign *a priori* expectation for the impact of the immigrant intake variable on trade.

6.4.2.3 Tariff Variables

It is common knowledge within the economic and business arena that tariffs will reduce the volume of trade and serve as a trade impediment measure. However, it is extremely difficult to measure tariffs accurately. Since our objective is to investigate the impact of trade impediment, an Openness variable could be more appropriate. Openness is calculated by dividing the value of the country's total trade by its total income, that is, total trade as a proportion of the total income (GDP). A higher Openness would indicate a more active engagement in the global trade system by the country, which could be the result of lower trade barriers. According to the definition of Openness, a more open economy would have a higher total trade to GDP ratio, hence a higher volume of trade over time. Thus, Openness would have a positive impact on trade.

6.4.3 The Empirical Model

Taking the arguments from Section 6.4.1 and Section 6.4.2 into account, Equation (6.25) can be adjusted into the following form:

$$\begin{aligned}\ln EX_{ijt} = \beta_{0i} &+ \beta_1 \ln Y_{it} + \beta_2 \ln Y_{jt} + \beta_3 \ln PY_{it} + \beta_4 \ln PY_{jt} \\ &+ \beta_5 \ln P_{it} + \beta_6 \ln P_{jt} + \beta_7 \ln O_{jt} + \beta_8 \ln M_{jit} + \beta_9 \ln M_{jit}^2 \\ &+ \beta_{10} \ln Dist_{ij} + \varepsilon_{it}\end{aligned} \tag{6.30}$$

where PY_{it} and PY_{jt} are per capita incomes, O_{jt} is openness and M_{jit}^2 is the square term of the immigrant intake variable. As was mentioned in Section 6.4.2.2, combining M_{jit} and M_{jit}^2 in the regression can estimate the impact of immigration on trade at different level of immigrant intake. In a log-log model like Equation (6.30), the combined estimated coefficients of M_{jit} and M_{jit}^2 estimates the elasticity of trade on the immigrant intake level. Up to a certain level of immigrant intake, the elasticity of exports due to immigrant intake is expected to increase, and then the elasticity of export will decrease. To show these different effects, M_{jit} and M_{jit}^2 are included in the model in Equation (6.30).

6.5 Conclusion

We determined that the fixed effect model is the best and viable model for cross section-time series (panel) data in estimating a country specific gravity trade model. We also made necessary adjustments to the variables for practical and empirical purposes. We finally came up with an empirical model, which is ready to be estimated for testing our hypothesis of the impact of immigrant information on trade between Australia and its major East Asian trade partners.

Before we can test our hypothesis, the accuracy and quality of our data are critical to the results of the estimates and their meaningful interpretation. In the next chapter (Chapter 7), we will discuss the preparation of data and the results of preliminary analysis of data used in the estimation of the model.

Chapter 7 DATA SOURCES, DATA PROCESSING AND PRELIMINARY ANALYSIS OF DATA

7.1 Introduction

The analytical framework for the country specific gravity model was developed in Chapter 6. In this chapter (Chapter 7), we discuss the data collection procedure, and data preparation for econometric analysis. Chapter 7 will be organised in the following manner: Section 7.2 presents the data collection methods and the process to treat missing data. Section 7.3 discusses how we resolve the inherent endogenous problems of the gravity model. Section 7.4 performs preliminary analyses of the data. The preliminary analyses include: (1) Present graphical examination of data and correlation analysis to see whether there is correlation between the explanatory variables and the dependant variables. (2) Perform stationarity tests for both individual data series and for the panel data variables. The objective of the stationarity tests is to investigate whether non-stationarity is inevitable in the individual data series and the panel variables, which are arranged over time. If the data series and the panel variables are found nonstationarity, remedial treatments should be applied before the data can be used in the regression analysis. Section 7.5 presents the conclusion of the chapter.

7.2 Data and Data Sources

7.2.1 An Overview of Data Sources

The analytical framework specified in Section 6.3 of Chapter 6 established that trade between country (*i*) and trade partner countries (*j*) is a function of the strength of their economies, geographical distances, general price levels, trade barrier levels and information about the foreign market. We intend to test this general model of Australian exports to and imports from eleven Asian countries over a thirty-eight year period from 1963 to year 2000. Data are collected in annual frequency, in real values indexed with the base year of 1996. The Asian countries involved in this study are China, Hong Kong, Indonesia, Japan, Malaysia, the Philippines, Singapore, South Korea, Taiwan, Thailand and Vietnam.

The empirical models specified in Chapter 6 consist of eleven variables. Exports in the export model (Imports in the import model) are the dependent variables. The independent variables are GDP for Australia's aggregate income, GDP for foreign countries' aggregate income, Per Capita GDP for Australia's average income level, the level of standard of living and the stage of economic development, Per Capita GDP for foreign countries for their stages of economic development, the general price level of Australia, the general price levels of trade partners, the levels of immigrant intake as the proxy for foreign market information inflows, the square of the immigrant intake level, the distances between the major economic centres of Australia and its Asian trade partners, and the openness of the foreign countries in the export model and the openness of Australia in the import model as a proxy for trade impediments. Since eleven countries are considered in the study, for each country there is a set of eleven variables. Thus there are 11×11 data series in the panel. The period of time in the study is thirty-eight years. If there are no missing data, we can expect that the number of data point to be $11 \times 11 \times 38 = 4598$ in the panel data set.

The data on Australia's exports and imports (except trade with Taiwan) were collected from the United Nations (UN) Statistics Division[56]. Data on Australia's trade with Taiwan are collected from two sources: the data for 1963 to 1980 were provided by the National Statistics via email, and data for 1981 to 2000 were collected from the Taiwanese National Statistics internet website.[57] Data on Gross Domestic Product (GDP) for all countries (except for Taiwan) were collected from the World Bank Word Tables (WBWT).[58] Taiwan's GDP data were collected from the Taiwanese National Statistics website. The Per Capita GDP, the price level and the openness for all countries were collected from the Penn World Table (PWT) 6.1 (Heston, Summers, & Aten, 2002). Distances between countries were obtained from two sources: data for the shipping routes by sea and the distance between two ports were collected from the US National Imagery and Mapping Agency (2001), and the data for land freight distance between the seaport to the capital city of the country are collected from the World Book Encyclopaedia CD-ROM ("The World Book : Multimedia Encyclopedia," 1999). When there are alternative shipping routes available, the one with the shortest shipping distance will be selected. If the seaport is located in the capital city of the country, then land freight distance is not necessary. The immigrant intake data for 1963 to 1995 were collected from the Australian Bureau of Immigration, Multicultural and Population Research (BIMPR) Statistics Section (Spudic, 1996), and the

---

[56] http://unstats.un.org/unsd/comtrade/. Accessed on various dates between October 2005 and December 2005.
[57] http://eng.stat.gov.tw/lp.asp?CtNode=2192&CtUnit=1051&BaseDSD=7. Accessed on 7th December, 2005.
[58] DX Econdata.

immigrant intake data for 1995 to 2000 were collected from the ABS Statistics[59] and the ABS Census 1996 and 2001.

Since the data were collected from a wide range of sources for the twelve countries (including Australia) over thirty-eight years, some data points were not available (or missing) due to various reasons from wartime disruption such as in the case of Vietnam, to the formation, merging and separation of countries such as the case of Malaysia and Singapore. A number of techniques were employed in estimating the missing data. Details about data processing and adjustment are presented in Section 7.2.2 below. Vietnam experienced great difficulties in data recording during the wartime, and most of the data cannot be found for the years before the mid-1980s. The number of missing observations for Vietnam is too large that meaningful extrapolation cannot be expected. As a result, in most of the econometric analysis, Vietnam could not be included, except in the case of causality tests between immigration and trade.

7.2.2 Data Collection and Preparation

7.2.2.1 Exports and Imports

Data on total exports and total imports of Australia (except exports to and imports from Taiwan) were collected from the United Nations (UN) Statistics Division internet website, using the Basic Selection method under the heading of "Data Query and Extraction". The data are reported in nominal values. We deflated the nominal trade data by the Australian Export Price Index for the export data and by the Import Price Index for the import data, both with the base year of 1996, to derive the real exports and real imports. The Export Price Index and the Import Price Index were collected from the dX EconData with the base year of 2000. The sliding procedure is employed to convert the base year from 2000 to 1996.

Data on Australia's trade with Taiwan are not reported by the UN, and we collected the data from Taiwan's National Statistics website. The data were available from the website for the period from 1981, and are in nominal values with the measurement unit in millions of New

[59] ABS, Catalogue No.3401.0 Overseas Arrivals and Departures, Australia Table 12: Permanent Movement, Settlers - Country of Birth, Major Groups and Selected Source Countries: Original.

Taiwanese (NT) currency. The data prior to 1981 were provided by the Taiwanese National Statistics upon. A two-step process was employed to convert the data in line with the UN trade data. Step One involved converting the nominal data measured by the NT currency into the nominal data in U.S. dollars by the average annual exchange rate reported in the Penn World Tables 6.1 (Heston et al., 2002). However, there were some missing data in the exchange rate variable for Taiwan in the Penn World Table. The missing exchange rates were obtained from the Taiwan's National Statistics Internet website and then the annual average was calculated to bring the exchange rate inline with the Penn World Tables. Step Two involved deflating the export and import data by the respective Australian Export Price Index and Import Price Index to derive the real trade data with the base year of 1996.

As mentioned in Section 3.3.6 and Section 3.3.8 of Chapter 3, the Federation of Malaysia was formed in 1963, and Singapore was part of the Federation of Malaysia from 1963 to 1965. There are some areas of concern in relating to the data on Australia's trade with these two countries. Trade with this region before the Federation was recorded as trade with Singapore. After the formation of the Federation of Malaysia, trade data with this region were recorded as trade with Malaysia. After Singapore departed from the Federation of Malaysia, Australia's trade with Malaysia and trade with Singapore were recorded as separate entries. Thus, there was no data on Australia's trade with Malaysia for 1963. Instead, it is recorded as trade with Singapore in 1963. For 1964 and 1965, trade with Singapore were included in the data for trade with Malaysia. We placed zero trade values with those missing records and we acknowledge that there are slight distortions of data in this area.

7.2.2.2 Aggregate Income (GDP)

The GDP in current prices for each country (except Taiwan) were collected from the World Bank World Tables (WBWT) in the dX EconData electronic database. The current price GDPs were then deflated by the corresponding GDP deflators, which were also collected from the WBWT. Again, GDP deflators were adjusted for the base year of 1996. The GDP in current prices for Taiwan was collected from the Taiwan National Statistics. The GDP data were then deflated by the corresponding GDP deflator.

7.2.2.3 Economic Development (per capita GDP)

Data for per capita GDP were collected from the Penn World Tables (PWT) 6.1. According to the PWT explanatory note, per capita GDP of a country is the average income at 1996 value and is obtained by the aggregates of consumption, investment and government expenditure, and then adjusted by the exports and imports to add back the foreign consumption of domestic production and to remove the domestic consumption of foreign goods. Since the per capita GDP data do not contain exports and imports, the data endogeneity problem does not affect the per capita GDP variables.

7.2.2.4 Price Levels

Data for the price levels were collected from the Penn World Tables 6.1. The PWT calculates the price level of a country by the Purchasing Power Parity (PPP) of GDP of a country divided by the exchange rate times 100, where the PPP is the country's currency value in relation to the real value in international dollars. Both the PPP and the exchange rate are expressed as national currency units per U.S. dollar, and the U.S. price level is 100. By this measure, the price levels for each country are indexed by the US price for each point in time and can be compared across different countries.

7.2.2.5 Openness

Data on openness are collected from the PWT. The openness variable is calculated as a country's total trade (sum of total exports and total imports) as a percentage of GDP and expressed in constant price with the base year of 1996. The openness variable replaced the tariff variable and it is used to measure the artificial resistance to trade. However, due to the definition of the openness variable and the way the openness variable is measured, it is used as an "opposite" proxy to the tariff variable and will have the opposite *a priori* expectation of the tariff variable. While tariff variable is expected to have a negative impact on trade, the openness variable is expected to have a positive sign. In the PWT, the openness data series have a number of missing data points. The data for the missing observations are generated by interpolation and extrapolation processes.

7.2.2.6 Distance between Countries

It is customary to use the distance between two major economic centres in the gravity model as the proxy variable for transportation costs, hence as a proxy for the natural trade resistance. However, difficulties arise when there are more than one major economic centres identified within a country. We resolved this problem by measuring the distance variable by the distance between two capital cities, but acknowledging that not all capital cities are the major economic centres of the country.

For example, to measure the distance between Australia and China, we selected Sydney as the seaport and measured the direct distance between Canberra and Sydney. Then we selected Shanghai as the seaport in China since Shanghai is the major seaport closest to Beijing. We measured the shortest shipping route between Sydney and Shanghai (via Vitiz Strait) and the direct distance between Shanghai and Beijing. The distance between Australia and China is the sum of the three distance components.

If a capital city of a trade partner country is also a seaport, e.g. Singapore, no land transportation is measured in the trade partner country.

7.2.2.7 Levels of Immigrant Intake

Data on immigrant intake levels were collected from three sources: the Australian Bureau of Immigration, Multicultural and Population Research (BIMPR), the ABS publications (Catalogue No. 3410.012), and the ABS Census 1996 and Census 2001. The data from BIMPR are available from 1945 to 1995 and are presented as annual numbers of arrivals from July of one year to June of the following year. Because the theory and some previous studies reveal that the foreign market information brought in by immigrants has a lagged effect on trade, we collected the immigrant time series starting from 1959/60 onward (while the other variables are from 1963) in order to allow a lagged period up to four years without forcing the other variables to lose observations. For our panel data set, the total number of observations is 380 ($T \times N$, where $T = 38$ and $N = 10$). If the immigrant intake data starts in 1963 and a four years lag is needed, T will be reduced by four. As a result, the number of observations in the model will be reduced to $T \times N = 34 \times 10 = 340$. This strategy of collecting a larger number of observations for the earlier end of the time series for the variable which is lagged, could effectively prevent a substantial loss of degrees of freedom for the panel data regression, imposed by the process of lagging.

From the ABS publication (Catalogue No. 3410.012), we collected the immigrant intake levels from 1996 to 2004. However, for Japan, South Korea and Thailand, from which there are relatively low emigrations to Australia, immigration data were not reported as separate entries in the ABS publication. Therefore, we used a combination of the ABS publications and population changes over the Census 1996 and Census 2001, to extrapolate the level of immigrant intake levels from those three countries.

Since the immigrant intake data are recorded for 12 months from July of one year to June in the following year, one lag of the immigrant variable in the model is in fact a lag of six months, two lags of the immigrant variable means a lag of eighteen months, and so on.

7.3 Resolution of the Data Endogeneity Problem

In Section 5.6.1 of Chapter 5, we came across the data endogeneity problem associated with the gravity model, which involves trade as a function of GDP. In the context of macroeconomics, the relation between trade and GDP is a mathematical identity as $(GDP = C + G + I + (EX - IM))$, that is, exports or imports are elements of GDP. If we regress exports or imports on GDP, then GDP will correlate with the error term of the gravity model, which violates the assumption of regressor-error independence. A number of possible solutions have been presented by some previous studies. For example, Cyrus (2002) replaced the GDP variable by a group of instrumental variables of physical capital, human capital, and labor accumulation rates, since those variables are correlated with the GDP variable but not correlated with the error term.

However, while the data for these instrumental variables may be available in developed countries, they are not very well recorded or documented in developing countries. The time-frame for this study also limits the availability of data for those instrumental variables. The longer the time dated back into the history, the harder it is to find the proper data for the instrumental variables. In addition, the use of a group of instrumental variables in our panel gravity model will increase the number of explanatory variables and substantially reduce the degrees of freedom of the regression – a trade-off between the degrees of freedom and endogeneity.

Instead of using instrumental variables, we opt for a simpler approach. We remove the trade component from the GDP data through the following process: For the Australian export model, since Australian exports form an element of Australian GDP, we deducted exports from Australian GDP. Since the volume of Australia's exports to a particular country is the same as imports by that country from Australia, these imports would reduce the importing country's GDP. Hence, we added this amount to the foreign country's GDP to reduce the endogeneity problem which is the Australian exports measured as part of the foreign country GDP. For example, in the data set for Australian trade with China, we deducted Australia's exports to China from the Australia's GDP and added the same amount to the China's GDP.

For the Australian import model, we applied the same process to tackle the endogeneity problem. Because the imports are just the opposite movement of goods as exports, we reversed the process we adopted for the export model: Australian imports were added to Australian GDP. The same amount of imports was deducted from the trade partner's GDP.

7.4 Preliminary Analysis of Data

The purpose of this section is to perform a preliminary analysis of data to investigate whether the trade variables are related to other variables in the model. Because the panel data set we use in this study has long time series, we are also interested in finding out whether the data set has a non-stationarity problem. We first graph the data and then perform simple correlation tests. Next, stationarity tests are conducted to test whether the data are appropriate for the econometric procedures we will use in Chapter 8.

7.4.1 Time Series Graphs

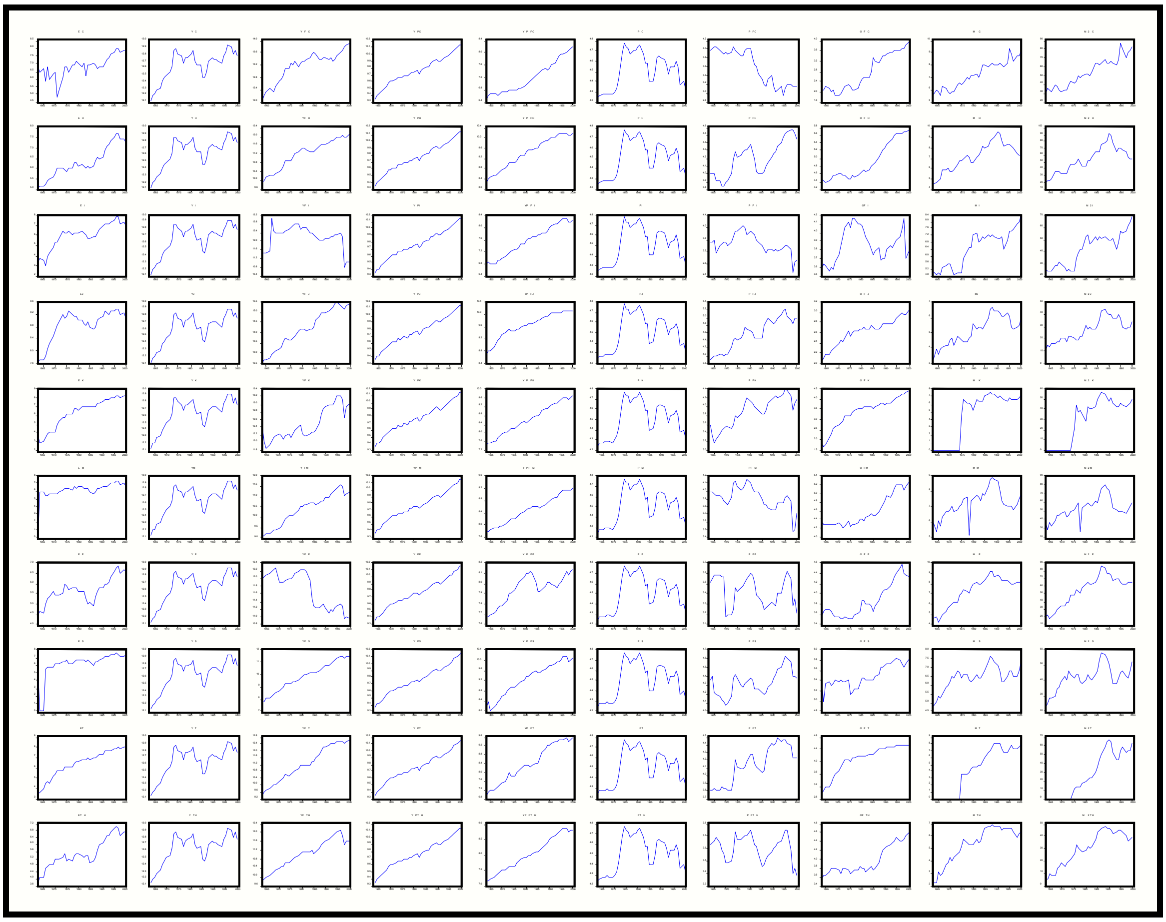
Figures 7.1 and 7.2 below display the time series graphs for the export model and the import model, respectively. Each of the Figures consists of 100 series (10 countries by 10 variables), where the first column is for the dependent variables and the other columns are for the independent variables. The objective of illustrating the data series in this format is to allow us to inspect the series for the relationship between the dependant variable and the independent variables for overall comparisons and as a preliminary analysis of the data. We acknowledge that the graphs for individual times series plots in Figure 7.1 are very small and both X- axes and Y-axes are not clearly be seen, and therefore, a sample of the expanded graphs is included in Appendix 7-C to provide clear illustrations. Since there are at least 130 different series, it is more practical to include just a sample for one country in Appendix 7-C.

In Figure 7.1, the time series graphs are arranged by countries and by variables.[60] Countries are arranged by rows according to alphabetical order. That is, China is in the first row, Hong Kong is in the second row, followed by Indonesia, Japan, Malaysia, South Korea, the Philippines, Singapore, Taiwan and Thailand, respectively. Variables are arranged by columns, from left to right: Australia's real exports (E), Australia's real GDP ($Y-E$), foreign real GDP (Y_f+E), Australia real per capita GDP (Y_p), foreign real per capita GDP (Y_{pf}), Australia real price level (P), foreign real price level (P_f), foreign countries' openness in real terms (O_f), Australia's immigrant intake from foreign countries (M), and immigrant intake square (M^2). The distance variable ($Dist_{ij}$), although important in the gravity model, is not included in the time series plots because it only varies across countries but not over time.

The graphs in Figure 7.1 reveal that, over the 38 years from 1963 to year 2000, most of the series trended upward, with some trending downward such as Australia's real price level in column 6. The Philippines' real GDP (row 7, column 3) shows a clear downward trend. In general, the plots exhibit a tendency toward a highly positive relationship between Australia's real exports and the majority of the explanatory variables in the gravity model for exports. The striking feature of Figure 7.1 is that the columns for Exports (the first column), Immigrant Intake (the second last column) and the square term of the Immigrant Intake (the last column) appear to have the similar trends of movement.

Figure 7.1 Time Series Plots for the Data Series in the Export Model

[60] For some variables, names required changes to suit the Eviews program. When the variables refer to Australia, the subscript of i is removed. They are: Australia's exports (E), Australia's GDP (Y), Australia's price level (P), Australia's openness (O) and the immigrant intake (M) and the square term (M^2). All variables that refer to Australia's trade partner have the subscript of f which stands for foreign country. In addition, the subscript j is used to identify the corresponding trade partner country. For instance, Y_{fC} stands for China's GDP and Y_{fH} stands for Hong Kong's GDP, and so on.

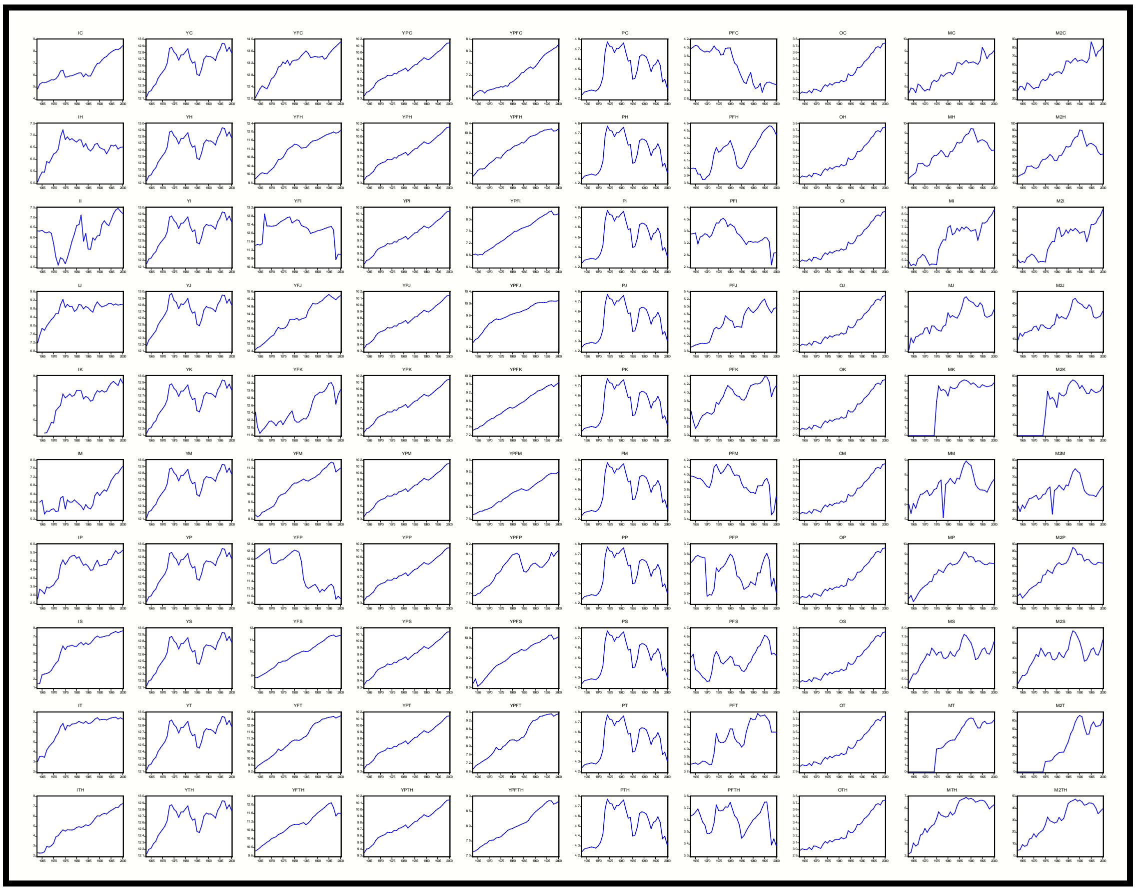


Note: the time series graphs are arranged by countries and by variables. Countries are arranged by rows according to the alphabetical order. Variables are arranged by columns. All series are in natural logarithm. The graphs are generated by Eviews econometric computer program.

In Figure 7.2 below, the time series plots for the import model are arranged in the same fashion as in Figure 7.1, but the first column in Figure 7.2 shows Australia's imports (I). In addition, the values for Y and Y_f are different variables, although with the same names as in Figure 7.1.

For the import model, Y is defined as $Y + I$ to recover the loss to imports, and Y_f is defined as $Y_f - I$ to deduct the foreign countries' exports to Australia from their GDP (Australia's imports from a foreign country is the same as that foreign country's exports to Australia). The openness variable in the import model is Australia's openness (O). The variables for real per capita GDPs (Y_p and Y_{pf}), real price levels (P and P_f), immigrant intake (M) and the square term of the immigrant intake (M^2) are identical variables as in Figure 7.1.

Figure 7.2 Time Series Plots for the Data Series in the Import Model



Note: the time series graphs are arranged by countries and by variables. Countries are arranged by rows according to the alphabetical order. Variables are arranged by columns.

The time series plots in Figure 7.2 also exhibit a general tendency for a highly positive relationship between the real imports variable and the independent variables in the import model. It can also be noticed that Australia's real per capita GDP (Y_p), Australia's price levels (P) and Australia's openness (O) are generally invariant across countries, although they do change over time. The columns for the import variable (in the first column), immigrant intake and the square term of the immigrant intake (the second last column and the last column, respectively) have upward trends. However, the trend movement of imports appears quite different from the trend movement for the immigrant intake and the square term of immigrant intake).

7.4.2 Correlation Analysis

Our primary focus of this study is on the relationship between Australia's intake immigrant information and Australia's trade with the immigrants' home countries. A strong positive relationship between immigrant intake and Australian trade flows with immigrant home countries as shown by the time series plots in Figures 7.1 and 7.2 would suggest the need for further investigation using more advanced techniques. Thus, in this section, we performed a correlation analysis of exports and imports with immigrant intake and lagged immigrant intake, for individual countries for forty-two years between 1963 and 2004 (up to 2001 for Japan, South Korea and Thailand). Since the data for exports and imports and the data for immigrant intake are available up to 2004 for the majority of countries, for the correlation analysis we use longer time series than for the regression analysis.

The correlation between Australia's exports to the Asian trade partners and immigrant intake from Asian trade partners are presented in Table 7.1, and the correlation between Australia's imports and immigrant intake are presented in Table 7.2. As shown in Table 7.1, the correlation between exports and immigrant intake varies widely from negative 0.238 for Vietnam (lagged 0 year) to positive 0.939 for Thailand (lagged for 10 years).[61] All correlation coefficients greater than positive 0.42 are statistically significant.

The variation in correlation is wider when immigrant intake and exports are concurrent. The variation decreased when immigrant intake are lagged. When lagged by five periods, the variations become the smallest. With no lagged in immigration intake, the correlation between immigration and trade is influenced by other factors, because it is not expected that exports can be influenced straightaway when the immigrant just landed. However, after several years' settlement, the new immigrants can find opportunities to trade with their home countries. Thus the improving correlation and narrowing the difference across countries can be speculated as partly contributed by immigrant foreign market information. A positive correlation, which is strengthened with the increase of the number of lags, indicates that there is a period of delay for the foreign market information to be utilised by industries, and immigration tends to benefit the export sector of the Australian economy in the long run.

---

[61] We decisided not to include Vietnam in our panel data set due to a large number of missing data for some variables for Vietnam. However, data for the Australia's trade with Vietnam and the immigrant intake from Vietnam are well recorded. We use Vietnam data for the test of causality between immigration and trade. Thus, we include Vietnam for the preliminary data analysis.

Vietnam is a special case as we find from Table 7.1. Although the long run relationship between exports and immigration can also be found for Vietnam, the correlations are low and negative except for the case of 10 lags. However, historical events of prolonged wars and economic embargos served as artificial distortions to both trade and immigration, which can be the elements that shaped Vietnam's difference from the other Asian countries.

Table 7.1 Correlation between Australia's Exports and Lagged Immigrant Intake from Eleven Asian Countries

Exports to:	Immigrant Intake (0 lag)	Immigrant Intake (1 lag)	Immigrant Intake (2 lags)	Immigrant Intake (3 lags)	Immigrant Intake (5 lags)	Immigrant Intake (10 lags)
China	.823	.759	.752	.783	.737	.754
Hong Kong	.361	.471	.587	.712	.890	.597
Indonesia	.641	.629	.617	.642	.704	.802
Japan	.481	.553	.602	.624	.604	.412
Malaysia	.123	.166	.248	.376	.609	.513
Philippines	.244	.310	.376	.452	.629	.785
Singapore	.527	.521	.534	.568	.619	.585
South Korea	.629	.664	.711	.761	.836	.862
Taiwan	.732	.752	.774	.788	.794	.611
Thailand	.631	.695	.762	.839	.939	.862
Vietnam	-.238	-.206	-.177	-.112	.085	.496

All correlations are statistically significant at 1% level, except those correlations which are +.412 or less.

The coefficients for correlation between Australia's immigrant intake and imports are less strong than that between immigrant intake and exports (except for China and Indonesia). Table 7.2 shows that for most of the countries, there is a decline in the correlation between immigrant intake and imports into Australia with the increase in lags.

The coefficients of correlations shown in Tables 7.1 and 7.2 support the argument that the positive impact of immigrant intake on exports takes about four years to show its effect, however, the effect is long lasting. While the impact of immigrant intake on imports has some shorter term positive effect, however, the effect fades out gradually over time.

Table 7.2 Correlations between Australia's Imports and Lagged Immigrant Intake from Eleven Asian Countries/Places

Imports from:	Immigrant Intake (0 lag)	Immigrant Intake (1 lag)	Immigrant Intake (2 lags)	Immigrant Intake (3 lags)	Immigrant Intake (5 lags)	Immigrant Intake (10 lags)
China	.799	.815	.836	.818	.761	.869
Hong Kong	.042	-.019	-.030	.011	-.039	-.334
Indonesia	.806	.771	.719	.674	.611	.799
Japan	.462	.527	.540	.521	.471	.335
Malaysia	.108	.062	.043	.065	.119	.690
Philippines	.254	.250	.262	.276	.300	.563
Singapore	.595	.566	.535	.509	.469	.691
South Korea	.510	.526	.550	.602	.595	.751
Taiwan	.712	.673	.647	.644	.614	.399
Thailand	.520	.561	.594	.597	.673	.875
Vietnam	-.222	-.191	-.154	-.103	.031	.475

All correlations are statistical significant at 1% level except those correlations which are +.399 or less.

7.4.3 Stationarity Tests

Tables 7.1 and 7.2 revealed that, in general, Australia's exports and imports are positively and strongly correlated with immigrant intake and lagged immigrant intake for the majority of countries in the sample. It is an encouraging finding for proceeding with further investigation into the relationship between immigration and trade in the form of a regression analysis. The results of the regression analysis will be presented and discussed in Chapter 8. Further investigation into the causality relation between immigration and trade is undertaken in Chapter 9. However, before we can proceed to the econometric analysis and the causality tests, it is important to test the time series data for stationarity/non-stationarity, using the available unit root tests for both individual data series and panel data sets.

Stationarity is a term used in empirical time series econometrics. Most economic time series data are collected as discrete data over time, and every individual observation in the time series are viewed as "just happen to be" or random or stochastic. Thus, a time series is a collection of "the representative of" or "the realisation of" random variables arranged in time. Although all the individual observations are good representatives of their populations at the particular time, to be able to generalise this representative to another time period, the order of "the representatives" in time are required to be well behaved – that is, the mean and the variance of the time series are required to be constant over time. The covariance is allowed to vary if, and only if the covariance is across two or more time periods. If the above requirements are not satisfied, the time series is called nonstationary time series. Studies using nonstationary time series data become *ad hoc* studies and the results cannot be generalised into other time periods (Gujarati, 2003, p.798).

7.4.3.1 Unit Root Tests for Individual Time Series

A number of techniques can be employed to investigate the stationarity properties of the time series. The simplest method would be the graphical examination of the series by plotting the series against time and plotting the correlogram from the time series. Figures 7.1 and 7.2 above are the plots for the series in the Export and the Import models, respectively. All of the time series plots exhibit random walk nonstationary properties.[62] All autocorrelation plots (not presented here) in the correlogram taper off. Most of the autocorrelations are still greater than positive 2 standard deviations after 10 lags. The graphical examinations of the individual series reveal the necessity for further investigation into the stationarity by a number of tests.

A number of unit root test methods can be employed for individual time series data, such as the Dickey-Fuller (DF) test, the Augmented Dickey-Fuller (ADF) test, the Phillips-Perron (PP) test, the Kwiatkowski, Phillips, Schmidt, and Shin (KPSS) test, the Elliot, Rothenberg and Stock (ERS) point optimal test, and the Ng-Perron (NP) test. Some of the tests are specific to a particular time series scenario and the application is limited. For example, the Elliot, Rothenberg and Stock (ERS) point optimal test cannot test a time series, which has shorter than 50 observations. For simplicity and practicality, we applied the ADF test, the PP test and the KPSS test for our individual time series data. Both the ADF and the PP test assume a unit root process in the series (unit root under the null hypothesis). The ADF test is a simpler and straightforward test, and the PP test produces more conservative test results, which tends to identify a time series as a unit root process where the ADF test fails to identify. Unlike the ADF and the PP test, the KPSS test assumes no unit root process in the time series (stationary under the null hypothesis).

The procedure we employed for the unit root tests are as follows: We first test the individual country data series with the popular ADF test and then the PP test. Any series

[62] A random walk is also called a "drunkard's walk. The direction of the step is random and unpredictable, however, each new step starts from the point where the previous step ends. The random walk process is usually used to describe the non-stationary process.

found no unit root process by the ADF test and/or the PP test will be further tested by the KPSS test. The reason for employing this procedure is that we want to be sure that those series found no unit root process by the ADF test and the PP test are really stationary. Thus, the ADF and the PP tests serve as screening procedures. However, the screening may still have some chance to go wrong. In order to verify the test results, we redefined the null hypothesis and then test it by the PKSS test.

We will now provide a detailed discussion of the test procedures and their results. The popular procedure to test stationarity is to investigate the ρ coefficient in the following equation:

$$Y_t = \rho Y_{t-1} + X_t{}'\delta + u_t \qquad -1 \le \rho \le 1 \tag{7.1}$$

where $x_t{}'\delta$ is an exogenous variable, such as constant and/or constant and trend, and u_t is pure random error. If $\rho = 1$, that is, the relation between observation Y at time t and observation Y at time $(t-1)$ is unitary, then, Y_t is a unit root nonstationary stochastic process. For simplicity and inline with other coefficient tests in regressions analysis, subtract Y_{t-1} from both sides of Equation (7.1) to get:

$$\begin{aligned} Y_t - Y_{t-1} &= \rho Y_{t-1} - Y_{t-1} + X_t{}'\delta + u_t \\ &= (\rho - 1)Y_{t-1} + X_t{}'\delta + u_t \end{aligned} \tag{7.2}$$

which can be written as:

$$\Delta Y_t = \alpha Y_{t-1} + X_t{}'\delta + u_t \tag{7.3}$$

where Δ is the first difference operator and $\alpha = (\rho - 1)$. The conventional hypothesis *t* test on $\alpha = 0$ is the same as the test on $\rho = 1$, which is the unit root test.

The Augmented Dickey-Fuller (ADF) Test

Dickey and Fuller (1979) developed the critical values for unit root tests called the τ (tau) statistic (DF test). The DF test assumes that the error term is uncorrelated. For the case where the error term is serially correlated, Dickey and Fuller developed a parametric correction for higher order correlation by adding p times lagged difference terms of the dependent variable to the right hand side of the test regression with the assumption that the dependent variable follows an $AR(p)$ process. The DF test augmented by the lagged difference of the dependent variable is called the Augmented Dickey-Fuller (ADF) test, which has the form:

$$\Delta Y_t = \alpha Y_{t-1} + X_t{}' \delta + \beta_p \sum_{p=1}^{m} \Delta Y_{t-p} + \varepsilon_t \tag{7.4}$$

where ε_t is a pure white noise error term and $\sum_{p=1}^{m} \Delta Y_{t-p} = (Y_t - Y_{t-1}) + (Y_t - Y_{t-2}) + ... + (Y_t - Y_{t-p})$. However, two practical issues are encountered when conducting the ADF test; selecting the lag length and the exogenous variable. The exogenous variable can be no intercept and no trend, an intercept only or an intercept and a linear trend.

We conducted ADF tests using Eviews for all individual data series in the export and import models. We allow the Eviews to select the optimal lag length by using the Schwarz Information Criterion. Three forms of non-stationarity are tested: Random Walk, Random Walk with Drift, and Random Walk with Drift around a Stochastic Trend. We present the ADF tests results in Tables 7-D.1 and 7-D.2 in Appendix to Chapter 7.

Before we discuss the test results, we give explanations of the names of the data series in Appendix to Chapter 7, Tables 7-D.1 and 7-D.2. The last letter in the series name stands for cross-section countries. For example, C is for China, H for Hong Kong, I for Indonesia, and so on. The other letters stands for the variable names. E stands for Australia's exports, Y stands for Australia's GDP, YF stands for foreign countries' GDP, YP is for Australia's per capita GDP, YPF is foreign countries' per capita GDP, P is Australia's general price level, and PF is foreign countries' general price level. O is Australia's openness, OF is foreign countries' openness, M is the immigrant intake level and M2 is the square term of the immigrant intake level. For example, the first series in Table 7-D.1 is EC; "E" is for Exports and C is for China, thus EC is the data series for the Australian exports to China. For the import model in Table 7-D.2, the way to name the data series is the same as in Table 7-D.1, except that the exports (E) is replaced by imports (I). This practice of naming the data series is carried on to the PP tests and to the KPSS tests.

Both Tables 7-D.1 and 7-D.2 have three test models, depending on how the exogenous variables are included. Test I is for random walk with drift, that is, the exogenous variable is a constant. Test II is for random walk with drift around a stochastic trend, that is the exogenous variables are constant and trend. Test III is for random walk only (with no drift, no trend), that is, the exogenous variable is not included. Out of the three forms of the ADF unit root tests, Test I and Test III are the special cases of the more general model of Test II.

Table 7-D.1 illustrates the ADF test results for data series used in the export model. For Test I, the ADF test found that all series are unit root except for four data series: EJ, EM, ET and OFT. When the Test II is used, the ADF test identified that seven data series do not have unit root problems. They are EC, EJ, EM, MC, M2C, PFP and PFS. However, when the Test III is applied, all of the individual data series are unit root. The EJ and EM series are found stationary by both Tests I and II.

Table 7-D.2 lists the unit root tests for all individual data series in the import model. Test I identifies three stationary series, they are imports from Hong Kong (IH), imports from Japan (IJ) and imports from Taiwan (IT). Test II identifies five stationary series. They are MC, M2C, IP, PFP and PFS. Out of the five series just mentioned, four are the same series as in the export model which have been identified as stationary series in Table 7-D.1. Only the IP series is a new data series found stationary in the import model. The results for Test III failed to identify any stationary series for the import model. In summary, the ADF regressions identify a total of thirteen stationary data series.

The Phillips-Perron (PP) Test

While the ADF test tackles the serial correlation error term problem by adding lagged difference of the dependent variable to the independent variables to alter the test regression, Phillips and Perron (1988) used nonparametric method to changes the test statistic, hence the serial correlation problem does not affect the asymptotic distribution of the *t* statistic. The *t* statistic is calculated as:

$$t_{\alpha}^{pp} = t_{\alpha}\left(\frac{\gamma_0}{f_0}\right)^{\frac{1}{2}} - \frac{T(f_0 - \gamma_0)(s_{\hat{\alpha}})}{2 f_0^{\frac{1}{2}} s} \qquad (7.5)$$

where $\hat{\alpha}$ is the estimated α in (7.3), t_{α} is the *t*-statistic of α in (7.3), $s_{\hat{\alpha}}$ is the standard error coefficient for the *t*-statistic and *s* is the standard error of the test regression (7.3). γ_0 is a consistent estimate of the error variance in (7.3) and at frequency of zero, f_0 is an estimator of the residual spectrum.[63]

To perform a PP test, we need to determine the exogenous variable in the test regression similar to the ADF test regression and the method of estimating the f_0. The PP test results are presented in Tables 7-D.3 and 7-D.4 of Appendix 7-D for the export model and the import model, respectively. We tested all three models: Test I, Test II, and Test III. For the method of estimating the f_0, we allow the Eviews' default of the Bartlet kernel method with Newey-West bandwidth selection. In the Test I regression, the PP test identifies five stationary data series in the export model (Table 7-B.3). They are YPFH, YPFJ, EM, ET and OFT. In the Test II regression, the PP test identifies six stationary data series. They are EC, MC, M2C, EM, ES and OFS. The Test III regression found that all the data series as nonstationary series.

For the import model as shown in Table 7-D.4 of Appendix 7-D, Test I identifies five nonstationary data series. They are IH, IJ, IT, YPFH and YPFJ. Test II identifies three data series as nonstationary, they are MC, M2C and IJ. However, those three series were found stationary in the Test I. Thus, Test II did not identify any new series as stationary. Test III found no stationary series. In summary, The PP test found sixteen stationary data series.

Comparing the stationary test results from ADF tests and the PP tests, both tests found very similar data series that are stationary in the export model and in the import model. Most of the series are found stationary by both tests, although some series are identified as stationary only by either test. Since wrongly rejecting unit root causes more harm than wrongly "accepting" unit root, we further verify the stationary series found from the ADF and PP tests, using the KPSS test.

---

63 More detailed explanation for the PP test can be found in the Eviews 5.0 help file.

The Kwiatkowski-Phillips-Schmidt-Shin (KPSS) Test

The KPSS test (1992) reversed the null hypothesis by assuming that the series is stationary (in contrast to the ADF test with the null hypothesis of nonstationary). It is an *LM* test based on the OLS residual from the regression of:

$$y_t = x_t{}'\delta + u_t \tag{7.6}$$

Since $x_t{}'\delta$ is the exogenous term of either constant or constant and trend specification, The KPSS test will be in the following two forms:

$$y_t = r_t + u_t \tag{7.7}$$

and

$$y_t = r_t + \beta t + u_t \tag{7.8}$$

The test statistic is:

$$LM = \frac{\sum_t S_t^2}{T^2 f_0} \tag{7.9}$$

where f_0 is same estimator as the PP test and S_t is the cumulative residual function of $S_t = \sum_{r=1}^{t} \hat{u}_r$. To specify the KPSS test, similar to the PP test, we need to specify whether an intercept or a trend and intercept are present in the test regression. We also need to select the method of estimating f_0.

The data series found stationary by either the ADF test or the PP test or by both are retested using the KPSS test, assuming they are stationary. Here we test the data series on the regression with a constant (Test I), and a constant with a linear trend (Test II), allowing Bartlet kernel with Newey-West bandwidth selection to choose f_0. In the column under the heading of Test I of Table 7.3 below, the KPSS test cannot reject the null of stationarity for three data series of IH, PFP and PFS. The Test II cannot reject stationarity for ten data series: EC, EJ, EM, ES, IP, MC M2C, OFS, PFP and PFS. A combined result of Test I and Test II reveal that the data series, which cannot be found non-stationary are only two – that is, PFP and PFS.

By using the ADF, PP and KPSS tests, out of a set of one hundred and thirty (130) individual time series data, only two (2) data series were found not to have a unit root. The rest were found to be nonstationary. The nonstationary series are required to be transformed into stationary series before they can be used for econometric analysis. We found that all nonstationary series are difference stationary stochastic processes or $I(1)$ processes. That is, by taking the first difference, the nonstationary series become stationary.

Table 7.3 The KPSS Tests for Stationarity

Series		KPSS Test Statistics	
		Test I	Test II
EC		0.647505*	0.085812
EJ		0.485028*	0.127861
EM		0.679501*	0.137110
ES		0.583467*	0.143486
ET		0.721152*	0.200624*
IH		0.324950	0.162934*
IJ		0.523309*	0.177522*
IP		0.533448*	0.131888
IT		0.613134*	0.180732*
MC		0.729161*	0.087647
M2C		0.730076*	0.073988
OFS		0.630073*	0.135261
OFT		0.672719*	0.172839*
PFP		0.127669	0.055513
PFS		0.451765	0.074026
YPFH		0.732642*	0.200225*
YPFJ		0.722108*	0.178189*
Asymptotic critical values	1% level	0.739	0.216
	5% level	0.463	0.146
	10% level	0.347	0.119

Test I, random walk with drift. Test II, random walk with drift around a stochastic trend.
* Reject null hypothesis of stationary at 5% significant level.

However, the gravity models to be estimated in Chapter 8 will use pooled cross-section and time series data or panel data. Panel unit root tests are also required to be performed before the pooled data can be used in the estimation of the gravity models. We will test the pooled data series in the next section using a range of panel unit tests.

7.4.3.2 Panel Unit Root Tests

The term Panel Data in this study refers to the pooling of time series data for all of the countries in the study. For example, the exports variable consists of Australia's exports to China over thirty-eight years from 1963 to year 2000 and Australia's exports to Hong Kong for the same period of time and so on until all ten countries in this study are included. Each variable in the panel data set consist of 380 observations (10 cross-section countries times 38 years). Each variable in the panel data set inherits the characteristics of all individual series that made up the variable. As pointed out by Levin *et al* (2002), if the time dimension of the panel is very large, the unit root testing procedure discussed in Section 7.4.3.1 will be sufficient and powerful to test the individual data series in the panel. If the time dimension is very small compared to the cross-section dimension, the non-stationarity problem has little impact on the regression results, and the usual panel data regression procedure will be appropriate. However, with a moderate size panel (between 20 and 250 cross-sections and 25 to 250 time periods per cross-section), the traditional unit root tests may not be sufficient or powerful.

Panel unit root tests are mostly similar to the unit root tests on single time series in Equation (7.1), but modified as:

$$Y_{it} = \rho_i Y_{it-1} + X_{it}'\delta_i + u_{it} \qquad -1 \le \rho \le 1 \qquad (7.10)$$

where i = 1, 2, 3,…N cross-section series. Within the range of $-1 \le \rho \le 1$, if $\rho < 1$, the series of Y_i is said to be stationary, if $\rho = 1$, Y_i is said to be a unit root nonstationary series.

A number of panel data nonstationary tests have been developed in recent years. Those tests can be classified into two broad categories, (i) those cross-section data that can be assumed independent, and (ii) those cross-section data that cannot be assumed independent. For the category of cross-sectional independent panel unit root tests, the popular method of tests are Levin, Lin and Chu test (2002), the Im, Pesaran and Shin test (2003), the Breitung test (2000) and the Hadri test (2000). For the category of cross-section dependent panel unit root tests, the Pesaran's (2004) cross-section dependence (CD) test, Moon and Perron's (2004) dynamic factor model test to capture the cross-section correlation, Bai and Ng's (2004) ADF test, Choi's (2002) error component model, and Pesaran's (2003) cross-sectional augmented Dickey-Fuller (CADF) test are available other tests.[64] The panel unit root test techniques assuming cross-section independence are better established.

[64] The discussion of those tests can be found in Baltagi (2005).

In this study, we assume that the cross-sections of data in our sample are independent. The variable GDP, per capita GDP and price level are independent between countries since different countries have their own business cycles and stages of economic development.

Strictly speaking, if in a three-country trade model, Country A is the exporter country and Countries B and C are importers, then exports from Country A to Country B are not independent from the exports from Country A to Country C. They are private goods that have the characteristics of rivalry and mutual exclusivity. In statistics terminology, if two events, A and B, are mutually exclusive events, then Event A and Event B are not independent. In fact, Event A and Event B are inter-dependent events because if one event happens, the other event must not happen, to be able to term "mutual exclusive" events. Bringing this concept of "mutual exclusive" in our exports example, for a particular item of goods, which is exported to one country, it will not be able to be exported to another country at the same time. One item of the goods exported to one country "excludes" the other country to import the same goods. In addition, if Country A's export capacity is fully utilised, increasing exports to Country B will reduce exports to Country C to be able to free the goods to export to Country B. In this situation, exports to Country B and exports to Country C are cross-section dependent. If cross-section dependence exists, the cross-section dependent panel unit root tests of Moon and Perron's (2004), Bai and Ng's (2004), Choi's (2002) and Pesaran's (2003) are more appropriate.

However, in this study, our sample of ten trade partners is a relatively small in a large population of all Australia's trade partners. Increasing exports to one of the Asian trade partner has very little impact on reducing exports to all other trade partners. Hence the effect of interdependence between the trade partners can be assumed quite small. Thus, we use the cross-section independent panel unit root tests of Levin, Lin and Chu (2002), Im, Pesaran and Shin (2003), Breitung (2000) and Hadri (2000).

The following subsections focus on the panel data unit root tests, which assume cross-section independence of the panel data. This category can be further classified into two subcategories: a more restrictive assumption of a common unit roots for all cross-sections or less restrictive assumption of individual unit roots for each cross-section units.

The panel unit root test will be conducted to test variables for the export model and the import model. Some variables are used in the Export model only, they are: Australia's exports, Australia's GDP (treatment discussed in Section 7.3) and foreign country's GDP (treatment discussed in Section 7.3). Some variables are only used in the Import model, they are: Australia's imports, Australia's GDP (different values from the Australia's GDP variable in the exports model, see Section 7.3) and foreign country's GDP (also different values from the foreign country's GDP in the exports model, see Section 7.3). Some variables are used for both export model and the import model, they are: per capita GDP for foreign countries, price level for foreign countries, foreign countries Openness and Australia's migrant intake level. Some variables do not need to have panel unit root test because they are invariant across cross-sections, e.g. Australia's per capita GDP, Australia's price level and Australia's openness variable. Unit root tests for those variables have been conducted as individual time series unit root tests in Section 7.4.3.1.

Levin, Lin and Chu (LLC) Test

Levin, Lin and Chu (2002) assume a common unit root across the cross-sections. LLC started with a basic ADF specification for panel data:

$$\Delta y_{it} = \alpha y_{it-1} + \sum_{L=1}^{p_i} \beta_{iL} \Delta y_{it-L} + X'_{it}\delta + u_{it} \tag{7.11}$$

where $\alpha = \rho - 1$, $i = 1,2,3,...,N$ cross-section units and L is the number of lag terms. p_i, the optimal lag order terms are allowed to vary across the cross-sections. If the null of $\alpha = 0$ is rejected in favour of the alternative of $\alpha < 0$, then the panel data has no unit root. Since p_i is allowed to vary for different cross-sections, the first step in the LLC test is to select the optimal p_i for each cross-section by using one ADF regression for each cross-section. Based on the optimal p_i and the appropriate exogenous (deterministic) variables of X_{it} the orthogonalised residuals ($\hat{e}_{it}$ and $\hat{v}_{it-1}$) are generated by two auxiliary regressions (regress Δy_{it} on Δy_{it-L} and X_{it}, and y_{it-1} on Δy_{it-L} and X_{it}). The residuals are then standardised as $\tilde{e}_{it}$ and $\tilde{v}_{it-1}$ by the regression standard error from Equation (7.11). The second step is to find out the ratio of the long-run standard deviation to the short-run standard deviation, and this ratio is then used to adjust the t-statistics in step 3. The final step is to obtain the panel test statistics by pooling all cross-section and time series observations to estimate:

$$\tilde{e}_{it} = \alpha \tilde{v}_{it-1} + \tilde{\varepsilon}_{it} \qquad (7.12)$$

With the conventional hypothesis t test for $\alpha = 0$, if $\alpha = 0$ cannot be rejected, the panel variable has a common unit root. If the null is rejected, then the test concludes that each of the individual series is stationary.[65]

The LLC test has its limitations, as acknowledged in Levin *et al* (2002). They are as the restrictive alternative hypothesis of identical first order autoregressive coefficient and the test's reliance crucially upon the "no-cross-section-dependence" assumptions.

To implement the LLC test, the specification of the number of lags used in the individual ADF regression is required. The kernel choice and the exogenous variables are also required to be determined. We performed the LLC test on all pooled variables for our export and import models allowing the Eviews to select the maximum lag length using Schwarz information criterion, and the Bartlett kernel method to obtain the average standard deviation ratio from cross-sections. We tested three exogenous variable models with intercept but no trend, intercept and trend, and no intercept no trend. The three LLC test results are presented in Table 7.4.

For the intercepts but no trend model, for eight out ten variables, the test rejects the null hypothesis of unit root. Only the variables of foreign price level and foreign openness are found to be with a unit root. When the intercepts and linear trends models are applied, the exports and imports variables are found to have no unit root. When the no intercept no trend model is used, all variables are found to have a unit root. When a unit root is found in the panel data, we should be cautious for the non-stationarity properties of the panel data.

---

[65] Detailed development of the three steps procedure and the t statistics are given in Levin *et al* (2002).

Table 7.4 Levin, Lin and Chu Panel Unit Root Tests

Variables	Intercept, no trend		Intercept and trend		No intercept, no trend	
	t-statistic	Probability	t-statistic	Probability	t-statistic	Probability
For Export model						
Australia's Exports	-5.5230	0.0000	-7.4943	0.0000	4.9934	1.0000
Australia's GDP	-4.5319	0.0000	-0.5978	0.2750	3.9378	1.0000
Foreign country's GDP	-3.8868	0.0001	-0.9872	0.1618	8.5281	1.0000
For Import Model						
Australia's Imports	-3.5946	0.0002	-1.7467	0.0403	5.6752	1.0000
Australia's GDP	-4.5409	0.0000	-0.6073	0.2718	3.9264	1.0000
Foreign country's GDP	-3.4283	0.0003	-0.8878	0.1873	7.1651	1.0000
For Export and Import						
Foreign per capita GDP	-2.0245	0.0215	0.1463	0.5582	12.3314	1.0000
Foreign Price level	-1.2792	0.1004	-0.9277	0.1768	0.0059	0.5024
Foreign Openness	-0.9584	0.1689	-1.6331	0.0512	7.8341	1.0000
Australia's Immigrant Intake	-2.9808	0.0014	-0.0058	0.4977	3.8213	0.9999

The values of Australia's per capita GDP, Australia's price level and Australia's openness variables change over time but do not change in cross-sections. Levin, Lin and Chu panel unit root tests do not apply to these variables.

Im, Pesaran and Shin (IPS) Test

Im, Pesaran and Shin (2003) provide a less restrictive test of panel unit root, allowing the panel data set to have individual unit roots. IPS specifies one ADF regression for each cross-section:

$$\Delta y_{it} = \alpha_i y_{it-1} + \sum_{L=1}^{p_i} \beta_{iL} \Delta y_{it-L} + X'_{it}\delta + u_{it} \tag{7.13}$$

The only difference between Equation (7.11) and Equation (7.13) is the term α_i. The null hypothesis becomes $\alpha_i = 0$ where $i = 1, 2, 3, ..., N$ cross-sections rather than $\alpha = 0$ in the LLC specification. The IPS testing procedure is based on the averaging of individual unit root test statistics:

$$\bar{t} = \frac{1}{N} \sum_{i=1}^{N} t_{\alpha_i} \tag{7.14}$$

where the t_{α_i} is the individual *t*-statistics for testing the null of $\alpha_i = 0$ for all *i* in Equation (7.13) and it generally has an asymptotic standard normal distribution if not all lag order p_i are zero across all i. For the special case when p_i are all zero across all i, IPS provide simulated critical values for given cross-section N and time series length T with intercepts only or intercepts and linear trends.[66]

To test the stationarity of the variables in our export and import models, we allowed the Eviews to choose the maximum lag length p_i using the Schwarz information criteria. We tested both models of intercepts only, and intercepts and linear trends as exogenous variables for the ADF regression. The test results are provided in Table 7.5. For the intercepts only model, three out of ten variables are found stationary: they are exports and Australia's GDP in the export model, and Australia's GDP in the import model. For the intercepts and linear trends model, two variables, exports and foreign price level are found stationary.

Although the LLC test and the IPS test are not directly comparable since the LLC test assumes a common unit root while the IPS test allows individual unit roots in the alternative hypothesis, the test results from the two tests revealed that, with our data set, the IPS test tends to be more conservative in rejecting a unit root.

Table 7.5 Im, Pesaran and Shin Panel Unit Root Tests

Variables	**Intercept, no trend**		**Intercept and trend**	
	t-statistic	**Probability**	**t-statistic**	**Probability**
For Export model				
Australia's Exports	-5.7217	0.0000	-6.7153	0.0000
Australia's GDP	-3.3468	0.0004	-0.5697	0.2845
Foreign country's GDP	-0.1663	0.4340	-0.6404	0.2610
For Import Model				
Australia's Imports	-1.4342	0.0758	-1.0039	0.1577
Australia's GDP	-3.4048	0.0003	-0.5297	0.2982
Foreign country's GDP	0.1599	0.5635	-0.5334	0.2969
For Export and Import				
Foreign per capita GDP	1.7953	0.9637	0.9909	0.8391
Foreign Price level	-0.8291	0.2035	-3.0981	0.0010
Foreign Openness	2.6030	0.9954	-0.3479	0.3640
Australia's Immigrant Intake	-0.6164	0.2688	0.6553	0.7439

The values of Australia's per capita GDP, Australia's price level and Australia's openness variables change over time but do not change in cross-sections. Im, Pesaran and Shin panel unit root tests do not apply to these variables.

[66] The critical values are provided in Im *et al* (2003).

Breitung's Test

Breitung (2000) test uses the same ADF regression as in LLC test of Equation (7.11), assuming a common unit root. However, the Breitung approach differs from the LLC test in that the Breitung test does not employ a bias adjustment (Baltagi, 2005, p.243) whereas such an adjustment is employed by the LLC test to correct for cross-sections specific variances in the panel data set. By using the bias adjustment, the LLC test suffers the loss of power when individual trends are included in the exogenous variable specification. Breitung uses three steps approach as in the LLC test but it differs from the LLC test in the following two ways: first, after selecting the appropriate lag length p_i for each cross-section by using one ADF regression for each cross-section in Step 1 of the LLC test, to obtain $\hat{e}_{it}$ and $\hat{v}_{it-1}$, Breitung regresses Δy_{it} on Δy_{it-L} to find the residual $\hat{e}_{it}$ and regresses y_{it-1} on Δy_{it-L} to find the residual $\hat{v}_{it-1}$. That is, Breitung dropped the deterministic variable X_{it}. Then the same standardising procedure as in LLC is applied to $\hat{e}_{it}$ and $\hat{v}_{it-1}$ to obtain $\tilde{e}_{it}$ and $\tilde{v}_{it-1}$. Second, Breitung detrends the residuals of $\tilde{e}_{it}$ and $\tilde{v}_{it-1}$ to obtain e^*_{it} and v^*_{it-1}. Step 3 replaces Equation (7.12) with the detrended residuals of e^*_{it} and v^*_{it-1} as:

$$e^*_{it} = \alpha v^*_{it-1} + \varepsilon^*_{it} \qquad (7.15)$$

The Breitung Test results are presented in Table 7.6. The intercepts and linear trends specification found that four variables are stationary and other two models found that all variables have a unit root.

Comparing the overall unit root test results from the LLC test, the IPS test, and the Breitung test, both the IPS test and the Breitung test found unit root for the same variables. That is, both test methods identify the same variables as nonstationary, although under different exogenous variable specifications and different assumptions about the behaviour of the underlying stationarity. Under the LLC test method, fewer variables are identified as having a unit root.

Table 7.6 Breitung Panel Unit Root Tests

Variables	Intercepts, no trend		Intercepts and trends		No intercept, no trend	
	t-statistic	Probability	t-statistic	Probability	t-statistic	Probability
For Export model						
Australia's Exports	2.2795	0.9887	-3.2324	0.0006	3.41174	0.9997
Australia's GDP	1.4125	0.9211	-3.0782	0.0010	4.12754	1.0000
Foreign country's GDP	1.7935	0.9636	-1.2386	0.1077	2.61171	0.9955
For Import Model						
Australia's Imports	0.4618	0.6779	0.0571	0.5228	1.18163	0.8813
Australia's GDP	1.4358	0.9245	-3.0215	0.0013	4.09732	1.0000
Foreign country's GDP	1.7849	0.9629	-1.2951	0.0977	2.53898	0.9944
For Export and Import						
Foreign per capita GDP	1.4331	0.9241	-1.1377	0.1276	1.95967	0.9750
Foreign Price level	-0.6158	0.2690	-1.8046	0.0356	1.88586	0.9703
Foreign Openness	-0.0057	0.4977	0.7090	0.7608	-0.99081	0.1609
Australia's Immigrant Intake	0.3764	0.6467	0.1779	0.5706	0.98012	0.8365

The values of Australia's per capita GDP, Australia's price level and Australia's openness variables change over time but do not change in cross-sections. Breitung panel unit root tests do not apply to these variables.

Some comments can be made about the design of the hypotheses of those three unit root test methods. For the LLC test, its null hypothesis is a common unit root. That is, all the time series of each cross-section unit converged to one single unit root for the whole panel data set. The test rejects the null hypothesis of unit root if all time-series are not unit root. However, it also rejects the null hypothesis if individual time series are unit root, as long as those individual unit roots do not converge to a single unit root for the whole panel data set. For the IPS test method, it acknowledges individual unit roots. As long as unit roots exist in each individual series, the panel data set is said to have a unit root problem. However, since the testing procedure is based on the averaging of the individual unit root test statistics, it could reject the null hypothesis if some of the individual series in the panel data set are not unit root. The Breitung test also pays attention to a common unit root, but reduces the drawback of losing power of the test when individual linear trend is included in the test regression of the LLC and IPS tests (Baltagi, 2005, p.243). The drawback of loss of power when linear trend is included in the test regression is due to the cross-section bias adjustment procedure employed by the LLC and the IPS tests.

For the above three methods of testing, we also experimented with different information criteria used to select the maximum lag length p_i and different kernel methods. Although the test results changed with these alternations, the conclusion of rejecting/not rejecting the null for each variable is not affected.

Hadri Test

The LLC, IPS and Breitung unit root tests assume unit root as the null and no unit root as the alternative. Hadri (2000) reversed the hypothesis by assuming that the panel data have a common stationary process with an alternative of nonstationary process. As long as the stationarity null is rejected, the panel data is assumed having the nonstationary problem. Similar to the KPSS test for individual series unit root test, Hadri developed a Lagrange Multiplier (*LM*) *z*-test on the residual of the individual OLS regression:

$$y_{it} = X_{it}'\delta + u_{it}. \tag{7.16}$$

Same as the KPSS test, the exogenous term of $X_{it}'\delta$ can be a constant only:

$$y_{it} = r_{it} + u_{it} \tag{7.17}$$

or constant and trend:

$$y_{it} = r_{it} + \beta_i t + u_{it} \tag{7.18}$$

The *LM* statistics provided by Hadri is:

$$LM = \frac{1}{N}\left(\sum\nolimits_{i=1}^{N}\left(\sum_t S_{it}^2 / T^2\right) / \hat{\sigma}_u^2\right) \tag{7.19}$$

where $S_i(t)$ are the spatial sums of the residuals,

$$S_i(t) = \sum_{j=1}^{t} \hat{u}_{ij} \tag{7.20}$$

and $\hat{\sigma}_u^2$ is a constant estimator of σ_u^2 under the null hypothesis. The possible way to estimate this is given by Hadri:

$$\hat{\sigma}_u^2 = \frac{1}{NT}\sum_{i=1}^{N}\sum_{t=1}^{T}\hat{u}_{it}^2 \tag{7.21}$$

For possible heteroskedasticity across i, an alternative *LM* test is provided:

$$LM = \frac{1}{N}\left(\sum_{i=1}^{N} \left(\sum_{t} S_{it}^{2} / T^{2} \right) / \hat{\sigma}_{u,i}^{2} \right) \qquad (7.22)$$

The statistics follow a normal z distribution.

Because there is no lag length term involved, the Hadri test only needs to determine the kernel selection method. In addition, Equation (7.16) does not permit the no intercept and no trend model; the test needs to specify either Equation (7.17) for the intercepts only or Equation (7.18) for the intercepts and linear trends.

We specified both models and allowed the Eviews' default setting for kernel selection. The test results of the two models are presented in Table 7.7. The Hadri test results reject stationarity for all variables.

Table 7.7 Hadri Panel Unit Root Test

Variables	Intercept, no trend		Intercept and trend	
	z-Statistic	Probability	z-Statistic	Probability
For Export model				
Australia's Exports	10.3304	0.0000	5.3035	0.0000
Australia's GDP	6.9378	0.0000	4.7992	0.0000
Foreign country's GDP	11.4260	0.0000	6.8898	0.0000
For Import Model				
Australia's Imports	10.1534	0.0000	6.8833	0.0000
Australia's GDP	6.7690	0.0000	4.7295	0.0000
Foreign country's GDP	11.4204	0.0000	6.7298	0.0000
For Export and Import				
Foreign per capita GDP	11.9225	0.0000	6.3868	0.0000
Foreign Price level	9.1756	0.0000	4.0637	0.0000
Foreign Openness	10.7662	0.0000	7.4379	0.0000
Australia's Immigrant Intake	10.0068	0.0000	7.0642	0.0000

The values of Australia's per capita GDP, Australia's price level and Australia's openness variables change over time but do not change in cross-sections. Hadri panel unit root tests do not apply to these variables.

From all of the above panel unit tests on our data, we found that all variables in the panel data set are non-stationary.

7.5 Conclusion

This chapter focused on the preparation of the data for econometric analysis in the next chapter (Chapter 8). We documented the sources of data, the strategies to tackle the missing data problem and the data endogeneity problem associated with the gravity model. We performed a correlation analysis of the data for the preliminary investigation of the possible relation between the dependent variable and the independent variables. We also performed thorough tests of unit roots for individual time series as well as for panel data set for each variable, which is formed by the same time series for each cross-section countries. Nonstationarity is generally found in all variables.

The stationarity/non-stationarity tests have significant implications for choosing the appropriate econometric techniques for the estimation procedures used in Chapter 8. If the dependent and the independent variables are nonstationary, the nonsense regression phenomenon of overestimated t-scores and overall fit are exhibited and the Durbin-Watson statistic is very low due to the spurious correlation between the dependent and the independent variables. The regression with spurious correlation is called spurious regression. If the regression is spurious, the estimates are inconsistent and hence are untrustworthy. It is suggested that if the regression is spurious, the first difference (further differences if necessary to achieve stationarity) of time series should be analysed to obtain estimates of parameters.

In macroeconomics, there is the basic concept of long run, steady-state equilibrium in which economic variables are moving together at the same pace over time. If such a relation exists, the economic variables are said to be cointegrated, and the underlying trend, which causes the spurious correlation may be cancelled out. Then, the regression will not be spurious and in fact the least squares estimator works better (Griffiths et al., 1993, p.700). A modified Dickey-Fuller unit root test on the OLS residual of the regression would be sufficient to find out whether such a co-integrating process exists in the times series.

The purpose of testing panel unit root for our data set is to identify whether the panel cointegration procedures are warranted to apply on the gravity models we use to investigate the long-run relation between immigration and trade. In the next chapter (Chapter 8), we focus on the panel cointegration techniques to analyse the long run and short run relations between immigration and trade.

Chapter 8 ECONOMETRIC ANALYSIS OF IMMIGRATION AND TRADE RELATIONSHIP

8.1 Introduction

Following the test of stationarity of the individual data series and the panel unit root tests in Chapter 7, we are now ready to perform panel data cointegration analysis using the gravity model, which was developed in Chapter 6. The major focus of Chapter 8 is the evaluation of the impact of immigrant intake on trade. Section 8.2 will carry on the study conducted in Chapter 7 into a new platform by investigating the problems associated with nonstationary time series in a regression analysis. The closely related areas of spurious regression, cointegration, and cointegration tests and the corresponding error correction model are discussed. In Section 8.3, we will test whether pooling the time series data across countries can enhance the performance of the model over individual regressions for each country to see whether advantages of using panel data can benefit this study. Section 8.4 performs panel cointegration tests and panel cointegration estimation for long run economic relation between immigration and trade for both export and import models. Section 8.5 performs error correction analysis to investigate the short run effects for the export model. Section 8.6 focuses on the import model. Section 8.7 concludes the chapter.

8.2 Spurious Regression, Cointegration and Error Correction

8.2.1 Spurious Regression

In section 7.4.2, we found high correlations between Australia's exports to its Asian trade partners and the levels of immigrant intake from those countries (For simplicity, we use "exports" and "immigrant intake level" instead). However, high correlation does not imply the underlying relation between the variables. Nonsense correlation can be found between economic time series (Yule, 1926) with high correlation if the time series are not stationary. Consequently, regressing one nonstationary time series with another nonstationary time series produces the regression results that "look good" in the sense of having high R^2 value and significant t-statistics, even though the two variables are not related (Griffiths et al., 1993, p.696). Granger and Newbold (1974) call the regression that looks good but has nonsense results a "spurious regression". The estimator of a spurious regression is not trustworthy because it rejects the null of $\beta = 0$ more frequently than it should if the variables are stationary.

Most macroeconomic variables such as GDP, prices, population, employment, exports and imports are nonstationary over time. In our unit root tests in Section 7.4.3, most of the time series in our panel data set are unit root and a few of them are near unit root. With those variables in the model, the spurious regression becomes a matter of concern. As stated in Griffiths *et al* (1993, p.697), in the presence of the properties of spurious regression, the estimated *t*- statistics for the significant tests for individual variables and the *F*- statistic for the significant test for the regression do not have the distributions like the conventional *t*- and *F*- statistics we expected to hold for the null hypothesis. That is, the critical values normally used are inappropriate in a regression using non-stationary time series data.

8.2.2 Cointegration Regression

In general, when two series are integrated in different order, their linear combination will be integrated toward the higher order of the two (Greene, 2000, p.790). That is, if variable y_t, an $I(1)$ process is regressed on variable x_t, an $I(2)$ process, then the residual obtained from $y_t - \beta x_t$ will be an $I(2)$ process.[67] If both y_t and x_t are $I(1)$ process, then the residual will be an $I(1)$ process.

However, Granger (1981) identified a very special situation when the difference between the two trended series happened to be not trended, i.e. become an $I(0)$ process. It is the situation when the two series are trending at the similar pace, or put it differently, both series largely moving up and down together. It could be viewed as a long-run equilibrium of movements between the two variables, which stability exists in the underlying data generation process. The estimation of long run relationships has been the focus of extensive research in time series econometrics. Any two series of data, which have long-run

---

[67] $I(1)$ stands for one integration process. In time series econometric context, if a non-stationary time series can be converted into a stationary time series by taking the first difference (one integration) process. $I(2)$ is a non-stationary times which requires two integration process (taking difference process for two times). Thus, $I(0)$ is a stationary time series because the time series requires no integration process.

equilibrium movement, are called cointegrated series. The existence and the nature of long-run relations can be investigated using cointegration techniques developed by Engle and Granger (1987), Johansen (1991; 1995), and Phillips and Ouliaris (1990). Regressing two cointegrated variables, the "spurious" properties vanish even if the individual variables are nonstationary. In a cointegrated regression, the least squares estimator is a better estimator and it converges to the true parameters faster than usual. The cointegrating regression represents a static or long run function and the parameters are long run average relationships in the population.

8.2.3 Cointegration Tests

For regression without cointegration, the residual will integrate toward the variable with higher order, as mentioned in Section 8.2.2. If all the variables in a regression are $I(1)$ process, the residual will be $I(1)$ process as well. That is $\rho = 1$. For $\hat{\rho} = 1$, the Durbin-Watson d becomes $d \approx 2(1-\hat{\rho}) = 2(1-1) = 0$.[68] Thus, for a simple cointegration test using the Durbin-Watson statistics, we only need to test the null hypothesis of DW $d = 0$ rather than DW $d = 2$ as in the case of autocorrelation. If the Durbin-Watson *d*-statistic is greater than the critical value, then $\hat{\rho} < 1$, and the residual is not unit root but is stationary. Hence the test can claim that the null hypothesis of no cointegration can be rejected. This cointegration test is the cointegrating regression Durbin-Watson (CRDW) test technique provided by Sargan and Bhargava (1983). However, the CRDW test cannot test whether the difference of the residual is stationary or not, hence limiting its usefulness (Davidson, 2000, p.379). Although we do not apply the DW *d*-statistics to test cointegration by the CRDW method in this study, a low value of DW *d*-statistic found in a long-run OLS regression does not necessarily imply that the regression has autocorrelation problem.

The Engle-Granger (1987) (EG) test of cointegration is the most popular cointegration ADF test on the stationarity of the residuals. If the ADF test rejects a unit root in the residuals while the variables are unit root, then we find the special case that the combination of the non-stationary time series variables in the regression forms a stationary residuals. Such a

[68] For no serial correlation in residual, we will test against DW $d = 2$ because $d \approx 2(1-\hat{\rho})$ and $\rho = 0$ for no serial correlation in residual. A low Durbin-Watson statistic, just for example, DW $d = 1$ could be a sign of the existence of serial correlation.

special case satisfies the long run equilibrium condition described in Section 8.2.2. As a result, the hypothesis of no cointegrating regression can be rejected.

We performed Engle-Granger cointegration tests for individual countries for the Export and Import models (See Table 8.1). To keep the presentation simple, we only list the *p*-values of the ADF tests for three kind of data generation process: ADF 1 is for the no intercept and no trend model, ADF 2 is for the intercept but no trend model, and ADF 3 is for the intercept and trend model. All the cointegration tests significantly reject the null hypothesis of no cointegration except ADF 3 for Indonesia in the Export model. The test results generally show that the gravity models for each country are individually cointegrated.[69]

Although the Engle-Granger cointegration test is of convenience and easy to implement, it is best for the testing of cointegration between two variables. However, when a multiple linear regression is found cointegrated, the Engle-Granger test has no systematic procedure to isolate more than one possible cointegration relation. In addition, Engle-Granger test involves regressing one residual on the next residual. That is, one error regresses on another error.

Table 8.1 The Significant Levels of Engle-Granger Cointegration Tests for Individual Countries

	Export model			**Import Model**		
	ADF 1	**ADF2**	**ADF 3**	**ADF 1**	**ADF2**	**ADF 3**
China	0.0000	0.0003	0.0018	0.0000	0.0002	0.0017
Hong Kong	0.0000	0.0013	0.0087	0.0000	0.0000	0.0001
Indonesia	0.0020	0.0294	0.1144	0.0006	0.0105	0.0486
Japan	0.0001	0.0019	0.0106	0.0000	0.0008	0.0051
Korea	0.0000	0.0002	0.0016	0.0000	0.0000	0.0004
Malaysia	0.0000	0.0000	0.0000	0.0000	0.0004	0.0029
Philippines	0.0000	0.0002	0.0018	0.0000	0.0000	0.0000
Singapore	0.0000	0.0000	0.0000	0.0000	0.0001	0.0010
Taiwan	0.0001	0.0026	0.0045	0.0000	0.0000	0.0003
Thailand	0.0000	0.0000	0.0000	0.0000	0.0002	0.0014

ADF 1 is the *p*-values for ADF test for cointegration for the model without intercept and without trend. ADF 2 is for the model with intercept but without trend. ADF 3 is for the model with intercept and with trend.

[69] Although they are cointegrated, the estimated coefficients for a number of countries are not significant when individual regressions are performed (refer to Appendix 8-B). In addition, the distance variable has no variation in the individual country model, and hence it is not applicable.

8.2.4 Error Correction Mechanism

The cointegrating regression describes the long run, steady-state equilibrium relationship between the cointegrated variables. However, the variables moving together in the long run do not imply the existence of a strong relationship in the short run. The short run relationship can be described by the error correction model of Engle-Granger (1987) where the short run disequilibrium is corrected by the error term to restore equilibrium toward the long run. In the error correction model, the nonstationary variables are differenced to achieve stationarity, and the lagged residual from the cointegrated regression is added to the error correction model. It is expected that the estimated coefficient of the lagged residual in the error correction model is negative and significant. That is, when one period positively deviates from the long run equilibrium, the next period will be adjusted down by the amount of the residual toward the long run equilibrium. Hence the error correction mechanism continuously adjusts the short run deviation to restore the long run equilibrium. The error correction mechanism is a short run dynamic mechanism.

We performed error correction procedure for each country for both Export and Import models. The results for individual countries are poor although all the error correction terms have the expected negative sign and are statistically significant. However, the error correction mechanism for individual countries is not the focus in this study.

8.3 The Poolability Tests

Pooling cross sections of non-stationary time series data into one data set will not remove the non-stationarity properties of the data and panel cointegration could still be tested but in a more complicated manner. In this section, we examine whether the data should be pooled in the first place.

The econometric technique applied to the analysis is partly governed by the model and partly governed by the assumption we make about the behaviour of the data generating process. For example, while the cross section data can be treated as the random sample of the population, time series econometricians developed special techniques to deal with time series data, which are treated as the "realisation" of a random variable arranged in time. Likewise, panel data can be viewed as time series data adding the dimension of cross-section units, or the random samples collected over more than one point in time. Issues of cross-section correlation, cross-section heteroskedasticity and cross-period correlation (serial correlation) could jointly influence the estimators and adversely affect the performance of the regression estimates.

The first question when we use panel data for the analysis is whether we should pool the data in the first place, or put it differently, whether pooling cross-section and time series into one data set can improve the explanatory power over the un-pooled data. To see whether pooling is better than not pooling, we will perform the poolability analyses described in the ensuing subsections.

8.3.1 Pooled by a Common Error across all Cross-sections

The simplest way we employ as the first test of poolability is to assume that there is a common error term throughout all cross-section units. That is, each of the cross-section units has its estimated regression but assuming one error term throughout all those regressions. However, other than the common error term, there are no any other restrictions imposed on the model. The assumption of one error term throughout all cross-section units is the assumption of constant variance throughout all cross-section units and throughout the whole period of the study (that is, pooling the data), while one error term for each regression assumes constant variance for individual units throughout the period of time of the study (that is, without pooling the data). This poolability test involves comparing the efficiency of the common-error regressions against the efficiency of the individual estimated regressions for each cross-section units. If there are efficiency gains of the common-error regressions over the individual estimated regressions, then the pooling with common-error term becomes the better choice.

To perform the test, we estimated the individual regressions for each country independently and then individual regressions for each country imposing one common residual for all the regressions. Since there are ten countries involved in this study, there are ten individual regression estimates comparing with another ten regressions pooled by common-error model. In order not to interrupt the flow of the text, we put the estimates in Appendix 8-A.

Appendix 8-A presents two types of estimation results for the export model. The first type of estimation results are for individual regression for each cross-section unit assuming all the cross-section units are independent from each other, that is, no common error term across cross-sections. The second type of estimation results is for individual regression for each cross-section unit assuming a common error through out all cross-sections. That is, errors of one cross-section unit can help to explain another cross-section unit and/or all other cross-section units. The estimated coefficients are identical for both models with different assumptions mentioned above. In fact the other measures such as goodness-of-fit (R-squared and *F*-test) and all the diagnostic measures are identical for both models (not included in Appendix 8-A). However, the standard errors for individual variables in the model are universally smaller for the model with the assumption of a constant error across all cross-section units. The model with the small standard errors is the more efficient model, that is, pooling the data across cross-sections can achieve efficiency gains comparing to the model that does not pool the data.

We perform the same test for the import model and come to the same conclusion as the export model. That is, pooling of the data achieves efficiency gains for import model over not pooling the data. However, we do not include the estimates for the import model in Appendix 8-A.

8.3.2 Pooled by SUR with Individual Cross-Section Parameters

In Section 8.3.1, we assumed that the error term is common across all cross-section units. It is possible that the error term is also contemporaneously correlated. If the error term is constant across cross-section units and correlated across cross-section units at the same period, we can apply the Seemingly Unrelated Regression (SUR) model for the pooling cross-section and time series data. The following procedure (see Greene, 2000, p.601; Griffiths et al., 1993, p.561) can be employed to test whether the error term has contemporaneous correlation:

$$H_O : \sigma_{ij} = 0$$
$$H_A : \text{at least one covariance is non-zero}$$

where σ_{ij} is the *ij*th covariance (the covariance across all cross-section units). The test statistics is:

$$\lambda = T\sum_{i=2}^{n}\sum_{j=1}^{i-1} r_{ij}^2 \quad (8.1)$$

where r_{ij} is the *ij*th residual correlation coefficient. Under the null hypothesis, the test statistic λ has an asymptotic χ^2 (chi-squared) distribution with $M(M-1)/2$ degree of freedom, where M is the number of equations.

Table 8.2 lists the correlation coefficients for the individual OLS residuals. The sum of squared correlation coefficients is 14.05959 and $T = 38$. Thus:

$$\lambda = 38 \times 14.05959 = 534.26$$

and the degrees of freedom are $10 \times (10-1)/2 = 45$, while the critical value from the chi-squared table is 69.96 for 1% significant level. The chi-squared test result rejects the null hypothesis of no contemporaneous correlation, thus the SUR model should be better than the individual regressions. The OLS estimates and the SUR estimates are presented in Appendix 8-B for comparison. The SUR estimates have higher *t*-statistics in most of the cross-section units, indicating that the SUR would be a better model.[70]

Table 8.2 The Correlation Matrix for the OLS Residuals for Export Model

	EC	EH	EI	EJ	EM	EP	ES	EK	ET	ETH
EC	1.0000	0.0171	-0.1200	-0.1735	-0.0822	-0.0213	0.0499	-0.1448	-0.0470	-0.2297
EH	0.0171	1.0000	0.1012	0.3208	0.0355	0.2525	0.1842	-0.0667	0.0212	0.2183
EI	-0.1200	0.1012	1.0000	0.4261	-0.1171	0.2048	-0.2348	0.1512	-0.0408	-0.0393
EJ	-0.1735	0.3208	0.4261	1.0000	-0.3322	0.2165	0.0017	0.2678	0.0344	-0.2841
EM	-0.0822	0.0355	-0.1171	-0.3322	1.0000	0.1309	-0.3828	-0.4405	0.0729	0.2819
EP	-0.0213	0.2525	0.2048	0.2165	0.1309	1.0000	0.2784	-0.1859	0.1708	0.2997
ES	0.0499	0.1842	-0.2348	0.0017	-0.3828	0.2784	1.0000	-0.0119	0.1364	0.1979
EK	-0.1448	-0.0667	0.1512	0.2678	-0.4405	-0.1859	-0.0119	1.0000	0.0263	-0.2132
ET	-0.0470	0.0212	-0.0408	0.0344	0.0729	0.1708	0.1364	0.0263	1.0000	0.4772
ETH	-0.2297	0.2183	-0.0393	-0.2841	0.2819	0.2997	0.1979	-0.2132	0.4772	1.0000

[70] In Appendix 8-B, we use *t*-statistics rather than the standard error because the standard error is harder to compare across the OLS estimates and the SUR due to the fact that the estimated coefficients are different between the two models.

The above two tests of poolability indicated that improvement of efficiency can be achieved by pooling the cross-section and time series data in the regression analysis. However, pooling by SUR can only generate the estimated coefficients for each country separately. The common or average coefficients among the ten countries cannot be extracted from the SUR. It could be possible for the ten countries to have a common coefficient vector (the panel data regression) representing the effect of immigrant intake on trade. That is, it would reduce the number of parameters to be estimated and increase the accuracy of the estimates. To test whether the panel model can improve the estimation over the SUR model, in the next section, we use the poolability test described in Baltagi (2005, p.55).

8.3.3 Pooled by Common Cross-Section Parameters

Basically, the poolability testing procedure is a Chow test on the restricted model against the unrestricted model, with the panel data regression as the restricted model (Baltagi, 2005, p. 54). The SUR is treated as the unrestricted model due to the fact that the SUR has more parameters to be estimated. Since heteroskedasticity is plausible across countries with substantial differences in economic capacity, generalised least squares (GLS) are used on both the restricted and the unrestricted models. The null hypothesis for the test is:

$$H_O: \beta_{ik} = \beta_k \tag{8.2}$$

where $i = 1,2,3,...N$ cross-section units and $k = 1,2,3,...K$ independent variables. The test statistic is:

$$F = \frac{(e'e - (e_1'e_1 + e_2'e_2 + ... + e_N'e_N))/(N-1)K'}{(e_1'e_1 + e_2'e_2 + ... + e_N'e_N)/N(T-K')} \sim F((N-1)K',\ N(T-K')) \tag{8.3}$$

where $e'e$ is the residual squares of the restricted model, $(e_1'e_1 + e_2'e_2 + ... + e_N'e_N)$ is the sum of the individual residual squares of the unrestricted model, and $K' = K + 1$. The asymptotic statistic follows the *F*-distribution with $(N-1)K'$ numerator degrees of freedom and $N(T-K')$ denominator degrees of freedom. The rationale of the *F*-test is that, if we restrict all the cross-section units to have a common coefficient, we will expect that the estimated error should be higher than individual coefficients for the variables in each individual regression. However, if the *F*-test found that the estimated error from the restricted model is not substantially higher (statistically insignificant) than that of the unrestricted model, then pooling the cross-section and time series data into a panel data set could be beneficial because fewer parameters are to be estimated and due to the improvement of precision.

However, if the F-statistic is significant enough to reject the null hypothesis, pooling the data can still reduce the standard error of the estimated coefficients, but the estimated coefficients are biased and the standard errors are not trustworthy (Griffiths et al., 1993, p. 556).

Because all of the data series in the data set are nonstationary, regressing non-stationary time series could result in spurious regressions. Fortunately, all of the data series can achieve stationarity by taking the first difference. That is the data series are $I(1)$ process. In the previous two poolability tests in Sections 8.3.1 and 8.3.2, we did not mention about the non-stationarity problem and cointegration regression. However, since all the series are $I(1)$ process and their residuals for individual country regressions are stationary with $I(0)$ process (except one of three ADF unit root test for the residual of the regression for Indonesia). All individual country regressions are cointegrated regressions. Thus, both poolability tests (in Sections 8.3.1 and 8.3.2) are valid. However, when testing the poolability by comparing the SUR with the panel regression with common cross-section parameters as discussed in Section 8.3.3, the comparison becomes invalid because the panel cointegration model requires additional treatment, which renders the two models not directly comparable (more details about the treatments on panel cointegration regression will be presented in Section 8.4). For this reason, we need to adjust the data.

What we have done to adjust the data is to take the first difference of the data series to turn them into stationary $I(0)$ process. Then both the SUR and the panel regression are estimated on the $I(0)$ series so that the poolability test can be performed. Appendix 8-C lists the estimated coefficients and the t-statistics of the SUR model and the panel data model. We do not list the standard errors because the standard errors are not directly comparable across the two models with different estimated coefficients. From the list, we find that the panel data model have higher t-statistics than the SUR model for most of the variables. An improvement of efficiency is evident from the panel data model.

Appendix 8-D lists the residuals of the restricted (the panel) model, and Appendix 8-E shows the residuals of the unrestricted (the SUR) model. Both residual tables have one observation less. The starting year is 1964, due to the loss of first observation when calculating the first difference. The sum of squares of the residuals for the restricted model is 102.9942 while the sum of squares of the residuals for the unrestricted is 72.20657. The number of countries is ten ($N = 10$). The period is from 1964 to 2000, which is $T = 37$ and the number of variables is $K' = K + 1 = 10$. The *F*-statistics for the sum of squares of those residuals is performed as:

$$\begin{aligned} F &= \frac{(e'e - (e_1'e_1 + e_2'e_2 + ... + e_N'e_N))/(N-1)K'}{(e_1'e_1 + e_2'e_2 + ... + e_N'e_N)/N(T-K')} \\ &= \frac{(102.9942 - 72.20657)/(10-1)10}{72.20657/10(37-10)} \approx 1.279 \end{aligned} \tag{8.4}$$

The critical F with $(N-1)K' = 90$ degrees of freedom for numerator and with $N(T-K') = 270$ degrees of freedom for denominator is 1.313 at 5% level of significance. The *F*-critical value can be obtained from the Excel function of $" = FINV(0.05, 90, 270)"$. Since the *F*-statistic of 1.279 is smaller than the *F*-critical value of 1.313, we cannot reject the null hypothesis. The test of failing to reject the null hypothesis indicates that the data can be pooled with common parameters across countries, and the common parameters model can achieve efficiency gain over the SUR model.

8.3.4 Pooled by the Fixed Effect LSDV Model

In Section 6.5 of Chapter 6, we presented a number of arguments to support the Fixed Effect panel regression model and some arguments to support the Random Effect model, and we came up with the conclusion that the Fixed Effect model should be used.[71]

To test whether the Fixed Effect model should be used, we can test the joint significance of the dummy variables. The test can be performed by the restricted / unrestricted *F*-test with the OLS model being the restricted model and the LSDV model being the unrestricted model (Baltagi, 2005, p. 13). For the fixed effect test, we included the distant variables in the model, which were previously excluded due to the lack of variability within each cross-section. The *F* statistics is:

$$F = \frac{(RRSS - URSS)/(N-1)}{URSS/(NT - N - K)} \sim F_{N-1, N(T-1)-K} \tag{8.5}$$

[71] We cannot use the random effect model because the random effect model requires that the number of cross-sections must be greater than the number of variables in the model. However, in our model, the number of the cross-sections equals to the number of variables.

where *RRSS* is Restricted Residual Sum of Squares (sum of squared errors) and *URSS* is Unrestricted Residual Sum of Squares. *K* is the number of right-hand-side variables in the unrestricted model. The *F*-tests results are presented in Table 8.3 for both Export and Import models. The *F* statistics of 37.95 for the Export model and 62.9 for the Import model are significantly higher than the *F* critical value of 2.49 at 1% significant level. This suggests that the null hypothesis of OLS panel model can be rejected and the test is in favour of the fixed effect model. The test procedures are presented in Appendix 8-F.

Table 8.3 F-test for the Fixed Effects

	Export Model	Import Model
RRSS	217.4634	277.0987
URSS	111.5904	107.8161
$df_1 = (N-1)$	9	9
$df_2 = (NT-N-K)$	351	351
$F-_{\text{Stat}}$	36.99	61.27
$F-_{\text{Critical}}$ *	2.46	2.46
p-value	0.000	0.000
H_0	Reject	Reject

*At 1% significant level.

In Section 8.3, we have gone through four steps to test the poolability of the data and found that the data are poolable with common parameters and with a fixed effect. In Section 8.4, we will address the issues of spurious regression and cointegration in the panel data LSDV model.

8.4 The Long Run Equilibrium between Immigration and Trade – A Panel Cointegration Approach

For panel data with long time periods, Entorf (1997) found that in the fixed effect panel regression with independent random walk, the nonsense regression properties hold as the nonsense time series regressions and the inferences based on the spurious *t*-statistic are misleading. Phillips and Moon (1999) demonstrate that, in a panel data set, the noise in the time series regression could be counter-balanced by pooling the cross-sections. Even if the panel regression is spurious, the pooled least squares estimator $\hat{\beta}$ is $\sqrt{N}$ - consistent for the long run average relation parameter β and has a limiting normal distribution. That is, the pooled OLS estimates are still good to use to infer the long run relation among variables. However, Kao (1999) found that in the presence of spurious regression in panel data, the estimated coefficient is consistent for its true value, but the *t*-statistic for the estimated coefficient diverges so that the inference about the population parameter is wrong. The asymptotic LSDV estimator for panel data is different from the asymptotic LSDV estimator of the spurious regression in pure time-series. In this Section, we will perform panel cointegration tests and panel cointegration estimations for the long run models. Prior to that, we undertake a literature review on panel cointegration tests.

8.4.1 A Literature Review on Panel Cointegration Tests

Panel cointegration tests are relatively new areas of exploration compared to the well-established panel unit root tests. Since the field was opened up by the pioneer research of Kao (1999), McCoskey and Kao (1998), and Pedroni (1995; 1997), in a few years, panel cointegration tests became a hot topic in econometrics and the literature concerning this topic enjoyed a rapid growth. Similar to the panel unit root tests, there are two approaches for the residual based cointegration tests; the one that assumes "no cointegration in the panel regression" (Kao, 1999; Pedroni, 1999; 2004; Westerlund, 2005a) and the one that assumes "cointegration in the panel regression" (McCoskey & Kao, 1998; Westerlund, 2007).

For the test of null hypothesis of no cointegration, Kao (1999) and Pedroni (1999; 2001; 2004) types of no cointegration tests are residual based Dickey-Fuller types of panel data tests. They are the extensions of the earlier time series work of Phillips and Ouliaris (1990) in relation to panel data. Their approaches utilise the idea of the time series regression cointegration of Engle-Granger (1987). That is, if the residual of the panel regression is stationary as shown by the DF test or the ADF test, the panel regression is said to be a cointegrated regression.

Westerlund (2005a) developed two new simple nonparametric tests of the null of no cointegration based on the variance ratio statistics of the residual, and the tests do not require the underlying assumption of the data generation process, the corrections for the residual serial correlations and the estimation of the associated nuisance parameters. It is the panel generalisation of the time series unit root test developed by Breitung (2002).

Rather than relying on residual based dynamic cointegration test, Westerlund (2007) proposed an error correction based structural cointegration test of null hypothesis of no cointegration. It is a panel extension of the time series cointegration test proposed by

Banerjee *et al* (1998). It is designed to test whether the error correction term in the error correction model is zero. If the null hypothesis of no error correction in the short-run dynamic error correction model is rejected, then the null of no cointegration in the long-run equilibrium model is also rejected.

For the test of null hypothesis of cointegration, McCoskey and Kao (1998) proposed a *LM* test by extending the Harris and Inder (1994) and Shin (1994) locally best-unbiased invariant (LBUI) test into a panel data version. The LBUI test is a variation of the locally best invariant (LBI) test of King and Hillier (1985) for time series. However, that the *LM* test suffers from size distortion for smaller samples was documented by Westerlund (2005b). In tackling this problem, Westerlund (2005b; 2006a; 2006b) and Westerlund and Edgerton (2007) advanced the techniques for testing the null hypothesis of cointegration to a number of fronts. On the one hand, they refined the existing *LM* test. On the other hand, they developed new test techniques.

Westerlund (2006b) enriched the McCoskey and Kao's (1998) *LM*-test by allowing structural breaks in the deterministic components of a cointegrated regression. In Westerlund (2006a), the sample was split into two sub-samples of even and odd numbered observations. Separate *LM* tests were performed for those two sub-samples and the test results then combined using the Bonferroni principle suggested by Choi (2004). This technique substantially reduces the size distortions.

In developing other cointegration tests rather than the *LM* test for null of cointegration, Westerlund (2005b) proposed a residual-based CUSUM test. It is also an extension of the time series counterpart proposed by Xiao (1999), and Xiao and Phillips (2002). The CUSUM test is a measure of the variation in the spurious regression residuals. If two sets of cross section and time series data are cointegrated, their residual should be stable and the variations should reflect the equilibrium errors. If the variation is excessive, the null of cointegration should be rejected.

The above studies assume a single cointegration vector in the model. It is possible to have multiple cointegration vectors. Other than applying the residual based test, Larsson, Lyhagen and Löthgren (2001) presented a likelihood-based test relying on the cointegrating rank in heterogeneous panel model and the test is based on the mean of the individual rank trace statistics. The test has its counterpart in time series which was developed by Johansen (1995). Groen and Kleibergen (2003) improved Larsson *et al* (2001) test by allowing cross-sectional correlation.

8.4.2 Panel Cointegration Tests for the Long Run Relation between Immigration and Trade

To perform the panel cointegration test on our data set, we selected the *LM*-test on the fixed effect LSDV model with the null hypothesis of cointegration. The *LM* test procedure is well documented in Harris and Inder (1994) for time series data and in McCoskey and Kao (1998) for panel data. As stated in Phillips and Ouliaris (1990), the primary interest of most cointegration tests is trying to find out whether there is a long run relation between the economic variables by testing whether those variables are cointegrated. Thus, cointegration is a better choice of the null hypothesis rather than the null hypothesis of no-cointegration.[72] As quoted in Phillips and Ouliaris (1990), Engle (1987) commented that a null hypothesis of cointegration would be far more useful in empirical research than the natural null of no-cointegration. In addition, for this study, we expect panel cointegration relation since the Hadri panel unit root tests results in Section 7.4.3.2 have shown that all variables are unit root by the panel unit root tests. Furthermore, cointegration relation can be established for all individual (cross-section) countries. We performed simple Engle and Granger cointegration tests for each individual country for Export and Import models. The test results are presented in Appendix 8-G and Appendix 8-H. Three types of ADF tests are performed on the residuals for each country: ADF 1 stands for the test regression with no intercept and no trend; ADF 2 is for the test regression with intercept but no trend; ADF 3 is the test regression with intercept and with trend. The results for all three ADF tests for each country for the export and import models significantly reject the null of no-cointegration except the ADF 3 for Indonesia in the import model.

McCoskey and Kao (1998) *LM*-test is a residual based panel cointegration test with the null hypothesis of cointegration. That is, the independent variables and the dependant variable in the panel regression model are cointegrated, unless the data strongly suggest otherwise. Their approach works this way: First, there should be a strong belief that the variables are

[72] However, Phillips and Ouliaris (1990) disagree with the use of the null hypothesis of cointegration.

cointegrated. Second, based on this supposition, the regression is estimated by the cointegration technique. Third, the residual from the "cointegrated" regression is tested by the *LM*-test. If the *LM*-test confirmed that the regression is "in fact" cointegrated, then the estimates obtained from the cointegrated regression can be interpreted as the long run equilibrium between the independent variables and the dependent variable. If the cointegration *LM*-test failed to confirm the cointegration relation between the independent and the dependent variables, then one cannot prove the long run equilibrium, and other procedures to estimate the regression should be investigated.

We follow the panel cointegration test procedure described by McCoskey and Kao (1998), that is, perform the cointegration estimation first, and then perform the cointegration test since the McCoskey and Kao panel cointegration test requires the residuals from a regression which is estimated by a panel cointegration technique. However, as logic of development, we present the cointegration test results first, and then we discuss the cointegration estimation and the interpretation of the estimates. We present the technical aspects of the panel cointegration test in Appendix 8-I and the panel cointegration estimations in the Appendix 8-J.

The panel cointegration regression is estimated using the Dynamic Ordinary Least Square (DOLS) technique suggested by Kao and Chiang (2000). The residual from the DOLS is used to calculate the *LM* statistic, which is the ratio of the residual variance to the Long Run Variance from the OLS regression (refer to Appendix 8-I for the procedure to derive the Long-Run Variance). The *LM* statistic is then compared with a standard Brownian motion process for time series (refer to Appendix 8-N for the procedure to obtain the standard Brownian motion mean and variance). If the *LM* statistic does not significantly deviate from the mean of the standard Brownian motion, then we cannot reject the null hypothesis of panel cointegration (refer to Appendix 8-I to see how the null hypothesis of panel cointegration is developed). With panel cointegration, the long run stability relation between the explanatory variables and the dependant variable in the model can be assumed. However, if the *LM* statistic significantly deviates from the mean either positively or negatively, then the regression estimated by the DOLS does not produce the well-behaved residuals to follow the standard Brownian motion. Thus the panel regression is not cointegrated.

We performed the panel cointegration test using the LM-DOLS test for our panel data. The detailed panel cointegration test procedure is presented in Appendix 8-I. The test results are extracted from Appendix 8-I and the discussion are presented below. (In this section, definition for the symbols such as θ which are not previously provided can be found in Appendix 8-I.)

Table 8.4 reports the cointegration test results for the Export model and for the Import model. The corresponding *p*-value for the Export model is 0.042 and 0 for the Import model. The null hypothesis of panel cointegration is $\theta = 0$ against the alternative of $\theta \neq 0$ at $\alpha = 5\%$ significant level, which become $\alpha / 2 = 0.025$. The *p*-value for Export of 0.042 is greater than the critical level of 0.025 suggesting the test fails to reject the null hypothesis of $\theta = 0$. That is, the component of $\theta \sum_{j=1}^{t} u_{ij}$ in Equation (I.13) in Appendix 8-I, which is the unit root component in the error term e_{it}, cannot be found. Now, we are quite confident to believe that after the regression is estimated by the DOLS technique (that is, minimising the impact of the unit root process in the explanatory variables by introducing the leads and lags of the first difference term), the regression for Export model is a panel-cointegrated regression.

Table 8.4 Panel Cointegration Tests for Export Model and the Import Model

	Export	Import
LM	0.037696	0.218229
μ_v	0.029217	0.029217
σ_v	0.000241	0.000241
N	10	10
Z	1.72786	38.5182
p-value	0.042007	0.000000
$\alpha / 2$	0.025	0.025
H_o	Cannot reject	Reject

LM is the *LM* statistics for the export and for import. μ_v and σ_v are the mean and standard deviation of the Brownian motion process. *N* is the number of cross-section units. *Z* is the *Z* statistic of the normal distribution.

Since the Export model is found to be a panel cointegration regression, the estimated coefficients represent the long run equilibrium relations between Australia's exports and the explanatory variables in the panel regression. Specifically, we can conclude that, amongst other independent variables, immigration and Australia's exports have a long run stability relation.

However, for the Import model, the p-value is 0, which is less than the significant level of 0.025, indicating that the DOLS residuals significantly deviate from the standard Brownian motion process. Thus, the test significantly rejects the null hypothesis of $\theta = 0$. Thus, the Import model is not a cointegrated model. From the cointegration test, we can conclude that the immigration and Australia's imports do not have a long run stability relation.

Since the cointegration test found different results for the export model and the import model, we will discuss the estimation techniques and the estimates separately in two sections. We will discuss the panel cointegration regression and inference for the export model in the next section, leaving those for the import model to be discussed in Section 8.6.

8.4.3 Panel Cointegration Regressions and Inferences: The Export Model

In this section, our attention is focussed on the rationale of the DOLS technique, the estimation results, the interpretation of the results and the inference to the immigration and trade relations. A brief review on the panel cointegration estimation literature is presented in Appendix 8-J.

In order to specify the DOLS panel cointegration model for our study, it is necessary to illustrate how the DOLS technique treats the non-stationarity in the panel and removes the spurious regression. In Kao and Chiang (2000), the DOLS was developed for panel data, which builds upon the time series work of Stock and Watson (1993) and Saikkonen (1991). Consider the fixed effect panel regression:

$$y_{it} = \alpha_i + x_{it}^{'}\beta + v_{it}, \quad i = 1,...,N, \;\; t = 1,...,T, \qquad (8.6)$$

and

$$x_{it} = x_{it-1} + \varepsilon_{it} \qquad (8.7)$$

Equation (8.7) means that explanatory variables are unit root because the current value of the variable is same as the previous value of the variable plus some error. After certain assumptions which are stated in Kao and Chiang's (2000) are satisfied, the process of v_{it} can be viewed as (see Saikkonen, 1991):

$$v_{it} = \sum_{j=-\infty}^{\infty} c_{ij}\varepsilon_{it+j} + u_{it} \tag{8.8}$$

for all *i* cross sections. Where *j* is the leads and lags term from negative infinity to positive infinity. In practice, the leads and lags may be truncated to capture only the most relevant lag length, and Equation (8.8) can be written as:

$$v_{it} = \sum_{j=-q}^{q} c_{ij}\varepsilon_{it+j} + \dot{u}_{it}. \tag{8.9}$$

where *q* is the lag length within a relevant range. Substitute Equation (8.9) into Equation(8.6), to get:

$$y_{it} = \alpha_i + x_{it}^{'}\beta + \sum_{j=-q}^{q} c_{ij}\varepsilon_{it+j} + \dot{u}_{it} \tag{8.10}$$

We rearrange Equation (8.7) to obtain:

$$\varepsilon_{it} = x_{it} - x_{it-1} = \Delta x_{it}\,. \tag{8.11}$$

Equation (8.11) is simply the first difference of the explanatory variables. Substitute Equation (8.11) into Equation (8.10) to obtain:

$$y_{it} = \alpha_i + x_{it}^{'}\beta_{DOLS} + \sum_{j=-q}^{q} c_{ij}\Delta x_{it+j} + \dot{u}_{it}\,. \tag{8.12}$$

Equation (8.12) is the DOLS regression. The DOLS specification removes the unit root component from the regression by simply adding leads and lags of the first difference of the explanatory variables to the OLS regression. Kao and Chiang (2000) shows that the $\hat{\beta}_{DOLS}$ has the same limiting distribution as Fully-Modified of OLS ($\hat{\beta}_{FM}$) (refer to Appendix 8-J for the literature review for this section). The DOLS regression has the advantage of convenience, and it is simple to estimate.

Following the DOLS regression procedure, the gravity model for Exports that we will estimate with our panel data, is specified below:

$$
\begin{aligned}
\ln(EX_{jt}) = {} & \beta_1 \ln(Y_{jt}) + \beta_2 \ln(YF_{jt}) + \beta_3 \ln(YP_t) + \beta_4 \ln(YPF_{jt}) \\
& + \beta_5 \ln(P_t) + \beta_6 \ln(PF_{jt}) + \beta_7 \ln(OF_{jt}) + \beta_8 \ln(M_{jt,L4}) \\
& + \beta_9 \ln(M^2_{jt,L4}) + \beta_{10} Dist_j + \beta_{11} DUM_{HK} + \ldots + \beta_{19} DUM_{TH} \\
& + \beta_{20} \Delta \ln(Y_{jt+2}) + \ldots + \beta_{27} \Delta \ln(M_{jit+2,L4}) \\
& + \ldots + \beta_{68} \Delta \ln(Y_{jt-5}) + \ldots + \beta_{75} \Delta \ln(M_{jit-5,L4}) + u_{jt}
\end{aligned}
\qquad (8.13)
$$

where EX_{jt} = Australia's exports to country i at time t.

β = Parameter of explanatory variables for the Export model.

Y_{jt} = Australia's GDP at time t. The E_{it} component of GDP to country i is removed from Australia's GDP to avoid the endogeneity between Australia's exports and Australia's GDP (refer to Section 7.3). It differs across cross-sections because the volumes of Australia's exports to each country are different. Thus, it is specific to the trade partner countries. We expect that Y_{jt} has a positive impact on the dependent variable EX_{jt}.

YF_{jt} = Foreign country i's GDP at time t. Similar to the arguments as in Y_{jt}, to reduce endogeneity problem with Australia's exports (the value of Australia's exports is the same value of foreign country's imports from Australia), the EX_{jt} component of the foreign GDP is added back to calculate the YF_{jt}. YF_{jt} is expected to have a positive sign in the panel gravity equation.

YP_t = Australia's per capita GDP at time t. YP_t has no cross-section variations in the panel. Thus, there is no j subscript. From the discussion in Section 6.6.1 in Chapter 6, YP_t could have positive or negative impacts on EX_{jt}. Thus the sign for YP_t is not clear.

YPF_{jt} = Foreign countries' per capita GDP at time t. YPF_{jt} is expected to be positively related to EX_{jt}.

P_t = General price level in Australia at time t. P_t has no cross-section variations in the panel, thus no j in the subscript. P_t is expected to have a positive impact on EX_{jt}.

PF_{jt} = Foreign countries' price level at time *t*. PF_{jt} is expected to be positively related to EX_{jt}.

OF_{jt} = Foreign countries' openness variable at time *t*. OF_{jt} is expected to have a positive relation with EX_{jt}.

$M_{jt,L4}$ = Immigrants intake from country *j* to Australia at time *t*, with a lag of four periods (equivalent to three and a half years). $M_{jt,L4}$ is expected to be positively related to EX_{jt}.

$M^2_{jt,L4}$ = The square term of the $M_{jt,L4}$. $M^2_{jt,L4}$ is expected to have a negative relation with EX_{jt} (The combination of $M_{jt,L4}$ and $M^2_{jt,L4}$ could produce positive or negative impacts on EX_{jt}).

$Dist_j$ = The distance between Australia and its trade partner country *j*. We expect that $Dist_j$ has a negative impact on Australia's exports.

DUM = $DUM_{HK}...DUM_{TH}$ stand for all the country intercept dummies except for China, which is the one not included in the model to avoid dummy variable trap. There are no *a priori* expectation of the sign of the variables.

ln = Natural logarithm.

Δ = First difference.

$_{jt+2}$ = Two lead terms.

$_{jt-5}$ = Five lag terms.

u_{jt} = The panel error term.

The term $\sum_{j=-q}^{q} c_{ij}\Delta x_{it+j}$ in Equation (8.12) corresponds to the leads and lags terms $\beta_{20}\Delta\ln(Y_{jt+2}) + ... + \beta_{27}\Delta\ln(M_{jit+2,L4}) + ... + \beta_{68}\Delta\ln(Y_{jt-5}) + ... + \beta_{75}\Delta\ln(M_{jit-5,L4})$ in Equation(8.13), and a two-leads and five-lag term is used in the Export model. The lead and lag terms are not economic variables but they are auxiliary variables used to control the non-stationarity in the explanatory variables. The significances of the lead and lag variables are not to be tested individually. Instead, the overall significance of the lead and lag terms can be tested by a joint *F*-test.

By taking into consideration of the significant variation in economic variables in the panel data set between countries, we choose the feasible GLS specification for cross-section-weight to correct cross section heteroskedasticity. The Export model is estimated by applying the dynamic generalised least squares (DGLS) technique with the Panel Corrected Standard Error (PCSE) robust covariance method.

The selection of the number of lead and lag terms is yet to have formal rules. A common practice is to select the optimal leads and lags according to some kind of information criterion such as Schwarz criterion or the Akaike Information Criterion. The optimal choice was made according to the overall performance of the combination of low scores of Schwarz criterion, Akaike Information Criterion, low *p*-value of the estimated coefficients and the expected signs of the estimated coefficients. We selected one lead and five lags for the Export model due to the fact that we lagged the immigrant variable for four periods. Lagging the other variables for five periods is equivalent to lagging the immigrant variable for one additional period.

We use Eviews 5.1 to perform the DGLS estimation, and the estimated results are presented in Appendix 8-K. A summary of the panel cointegration estimation results is presented in Table 8.5. The estimated regression has overall significance. It has high R-square and adjusted R-square values. Most variables are significant with expected signs. Although the DW statistics are not close to 2, however, for cointegrating regression, the test statistic is tested as $DW = 0$ rather than $DW = 2$ which was discussed in Section 8.2.3. Comparing Table 8.5 with the individual country cointegration regressions in Appendix 8-G, the use of panel cointegration technique does significantly raise the explanatory power of the variables. As a result, the efficiency of the estimates is improved as evident in the substantial increase in the number of statistically significant estimated coefficients.

Before we move on to the interpretation of the estimated regression, for convenience, we restate the expectations we stipulated in Section 5.6 (Chapter 5) and Section 6.6 (Chapter 6). For the Export model, it is expected that the GDP variables for Australia (*Y*) and its trade partners (*YF*) are both positively related to Australia's exports (*E*). For the Australia's per capita GDP variable (*YP*), the expected sign is not clear while the importer countries' per capita GDP variable (*YPF*) is expected to be positively related to Australia's exports. The general price level (*P*) of Australia is expected to have a negative relation with exports, while the general price level of Australia's trade partner (*PF*) is expected to have a positive relation with Australia's exports. The foreign country's openness (OF) is used to replace the difficult-to-quantify tariff or tax variable, which is originally designed to model the artificial or policy related trade impediments in the gravity model. Due to the way the openness (OF) variable is measured and recorded, it turns out to be a trade enhancement variable. The greater the openness of a trade partner country, the greater is the expected volume of Australia's exports. Thus, Openness is expected to have a positive sign with Australia's exports.

The immigrant variable is non-linear. A square term of the immigrant variable is used to reflect the immigrant hump and social capital hump theory (refer to Section 2.4) of Chapter 2, that is, immigrant information is positively related to exports up to certain level of immigrant intake and then the positive impact on trade will gradually decrease as the immigrant intake level keeps increasing. Thus we expect that $M_{it,L4}$ has a positive sign and $M_{it,L4}^2$ has a negative sign (the combination of $M_{it,L4}$ and $M_{it,L4}^2$ could produce a positive or a negative elasticity depending on the level of *M*). Looking back to the history of immigration and trade as discussed in Section 3.3 of Chapter 3, we noticed that immigrants from some countries started exporting Australian goods to their country of origin earlier than immigrants from other countries due to variations in financial background and business skill levels at the time of immigration. In a study of the impact of Thai students who studied for their degrees in Australian universities, on the trade between Australia and Thailand, McCrohan and Lung (2001) found that it takes an average of 8 years lag time (from arrival) before the impact on trade can be noticed. This time lag can be justified by the period of time students take to complete their degrees and then return to Thailand to find employment or to start up businesses before a noticeable increase in the volume of trade. Similarly, we expect that there will be a time lag between immigrant arrivals and their effects on trade. This time lag can be justified by the time lag for the market information to pass on to businesses and the time lag for businesses to respond to and use the market information. Therefore, an average of a four-period lag for *M* variable is used.

The variable for the distance between countries $Dist_j$ is included in the export model representing transportation costs and other natural or physical costs associated with taking the goods to the destination. $Dist_j$ is expected to be negatively related to Australia's exports.

For the intercept dummy variables, to avoid dummy variable trap, we dropped one intercept dummy – intercept dummy for China. There are no *a priori* expectations for all other intercept dummies to be higher or lower, compared with China.

After restating the expectations for the parameters in the model, we interpret the estimates below. The estimation results are included in Table 8.5. All the variables, except *YF*, are significant at 5 per cent level with the expected sign.[73] Standard errors of coefficients are given in parentheses. The regressions are estimated in "log-log" format, and the estimated coefficients are interpreted as the average elasticity, that is, the average percentage change in the variable of exports due to a one per cent change in the corresponding explanatory variable. Over the period of thirty-eight years and across ten countries, Australia's exports are largely depended on the production capacity of Australia (for example, 2.2127 per cent increase in exports is associated with 1 per cent increase in GDP). It is the strongest elasticity amongst the economic variables in the whole regression equation.

Australia's exports are negatively related to foreign countries' GPD with an elasticity of -0.4668. The elasticity of -0.4668 means that, for every 1 percent increase in foreign GDP, Australia's exports to the ten Asian countries, on average, decrease by 0.4668 percent. Although the elasticity is low and in fact is inelastic, the negative relation is somewhat surprising, and unexpected in the gravity model. The negative elasticity does not suggest that Australia's exports are inferior goods in the foreign market. In the gravity model, the GDP is more a production measure than a consumption measure. One possible explanation is that foreign countries' production is somewhat competing against Australia's exports. The higher the production in foreign countries, the lower is the demand for imports from Australia.

The per capita GDP of Australia has a negative impact on Australia's exports, with an elasticity of -0.7414. This result can be interpreted as the domestic income elasticity of demand for domestically produced goods, which negatively affects the supply of exports.

[73] *YF* variable is significant at 5% level, however, the sign is unexpected.

Holding all other factors constant, the higher the per capita income of Australia, the greater is the demand for all goods, thus reducing the domestically made goods available for export.

Table 8.5 Panel Cointegrated Estimates for Gravity Model for Exports

Independent Variables	Coefficients
Y	2.2127 (0.2862)
YF	-0.4668 (0.0407)[x]
YP	-0.7414 (0.2878)
YPF	1.3813 (0.0725)
P	-1.1037 (0.3227)
PF	0.3972 (0.0932)
OF	0.5152 (0.0592)
M_{L4}	0.1945 (0.0200)
M_{L4}^2	-0.0205 (0.0022)
Dist	-1.7462 (0.1746)
DUMH	-6.1060 (0.2904)
DUMI	-2.4992 (0.1294)
DUMJ	-1.4293 (0.2374)
DUMM	-4.8559 (0.2267)
DUMP	-3.6532 (0.1372)
DUMS	-6.8303 (0.3338)
DUMK	-2.8152 (0.2147)
DUMT	-3.7700 (0.2437)
DUMTH	-4.1328 (0.1882)
R^2	0.9996
Adj-R^2	0.9995
D-W stat	1.3173
Residual Sum of Squares	232.1215
NT	300

[x] *YF,* the variable of foreign GDP is significant at 5% level but with unexpected sign.
All the other variables are significant at 5% level. Standard errors are in parentheses. Table 8.5 does not show the estimates of the leads and lags term in the panel cointegration estimation for the Export model. Full details for the leads and lags are given in Appendix 8-K.

The foreign countries' per capita GDP has a strong positive impact on Australia's exports with an elasticity of 1.3813. We can interpret this result as the foreign income elasticity of demand to Australia's exports. The higher the foreigner's per capita income, the greater the demand for all goods including higher demand for imports from Australia. Thus, the elasticity is positive.

For the general price level of Australia, the price elasticity of exports is negative and elastic with an elasticity of -1.1037. We can interpret the negative sign as the substitution effect between domestic market and the foreign market. A higher domestic price attracts exporters to sell goods on the domestic market, hence reduces the supply to the export market.

The general price level of foreign countries is positively related to Australia's exports with an elasticity of 0.3972. However, this elasticity is not interpreted as price elasticity of demand of Australian goods in the foreign country. Instead, the general price level of the foreign countries serves as a foreign market signal. A higher foreign price provides a greater incentive for Australian exporters to sell more goods on foreign markets.

The foreign country openness variable has an estimated coefficient of 0.5152. Thus, the higher the openness of the foreign countries, it is easier for Australia's exporters to sell their goods overseas.

The immigrant variable (M) is our major focus. There are two forces, at the same time, governing the impact (or the slope coefficients) of the immigrant intake variable on the volume of Australia's exports. They are M and M^2. Estimated coefficients for M and M^2 have the expected signs. That is, M is positive and M^2 is negative. They are significant at 5 per cent level. Since both positive force and the negative force are working at the same time, if the positive force is stronger than the negative force, then the impact of M on exports will be positive. Conversely, if the negative force overpowers the positive force, then the net impact of M on exports will be negative. In fact, whether the net impact of immigration on Exports is positive or negative depends on the changes in the level of immigrant intake M. The rate of change can be calculated as:

$$\frac{dE}{dM} = \frac{d(0.1945M - 0.0205M^2)}{dM}$$
$$= 0.1945 - 2 \times 0.0205M \qquad (8.14)$$
$$= 0.1945 - 0.0410M$$

Equation (8.14) shows that exports increase as immigrant intake level increases, but at a decreasing rate. That is, there would be a certain level of immigrant intake, which can achieve the highest impact (the greatest elasticity) on exports. Before that level of immigrant intake, the slope is positive and increasing. After that level of immigrant intake, the slope is still positive but is decreasing. The results here agree with the finding of Gould (1996) in the case of USA. In addition, another level of immigrant intakes could cause the elasticity to be negative. The following calculation is to find out the optimal level of immigrant intake, the highest elasticity at the optimal level of immigrant intake and the level of immigrant intake that could trigger the negative elasticity. To find the highest level of elasticity, we set Equation (8.14) to be zero, to obtain:

$$0.1945 - 0.0410M = 0$$
$$M = {}^{0.1945}\!/_{0.0410} \qquad (8.15)$$
$$= 4.7439$$

That is, at the immigrant intake level of M = 4.7439, the estimated coefficient (the export elasticity of immigrant intake) will be at its highest value of:

$$0.1945M - 0.0205M^2$$
$$= 0.1945 \times 4.7439 - 0.0205 \times 4.7439^2 \qquad (8.16)$$
$$= 0.4613$$

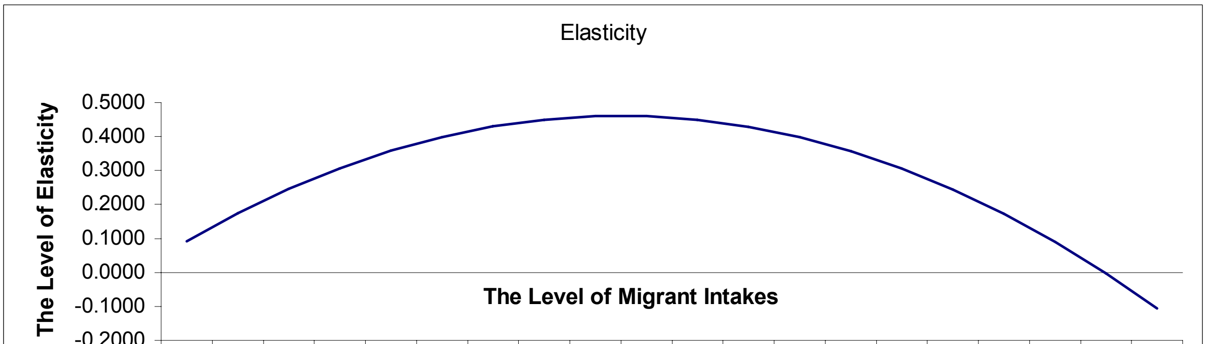
Since the gravity model is estimated as a log-log model, taking the antilog of M = 4.7439, we can find the optimal immigrant intake level $EXP(4.739) = 114.8816 \approx 115$ persons per year. When the immigrant level is less than the average of 115 persons per year per source country, the immigrant information effect is rising when immigrant intake is increasing. At 115 person per year level, the positive immigrant information effect on exports is at its highest of 0.4613. That is, for a 1 per cent increase in immigrant intake, the volume of exports will increase by 0.4613 per cent. As mentioned in Section 6.6.2 of Chapter 6, this elasticity represents the combined effect of the positive force of immigrant information and the negative force of labour substitution to trade. If we can separate the labour substitution effect on trade from the elasticity, then the stronger immigrant information effect can be revealed. However, this model is not equipped to distinguish the two effects. After the immigrant intake level of 115 persons per year per source country, the elasticity starts decreasing at a decreasing rate. That is, the elasticity reduces very slowly as the immigrant intake level increases. Eventually, the negative effect from M^2 will counter-balance the positive effect from M. At this stage, the elasticity becomes zero. Any increase in the volume of immigrant intake after this level will result a negative elasticity on exports.

To find the level of immigrant intake, which starts to result in the immigrant-elasticity of export to turn negative, we set Equation (8.16) to zero to get:

$$\begin{aligned} 0.1945M - 0.0205M^2 &= 0 \\ 0.1945 - 0.0205M &= 0 \\ M &= 0.1945/0.0205 \\ &= 9.4878 \end{aligned} \qquad (8.17)$$

That is, if the immigrant level increased up to M = 9.4878, which is $EXP(9.4878) = 13{,}197.79 \approx 13{,}198$ persons per year per source country, the positive immigrant information effect on exports will balance out by the negative effect of immigrant labour substitution to exports. Figure 8.1 illustrates this effect.

Figure 8.1 Immigrant Elasticity of Exports at Various Levels of Immigrant Intake



	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0	5.5	6.0	6.5	7.0	7.5	8.0	8.5	9.0	9.5	10.0
Elasticity	0.09	0.17	0.24	0.30	0.35	0.39	0.42	0.45	0.46	0.46	0.44	0.42	0.39	0.35	0.30	0.24	0.17	0.09	-0.00	-0.10

We can now revisit the discussion of the estimated immigrant-elasticity of export. Although the highest elasticity is 0.4613 at the immigrant level of 115 persons per year, which is inelastic, the immigrant information effect on export is quite powerful. As stated before, the elasticity of 0.4613 means a 10 per cent increase in immigrant intake leads to a 4.613 per cent increase in exports. A 10 per cent of 115 persons is about 2 persons; a 4.613 per cent increase in exports would be millions of dollars. Because the volume of exports is significantly higher than the volume of immigrant intakes, the marginal benefit to exports from additional intake of immigrants is enormous. To illustrate this point, we selected the exports for the year 2000 and the immigrant intake data for the 1996 for each immigrant source country and calculated the marginal exports per additional immigrant, as shown in Table 8.6.

Table 8.6 Illustration of Marginal Export per Additional Migrant (MEAM)

	A	B	M	η	E	C	MEAM
		$(=1\%\text{A})$	$(=\ln \text{A})$	$(=0.1945M-0.0205M^2)$		$(=E\times\eta)$	$(=C/B)$
					US \$ m	US \$	US \$
China	7,770	78	8.9580	0.0973	2,566	2,496,163	32,126
HK	3,890	39	8.2662	0.2070	1,451	3,003,759	77,217
Indonesia	1,760	18	7.4731	0.3087	1,054	3,252,075	184,777
Japan	224	2	5.4116	0.4522	8,519	38,521,164	17,196,948
Korea	804	8	6.6896	0.3837	3,498	13,423,834	1,669,631
Malaysia	1,070	11	6.9754	0.3593	837	3,007,551	281,079
Philippines	2,830	28	7.9480	0.2509	721	1,807,706	63,877
Singapore	940	9	6.8459	0.3708	1,826	6,771,037	720,323
Taiwan	2,170	22	7.6825	0.2843	2,864	8,143,185	375,262
Thailand	740	7	6.6067	0.3902	837	3,266,658	441,440

A= The level of immigrant intake at 1996.
B= 1% of the immigrant intake level ($(B = 0.01A)$).
M= The logarithm value of immigrant intake *M* at 1996. $M = \ln(A)$.
η= The immigrant elasticity of export at the level of immigrant intake in column M, ($\eta = 0.1945M - 0.0205M^2$).
E= Volume of exports at 2000 to the immigrant source countries, in millions of US dollars (US \$ m).
C=Volume of exports change resulting from the immigrant intake, in US dollars, ($C = E \times \eta$).
MEAM=The marginal exports per additional migrant ($MEAM = C/B$) in US dollars.

We use China as an example of migrant source country to discuss the information given in Table 8.6. To work out the impact (marginal effect) of Chinese immigrants in 1996 on Australia's exports to China in Year 2000, we need to find out the immigrant-elasticity of exports at the level of immigrant intake in 1996. Exports are not a linear function of the level of immigrant intake, that is, the level of elasticity changes when the level of immigrant intake changes. We need to use the Equation (8.16) to obtain the elasticity for a given level of immigrant intake. The amount of immigrant intake from China was 7,770 persons (in the column labelled *A* in Table 8.6). *M*, which is the log of *A,* is 8.9580. Note that the value of 8.9580 is the figure very close to the point where the elasticity is near zero (refers to

Equation (8.17)). By using Equation (8.16), the elasticity we obtained based on $M = 8.9580$ is 0.0973. Four years after, which is in Year 2000, the volume of Australia's exports to China was USD $2,565.7 million. The elasticity of 0.097 reads as a 1 per cent increases in the level of immigrant intake in 1996 will have positive impact on Australia's exports increase to China of 0.097 per cent in Year 2000. To calculate the immigrant information impact on exports, we apply this elasticity of 0.097 to the actual data. A 1 per cent change in immigrant intake counts for 78 persons, and 0.097 percent change in exports counts for U.S. $2.496 million. The additional U.S. $2.496 millions of exports result from the additional 78 persons of immigrant intake. Dividing the change in exports by the change in immigrant intake, we get the average immigrant impact on exports of U.S. $32,126 in Year 2000. We can find this answer in the column labelled "MEAM" in Table 8.6. In the MEAM column, we notice that Australia's exports to China has the lowest marginal effect in Year 2000 due to the high volume of immigrant intake from China. Exports to the Philippines also have low marginal effect due to the relatively low exports to the Philippines (refer to Section 3.3.7 of Chapter 3). Exports to Japan have very high marginal effect due to historically low immigrant intake level and high exports (refer to Section 3.3.4 of Chapter 3). Immigrants from other countries with an immigrant intake level between one thousand to three thousand persons had quite substantial marginal effects on exports.

Figure 8.1 and Table 8.6 provide significant information for Australia's trade and immigration policy. While there are arguments against the use of immigration as a short-term economic tool to curb the labour shortage, immigration can be used as a long term export growth strategy. Our model found that holding other factors constant, any level of immigration below 13,000 persons per source country per annum would have a positive impact on exports. The immigrant intake level higher than 13,000 persons per source country per annum could have negative impact on exports. Within the range of immigrant intake level below 13,000 persons per source country per annum, a moderate level of immigrant intake would have higher positive impact on exports.

The estimated coefficient for the distance between countries $Dist_j$ is negative which confirmed with the *a priori* expectation. The elasticity of -1.7462 seems too strong. However, the distance between countries does not change over time. It does not have the sense of "long run" static relation with exports. It is better to interpret the impact of the distance variable in the short run model.

Table 8.7 below shows the calculation of the intercept dummies in the export model.

Table 8.7 Estimated Coefficients for Dummy Variables and Exponentials

Dummy variables (D)	Estimated Coefficients (E)	Exponentials (=Exp(E))
DUMH	-6.106	0.002229
DUMI	-2.4992	0.082151
DUMJ	-1.4293	0.239476
DUMM	-4.8559	0.007782
DUMP	-3.6532	0.025908
DUMS	-6.8303	0.001081
DUMK	-2.8152	0.059893
DUMT	-3.77	0.023052
DUMTH	-4.1328	0.016038

Estimated coefficients for dummy variables are extracted from Appendix 8-K.

The column on estimated exponentials Table 8.7 reveals that, holding all other factors constant, Australia's exports to Japan is about 24 per cent more than Australia's exports to China. Australia' exports to Indonesia is about 8.2 per cent more than Australia's exports to China and Australia's exports to South Korea is about 6 per cent more than Australia's exports to China. Australia's exports to Taiwan is about 2.3 per cent more than the exports to China, while exports to Thailand is about 1.6 per cent more than exports to China. Australia's exports to Hong Kong, Malaysia and Singapore are about the same level as Australia's exports to China.

The panel cointegration test in Section 8.4.2 found that the Export model is a long run equilibrium model. Section 8.4.3 estimated the model and made inferences on the long run relation between immigrant information and Australia's exports. In next section, we pay attention to the short run dynamics of the export model.

8.5 Short Run Dynamics: the Export Model

In Section 8.4, we analysed the long run equilibrium relation between immigrant intake and Australia's exports, using the gravity model for ten countries. In this section, we focus on the short run effects of immigration on exports. The panel error correction model used to study the short run relation is:

$$\begin{aligned}\Delta E_{jt} &= \delta_1 \Delta Y_{jt} + \delta_2 \Delta YF_{jt} + \delta_3 \Delta YP_{jt} + \delta_4 \Delta YPF_{jt} + \delta_5 \Delta P_{jt} + \delta_6 \Delta PF_{jt} \\ &+ \delta_7 \Delta OF_{jt} + \delta_8 \Delta M_{jt,L4} + \delta_9 \Delta M^2_{jt,L4} + \delta_{10} Dist_j + \delta_{11} u_{jt-1} \\ &+ \delta_{12} DUM_{HK} + \ldots + \delta_{20} DUM_{TH} + \tilde{u}_{jt}\end{aligned} \quad (8.18)$$

Where: Δ = First difference.

δ = Parameters of explanatory variables of the Error Correction model.

u_{jt-1} = Error correction term. It is the lagged residual obtained from the panel-cointegrated estimation in Equation (8.13). We expect that u_{jt-1} has a negative sign.

$\tilde{u}_{jt}$ = The error term.

All other symbols have the same interpretation as in Equation (8.13). Equation (8.18) is used to model the dynamic mechanism through which the exports level consistently correcting itself toward the long run equilibrium. If at one period of time, the exports are below the long run equilibrium that the model predicted, in the next period of time exports will adjust upward to restore the equilibrium, and *vice versa* for exports above the long run equilibrium. Table 8.8 shows the estimates of the error correction model. All the variables in the error correction model have the expected signs except the variable $Dist_j$, which is the distance variable.

The performance of the error correction model is generally satisfactory with adjusted R^2 of 0.52 and a DW statistic of 2.02. The error correction term is –0.337, which is quite robust to adjust the short run disequilibrium toward the long run equilibrium. If the actual level of exports is below the long run exports level (an under-exports error) in this period of time, the error correction mechanism will automatically adjust the exports up by 33.7% of that volume of under-exports error in the next period. If in one period, exports are above the long run level, exports in the next period will be adjusted down by 33.7% of that volume of over-exports, hence moving towards the long run exports level.

Table 8.8 Error Correction Estimates for the Export Model

Independent Variables	Coefficients
ΔY	1.501014 (0.377596)**
ΔYF	0.353948 (0.154688)**
ΔYP	-2.167626 (0.606949)**
ΔYPF	0.240719 (0.2865)
ΔP	-0.515175 (0.361795)
ΔPF	0.128376 (0.174539)
ΔOF	0.451271 (0.099461)**
ΔM_{L4}	0.039599 (0.012032)**
ΔM_{L4}^2	-0.004233 (0.001699)**
Dist	0.002547 (0.007606)
u_{jt-1}	-0.337038 (0.045514)**
DUMH	0.010941 (0.073742)
DUMI	0.089774 (0.074902)
DUMJ	-0.021502 (0.071761)
DUMM	0.003658 (0.07483)
DUMP	0.037649 (0.070266)
DUMS	-0.006876 (0.073662)
DUMK	0.081504 (0.082784)
DUMT	0.031126 (0.070911)
DUMTH	0.026249 (0.075793)
R^2	0.520424
Adj-R^2	0.487882
D-W stat	2.02542
Residual Sum of Squares	293.6533
NT	300

Standard errors of the estimated coefficients are in parentheses and those variables with "**" signs are significant at 5% level.

The estimated coefficient for the distance variable *D* in the short run dynamic model is positive. It is the opposite of the sign of *D* in the long run model. Australia does export disproportionately higher volumes to those countries located far away such as Japan, China and Korea, and exports less to those countries that are geographically closer, e.g. Indonesia and the Philippines. This may be the reason for the positive sign of the coefficient for the Distance in the short run.

For the other variables in the short run model, interpretations are quite similar to the long-run model.

8.6 The Import Model

Although in the panel cointegration test in Section 8.4.2 we found that the Import model is not cointegrated, we still present the estimation method for the import model because the panel cointegration estimation is required before the cointegration test.

The gravity model for Imports is specified as:

$$\begin{aligned} I_{jt} = {} & \alpha_1 \ln(Y_{jt}) + \alpha_2 \ln(YF_{jt}) + \alpha_3 \ln(YP_{jt}) + \alpha_4 \ln(YPF_{jt}) + \alpha_5 \ln(P_{jt}) \\ & + \alpha_6 \ln(PF_{jt}) + \alpha_7 \ln(O_t) + \alpha_8 \ln(M_{jt,L2}) + \alpha_9 \ln(M^2_{jt,L2}) + \alpha_{10} \ln(Dist_j) \\ & + \alpha_{11} DUM_{HK} + \ldots + \alpha_{19} DUM_{TH} + \alpha_{20} \Delta \ln(Y_{jt+1}) + \ldots + \alpha_{27} \Delta \ln(M_{jt+1,L2}) \\ & + \ldots + \alpha_{44} \Delta \ln(Y_{jt-3}) + \ldots + \alpha_{51} \Delta \ln(M_{jt-3,L2}) + e_{jt} \end{aligned} \tag{8.19}$$

where I_{jt} = Australia's imports from trade partner country j at time t.

α = Parameters for explanatory variables in the Import model.

Y_{jt} = Australia's GDP at time *t*. Similar to the Y_{jt} in the Export model, adjustment is made to the data, but the adjustment procedure is different from the Export model. The I_{jt} component of GDP is added back (refer to Section 7.3 in Chapter 7). We expect that Y_{jt} has a positive impact on I_{jt}.

YF_{jt} = Foreign countries' GDP at time *t*. The I_{jt} component is removed from the foreign GDP. We expect that YF_{jt} has a positive impact on I_{jt}.

YP_{jt} = Australia's per capita GDP at time t. We expect that YP_{jt} has a positive impact on I_{jt}.

YPF_{jt} = Foreign countries' per capita GDP at time t. YPF_{jt} could have a positive or negative impact on I_{jt}.

P_{jt} = General price level in Australia at time t. We expect that P_{jt} has a positive impact on I_{jt}.

PF_t = General price level in trade partner countries at time t. We expect that PF_t has a negative impact on I_{jt}.

O_t = Openness variable for Australia at time t. This variable has no cross section variations. We expect that O_t has a positive impact on I_{jt}.

$M_{jit,L2}$ = Immigrant intake from country j to Australia at time t, with a lag of two periods (which equals to a lag of one and a half years). We expect that $M_{jit,L2}$ has a positive impact on I_{jt}.

$M^2_{jit,L2}$ = The square of $M_{it,L2}$. We expect that $M^2_{jit,L2}$ has a negative sign.

$_{jt+1}$ = One period lead term.

$_{jt-3}$ = Three periods lag term.

e_{jt} = The error term.

Other than the symbols we specified above, the rest of symbols in the import model of Equation (8.19) have the same interpretation as those symbols in the Export model of Equation (8.13). Applying the same criteria to select the optimal lead and lag terms, for the import model, one lead and three lags are selected. The Import model is estimated using the DGLS and with Panel-Corrected Standard Errors (PCSE) technique with the Parks (1967) estimator (Eviews refers the Parks estimator as the cross-section SUR), The PCSE with Park estimator corrects the cross-section heteroskedasticity as well as the contemporaneous correlation within each cross-section. The estimated results are presented in Appendix 8-K. We found that the use of DGLS for panel cointegration estimation does improve over the individual country cointegration estimation.

However, the Import model is less promising. The cointegration test in Section 8.4.2 and the residual plots in Appendix 8-M reveal that the Import model is not panel cointegrated. As a result, the panel regression using the level data cannot escape from consequences of a spurious regression. One way to tackle this problem is to turn the data series into stationary by the taking the first difference. Then the estimation is performed on the first differenced data.

The Eviews output for the Import model using the first differenced data is shown in Appendix 8-Q. The estimation results show that the variables are not significant and the statistical performance of the model is very poor. The finding is disturbing because comparing the Exports model with the Import model, we expected that immigrants have impacts on imports sooner than on exports. However, the results for the Import model cannot confidently confirm this expectation (the significance level is 11 per cent).

Although the Import model is not significant, the discussion shall not necessary end here. If we can assume that the Import model is panel cointegrated, then the short-run model is the error correction model. We tested this assumption and estimated the panel error correction model. The results substantially improved. The Eviews output for the error correction model for Import is shown in Appendix 8-R.

The comparison between the error correction model and the stationary first differenced model raises one concern: What is the chance that the panel cointegration of the Import model has been wrongly rejected by the *LM* cointegration test? Although the DOLS in the *LM* test procedure is easy to run, the *LM* test itself has been criticised by Westerlund and Edgerton (2007) as: (1) relying on cross-section independence and (2) the test is highly sensitive to serial correlation. In addition, we found that the Brownian motion simulation is highly sensitive to the number of regressors K but insensitive to the number of observations T and the number of repeats in trials.[74]

---

[74] Shortcomings of the Brownian motion simulation are discussed in Appendix to Chapter 10.

8.7 Conclusion

In this chapter, literature in the field of cointegration tests and panel cointegration test were extensively reviewed. Our data were tested to determine the form of regression that would be applied. The Lagrange Multiplier (*LM*) panel cointegration tests were selected to test the Export and Import models. We found that the Export model is panel cointegrated and the Import model is not cointegrated. The dynamic generalised least squares (DGLS) technique was applied to estimate the panel gravity model for the impact of Australia's immigrant intake on Australia's exports and imports.

Estimated results from the Export model reveal that immigrant intake has a long run positive sustainable impact on Australia's exports. On average, over the ten countries, the immigrant intake level of 13,000 persons per year per source country could have a positive contribution on Australia's exports. The marginal impact of additional immigrant on exports is also substantial. Similar results are found from the short run error correction model. Other than the impact of immigrants on exports, all other factors in the model have the expected relation with exports. The size of the economy between trading partners are still the greatest influence on trade.

For the Import model, long run equilibrium between immigration and imports cannot be established. We remove the non-stationary process by taking the first difference of the data to restore stationarity. Regression using the stationary data for the Import model failed to produce statistically significant results. It appears that immigrants do not have significant influence on the level of imports from the immigrant home countries.

In the next chapter, we will explore the topic of possible causal relation between immigration and exports, which is closely related to the topic of cointegration.

Chapter 9 CAUSALITY TESTS

9.1 Introduction

In Chapter 8, we found that there is a long run positive relation between the levels of immigrant intake from the ten Asian countries and Australia's exports to those countries. In this chapter, we move one step ahead by asking the questions: Does the long run equilibrium relation between immigration and trade also imply a "causal" relation between immigration and trade? If the causal relation exists, what is the direction of the causation?

Chapter 9 will be organised as follow: Section 9.2 briefly reviews the literature on the causality tests. Section 9.3 selects the causality test model for this analysis, performs the tests and interprets the test results. Section 9.4 performs the causality test for the case of Vietnam. Section 9.5 concludes the chapter.

9.2 A Brief Review of Causality Tests

In a model using cross-section data, it is difficult to establish a causal relation for two economic events that occurs simultaneously. However, when time series data are involved, it is possible that one event that occurs now could have an impact on another event sometime in the future, or earlier events could influence later events.

9.2.1 Granger Causality Test

Based on the supposition that causality occurs if earlier events help to explain later events, Granger (1969) illustrated the causality test by a two variable autoregressive distributed-lag model:

$$X_t = \sum_{j=1}^{m} a_j X_{t-j} + \sum_{j=1}^{m} b_j Y_{t-j} + \varepsilon_t \tag{9.1}$$

$$Y_t = \sum_{j=1}^{m} c_j X_{t-j} + \sum_{j=1}^{m} d_j Y_{t-j} + \eta_t \tag{9.2}$$

where X_t and Y_t are stationary time series. ε_t and η_t are uncorrelated white-noise series[75]. In Equation (9.1), if the inclusion of $\sum_{j=1}^{m} b_j Y_{t-j}$, the past values of Y_t, can significantly improve the prediction of X_t, while if the inclusion of $\sum_{j=1}^{m} c_j X_{t-j}$ in Equation (9.2) does not significantly improve the prediction of Y_t, then it is said that "Y_t Granger causes X_t". The term "Granger causes" is used to distinguish from the meaning of "cause" in plain English. "Y_t Granger causes X_t" means that Y_t contains better information to predict X_t comparing using the past information of other variables in the test. Conversely, in Equation (9.2), if the inclusion of $\sum_{j=1}^{m} c_j X_{t-j}$ can improve the prediction of Y_t, and at the same time, the inclusion of $\sum_{j=1}^{m} b_j Y_{t-j}$ in Equation (9.1) does not improve the prediction of X_t, then it is said that "X_t Granger causes Y_t". If both $\sum_{j=1}^{m} c_j X_{t-j}$ and $\sum_{j=1}^{m} b_j Y_{t-j}$ are significant at the same time, the situation is called a bi-directional causality or a feedback, which means that X_t Granger causes Y_t, as well as Y_t Granger causes X_t. On the other hand, if both $\sum_{j=1}^{m} c_j X_{t-j}$ and $\sum_{j=1}^{m} b_j Y_{t-j}$ are not significant, then independence of X_t and Y_t is suggested.

In practice, the number of lagged terms m can be determined by Akaike criterion or Schwarz information criterion. The number of lags for X_t and Y_t do not have to be the same. Thus, Equations (9.1) and (9.2) can be written as:

$$X_t = \sum_{i=1}^{n} a_i X_{t-i} + \sum_{j=1}^{m} b_j Y_{t-j} + \varepsilon_t \tag{9.3}$$

$$Y_t = \sum_{i=1}^{n} c_i X_{t-i} + \sum_{j=1}^{m} d_j Y_{t-j} + \eta_t \tag{9.4}$$

Now, the n lags are for X_t and m lags are for Y_t. In addition, the individual lags may not be all statistically significant under t-test. The joint F-tests are used to determine whether X_t or Y_t are not significant.

---

[75] In causality test, the subscripts of i and j have different definition from the panel gravity model. i represents the lag term of the independent veraibles and j represents the lag term of the dependent variable.

9.2.2 Sim's Test

Sims (1972) criticised that the Granger causality test procedure reaches the conclusion that X_t "causes" Y_t by only comparing the performance of the X_t coefficient with other variables in the test regression. As long as the X_t coefficient performs better than the other components in the test regression, then X_t is said to "cause" Y_t, and *vice versa* for Y_t "causes" X_t. Sims (1972) argued that only in the special case where all future values of *X* have no role to play in the regression, that is no backward causation over time, then the causality of *X* to *Y* can be established.

Sims (1972) used a distributed lag method for the causality test and ended up with a simple test model with the past (the lag), current and future (the lead) values of *X*. If the joint *F*-test of all the future values of *X* is insignificantly different from zero, then it is possible that X_t causes Y_t. The Sim's representations are given below:

$$Y_t = \alpha + \sum_{i=1}^{k} \beta_k X_{t-i} + \sum_{j=1}^{m} \gamma_m X_{t+j} + u_t \qquad (i = 1,2,3,...k \text{ and } j = 1,2,3,...m) \qquad (9.5)$$

$$X_t = \varphi + \sum_{i=1}^{k} \phi_k Y_{t-i} + \sum_{j=1}^{m} \lambda_m Y_{t+j} + v_t \qquad (i = 1,2,3,...k \text{ and } j = 1,2,3,...m) \qquad (9.6)$$

Basically, Sims' (1972) model is a twist of the Granger causality model by shifting the time forward into the future. If the *F*-test on the $\sum_{j=1}^{m} \gamma_m X_{t+j}$ is significantly different from zero (that is, the future X_t has some role to play in explaining Y_t), while the *F*-test on the $\sum_{j=1}^{m} \lambda_m Y_{t+j}$ is not significantly different from zero (that is, the future Y_t has no role to play in explaining X_t), then it is possible that *Y* Granger causes *X* and *X* does not Granger cause *Y*. In practice, Sims (1972) warned that attention should be paid on both the joint *F*-tests for the possible causal direction as well as the estimated coefficients of the lead terms ($\sum_{j=1}^{m} \gamma_m$) in Equation (9.5) and $\sum_{j=1}^{m} \lambda_m$ in Equation (9.6). If the estimated coefficients of the lead terms in Equation (9.5) are as large as or larger than the estimated coefficients of the past values ($\sum_{i=1}^{k} \beta_k$), according to Sims (1972), bidirectional causality may be important even if the joint F-test found that the future values are significantly different from zero. The same argument applies to Equation (9.6).

9.2.3 The Vector Autoregression Model (VAR) for Causality Test

The Vector Autoregression (VAR) model is mainly a macro-econometric forecasting model developed by Sims (1980), which is motivated by alleviating the identification problems associated with the simultaneous structural equation model. In a system of one-equation-at-a-time, specification of a large model for macroeconomic forecasting, exact- or over-identification has to be achieved in order to estimate the system. To achieve identification, some variables in the system of equations need to be treated as predetermined or exogenous variables, while some of the variables as endogenous. The decision of classifying a variable to be an exogenous variable often has no clear guidelines. Hence, the viability of a macroeconomic forecasting model often lies on the success of identification, which rests on an arbitrary selection of the exogenous variables. The model could fail if the exogenous variables can be classified as endogenous variables according to other criteria.

Sims (1980) provided an alternative strategy for empirical macroeconomics forecasting of unconstrained vector autoregression models, which treats all variables as endogenous, without restrictions based on supposed *a priori* knowledge. In the case of a two equations system with two variables and one lag, the VAR can be represented as:

$$\begin{bmatrix} X_t \\ Y_t \end{bmatrix} = \begin{bmatrix} \phi \\ \varphi \end{bmatrix} + \begin{bmatrix} \alpha & \beta \\ \gamma & \lambda \end{bmatrix} \begin{bmatrix} X_{t-1} \\ Y_{t-1} \end{bmatrix} + \begin{bmatrix} \varepsilon_t \\ \upsilon_t \end{bmatrix} \qquad (9.7)$$

The system can be written as:

$$\begin{aligned} X_t &= \phi + \alpha X_{t-1} + \beta Y_{t-1} + \varepsilon_t \\ Y_t &= \varphi + \gamma X_{t-1} + \lambda Y_{t-1} + \upsilon_t \end{aligned}.$$

Each equation in the system can be estimated by OLS or the system can be estimated by SUR techniques. The interpretations of the estimated coefficients are as for OLS estimates. The VAR system has its advantages in the area of forecasting and the estimation of Impact Multiplier and Long-term Multiplier through an impulse-respond function. We are more interested in another advantage in using the VAR model, which is its ability to test causality. The VAR system has great similarity to the Granger Causality test in Equation (9.3) and (9.4).

The VAR Granger causality test is a Chi-squared test. It tests whether the dependent variable can be better explained by excluding the endogenous variable(s). If the regression, which excludes the endogenous variables, is significantly rejected, then the endogenous variables should help to explain the dependent variable. Since the endogenous variables are in lag terms, the decision to retain the endogenous variables in the regression by the causality test means that the information from the previous periods of the endogenous variable(s) can help to explain the later results of the dependent variable. As a result, the causality relation can be established.

In order to perform the VAR, we need to determine the appropriate lag length in the system. This task requires some trial and error based on the best (the lowest) value of the Akaike information criterion and Schwarz criterion. Econometric computer packages such as Eviews provide statistics on lag length selection criteria. The test of causality in the VAR system is the *F*-test similar to the Granger causality test.

9.3 Test of Causality for Immigration and Trade

9.3.1 A Preamble to this section

In Section 8.4.2, the DOLS-LM panel cointegration test found that the gravity model for immigration and trade was cointegrated for the Export model, but the Import model is not cointegrated. For a cointegrated model, there is a long run or stable relationship between the dependent and independent variables. The error term of the long run cointegrated regression is the "equilibrium error" which adjusts the dependent variable's short run behaviour to its long rum value. This continuous adjustment from the short run towards the long run is the dynamic error correction mechanism (ECM) of Engle and Granger (1987). A related important theorem, known as the Granger representation theorem, states that, if two variables X and Y are cointegrated, then the relationship between the two variables could be expressed as the ECM (Gujarati, 2003, p.825).

Causality and cointegration are related issues bounded by Granger representation theorem. As Gujarati (2003, p. 852) states, one of the implications of the theorem is that if two $I(1)$ process variables *X* and *Y* are cointegrated, then either *X* must cause *Y* or *Y* must cause *X*. However, if two $I(1)$ process variables are not cointegrated, then the whole question of causality may become moot. As a pre-empt of our causality test for the Export and Import models, the Export model is cointegrated and thus it is expected that the causality relationship exists, while the Import model is not cointegrated, and causality relationship is not expected.

9.3.2 VEC Granger Causality Test for the Export Model

For the Export model, in order to test whether immigrants cause exports or exports cause immigration, we treat exports (*E*) and immigrants (*M*) as endogenous variables. We specify our causality test model as a vector autoregression error correction (VAR-EC) model or simplified as vector error correction (VEC) model. It is the VAR version of the error correction model specified in Section 8.5. We use two variables *M* and M^2 in the VAR, but theoretically, *M* and M^2 are viewed as one variable and they are treated as endogenous variables in the ECM system, as:

$$\begin{aligned}\Delta E_{it} &= \delta_1 DUM_{HK} + \ldots + \delta_9 DUM_{TH} + \delta_{10}\Delta Y_{it} + \delta_{11}\Delta YF_{it} + \delta_{12}\Delta YP_{it} \\ &+\delta_{13}\Delta YPF_{it} + \delta_{14}\Delta P_{it} + \delta_{15}\Delta PF_{it} + \delta_{16}\Delta OF_{it} + \delta_{17}D_i \\ &+\delta_{18}u_{it-1} + \sum_{j=1}^{k}\varsigma_j \Delta M_{it-j} + \sum_{j=1}^{k}\zeta_j \Delta M^2_{it-j} + \sum_{j=1}^{k}\psi_j \Delta E_{it-j} + \tilde{u}_{it}\end{aligned} \tag{9.8}$$

$$\begin{aligned}\Delta M_{it} &= \delta_{19} DUM_{HK} + \ldots + \delta_{27} DUM_{TH} + \delta_{28}\Delta Y_{it} + \delta_{29}\Delta YF_{it} + \delta_{30}\Delta YP_{it} \\ &+\delta_{31}\Delta YPF_{it} + \delta_{32}\Delta P_{it} + \delta_{33}\Delta PF_{it} + \delta_{34}\Delta OF_{it} + \delta_{35}D_i \\ &+\delta_{36}u_{it-1} + \sum_{j=1}^{k}\theta_j \Delta M_{it-j} + \sum_{j=1}^{k}\gamma_j \Delta M^2_{it-j} + \sum_{j=1}^{k}\lambda_j \Delta E_{it-j} + \tilde{u}_{it}\end{aligned} \tag{9.9}$$

$$\begin{aligned}\Delta M^2{}_{it} &= \delta_{37} DUM_{HK} + \ldots + \delta_{45} DUM_{TH} + \delta_{46}\Delta Y_{it} + \delta_{47}\Delta YF_{it} + \delta_{48}\Delta YP_{it} \\ &+\delta_{49}\Delta YPF_{it} + \delta_{50}\Delta P_{it} + \delta_{51}\Delta PF_{it} + \delta_{52}\Delta OF_{it} + \delta_{53}D_i \\ &+\delta_{54}u_{it-1} + \sum_{j=1}^{k}\hbar_j \Delta M_{it-j} + \sum_{j=1}^{k}\wp_j \Delta M^2_{it-j} + \sum_{j=1}^{k}\lambda\!\!\!^-_j \Delta E_{it-j} + \tilde{u}_{it}\end{aligned} \tag{9.10}$$

where δ_{18}, δ_{36} and δ_{54} are coefficients of error correction terms in the VAR system. ς_j, ζ_j, ψ_j, θ_j, γ_j, λ_j, $\hbar_j$, $\wp_j$ and $\lambda\!\!\!^-_j$ are the coefficients of the lag terms in the system. Since we are testing the causality between immigration and trade, only *M* and *E* are treated as endogenous variables in the VEC and thus only the lags of *M* and *E* are included in the right hand side of the VEC system equations of (9.8), (9.9) and (9.10). The other variables are treated as exogenous.

The error correction term u_{it-1} is the residual from the regression of *E* on *M* and M^2, similar to the error correction model. It is expected that δ_{18} has a negative sign. For Equation (9.9), the dependent variable is reversed, thus the sign for δ_{36} should be opposite to δ_{18}, which is positive in this case. Equation (9.10) is the square term of *M*, and δ_{54} should be opposite to δ_{36} in Equation (9.9). For a correctly specified VEC model, δ_{18} in Equation (9.8) should be statistically significant, while δ_{36} and δ_{54} should be statistically insignificant.

With several lags of the same variables in the model, no individual estimated coefficients are expected to be significant. The *F*-test is used to test the collective significance of the lag terms in the model.

In the cointegration estimation in Section 8.2.4 of Chapter 8, we selected a four lags term for the immigrant intake variables. For the causality test, from a trial and error for the lag length ranging from one to eight lags, we found that the best according to the combined Akaike information criterion and Schwarz criterion is a three lags term. The four lags term is the second best, followed by the eight lags term (see Table 9.1).

We would like to distinguish between the lag terms of the cointegration model and the lag terms of the causality model. In the cointegration model, the four lags term is the fourth year after the immigrant arrival.[76] We found that the volume of exports has a strong positive correlation with the immigrant intake level four years ago (but not for the last four years). In the causality test model, the lag term of three years means that for "the period of last thirty-six months cumulatively". If the causality can be established, then it can be interpreted as "the explanatory power for today's volume of exports can be improved by looking at the cumulative effect of last thirty six months' immigrant intake level".

[76] For simplicity of the argument, we say a four-year lag. Recall that the immigrant arrival data was recorded for the yearly basis from 1 July of one year to 31 Jun of the following year. A four-year lag, in fact, means three and a half years (or forty two months) ago.

Table 9.1 Lag Length Selection Criterion for VEC Panel Causality Test for the Export Model

	1 lag	2 lags	3 lags	4 lags	5 lags	6 lags	7 lags	8 lags
Akaike information criterion	6.319	6.017	5.646	5.669	5.664	5.711	5.718	5.567
Schwarz criterion	7.031	6.844	6.592	6.739	6.866	7.048	7.199	7.199

We performed the panel VEC estimation with a three lags term, and then the VEC causality test is based on the VEC estimations (the VEC causality test results generated by Eviews are shown in Table 9.2 below). The VEC estimation results from Eviews are included in Appendix 9-A. In Appendix 9-A, the error correction term (named "CointEq1" in the Eviews output) is negative and statistically significant for Equation (9.8), which confirms with our *a priori* expectation. The *F*-statistic is 7.177 for Equation (9.8), which is statistically significant. These results indicate that Equation (9.8) is good to use for causality test. For Equation (9.9), the error correction term is positive and insignificant, and the error correction term is negative and insignificant for Equation (9.10). Both of these come up to our expectations as well. However, the *F*-statistics are insignificant for both Equations (9.9) and (9.10) indicating that both Equations (9.9) and (9.10) are not very useful for causality test. The combined results of the three *F*-statistics point to the direction that it is possible that *M* Granger causes *E*, but it is not likely that *E* Granger causes *M*. The Akaike information criterion for three lags is 5.646 and the Schwarz criterion is 6.592. We can find in Table 9.1 that the information criteria for three lags are the lowest amongst the range of lags from one to eight.

Table 9.2 includes the Eviews output for the VEC Granger causality test with three lags. The Chi-squared test for the dependent variable of D(E) is statistically significant with a *p*-value for D(M) being 0.0255. Meanwhile, the Chi-squared test for the dependent variable of D(M) is statistically insignificant with a *p*-value of 0.5141. The VEC Granger causality test results reject the hypothesis of "*M* does not cause *E*" but cannot reject the hypothesis of "*E* does not cause *M*". This result indicates that the level of immigrant intake Granger causes the volume of exports but the volume of exports does not Granger cause the level of immigrant intake. Thus, the test found one-way Granger causality of immigrant intake to exports.

We also performed VEC causality tests for all eight lags. The significant levels of the VEC Granger causality tests are shown in Table 9.3. For lags up to two, the causality test reveals that the immigrant intake level is independent of exports, that is immigrant intake does not Granger cause exports and exports does not Granger cause the immigrant intake level. From three lags onwards, there is strong possibility that the immigrant intake level one-way Granger causes exports. That is, exports does not Granger cause the immigrant intake level.

Table 9.2 VEC Granger Causality Test with Three Lags by Eviews

VEC Granger Causality/Block Exogeneity Wald Tests Sample: 1963 2000 Included observations: 340			
Dependent variable: D(E)			
Excluded	Chi-sq	df	Prob.
D(M)	9.303190	3	0.0255
D(M2)	6.701554	3	0.0820
All	11.45843	6	0.0752
Dependent variable: D(M)			
Excluded	Chi-sq	df	Prob.
D(E)	2.291536	3	0.5141
D(M2)	3.839654	3	0.2793
All	6.139998	6	0.4077
Dependent variable: D(M2)			
Excluded	Chi-sq	df	Prob.
D(E)	1.514110	3	0.6790
D(M)	5.463749	3	0.1408
All	6.876393	6	0.3324

D(.) is the first difference operator and it is part of the VEC procedure. For example, D(E) is the first difference of the export variable.

Table 9.3 The Significant Level of VEC Panel Granger Causality Test with Various Lags for the Export Model

	1 lag	2 lags	3 lags	4 lags	5 lags	6 lags	7 lags	8 lags
M cause *E*	0.1600	0.1874	0.0255	0.0487	0.0080	0.0074	0.0015	0.0002
M^2 cause *E*	0.2538	0.2971	0.0820	0.1884	0.0548	0.0633	0.0354	0.0146
M & M^2 cause E	0.3603	0.2572	0.0752	0.1211	0.0550	0.0863	0.0283	0.0070
E cause *M*	0.8836	0.2549	0.5141	0.7153	0.2642	0.1293	0.1945	0.2719

9.3.3 VAR Granger Causality Test for the Import Model

As we mentioned in Section 9.3.1, we do not expect a strong causality relation in the Import model. To test whether it is the case, we also apply the VAR technique for the causality test. Since the data series in the Import model are unit root series, but panel cointegration cannot be found by the DOLS-LM test in Section 8.4.2, we cannot use VEC procedure. Instead, we apply VAR on the first difference of the data series. To select the appropriate lag lengths, similar to the causality test for the Export model, trial and error for lag length ranging from one to eight lags was attempted. Akaike information criterion (AIC) and Schwarz criterion (SC) are used to select the best lag length.

From Table 9.4 below, we can observe a somewhat strange pattern - the AIC and SC values move in opposite directions when the number of lags increased from one to eight; the AIC is decreasing while the SC is increasing. It is difficult to determine what lag length is appropriate for the VAR estimation. Without specifying the appropriate lag length, we performed the VAR Granger causality test with various lag lengths, and the causality test results are presented in Table 9.5. We found that we cannot reject the null of “immigrant intake level does not Granger cause imports” for all eight lags. Thus, we cannot find the notion of “immigrants cause imports”. With five lags and more, the VAR Granger causality tests found that “imports Granger cause immigrant intake level”.

Table 9.4 Lag Length Selection Criterion for VAR Panel Causality Test for the Import Model

	1 lag	2 lags	3 lags	4 lags	5 lags	6 lags	7 lags	8 lags
Akaike information criterion	3.253	3.031	3.027	2.979	2.849	2.911	2.852	2.812
Schwarz criterion	3.912	3.808	3.929	4.013	4.023	4.233	4.332	4.460

These causality tests results are rather a surprise, which does not conform to our expectation. Our expectation has been that after coming to Australia, immigrants would continue to consume the products they used to consume in their home countries. Although this expectation is reasonable, it is not strong enough to establish a statistical significance from the empirical test.

Table 9.5 The Significance Level of VAR Granger Causality Tests with Various Lags for the Import Model

	1 lag	2 lags	3 lags	4 lags	5 lags	6 lags	7 lags	8 lags
M causes I	0.2000	0.8289	0.4393	0.4722	0.3597	0.2069	0.2634	0.4669
M^2 causes *I*	0.3076	0.8387	0.4656	0.4511	0.4456	0.2281	0.3113	0.5227
M and M^2 cause *I*	0.2082	0.4784	0.6234	0.6309	0.3264	0.1826	0.0725	0.3215
I causes *M*	0.4750	0.6227	0.4017	0.4573	0.0126	0.0205	0.0140	0.0104

9.4 The Case of Vietnam

The above causality tests (in Sections 9.3.2 and 9.3.3) are performed using panel data on a gravity model for ten countries, excluding Vietnam due to insufficient observations for most of the explanatory variables. Although we could not include Vietnam in the gravity model, we do observe that the level of immigrant intake from Vietnam and Australia's trade with Vietnam move together with a rapid increase for a long period of time (with some lags). This information is too powerful to ignore. Since we have sufficient observations for the data on exports and imports, as well as immigrant intake data, we can perform a simple two variables causality test for immigration and trade for the case of Vietnam.

The exports data for Vietnam are available from 1963 to 2004. For historical reasons, trade data before 1975 were collected by summing up Australia's exports to both North Vietnam and South Vietnam. The import data are available from 1972 to 2003. Immigrant data are from 1975 to 2004.

9.4.1 Causality Test for Immigrant Intake and Exports: Vietnam

The Johansen cointegration test found that there is one cointegration equation for immigrant intake from Vietnam and Australia's exports to Vietnam. The Eviews output for the Johansen cointegration test is included in Appendix 9-B. Since the variables are cointegrated, VEC procedure can be used to test causality. Due to the shorter data series, the maximum lag length is five. The trial and error for the lag length found that two lags is the best choice, as shown in Table 9.6.

Table 9.6 Lag Length Selection Criterion for VEC Panel Causality Test for the Export Model: Vietnam

	1 lag	2 lags	3 lags	4 lags	5 lags
Akaike information criterion	3.190634	2.791338	3.333102	3.23823	2.772121
Schwarz criterion	4.047051	4.087175	5.075082	5.432207	5.422742

Table 9.7 VEC Granger Causality Test for Exports to Vietnam

VEC Granger Causality/Block Exogeneity Wald Tests
Sample: 1975 2004
Included observations: 27

Dependent variable: D(EVI)

Excluded	Chi-sq	df	Prob.
D(MVI)	7.106022	2	0.0286
D(MVI2)	6.590856	2	0.0371
All	12.31831	4	0.0151

Dependent variable: D(MVI)

Excluded	Chi-sq	df	Prob.
D(EVI)	0.234069	2	0.8896
D(MVI2)	2.047931	2	0.3592
All	2.065064	4	0.7238

Dependent variable: D(MVI2)

Excluded	Chi-sq	df	Prob.
D(EVI)	0.226985	2	0.8927
D(MVI)	1.765827	2	0.4136
All	1.792674	4	0.7738

D(.) is the first difference operator and it is part of the VEC procedure. For example, D(EVI) is the first difference of the export variable for Vietnam.

The VEC estimate with two lags is included in Appendix 9-C and the VEC Granger causality test is in Table 9.7. From Table 9.7, we find that the Granger non-causality of MVI (immigrant from Vietnam) to EVI (exports to Vietnam) is rejected with a significant level of 0.0151. That is, immigrant intake from Vietnam Granger causes Australia's exports to Vietnam. However, EVI "does not Granger cause" MVI cannot be rejected at a significant level of 0.8896. Thus for Vietnam, there is a one-direction causality of "immigrant causes exports".

9.4.2 Causality Test for Immigrant Intake and Imports: Vietnam

As for exports, cointegration relation between immigrant intake from Vietnam and imports from Vietnam can be found by the Johansen test. VEC procedure is used for causality test. By trial and error, we found that two lags is the best choice (Table 9.8). The VEC estimates with two lags are included in Appendix 9-D, and the VEC Granger causality test with two lags is shown in Table 9.9.

The Grange causality test results in Table 9.9 indicates that the joint impact of MVI and MVI^2 has its significant level of 0.017. This test result shows that the level of immigrant intake from Vietnam Granger causes the volume of imports from Vietnam. However, the test for "IVI (the volume of imports) does not Granger cause MVI" has a significant level of 0.4705. That is, the hypothesis of "imports do not Granger cause immigrants" cannot be rejected. Thus, we can say that immigrant one-way causes imports.

Table 9.8 Lag Length Selection Criterion for VEC Panel Causality Test for the Import Model*

	1 lag	2 lags	3 lags	4 lags
Akaike information criterion	13.43079	12.04887	12.08995	11.59438
Schwarz criterion	14.29468	13.35535	13.84513	13.80323

* Due to the shorter series of data, only a maximum of four lags can be tried.

From the test results of Sections 9.4.1 and 9.4.2, we conclude that there is a one-way causation from immigrant to trade. Therefore, we can claim that, for the case of Vietnam, the level of immigrant intake causes trade (exports and imports) and trade does not cause the level of immigration.

Table 9.9 VEC Granger Causality Test for Immigrant Intake and Imports

VEC Granger Causality/Block Exogeneity Wald Tests
Sample: 1959 2004
Included observations: 26

Dependent variable: D(IVI)

Excluded	Chi-sq	df	Prob.
D(MVI)	5.326293	2	0.0697
D(MVI2)	6.128066	2	0.0467
All	12.05107	4	0.0170

Dependent variable: D(MVI)

Excluded	Chi-sq	df	Prob.
D(IVI)	1.507721	2	0.4705
D(MVI2)	1.612634	2	0.4465
All	3.315844	4	0.5064

Dependent variable: D(MVI2)

Excluded	Chi-sq	df	Prob.
D(IVI)	1.188459	2	0.5520
D(MVI)	1.798950	2	0.4068
All	3.096430	4	0.5418

9.5 Conclusion

In this chapter, we used the Vector Autoregression technique to test the causality between immigration and trade. For a panel gravity model of ten countries, amongst other factors, there is strong evidence that the immigrant intake of the last three years one-way Granger cause the volume of exports today, but exports do not help to explain the future level of immigrants. However, for imports, the causal relations run in the opposite direction. The test found no evidence that immigrants Granger cause imports. However, imports Granger cause the immigrant level. For the single country of Vietnam, with a simple two variables model, we found strong evidence that immigrants Granger cause both exports and imports, but not *vice versa*.

Thus far, in the thesis, we completed the investigation on the long run and short run relations between immigration and trade, and we have achieved the objective of testing the possible causal relation between these two factors of the economy. In the next chapter, we conclude the thesis by discussing the significances and implications of the finding and limitations of the methodology employed in this study, as well as suggesting some directions for future research on the subject covered in this thesis.

Chapter 10 SUMMARY AND CONCLUSION

10.1 Introduction

This study examined an aspect of international immigration that has received limited attention so far in the literature. That is, social capital and human capital of immigrants, which link immigrant home countries and the immigrant receiving countries, having commercial value effects on the two-way trade between the immigrant home countries and the immigrant receiving countries. The primary question for which we searched an answer in this study was: Do increased immigrant intake increase trade, that is, do immigrants facilitate trade? In order to answer this question, we investigated whether social capital and human capital of immigrants benefit the immigrant receiving country by way of facilitating bilateral trade flow between the immigrant home country and the immigrant receiving country.

The investigation in this study was conducted at both theoretical and empirical levels. At the theoretical level, we used the theory of information economics and argued that social capital brought in by immigrants can reduce the transaction costs for exporters and importers. That is, exporters could receive higher prices with immigrant information than they would receive without immigration. On the other hand, importers could pay lower prices than otherwise. This gives incentive for traders to trade more.

At the empirical level, first, we developed gravity models, which included immigrant intake variable. These models were estimated using data for a panel of ten countries over thirty-eight years, to investigate the long run relation of immigrant intake on bilateral trade flows. Second, we investigated the possible causal relation between immigration and trade.

In the remainder of this chapter, first, an overview of the study is provided. A summary of key findings of the study is presented next. Then, the policy implications of the findings are discussed. Next, the chapter discusses the limitations of this study. Finally, some suggestions for further research are provided.

10.2 An Overview of the Study

The literature review on the economic theories of trade and immigration presented in Chapter 2 demonstrated that a growing number of studies disagree with the notion of immigration-trade substitution. The notion of immigration-trade substitution has two parts: the first part is that trade equalises wages, which reduces the incentive to migrate, that is, trade is a substitute for immigration; the second part is that immigration equalises wages, hence equalises prices of the goods, which reduces the incentive to trade, that is, immigration is a substitute for trade.

However, in this study, we argued that trade could only be a substitute for immigration for those immigrants who are predominantly motivated by wage differences between countries, but it does not have an effect on the immigrants who are motivated by other reasons. We also argued that, immigration could only be a substitute for trade to the extent of the labour component that immigrants bring in with them. All other components, including the social capital and human capital components, which could have commercial values on trade, will not be a substitute for trade but rather complements trade. Immigration entrepreneur literature reviewed in Chapter 2 provides support for these arguments.

Chapter 3 discussed the history of immigration of Australia focusing on selected Asian immigrant source countries. A brief history of Australian trade with those Asian countries is also provided. Recorded trade data show that Australia's trade with those Asian countries increased with an increasing rate over the past forty years. Over the same period of time, new immigrant arrivals from those countries also show an upward trend. This shows that both trade and immigrants increased over time, pointing to a direction of long run positive co-relation between trade and immigration. Thus, the argument that "immigration is a substitute for trade" is questionable, at least in the Australian context.

In order to explain this long run positive co-relation, we introduced the arguments from the field of Information Economics. In Chapter 4, a general equilibrium model for immigration and trade was established to illustrate the case for a positive relationship between immigration and trade by using the theory in Information Economics. We first established the argument that price is a function of information and both buyers and sellers in the market engage in searching activities for market information. Market information searching is always a rewarding activity. For buyers, price is a negative function of buyer's searching (or looking) for sellers. That is, the more market information the buyer has, the lower the price he/she can find from a price distribution offered by a range of sellers. For sellers, price is a positive function of seller's searching for buyers. The better the information the seller gathers through searching for buyers, the better the price the seller can negotiate from a range of more-or-less informed buyers. However, information economics states that market information searches result in costs to the searcher. We can expect that the search cost will be higher for international market than for domestic market. If seller firms or buyer firms in the international market can employ someone who already possesses market information, then seller firms can benefit from higher price for exports, while the buyer firms can benefit from a lower price of imports. As a result, international trade will increase. It is suggested that immigrants are in a better position to provide market information for both exporters and importers.

Following the logic we developed above, a constrained maximisation method was used to derive the equation in which immigrant information is clearly shown to reduce importable sector's price and to raise exportable sector's price.

After establishing the hypothesis of immigrants enhancing trade in Chapter 4, the gravity model is selected to test this hypothesis. Chapter 5 was devoted to a comprehensive review of literature of the theory and the application of the gravity model in international trade flow analysis. Most of the gravity models for trade are studies of trade among countries at a point in time. Only Gould's (1996) model of trade was for between one country (USA) and the rest of the world, over a period of time. There are some empirical studies for the trade between one country and a group of other countries (the country-specific model of the gravity model) such as Gunawardana and Hewarathna (2000), Gunawardana (2005) and Blomqvist (2004). However, the theoretical foundation of the gravity model for trade between a country's trades with a group of other countries has yet to be attempted.

In Chapter 6, a gravity model for trade between one country and a group of trade partner countries (a country specific model) was developed with theoretical support from Oguledo and MacPhee (1994) approach. Our country-specific gravity model differs from the conventional gravity model. The conventional gravity model is suitable for total trade with all individual countries, with individual countries being part of the total, and the sum of the individual is the total. Our country-specific gravity model is suitable for focusing on trade of one country with a group of other countries, e.g. Australia's trade with a group of Asian countries. What is special about this model is that the sum of trade with this group of Asian countries is not the total trade of Australia because Australia also trades with countries other than that group of Asian countries. In Gould's (1996) model of one country's trade with the rest of the world, he used the Bergstrand (1985) approach to build his model, which required the assumption of balanced total trade. The model we adapted in this study does not require the assumption of balanced total trade. Our model supports the argument of immigrant information as a factor determining international trade.

Chapter 6 also investigated the econometric techniques suitable to country specific gravity model, which utilises the pooled cross-section and time series data. The selection of random effect or the fixed effect is determined on both theoretical and practical grounds. Variables in the gravity model and their hypothetical impacts on Australia's exports and imports were discussed.

Chapter 7 reported the data sources and data collection techniques, discussed the necessary data manipulation procedures and conducted preliminary analysis of data. Chapter 8 performed a range of tests to reach at a regression model, which is suitable to the panel cointegration test. A long run equilibrium model was estimated using panel cointegration estimation and inference procedures. A short run dynamic model was also estimated.

Following the panel cointegration estimation results, which established the long run equilibrium relations between immigration and trade, in Chapter 10, we proceeded to find out whether there is causality between immigration and trade, applying Granger-Sims causality tests.

10.3 Achievements and Findings of the Study

The conventional theory of the economics of immigration and trade offers the following reasoning: Immigrants as units of labour, moving across national boarders, will increase the supply of labour in the immigrant receiving country and will decrease the supply of labour in the immigrant home country. Immigration represents a shift of the labour supply curve to the right, as well as a change to a more elastic of supply of labour in the immigrant receiving country. Meanwhile, emigration represents a shift of the labour supply curve to the left as well as a change to a less elastic of supply of labour in the emigrant sending (home) country. Thus, wages in the immigrant receiving country will decrease and the wages in the immigrant home countries will increase. Wages converge between the immigrant receiving country and the immigrant home country. As wages converge, comparative advantages of both the countries change and hence trade will reduce. Conventional economic theory of immigration and trade concludes that increased immigrant intake will reduce trade between the immigrant receiving countries and the immigrant home countries. Thus, international immigration is a substitute for international trade.

In this thesis, we challenge the conventional "immigration substitutes trade" conclusion by questioning the way the immigrants are measured. In conventional theory, immigrants are measured as units of labour. The use of this measure was for convenience to simplify the model to analyse the impacts of immigration on the economy. The factor price equalisation theorem of H-O-S was accepted, and wildly used to support the "immigration-trade substitution" theory. We questioned whether immigrants could be measured as units of labour only. If immigrants can be treated in a broader manner, would the conclusion of "immigration-trade substitution" be still valid?

We postulate that immigration has two effects on international trade: the labour movement effect which substitutes trade, and the social capital and human capital movement effect which enhances trade. The labour movement effect could equalise wages if immigration is in a massive scale, and hence reduce trade. The social capital and human capital movement effect provides market information, and hence increases trade. The two effects work together to affect trade.

The first innovative achievement of this study was in Chapter 4, which utilised the theory of information economics and the duality theory to derive a model, which clearly shows that immigrant information unambiguously and simultaneously benefits exporter and importer in the immigrant receiving country in terms of better price deals.

In order to test whether the reality supports this model, we focus on the case of Australia's immigrant intake from a group of eleven Asian countries and Australia's trade with this group of Asian countries. We use the empirically successful gravity trade model to analyse the data. However, the conventional gravity model has been developed for cross-section studies and is based on total trade amongst all trading partners. The second achievement of this study rests on the innovative development of a gravity model which incorporates the immigrant intake variable to proxy foreign market information contribution by immigrants. This gravity model adapted the modelling approach of Oguledo and MacPhee (1994), and is supported by firm economic grounds.

The third achievement of this study is the investigation of the long-run relationship between Australia's immigrant intake levels and Australia's trade with the immigrant source countries. To our knowledge, there are no previous studies on the long run relationship between Australian immigration and trade. The most relevant study in this area is that of Gould (1996) for USA which used panel data, but it did not estimate the long run co-integration relation.

Using a panel data set that consisted of ten of Australia's trade partner countries over thirty-eight years, the hypothesis of positive relation between immigrant foreign market information and international trade was tested. We used the data of immigrant intake levels as proxy for immigrant information. We acknowledge that immigrant intake levels have dual and counterbalanced effects on trade occurring simultaneously: the factor price equalisation effect and the foreign market information effect. If the factor price equalisation effect were stronger, then the total effect of immigration on trade would be negative. If the foreign market information effect were stronger, then the total effect of immigration on trade would be positive.

The results of our study are in sharp contrast to those of the standard 2 X 2 H-O-S model. Within a certain volume of immigrant intake, the immigrant intake level appears to have strong positive effect on Australia's exports, but a weak positive effect on imports. That is, the positive effect of immigrant information is stronger than the negative effect of labour movement on exports and imports. Overall, export sector in the Australia's economy appears to benefit the most from immigrant foreign market information, while the import sector benefits the least. The immigrant intake level is included in the models by considering the joint positive and negative effects, with the positive effect being the foreign market information and the negative effect being labour immigration substitution effect on trade.

For the long run effect of immigration on exports, on average of over the ten countries, the highest elasticity is positive 0.4613, which means a 10 per cent increase in Australia's immigrant intake will lead to 4.61 per cent increase in Australia's exports to the immigrant source country. The elasticity slowly reduces as the immigrant intake level increases beyond the optimal level.

On average, for each country, if the immigrant intake level is kept at a maximum of 13,000 persons per source country per year, immigrants will have an overall (after counter balancing the effect of labour and the effect of market information) positive impact on exports. The dollar value of exports per additional new immigrant intake is also substantial since the level of exports is in billions of dollars and the level of immigrant intake ranges from a few hundred to a few thousand persons. One per cent of ten thousand immigrants are only one hundred persons, while 0.4 per cent exports increase could be worth thousands of million dollars. However, in the short run dynamic analysis, the positive impact of immigrants on trade was found to be only a half of the impact found from long-run equilibrium analysis.

For imports, panel cointegration cannot be found and the long run relation cannot be established. However, we still found that immigrants have a positive impact on imports, although the impact is not as strong as on exports. The possible explanation for the empirical results of a stronger impact on exports by immigrant intake and a weak impact on imports could be that imports are more influenced by the strength of the domestic economy, but less influenced by immigrant preferences for their home country products. Even if immigrants' preferences for home products were strong, since the volume of immigrants is low, the market for immigrants' home products is too small to have a statistically significant impact on imports as shown by the empirical analysis. On the other hand, foreign markets for exports are relatively large. The commercial value of the foreign market information has unlimited potential, and once the foreign markets are discovered, exporters benefit from enormous export opportunities.

The fourth achievement of this study is an investigation of a possible causal relation between immigration and trade. The causality test found that the change in immigrant intake level in the earlier period of time could help to explain the change in exports later, but it is not strong enough to explain the change in imports later. On the other hand, the change in immigrant level can be explained by the changes in imports in earlier period but cannot be explained by the change in exports in earlier period. That is, the test found that immigrants "Granger cause" exports and imports "Granger cause" the immigrant level, but immigrants does not "Granger cause" imports and exports does not "Granger cause" the immigrant level.

10.4 Policy Implications

Historically, labour supply was the major concern for the immigration policy in Australia. The technical skills and business skills were later introduced into the immigration policy. The immigration policy centred on labour supply and skill levels was aimed at short-term economic benefit to Australia.

In addition, an immigration policy consistent with maximising long run export performance can be developed. Countries from which there are relatively low immigrant intake levels might have greater market potential that can be explored by Australia. An immigration policy, which stimulates immigrant intakes from those countries, could raise the prospects of greater social capital to be brought into Australia, which would strengthen the commercial bonds between Australia and those countries. Countries from which there are already high levels of immigrant intake would have relatively lower marginal social capital contribution by additional immigrants. An immigration policy that slows down immigrant intake from those countries would be preferable, thereby freeing some immigrant quotas to be re-allocated to the countries from which immigrant intake are lower. As time goes by, immigrants from the previous low immigrant intake level countries will gradually increase and from the formerly high immigrant intake level countries will gradually decrease. Meanwhile, foreign markets would also experience dynamic changes. The immigrant intake level from previously lower migrant intake countries can be increased to anticipate the need for new foreign market information.

Foreign markets are dynamic, and the immigrant policies in regarding to the level of immigrant intakes from certain countries are also dynamic with cycles. The length of the cycle and the rate of the change cannot be predetermined by hard and fast rules. It is subject to the dynamics of the foreign market. However, the average lag length between the immigrants' arrival and their effect on trade can easily be found through empirical analysis. Although this study found the most likely lag length taken by a typical immigrant's foreign market information to be transferred into commercial use, it does not propose to exclude any government policy, which provides business skill training such as entrepreneur education programs to immigrants, and/or export market development subsidies to immigrants. These kinds of government assistance can provide incentives to immigrants to export Australian goods in a shorter period than the lag length found in this study. Based on the same argument, government policy can also be used to kindle the potential of those immigrants who possess foreign market information but yet to know about it or yet to have any chance of utilising their social capital for commercial purpose.

Although this study does not explicitly investigate the impact of different categories of immigrants on Australia's trade performance, however, it can be implied that the immigrants who possess greater volume of social capital will be expected to have greater opportunity to transfer their social capital into commercial success. In selecting immigrant applicants, in addition to skill workers and business operators, priority may be given to those people having a career involving human and business networks such as sales representatives, marketing consultants and business consultants.

10.5 Limitations of the Study

In our model, we were unable to distinguish between the categories of immigrants and it is naïve to assume that all immigrants can bring the same quantity and quality of social capital with them. It is not hard to understand that the education level, social skills and the business skills of the immigrants largely determine the quality of the social capital they bring with them, which in turn influences trade. To our knowledge, there are at least two current, on-going studies about the connection between immigrants and trade. One is about the effect of Eastern European diasporas from transitional economies and Australia's trade with those Eastern European countries (being conducted at University of South Australia). The other study is about the effect of the Italian immigrants in Australia on Australia's trade performance with Italy since 1945 (at Swinburne University). The preliminary findings for those studies indicate that there is no significant relation between immigrants and trade. One thing in common in their explanations for the lack of statistically significant results is that the groups of immigrants under their studies possess insufficient social capital at the time of their immigration. Although their studies are still in the state of work-in-progress, their preliminary findings are instructive in supporting the need for further investigation of the effect of different immigrant categories on differing trade performances.

Our analysis excludes Vietnam in the estimation of the gravity models using panel data due to insufficient observations of some data series such as GDP, per capita GDP, price level and

Openness. However, the strong immigrant figures and strong trade growth between Australia and Vietnam was the original driving force to motivate this study.

Although care and action have been taken to reduce the endogeneity between value of trade (exports and imports) and GDP in the gravity model, if we could obtain data for the instrumental variables as Cyrus (2002) used in her study[77], the model would have performed better.

In the area of econometric techniques, due to the complexity of panel data analysis, there are at least four shortcomings of this study. First, this study assumes cross-section independence through out all the panel unit root tests and the panel cointegration test. However, techniques of testing such assumptions are yet to be identified. Second, panel heteroskedasticity is assumed, although the assumption is reasonable, and the DGLS estimation is superior over the DOLS, the test of heteroskedasticity in panel cointegration is yet to be conducted. Third, the structural break or structural shift technique is yet to be employed for this type of panel analysis even though within the period of study, significant changes were observed in immigration policy such as the abolishing of the White Australia policy. Forth is the use of DOLS-LM test. Although the *a priori* expectation of panel cointegration is in place, which means that the DOLS-LM test for cointegration is appropriate, the Brownian motion simulations for the mean μ_v and variance σ_v are very restrictive. The value of μ_v and σ_v are very sensitive to the number of variables (K) used in the simulation but not sensitive to the number of observations (T) used. For each K increases, the simulated results of μ_v and σ_v decrease dramatically. As a result, the null of cointegration is very often rejected. This leads to our concern about the rejection of cointegration for the Import model (See Appendix to Chapter 10).

As we have been arguing, once immigrants moved into the receiving country, they could have two effects on the receiving country's trade performance; the labour movement effect and the foreign market information effect. In the empirical estimation, we found that a lag of four periods was the most appropriate lag length supported by both theory and empirical evidence. However, the act of lagging the immigrant variable by four periods forced the labour substitution effect also to be lagged by four periods.

---

[77] Refer to Section 8.3.

10.6 Areas for Further Research

This study adds to the existing body of knowledge, from a long run equilibrium perspective, by disagreeing with the belief that international immigration is an unambiguous substitute for international trade. Evidence from this study shows that, within certain levels of immigrant intake, international trade is enhanced by immigrants rather than replaced by immigrants. Following this finding, it is interesting for further investigate whether immigrant information benefits inter-industry trade or it benefits intra-industry trade or both.

It is also interesting to pursue a similar study for the case of Australia's immigrant intakes and trade with other country groups such as India and Sri Lanka, Middle East countries and Latin American countries.

It is clear that there was a significant structural change in immigration within the period of study, that is, the change that occurred after abolishing of the White Australia policy. This significant change reorientates the mentality of Australians about the geographical location of Australia – from isolation from European countries to proximity to Asian countries. This reorientation of mentality has significant impact on the level of Asian immigrant intakes after the change and also it has significant implications on Australia's trade with Asian countries. It is an interesting area for further exploration, and if it can successfully introduce the structural change into the panel cointegration model, the regression will have a better fit of the data and an improvement of the estimation outcome.

Future studies on the econometric techniques that can be used to separate the simultaneous impact of immigrants on the labour substitution effect and the lagged impact on trade facilitation in the panel data model may also be useful.

Last, but not least, the Brownian motion simulation for the panel cointegration test requires three parameters: the number of variables in the model *k*, the number of observations *T* (time period) in the simulation and the number of replications (asymptotic). The sensitivity of Brownian motion simulation deserves a closer examination. The simulation results of μ_v and σ_v^2 are highly sensitive to *k* but insensitive to *T* and the number of replications in the simulation. Further research to improve the simulation results is also worth pursuing.

APPENDIX TO CHAPTER 7

In this section of appendix, the data sets for the Export model and the Import model are presented. There are twenty (20) tables in this appendix. They are divided into two sections: Appendix 7-A includes ten (10) tables, one table for each trade partner country of Australia for the exports model; Appendix 7-B also includes ten (10) tables, for the Import model.

Throughout Appendix 7-A and Appendix 7-B, data for exports, imports, Australia's GDP and GDP for foreign countries are in real term based on 1996 and the unit of measurement is in million of U.S. dollars. Australia's per capita GDP and per capita GDP for foreign countries are in real terms, based on 1996 and the unit of measurement is in U.S. dollar. The price variables for Australia and for foreign countries are the price ratios against the price in the U.S. within the same year. Openness variable is the ratio of total trade to GDP in real terms. Migrant variable is the number of immigrant entered into Australia in the year and the data series is lagged for four periods.

The data for the variables for Australia's real GDP and the real GDP for foreign countries are not the same for each table through out Appendix 7-A and Appendix 7-B. The differences are due to the adjustment to remove the endogenous problem between GDP and exports and imports (see Section 7.3 in Chapter 7).

Appendix 7-A Data Sets for the Panel Gravity Model for Exports

Table 7-A-1 China*

Year	Export	GDP_{Aust}	GDP_{Chi}	$GDPP_{Aust}$	$GDPP_{Chi}$	$Price_{Aust}$	$Price_{Chi}$	$Open_{Chi}$	Mig_{Chi}
1963	883	183999	171412	11505	668	69.71	53.65	8.10	433
1964	648	197631	198281	12142	724	71.56	56.05	8.20	611
1965	758	201402	230670	12257	777	72.10	58.23	8.94	680
1966	365	215410	255031	12692	805	72.56	56.94	8.30	1184
1967	893	222908	240869	13065	786	73.07	53.26	7.39	248
1968	418	243230	230674	13906	741	72.63	51.17	7.68	373
1969	549	256239	269724	14385	797	72.26	49.68	6.63	352
1970	605	268112	322016	14708	820	73.83	50.77	6.33	256
1971	129	282433	344169	14940	834	76.46	49.65	6.87	525
1972	191	306464	391783	15124	851	82.95	52.14	7.88	458
1973	445	383871	477356	15666	884	107.79	57.21	9.09	352
1974	889	389088	495954	15591	881	118.53	53.35	10.15	287
1975	858	363873	568370	15620	912	113.92	51.63	9.03	333
1976	642	351270	535629	16106	901	112.78	46.36	7.98	322
1977	990	321079	602818	16025	941	106.54	46.80	7.87	586
1978	1009	348525	508832	16599	926	111.06	53.88	8.59	721
1979	1344	348517	586261	16778	1026	110.86	54.61	10.86	639
1980	1171	366061	605476	17092	1072	114.36	54.83	11.75	744
1981	941	383125	606117	17457	1131	117.28	44.82	12.75	1164
1982	1089	328949	636359	16706	1216	107.21	38.47	12.54	1000
1983	535	308364	707003	17311	1295	97.71	36.41	12.90	1219
1984	982	314311	760058	17887	1456	98.46	31.18	16.44	1342
1985	991	260156	821479	18386	1477	81.58	27.56	28.15	1385
1986	1108	254814	761997	18535	1607	82.19	24.42	24.45	1167
1987	1064	281471	658026	19266	1711	89.20	23.76	23.10	1613
1988	830	327166	671538	19796	1755	102.41	27.68	26.10	3144
1989	869	343483	687731	20462	1673	104.20	30.62	29.75	3138
1990	937	338660	674380	20070	1790	103.65	23.51	30.66	2693
1991	1208	338684	671194	19865	1977	101.71	21.12	32.02	3281
1992	1378	330808	690799	20368	2204	95.62	21.54	33.98	3819
1993	1544	317970	622849	20979	2455	87.84	23.80	35.19	3069
1994	2097	356026	652835	21692	2645	93.61	19.25	37.98	3256
1995	2199	376242	744175	22293	2818	94.74	22.82	37.46	3388
1996	3001	411617	819527	22835	2969	99.17	24.33	37.27	3046
1997	2865	407894	893883	23614	3110	93.65	24.54	41.32	2740
1998	2205	363845	964113	24596	3276	79.36	23.96	41.05	3708
1999	2579	387691	1032759	25405	3415	81.38	23.51	45.87	11260
2000	2557	355083	1115518	25535	3747	74.57	23.14	53.49	7770

* The variables for the square of Migrant Intake level and the variable for Distance are not included in Table 7-A-1. Variables for Export, GDP_{Aust}, GDP_{Chi}, are in real term based on 1996 and the unit of measurement is in million of U.S. dollars. Per capita GDP variables of $GDPP_{Aust}$ and $GDPP_{Chi}$ are in real term based on 1996 and the unit of measurement is in U.S. dollar. $Price_{Aust}$ and $Price_{Chi}$ are the price ratios against the price in the U.S. within the same year. $Open_{Chi}$ variable is the ratio of total trade to GDP for China in real term. Mig_{Chi} variable is the number of immigrant entered into Australia from Chins in the year and the data series has been lagged for four periods. Distance between Australia and China is calculated as 9,901 kilometres, and the variable is invariant over time.

Table 7-A-2 Hong Kong*

Year	Export	GDP_{Aust}	GDP_{HK}	$GDPP_{Aust}$	$GDPP_{HK}$	$Price_{Aust}$	$Price_{HK}$	$Open_{H}$	Mig_{HK}
1963	154	185353	20229	11505	3997	69.71	54.45	86.13	45
1964	176	198512	22592	12142	4369	71.56	54.74	85.17	73
1965	176	202370	25290	12257	4978	72.10	54.40	78.75	85
1966	182	215720	27056	12692	5290	72.56	50.41	82.19	99
1967	222	223942	27471	13065	5280	73.07	50.43	86.86	88
1968	253	243474	26931	13906	5436	72.63	47.01	95.50	109
1969	271	256637	30112	14385	5996	72.26	46.97	97.99	130
1970	331	268479	32979	14708	6540	73.83	48.76	99.47	158
1971	400	282094	35945	14940	6995	76.46	50.11	99.24	389
1972	415	306170	42217	15124	7570	82.95	54.91	95.91	388
1973	434	383888	52107	15666	8354	107.79	66.37	94.28	404
1974	390	389800	54298	15591	8325	118.53	72.10	87.15	322
1975	360	364530	55506	15620	8166	113.92	67.84	88.43	299
1976	404	351578	65420	16106	9271	112.78	68.94	96.55	348
1977	401	321867	77007	16025	10329	106.54	72.21	90.11	664
1978	546	349125	83577	16599	11173	111.06	73.71	95.44	875
1979	530	349662	87441	16778	11493	110.86	75.00	101.11	897
1980	475	367083	96766	17092	12516	114.36	79.37	106.85	1102
1981	479	383746	94168	17457	13407	117.28	72.99	111.24	1489
1982	444	329767	88955	16706	13649	107.21	67.08	105.80	1180
1983	416	308516	79085	17311	14271	97.71	56.76	111.68	799
1984	474	314927	80702	17887	15295	98.46	54.84	120.21	775
1985	406	260909	81055	18386	15179	81.58	54.47	126.22	1295
1986	469	255591	89923	18535	16579	82.19	56.61	130.72	1369
1987	597	282017	101713	19266	18441	89.20	59.69	150.28	2017
1988	695	327328	109825	19796	19782	102.41	64.00	172.57	3289
1989	644	343753	112519	20462	20101	104.20	68.10	182.67	3118
1990	715	338922	114783	20070	20846	103.65	70.84	193.00	3403
1991	1021	338881	121661	19865	21902	101.71	73.40	212.10	5571
1992	1226	330969	130257	20368	23284	95.62	78.49	236.14	7307
1993	1370	318156	138521	20979	24315	87.84	82.43	250.22	8054
1994	1624	356510	146326	21692	25268	93.61	87.68	265.14	13541
1995	1889	376574	152193	22293	25670	94.74	91.11	283.99	12913
1996	2145	412483	158738	22835	25994	99.17	93.63	286.20	6520
1997	2210	408559	166540	23614	26524	93.65	96.77	288.92	3333
1998	1699	364384	157834	24596	24344	79.36	96.03	293.02	4135
1999	1646	388595	162811	25405	24663	81.38	91.98	290.57	4360
2000	1454	356261	178629	25535	26703	74.57	85.78	309.58	3890

* The variables for the square of Migrant Intake level and the variable for Distance are not included in Table 7-A-2. Variables for Export, GDP_{Aust}, GDP_{HK}, are in real term based on 1996 and the unit of measurement is in million of U.S. dollars. Per capita GDP variables of $GDPP_{Aust}$ and $GDPP_{HK}$ are in real term based on 1996 and the unit of measurement is in U.S. dollar. $Price_{Aust}$ and $Price_{HK}$ are the price ratios against the price in the U.S. within the same year. $Open_{HK}$ variable is the ratio of total trade to GDP for Hong Kong in real term. Mig_{HK} variable is the number of immigrant entered into Australia from Hong Kong in the year and the data series is lagged for four periods. Distance between Australia and Hong Kong is calculated as 8,385 kilometres, and the variable is invariant over time.

Table 7-A-3 Indonesia*

Year	Export	GDP_{Aust}	GDP_{Indo}	$GDPP_{Aust}$	$GDPP_{Indo}$	$Price_{Aust}$	$Price_{Indo}$	$Open_{Indo}$	Mig_{Indo}
1963	31	185582	92223	11505	922	69.71	33.84	36.16	293
1964	44	198757	96193	12142	940	71.56	34.20	38.49	290
1965	33	202607	94436	12257	903	72.10	34.96	37.45	172
1966	20	215994	99514	12692	930	72.56	24.14	34.93	157
1967	49	224210	440310	13065	914	73.07	30.66	36.74	170
1968	69	243748	249075	13906	999	72.63	31.78	35.96	133
1969	124	256848	243582	14385	1040	72.26	34.28	39.21	146
1970	199	268654	235610	14708	1097	73.83	33.17	41.97	135
1971	199	282345	233860	14940	1143	76.46	30.16	47.02	204
1972	288	306337	239584	15124	1198	82.95	32.50	52.29	225
1973	574	383681	264165	15666	1302	107.79	40.52	57.46	264
1974	547	389576	285043	15591	1349	118.53	49.02	61.52	239
1975	547	364283	302445	15620	1425	113.92	48.85	58.21	183
1976	549	351390	320346	16106	1477	112.78	54.87	64.04	138
1977	407	321860	347362	16025	1572	106.54	57.60	63.29	148
1978	500	349185	356313	16599	1694	111.06	53.62	60.38	146
1979	496	349710	270945	16778	1770	110.86	43.51	59.66	142
1980	540	366988	292557	17092	1891	114.36	47.30	58.59	359
1981	658	383504	314071	17457	2023	117.28	44.88	55.03	512
1982	479	329722	302926	16706	2019	107.21	42.69	52.17	649
1983	398	308539	238969	17311	2128	97.71	35.09	48.23	631
1984	315	315119	226800	17887	2232	98.46	32.73	44.70	1358
1985	294	261053	216834	18386	2285	81.58	29.99	42.33	1520
1986	352	255734	199140	18535	2359	82.19	26.77	44.05	869
1987	323	282337	163611	19266	2417	89.20	23.66	45.69	979
1988	494	327570	169990	19796	2510	102.41	26.13	39.60	1304
1989	694	343693	176885	20462	2682	104.20	26.31	40.37	1083
1990	982	338607	185558	20070	2851	103.65	25.58	40.81	1385
1991	1131	338765	190872	19865	3031	101.71	25.92	44.67	1243
1992	1266	330926	196715	20368	3196	95.62	25.63	46.79	1422
1993	1218	318316	204944	20979	3340	87.84	26.90	45.66	1252
1994	1473	356664	212966	21692	3506	93.61	27.69	47.82	1071
1995	1680	376798	221958	22293	3642	94.74	29.87	50.39	1145
1996	2386	412239	229785	22835	3891	99.17	29.62	52.41	1184
1997	2443	408323	193890	23614	3990	93.65	26.00	56.04	622
1998	1252	364860	49060	24596	3526	79.36	11.98	64.00	1013
1999	1380	388852	62769	25405	3524	81.38	17.81	40.35	1790
2000	1053	356688	61320	25535	3637	74.57	18.06	45.02	1760

* The variables for the square of Migrant Intake level and the variable for Distance are not included in Table 7-A-3. Variables for Export, GDP_{Aust}, GDP_{Indo}, are in real term based on 1996 and the unit of measurement is in million of U.S. dollars. Per capita GDP variables of $GDPP_{Aust}$ and $GDPP_{Indo}$ are in real term based on 1996 and the unit of measurement is in U.S. dollar. $Price_{Aust}$ and $Price_{Indo}$ are the price ratios against the price in the U.S. within the same year. $Open_{Indo}$ variable is the ratio of total trade to GDP for Indonesia in real term. Mig_{Indo} variable is the number of immigrant entered into Australia from Indonesia in the year and the data series is lagged for four periods. Distance between Australia and Indonesia is calculated as 7,367 kilometres, and the variable is invariant over time.

Table 7-A-4 Japan*

Year	Export	GDP_{Aust}	GDP_{Jap}	$GDPP_{Aust}$	$GDPP_{Jap}$	$Price_{Aust}$	$Price_{Jap}$	$Open_{Jap}$	Mig_{Jap}
1963	2112	181717	275136	11505	6009	69.71	50.12	7.74	24
1964	2232	194674	307105	12142	6631	71.56	51.59	8.11	28
1965	2279	198875	324654	12257	6917	72.10	53.03	8.69	43
1966	2574	211670	359239	12692	7584	72.56	53.90	8.98	40
1967	3247	219278	399078	13065	8358	73.07	55.32	9.32	22
1968	3730	238317	450404	13906	9411	72.63	55.53	9.66	50
1969	4873	250047	506948	14385	10357	72.26	55.16	10.05	36
1970	5856	261106	561242	14708	11396	73.83	55.58	10.87	53
1971	6765	274091	603333	14940	11792	76.46	57.40	11.55	56
1972	7547	296777	756399	15124	12620	82.95	67.54	11.45	64
1973	9869	369976	913104	15666	13327	107.79	81.71	12.25	66
1974	8956	377556	838543	15591	12958	118.53	85.62	13.92	96
1975	9421	352554	850913	15620	13148	113.92	82.00	12.73	100
1976	10852	338068	886173	16106	13523	112.78	84.45	13.64	66
1977	9537	309637	1020093	16025	13980	106.54	94.01	14.10	113
1978	9169	337958	1367684	16599	14588	111.06	116.84	13.82	110
1979	8996	337749	1386282	16778	15256	110.86	108.90	14.23	89
1980	8188	355762	1377541	17092	15631	114.36	103.16	14.35	82
1981	8080	373539	1457156	17457	15968	117.28	100.75	14.91	79
1982	7396	320958	1326021	16706	16339	107.21	84.87	14.38	108
1983	6745	300451	1412329	17311	16575	97.71	87.31	14.29	119
1984	7550	306362	1456655	17887	17115	98.46	87.12	15.55	274
1985	6658	252864	1523682	18386	17779	81.58	85.47	15.23	197
1986	6040	248814	2217037	18535	18194	82.19	118.54	14.46	225
1987	6486	275135	2680590	19266	18930	89.20	133.89	14.41	204
1988	8273	318235	3231430	19796	20118	102.41	146.60	15.07	188
1989	8635	334161	3161288	20462	21113	104.20	134.25	16.03	250
1990	9022	329152	3169192	20070	22194	103.65	127.14	16.26	393
1991	10930	328472	3520243	19865	22820	101.71	134.13	16.03	722
1992	10193	321469	3779014	20368	22913	95.62	143.07	16.20	806
1993	9737	309260	4313044	20979	22904	87.84	160.81	16.06	634
1994	10883	347051	4743843	21692	23036	93.61	172.67	16.78	574
1995	10775	367048	5254006	22293	23271	94.74	183.49	17.86	536
1996	11677	402835	4700073	22835	24047	99.17	155.15	18.91	435
1997	11960	398657	4305491	23614	24428	93.65	138.20	19.75	409
1998	9882	355677	3933923	24596	24055	79.36	126.33	19.12	527
1999	10546	379971	4522021	25405	24142	81.38	142.00	19.43	445
2000	8548	348688	4914318	25535	24672	74.57	144.83	21.08	224

* The variables for the square of Migrant Intake level and the variable for Distance are not included in Table 7-A-4. Variables for Export, GDP_{Aust}, GDP_{Jap}, are in real term based on 1996 and the unit of measurement is in million of U.S. dollars. Per capita GDP variables of $GDPP_{Aust}$ and $GDPP_{Jap}$ are in real term based on 1996 and the unit of measurement is in U.S. dollar. $Price_{Aust}$ and $Price_{Jap}$ are the price ratios against the price in the U.S. within the same year. $Open_{Jap}$ variable is the ratio of total trade to GDP for Japan in real term. Mig_{Jap} variable is the number of immigrant entered into Australia from Japan in the year and the data series is lagged for four periods. Distance between Australia and Japan is calculated as 8,294 kilometres, and the variable is invariant over time.

Table 7-A-5 South Korea*

Year	Export	GDP_{Aust}	GDP_{SK}	$GDPP_{Aust}$	$GDPP_{SK}$	$Price_{Aust}$	$Price_{SK}$	$Open_{SK}$	Mig_{SK}
1963	37	185570	255758	11505	1722	69.71	35.74	6.72	0
1964	19	198805	167076	12142	1820	71.56	28.28	5.31	0
1965	21	202627	141123	12257	1869	72.10	23.74	6.05	0
1966	29	215978	156171	12692	2061	72.56	25.82	8.12	0
1967	44	224217	166251	13065	2127	73.07	29.31	10.09	0
1968	54	243769	181553	13906	2329	72.63	32.13	12.82	0
1969	64	256934	198878	14385	2615	72.26	33.33	14.49	0
1970	61	268838	199852	14708	2777	73.83	34.54	14.94	0
1971	128	282435	193764	14940	2957	76.46	33.85	16.51	0
1972	202	306450	179174	15124	3034	82.95	33.12	18.04	0
1973	279	384116	198360	15666	3361	107.79	35.20	23.17	0
1974	315	389907	209264	15591	3559	118.53	43.93	23.23	0
1975	464	364394	185710	15620	3720	113.92	41.72	23.90	0
1976	459	351507	204986	16106	4077	112.78	46.37	28.21	0
1977	495	321741	225389	16025	4432	106.54	50.18	30.89	0
1978	857	348723	246830	16599	4770	111.06	58.49	34.18	0
1979	872	349181	263488	16778	5048	110.86	65.32	33.96	95
1980	717	366728	206694	17092	4830	114.36	61.81	35.24	798
1981	1111	382897	196377	17457	5058	117.28	59.11	36.74	425
1982	997	329067	196064	16706	5351	107.21	53.55	36.16	491
1983	980	307797	204624	17311	5847	97.71	51.07	36.64	397
1984	1065	314211	212884	17887	6264	98.46	50.18	36.60	204
1985	981	260169	210630	18386	6601	81.58	46.91	35.16	717
1986	979	254972	229728	18535	7244	82.19	46.11	39.03	588
1987	1111	281416	273384	19266	7969	89.20	49.87	42.67	557
1988	1531	326326	340510	19796	8732	102.41	57.97	43.53	660
1989	1757	342417	395910	20462	9203	104.20	64.95	43.12	1212
1990	1973	337442	409969	20070	9959	103.65	66.67	43.01	1550
1991	2468	337361	432757	19865	10801	101.71	68.06	45.32	1810
1992	2428	329696	430189	20368	11246	95.62	67.87	46.53	1666
1993	2617	316830	444117	20979	11723	87.84	68.92	47.99	1378
1994	2961	355144	481085	21692	12585	93.61	72.74	52.63	982
1995	3235	375131	547190	22293	13553	94.74	80.09	59.71	1224
1996	3422	411190	561102	22835	14320	99.17	79.76	63.12	929
1997	3537	407212	497708	23614	14786	93.65	70.46	67.63	673
1998	2818	363193	314385	24596	13436	79.36	50.13	71.00	666
1999	3660	386644	405831	25405	14813	81.38	59.65	77.21	940
2000	3500	354077	463138	25535	15881	74.57	64.75	86.31	804

* The variables for the square of Migrant Intake level and the variable for Distance are not included in Table 7-A-5. Variables for Export, GDP_{Aust}, GDP_{SK}, are in real term based on 1996 and the unit of measurement is in million of U.S. dollars. Per capita GDP variables of $GDPP_{Aust}$ and $GDPP_{SK}$ are in real term based on 1996 and the unit of measurement is in U.S. dollar. $Price_{Aust}$ and $Price_{SK}$ are the price ratios against the price in the U.S. within the same year. $Open_{SK}$ variable is the ratio of total trade to GDP for South Korea in real term. Mig_{SK} variable is the number of immigrant entered into Australia from South Korea in the year and the data series is lagged for four periods. Distance between Australia and South Korea is calculated as 10,833 kilometres, and the variable is invariant over time.

Table 7-A-6 Malaysia *

Year	Export	GDP_{Aust}	GDP_{MAL}	$GDPP_{Aust}$	$GDPP_{MAL}$	$Price_{Aust}$	$Price_{MAL}$	$Open_{MAL}$	Mig_{MAL}
1963	0	185638	8273	11505	2366	69.71	53.84	81.18	232
1964	347	198193	8965	12142	2428	71.56	53.63	74.46	262
1965	395	202007	9640	12257	2531	72.10	52.86	74.60	337
1966	214	215666	10268	12692	2643	72.56	51.97	72.08	223
1967	252	223896	10674	13065	2655	73.07	52.15	72.43	414
1968	295	243413	11545	13906	2760	72.63	50.86	74.74	224
1969	304	256590	12100	14385	2829	72.26	48.51	73.74	438
1970	292	268530	12803	14708	2910	73.83	46.75	76.88	319
1971	323	282191	13586	14940	3007	76.46	46.04	73.12	542
1972	365	306236	16107	15124	3199	82.95	50.19	66.91	808
1973	455	383857	20787	15666	3454	107.79	60.83	69.69	828
1974	670	389401	22990	15591	3659	118.53	63.18	80.28	946
1975	611	364199	23219	15620	3625	113.92	58.63	71.49	1067
1976	548	351392	24381	16106	3921	112.78	55.70	73.35	745
1977	483	321758	27042	16025	4132	106.54	57.27	74.16	841
1978	705	348920	30780	16599	4324	111.06	59.92	76.13	1128
1979	682	349449	35551	16778	4613	110.86	63.32	83.05	1201
1980	718	366726	38431	17092	4905	114.36	61.30	84.81	1777
1981	748	383383	38856	17457	5105	117.28	57.00	81.39	2118
1982	571	329606	40410	16706	5259	107.21	54.35	86.48	168
1983	612	308266	43214	17311	5421	97.71	54.75	90.40	1585
1984	563	314819	46000	17887	5640	98.46	53.76	93.09	1865
1985	406	260909	42868	18386	5469	81.58	48.84	89.03	2393
1986	329	255762	41675	18535	5325	82.19	45.87	91.61	1937
1987	358	282296	44995	19266	5435	89.20	46.08	97.54	1652
1988	557	327495	47869	19796	5766	102.41	44.36	104.76	2413
1989	638	343760	50549	20462	6132	104.20	43.19	116.35	2284
1990	703	338935	55168	20070	6540	103.65	43.20	127.04	3946
1991	780	339134	59345	19865	6930	101.71	42.48	140.02	6239
1992	837	331381	69662	20368	7230	95.62	47.15	134.78	7681
1993	996	318552	75832	20979	7611	87.84	47.33	147.82	6417
1994	1246	356896	81344	21692	8095	93.61	47.38	169.21	5744
1995	1384	377116	93616	22293	8704	94.74	50.81	183.62	3123
1996	1608	413026	102480	22835	9166	99.17	52.25	179.51	1555
1997	1599	409180	98390	23614	9491	93.65	47.81	178.26	1252
1998	1059	365065	65302	24596	9428	79.36	31.97	159.18	1107
1999	1193	389034	71527	25405	9426	81.38	33.31	172.02	1090
2000	835	356921	77527	25535	9937	74.57	40.86	194.23	1070

* The variables for the square of Migrant Intake level and the variable for Distance are not included in Table 7-A-6. Variables for Export, GDP_{Aust}, GDP_{MAL}, are in real term based on 1996 and the unit of measurement is in million of U.S. dollars. Per capita GDP variables of $GDPP_{Aust}$ and $GDPP_{MAL}$ are in real term based on 1996 and the unit of measurement is in U.S. dollar. $Price_{Aust}$ and $Price_{MAL}$ are the price ratios against the price in the U.S. within the same year. $Open_{MAL}$ variable is the ratio of total trade to GDP for Malaysia in real term. Mig_{MAL} variable is the number of immigrant entered into Australia from Malaysia in the year and the data series is lagged for four periods. Distance between Australia and Malaysia is calculated as 8,254 kilometres, and the variable is invariant over time.

Table 7-A-7 Philippines*

Year	Export	GDP_{Aust}	GDP_{PHIL}	$GDPP_{Aust}$	$GDPP_{PHIL}$	$Price_{Aust}$	$Price_{PHIL}$	$Open_{PHIL}$	Mig_{PHIL}
1963	86	185479	165093	11505	2165	69.71	33.63	35.25	10
1964	104	198646	170892	12142	2169	71.56	34.46	38.38	37
1965	97	202501	180195	12257	2208	72.10	35.63	40.18	46
1966	151	215773	188461	12692	2226	72.56	36.11	40.82	72
1967	192	223988	198576	13065	2292	73.07	35.67	39.30	94
1968	218	243526	208421	13906	2344	72.63	35.47	36.72	125
1969	272	256636	218306	14385	2382	72.26	35.28	35.13	67
1970	236	268605	149895	14708	2401	73.83	23.94	35.31	98
1971	228	282310	145544	14940	2467	76.46	24.32	33.82	147
1972	233	306409	146674	15124	2544	82.95	24.23	34.21	214
1973	259	384146	157556	15666	2692	107.79	25.81	34.74	270
1974	403	389782	163557	15591	2732	118.53	31.89	33.95	328
1975	359	364533	162830	15620	2787	113.92	30.65	34.08	373
1976	294	351720	172043	16106	2914	112.78	31.71	33.72	504
1977	334	321958	181830	16025	2999	106.54	32.28	35.57	504
1978	321	349417	191032	16599	3076	111.06	33.25	37.16	1030
1979	329	349945	201843	16778	3169	110.86	34.96	39.02	1111
1980	269	367386	209101	17092	3275	114.36	36.58	47.49	1681
1981	275	384018	205251	17457	3293	117.28	35.87	47.45	1462
1982	269	329988	197641	16706	3332	107.21	33.63	44.57	1256
1983	195	308797	154086	17311	3269	97.71	29.37	44.51	2013
1984	154	315314	94849	17887	2991	98.46	28.84	43.88	2792
1985	169	261213	79013	18386	2769	81.58	27.71	39.06	3251
1986	134	256000	74441	18535	2752	82.19	25.62	43.47	2735
1987	212	282467	77042	19266	2816	89.20	26.08	48.25	2874
1988	267	327843	80401	19796	2925	102.41	26.40	52.90	3162
1989	328	344132	83117	20462	2992	104.20	27.72	56.90	4128
1990	339	339363	76485	20070	3007	103.65	27.21	58.37	6409
1991	379	339556	67241	19865	2950	101.71	26.80	58.52	10429
1992	402	331841	72627	20368	2888	95.62	30.33	63.00	9204
1993	433	319152	69800	20979	2885	87.84	30.33	67.18	6080
1994	540	357618	74818	21692	2951	93.61	33.08	75.09	6388
1995	702	377847	80596	22293	3029	94.74	35.54	81.57	5917
1996	877	413766	83735	22835	3122	99.17	36.91	89.78	3731
1997	956	409833	78445	23614	3358	93.65	34.58	96.94	4179
1998	639	365512	56133	24596	3221	79.36	26.53	81.55	4116
1999	779	389435	60697	25405	3333	81.38	28.75	77.41	3250
2000	718	357046	56934	25535	3424	74.57	24.90	76.29	2830

* The variables for the square of Migrant Intake level and the variable for Distance are not included in Table 7-A-7. Variables for Export, GDP_{Aust}, GDP_{PHIL}, are in real term based on 1996 and the unit of measurement is in million of U.S. dollars. Per capita GDP variables of $GDPP_{Aust}$ and $GDPP_{PHIL}$ are in real term based on 1996 and the unit of measurement is in U.S. dollar. $Price_{Aust}$ and $Price_{PHIL}$ are the price ratios against the price in the U.S. within the same year. $Open_{PHIL}$ variable is the ratio of total trade to GDP for the Philippines in real term. Mig_{PHIL} variable is the number of immigrant entered into Australia from the Philippines in the year and the data series is lagged for four periods. Distance between Australia and the Philippines is calculated as 7,400 kilometres, and the variable is invariant over time.

Table 7-A-8 Singapore*

Year	Export	GDP_{Aust}	GDP_S	$GDPP_{Aust}$	$GDPP_S$	$Price_{Aust}$	$Price_S$	$Open_S$	Mig_S
1963	175	185314	2615	11505	3606	69.71	78.22	218.60	120
1964	0	198840	2627	12142	4273	71.56	81.16	145.30	124
1965	0	202662	3092	12257	3151	72.10	67.81	208.14	88
1966	224	215648	3428	12692	3409	72.56	66.46	215.74	109
1967	277	223857	3832	13065	3761	73.07	64.55	202.67	118
1968	285	243427	4367	13906	4251	72.63	61.86	208.67	155
1969	348	256527	4982	14385	4773	72.26	60.70	220.74	205
1970	451	268318	5680	14708	5319	73.83	58.83	218.05	201
1971	547	281909	6338	14940	5870	76.46	59.13	223.65	237
1972	499	306059	7889	15124	6555	82.95	65.03	216.81	342
1973	615	383620	9957	15666	7255	107.79	79.00	219.71	411
1974	678	389389	10673	15591	7602	118.53	83.76	223.89	512
1975	825	363916	11178	15620	7934	113.92	79.70	171.61	676
1976	526	351420	11490	16106	8387	112.78	73.99	177.04	606
1977	497	321740	12624	16025	8847	106.54	72.33	185.16	930
1978	623	349026	14823	16599	9551	111.06	74.54	190.19	782
1979	739	349369	17048	16778	10460	110.86	76.22	209.52	620
1980	854	366527	18716	17092	11460	114.36	79.27	229.82	730
1981	775	383347	20664	17457	11944	117.28	77.63	232.41	742
1982	729	329405	21777	16706	12290	107.21	71.20	227.82	525
1983	672	308189	24025	17311	13146	97.71	71.18	221.53	503
1984	853	314468	25639	17887	14011	98.46	70.56	221.38	561
1985	692	260541	24262	18386	13501	81.58	67.08	220.87	759
1986	438	255629	25248	18535	13748	82.19	65.96	242.98	623
1987	599	282014	28779	19266	14829	89.20	68.16	250.42	573
1988	710	327310	33423	19796	16086	102.41	72.48	290.72	759
1989	756	343618	38111	20462	16949	104.20	74.31	291.63	870
1990	1042	338536	44558	20070	17953	103.65	79.96	301.31	1530
1991	1272	338618	49659	19865	18279	101.71	82.54	311.00	2070
1992	1233	330961	56105	20368	18842	95.62	87.90	311.33	1946
1993	1330	318198	63384	20979	20769	87.84	89.98	320.58	1567
1994	1494	356642	74613	21692	21263	93.61	95.37	336.51	1275
1995	1608	376876	86705	22293	22650	94.74	101.32	341.03	867
1996	1828	412803	94025	22835	24939	99.17	100.25	326.18	472
1997	1752	409025	96504	23614	25048	93.65	95.09	310.47	502
1998	1370	364734	84994	24596	21306	79.36	80.95	290.92	650
1999	1377	388856	90116	25405	22224	81.38	82.07	306.49	860
2000	1824	355866	96711	25535	23514	74.57	80.12	341.59	940

* The variables for the square of Migrant Intake level and the variable for Distance are not included in Table 7-A-8. Variables for Export, GDP_{Aust}, GDP_S, are in real term based on 1996 and the unit of measurement is in million of U.S. dollars. Per capita GDP variables of $GDPP_{Aust}$ and $GDPP_S$ are in real term based on 1996 and the unit of measurement is in U.S. dollar. $Price_{Aust}$ and $Price_S$ are the price ratios against the price in the U.S. within the same year. $Open_S$ variable is the ratio of total trade to GDP for Singapore in real term. Mig_S variable is the number of immigrant entered into Australia from Singapore in the year and the data series is lagged for four periods. Distance between Australia and Singapore is calculated as 7,910 kilometres, and the variable is invariant over time.

Table 7-A-9 Taiwan*

Year	Export	GDP_{Aust}	GDP_T	$GDPP_{Aust}$	$GDPP_T$	$Price_{Aust}$	$Price_T$	$Open_T$	Mig_T
1963	33	185577	12192	11505	1038	69.71	44.88	19.24	0
1964	39	198768	14277	12142	1179	71.56	45.27	21.18	0
1965	58	202565	15795	12257	1267	72.10	45.53	23.77	0
1966	92	215872	17360	12692	1350	72.56	44.62	24.18	0
1967	115	224108	19430	13065	1477	73.07	45.50	26.92	0
1968	88	243719	20942	13906	1558	72.63	46.68	32.28	0
1969	169	256784	23161	14385	1677	72.26	46.57	35.73	0
1970	226	268619	25786	14708	1826	73.83	45.71	40.32	0
1971	290	282231	29198	14940	2023	76.46	44.60	45.61	0
1972	314	306302	33994	15124	2314	82.95	44.72	51.69	0
1973	325	384049	42660	15666	2853	107.79	51.87	57.35	0
1974	465	389694	39061	15591	2559	118.53	67.73	58.75	0
1975	427	364442	39785	15620	2562	113.92	61.15	54.26	0
1976	444	351526	46569	16106	2940	112.78	59.96	62.32	0
1977	469	321776	50959	16025	3151	106.54	59.94	61.56	0
1978	674	348960	59398	16599	3598	111.06	61.24	64.56	0
1979	787	349301	67094	16778	3979	110.86	65.86	67.11	32
1980	774	366645	70201	17092	4091	114.36	72.33	66.97	35
1981	880	383206	70252	17457	4019	117.28	72.09	66.70	36
1982	913	329172	68787	16706	3861	107.21	63.88	64.30	44
1983	903	307895	73240	17311	4046	97.71	60.57	67.74	71
1984	1025	314259	82659	17887	4499	98.46	59.36	71.20	93
1985	939	260223	86862	18386	4663	81.58	56.48	67.52	118
1986	1026	254914	104718	18535	5565	82.19	58.56	75.16	122
1987	1114	281412	140016	19266	7376	89.20	68.92	82.20	126
1988	1331	326566	167783	19796	8729	102.41	76.63	84.86	238
1989	1542	342675	194622	20462	10014	104.20	83.25	84.38	381
1990	1545	337945	200622	20070	10215	103.65	81.80	82.75	804
1991	2068	337781	217004	19865	10917	101.71	82.02	87.55	1145
1992	2066	330079	245359	20368	12244	95.62	88.89	89.43	2100
1993	2073	317408	251804	20979	12453	87.84	85.71	89.85	3055
1994	2266	355854	263418	21692	12915	93.61	86.18	87.35	3491
1995	2442	375982	275740	22293	13396	94.74	87.09	91.35	3172
1996	2814	411805	282460	22835	13605	99.17	83.88	91.41	1434
1997	3107	407648	289987	23614	13833	93.65	80.03	95.74	785
1998	2698	363321	262066	24596	12388	79.36	69.07	95.38	794
1999	3037	387247	281692	25405	13214	81.38	69.07	95.38	1640
2000	2852	354768	298944	25535	13912	74.57	69.07	95.38	2170

* The variables for the square of Migrant Intake level and the variable for Distance are not included in Table 7-A-9. Variables for Export, GDP_{Aust}, GDP_T, are in real term based on 1996 and the unit of measurement is in million of U.S. dollars. Per capita GDP variables of $GDPP_{Aust}$ and $GDPP_T$ are in real term based on 1996 and the unit of measurement is in U.S. dollar. $Price_{Aust}$ and $Price_T$ are the price ratios against the price in the U.S. within the same year. $Open_T$ variable is the ratio of total trade to GDP for Taiwan in real term. Mig_T variable is the number of immigrant entered into Australia from Taiwan in the year and the data series is lagged for four periods. Distance between Australia and Taiwan is calculated as 9,642 kilometres, and the variable is invariant over time.

Table 7-A-10 Thailand*

Year	Export	GDP_{Aust}	GDP_{TH}	$GDPP_{Aust}$	$GDPP_{TH}$	$Price_{Aust}$	$Price_{TH}$	$Open_{TH}$	Mig_{TH}
1963	43	185559	18734	11505	1261	69.71	37.98	34.66	3
1964	58	198732	20060	12142	1305	71.56	38.36	37.63	2
1965	62	202559	21692	12257	1370	72.10	39.23	37.61	9
1966	96	215866	24129	12692	1476	72.56	40.30	41.32	9
1967	117	224105	26215	13065	1553	73.07	38.32	44.67	9
1968	120	243672	28339	13906	1641	72.63	36.16	45.23	10
1969	126	256845	30190	14385	1702	72.26	35.09	44.83	22
1970	164	268701	33666	14708	1836	73.83	32.75	42.80	17
1971	171	282381	35314	14940	1863	76.46	32.78	39.83	20
1972	167	306497	36825	15124	1882	82.95	33.19	43.70	43
1973	195	384240	40976	15666	2017	107.79	35.87	44.37	48
1974	239	390016	43345	15591	2039	118.53	41.71	42.33	76
1975	156	364800	45391	15620	2095	113.92	39.72	38.91	54
1976	163	351890	49569	16106	2241	112.78	39.62	40.29	76
1977	160	322191	54438	16025	2404	106.54	39.94	42.52	93
1978	219	349549	60271	16599	2590	111.06	41.00	41.93	108
1979	235	350077	63290	16778	2687	110.86	40.86	46.03	170
1980	236	367434	66369	17092	2756	114.36	42.61	45.19	305
1981	215	384100	65915	17457	2878	117.28	40.17	44.09	232
1982	186	330094	65841	16706	2954	107.21	38.10	40.76	212
1983	207	308782	69543	17311	3068	97.71	37.21	43.70	196
1984	212	315244	71549	17887	3199	98.46	35.23	46.02	209
1985	133	261260	65112	18386	3290	81.58	31.47	42.81	299
1986	148	255982	70966	18535	3393	82.19	32.17	43.76	236
1987	201	282479	79508	19266	3634	89.20	33.47	51.18	276
1988	293	327811	91712	19796	4036	102.41	34.65	60.46	494
1989	389	344059	101350	20462	4415	104.20	35.56	66.00	776
1990	434	339252	113157	20070	4838	103.65	36.77	70.17	864
1991	537	339389	123154	19865	5167	101.71	37.31	73.72	930
1992	678	331549	133818	20368	5479	95.62	38.27	76.45	1017
1993	679	318890	145233	20979	5834	87.84	39.05	79.36	889
1994	838	357312	159630	21692	6288	93.61	40.77	83.06	945
1995	1045	377479	175775	22293	6766	94.74	42.69	90.33	863
1996	1135	413505	182838	22835	7094	99.17	42.72	84.20	686
1997	1092	409695	146079	23614	7029	93.65	35.94	84.16	735
1998	670	365479	99038	24596	6269	79.36	29.74	86.75	799
1999	849	389368	112928	25405	6510	81.38	31.33	91.62	796
2000	836	356920	111886	25535	6857	74.57	29.61	101.16	740

* The variables for the square of Migrant Intake level and the variable for Distance are not included in Table 7-A-10. Variables for Export, GDP_{Aust}, GDP_{TH}, are in real term based on 1996 and the unit of measurement is in million of U.S. dollars. Per capita GDP variables of $GDPP_{Aust}$ and $GDPP_{TH}$ are in real term based on 1996 and the unit of measurement is in U.S. dollar. $Price_{Aust}$ and $Price_{TH}$ are the price ratios against the price in the U.S. within the same year. $Open_{TH}$ variable is the ratio of total trade to GDP for Thailand in real term. Mig_{TH} variable is the number of immigrant entered into Australia from Thailand in the year and the data series is lagged for four periods. Distance between Australia and Thailand is calculated as 9,469 kilometres, and the variable is invariant over time.

Appendix 7-B The Data Sets for the Gravity Model for Imports

Table 7-B-1 China*

Year	Import	GDP_{Aust}	GDP_{Chi}	$GDPP_{Aust}$	$GDPP_{Chi}$	$Price_{Aust}$	$Price_{Chi}$	$Open_{Aust}$	Mig_{Chi}
1963	127	186667	170296	11505	668	69.71	53.65	19.77	433
1964	191	200349	197121	12142	724	71.56	56.05	20.24	611
1965	218	204331	229408	12257	777	72.10	58.23	20.06	680
1966	216	217626	254026	12692	805	72.56	56.94	19.99	1184
1967	229	225932	239468	13065	786	73.07	53.26	20.65	248
1968	250	245587	229556	13906	741	72.63	51.17	20.00	373
1969	279	258867	268363	14385	797	72.26	49.68	21.13	352
1970	275	270641	320597	14708	820	73.83	50.77	21.08	256
1971	300	284364	343026	14940	834	76.46	49.65	20.69	525
1972	384	308800	390278	15124	851	82.95	52.14	20.40	458
1973	573	387226	474874	15666	884	107.79	57.21	21.71	352
1974	617	392835	492707	15591	881	118.53	53.35	22.63	287
1975	348	366227	566006	15620	912	113.92	51.63	22.09	333
1976	356	353218	533442	16106	901	112.78	46.36	23.01	322
1977	386	323523	599877	16025	941	106.54	46.80	22.52	586
1978	388	350882	505832	16599	926	111.06	53.88	23.12	721
1979	423	351438	582271	16778	1026	110.86	54.61	23.41	639
1980	457	368792	601525	17092	1072	114.36	54.83	23.24	744
1981	498	385382	602573	17457	1131	117.28	44.82	24.07	1164
1982	501	331231	632384	16706	1216	107.21	38.47	23.61	1000
1983	358	309648	704636	17311	1295	97.71	36.41	24.00	1219
1984	452	316221	756515	17887	1456	98.46	31.18	26.61	1342
1985	376	261997	818194	18386	1477	81.58	27.56	25.96	1385
1986	386	256705	758547	18535	1607	82.19	24.42	26.01	1167
1987	554	283434	654333	19266	1711	89.20	23.76	27.12	1613
1988	788	329103	667999	19796	1755	102.41	27.68	29.30	3144
1989	1086	345755	683707	20462	1673	104.20	30.62	29.31	3138
1990	1141	341010	670308	20070	1790	103.65	23.51	30.07	2693
1991	1456	341517	666506	19865	1977	101.71	21.12	31.92	3281
1992	1769	334145	685622	20368	2204	95.62	21.54	32.76	3819
1993	1952	321664	617799	20979	2455	87.84	23.80	34.10	3069
1994	2400	360663	647487	21692	2645	93.61	19.25	36.08	3256
1995	2784	381427	738768	22293	2818	94.74	22.82	37.10	3388
1996	3228	417882	813262	22835	2969	99.17	24.33	39.39	3046
1997	3508	414264	887477	23614	3110	93.65	24.54	40.18	2740
1998	3475	369613	958160	24596	3276	79.36	23.96	39.47	3708
1999	3973	394028	1025943	25405	3415	81.38	23.51	41.93	11260
2000	4846	362268	1107475	25535	3747	74.57	23.14	42.32	7770

* The variables for the square of Migrant Intake level and the variable for Distance are not included in Table 7-B-1. Variables for Import, GDP_{Aust}, GDP_{Chi}, are in real term based on 1996 and the unit of measurement is in million of U.S. dollars. Per capita GDP variables of $GDPP_{Aust}$ and $GDPP_{Chi}$ are in real term based on 1996 and the unit of measurement is in U.S. dollar. $Price_{Aust}$ and $Price_{Chi}$ are the price ratios against the price in the U.S. within the same year. $Open_{Aust}$ variable is the ratio of total trade to GDP for China in real term. Mig_{Chi} variable is the number of immigrant entered into Australia from Chins in the year and the data series has been lagged for four periods. Distance between Australia and China is calculated as 9,901 kilometres, and the variable is invariant over time.

Table 7-B-2 Hong Kong*

Year	Import	GDP_{Aust}	GDP_{HK}	$GDPP_{Aust}$	$GDPP_{HK}$	$Price_{Aust}$	$Price_{HK}$	$Open_{Aust}$	Mig_{HK}
1963	156	186907	18187	11505	3997	69.71	54.45	19.77	45
1964	195	200384	20143	12142	4369	71.56	54.74	20.24	73
1965	238	204482	22469	12257	4978	72.10	54.40	20.06	85
1966	236	217777	24090	12692	5290	72.56	50.41	19.99	99
1967	370	226946	23277	13065	5280	73.07	50.43	20.65	88
1968	348	246267	23022	13906	5436	72.63	47.01	20.00	109
1969	416	259776	25712	14385	5996	72.26	46.97	21.13	130
1970	508	272098	28050	14708	6540	73.83	48.76	21.08	158
1971	532	285734	31037	14940	6995	76.46	50.11	20.69	389
1972	617	310061	36964	15124	7570	82.95	54.91	20.40	388
1973	1035	389404	44587	15666	8354	107.79	66.37	21.71	404
1974	1403	395991	45449	15591	8325	118.53	72.10	22.63	322
1975	928	368261	49667	15620	8166	113.92	67.84	22.09	299
1976	1040	355367	59332	16106	9271	112.78	68.94	23.01	348
1977	915	325058	71638	16025	10329	106.54	72.21	22.52	664
1978	965	352442	78021	16599	11173	111.06	73.71	23.12	875
1979	887	352567	82830	16778	11493	110.86	75.00	23.41	897
1980	839	369638	92900	17092	12516	114.36	79.37	23.24	1102
1981	922	386227	90384	17457	13407	117.28	72.99	24.07	1489
1982	903	331957	85589	16706	13649	107.21	67.08	23.61	1180
1983	680	310191	76438	17311	14271	97.71	56.76	24.00	799
1984	784	316751	77930	17887	15295	98.46	54.84	26.61	775
1985	623	262369	78834	18386	15179	81.58	54.47	25.96	1295
1986	579	256977	87745	18535	16579	82.19	56.61	26.01	1369
1987	636	283541	99333	19266	18441	89.20	59.69	27.12	2017
1988	762	329072	107118	19796	19782	102.41	64.00	29.30	3289
1989	787	345417	110096	20462	20101	104.20	68.10	29.31	3118
1990	662	340486	112629	20070	20846	103.65	70.84	30.07	3403
1991	632	340632	119410	19865	21902	101.71	73.40	31.92	5571
1992	610	332915	127949	20368	23284	95.62	78.49	32.76	7307
1993	509	320147	136323	20979	24315	87.84	82.43	34.10	8054
1994	599	358791	143944	21692	25268	93.61	87.68	36.08	13541
1995	730	379341	149308	22293	25670	94.74	91.11	37.10	12913
1996	710	415364	155857	22835	25994	99.17	93.63	39.39	6520
1997	736	411530	163688	23614	26524	93.65	96.77	40.18	3333
1998	622	366804	155513	24596	24344	79.36	96.03	39.47	4135
1999	670	390837	160483	25405	24663	81.38	91.98	41.93	4360
2000	679	358437	176099	25535	26703	74.57	85.78	42.32	3890

* The variables for the square of Migrant Intake level and the variable for Distance are not included in Table 7-B-2. Variables for Import, GDP_{Aust}, GDP_{HK}, are in real term based on 1996 and the unit of measurement is in million of U.S. dollars. Per capita GDP variables of $GDPP_{Aust}$ and $GDPP_{HK}$ are in real term based on 1996 and the unit of measurement is in U.S. dollar. $Price_{Aust}$ and $Price_{HK}$ are the price ratios against the price in the U.S. within the same year. $Open_{Aust}$ variable is the ratio of total trade to GDP for Hong Kong in real term. Mig_{HK} variable is the number of immigrant entered into Australia from Hong Kong in the year and the data series is lagged for four periods. Distance between Australia and Hong Kong is calculated as 8,385 kilometres, and the variable is invariant over time.

Table 7-B-3 Indonesia*

Year	Import	GDP_{Aust}	GDP_{Indo}	$GDPP_{Aust}$	$GDPP_{Indo}$	$Price_{Aust}$	$Price_{Indo}$	$Open_{Aust}$	Mig_{Indo}
1963	563	190204	92223	11505	922	69.71	33.84	19.77	293
1964	559	203258	96193	12142	940	71.56	34.20	20.24	290
1965	587	207157	94436	12257	903	72.10	34.96	20.06	172
1966	528	219940	99514	12692	930	72.56	24.14	19.99	157
1967	514	227987	401737	13065	914	73.07	30.66	20.65	170
1968	546	247637	230424	13906	999	72.63	31.78	20.00	133
1969	501	260338	229001	14385	1040	72.26	34.28	21.13	146
1970	300	270798	227296	14708	1097	73.83	33.17	21.08	135
1971	151	283484	229291	14940	1143	76.46	30.16	20.69	204
1972	100	307259	236091	15124	1198	82.95	32.50	20.40	225
1973	146	385215	259206	15666	1302	107.79	40.52	21.71	264
1974	136	390905	281604	15591	1349	118.53	49.02	22.63	239
1975	108	365384	299511	15620	1425	113.92	48.85	22.09	183
1976	145	352554	317343	16106	1477	112.78	54.87	23.01	138
1977	219	323039	344456	16025	1572	106.54	57.60	22.52	148
1978	336	350741	352554	16599	1694	111.06	53.62	23.12	146
1979	484	351585	267178	16778	1770	110.86	43.51	23.41	142
1980	735	369407	288478	17092	1891	114.36	47.30	23.24	359
1981	781	385947	309932	17457	2023	117.28	44.88	24.07	512
1982	1260	332598	297837	16706	2019	107.21	42.69	23.61	649
1983	338	309616	237184	17311	2128	97.71	35.09	24.00	631
1984	498	316294	224897	17887	2232	98.46	32.73	26.61	1358
1985	227	261772	215651	18386	2285	81.58	29.99	25.96	1520
1986	222	256474	197837	18535	2359	82.19	26.77	26.01	869
1987	397	283230	162137	19266	2417	89.20	23.66	27.12	979
1988	357	328589	168364	19796	2510	102.41	26.13	29.30	1304
1989	439	345023	174851	20462	2682	104.20	26.31	29.31	1083
1990	447	340251	183143	20070	2851	103.65	25.58	30.07	1385
1991	788	340799	188074	19865	3031	101.71	25.92	31.92	1243
1992	949	333274	193615	20368	3196	95.62	25.63	32.76	1422
1993	812	320465	202314	20979	3340	87.84	26.90	34.10	1252
1994	739	358936	210355	21692	3506	93.61	27.69	36.08	1071
1995	969	379584	218973	22293	3642	94.74	29.87	37.10	1145
1996	1341	415995	226029	22835	3891	99.17	29.62	39.39	1184
1997	1606	412389	190228	23614	3990	93.65	26.00	40.18	622
1998	1762	367927	47482	24596	3526	79.36	11.98	39.47	1013
1999	1523	391662	61478	25405	3524	81.38	17.81	41.93	1790
2000	1367	359069	60272	25535	3637	74.57	18.06	42.32	1760

* The variables for the square of Migrant Intake level and the variable for Distance are not included in Table 7-B-3. Variables for Import, GDP_{Aust}, GDP_{Indo}, are in real term based on 1996 and the unit of measurement is in million of U.S. dollars. Per capita GDP variables of $GDPP_{Aust}$ and $GDPP_{Indo}$ are in real term based on 1996 and the unit of measurement is in U.S. dollar. $Price_{Aust}$ and $Price_{Indo}$ are the price ratios against the price in the U.S. within the same year. $Open_{Aust}$ variable is the ratio of total trade to GDP for Indonesia in real term. Mig_{Indo} variable is the number of immigrant entered into Australia from Indonesia in the year and the data series is lagged for four periods. Distance between Australia and Indonesia is calculated as 7,367 kilometres, and the variable is invariant over time.

Table 7-B-4 Japan*

Year	Import	GDP_{Aust}	GDP_{Jap}	$GDPP_{Aust}$	$GDPP_{Jap}$	$Price_{Aust}$	$Price_{Jap}$	$Open_{Aust}$	Mig_{Jap}
1963	1334	196465	268041	11505	6009	69.71	50.12	19.77	24
1964	1901	213860	298103	12142	6631	71.56	51.59	20.24	28
1965	2651	222972	313564	12257	6917	72.10	53.03	20.06	43
1966	2423	233981	349126	12692	7584	72.56	53.90	19.99	40
1967	2974	245687	387394	13065	8358	73.07	55.32	20.65	22
1968	3465	267900	437472	13906	9411	72.63	55.53	20.00	50
1969	4036	283686	492152	14385	10357	72.26	55.16	21.13	36
1970	4459	296842	545668	14708	11396	73.83	55.58	21.08	53
1971	5358	314177	585672	14940	11792	76.46	57.40	20.69	56
1972	5359	335760	738712	15124	12620	82.95	67.54	20.40	64
1973	8078	422595	888742	15666	13327	107.79	81.71	21.71	66
1974	10462	432368	813890	15591	12958	118.53	85.62	22.63	96
1975	7126	389992	832920	15620	13148	113.92	82.00	22.09	100
1976	8295	378161	866263	16106	13523	112.78	84.45	23.01	66
1977	7398	343857	1002846	16025	13980	106.54	94.01	22.52	113
1978	7532	370195	1351025	16599	14588	111.06	116.84	23.12	110
1979	5897	364758	1371190	16778	15256	110.86	108.90	23.41	89
1980	6445	382048	1362228	17092	15631	114.36	103.16	23.24	82
1981	8303	400947	1440185	17457	15968	117.28	100.75	24.07	79
1982	7986	344716	1310076	16706	16339	107.21	84.87	23.61	108
1983	6680	320295	1398411	17311	16575	97.71	87.31	24.00	119
1984	7430	327352	1441594	17887	17115	98.46	87.12	26.61	274
1985	7032	272022	1509451	18386	17779	81.58	85.47	25.96	197
1986	6246	264953	2204419	18535	18194	82.19	118.54	26.01	225
1987	5732	290165	2667903	19266	18930	89.20	133.89	27.12	204
1988	7576	337206	3214125	19796	20118	102.41	146.60	29.30	188
1989	9302	355053	3141641	20462	21113	104.20	134.25	29.31	250
1990	8021	348537	3150776	20070	22194	103.65	127.14	30.07	393
1991	7362	347856	3502010	19865	22820	101.71	134.13	31.92	722
1992	7659	340398	3761298	20368	22913	95.62	143.07	32.76	806
1993	7934	327954	4295474	20979	22904	87.84	160.81	34.10	634
1994	8609	367116	4724783	21692	23036	93.61	172.67	36.08	574
1995	8629	387364	5234157	22293	23271	94.74	183.49	37.10	536
1996	7998	422652	4680256	22835	24047	99.17	155.15	39.39	435
1997	8445	419133	4284789	23614	24428	93.65	138.20	40.18	409
1998	7949	374019	3915334	24596	24055	79.36	126.33	39.47	527
1999	8194	398105	4503004	25405	24142	81.38	142.00	41.93	445
2000	8111	365272	4895683	25535	24672	74.57	144.83	42.32	224

* The variables for the square of Migrant Intake level and the variable for Distance are not included in Table 7-B-4. Variables for Import, GDP_{Aust}, GDP_{Jap}, are in real term based on 1996 and the unit of measurement is in million of U.S. dollars. Per capita GDP variables of $GDPP_{Aust}$ and $GDPP_{Jap}$ are in real term based on 1996 and the unit of measurement is in U.S. dollar. $Price_{Aust}$ and $Price_{Jap}$ are the price ratios against the price in the U.S. within the same year. $Open_{Aust}$ variable is the ratio of total trade to GDP for Japan in real term. Mig_{Jap} variable is the number of immigrant entered into Australia from Japan in the year and the data series is lagged for four periods. Distance between Australia and Japan is calculated as 8,294 kilometres, and the variable is invariant over time.

Table 7-B-5 South Korea*

Year	Import	GDP_{Aust}	GDP_{SK}	$GDPP_{Aust}$	$GDPP_{SK}$	$Price_{Aust}$	$Price_{SK}$	$Open_{Aust}$	Mig_{SK}
1963	66	186178	250813	11505	1722	69.71	35.74	19.77	0
1964		198840	166853	12142	1820	71.56	28.28	20.24	0
1965		202662	140911	12257	1869	72.10	23.74	20.06	0
1966	64	216504	153267	12692	2061	72.56	25.82	19.99	0
1967	66	224763	163574	13065	2127	73.07	29.31	20.65	0
1968	92	244485	178412	13906	2329	72.63	32.13	20.00	0
1969	133	257906	194971	14385	2615	72.26	33.33	21.13	0
1970	127	269716	196708	14708	2777	73.83	34.54	21.08	0
1971	290	284308	187532	14940	2957	76.46	33.85	20.69	0
1972	356	308646	172440	15124	3034	82.95	33.12	20.40	0
1973	415	386485	191123	15666	3361	107.79	35.20	21.71	0
1974	893	393943	198389	15591	3559	118.53	43.93	22.63	0
1975	687	367415	178314	15620	3720	113.92	41.72	22.09	0
1976	767	354509	198400	16106	4077	112.78	46.37	23.01	0
1977	890	324986	218779	16025	4432	106.54	50.18	22.52	0
1978	760	351887	241224	16599	4770	111.06	58.49	23.12	0
1979	825	352416	258185	16778	5048	110.86	65.32	23.41	95
1980	1135	370293	201516	17092	4830	114.36	61.81	23.24	798
1981	1148	386678	191221	17457	5058	117.28	59.11	24.07	425
1982	1107	332324	191454	16706	5351	107.21	53.55	23.61	491
1983	643	310128	201300	17311	5847	97.71	51.07	24.00	397
1984	763	316717	209328	17887	6264	98.46	50.18	26.61	204
1985	690	262470	207327	18386	6601	81.58	46.91	25.96	717
1986	554	256941	226861	18535	7244	82.19	46.11	26.01	588
1987	588	283478	270307	19266	7969	89.20	49.87	27.12	557
1988	861	329190	336187	19796	8732	102.41	57.97	29.30	660
1989	1126	345800	390816	20462	9203	104.20	64.95	29.31	1212
1990	1015	340872	405134	20070	9959	103.65	66.67	30.07	1550
1991	1138	341175	427806	19865	10801	101.71	68.06	31.92	1810
1992	1014	333344	425739	20368	11246	95.62	67.87	32.76	1666
1993	1070	320737	439594	20979	11723	87.84	68.92	34.10	1378
1994	1469	359695	476142	21692	12585	93.61	72.74	36.08	982
1995	1804	380432	541705	22293	13553	94.74	80.09	37.10	1224
1996	2092	416746	555546	22835	14320	99.17	79.76	39.39	929
1997	1821	412600	492486	23614	14786	93.65	70.46	40.18	673
1998	1580	367748	310207	24596	13436	79.36	50.13	39.47	666
1999	2459	392565	400289	25405	14813	81.38	59.65	41.93	940
2000	1859	359522	457822	25535	15881	74.57	64.75	42.32	804

* The variables for the square of Migrant Intake level and the variable for Distance are not included in Table 7-B-5. Variables for Import, GDP_{Aust}, GDP_{SK}, are in real term based on 1996 and the unit of measurement is in million of U.S. dollars. Per capita GDP variables of $GDPP_{Aust}$ and $GDPP_{SK}$ are in real term based on 1996 and the unit of measurement is in U.S. dollar. $Price_{Aust}$ and $Price_{SK}$ are the price ratios against the price in the U.S. within the same year. $Open_{Aust}$ variable is the ratio of total trade to GDP for South Korea in real term. Mig_{SK} variable is the number of immigrant entered into Australia from South Korea in the year and the data series is lagged for four periods. Distance between Australia and South Korea is calculated as 10,833 kilometres, and the variable is invariant over time.

Table 7-B-6 Malaysia *

Year	Import	GDP_{Aust}	GDP_{MAL}	$GDPP_{Aust}$	$GDPP_{MAL}$	$Price_{Aust}$	$Price_{MAL}$	$Open_{Aust}$	Mig_{MAL}
1963		185638	8273	11505	2366	69.71	53.84	19.77	232
1964	410	202079	7486	12142	2428	71.56	53.63	20.24	262
1965	452	206122	8058	12257	2531	72.10	52.86	20.06	337
1966	235	217771	9420	12692	2643	72.56	51.97	19.99	223
1967	273	226249	9696	13065	2655	73.07	52.15	20.65	414
1968	266	245699	10525	13906	2760	72.63	50.86	20.00	224
1969	291	258947	11051	14385	2829	72.26	48.51	21.13	438
1970	301	270804	11731	14708	2910	73.83	46.75	21.08	319
1971	263	284144	12603	14940	3007	76.46	46.04	20.69	542
1972	272	308190	15042	15124	3199	82.95	50.19	20.40	808
1973	497	386869	19185	15666	3454	107.79	60.83	21.71	828
1974	543	392538	21253	15591	3659	118.53	63.18	22.63	946
1975	299	366053	22006	15620	3625	113.92	58.63	22.09	1067
1976	458	353540	22989	16106	3921	112.78	55.70	23.01	745
1977	412	323598	25833	16025	4132	106.54	57.27	22.52	841
1978	413	350949	29421	16599	4324	111.06	59.92	23.12	1128
1979	457	351520	34175	16778	4613	110.86	63.32	23.41	1201
1980	413	368696	37085	17092	4905	114.36	61.30	23.24	1777
1981	379	385145	37534	17457	5105	117.28	57.00	24.07	2118
1982	345	330951	39321	16706	5259	107.21	54.35	23.61	168
1983	287	309529	42173	17311	5421	97.71	54.75	24.00	1585
1984	368	316087	44955	17887	5640	98.46	53.76	26.61	1865
1985	315	261906	41985	18386	5469	81.58	48.84	25.96	2393
1986	299	256584	40822	18535	5325	82.19	45.87	26.01	1937
1987	359	283181	44053	19266	5435	89.20	46.08	27.12	1652
1988	562	328834	46370	19796	5766	102.41	44.36	29.30	2413
1989	662	345275	48836	20462	6132	104.20	43.19	29.31	2284
1990	560	340375	53546	20070	6540	103.65	43.20	30.07	3946
1991	654	340656	57660	19865	6930	101.71	42.48	31.92	6239
1992	738	333050	67836	20368	7230	95.62	47.15	32.76	7681
1993	691	320338	73935	20979	7611	87.84	47.33	34.10	6417
1994	858	359060	79107	21692	8095	93.61	47.38	36.08	5744
1995	1123	379740	90938	22293	8704	94.74	50.81	37.10	3123
1996	1333	415987	99519	22835	9166	99.17	52.25	39.39	1555
1997	1555	412338	95296	23614	9491	93.65	47.81	40.18	1252
1998	1624	367790	62837	24596	9428	79.36	31.97	39.47	1107
1999	1932	392056	68742	25405	9426	81.38	33.31	41.93	1090
2000	2231	359864	74809	25535	9937	74.57	40.86	42.32	1070

* The variables for the square of Migrant Intake level and the variable for Distance are not included in Table 7-B-6. Variables for Import, GDP_{Aust}, GDP_{MAL}, are in real term based on 1996 and the unit of measurement is in million of U.S. dollars. Per capita GDP variables of $GDPP_{Aust}$ and $GDPP_{MAL}$ are in real term based on 1996 and the unit of measurement is in U.S. dollar. $Price_{Aust}$ and $Price_{MAL}$ are the price ratios against the price in the U.S. within the same year. $Open_{Aust}$ variable is the ratio of total trade to GDP for Malaysia in real term. Mig_{MAL} variable is the number of immigrant entered into Australia from Malaysia in the year and the data series is lagged for four periods. Distance between Australia and Malaysia is calculated as 8,254 kilometres, and the variable is invariant over time.

Table 7-B-7 Philippines*

Year	Import	GDP_{Aust}	GDP_{PHIL}	$GDPP_{Aust}$	$GDPP_{PHIL}$	$Price_{Aust}$	$Price_{PHIL}$	$Open_{Aust}$	Mig_{PHIL}
1963	16	185768	163942	11505	2165	69.71	33.63	19.77	10
1964	29	199067	169239	12142	2169	71.56	34.46	20.24	37
1965	26	202858	178805	12257	2208	72.10	35.63	20.06	46
1966	22	216188	186877	12692	2226	72.56	36.11	19.99	72
1967	33	224519	196619	13065	2292	73.07	35.67	20.65	94
1968	31	244061	206480	13906	2344	72.63	35.47	20.00	125
1969	33	257247	216090	14385	2382	72.26	35.28	21.13	67
1970	36	269148	147967	14708	2401	73.83	23.94	21.08	98
1971	46	282866	143713	14940	2467	76.46	24.32	20.69	147
1972	54	307011	144650	15124	2544	82.95	24.23	20.40	214
1973	117	385080	154465	15666	2692	107.79	25.81	21.71	270
1974	162	391008	159966	15591	2732	118.53	31.89	22.63	328
1975	121	365432	160069	15620	2787	113.92	30.65	22.09	373
1976	146	352559	169389	16106	2914	112.78	31.71	23.01	504
1977	187	322947	178698	16025	2999	106.54	32.28	22.52	504
1978	203	350382	188037	16599	3076	111.06	33.25	23.12	1030
1979	211	350921	198910	16778	3169	110.86	34.96	23.41	1111
1980	177	368172	206829	17092	3275	114.36	36.58	23.24	1681
1981	192	384772	203087	17457	3293	117.28	35.87	24.07	1462
1982	152	330602	195845	16706	3332	107.21	33.63	23.61	1256
1983	116	309241	152869	17311	3269	97.71	29.37	24.00	2013
1984	126	315702	94117	17887	2991	98.46	28.84	26.61	2792
1985	110	261597	78361	18386	2769	81.58	27.71	25.96	3251
1986	88	256286	73936	18535	2752	82.19	25.62	26.01	2735
1987	90	282831	76395	19266	2816	89.20	26.08	27.12	2874
1988	120	328306	79584	19796	2925	102.41	26.40	29.30	3162
1989	158	344704	82141	20462	2992	104.20	27.72	29.31	4128
1990	112	339884	75670	20070	3007	103.65	27.21	30.07	6409
1991	116	340078	66526	19865	2950	101.71	26.80	31.92	10429
1992	123	332398	71914	20368	2888	95.62	30.33	32.76	9204
1993	124	319742	69085	20979	2885	87.84	30.33	34.10	6080
1994	165	358340	74014	21692	2951	93.61	33.08	36.08	6388
1995	167	378769	79618	22293	3029	94.74	35.54	37.10	5917
1996	222	414876	82625	22835	3122	99.17	36.91	39.39	3731
1997	279	411080	77255	23614	3358	93.65	34.58	40.18	4179
1998	235	366422	55345	24596	3221	79.36	26.53	39.47	4116
1999	249	390430	59885	25405	3333	81.38	28.75	41.93	3250
2000	286	358075	56104	25535	3424	74.57	24.90	42.32	2830

* The variables for the square of Migrant Intake level and the variable for Distance are not included in Table 7-B-7. Variables for Import, GDP_{Aust}, GDP_{PHIL}, are in real term based on 1996 and the unit of measurement is in million of U.S. dollars. Per capita GDP variables of $GDPP_{Aust}$ and $GDPP_{PHIL}$ are in real term based on 1996 and the unit of measurement is in U.S. dollar. $Price_{Aust}$ and $Price_{PHIL}$ are the price ratios against the price in the U.S. within the same year. $Open_{Aust}$ variable is the ratio of total trade to GDP for the Philippines in real term. Mig_{PHIL} variable is the number of immigrant entered into Australia from the Philippines in the year and the data series is lagged for four periods. Distance between Australia and the Philippines is calculated as 7,400 kilometres, and the variable is invariant over time.

Table 7-B-8 Singapore*

Year	Import	GDP_{Aust}	GDP_S	$GDPP_{Aust}$	$GDPP_S$	$Price_{Aust}$	$Price_S$	$Open_{Aust}$	Mig_S
1963	4	185674	2601	11505	3606	69.71	78.22	19.77	120
1964	4	198875	2613	12142	4273	71.56	81.16	20.24	124
1965	13	202758	2898	12257	3151	72.10	67.81	20.06	88
1966	14	216130	3209	12692	3409	72.56	66.46	19.99	109
1967	15	224390	3607	13065	3761	73.07	64.55	20.65	118
1968	17	243965	4096	13906	4251	72.63	61.86	20.00	155
1969	21	257166	4645	14385	4773	72.26	60.70	21.13	205
1970	33	269128	5257	14708	5319	73.83	58.83	21.08	201
1971	49	282883	5882	14940	5870	76.46	59.13	20.69	237
1972	66	307071	7234	15124	6555	82.95	65.03	20.40	342
1973	173	385342	9023	15666	7255	107.79	79.00	21.71	411
1974	377	391871	9335	15591	7602	118.53	83.76	22.63	512
1975	245	365867	10300	15620	7934	113.92	79.70	22.09	676
1976	358	353225	10394	16106	8387	112.78	73.99	23.01	606
1977	376	323495	11385	16025	8847	106.54	72.33	22.52	930
1978	406	350931	13329	16599	9551	111.06	74.54	23.12	782
1979	359	351282	15471	16778	10460	110.86	76.22	23.41	620
1980	363	368584	17363	17092	11460	114.36	79.27	23.24	730
1981	482	385349	19237	17457	11944	117.28	77.63	24.07	742
1982	559	331336	20304	16706	12290	107.21	71.20	23.61	525
1983	425	309762	22596	17311	13146	97.71	71.18	24.00	503
1984	542	316365	24139	17887	14011	98.46	70.56	26.61	561
1985	445	262101	23157	18386	13501	81.58	67.08	25.96	759
1986	526	256902	23795	18535	13748	82.19	65.96	26.01	623
1987	737	283672	26814	19266	14829	89.20	68.16	27.12	573
1988	980	329333	31143	19796	16086	102.41	72.48	29.30	759
1989	1193	345876	35288	20462	16949	104.20	74.31	29.31	870
1990	1024	340883	41908	20070	17953	103.65	79.96	30.07	1530
1991	1066	341097	47092	19865	18279	101.71	82.54	31.92	2070
1992	1159	333498	53362	20368	18842	95.62	87.90	32.76	1946
1993	1246	320921	60508	20979	20769	87.84	89.98	34.10	1567
1994	1257	359475	71566	21692	21263	93.61	95.37	36.08	1275
1995	1626	380252	83190	22293	22650	94.74	101.32	37.10	867
1996	1819	416473	90402	22835	24939	99.17	100.25	39.39	472
1997	2077	412853	92961	23614	25048	93.65	95.09	40.18	502
1998	1812	367976	81735	24596	21306	79.36	80.95	39.47	650
1999	2039	392160	85630	25405	22224	81.38	82.07	41.93	860
2000	2222	359856	92181	25535	23514	74.57	80.12	42.32	940

* The variables for the square of Migrant Intake level and the variable for Distance are not included in Table 7-B-8. Variables for Import, GDP_{Aust}, GDP_S, are in real term based on 1996 and the unit of measurement is in million of U.S. dollars. Per capita GDP variables of $GDPP_{Aust}$ and $GDPP_S$ are in real term based on 1996 and the unit of measurement is in U.S. dollar. $Price_{Aust}$ and $Price_S$ are the price ratios against the price in the U.S. within the same year. $Open_{Aust}$ variable is the ratio of total trade to GDP for Singapore in real term. Mig_S variable is the number of immigrant entered into Australia from Singapore in the year and the data series is lagged for four periods. Distance between Australia and Singapore is calculated as 7,910 kilometres, and the variable is invariant over time.

Table 7-B-9 Taiwan*

Year	Import	GDP_{Aust}	GDP_T	$GDPP_{Aust}$	$GDPP_T$	$Price_{Aust}$	$Price_T$	$Open_{Aust}$	Mig_T
1963	21	185807	12035	11505	1038	69.71	44.88	19.77	0
1964	35	199118	14029	12142	1179	71.56	45.27	20.24	0
1965	36	202935	15526	12257	1267	72.10	45.53	20.06	0
1966	32	216267	17068	12692	1350	72.56	44.62	19.99	0
1967	67	224765	18946	13065	1477	73.07	45.50	20.65	0
1968	96	244516	20378	13906	1558	72.63	46.68	20.00	0
1969	124	257846	22410	14385	1677	72.26	46.57	21.13	0
1970	158	269909	24857	14708	1826	73.83	45.71	21.08	0
1971	258	284116	27795	14940	2023	76.46	44.60	20.69	0
1972	373	308740	32078	15124	2314	82.95	44.72	20.40	0
1973	714	387891	39449	15666	2853	107.79	51.87	21.71	0
1974	971	394255	36027	15591	2559	118.53	67.73	22.63	0
1975	508	366787	38087	15620	2562	113.92	61.15	22.09	0
1976	793	354591	44153	16106	2940	112.78	59.96	23.01	0
1977	754	324590	48714	16025	3151	106.54	59.94	22.52	0
1978	926	352335	56668	16599	3598	111.06	61.24	23.12	0
1979	961	352747	64273	16778	3979	110.86	65.86	23.41	32
1980	1028	370056	67622	17092	4091	114.36	72.33	23.24	35
1981	1213	386807	67653	17457	4019	117.28	72.09	24.07	36
1982	1084	332281	66375	16706	3861	107.21	63.88	23.61	44
1983	1003	310735	70913	17311	4046	97.71	60.57	24.00	71
1984	1225	317455	79895	17887	4499	98.46	59.36	26.61	93
1985	982	262911	84396	18386	4663	81.58	56.48	25.96	118
1986	1018	257595	102105	18535	5565	82.19	58.56	26.01	122
1987	1213	284290	136993	19266	7376	89.20	68.92	27.12	126
1988	1537	329997	163908	19796	8729	102.41	76.63	29.30	238
1989	1754	346511	190247	20462	10014	104.20	83.25	29.31	381
1990	1405	341299	196821	20070	10215	103.65	81.80	30.07	804
1991	1467	341528	212828	19865	10917	101.71	82.02	31.92	1145
1992	1485	333844	241297	20368	12244	95.62	88.89	32.76	2100
1993	1420	321105	247893	20979	12453	87.84	85.71	34.10	3055
1994	1580	359811	259349	21692	12915	93.61	86.18	36.08	3491
1995	1704	380330	271328	22293	13396	94.74	87.09	37.10	3172
1996	1833	416487	277778	22835	13605	99.17	83.88	39.39	1434
1997	1856	412634	284976	23614	13833	93.65	80.03	40.18	785
1998	1549	367717	257715	24596	12388	79.36	69.07	39.47	794
1999	1766	391896	277010	25405	13214	81.38	69.07	41.93	1640
2000	1512	359203	294310	25535	13912	74.57	69.07	42.32	2170

* The variables for the square of Migrant Intake level and the variable for Distance are not included in Table 7-B-9. Variables for Import, GDP_{Aust}, GDP_T, are in real term based on 1996 and the unit of measurement is in million of U.S. dollars. Per capita GDP variables of $GDPP_{Aust}$ and $GDPP_T$ are in real term based on 1996 and the unit of measurement is in U.S. dollar. $Price_{Aust}$ and $Price_T$ are the price ratios against the price in the U.S. within the same year. $Open_{Aust}$ variable is the ratio of total trade to GDP for Taiwan in real term. Mig_T variable is the number of immigrant entered into Australia from Taiwan in the year and the data series is lagged for four periods. Distance between Australia and Taiwan is calculated as 9,642 kilometres, and the variable is invariant over time.

Table 7-B-10 Thailand[*]

Year	Import	GDP_{Aust}	GDP_{TH}	$GDPP_{Aust}$	$GDPP_{TH}$	$Price_{Aust}$	$Price_{TH}$	$Open_{Aust}$	Mig_{TH}
1963	10	185721	18629	11505	1261	69.71	37.98	19.77	3
1964	10	198918	19939	12142	1305	71.56	38.36	20.24	2
1965	10	202739	21576	12257	1370	72.10	39.23	20.06	9
1966	11	216111	23978	12692	1476	72.56	40.30	19.99	9
1967	19	224424	26009	13065	1553	73.07	38.32	20.65	9
1968	18	243975	28137	13906	1641	72.63	36.16	20.00	10
1969	21	257163	29974	14385	1702	72.26	35.09	21.13	22
1970	27	269087	33375	14708	1836	73.83	32.75	21.08	17
1971	51	282894	34899	14940	1863	76.46	32.78	20.69	20
1972	58	307030	36384	15124	1882	82.95	33.19	20.40	43
1973	79	384900	40446	15666	2017	107.79	35.87	21.71	48
1974	103	390772	42754	15591	2039	118.53	41.71	22.63	76
1975	91	365326	44935	15620	2095	113.92	39.72	22.09	54
1976	106	352434	49066	16106	2241	112.78	39.62	23.01	76
1977	103	322703	53954	16025	2404	106.54	39.94	22.52	93
1978	103	350110	59753	16599	2590	111.06	41.00	23.12	108
1979	110	350675	62725	16778	2687	110.86	40.86	23.41	170
1980	131	368072	65781	17092	2756	114.36	42.61	23.24	305
1981	143	384673	65373	17457	2878	117.28	40.17	24.07	232
1982	132	330567	65370	16706	2954	107.21	38.10	23.61	212
1983	145	309291	69020	17311	3068	97.71	37.21	24.00	196
1984	174	315779	70977	17887	3199	98.46	35.23	26.61	209
1985	159	261671	64657	18386	3290	81.58	31.47	25.96	299
1986	183	256420	70455	18535	3393	82.19	32.17	26.01	236
1987	239	283024	78849	19266	3634	89.20	33.47	27.12	276
1988	317	328541	90807	19796	4036	102.41	34.65	29.30	494
1989	425	345007	100181	20462	4415	104.20	35.56	29.31	776
1990	411	340212	112000	20070	4838	103.65	36.77	30.07	864
1991	492	340482	121885	19865	5167	101.71	37.31	31.92	930
1992	546	332847	132358	20368	5479	95.62	38.27	32.76	1017
1993	512	320150	143848	20979	5834	87.84	39.05	34.10	889
1994	624	358817	158040	21692	6288	93.61	40.77	36.08	945
1995	732	379343	173867	22293	6766	94.74	42.69	37.10	863
1996	847	415501	180842	22835	7094	99.17	42.72	39.39	686
1997	986	411777	144051	23614	7029	93.65	35.94	40.18	735
1998	976	367152	97544	24596	6269	79.36	29.74	39.47	799
1999	1322	391467	110936	25405	6510	81.38	31.33	41.93	796
2000	1469	359163	109680	25535	6857	74.57	29.61	42.32	740

[*] The variables for the square of Migrant Intake level and the variable for Distance are not included in Table 7-B-10. Variables for Import, GDP_{Aust}, GDP_{TH}, are in real term based on 1996 and the unit of measurement is in million of U.S. dollars. Per capita GDP variables of $GDPP_{Aust}$ and $GDPP_{TH}$ are in real term based on 1996 and the unit of measurement is in U.S. dollar. $Price_{Aust}$ and $Price_{TH}$ are the price ratios against the price in the U.S. within the same year. $Open_{Aust}$ variable is the ratio of total trade to GDP for Thailand in real term. Mig_{TH} variable is the number of immigrant entered into Australia from Thailand in the year and the data series is lagged for four periods. Distance between Australia and Thailand is calculated as 9,469 kilometres, and the variable is invariant over time.

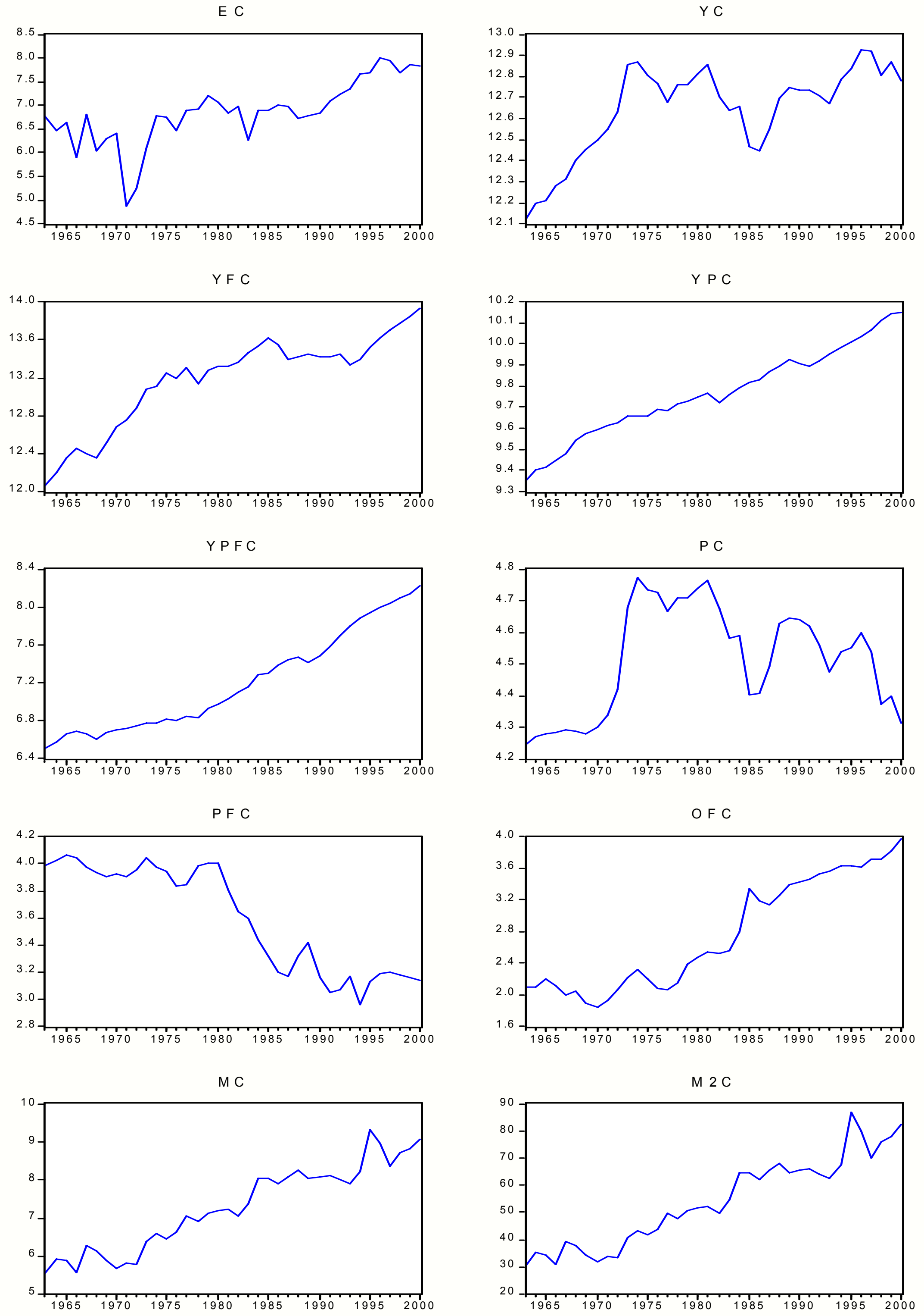
Appendix 7-C A Sample of the Time Series Plots

In this Appendix, we display two sets of time series plots. They are the expanded graphs from Figure 7.1. Figures 7-C.1 displays the plots for the first column in Figure 7.1 for the data series of Australia's exports to the 10 East Asian trading partners. For the names of the graphs, the first letter E stands for exports, and the second letter stands for the corresponding trade partner countries. For example, the first time series plot with the name of EC is the data series for Australia's exports to China from 1963 to 2000. Likewise, the time series plot with the name EH is the data series for Australia's exports to Hong Kong.

Figure 7-C.2 displays the plots for the first row in Figure 7.1 for the data series for China only. The first time series plot is EC, which is the one as in Figure 7-C.1. The second time series is YC, which is for the Australia's GDP (free of exports to China) for the period from 1963 to year 2000. The reason we use YC because the exports component EC has been deducted from the Australia's GDP, hence YC and EC do not have the endogenous problem. The third graph is the YFC data series, which is the China's GDP adjusted (add the EC component) by imports from Australia. The fourth graph is labelled YPC, which is Australia's per capita GDP. The YPC data series will be the same for all cross sections. The fifth graph is YPFC, which is the China's per capita GDP. The sixth graph is PC, which is the price level in Australia for this period of time. It does not change for all cross sections. The seventh graph is PFC, which is China's price level. The eighth graph is OFC, which is China's openness. The second last graph is MC, which is the immigrant intake level from China for this period of time. The last graph is labelled M2C, which is the square term of MC.

Figure 7-C.1 Time Series Plots for Australia's Exports to Ten Asian Countries from 1964 to Year 2000 (as the Expanded Graphs for the First Column in Figure 7.1)

Figure 7-C.2 Time series Plots for the Variables in the Gravity Model for Australia's Exports to China (as the Expanded Graphs in the First Row in Figure 7.2)



Appendix 7-D Stationarity Test Results

Table 7-D.1 Three Forms of ADF Tests for each Data Series for the Export Model

Series	I	II	III	Series	I	II	III
EC	0.3560	0.0269*	0.7407	EM	0.0000**	0.0000**	0.7150
YC	0.1284	0.4135	0.9446	YM	0.1287	0.4082	0.9448
YFC	0.2510	0.5057	0.9996	YFM	0.4196	0.6597	0.9998
YPC	0.7893	0.2942	1.0000	YPM	0.7893	0.2942	1.0000
YPFC	0.9998	0.9463	1.0000	YPFM	0.9124	0.1709	0.9995
PC	0.2778	0.7732	0.7017	PM	0.2778	0.7732	0.7017
PFC	0.8464	0.5398	0.1390	PFM	0.0681	0.0533	0.3737
OFC	0.9826	0.2266	0.9961	OFM	0.9959	0.4805	0.9922
MC	0.9133	0.0074**	0.9970	MM	0.1101	0.1744	0.7191
M2C	0.9443	0.0025**	0.9959	M2M	0.1683	0.2992	0.6509
EH	0.6861	0.7896	0.9966	EP	0.4782	0.6492	0.9662
YH	0.1295	0.4105	0.9444	YP	0.1309	0.4121	0.9448
YFH	0.6226	0.5680	0.9926	YFP	0.8021	0.2567	0.2766
YPH	0.7893	0.2942	1.0000	YPP	0.7893	0.2942	1.0000
YPFH	0.1058	0.9668	1.0000	YPFP	0.4201	0.4944	0.9563
PH	0.2778	0.7732	0.7017	PP	0.2778	0.7732	0.7017
PFH	0.3550	0.1684	0.7837	PFP	0.2324	0.0086**	0.4655
OFH	0.9982	0.7649	1.0000	OFP	0.9337	0.3175	0.9794
MH	0.2569	0.9715	0.8107	MP	0.2354	0.9724	0.9681
M2H	0.3336	0.9775	0.6889	M2P	0.3486	0.9762	0.9222
EI	0.2620	0.7939	0.9520	ES	0.1239	0.0563	0.5778
YI	0.1298	0.4099	0.9449	YS	0.1319	0.4153	0.9442
YFI	0.3036	0.3987	0.5865	YFS	0.3582	0.2412	0.9983
YPI	0.7893	0.2942	1.0000	YPS	0.7893	0.2942	1.0000
YPFI	0.8167	0.9237	1.0000	YPFS	0.6378	0.8408	0.9999
PI	0.2778	0.7732	0.7017	PS	0.2778	0.7732	0.7017
PFI	0.6143	0.5555	0.4195	PFS	0.2007	0.0281*	0.6272
OFI	0.2562	0.6512	0.7541	OFS	0.6585	0.0508	0.8426
MI	0.8903	0.4685	0.9676	MS	0.1427	0.1758	0.9449
M2I	0.9257	0.4721	0.9688	M2S	0.1531	0.1554	0.8149
EJ	0.0032**	0.0300*	0.9736	ET	0.0241*	0.3476	0.9995
YJ	0.1328	0.3922	0.9441	YT	0.1288	0.4119	0.9431
YFJ	0.5370	0.2771	1.0000	YFT	0.3657	0.6734	1.0000
YPJ	0.7893	0.2942	1.0000	YPT	0.7893	0.2942	1.0000
YPFJ	0.1708	0.0880	0.9393	YPFT	0.5896	0.5054	1.0000
PJ	0.2778	0.7732	0.7017	PT	0.2778	0.7732	0.7017
PFJ	0.6168	0.1358	0.9703	PFT	0.4096	0.2769	0.8866
OFJ	0.4370	0.3176	0.9998	OFT	0.0011**	0.5500	0.9999
MJ	0.2016	0.5079	0.9077	MT	0.8118	0.7680	0.9264
M2J	0.3543	0.6852	0.8289	M2T	0.8437	0.1829	0.8303
EK	0.6094	0.9297	0.9966	ETH	0.4801	0.5053	0.9884
YK	0.1276	0.4117	0.9429	YTH	0.1304	0.4117	0.9447
YFK	0.8435	0.0548	0.8481	YFTH	0.2677	0.6981	0.9984
YPK	0.7893	0.2942	1.0000	YPTH	0.7893	0.2942	1.0000
YPFK	0.7479	0.6373	1.0000	YPFTH	0.8271	0.3074	0.9989
PK	0.2778	0.7732	0.7017	PTH	0.2778	0.7732	0.7017
PFK	0.7273	0.2000	0.8749	PFTH	0.1215	0.2904	0.4195
OFK	0.4451	0.5854	0.9999	OFTH	0.9828	0.8276	0.9982
MK	0.6358	0.8649	0.7838	MTH	0.0845	0.8757	0.9663
M2K	0.6630	0.7774	0.7734	M2TH	0.2993	0.9503	0.9174

Three forms of ADF tests for nonstationary: I. random walk with drift, II. random walk with drift around a stochastic trend and III. random walk without drift and trend. The Values in the columns are *p*-value.

* Reject null of unit root at 5% significant level. ** Reject unit root at 1% significant level.

Table 7-D.2 Three Forms of ADF Tests for each Data Series for the Import Model

Series	I	II	III	Series	I	II	III
IC	0.9606	0.8973	0.9994	IM	0.9620	0.6093	0.9350
YC	0.1352	0.4050	0.9463	YM	0.1421	0.4194	0.9457
YFC	0.2482	0.5035	0.9996	YFM	0.5704	0.7136	0.9996
YPC	0.7893	0.2942	1.0000	YPM	0.7893	0.2942	1.0000
YPFC	0.9998	0.9463	1.0000	YPFM	0.9124	0.1709	0.9995
PC	0.2778	0.7732	0.7017	PM	0.2778	0.7732	0.7017
PFC	0.8464	0.5398	0.1390	PFM	0.0681	0.0533	0.3737
OC	1.0000	0.9067	0.9999	OM	1.0000	0.9067	0.9999
MC	0.9133	0.0074**	0.9970	MM	0.1101	0.1744	0.7191
M2C	0.9443	0.0025**	0.9959	M2M	0.1683	0.2992	0.6509
IH	0.0238*	0.3204	0.9204	IP	0.2587	0.0003**	0.9698
YH	0.1266	0.4077	0.9435	YP	0.1315	0.4120	0.9449
YFH	0.6710	0.5768	0.9907	YFP	0.8040	0.2552	0.2746
YPH	0.7893	0.2942	1.0000	YPP	0.7893	0.2942	1.0000
YPFH	0.1058	0.9668	1.0000	YPFP	0.4201	0.4944	0.9563
PH	0.2778	0.7732	0.7017	PP	0.2778	0.7732	0.7017
PFH	0.3550	0.1684	0.7837	PFP	0.2324	0.0086**	0.4655
OH	1.0000	0.9067	0.9999	OP	1.0000	0.9067	0.9999
MH	0.2569	0.9715	0.8107	MP	0.2354	0.9724	0.9681
M2H	0.3336	0.9775	0.6889	M2P	0.3486	0.9762	0.9222
II	0.6485	0.5427	0.7431	IS	0.0901	0.6811	0.9944
YI	0.1341	0.3995	0.9414	YS	0.1326	0.4110	0.9459
YFI	0.3352	0.4427	0.5829	YFS	0.4995	0.2342	0.9985
YPI	0.7893	0.2942	1.0000	YPS	0.7893	0.2942	1.0000
YPFI	0.8167	0.9237	1.0000	YPFS	0.6378	0.8408	0.9999
PI	0.2778	0.7732	0.7017	PS	0.2778	0.7732	0.7017
PFI	0.6143	0.5555	0.4195	PFS	0.2007	0.0281*	0.6272
OI	1.0000	0.9067	0.9999	OS	1.0000	0.9067	0.9999
MI	0.8903	0.4685	0.9676	MS	0.1427	0.1758	0.9449
M2I	0.9257	0.4721	0.9688	M2S	0.1531	0.1554	0.8149
IJ	0.0171*	0.2067	0.9656	IT	0.0127*	0.7027	0.9844
YJ	0.0801	0.4649	0.9348	YT	0.1301	0.4145	0.9448
YFJ	0.5444	0.2864	1.0000	YFT	0.4145	0.6784	0.9981
YPJ	0.7893	0.2942	1.0000	YPT	0.7893	0.2942	1.0000
YPFJ	0.1708	0.0880	0.9393	YPFT	0.5896	0.5054	1.0000
PJ	0.2778	0.7732	0.7017	PT	0.2778	0.7732	0.7017
PFJ	0.6168	0.1358	0.9703	PFT	0.4096	0.2769	0.8866
OJ	1.0000	0.9067	0.9999	OT	1.0000	0.9067	0.9999
MJ	0.2016	0.5079	0.9077	MT	0.8118	0.7680	0.9264
M2J	0.3543	0.6852	0.8289	M2T	0.8437	0.1829	0.8303
IK	0.1163	0.4499	0.9741	ITH	0.8265	0.6304	1.0000
YK	0.1288	0.4108	0.9451	YTH	0.1324	0.4106	0.9457
YFK	0.8507	0.0599	0.8509	YFTH	0.2658	0.7075	0.9982
YPK	0.7893	0.2942	1.0000	YPTH	0.7893	0.2942	1.0000
YPFK	0.7479	0.6373	1.0000	YPFTH	0.8271	0.3074	0.9989
PK	0.2778	0.7732	0.7017	PTH	0.2778	0.7732	0.7017
PFK	0.7273	0.2000	0.8749	PFTH	0.1215	0.2904	0.4195
OK	1.0000	0.9067	0.9999	OTH	1.0000	0.9067	0.9999
MK	0.6358	0.8649	0.7838	MTH	0.0845	0.8757	0.9663
M2K	0.6630	0.7774	0.7734	M2TH	0.2993	0.9503	0.9174

Three forms of ADF tests for nonstationary: I. random walk with drift, II. random walk with drift around a stochastic trend and III. random walk without drift and trend. The Values in the columns are *p*-value.

* Reject null of unit root at 5% significant level. ** Reject unit root at 1% significant level.

Table 7-D.3 Three Forms of PP Tests for each Data Series for the Export Model

Series	I	II	III	Series	I	II	III
EC	0.4358	0.0287*	0.8312	EM	0.0000**	0.0000**	0.7118
YC	0.1180	0.4847	0.9446	YM	0.1263	0.4939	0.9448
YFC	0.2627	0.4973	0.9994	YFM	0.4088	0.8820	0.9993
YPC	0.7895	0.2942	1.0000	YPM	0.7895	0.2942	1.0000
YPFC	0.9998	0.9570	1.0000	YPFM	0.9344	0.4540	1.0000
PC	0.3734	0.8737	0.7017	PM	0.3734	0.8737	0.7017
PFC	0.8549	0.4657	0.1088	PFM	0.4406	0.4892	0.2679
OFC	0.9881	0.4709	0.9982	OFM	0.9981	0.4902	0.9922
MC	0.9001	0.0325*	1.0000	MM	0.1495	0.2001	0.8051
M2C	0.9602	0.0373*	1.0000	M2M	0.2084	0.3242	0.7151
EH	0.6841	0.6140	0.9918	EP	0.4546	0.5461	0.9577
YH	0.1231	0.4894	0.9444	YP	0.1241	0.4905	0.9448
YFH	0.3462	0.7886	0.9999	YFP	0.9227	0.5798	0.1730
YPH	0.7895	0.2942	1.0000	YPP	0.7895	0.2942	1.0000
YPFH	0.0203*	0.9882	1.0000	YPFP	0.5574	0.7415	0.9808
PH	0.3734	0.8737	0.7017	PP	0.3734	0.8737	0.7017
PFH	0.6727	0.5265	0.8725	PFP	0.1499	0.3301	0.4671
OFH	0.9943	0.7356	0.9993	OFP	0.8988	0.6860	0.9662
MH	0.2264	0.9692	0.8761	MP	0.2152	0.9868	0.9571
M2H	0.3547	0.9640	0.7584	M2P	0.3650	0.9758	0.8966
EI	0.2741	0.7276	0.9249	ES	0.2112	0.0450*	0.7598
YI	0.1232	0.4884	0.9449	YS	0.1225	0.4883	0.9442
YFI	0.3036	0.6022	0.5799	YFS	0.5592	0.8369	1.0000
YPI	0.7895	0.2942	1.0000	YPS	0.7895	0.2942	1.0000
YPFI	0.8257	0.7683	1.0000	YPFS	0.5294	0.8381	0.9999
PI	0.3734	0.8737	0.7017	PS	0.3734	0.8737	0.7017
PFI	0.6143	0.5864	0.3807	PFS	0.4346	0.4448	0.6804
OFI	0.2586	0.6648	0.7635	OFS	0.6585	0.0420*	0.9025
MI	0.8873	0.4159	0.9671	MS	0.1200	0.3200	0.9449
M2I	0.9257	0.3983	0.9697	M2S	0.1770	0.3692	0.9046
EJ	0.0709	0.7268	0.9306	ET	0.0000**	0.0455	0.9989
YJ	0.1264	0.4703	0.9441	YT	0.1226	0.4902	0.9431
YFJ	0.4304	0.5960	0.9999	YFT	0.4629	0.8358	1.0000
YPJ	0.7895	0.2942	1.0000	YPT	0.7895	0.2942	1.0000
YPFJ	0.0003**	0.3633	0.9998	YPFT	0.6437	0.7377	1.0000
PJ	0.3734	0.8737	0.7017	PT	0.3734	0.8737	0.7017
PFJ	0.6233	0.4356	0.9777	PFT	0.4986	0.6635	0.8690
OFJ	0.3356	0.3289	1.0000	OFT	0.0008**	0.5439	0.9957
MJ	0.2010	0.4898	0.9120	MT	0.8076	0.7107	0.9264
M2J	0.3489	0.6852	0.8174	M2T	0.8854	0.5417	0.9143
EK	0.6076	0.9268	0.9933	ETH	0.4817	0.4268	0.9884
YK	0.1213	0.4898	0.9429	YTH	0.1239	0.4907	0.9447
YFK	0.8276	0.0548	0.8583	YFTH	0.3233	0.9252	0.9940
YPK	0.7895	0.2942	1.0000	YPTH	0.7895	0.2942	1.0000
YPFK	0.6928	0.5678	1.0000	YPFTH	0.8439	0.6416	1.0000
PK	0.3734	0.8737	0.7017	PTH	0.3734	0.8737	0.7017
PFK	0.7135	0.5165	0.8702	PFTH	0.3118	0.5635	0.4496
OFK	0.4302	0.7626	0.9993	OFTH	0.9741	0.9033	0.9962
MK	0.6143	0.8649	0.7838	MTH	0.0517	0.9037	0.9529
M2K	0.6491	0.7180	0.7734	M2TH	0.3140	0.9377	0.8903

Three forms of PP tests for nonstationary: I. random walk with drift, II. random walk with drift around a stochastic trend and III. random walk with drift and trend. The Values in the columns are *p*-value.

* Reject null of unit root at 5% significant level. ** Reject unit root at 1% significant level.

Table 7-D.4 Three Forms of PP Tests for each Data Series for the Import Model

Series	I	II	III	Series	I	II	III
IC	0.9525	0.8973	0.9990	IM	0.9777	0.7361	0.9485
YC	0.1265	0.4818	0.9463	YM	0.1135	0.4614	0.9457
YFC	0.2599	0.5035	0.9994	YFM	0.5695	0.8974	0.9989
YPC	0.7895	0.2942	1.0000	YPM	0.7895	0.2942	1.0000
YPFC	0.9998	0.9570	1.0000	YPFM	0.9344	0.4540	1.0000
PC	0.3734	0.8737	0.7017	PM	0.3734	0.8737	0.7017
PFC	0.8549	0.4657	0.1088	PFM	0.4406	0.4892	0.2679
OC	0.9994	0.8385	1.0000	OM	0.9994	0.8385	1.0000
MC	0.9001	0.0325*	1.0000	MM	0.1495	0.2001	0.8051
M2C	0.9602	0.0373*	1.0000	M2M	0.2084	0.3242	0.7151
IH	0.0238*	0.3041	0.9111	IP	0.2564	0.5527	0.9674
YH	0.1203	0.4864	0.9435	YP	0.1243	0.4903	0.9449
YFH	0.4679	0.8298	0.9999	YFP	0.9231	0.4795	0.1700
YPH	0.7895	0.2942	1.0000	YPP	0.7895	0.2942	1.0000
YPFH	0.0203*	0.9882	1.0000	YPFP	0.5574	0.7415	0.9808
PH	0.3734	0.8737	0.7017	PP	0.3734	0.8737	0.7017
PFH	0.6727	0.5265	0.8725	PFP	0.1499	0.3301	0.4671
OH	0.9994	0.8385	1.0000	OP	0.9994	0.8385	1.0000
MH	0.2264	0.9692	0.8761	MP	0.2152	0.9868	0.9571
M2H	0.3547	0.9640	0.7584	M2P	0.3650	0.9758	0.8966
II	0.5639	0.5381	0.7347	IS	0.0566	0.6811	0.9852
YI	0.1317	0.4843	0.9414	YS	0.1259	0.4910	0.9459
YFI	0.3577	0.6281	0.5755	YFS	0.6376	0.8025	1.0000
YPI	0.7895	0.2942	1.0000	YPS	0.7895	0.2942	1.0000
YPFI	0.8257	0.7683	1.0000	YPFS	0.5294	0.8381	0.9999
PI	0.3734	0.8737	0.7017	PS	0.3734	0.8737	0.7017
PFI	0.6143	0.5864	0.3807	PFS	0.4346	0.4448	0.6804
OI	0.9994	0.8385	1.0000	OS	0.9994	0.8385	1.0000
MI	0.8873	0.4159	0.9671	MS	0.1200	0.3200	0.9449
M2I	0.9257	0.3983	0.9697	M2S	0.1770	0.3692	0.9046
IJ	0.0000**	0.0419*	0.9649	IT	0.0011**	0.7081	0.9622
YJ	0.0847	0.4298	0.9223	YT	0.1230	0.4925	0.9448
YFJ	0.4363	0.6052	0.9999	YFT	0.5154	0.8483	1.0000
YPJ	0.7895	0.2942	1.0000	YPT	0.7895	0.2942	1.0000
YPFJ	0.0003**	0.3633	0.9998	YPFT	0.6437	0.7377	1.0000
PJ	0.3734	0.8737	0.7017	PT	0.3734	0.8737	0.7017
PFJ	0.6233	0.4356	0.9777	PFT	0.4986	0.6635	0.8690
OJ	0.9994	0.8385	1.0000	OT	0.9994	0.8385	1.0000
MJ	0.2010	0.4898	0.9120	MT	0.8076	0.7107	0.9264
M2J	0.3489	0.6852	0.8174	M2T	0.8854	0.5417	0.9143
IK	0.0885	0.4713	0.9674	ITH	0.8265	0.6178	0.9999
YK	0.1270	0.4989	0.9451	YTH	0.1257	0.4898	0.9457
YFK	0.8472	0.0599	0.8606	YFTH	0.3221	0.9304	0.9935
YPK	0.7895	0.2942	1.0000	YPTH	0.7895	0.2942	1.0000
YPFK	0.6928	0.5678	1.0000	YPFTH	0.8439	0.6416	1.0000
PK	0.3734	0.8737	0.7017	PTH	0.3734	0.8737	0.7017
PFK	0.7135	0.5165	0.8702	PFTH	0.3118	0.5635	0.4496
OK	0.9994	0.8385	1.0000	OTH	0.9994	0.8385	1.0000
MK	0.6143	0.8649	0.7838	MTH	0.0517	0.9037	0.9529
M2K	0.6491	0.7180	0.7734	M2TH	0.3140	0.9377	0.8903

Three forms of PP tests for nonstationary: I. random walk with drift, II. random walk with drift around a stochastic trend and III. random walk without drift and trend. The Values in the columns are *p*-value.

* Reject null of unit root at 5% significant level. ** Reject unit root at 1% significant level.

APPENDIX TO CHAPTER 8

Appendix 8-A OLS Estimates with Individual Errors and OLS Estimates with a Common Error for the Panel Regression (Export Model)

Variables	β	S_eI[*]	S_eII[^]	Variables	β	S_eI	S_eII
C	17.32708	10.58454	9.085718	C	-42.4316	8.043457	6.904464
YC	-5.62367	1.22229	1.049208	YP	2.597661	0.741374	0.636392
YFC	-0.53316	0.372331	0.319607	YFP	0.441	0.399856	0.343235
YPC	1.703866	2.08473	1.789522	YPP	2.927534	1.541342	1.323081
YPFC	4.344818	0.721793	0.619583	YPFP	-1.96187	0.926302	0.795133
PC	5.479101	0.994195	0.853412	PP	-0.99089	0.748266	0.642308
PFC	2.06449	0.474108	0.406972	PFP	0.674852	0.489122	0.41986
OFC	-0.06628	0.406244	0.348718	OFP	0.031937	0.353639	0.303562
ML4C	-2.92566	0.877538	0.753274	ML4P	-0.22613	0.220418	0.189206
M2L4C	0.164648	0.061012	0.052372	M2L4P	0.0135	0.017534	0.015051
C	-3.93595	5.541349	4.756666	C	46.08931	51.03126	43.80498
YH	2.245357	0.449448	0.385804	YS	2.675791	3.06386	2.630002
YFH	-0.02402	0.534387	0.458715	YFS	4.133141	1.946049	1.670479
YPH	-2.4113	1.111283	0.95392	YPS	-13.0179	6.701545	5.752573
YPFH	0.749006	0.569634	0.488971	YPFS	-4.96926	2.82509	2.425043
PH	-1.81839	0.479289	0.411419	PS	-3.37429	2.852928	2.448939
PFH	0.6057	0.457586	0.39279	PFS	-2.49818	1.962117	1.684272
OFH	0.657593	0.408096	0.350308	OFS	4.415738	1.613214	1.384775
ML4H	0.217742	0.336171	0.288568	ML4S	18.36338	5.581507	4.791138
M2L4H	-0.00897	0.022744	0.019523	M2L4S	-1.3626	0.427172	0.366682
C	-41.4423	11.25368	9.660107	C	12.26413	12.53649	10.76126
YI	3.610154	0.84585	0.726074	YK	0.023878	0.670609	0.575648
YFI	0.246933	0.132045	0.113347	YFK	-0.23274	0.386855	0.332075
YPI	-0.90597	1.844655	1.583443	YPK	-2.93804	1.991743	1.709702
YPFI	1.550385	0.600875	0.515788	YPFK	1.783988	0.594904	0.510662
PI	-1.52699	0.724135	0.621594	PK	1.012408	0.658687	0.565413
PFI	0.219196	0.367467	0.315432	PFK	0.312654	0.518924	0.445442
OFI	0.828946	0.497924	0.427415	OFK	1.232673	0.330849	0.284
ML4I	-0.5038	1.317695	1.131103	ML4K	0.01467	0.090396	0.077595
M2L4I	0.049686	0.110727	0.095048	M2L4K	-0.00048	0.013	0.011159
C	-12.3322	6.285582	5.395513	C	-2.23292	5.308397	4.556702
YJ	1.584213	0.261015	0.224054	YT	2.686215	0.487995	0.418893
YFJ	-1.50928	0.33133	0.284412	YFT	9.662789	1.459331	1.252682
YPJ	-0.67646	0.942361	0.808918	YPT	-4.84683	1.207014	1.036095
YPFJ	2.748588	0.382427	0.328273	YPFT	-9.32861	1.415801	1.215316
PJ	-0.75002	0.333245	0.286056	PT	-2.38319	0.627102	0.538301
PFJ	1.54591	0.346437	0.29738	PFT	0.481674	0.417395	0.35829
OFJ	-0.05627	0.47101	0.404312	OFT	0.218419	0.306823	0.263375
ML4J	-0.38985	0.26825	0.230265	ML4T	-0.04705	0.039489	0.033897
M2L4J	0.044948	0.024521	0.021049	M2L4T	-0.00326	0.005075	0.004356
C	-49.0195	54.68431	46.94074	C	-14.509	5.407982	4.642185
YM	4.122319	3.063424	2.629628	YTH	2.416066	0.326133	0.279951
YFM	0.955117	3.130345	2.687073	YFTH	0.744445	0.250782	0.21527
YPM	2.692827	8.830319	7.579902	YPTH	-1.95322	0.820654	0.704445
YPFM	-1.07266	4.836477	4.151608	YPFTH	0.258661	0.496252	0.42598
PM	-3.08162	3.134008	2.690217	PTH	-1.57263	0.395648	0.339622
PFM	0.75283	3.428236	2.942781	PFTH	0.148607	0.341426	0.293079
OFM	-1.70134	1.628225	1.39766	OFTH	1.194329	0.222757	0.191214
ML4M	-1.61088	2.766646	2.374876	ML4TH	0.069603	0.088367	0.075854
M2L4M	0.120339	0.19704	0.169138	M2L4TH	-0.00984	0.011688	0.010033

[*] Standard error of estimates for Model I – constant error within individual cross-section units.
[^] Standard error of estimates for Model II – constant error across all individual cross-section units

Appendix 8-B OLS Estimates and SUR Estimates (Export Model)

	OLS		SUR			OLS		SUR	
Variables	β	*t*-Stat	β	*t*-Stat	Variables	β	*t*-Stat	β	*t*-Stat
C	17.32708	1.90707	17.63437	2.09779	C	-42.43161	-6.14553	-40.87241	-6.83775
YC	-5.62367	-5.35992	-5.35977	-5.36758	YP	2.59766	4.08186	2.72830	4.67318
YFC	-0.53316	-1.66816	-0.55897	-1.85613	YFP	0.44100	1.28483	0.26664	0.89276
YPC	1.70387	0.95214	1.70151	1.00945	YPP	2.92753	2.21267	2.11937	1.80633
YPFC	4.34482	7.01249	4.06041	6.95237	YPFP	-1.96187	-2.46735	-0.99690	-1.41169
PC	5.47910	6.42023	5.33867	6.55829	PP	-0.99089	-1.54271	-1.23118	-2.10389
PFC	2.06449	5.07281	1.90804	5.00337	PFP	0.67485	1.60733	0.70495	1.92262
OFC	-0.06628	-0.19006	-0.06017	-0.19056	OFP	0.03194	0.10521	0.06388	0.24306
ML4C	-2.92566	-3.88393	-3.01255	-4.36654	ML4P	-0.22613	-1.19517	-0.24046	-1.49540
M2L4C	0.16465	3.14378	0.17572	3.66865	M2L4P	0.01350	0.89692	0.01370	1.05483
C	-3.93595	-0.82746	-5.96578	-1.39045	C	46.08931	1.05215	8.41019	0.21046
YH	2.24536	5.81994	2.28634	6.31623	YS	2.67579	1.01741	4.16752	1.75569
YFH	-0.02402	-0.05236	-0.24852	-0.61923	YFS	4.13314	2.47423	2.13171	1.52641
YPH	-2.41130	-2.52778	-2.14514	-2.45157	YPS	-13.01792	-2.26297	-9.10073	-1.69094
YPFH	0.74901	1.53180	1.05067	2.41865	YPFS	-4.96926	-2.04914	-2.12092	-1.11110
PH	-1.81839	-4.41980	-1.99656	-5.19224	PS	-3.37429	-1.37786	-3.69376	-1.65614
PFH	0.60570	1.54205	0.84211	2.42903	PFS	-2.49818	-1.48324	-2.30717	-1.59702
OFH	0.65759	1.87719	0.37491	1.21611	OFS	4.41574	3.18878	3.16138	2.77649
ML4H	0.21774	0.75456	0.15518	0.62078	ML4S	18.36338	3.83278	12.56604	3.29715
M2L4H	-0.00897	-0.45943	-0.00467	-0.27613	M2L4S	-1.36260	-3.71603	-0.91976	-3.14545
C	-41.44226	-4.29004	-42.48080	-4.80635	C	12.26413	1.13966	11.39785	1.15173
YI	3.61015	4.97216	3.81023	5.43438	YK	0.02388	0.04148	0.22949	0.41204
YFI	0.24693	2.17856	0.29375	2.86261	YFK	-0.23274	-0.70086	-0.78096	-2.68180
YPI	-0.90597	-0.57215	-1.12662	-0.75015	YPK	-2.93804	-1.71845	-2.81311	-1.76858
YPFI	1.55039	3.00586	1.56021	3.22079	YPFK	1.78399	3.49348	2.31018	4.94862
PI	-1.52699	-2.45657	-1.37216	-2.32823	PK	1.01241	1.79056	0.74367	1.37879
PFI	0.21920	0.69491	0.04503	0.16455	PFK	0.31265	0.70190	0.85454	2.21422
OFI	0.82895	1.93944	0.58708	1.55681	OFK	1.23267	4.34041	0.80634	3.26059
ML4I	-0.50380	-0.44541	-0.20769	-0.20952	ML4K	0.01467	0.18906	-0.01518	-0.22507
M2L4I	0.04969	0.52275	0.02471	0.29666	M2L4K	-0.00048	-0.04260	-0.00013	-0.01316
C	-12.33219	-2.28564	-11.43374	-2.67900	C	-2.23292	-0.49003	-4.78008	-1.09756
YJ	1.58421	7.07069	1.46292	7.19310	YT	2.68622	6.41265	2.49291	6.40575
YFJ	-1.50928	-5.30666	-1.34565	-5.86171	YFT	9.66279	7.71368	8.62266	7.61528
YPJ	-0.67646	-0.83625	-0.50364	-0.77208	YPT	-4.84683	-4.67798	-4.10665	-4.25880
YPFJ	2.74859	8.37287	2.31806	8.46222	YPFT	-9.32861	-7.67587	-8.37900	-7.62434
PJ	-0.75002	-2.62194	-0.56556	-2.36461	PT	-2.38319	-4.42724	-2.03519	-4.24436
PFJ	1.54591	5.19844	1.28585	5.33315	PFT	0.48167	1.34437	0.30527	1.01148
OFJ	-0.05627	-0.13918	0.27033	0.87740	OFT	0.21842	0.82931	0.34435	1.44686
ML4J	-0.38985	-1.69306	-0.28370	-1.73338	ML4T	-0.04705	-1.38787	-0.01344	-0.45648
M2L4J	0.04495	2.13539	0.03498	2.31499	M2L4T	-0.00326	-0.74749	-0.00345	-0.93734
C	-49.01949	-1.04428	-25.67434	-0.66956	C	-14.50903	-3.12548	-13.80300	-3.68835
YM	4.12232	1.56764	5.77217	2.40457	YTH	2.41607	8.63031	2.74638	11.51054
YFM	0.95512	0.35545	1.26708	0.59255	YFTH	0.74445	3.45820	0.74112	4.34879
YPM	2.69283	0.35526	-1.68432	-0.26841	YPTH	-1.95322	-2.77270	-2.26593	-3.85612
YPFM	-1.07266	-0.25837	-0.24694	-0.07682	YPFTH	0.25866	0.60721	0.37520	1.11184
PM	-3.08162	-1.14549	-4.17149	-1.71083	PTH	-1.57263	-4.63054	-1.75635	-6.49896
PFM	0.75283	0.25582	-0.82870	-0.37016	PFTH	0.14861	0.50706	-0.05815	-0.25227
OFM	-1.70134	-1.21728	-2.10484	-1.75602	OFTH	1.19433	6.24605	0.93646	6.61773
ML4M	-1.61088	-0.67830	-1.41587	-0.80630	ML4TH	0.06960	0.91759	-0.03292	-0.60380
M2L4M	0.12034	0.71148	0.11799	0.92884	M2L4TH	-0.00984	-0.98071	0.00388	0.52746

Appendix 8-C Comparison for Estimated Coefficients and $t-$Statistics for the SUR Model and the Panel Data Model*(Export Model)

SUR Model

Variables	β	*t*-Stat	Variables	β	*t*-Stat
C	-0.56823	-0.80711	C	0.11571	2.50099
YC	-2.27405	-1.06539	YP	1.90672	1.72632
YFC	0.48651	1.05273	YFP	0.64909	1.57703
YPC	-3.18063	-0.85174	YPP	-1.92184	-0.98184
YPFC	0.09324	0.97408	YPFP	-0.75650	-0.56587
PC	3.36644	1.64971	PP	-1.04886	-0.99763
PFC	0.24529	0.57666	PFP	0.56005	1.32397
OFC	0.52736	1.58184	OFP	-0.60794	-1.65988
ML4C	-3.18862	-5.04911	ML4P	0.10104	0.57726
M2L4C	0.19522	4.33050	M2L4P	-0.01202	-0.80845
C	0.01951	0.69237	C	0.46451	0.94130
YH	1.54902	2.31852	YS	11.76781	1.56660
YFH	-0.39540	-0.91303	YFS	-0.06050	-0.01698
YPH	-2.87088	-2.51117	YPS	-28.91788	-2.12429
YPFH	0.71593	1.46121	YPFS	-2.47600	-0.90740
PH	-0.89959	-1.36585	PS	-8.95445	-1.35880
PFH	0.52271	1.48029	PFS	-1.43632	-0.43960
OFH	1.24113	4.10574	OFS	2.89352	1.84646
ML4H	0.50106	2.37193	ML4S	17.43618	2.86527
M2L4H	-0.03152	-2.21226	M2L4S	-1.30072	-2.75244
C	-0.01341	-0.21204	C	0.18306	2.20522
YI	2.48939	1.79554	YK	1.65021	1.30866
YFI	0.27924	2.34363	YFK	-0.08730	-0.17854
YPI	0.90822	0.37641	YPK	-4.02496	-1.83002
YPFI	1.45950	1.51414	YPFK	-0.81462	-0.71573
PI	-1.21623	-0.91808	PK	-0.85313	-0.70445
PFI	0.42714	1.56538	PFK	0.89075	1.67442
OFI	0.71185	1.99358	OFK	0.67367	2.13502
ML4I	-0.28409	-0.33131	ML4K	0.01702	0.27083
M2L4I	0.02111	0.30361	M2L4K	-0.01156	-1.32876
C	-0.02949	-1.14086	C	-0.03265	-0.55083
YJ	0.32633	0.59916	YT	2.61471	2.73059
YFJ	-0.09504	-0.20152	YFT	13.16494	4.39988
YPJ	0.49724	0.52662	YPT	-4.25534	-2.50200
YPFJ	1.67372	3.04622	YPFT	-13.02384	-4.43052
PJ	0.61131	1.15210	PT	-2.03523	-2.02633
PFJ	-0.20901	-0.45234	PFT	0.49932	1.47658
OFJ	0.03009	0.10142	OFT	-0.47245	-1.19874
ML4J	-0.37542	-2.97264	ML4T	0.01357	0.30514
M2L4J	0.04060	3.06791	M2L4T	-0.00628	-0.96987
C	-0.34099	-0.87056	C	-0.01405	-0.39167
YM	-3.06543	-0.47102	YTH	2.25605	2.93494
YFM	4.18712	1.15434	YFTH	0.34004	0.92305
YPM	16.95468	1.42743	YPTH	-1.37434	-1.03151
YPFM	0.78459	0.13598	YPFTH	1.21928	1.71259
PM	3.26142	0.54447	PTH	-1.33847	-1.81916
PFM	-2.06153	-0.61842	PFTH	0.54386	1.34574
OFM	-3.94641	-1.85156	OFTH	0.56607	2.59120
ML4M	-1.78754	-0.86068	ML4TH	-0.09243	-1.41776
M2L4M	0.14332	0.89732	M2L4TH	0.01338	1.37870

Panel Data Model

Variables	β	*t*-Stat
C	0.04167	2.43117
Y	1.85372	4.62992
YF	0.24372	2.14998
YP	-2.27039	-3.28270
YPF	0.37062	1.51420
P	-1.03118	-2.66534
PF	0.25283	1.62067
OF	0.67136	4.69558
ML4	-0.01460	-0.37004
M2L4	-0.00059	-0.14070

*All data series have been taken the first difference to achieve stationarity.

Appendix 8-D Residuals for all Cross-section Countries from the Panel Model using the First Difference of the Data Series (Export Model)

Years	RESID C	RESID H	RESID I	RESID J	RESID M	RESID P	RESID S	RESID K	RESID T	RESID TH
1964	-0.44604	0.03804	0.22409	-0.10344	5.84254	0.02093	-4.77011	-0.25535	-0.06449	0.12974
1965	-0.02029	0.01844	-0.29056	-0.09578	0.07751	-0.16066	-0.55057	0.01886	0.21505	-0.00669
1966	-0.75951	-0.11427	-0.53920	-0.02182	-0.68471	0.33573	5.26341	-0.07910	0.32617	0.21577
1967	0.96681	0.09292	-0.00794	0.11550	0.11649	0.22405	0.19118	0.11999	0.01960	0.03244
1968	-0.87302	-0.04843	0.60008	-0.03866	-0.02084	0.08893	-0.15121	-0.16373	-0.58242	-0.11820
1969	0.29157	-0.06466	0.46484	0.11871	-0.02542	0.17964	0.02820	-0.05627	0.43990	-0.03716
1970	0.00566	0.10627	0.37910	0.01691	-0.16557	-0.02097	0.16652	-0.11233	0.06987	0.21243
1971	-1.70052	0.12732	-0.15962	0.00214	0.08786	-0.01023	0.07506	0.60692	0.01492	0.05081
1972	0.10377	-0.07013	0.18309	-0.05000	0.07815	-0.05660	-0.22230	0.33412	-0.19337	-0.22056
1973	0.40113	-0.21260	0.38006	-0.06676	-0.12519	-0.12711	-0.08740	-0.17555	-0.35506	-0.09413
1974	0.55108	-0.03376	-0.13481	-0.18086	0.20386	0.48281	0.06295	0.12797	0.40298	0.25167
1975	0.09004	-0.04647	0.09991	0.20840	0.09208	-0.04599	0.53439	0.49256	0.05041	-0.29267
1976	-0.09220	-0.00072	-0.06900	0.10406	-0.12140	-0.15434	-0.45470	-0.17124	-0.13041	0.01150
1977	0.49699	0.10228	-0.22912	-0.13187	-0.09085	0.13685	-0.05031	0.03698	0.11788	-0.02442
1978	-0.04366	0.14308	0.16504	-0.23783	0.21942	-0.16710	0.03822	0.33666	0.16605	0.20704
1979	-0.02877	-0.10950	0.13942	-0.05894	-0.18881	-0.04431	-0.00159	-0.03675	0.01711	-0.04194
1980	-0.27540	-0.24697	0.05020	-0.15301	-0.04054	-0.45466	-0.03000	-0.11701	-0.07210	-0.03123
1981	-0.35016	-0.05351	0.19606	-0.13184	0.04109	-0.01236	-0.20202	0.36480	0.08900	-0.11089
1982	0.27641	0.14424	-0.09156	0.13896	-0.27840	0.20265	0.06575	0.05850	0.22005	0.08365
1983	-0.73051	-0.02000	0.07670	-0.05156	0.11148	-0.12090	-0.03497	0.01029	-0.03425	0.06822
1984	0.29914	0.03120	-0.11624	0.00932	-0.15608	0.03038	0.19823	0.04031	0.00599	-0.06276
1985	-0.43359	-0.01320	0.19286	0.05555	-0.06261	0.49316	0.00406	0.17815	0.12680	-0.15483
1986	0.32472	0.09770	0.18662	-0.18544	-0.21497	-0.30599	-0.55706	-0.12844	-0.07359	0.06822
1987	0.02755	-0.03148	-0.11151	-0.10327	-0.11475	0.25123	0.13181	-0.13264	-0.20846	0.00458
1988	-0.48213	-0.13654	0.44674	-0.02316	0.21452	-0.01789	-0.18243	0.07499	-0.04954	0.01185
1989	-0.14935	-0.19242	0.25369	-0.05572	-0.04848	0.08331	-0.04590	0.05609	0.06132	0.11577
1990	0.03996	0.05833	0.33447	0.04994	-0.00324	0.08282	0.24506	0.13199	0.03709	0.01142
1991	0.21243	0.24821	0.02614	0.16877	-0.02219	0.18967	0.11414	0.14859	0.20070	0.11840
1992	0.09109	0.07530	0.07384	-0.09536	0.06545	-0.03974	-0.07463	-0.02323	-0.03083	0.17824
1993	0.17808	0.06189	0.00143	-0.07329	0.05882	0.03580	0.01467	0.05592	0.02820	-0.04688
1994	0.07789	0.00384	0.01071	-0.09724	-0.06933	-0.03485	-0.13575	-0.12873	-0.00801	0.01303
1995	-0.04054	0.00319	0.01072	-0.18517	-0.12738	0.08347	-0.07914	-0.14746	-0.05371	0.03183
1996	0.18125	-0.02729	0.20716	-0.03211	0.01504	-0.00525	0.03353	-0.11222	0.00362	0.04262
1997	-0.19898	-0.02757	0.01893	0.01882	0.01507	0.05058	-0.00458	0.01054	0.01733	0.07165
1998	-0.17759	-0.14878	-0.03719	-0.01002	-0.01131	0.03333	-0.03407	0.02789	-0.00667	-0.23751
1999	-0.00522	-0.10348	0.45162	-0.08578	-0.07175	0.15098	-0.13088	0.01050	0.04762	0.05406
2000	-0.14085	-0.16279	-0.28825	-0.27157	-0.42308	0.03524	0.21835	-0.14024	0.00430	-0.03450

Appendix 8-E Residuals for all Cross-Section Countries from the SUR Model using the First Difference of the Data Series (Export Model)

Years	RESID C	RESID H	RESID I	RESID J	RESID M	RESID P	RESID S	RESID K	RESID T	RESID TH
1964	0.06077	0.06033	0.10847	-0.11327	4.71047	0.05854	-3.16915	-0.34137	-0.06761	0.12785
1965	0.09540	0.00069	-0.28673	0.01005	0.02395	-0.21045	-0.55954	0.00403	0.09810	0.04927
1966	-0.25174	-0.04094	-0.50806	-0.03784	-1.22573	0.25337	4.17408	0.01007	0.08642	0.16122
1967	-0.04960	0.17427	0.25356	0.02322	0.06044	0.09347	0.19056	0.05519	0.01988	0.06898
1968	0.01076	0.00108	0.09514	0.00128	-0.66264	-0.08503	-0.78597	-0.02864	-0.41845	-0.13690
1969	0.41872	-0.03374	0.29566	0.09230	-0.29737	0.01811	-0.94512	0.01335	0.36736	-0.04477
1970	-0.23167	0.09103	0.27287	0.05030	-0.20385	0.19225	0.43835	-0.19717	0.10122	0.16583
1971	-0.98714	0.00660	-0.14934	0.08629	-0.25929	-0.16964	-0.46828	0.56468	0.06413	0.02411
1972	0.02710	0.00043	0.08956	0.00496	-0.72233	-0.10257	-0.93051	0.23264	-0.07746	-0.15632
1973	0.10629	-0.05850	0.12770	0.01362	-0.77222	-0.12377	0.58849	-0.00002	-0.13237	-0.11385
1974	0.07163	0.02561	-0.16310	-0.07749	0.69266	0.25178	-0.01241	-0.17145	0.15087	0.21051
1975	0.02919	0.02111	0.06069	0.09649	-0.52948	-0.09504	0.80070	0.34061	-0.16599	-0.27767
1976	-0.21597	0.06510	-0.13879	0.12882	-0.57575	-0.21293	0.30217	-0.14209	0.07449	0.02505
1977	0.77138	0.02157	-0.25364	-0.04726	-0.17369	0.12045	-0.25403	-0.08394	-0.10934	-0.04465
1978	0.24738	0.17257	-0.01798	-0.07858	-0.20036	-0.16309	0.33853	0.27223	0.14084	0.11093
1979	-0.02541	-0.10705	0.09881	-0.08327	-0.07427	-0.08021	0.06734	-0.00583	-0.05649	-0.03301
1980	-0.11490	-0.25562	-0.09072	-0.16380	-0.35127	-0.21686	-0.13010	-0.15122	-0.24899	-0.11612
1981	0.01808	-0.07978	0.07182	-0.06270	-0.38009	-0.09217	-0.20972	0.25252	-0.05351	-0.10477
1982	-0.17923	0.01567	0.07953	-0.01255	0.71198	-0.00831	-0.56983	-0.13260	-0.09807	0.07606
1983	-0.49621	0.00410	-0.02366	-0.01476	-0.21660	-0.08197	0.74056	0.05765	0.01259	0.11025
1984	0.53211	0.06868	-0.26688	0.02244	-0.52951	-0.04266	0.58111	0.00431	0.09621	-0.01875
1985	-0.09254	-0.05751	0.20999	0.02701	-0.57053	0.21831	0.31570	0.27674	-0.00414	-0.16002
1986	0.01765	0.09985	0.25021	-0.01210	0.11900	-0.16416	-0.56396	-0.11136	0.09827	0.11181
1987	0.13423	0.01120	-0.20903	-0.01836	-0.21821	0.37188	0.76726	-0.03730	-0.00380	0.01917
1988	-0.40774	-0.12561	0.20326	0.06534	0.07747	0.08578	-0.31332	0.08806	0.02426	-0.05366
1989	-0.02611	-0.16778	0.10217	-0.09126	0.11530	0.11787	0.30124	0.06960	0.04929	0.01460
1990	-0.08400	-0.05933	0.30642	-0.04527	0.39257	0.03228	0.09981	-0.04252	-0.11455	-0.09075
1991	0.16528	0.15625	-0.02456	0.13198	0.38234	0.08895	-0.11592	0.02501	0.12654	0.03627
1992	0.16537	0.04477	-0.03022	-0.01288	-0.67778	-0.13284	-0.03110	-0.10940	-0.03305	0.10931
1993	0.24849	0.06345	-0.13451	0.10936	0.28137	0.01624	-0.06209	-0.02254	0.02312	-0.09345
1994	0.28064	0.05998	-0.15752	0.07497	0.41146	0.01521	-0.43994	-0.15412	-0.02928	-0.07947
1995	-0.05020	0.03074	-0.13977	-0.00664	0.30339	0.08075	-0.18597	-0.13206	-0.01355	-0.02236
1996	0.19665	0.00968	0.04301	-0.03628	0.05470	0.01663	0.43591	-0.16888	-0.03034	-0.02706
1997	-0.05589	0.02447	-0.01970	0.02220	-0.08016	0.18452	0.05475	-0.01250	0.05537	0.14225
1998	-0.03697	-0.10710	0.18836	-0.07509	-0.09740	-0.16901	-0.35530	-0.04797	-0.00270	-0.03259
1999	-0.22156	0.00207	0.03338	0.09407	0.03740	-0.07358	-0.13715	0.06467	0.11754	0.03642
2000	-0.07026	-0.13835	-0.27635	-0.06528	0.44403	0.00790	0.04281	-0.23840	-0.04682	0.00626

Appendix 8-F Fixed Effect Tests for Export and Import Models

For exports, the residual sum of squares for the restricted model (*RRSS*) is 217.4634 in Table 8-F.1 below and the residual sum of squares for the unrestricted model (*URSS*) is 111.5904 in Table 8-F.2. The F-test statistics for exports is:

$$
\begin{aligned}
F &= \frac{(RRSS - URSS)/(N-1)}{URSS/(NT-N-K)} \sim F_{N-1,N(T-1)-K} \\
&= \frac{(217.4634\text{-}111.5904)/(10\text{-}1)}{111.5904/(10\times 38\text{-}10\text{-}19)} \\
&= \frac{11.764}{0.318} \\
&= 36.99
\end{aligned}
$$

The F –statistics of 37.95 would be significant at any level to reject the null hypothesis of No-Effect model for exports, which is that all the cross-section dummies of the fixed effect model are zero. Thus, the fixed effect model for exports is a better model.

Before we read the tables in this appendix (Appendix 8-F), some explanations to the Eviews output are necessary. (1) There are "?" signs as part of the variable name. It is a procedure used by the Eviews' pool object function. The "?" refers to the cross-section identifier. It is used to call out the cross-section units from the data file and stack the data cross-section units one after another. For example, the dependent variable "$E?$" in Table 8-F.1 means E_i where $i = 1, 2, 3, \ldots N$, the exports from Australia to each $N = 10$ Asian countries. The variable of "$YF?$" means that the GDP time series for 10 Asian countries are stacked together to form a variable called YF. In order to maintain the original Eviews output, we keep the "?" as part of the variable name in these tables. (2) The variables begin with "DUM" in Table 8-F.2 are the country dummy variables for the fixed effect LSDV model.

Table 9-F.1 The Restricted Model for Export

Dependent Variable: E?
Method: Pooled Least Squares
Sample: 1963 2000
Included observations: 38
Cross-sections included: 10
Total pool (balanced) observations: 380

Variable	Coefficient	Std. Error	t-Statistic	Prob.
Y?	0.523596	0.496939	1.053644	0.2927
YF?	0.244002	0.059557	4.096953	0.0001
YP?	1.091893	0.567000	1.925736	0.0549
YPF?	0.591019	0.084876	6.963325	0.0000
P?	0.047015	0.446432	0.105313	0.9162
PF?	0.577244	0.145358	3.971180	0.0001
OF?	-0.494128	0.099917	-4.945379	0.0000
ML4?	0.091860	0.058184	1.578779	0.1152
M2L4?	-0.000470	0.006646	-0.070661	0.9437
LDIST?	-2.175595	0.306983	-7.087029	0.0000

R-squared	0.707921	Mean dependent var	6.441740
Adjusted R-squared	0.700816	S.D. dependent var	1.401597
S.E. of regression	0.766641	Akaike info criterion	2.332368
Sum squared resid	217.4634	Schwarz criterion	2.436057
Log likelihood	-433.1499	Durbin-Watson stat	0.529170

Table 8-F.2 OLS Estimates of the Fixed Effect Panel Model for Export

Dependent Variable: E?
Method: Pooled Least Squares
Included observations: 38
Cross-sections included: 10
Total pool (balanced) observations: 380

Variable	Coefficient	Std. Error	t-Statistic	Prob.
Y?	2.152177	0.409101	5.260747	0.0000
YF?	-0.342789	0.083832	-4.089010	0.0001
YP?	-0.508779	0.547031	-0.930073	0.3530
YPF?	1.461103	0.202502	7.215237	0.0000
P?	-0.441357	0.352119	-1.253432	0.2109
PF?	0.315967	0.145454	2.172278	0.0305
OF?	0.265123	0.120474	2.200659	0.0284
ML4?	0.152536	0.055652	2.740902	0.0064
M2L4?	-0.017836	0.006067	-2.939743	0.0035
LDIST?	-2.332231	0.342870	-6.802083	0.0000
DUMH?	-5.597895	0.585613	-9.559028	0.0000
DUMI?	-2.736001	0.217775	-12.56340	0.0000
DUMJ?	-1.936520	0.523746	-3.697445	0.0003
DUMM?	-4.485783	0.462574	-9.697438	0.0000
DUMP?	-3.665291	0.256980	-14.26296	0.0000
DUMS?	-6.316980	0.676799	-9.333607	0.0000
DUMK?	-2.829857	0.426238	-6.639152	0.0000
DUMT?	-3.395332	0.482948	-7.030427	0.0000
DUMTH?	-3.774365	0.372200	-10.14070	0.0000

R-squared	0.850121	Mean dependent var	6.441740
Adjusted R-squared	0.842648	S.D. dependent var	1.401597
S.E. of regression	0.555981	Akaike info criterion	1.712541
Sum squared resid	111.5904	Schwarz criterion	1.909550
Log likelihood	-306.3828	Durbin-Watson stat	1.020289

For imports, the *RRSS* is 277.0987 in Table 8-F.3 and the *URRS* is 107.8161 in Table 8-F.4 below. The *F*-test of fixed effect is as follow:

$$F = \frac{(RRSS - URSS)/(N-1)}{URSS/(NT-N-K)} \sim F_{N-1,N(T-1)-K}$$
$$= \frac{(277.0987\text{-}107.8161)/(10\text{-}1)}{107.8161/(10\times 38\text{-}10\text{-}19)}$$
$$= \frac{18.81}{0.307}$$
$$= 61.27$$

With the *F*-statistics of 62.9, we can conclude that the fixed effect panel model for imports is more efficient than the no effect panel model for imports.

Table 8-F.3 The Restricted Model for Imports

Dependent Variable: I?
Method: Pooled Least Squares
Sample: 1963 2000
Included observations: 38
Cross-sections included: 10
Total pool (unbalanced) observations: 378

Variable	Coefficient	Std. Error	t-Statistic	Prob.
Y?	1.287106	0.570312	2.256845	0.0246
YF?	0.516669	0.034089	15.15662	0.0000
YP?	-3.066840	0.830081	-3.694629	0.0003
YPF?	0.704125	0.089784	7.842434	0.0000
P?	0.370492	0.503177	0.736305	0.4620
PF?	0.025013	0.166950	0.149825	0.8810
O?	2.371365	0.518678	4.571938	0.0000
ML2?	0.084973	0.072977	1.164376	0.2450
M2L2?	-0.008294	0.008226	-1.008222	0.3140
LDIST?	-0.203824	0.377848	-0.539434	0.5899

R-squared	0.669550	Mean dependent var	6.191185
Adjusted R-squared	0.661469	S.D. dependent var	1.491399
S.E. of regression	0.867747	Akaike info criterion	2.580267
Sum squared resid	277.0987	Schwarz criterion	2.684365
Log likelihood	-477.6704	Durbin-Watson stat	0.090951

Table 8-F.4 OLS Estimates of the Fixed Effect Panel Model for Imports

Dependent Variable: I?
Method: Pooled Least Squares
Sample: 1963 2000
Included observations: 38
Cross-sections included: 10
Total pool (unbalanced) observations: 378

Variable	Coefficient	Std. Error	t-Statistic	Prob.
Y?	1.227868	0.407117	3.016005	0.0027
YF?	0.134998	0.086977	1.552110	0.1215
YP?	-0.288264	0.709972	-0.406022	0.6850
YPF?	0.881736	0.210269	4.193375	0.0000
P?	0.904626	0.382435	2.365435	0.0185
PF?	-0.937417	0.153723	-6.098076	0.0000
O?	0.917538	0.488672	1.877613	0.0612
ML2?	0.321639	0.061311	5.245993	0.0000
M2L2?	-0.034967	0.006539	-5.347143	0.0000
LDIST?	-2.018106	0.439860	-4.588064	0.0000
DUMH?	-1.492461	0.657552	-2.269726	0.0238
DUMI?	-1.348521	0.239809	-5.623324	0.0000
DUMJ?	0.224519	0.566958	0.396007	0.6923
DUMM?	-1.081961	0.515659	-2.098210	0.0366
DUMP?	-3.022937	0.299858	-10.08122	0.0000
DUMS?	-2.140101	0.753431	-2.840474	0.0048
DUMK?	-0.713652	0.456348	-1.563833	0.1187
DUMT?	-0.358101	0.523933	-0.683486	0.4947
DUMTH?	-2.231523	0.393277	-5.674172	0.0000

R-squared	0.871426	Mean dependent var	6.191185
Adjusted R-squared	0.864979	S.D. dependent var	1.491399
S.E. of regression	0.548018	Akaike info criterion	1.683939
Sum squared resid	107.8161	Schwarz criterion	1.881724
Log likelihood	-299.2644	Durbin-Watson stat	0.208439

Appendix 8-G Individual Country Cointegration Regressions for the Export Model

Variable	China	Hong Kong	Indonesia	Japan	Korea	Malaysia	Philippines	Singapore	Taiwan	Thailand
Intercept	17.3271	-3.9360	-41.4423	-12.3322	12.2641	-49.0195	-42.4316	46.0893	-2.2329	-14.5090
	1.64	-0.71	-3.68**	-1.96*	0.98	-0.90	-5.28**	0.90	-0.42	-2.68**
YC	-5.6237	2.2454	3.6102	1.5842	0.0239	4.1223	2.5977	2.6758	2.6862	2.4161
	-4.60**	5.00**	4.27**	6.07**	0.04	1.35	3.50**	0.87	5.50**	7.41**
YFC	-0.5332	-0.0240	0.2469	-1.5093	-0.2327	0.9551	0.4410	4.1331	9.6628	0.7444
	-1.43	-0.04	1.87*	-4.56**	-0.60	0.31	1.10	2.12**	6.62**	2.97**
YPC	1.7039	-2.4113	-0.9060	-0.6765	-2.9380	2.6928	2.9275	-13.0179	-4.8468	-1.9532
	0.82	-2.17**	-0.49	-0.72	-1.48	0.30	1.90*	-1.94*	-4.02**	-2.38**
YPFC	4.3448	0.7490	1.5504	2.7486	1.7840	-1.0727	-1.9619	-4.9693	-9.3286	0.2587
	6.02**	1.31	2.58**	7.19**	3.00**	-0.22	-2.12**	-1.76*	-6.59**	0.52
PC	5.4791	-1.8184	-1.5270	-0.7500	1.0124	-3.0816	-0.9909	-3.3743	-2.3832	-1.5726
	5.51**	-3.79**	-2.11**	-2.25**	1.54	-0.98	-1.32	-1.18	-3.80**	-3.97**
PFC	2.0645	0.6057	0.2192	1.5459	0.3127	0.7528	0.6749	-2.4982	0.4817	0.1486
	4.35**	1.32	0.60	4.46**	0.60	0.22	1.38	-1.27	1.15	0.44
OFC	-0.0663	0.6576	0.8289	-0.0563	1.2327	-1.7013	0.0319	4.4157	0.2184	1.1943
	-0.16	1.61	1.66	-0.12	3.73**	-1.04	0.09	2.74**	0.71	5.36**
ML4C	-2.9257	0.2177	-0.5038	-0.3899	0.0147	-1.6109	-0.2261	18.3634	-0.0470	0.0696
	-3.33**	0.65	-0.38	-1.45	0.16	-0.58	-1.03	3.29**	-1.19	0.79
M2L4C	0.1646	-0.0090	0.0497	0.0449	-0.0005	0.1203	0.0135	-1.3626	-0.0033	-0.0098
	2.70**	-0.39	0.45	1.83*	-0.04	0.61	0.77	-3.19**	-0.64	-0.84
Adj R-squared	0.8128	0.9794	0.9598	0.9662	0.9882	0.4124	0.9098	0.7194	0.9934	0.9895
F-statistic	18.8543	196.3102	99.0365	118.4104	344.6979	3.8855	42.4523	11.5398	620.1097	390.2345
D-W statistic	1.6122	1.0277	0.9074	1.1548	1.6028	1.4454	1.6529	1.7751	2.1577	2.2604
Cointegration test§										
ADF 1	-5.0272	-4.4793	-3.2290	-4.3032	-5.7334	-10.0532	-5.0425	-7.1948	-4.2473	-7.1265
ADF 2	-4.9570	-4.3972	-3.1791	-4.2501	-5.2317	-10.1540	-4.9690	-7.0881	-4.1834	-7.1207
ADF 3	-4.8962	-4.2895	-3.1308	-4.2046	-5.0473	-10.8246	-4.8959	-6.9808	-4.6006	-7.2217

** t-statistics with 5% significant level. * t-statistics with 10% significant level. § ADF 1- ADF test with no intercept and no trend. ADF 2 – ADF test with intercept but no trend. ADF 3 – ADF test with intercept and with trend.

Appendix 8-H Individual Country Cointegration Regression for the Import Model

Variables	China	Hong Kong	Indonesia	Japan	Korea	Malaysia	Philippines	Singapore	Taiwan	Thailand
Intercept	-19.0861	-27.0495	40.23326	-18.1689	-40.7476	-24.5536	-43.7982	-52.3869	-52.4385	-18.0625
	-3.96**	-4.36**	2.55**	-3.22**	-3.07**	-3.44**	-5.81**	-4.42**	-4.91**	-2.08**
Y	1.5618	0.748559	1.731603	0.592642	0.0709	-0.3060	-1.7932	-2.9268	0.4461	0.4050
	2.74**	1.30	0.99	2.14**	0.08	-0.63	-1.67	-4.22**	0.52	0.87
YF	-0.6102	-0.45547	-0.06028	-1.6847	-0.4122	-2.1597	0.2607	0.7932	3.2531	-0.2992
	-3.06**	-0.84	-0.20	-2.79**	-0.97	-5.57**	0.50	2.09**	1.73*	-0.53
YP	0.3195	2.320327	-8.05072	1.285776	3.8806	1.1526	3.6145	5.9515	4.3044	0.1108
	0.32	1.80*	-2.57**	1.15	1.79*	1.07	2.26**	3.13**	2.05**	0.08
YPF	1.1319	0.259002	-0.84797	2.652191	0.5298	2.4300	1.9067	-1.1187	-2.5099	1.0157
	2.21**	0.44	-0.46	4.02**	0.83	3.34**	1.89*	-2.11**	-1.26	1.00
P	-0.0013	1.261163	-1.03333	0.010161	1.7168	1.3003	3.3554	5.3540	2.3141	1.2693
	0.00	2.43**	-0.57	0.03	2.00*	2.50**	3.20**	7.75**	2.56**	2.44**
PF	0.0593	0.088104	0.325654	1.437285	1.0673	1.6109	-0.4058	-0.4798	-0.8877	-1.1969
	0.27	0.14	0.48	2.29**	1.81*	3.22**	-0.62	-0.67	-1.28	-1.83*
O	1.8200	-1.31566	7.247335	-0.16652	-0.8376	3.9081	0.8828	1.0220	-3.2884	2.5617
	1.98*	-1.84*	2.94**	-0.32	-0.96	7.79**	0.79	0.82	-4.63**	2.69**
ML2	-0.9176	0.65824	2.378452	-0.43129	0.2062	0.0219	0.6297	4.2840	-0.0499	0.7248
	-2.20**	1.78*	1.04	-1.28	1.82*	0.06	1.87*	4.02**	-0.63	2.86**
M2L2	0.0567	-0.04729	-0.13065	0.046356	-0.0426	0.0001	-0.0667	-0.3211	-0.0026	-0.0548
	1.98*	-1.90*	-0.72	1.50	-2.68**	0.01	-2.86**	-4.02**	-0.27	-2.51**
Adj R-squared	0.9816	0.932766	0.60323	0.943841	0.9660	0.9465	0.9602	0.9903	0.9771	0.9913
F-statistic	220.8379	58.03555	7.250329	70.09436	111.6357	73.76181	100.3027	421.569	176.0402	471.3692
D-W statistic	1.6380	1.931491	1.042893	1.430194	1.6770	1.6767	2.0026	1.6669	1.8938	1.6478
Cointegration test§										
ADF 1	-5.0715	-6.0368	-3.6517	-4.61903	-5.54587	-4.96656	-6.99062	-5.29564	-5.69894	-5.13125
ADF 2	-4.9870	-5.94513	-3.60233	-4.55252	-5.47851	-4.873	-6.89197	-5.22801	-5.61902	-5.06237
ADF 3	-4.9164	-5.88089	-3.54991	-4.49492	-5.49947	-4.77028	-6.74228	-5.12481	-5.5403	-4.97053

** t-statistics with 5% significant level. * t-statistics with 10% significant level. § ADF 1- ADF test with no intercept and no trend. ADF 2 – ADF test with intercept but no trend. ADF 3 – ADF test with intercept and with trend.

Appendix 8-I LM-DOLS Panel Cointegration Test Procedure

This appendix explains the LM-DOLS panel cointegration test procedure of McCoskey and Kao (1998) step by step, less technically and more intuitively. The objective is to improve the understanding to the rather technical testing procedure explanation provided by McCoskey and Kao (1998). Then, the testing procedure is applied to the panel data regression of the gravity model in the study of immigration and trade. The empirical test results were presented and discussed in Section 9.4.3 in Chapter 9.

The Non-stationary Panel Regression Model

Let $\{y_{it}, x_{it}\}$ be non-stationary $I(1)$ process time series for all cross-sections. α_i are cross-section specific intercepts and β are common slop. The panel regression is:

$$y_{it} = \alpha_i + x_{it}^{'}\beta + v_{it}, \quad i = 1,...,N, \ \ t = 1,...,T, \tag{I.1}$$

$$x_{it} = x_{it-1} + \varepsilon_{it} \tag{I.2}$$

where in Equation (I.1), y_{it} is a column vector which stacks $i = 1,...,N$ cross-sections of trended dependant variables each with time periods of $t = 1,...,T$. The column vector y_{it} has $N \times T$ rows. α_i is a row vector of $i = 1,...,N$ cross-section specific intercepts. The model consists of k independent variables, and therefore x_{it} is a matrix with the dimensions of k columns and $N \times T$ rows. β is a column vector of k coefficients. v_{it} is a column vector of residuals of the panel regression, which have the same dimensions as y_{it}.

In Equation (I.2), the matrix dimensions of x_{it} were described in the previous section. Each series of x_{it} has a corresponding series of ε_{it}. Thus, ε_{it} is a $k \times N$ series. However, in empirical analysis, Equation (I.2) has the number of time periods of $T-1$ which is one period of time less than in Equation (I.1) due to the fact that it is lagged by one time period. Thus, the dimensions of the ε_{it} matrix are k number of columns and

$N \times (T-1)$ number of rows. This specification of Equation (I.2) implies Equation (I.1) has spurious relationship.

The Null Hypothesis for Panel Cointegration Test

The presence of the non-stationary error terms leads to spurious relationship amongst the variables in the regression model. The non-stationary error terms (v_{it}) are composed of two components: One is the random walk component γ_{it}; and the other is a well-behaved Independently and Identically Distributed (*i.i.d.*) random component u_{it} with a normal distribution $iid\left(0, \sigma_u^2\right)$. Thus

$$v_{it} = \gamma_{it} + u_{it} \tag{I.3}$$

Equation (I.3) separates the error terms v_{it} into the unit root component γ_{it} and the *iid* component of u_{it}. A unit root can be defined as "the value of a current observation is the value of the immediate previous observation plus a random error". Then the unit root component γ_{it} can be described as:

$$\gamma_{it} = \gamma_{it-1} + \theta u_{it} \tag{I.4}$$

where γ_{it-1} is the γ_{it} lagged by one time period. Since γ_{it} is unit root process, the one time period lag of γ_{it}, which is γ_{it-1}, is also a unit root process. θ is a scalar, representing the magnitude of the shock of the random walk and the stationary components. Equations (I.3) and (I.4) together allow for correlations between the regression residuals v_{it} over time, which leads to non-stationary behaviour in the error term.

The random walk γ_{it} at a particular period of time is equal to γ_{it-1} for all *t*. Using the backward substitution process, that is, γ_{it-1} equals to γ_{it-2}, and γ_{it-2} equals to γ_{it-3}, and so on, eventually, γ_{it} for any length of periods of *T* reduces to γ_{i0}. However, under an empirical context, γ_{i0} does not exist because there is no 0 time period or t = 0. This means that the random walk component γ_{it-1} of the error term is redundant. Hence, the backward substitution operator for Equation (I.4) is:

$$\gamma_{i1} = \gamma_{i1-1} + \theta u_{i1} = \gamma_{i0} + \theta u_{i1} \quad \text{(I.5)}$$

where $\gamma_{i1-1} = \gamma_{i0}$. Hence, in time period 1, γ_{i1} is equivalent to $\gamma_{i0} + \theta u_{i1}$. Since γ_{i0} does not exist, the non-stationary component of the error term γ_{i1} is reduced to:

$$\gamma_{i1} = \theta u_{i1} \quad \text{(I.6)}$$

The backward substitution further operating to time period 2 is,

$$\gamma_{i2} = \gamma_{i2-1} + \theta u_{i2} = \gamma_{i1} + \theta u_{i2} \quad \text{(I.7)}$$

where $\gamma_{i2-1} = \gamma_{i1}$. Substitute Equation (I.6) into Equation (I.7), get

$$\gamma_{i2} = \theta u_{i1} + \theta u_{i2} \quad \text{(I.8)}$$

Similarly, to time period 3,

$$\gamma_{i3} = \gamma_{i3-1} + \theta u_{i3} = \gamma_{i2} + \theta u_{i3} \quad \text{(I.9)}$$

The substitute of Equation (I.8) into Equation (I.9) leads to

$$\gamma_{i3} = \theta u_{i1} + \theta u_{i2} + \theta u_{i3} \quad \text{(I.10)}$$

The substitution process continues up to $t = T$.

From the above illustration of backward substitution, the process of Equations (I.6), (I.8) and (I.10) demonstrates that for each consecutive time period t increase, the value of γ_{it} will be changed by the adding the error at the tth time period. The process of cumulating corresponding error is the cumulative sum (also called partial sum) process. Hence, we can generalise that, for each consecutive period of t, γ_{it} is only the cumulative sum of the θu_{it} up to the corresponding time period t.

To better illustrate the cumulative sum process, we extend the cumulative process of Equations (I.6), (I.8) and (I.10) as:

$$
\begin{aligned}
\gamma_{i1} &= \theta u_{i1} \\
\gamma_{i2} &= \theta u_{i1} + \theta u_{i2} \\
\gamma_{i3} &= \theta u_{i1} + \theta u_{i2} + \theta u_{i3} \\
&\,. \\
&\,. \\
\gamma_{iT} &= \theta u_{i1} + \theta u_{i2} + \theta u_{i3} + \ldots + \theta u_{iT}
\end{aligned}
\tag{I.11}
$$

The cumulative sum process in Equation (I.11) can be expressed in a condensed form as $\gamma_{it} = \theta \sum_{j=1}^{t} u_{ij}$, where *j* refers the number of the partial sums involved for the previous *j* time periods up to the current time *t*.

Therefore, with backward substitution explained above, Equations (I.3) and (I.4) can be reduced into one equation as:

$$v_{it} = \theta \sum_{j=1}^{t} u_{ij} + u_{it} \tag{I.12}$$

Therefore, Equation (I.12) implies that the partial sum of the well-behaved *i.i.d.* residuals (u_{it}) component contributes the non-stationarity behaviour of the panel regression errors.

Substituting Equation (I.12) into Equation (I.1) gives

$$
\begin{aligned}
y_{it} &= \alpha_i + x_{it}'\beta + \theta \sum_{j=1}^{t} u_{ij} + u_{it} \\
&= \alpha_i + x_{it}'\beta + e_{it}
\end{aligned}
\tag{I.13}
$$

where $e_{it} = \theta \sum_{j=1}^{t} u_{ij} + u_{it}$.[78]

Testing the null hypothesis of $\theta = 0$ in Equation (I.13) is equivalent to test the difference between e_{it} and u_{it} when the e_{it} being the estimated residual from the regression and the u_{it} is the well-behaved unknown corresponding contemporary errors.[79] If e_{it} is significantly different from u_{it}, then $\theta \sum_{j=1}^{t} u_{ij}$ has some impact on e_{it} and therefore the cointegration between y_{it} and x_{it} can be rejected. If e_{it} is not significantly different

[78] v_{it} is error term in this model, while e_{it} is residual of the estimated regression.
[79] The error term can be regarded as the population errors.

from u_{it}, then $\theta\sum_{j=1}^{t} u_{ij}$ is not statistically different from 0. Then, not enough sample evidence to reject the cointegration.

Procedure for the LM Panel Cointegration Test

Having explained the hypothesis of the panel cointegration test, the statistical procedure to perform the test is discussed in the following section. The test procedure involves a number of steps and they are discussed systematically.

Step One – Obtaining the Non-stationary Component of the Residual

To find the non-stationary component $\theta\sum_{j=1}^{t} u_{ij}$ of the residuals e_{it}, we have to obtain u_{it} first. u_{it} is the $iid\left(0,\sigma_u^2\right)$ residuals of the regression and this regarded as stationary. According to the null hypothesis, the *a priori* expectation is that the regression is cointegrated. Therefore, the presence of cointegration can be inferred by testing for the stationary property of the residuals.

To obtain the stationary residuals u_{it}, the Dynamic Ordinary Least Squares (DOLS) is used. According to DOLS, Equation (I.13) is transformed as follows:[80]

$$y_{it} = \alpha_i + x_{it}^{'}\beta_{DOLS} + \sum_{j=-\infty}^{\infty} c_{ij}\Delta x_{it+j} + u_{it} \qquad \text{(I.14)}$$

where β_{DOLS} is the DOLS estimated coefficients for the explanatory variables. Δx_{it} is the first difference of the explanatory variables. It is the re-arranging of Equation (I.2), that is $\Delta x_{it} = \varepsilon_{it} = x_{it} - x_{it-1}$. *j* and *q* are the lead and lag terms of the Δx_{it}, c_{ij} is the estimated coefficients for the lead and lag terms.

The DOLS technique is one of a number of methods that impose restriction on the residuals to be stationary.[81] The terms $\sum_{j=-\infty}^{\infty} c_{ij}\Delta x_{it+j}$ and u_{it} in DOLS regression together

[80] The procedure for the transformation is explained in Appendix 9-J.

are empirically equivalent v_{it} in Equation (I.1). The first part account for the non-stationary component, and the second part is the stationary component. However, the ∞ in term $\sum_{j=-\infty}^{\infty} c_{ij}\Delta x_{it+j}$ means infinite number of Δx_{it} explanatory variables involved which is inoperative. Empirically, $\sum_{j=-\infty}^{\infty} c_{ij}\Delta x_{it+j}$ is truncated to $\sum_{j=-q}^{q} c_{ij}\Delta x_{it+j}$ and hence u_{it} becomes $\dot{u}_{it}$. Equation (I.14) becomes

$$y_{it} = \alpha_i + x_{it}^{'}\beta_{DOLS} + \sum_{j=-q}^{q} c_{ij}\Delta x_{it+j} + \dot{u}_{it} \tag{I.15}$$

$\dot{u}_{it}$ can be obtained from empirically estimating Equation (I.15).

Step Two – the LM Statistics

Prior to discussing the details of the LM statistics, it is useful to understand the rationality of the test. The test involves comparison of $\sum_{j=1}^{t} \dot{u}_{ij}$ against e_{it} to obtain a ratio. The value of the ratio ranges from 0 to 1. If the value of the ratio is close to 0, it implies that $\sum_{j=1}^{t} \dot{u}_{ij}$ has little contribution to e_{it}, then θ in $e_{it} = \theta\sum_{j=1}^{t} \dot{u}_{ij} + \dot{u}_{it}$ is not statistically different to 0. Hence, $e_{it} = \dot{u}_{it}$ and e_{it} is also *i.i.d.* residuals with stationarity. Thus, the panel regression is a cointegrated regression. Otherwise, e_{it} is not *i.i.d.* stationary residuals.

In McCoskey and Kao (1998), the panel *LM* test statistics is defined as

$$LM = \frac{1}{N}\sum_{i=1}^{N}\left(LM_i\right) \tag{I.16}$$

The panel *LM* is the average of LM_i statistics across all cross-section units. The individual *LM* is denoted as:

$$LM_i = \frac{\frac{1}{T^2}\sum_{t=1}^{T} S_{it}^2}{\varpi_{v,\varepsilon}^2} \tag{I.17}$$

---

[81] The other techniques to remove the non-stationarity in the residuals are Bias-corrected OLS (BCOLS) and Fully Modified OLS (FMOLS). Brief discussions of the BCOLS and FMOLS techniques are provided in Appendix 9-J.

where $S_{it} = \sum_{j=1}^{t} \hat{u}_{ij}$, which is the partial sum (cumulative sum) process as shown in Equation (I.11). Hence the variance of the partial sum process is $\sum_{t=1}^{T} S_{it}^2$. The denominator $\varpi_{v,\varepsilon}^2$ is the long run variance for the population error term v_{it}.[82] The LM_i statistics in Equation (I.17) involves comparison of the sample long-run residual variance $\sum_{t=1}^{T} S_{it}^2$ with the theoretical (population) long-run error variance $\varpi_{v,\varepsilon}^2$.

Step Three – The Population Long Run Variance $\varpi_{v,\varepsilon}^2$

The population long-run variance $\varpi_{v,\varepsilon}^2$ in the *LM* statistics above is derived in the following way: Let w_{it} be the set which consists of two errors $\left(v_{it}, \varepsilon_{it}'\right)'$, where v_{it} is the error term in Equation (I.1)[83] and ε_{it} are unit root error term of the explanatory variables x_{it} in Equation (I.2). The long-run covariance matrix of w_{it} is:

$$\Omega = \lim_{T\to\infty} \frac{1}{T} \mathrm{E}\left(\sum_{t=1}^{T} w_{it}\right)\left(\sum_{t=1}^{T} w_{it}\right)' = \Sigma + \Gamma + \Gamma' \equiv \begin{bmatrix} \varpi_1^2 & \varpi_{12} \\ \varpi_{21} & \Omega_{22} \end{bmatrix} \tag{I.18}$$

where

$$\Sigma = \lim_{T\to\infty} \frac{1}{T} \sum_{t=1}^{T} \mathrm{E}\left(w_{it} w_{it}'\right) \equiv \begin{bmatrix} \sigma_1^2 & \Sigma_{12} \\ \Sigma_{21} & \Sigma_{22} \end{bmatrix}$$

and

$$\Gamma = \lim_{T\to\infty} \frac{1}{T} \sum_{k=1}^{T-1} \sum_{t=k-1}^{T} \mathrm{E}\left(w_{it} w_{it-k}'\right) \equiv \begin{bmatrix} \Gamma_{11} & \Gamma_{12} \\ \Gamma_{21} & \Gamma_{22} \end{bmatrix}$$

---

82 $\varpi_{1.2}^2$ is used in McCoskey and Kao (1998) for the population long run variance. However, a symbol of $\varpi_{v,\varepsilon}^2$ may be easier to relate to where the long run variance is derived from.

83 In McCoskey and Kao (1998), $w_{it} = (u_{it}, \varepsilon_{it}')'$ is used. The u_{it} in $w_{it} = (u_{it}, \varepsilon_{it}')'$ is a typing error (a typo). It should be $w_{it} = (v_{it}, \varepsilon_{it}')'$. u_{it} should be replaced by v_{it}. The reason is: v_{it} is the error term for the panel regression, but u_{it} is the *i.i.d.* residuals of the unit root process in the explanatory variables x_{it}, and u_{it} is a component of ε_{it}. The mistake comes from borrowing the equations from earlier work of Kao and Chiang (later published as Kao and Chiang (2000)), and failed to change the notation to suit the new article of McCoskey and Kao (1998). In Kao and Chiang (2000), u_{it} is for the error term in the panel regression. However, McCoskey and Kao (1998) uses the notation of v_{it} for the error term in the panel regression, but in the panel cointegration test, they still use the notation of u_{it}.

and ϖ_1^2 is an $1 \times 1 \times \infty$ matrix, ϖ_{12} is an $1 \times k \times \infty$ matrix, ϖ_{21} is an $k \times 1 \times \infty$ matrix and Ω_{22} is a $k \times k \times \infty$ matrix. Γ is the variance component adjusted for long run. The adjustment process is carried out using kernel method.[84] The long run variance $\varpi_{v,\varepsilon}^2$ is defined as:

$$\varpi_{v,\varepsilon}^2 = \varpi_1^2 - \varpi_{12}\Omega_{22}^{-1}\varpi_{21} . \tag{I.19}$$

However, in empirical analysis, the population long run variance $\varpi_{v,\varepsilon}^2$ is unknown. It is estimated $\hat{\varpi}_{v,\varepsilon}^2$ using sample data. Hence the estimated long run variance is:

$$\hat{\varpi}_{v,\varepsilon}^2 = \hat{\varpi}_1^2 - \hat{\varpi}_{12}\hat{\Omega}_{22}^{-1}\hat{\varpi}_{21} \tag{I.20}$$

The estimated $\hat{\varpi}_{v,\varepsilon}^2$ has a time dimension of *T*, which is the sample size. In contrast, $\varpi_{v,\varepsilon}^2$ has the time dimension of infinity ∞. Hence, Equation (I.17) becomes:

$$LM_i = \frac{\frac{1}{T^2}\sum_{t=1}^{T} S_{it}^2}{\hat{\varpi}_{v,\varepsilon}^2} \tag{I.21}$$

The only change is replacing $\varpi_{v,\varepsilon}^2$ in Equation (I.17) with $\hat{\varpi}_{v,\varepsilon}^2$.

Step Four - Apply the LM Statistics to the Brownian-motion Distribution

Assuming sequentially asymptotic property of $T \to \infty$ followed by $N \to \infty$, it is expected that, if the regression is cointegrated, the *LM* statistic should follow the standardised Brownian motion random walk process, hence the limiting distribution is

$$\sqrt{N}\left(LM - \mu_v\right) \Rightarrow N(0, \sigma_v^2) \tag{I.22}$$

The critical values of mean μ_v and variance σ_v^2 can be simulated Wiener process that is based on the standardised Brownian motion. Harris and Inder (1994) applied this procedure to simulate the μ_v and σ_v^2 for time series data. McCoskey and Kao (1998) applied the same procedure for panel data. However, the application by McCoskey and Kao (1998) simulated the values for models up to five independent variables. The

[84] The GAUSS code for calculating the long run co-variance matrix can be downloaded from Professor Bruce E. Hansen's website http://www.ssc.wisc.edu/~bhansen/progs/et_95.html (access 15/12/2006).

significant level (*p*-value or the *prob*(z)) for the corresponding *LM* statistics can be obtained by re-arrange Equation (I.22) as:

$$prob\left(z = \frac{LM - \mu_v}{\sigma_v / \sqrt{N}} \right) \tag{I.23}$$

If the *prob*(z) is greater than $\alpha/2$ for two-tailed test, then the *LM* test failed to reject the null hypothesis of panel cointegration. However, if the *prob*(z) is less than $\alpha/2$, then panel cointegration should be rejected.

Application of the LM Cointegration Test to the Export and Import Model

Given the explanation to the *LM* cointegration test procedure, the following sections provide a general procedure of the *LM* test for our immigration and trade analysis, and then we elaborate each steps and show how the *LM* test is calculated.[85]

We first obtain the numerator part of the *LM* statistic, which is $(1/T^2 \sum_{t=1}^{T} S_{it}^2)$, one for each cross section in the panel from a panel cointegrated DOLS estimation. That is, we estimate the gravity model with panel cointegration DOLS procedure and then obtain the residuals for the whole panel. Then the residuals are divided into 10 cross sections – one cross section for one country. The residuals for each cross section is used to calculate the $(1/T^2 \sum_{t=1}^{T} S_{it}^2)$. We then calculate one common long run variance $\varpi_{v,\varepsilon}^2$ for the whole panel data set. Individual *LM* statistics can be obtained by dividing $(1/T^2 \sum_{t=1}^{T} S_{it}^2)$ by

---

[85] The procedures to obtain the *LM* cointegration tests statistic are implemented using MS-Excel. An Excel add-in program called Matrix 2.3 is used to handle all matrix manipulations. The Matrix 2.3 is a free-ware, which can be downloaded from http://digilander.libero.it/foxes/SoftwareDownload.htm (accessed 23/12/2006). The Monte Carlo simulation for Brownian motion data generating process is conducted in GAUSS light environment using the GAUSS code provided by Professor Kao. Chiang and Kao (2002) developed the NPT (Nonstationary Panel Time Series), together with the software COINT 2.0 (by Sam Ouliaris and Peter C. B. Phillips) can perform the panel cointegration *LM* test in the GAUSS environment. The NPT 1.3 is a free-ware which can be downloaded from Professor Kao's website at http://www.maxwell.syr.edu/maxpages/faculty/cdkao/working/npt.html.

$\varpi_{v,\varepsilon}^2$. The *LM* statistics for each cross section are then averaged to derive the *LM* statistic for the whole panel. After we obtained the panel *LM* statistic, then we use the *LM* statistic to compare with the Brownian motion moments. The Brownian motion moments of mean μ_v and variance σ_v^2 can be obtained by simulation using the method described in McCoskey and Kao (1998) and using the Harris's GAUSS code for moments displayed in Appendix 8-N (in Appendix for Chapter 8). By using the normal distribution with mean of μ_v and variance of σ_v^2, if the *LM* statistics is significant different form μ_v, then we can conclude that the θ in Equation (I.13) is significant different from zero, that is, the unit root component of Equation (I.4) persists and the panel regression is not cointegrated. This procedure applies to both Export and Import data sets.

The following sections will elaborate each steps in the *LM* test procedure:

1. Obtaining the Numerator Term of the LM Statistics

The following is the procedure we used to calculate the numerator term of the *LM* statistics ($\frac{1}{T^2}\sum_{t=1}^{T} S_{it}^2$) for each cross section.

We use the cointegrated panel regression residuals $\hat{u}_{it}$ obtained from a fixed effect Dynamic Generalised Least Squares (DGLS) regression. The DGLS is the feasible generalised regression of the DOLS, which is employed to minimise the impact of unknown cross section heteroskedasticity in the data set.[86]

Since there are ten countries in the panel data set, that is $i = 10$, we divided the panel residuals into ten partitions corresponding to individual countries. Each partition is then partially summed and then squared. The squared partial-sums of the residuals are then summed along the time to get a ($\sum_{t=1}^{T} S_t^2$) figure, which is the sum of squares of the partial-sum residuals. Repeat the procedure for each cross-section to get ten ($\sum_{t=1}^{T} S_t^2$)

[86] The DOLS technique and the estimated coefficients will be discussed in Section 9.4.3 and the DGLS estimates for the Export model and for the imports model is shown in Appendix 9-K.

figures.[87] Each $(\sum_{t=1}^{T} S_t^2)$ is then divided by T^2 (i.e. $38^2 = 1444$) to come up with an average variation within a cross section of $(\frac{1}{T^2}\sum_{t=1}^{T} S_t^2)$. Each individual $(\frac{1}{T^2}\sum_{t=1}^{T} S_t^2)$ is then divided by a common long run variance $\varpi_{v,\varepsilon}^2$. The *LM* statistics for the panel will be the average (which is the term of $\frac{1}{N}$ on the RHS in Equation (I.16)) of the ten individual $(\frac{1}{T^2}\sum_{t=1}^{T} S_t^2)$.

2. To Obtain the Estimated Long Run Variance

Now we move on to the calculation of $\varpi_{v,\varepsilon}^2$. The procedure is rather complicated. The following gives a simple explanation. The GAUSS code for calculating the long-run covariance matrix for a single time series with a choice of three kinds of bandwidths and three kinds of kernels can be obtained from Professor Bruce E. Hansen's website and it is a freeware.[88] However, for our study, we do not use the whole freeware and some modification is necessary for panel data regression.

To come up with our panel data long run variance $\varpi_{v,\varepsilon}^2$, we first estimate the panel regression with fixed effect OLS by

$$\tilde{y}_{it} = \alpha_i + \tilde{x}_{it}'\beta + v_{it} \qquad \text{(I.24)}$$

where $\tilde{y}_{it} = y_{it} - \overline{y}_i$ and $\tilde{x}_{it} = x_{it} - \overline{x}_i$ which is the demean process to reduce the time variation. To estimate the panel regression with trended data by the OLS technique, it results a spurious regression. The residual v_{it} in Equation (I.24) are used to calculate the coefficient of autocorrelation $\hat{\rho}_{v_i}$ in $v_{it} = \hat{\rho}_{u_i} v_{it-1} + \varphi_{it}$. The ε_{it} in Equation (I.2) are used to obtain $\hat{\rho}_{\varepsilon_i}$ in $\varepsilon_{it} = \hat{\rho}_{\varepsilon_i}\varepsilon_{it-1} + \psi_{it}$ as well as the residual variances of $\hat{\sigma}_{\varphi_i}$ and $\hat{\sigma}_{\psi_i}$. For panel data, $\hat{\rho}_{v_i}$ is a column vector of $i \times 1$ (i = 1, 2, …,10) autocorrelation coefficients, which is one for each cross section for the residual v_{it} in Equation (I.24). $\hat{\rho}_{\varepsilon_i}$ is a matrix of $i \times k$ (i = 1, 2, …,10 and k =1, 2, …,9) autocorrelation coefficients for the residuals

---

[87] The degree of freedom is reduced by the lead-lag operations. The number of data points in the Export model reduced down to 300 by a 2 leads and 5 lags operation and the number of data points for Imports model reduced down to 330 by a 1 lead and 3 lags operation.

[88] I sincerely appreciate for both the clarification of his GAUSS code and the instructions offered by Professor Hansen for obtaining the kernel value when the bandwidth equals to zero.

ε_{it} in Equation (I.2). Note, we have 10 variables in x_{it}, however, only $k = 9$ for the $\hat{\rho}_{\varepsilon_i}$ can be obtained in the calculation of the long run covariance matrix because the Distance variable in the model has no first order autoregressive $AR(1)$. Thus the set of residuals $w_{ith} = (v_{it}, \varepsilon'_{itk})'$ to be use for calculating the long run covariance matrix and the long run variances become a matrix of $IT \times H$ where $H = k+1$. Likewise, there are $i \times 1$ (i = 1, 2, …,10) residual variances of $\hat{\sigma}_{\varphi}$ and $i \times k$ (i = 1, 2, …,10 and k =1, 2, …,9) residual variances of $\hat{\sigma}_{\psi}$. The panel long run covariance matrix is the average of the all individual cross section units' long run covariance matrix. Thus, the kernel to adjust the long run covariance matrix is specific to individual cross section. That is, each cross section units in the panel data set have their own kernel value, which is dictated by the specific bandwidth to individual cross section units. The bandwidths for each cross section are determined by the aggregate impact of the $H = k+1$ autocorrelation coefficients $\hat{\rho}_h$ and the residual variances $\hat{\sigma}_h$. We selected the Bartlett kernel (K)[89]

$$K(j,q) = \begin{cases} 1 - j/q & 0 \le j \le q \\ 0 & \text{otherwise} \end{cases} \tag{I.25}$$

and where q is the Bartlett bandwidth for lag truncation and can be calculated by

$$q = 1.1447(\hat{\alpha}T)^{1/3} \tag{I.26}$$

where

$$\hat{\alpha} = \left(\sum_{h=1}^{H} \frac{4\hat{\rho}_h^{\,2}\hat{\sigma}_h^4}{(1-\hat{\rho}_h)^6(1+\hat{\rho}_h)^2} \right) \Big/ \left(\sum_{h=1}^{H} \frac{\hat{\sigma}_h^4}{(1-\hat{\rho}_h)^4} \right) \tag{I.27}$$

and j is the jth integer number which the highest j value equals to the rounding down of the bandwidth to its nearest integer. For example, the bandwidth for the data set for China in the Export model is calculated as $q_C = 2.23095776$,[90] the rounding down nearest integer is 2 – two lag truncations. Thus there are two j values for China, $j = 1$ and $j = 2$. As a result, we estimate the long run covariance matrix for China using two

[89] The Bartlett kernel (K) formula can be found in the Eviews 5.1 User's Guide prepared by Quantitative Micro Software.

[90] Our Excel spreadsheet grown enormous due to the number of cross sections involved and the number of kernel adjustment required. Thus the spreadsheet is not included in this thesis but the Excel file is available upon request.

kernel values K_1 and K_2 to adjust its contemporary covariance matrix toward the long run covariance. K_1 is calculated as $K_1 = 1 - 1/2.23095776 \approx 0.5518$ and K_2 is calculated by $K_2 = 1 - 2/2.23095776 \approx 0.1035$. Here are two more examples: Hong Kong's exports data has a bandwidth of $q_{HK} = 3.252536779$ - that is, a three lag truncations. Thus, it has $j = 1,2,3$ and three kernel values. Japan has a bandwidth of $q_J = 0.441980561$ in the Import model. The rounding down of q_J equals to 0, which means it does not have a positive integer *j*. That is, the long run adjustment is not necessary.[91]

After the Γ in Equation (I.18) is adjusted by kernel, we can compile the long run covariance matrix for individual cross section using the same equation. We then average the long run covariance matrices across all cross sections to obtain the long run covariance matrix for the panel data set. The $\varpi^2_{v,\varepsilon}$ is then obtained by Equation (I.19).

With the value of $(\sum_{t=1}^{T} S_t^2)$, T^2 and $\varpi^2_{v,\varepsilon}$ obtained, we can calculate the *LM* statistic for individual cross section as well as the *LM* statistics for the panel as a whole for both Export and Import models. Table I.1 below show the results of individual *LM* statistics and the average *LM* statistic for the Export model and Table I.2 shows the results for the Import model. By comparing Table I.1 and Table I.2, we found that the Import model in Table I.2 has much greater $(\sum_{t=1}^{T} S_t^2)$ than the Export model in Table I.1. The average *LM* statistic (LM-DOLS) of 0.218229 of the Import model is higher than the *LM* statistics of 0.037696 in the Export model. The higher value of LM-DOLS in the Import model is largely the responsibility of the $(\sum_{t=1}^{T} S_t^2)$ from HK (Hong Kong) and from TH (Thailand) in the Import model. We can find this by referring to the residual plots for the Import model in Appendix 8-M. The second graph in the residual plot from the left on the first row in the Appendix 8-M is the residual graph for Hong Kong and the graph is all the way downward slopping, exhibiting a series of non-stationary residuals. Also, the graph for Thailand is the last graph in Appendix 8-M, upward movement of the residual is evident, again exhibiting non-stationarity. From the residual graphs, the

[91] Personal communication with Prof. Hansen about the treatment on the zero kernel issue which is not covered in the UR_REG freeware.

Import model is not likely a panel co-integrated model. However, the formal test procedure we will carry out in the following will give a clear answer about whether the Export model and the Import model are co-integrated or not.

Table I.1 *LM* statistics for the Export Model

	C	HK	I	J	K	M	P	S	T	TH	LM_DOLS
$(\sum_{t=1}^{T} S_t^2)$	75.666	9.0756	30.595	11.252	15.079	11.145	15.455	7.976	7.258	7.241	
T^2	1444	1444	1444	1444	1444	1444	1444	1444	1444	1444	
$\hat{\varpi}_{1.2}$	0.3504	0.3504	0.3504	0.3504	0.3504	0.3504	0.3504	0.3504	0.3504	0.3504	
LM_i	0.1495	0.0179	0.0605	0.0222	0.0298	0.022	0.0305	0.016	0.014	0.014	**0.037696**

Table I.2 *LM* statistics for the Import Model

	C	HK	I	J	K	M	P	S	T	TH	LM_DOLS
$(\sum_{t=1}^{T} S_t^2)$	85.298	577.17	134.13	40.009	33.043	185.20	169.94	1023	84.27	552.8	
T^2	1444	1444	1444	1444	1444	1444	1444	1444	1444	1444	
$\hat{\varpi}_{1.2}$	0.9155	0.9155	0.9155	0.9155	0.9155	0.9155	0.9155	0.915	0.915	0.915	
LM_i	0.0645	0.4366	0.1015	0.0303	0.025	0.1401	0.1286	0.774	0.064	0.418	**0.218229**

Before we can conduct the test using Equation (I.22), we need to obtain values of the μ_v, which is the mean from the Brownian motion approximation through the Monte Carlo simulation and the variance of σ_v^2. Since McCoskey and Kao (1998) provide a table for the moments up to five independent variables, we need to simulate the μ_v and the σ_v^2 for eight independent variables for our test.[92] The simulation is conducted by using the GAUSS code, which is kindly provided by Professor Kao. The GAUSS code is attached in Appendix 8-N. The simulation is conducted on the GAUSS Light version of the program using the sample size of one thousand (T = 1,000), eight independent variables

[92] Although there are ten independent variables in the regression, only eight variables are needed in the Monte Carlo simulation. It is because that the distance variables do not have variation over the time T and do not follow the Brownian motion. The variable of M^2 is the square of M, but in fact, M and M^2 forms one variable.

(k = 8), and 10,000 replications.[93] We obtained the moments $\mu_v = 0.029216956$ and $\sigma_v^2 = 0.000240795$.

With all the elements of LM, μ_v, σ_v^2 and N for the test in hand, we can now calculate the significant level of the LM test. Equation (I.22) can be viewed as

$$Z = \frac{LM - \mu_v}{\sigma_v / \sqrt{N}} \tag{I.28}$$

which follows the standard normal distribution $N(0,1)$. The Z for the Export model is 1.72786 and for the Import model is 38.5182.

Table I.3 reports the cointegration test results for Export model and for the Import model. The corresponding p-value for the Export model is 0.042 and 0 for the Import model. Since the null hypothesis of panel cointegration is $\theta = 0$ against the alternative of $\theta \neq 0$. With 5% significant level (α = 0.05), a two-tailed test makes both tails at 0.025 each ($\alpha / 2 = 0.025$). The p-value for the Export model is 0.042, which is greater than the critical level of 0.025 suggesting that the null hypothesis of $\theta = 0$ cannot be rejected. Since $\theta = 0$, then $\theta \sum_{j=1}^{t} u_{ij} = 0$, thus

$$\begin{aligned} e_{it} &= \theta \sum_{j=1}^{t} u_{ij} + u_{it} \\ &= 0 + u_{it} \\ e_{it} &= u_{it} \end{aligned} \tag{I.29}$$

which means that the panel regression residuals are stationary, hence the gravity model for Export is a panel cointegrated model. Now, we are quite confident to believe that if the regression is estimated by the DOLS technique (that is, minimising the impact of the unit root process in the explanatory variables by introducing the leads and lags of the first difference term), the regression is panel cointegrated.

[93] I have conducted some experiment to see whether it is necessary to use large sample size such as T=4000 and large number of replications such as 50,000 times which is advocated by McCoskey and Kao (1998). I found that the moments obtained from using T=1000 and 10,000 replications are marginally smaller than the results reported in Table I of McCoskey and Kao (1998). Further discussion about the Brownian motion simulation will be found in Chapter 11.

Table I.3 Panel Cointegration Tests for Export Model and the Import Model

	Export	Import
LM	0.037696	0.218229
μ_v	0.029217	0.029217
σ_v	0.000241	0.000241
N	10	10
Z	1.72786	38.5182
p-value	0.042007	0.000000
$\alpha/2$	0.025	0.025

The estimated coefficients in the panel-cointegrated regression represent the long run equilibrium relation between Australia's exports and the explanatory variables in the panel regression. Specifically, relating to the significance of this study, we can conclude that, amongst other independent variables, immigration and exports has the long run stability relation.

However, for the Import model, the test shows that we can significantly reject the null hypothesis of $\theta = 0$ at the significant level of 0%. Thus strong evidence shows that the Import model is not a cointegrated model. Thus the long run relation between immigration and imports cannot be established.

Appendix 8-J A Brief Literature Review of the Panel Cointegration Estimation Procedure

In Section 8.4.2, the panel cointegration tests found that the assumption of panel cointegration could not be rejected for the Export model. As part of the test, the panel cointegration estimation technique of DGLS was applied (for simplicity, we continue to use the technique of DOLS to illustrate the panel cointegration estimation, although we apply the DGLS – the generalised version of the DOLS by cross-section weighting). Yet we did not discuss the DOLS panel cointegration estimation in details, nor did the other panel cointegration techniques. In this Appendix, we will briefly review the literature on why the OLS panel cointegration estimations are inconsistent. Other panel cointegration estimation techniques such as the BCOLS (bias-corrected OLS), the FMOLS (fully modified OLS) and DOLS are also reviewed. We then present the estimation results of our panel regression.

In Kao and Chiang (2000), if the panel regression (Equation (I.1) in Appendix 8-I) is a cointegrated regression, and if the OLS technique is applied to estimate the regression, then the OLS estimator for β is

$$\hat{\beta}_{OLS} = \left(\sum_{i=1}^{N} \sum_{t=1}^{T} \tilde{x}_{it} \tilde{x}'_{it} \right)^{-1} \left(\sum_{i=1}^{N} \sum_{t=1}^{T} \tilde{x}_{it} \tilde{y}_{it} \right) \qquad \text{(J.1)}$$

where $\tilde{x}_{it} = x_{it} - \overline{x}_i$, $\tilde{y}_{it} = y_{it} - \overline{y}_i$ and $\overline{x}_i = (1/T)\sum_{i=1}^{T} x_{it}$, $\overline{y}_i = (1/T)\sum_{i=1}^{T} y_{it}$. With the long run covariance matrix of $\Omega_i = \Sigma + \Gamma + \Gamma' \equiv \begin{bmatrix} \varpi_{1i}^2 & \varpi_{12i} \\ \varpi_{21i} & \Omega_{22i} \end{bmatrix}$ from Equation (I.18) and the one-sided long run covariance of $\Pi_i = \Sigma_i + \Gamma_i = \begin{bmatrix} \Pi_{11i} & \Pi_{12i} \\ \Pi_{21i} & \Pi_{22i} \end{bmatrix}$, Kao and Chiang (2000) and Baltagi (2005, p258-259) demonstrated that

$$\sqrt{N}T\left(\hat{\beta}_{OLS} - \beta\right) - \sqrt{N}\delta_{NT} \Rightarrow N\left(0, 6\Omega_{22i}^{-1}\varpi_{12i}\right) \qquad \text{(J.2)}$$

where $\delta_{NT} = \left[\frac{1}{N} \sum_{i=1}^{N} \frac{1}{T^2} \sum_{t=1}^{T} \tilde{x}_{it} \tilde{x}'_{it} \right]^{-1} \left[\frac{1}{N} \sum_{i=1}^{N} \Omega_{22i}^{1/2} \left(\int \tilde{W}_i dW'_i \right) \Omega_{22i}^{-1/2} \varpi_{21i} + \Pi_{21i} \right]$

where $\tilde{W}_i = W_i - \int W_i$ and W_i is the standard Brownian motion for the explanatory variables x_i. Equation (J.2) shows that the OLS estimator $\hat{\beta}_{OLS}$ for panel cointegration estimation is bias because

$$\sqrt{N}T\left(\hat{\beta}_{OLS} - \beta\right) - \sqrt{N}\delta_{NT} \Rightarrow 0 \qquad \text{(J.3)}$$

that is, $\sqrt{N}T\left(\hat{\beta}_{OLS} - \beta\right) = \sqrt{N}\delta_{NT}$ which is non-zero. $\hat{\beta}_{OLS}$ is also inconsistent due to the variance of the distribution $6\Omega_{22i}^{-1}\varpi_{12i}$ which is not a single value throughout the whole regression and which could change when i (the cross sections) changes. Thus Kao and Chiang (2000) conclude that the $\hat{\beta}_{OLS}$ is bias and inconsistent.

Since the bias comes from the non-zero property of Equation (J.3), we can correct the bias by forcing $\left(\hat{\beta}_{OLS} - \beta\right) = 0$. To achieve this, let $\hat{\beta}_{OLS}^{+}$ be the unbiased estimator of β. Be able to turn $\hat{\beta}_{OLS}$ into $\hat{\beta}_{OLS}^{+}$, we need the following adjustment:

$$\begin{aligned}
&\sqrt{N}T\left(\hat{\beta}_{OLS} - \hat{\beta}_{OLS}^{+}\right) - \sqrt{N}\delta_{NT} \Rightarrow 0 \\
&\sqrt{N}T\left(\hat{\beta}_{OLS} - \hat{\beta}_{OLS}^{+}\right) = \sqrt{N}\delta_{NT} \\
&\left(\hat{\beta}_{OLS} - \hat{\beta}_{OLS}^{+}\right) = \frac{\hat{\delta}_{NT}}{T} \\
&\hat{\beta}_{OLS}^{+} = \hat{\beta}_{OLS} - \frac{\hat{\delta}_{NT}}{T}
\end{aligned} \qquad \text{(J.4)}$$

Equation (J.4) shows that the unbiased estimator can be obtained by taking away the component of $\hat{\delta}_{NT}/T$ from the biased OLS estimator $\hat{\beta}_{OLS}$. However, Chen, McCoskey and Kao (1999) investigated the finite sample properties of this bias-corrected OLS (BCOLS) estimator and they found that the BCOLS does not improve over the OLS estimator in general.

Kao and Chiang (2000) examine the limiting distribution of the fully modified OLS (FMOLS) estimator $\hat{\beta}_{FM}$. The FM method was originated by Phillips and Hansen (1990) to eliminate both endogeneity problem in the regressor in time series regression and the serial correlation problem in errors. The FM method is also used by Pedroni (2000) in panel cointegration estimation. In the form of FMOLS by Kao and Chiang (2000) to correct the $\hat{\beta}_{OLS}$, define

$$v_{it}^{+} = v_{it} - \varpi_{12}\Omega_{22}^{-1}\varepsilon_{it} \tag{J.5}$$

$$y_{it}^{+} = y_{it} - \varpi_{12}\Omega_{22}^{-1}\Pi x_{it} \tag{J.6}$$

Note that

$$\begin{bmatrix} v_{it}^{+} \\ \varepsilon_{it} \end{bmatrix} = \begin{bmatrix} 1 & -\varpi_{12}\Omega_{22}^{-1} \\ 0 & \mathrm{I}_k \end{bmatrix} \begin{bmatrix} v_{it} \\ \varepsilon_{it} \end{bmatrix}$$

which has a long run covariance matrix of

$$\begin{bmatrix} \varpi_{12} & 0 \\ 0 & \Omega_{22} \end{bmatrix}$$

where I_k is a $k \times k$ identity matrix. Let $\hat{\varpi}_{12}$ be the unbiased estimator for ϖ_{12} and $\hat{\Omega}_{22}$ be the unbiased estimator for Ω_{22}, then the endogeneity correction is modifying the variable y_{it}, get

$$\begin{aligned} \hat{y}_{it}^{+} &= y_{it} - \hat{\varpi}_{12}\hat{\Omega}_{22}^{-1}\Pi x_{it} \\ &= \alpha_i + x_{it}'\beta + u_{it} - \hat{\varpi}_{12}\hat{\Omega}_{22}^{-1}\Pi x_{it}. \end{aligned}$$

To correct the serial correlation in the error term, Kao and Chiang (2000) used the correction term of

$$\begin{aligned} \hat{\Pi}_{21}^{+} &= \begin{pmatrix} \hat{\Pi}_{21} & \hat{\Pi}_{22} \end{pmatrix} \begin{pmatrix} 1 \\ -\hat{\Omega}_{22}^{-1}\hat{\varpi}_{21} \end{pmatrix} \\ &= \hat{\Pi}_{21} - \hat{\Pi}_{22}\hat{\Omega}_{22}^{-1}\hat{\varpi}_{21} \end{aligned}$$

where $\begin{pmatrix} \hat{\Pi}_{21} & \hat{\Pi}_{22} \end{pmatrix}$ are kernel estimates of $\begin{pmatrix} \Pi_{21} & \Pi_{22} \end{pmatrix}$. The FMOLS estimator is then

$$\hat{\beta}_{FM} = \left[\sum_{i=1}^{N} \sum_{t=1}^{T} \tilde{x}_{it}\tilde{x}_{it}' \right]^{-1} \left[\sum_{i=1}^{N} \left(\sum_{t=1}^{T} \tilde{x}_{it}\hat{y}_{it}^{+} - T\hat{\Pi}_{21}^{+} \right) \right] \tag{J.7}$$

The difference between the $\hat{\beta}_{OLS}$ in Equation (J.1) and $\hat{\beta}_{FM}$ in Equation (J.7) is that the $\tilde{y}_{it}$ has been modified by removing the endogeneity, become $\hat{y}_{it}^{+}$ and the term $\sum_{t=1}^{T} \tilde{x}_{it}\tilde{y}_{it}$ has been modified to become $\sum_{t=1}^{T} \tilde{x}_{it}\hat{y}_{it}^{+} - T\hat{\Pi}_{21}^{+}$ by removing the serial correlation in the error term. The limiting distribution of the FMOLS estimator becomes

$$\sqrt{N}T\left(\hat{\beta}_{FM}-\beta\right)\Rightarrow N\left(0,2\Omega_{22}^{-1}\varpi_{12}\right) \tag{J.8}$$

and now we can expect that the $\hat{\beta}_{FM}$ is unbiased because in the normal distribution of $N\left(0,2\Omega_{22}^{-1}\varpi_{12}\right)$, the means is 0.

However, in Kao and Chiang's (2000) Monte Carlo simulations, the FMOLS estimator and their *t*-statistic cannot outperform the OLS estimator. But the DOLS outperforms both the OLS and FMOLS estimators in all counts. We turn our attention to the DOLS panel cointegration estimation.

The DOLS panel cointegration estimation is also illustrated in Kao and Chiang's (2000) which builds upon the time series work of Stock and Watson (1993) and Saikkonen (1991). Consider the fixed effect panel regression of Equations (I.1) and (I.2) which reproduced as

$$y_{it}=\alpha_i+x_{it}^{'}\beta+v_{it}, \quad i=1,...,N, \ \ t=1,...,T, \tag{J.9}$$

and

$$x_{it}=x_{it-1}+\varepsilon_{it} \tag{J.10}$$

With satisfying certain assumptions which are stated in Kao and Chiang's (2000), the process of v_{it} can be viewed as (see Saikkonen, 1991)

$$v_{it}=\sum_{j=-\infty}^{\infty}c_{ij}\varepsilon_{it+j}+u_{it} \tag{J.11}$$

for all i cross sections, where j is the leads and lags terms. In practice, the leads and lags may be truncated and Equation (J.11) can be written as

$$v_{it}=\sum_{j=-q}^{q}c_{ij}\varepsilon_{it+j}+\dot{u}_{it}. \tag{J.12}$$

Substitute Equation (J.12) into Equation (J.9), get

$$y_{it}=\alpha_i+x_{it}^{'}\beta+\sum_{j=-q}^{q}c_{ij}\varepsilon_{it+j}+\dot{u}_{it} \tag{J.13}$$

To make Equation (J.13) be able to estimated by the data, we rearrange Equation (J.10) to get

$$\varepsilon_{it} = x_{it} - x_{it-1} = \Delta x_{it} . \quad \text{(J.14)}$$

It is simply the first difference of the explanatory variables. Substitute Equation (J.14) into Equation (J.13) get

$$y_{it} = \alpha_i + x_{it}^{'} \beta_{DOLS} + \sum_{j=-q}^{q} c_{ij} \Delta x_{it+j} + \dot{u}_{it} . \quad \text{(J.15)}$$

Equation (J.15) is the DOLS regression, which is simply adding leads and lags of the first difference of the explanatory variables to the OLS regression. Kao and Chiang (2000) shows that the $\hat{\beta}_{DOLS}$ has the same limiting distribution as $\hat{\beta}_{FM}$ in Equation (J.8).

Appendix 8-K DGLS Estimates for Export and Import

Dependent Variable: E?
Method: Pooled EGLS (Cross-section SUR)

Sample (adjusted): 1969 1998
Included observations: 30 after adjustments
Cross-sections included: 10
Total pool (balanced) observations: 300
Linear estimation after one-step weighting matrix
Cross-section weights (PCSE) standard errors &
covariance (no d.f. correction)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
Y?	2.2127	0.2862	7.7312	0.0000
YF?	-0.4668	0.0407	-11.4583	0.0000
YP?	-0.7414	0.2878	-2.5765	0.0106
YPF?	1.3813	0.0725	19.0593	0.0000
P?	-1.1037	0.3227	-3.4206	0.0007
PF?	0.3972	0.0932	4.2627	0.0000
OF?	0.5152	0.0592	8.6979	0.0000
ML4?	0.1945	0.0200	9.7403	0.0000
M2L4?	-0.0205	0.0022	-9.5117	0.0000
LDIST?	-1.7462	0.1746	-10.0035	0.0000
DUMH?	-6.1060	0.2904	-21.0267	0.0000
DUMI?	-2.4992	0.1294	-19.3209	0.0000
DUMJ?	-1.4293	0.2374	-6.0207	0.0000
DUMM?	-4.8559	0.2267	-21.4205	0.0000
DUMP?	-3.6532	0.1372	-26.6216	0.0000
DUMS?	-6.8303	0.3338	-20.4622	0.0000
DUMK?	-2.8152	0.2147	-13.1102	0.0000
DUMT?	-3.7700	0.2437	-15.4690	0.0000
DUMTH?	-4.1328	0.1882	-21.9588	0.0000
DY?(2)	1.0433	0.7045	1.4808	0.1401
DYF?(2)	-0.3661	0.1518	-2.4110	0.0167
DYP?(2)	-0.1841	0.7228	-0.2547	0.7992
DYPF?(2)	0.9016	0.2326	3.8767	0.0001
DP?(2)	-0.9388	0.6890	-1.3625	0.1744
DPF?(2)	0.4003	0.1812	2.2100	0.0281
DOF?(2)	-0.2227	0.1224	-1.8186	0.0703
DML4?(2)	-0.0041	0.0144	-0.2862	0.7750
DY?(1)	-1.0648	0.7723	-1.3787	0.1693
DYF?(1)	0.0406	0.1565	0.2594	0.7956
DYP?(1)	3.2194	1.0148	3.1724	0.0017
DYPF?(1)	0.6695	0.2381	2.8121	0.0054
DP?(1)	0.8789	0.7772	1.1308	0.2593
DPF?(1)	0.0277	0.1743	0.1589	0.8739
DOF?(1)	0.4230	0.1140	3.7099	0.0003
DML4?(1)	-0.0067	0.0153	-0.4393	0.6609
DY?(-1)	1.2043	0.8036	1.4986	0.1354
DYF?(-1)	0.8642	0.1438	6.0115	0.0000
DYP?(-1)	-1.4916	0.7948	-1.8767	0.0619
DYPF?(-1)	-0.6975	0.2327	-2.9969	0.0030
DP?(-1)	-0.5561	0.7694	-0.7228	0.4706
DPF?(-1)	-0.3022	0.1655	-1.8261	0.0692
DOF?(-1)	0.0006	0.1509	0.0038	0.9970
DML4?(-1)	-0.0189	0.0143	-1.3140	0.1902
DY?(-2)	0.4321	0.6766	0.6387	0.5237
DYF?(-2)	0.2835	0.0921	3.0798	0.0023
DYP?(-2)	-1.0976	1.0015	-1.0960	0.2743

Dependent Variable: I?
Method: Pooled EGLS (Cross-section SUR)

Sample (adjusted): 1967 1999
Included observations: 33 after adjustments
Cross-sections included: 10
Total pool (balanced) observations: 330
Linear estimation after one-step weighting matrix
Cross-section SUR (PCSE) standard errors &
covariance (no d.f. correction)

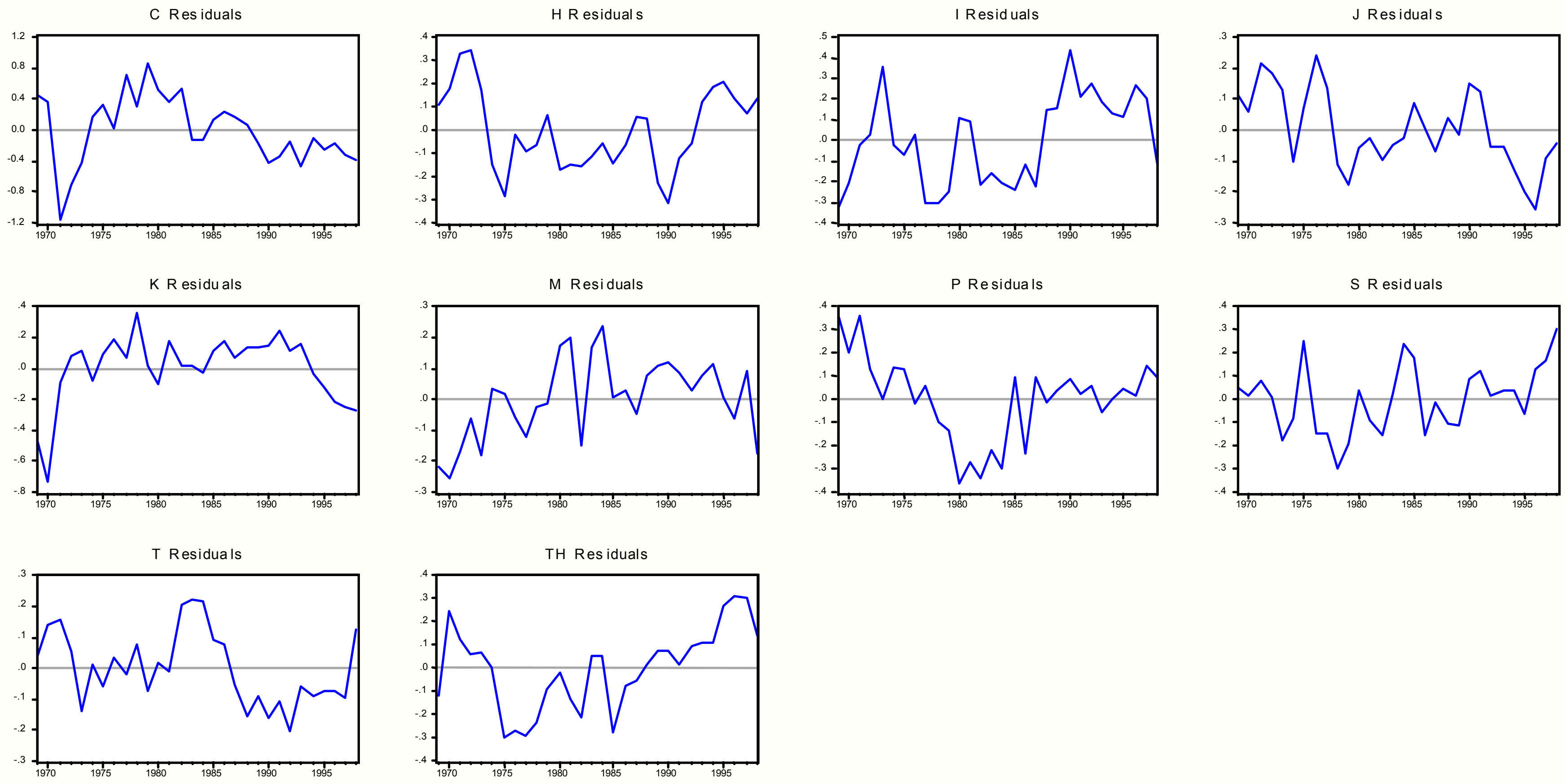
Variable	Coefficient	Std. Error	t-Statistic	Prob.
Y?	0.9943	0.2864	3.4724	0.0006
YF?	0.0885	0.0441	2.0072	0.0457
YP?	1.3724	0.5803	2.3652	0.0187
YPF?	0.8564	0.0842	10.1664	0.0000
P?	1.0605	0.3565	2.9747	0.0032
PF?	-0.7791	0.0871	-8.9449	0.0000
O?	0.1300	0.4447	0.2924	0.7702
ML2?	0.2072	0.0176	11.7992	0.0000
M2L2?	-0.0254	0.0021	-12.0591	0.0000
LDIST?	-3.2064	0.4580	-7.0008	0.0000
DUMH?	-1.7739	0.3230	-5.4924	0.0000
DUMI?	-1.7954	0.1918	-9.3616	0.0000
DUMJ?	0.0459	0.2695	0.1701	0.8650
DUMM?	-1.5244	0.2562	-5.9499	0.0000
DUMP?	-3.2422	0.2011	-16.1260	0.0000
DUMS?	-2.3780	0.4008	-5.9328	0.0000
DUMK?	-0.6201	0.2155	-2.8774	0.0043
DUMT?	-0.4994	0.2598	-1.9223	0.0556
DUMTH?	-2.2344	0.2087	-10.7050	0.0000
DY?(1)	-0.1959	0.8764	-0.2235	0.8233
DYF?(1)	0.1248	0.1676	0.7451	0.4568
DYP?(1)	2.5147	1.2747	1.9728	0.0495
DYPF?(1)	0.4476	0.3219	1.3906	0.1654
DP?(1)	0.4328	0.8785	0.4927	0.6226
DPF?(1)	-0.2309	0.1867	-1.2367	0.2172
DO?(1)	-1.1588	0.5862	-1.9770	0.0490
DML2?(1)	-0.0029	0.0196	-0.1473	0.8830
DY?(-1)	-0.1820	0.7709	-0.2361	0.8135
DYF?(-1)	0.0939	0.1548	0.6068	0.5445
DYP?(-1)	0.7086	1.0332	0.6858	0.4934
DYPF?(-1)	-0.8133	0.2954	-2.7530	0.0063
DP?(-1)	0.8766	0.8273	1.0595	0.2903
DPF?(-1)	-0.0227	0.1721	-0.1319	0.8951
DO?(-1)	-0.9588	0.6696	-1.4321	0.1532
DML2?(-1)	0.0305	0.0183	1.6702	0.0960
DY?(-2)	2.2836	0.8997	2.5382	0.0117
DYF?(-2)	0.0703	0.1529	0.4597	0.6461
DYP?(-2)	-3.2329	1.2305	-2.6273	0.0091
DYPF?(-2)	0.0302	0.2422	0.1248	0.9008
DP?(-2)	-2.9277	0.9533	-3.0712	0.0023
DPF?(-2)	0.1860	0.1711	1.0871	0.2779
DO?(-2)	0.6011	0.7103	0.8462	0.3982
DML2?(-2)	0.0228	0.0176	1.2996	0.1948
DY?(-3)	-1.5751	0.9482	-1.6613	0.0978
DYF?(-3)	0.3465	0.1449	2.3908	0.0175
DYP?(-3)	0.2065	1.2443	0.1659	0.8683

DYPF?(-2)	-0.1022	0.2078	-0.4917	0.6234
DP?(-2)	-0.0333	0.6725	-0.0496	0.9605
DPF?(-2)	-0.1652	0.1489	-1.1095	0.2684
DOF?(-2)	0.4145	0.1409	2.9420	0.0036
DML4?(-2)	0.0377	0.0147	2.5650	0.0110
DY?(-3)	0.4935	0.6413	0.7696	0.4423
DYF?(-3)	0.2876	0.0812	3.5405	0.0005
DYP?(-3)	-2.0370	0.7244	-2.8122	0.0054
DYPF?(-3)	-0.3378	0.2111	-1.6001	0.1110
DP?(-3)	-0.1182	0.6104	-0.1937	0.8466
DPF?(-3)	-0.4208	0.1250	-3.3677	0.0009
DOF?(-3)	0.0856	0.1458	0.5869	0.5579
DML4?(-3)	0.0143	0.0153	0.9353	0.3506
DY?(-4)	-2.5712	0.8144	-3.1573	0.0018
DYF?(-4)	0.1049	0.0854	1.2285	0.2206
DYP?(-4)	0.0919	0.7076	0.1299	0.8968
DYPF?(-4)	0.2065	0.1843	1.1204	0.2637
DP?(-4)	3.0988	0.8148	3.8030	0.0002
DPF?(-4)	-0.2737	0.1305	-2.0974	0.0371
DOF?(-4)	0.0657	0.1267	0.5186	0.6045
DML4?(-4)	0.0305	0.0149	2.0456	0.0420
DY?(-5)	0.1636	0.5464	0.2994	0.7649
DYF?(-5)	0.0406	0.0743	0.5469	0.5850
DYP?(-5)	-2.5512	0.8616	-2.9611	0.0034
DYPF?(-5)	0.1468	0.1718	0.8544	0.3938
DP?(-5)	0.1709	0.5124	0.3335	0.7391
DPF?(-5)	0.0497	0.1158	0.4292	0.6682
DOF?(-5)	0.2713	0.1309	2.0722	0.0394
DML4?(-5)	0.0310	0.0141	2.1958	0.0291
	Weighted Statistics			
R^2	0.9996	Mean dep var		82.2961
Adj R^2	0.9995	S.D. dep var		46.8175
S.E. of reg	1.0157	SSR		232.122
D-W stat	1.3173			
	Unweighted Statistics			
R^2	0.9642	Mean dep var		6.6892
Adjusted R^2	12.8992	D-W stat		0.8933

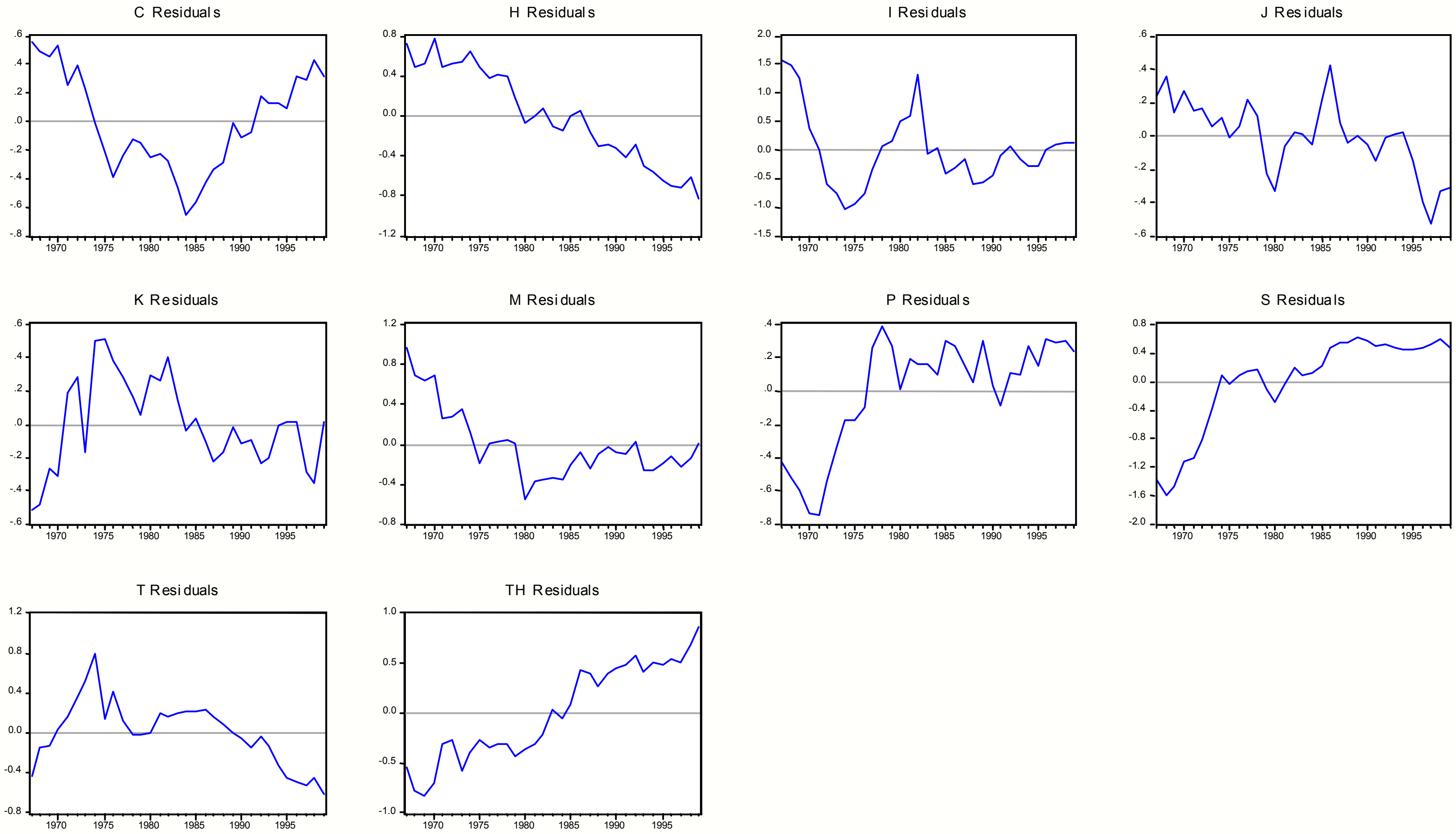
DYPF?(-3)	-0.1126	0.2288	-0.4921	0.6230
DP?(-3)	2.4241	0.8640	2.8056	0.0054
DPF?(-3)	-0.1453	0.1609	-0.9031	0.3673
DO?(-3)	-1.5008	0.8741	-1.7169	0.0871
DML2?(-3)	0.0184	0.0172	1.0702	0.2854
	Weighted Statistics			
R^2	0.9979	Mean dep var		27.8042
Adj R^2	0.9975	S.D. dep var		19.5520
S.E. of reg	0.9811	SSR		268.571
D-W stat	0.9113			
	Unweighted Statistics			
R^2	0.8967	Mean dep var		6.3410
Adjusted R^2	60.3420	D-W stat		0.2303

(1)For the Export model, the immigrant intake variable is lagged by four periods. Since the immigrant intake data is collected with a six months shift, the four period lagged is effectively three and a half years lag.
(2)For the Import model, the immigrant intake variable is lagged by two periods, which is one and a half-year lag.
(3) For the lead and lag term in the regression which forms the dynamic part of the DGLS, they are used to remove the unit roots components in the explanatory variables x_{it} from the regression residuals. The estimated coefficients for the leads and lags are not required to be statistically significant in the regression. The choice of the leads and lags are guided by an optimal choice amongst the factors of Schwarz criterion, the Akaike information criterion, the sign and the *p*-value of the estimated coefficients of the economic variables in the DGLS regression. We selected 2 leads and 5 lags term for the Export model and 1 lead and 3 lags for the Import model.
(4)We do not use the square of the immigrant variable in the lead-lag operation because it is just the square of the immigrant variable. We also do not use the distance variables in the lead-lag operation because they are time invariant and will not follow the unit root process.
(4) The R squared for both Export model and Import model are high. All the estimated coefficients are statistically significant except the openness variables (O) and the intercept dummy for Japan in the Import model. The DGLS regressions are not spurious regressions.
(5)The *LM*-cointegration test results in Section 9.4.2 cannot find evidence to prove that the models are not cointegrated for Export mode. However, the test result strongly rejects cointegration in the Import model. The residual plots in Appendix 8_J and 8_K illustrate this difference.

Appendix 8_L Residual Plots for the Export Model



Appendix 8_M Residual Plots for the Import Model



Appendix 8-N GAUSS Code for Brownian Motion Simulation[94]

```
@*******************************************************************@
@*** Harris Code for Moments                                   ****@
@*******************************************************************@
output file=harris4.out reset;
@--Define some initial values.---@

N=1;
T=1000;
k=8;
rec=10000;
s2=zeros(rec,1);

i=1; do until i>rec;

/* Approximate various integrals */

      dW1=rndn(T,1);
      dW2=rndn(T,k);          /* k is the number of regressors */
      W1=cumsumc(dW1);
      W2=cumsumc(dW2);
      iW2=sumc(W2)/T^(3/2);
      iW2W2=invpd(W2'W2/(T^2));
      iW2dW1=W2'dW1/T;

/* Approximate P, Q, R, S */

      P=1-iW2'iW2W2*iW2;
      Q=W1[T]/(T^.5)-iW2'iW2W2*iW2dW1;
      R=iW2W2*iW2;
      S=iW2W2*iW2dW1;

/* Obtain realization of V */

  V=W1/(T^.5)-inv(P)*Q*seqa(1,1,T)/T-cumsumc(W2)/(T^(3/2))*(S-
R*inv(P)*Q);

/* Integral of V^2 */

      s2[i]=sumc(V^2/T);

i=i+1;
endo;

s3=sortc(s2,1);

mu=sumc(s2)/rec;
msigma=1/(rec-1)*(s2-mu*ones(rec,1))'*(s2-mu*ones(rec,1));
print "5% confidence level: " s3[.95*rec];
print "N=" N;
print "T=" T;
print "rec=" rec;
print "k=" k;

print "mean and variance: " mu~msigma;
{vnam,mean,var,std,min,max,valid,mis}=DSTAT(0,s2);
print mean~var;
```

---

94 The GAUSS code is kindly provided by Professor Kao.

Appendix 9-O GAUSS Code for Calculating Long Run Covariance Matrix[95]

```
/*  URREG.PRC

Procedures to implement unit root testing with regression covariates.

Bruce E. Hansen
Department of Economics
Social Science Building
University of Wisconsin
Madison, WI 53706-1393
bhansen@ssc.wisc.edu
http://www.ssc.wisc.edu/~bhansen/

This file contains four GAUSS procedures:
UR_REG, LR_VAR, UR_CRITS, UR_ADF.

@ GLOBAL VARIABLES: @

_kernel  = 1;
_band    = 0;
_urprint = 1;
_white   = 0;


@ PROCEDURE CODE: @

proc (2) = lr_var(u);
local te,p,eb,ef,ae,ee,se,ad,a1,a2,bandw,jb,jband,kern,lam,omega;
local tm,j,kj,e,tu,au,eau;

tu = rows(u);
p = cols(u);
if _white == 1;
  te = tu-1;
  au = u[2:tu,.]/u[1:te,.];
  e = u[2:tu,.] - u[1:te,.]*au;
else;
  e = u;
  te = tu;
endif;
if _band == 0;
 eb = e[1:te-1,.];
 ef = e[2:te,.];
 ae = sumc(eb.*ef)./sumc(eb.^2);
 ee = ef - eb.*(ae');
 se = meanc(ee.^2);
 ad = sumc((se./((1-ae).^2)).^2);
 a1 = 4*sumc((ae.*se./(((1-ae).^3).*(1+ae))).^2)/ad;
 a2 = 4*sumc((ae.*se./((1-ae).^4)).^2)/ad;
 if _kernel == 2;                              @  Quadratic Spectral @
  bandw = 1.3221*((a2*te)^.2);
 elseif _kernel == 1;                          @  Parzen     @
  bandw = 2.6614*((a2*te)^.2);
   if bandw > (te-2); bandw = te-2; endif;
```

[95] The GAUSS code is part of the free-ware called UR-REG made available to the public by Professor Bruce E. Hansen.

```
 elseif _kernel == 3;                          @  Bartlett   @
   bandw = 1.1447*((a1*te)^.333);
   if bandw > (te-2); bandw = te-2; endif;
 endif;
else;
 bandw = _band;
endif;

@ Estimate Covariances @
if _kernel == 2;                                  @ Quadratic Spectral
Kernel @
  tm = te-1;
  jb = seqa(1,1,tm)/bandw;
  jband = jb*1.2*pi;
  kern = ((sin(jband)./jband - cos(jband))./(jband.^2)).*3;
elseif _kernel == 1;                          @  Parzen kernel @
  tm = floor(bandw);
  if tm > 0;
   jb = seqa(1,1,tm)/bandw;
   kern = (1 - (jb.^2)*6 + (jb.^3)*6).*(jb .<= .5);
   kern = kern + ((1-jb).^3).*(jb .> .5)*2;
  endif;
elseif _kernel == 3;                          @  Bartlett kernel @
  tm = floor(bandw);
  if tm > 0;
    kern = 1 - seqa(1,1,tm)/bandw;
  endif;
endif;

lam = zeros(p,p);
j = 1; do while j <=tm;
  kj = kern[j];
  lam = lam + (e[1:te-j,.]'e[1+j:te,.])*kj;
j = j + 1; endo;
omega = (moment(e,0) + lam + (lam'))/te;
```

Appendix 8-P Panel Error Correction Estimation for the Export Model

Dependent Variable: DE?
Method: Pooled EGLS (Cross-section SUR)
Sample (adjusted): 1970 1999
Included observations: 30 after adjustments
Cross-sections included: 10
Total pool (balanced) observations: 300
Linear estimation after one-step weighting matrix
White diagonal standard errors & covariance (d.f. corrected)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
DY?	1.501014	0.377596	3.975188	0.0001
DYF?	0.353948	0.154688	2.288141	0.0229
DYP?	-2.167626	0.606949	-3.57135	0.0004
DYPF?	0.240719	0.2865	0.840207	0.4015
DP?	-0.515175	0.361795	-1.423942	0.1556
DPF?	0.128376	0.174539	0.735515	0.4626
DOF?	0.451271	0.099461	4.537166	0
DML4?	0.039599	0.012032	3.291094	0.0011
DM2L4?	-0.004233	0.001699	-2.49062	0.0133
RESID?(-1)	-0.337038	0.045514	-7.40519	0
LDIST?	0.002547	0.007606	0.334833	0.738
DUMH?	0.010941	0.073742	0.148365	0.8822
DUMI?	0.089774	0.074902	1.198557	0.2317
DUMJ?	-0.021502	0.071761	-0.299627	0.7647
DUMK?	0.081504	0.082784	0.984534	0.3257
DUMM?	0.003658	0.07483	0.04888	0.961
DUMP?	0.037649	0.070266	0.535803	0.5925
DUMS?	-0.006876	0.073662	-0.093341	0.9257
DUMT?	0.031126	0.070911	0.438948	0.661
DUMTH?	0.026249	0.075793	0.346321	0.7294

Weighted Statistics

R-squared	0.520424	Mean dependent var	0.434119
Adjusted R-squared	0.487882	S.D. dependent var	1.442432
S.E. of regression	1.024091	Sum squared resid	293.6533
Durbin-Watson stat	2.02542		

Unweighted Statistics

R-squared	0.985384	Mean dependent var	0.06392
Sum squared resid	8.949886	Durbin-Watson stat	2.0567

Appendix 8-Q GLS Estimates for the Import Model on First Differenced Data

Dependent Variable: DI?
Method: Pooled EGLS (Cross-section weights)
Sample (adjusted): 1964 2000
Included observations: 37 after adjustments
Cross-sections included: 10
Total pool (unbalanced) observations: 366
Linear estimation after one-step weighting matrix
White cross-section standard errors & covariance (no d.f. correction)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
DY?	0.178055	0.758010	0.234898	0.8144
DYF?	-0.289526	0.202212	-1.431798	0.1531
DYP?	0.909336	1.283483	0.708491	0.4791
DYPF?	0.412887	0.438949	0.940625	0.3476
DP?	1.064793	0.659627	1.614235	0.1074
DPF?	0.247276	0.236143	1.047144	0.2958
DO?	0.772587	0.476918	1.619957	0.1061
DML2?	0.046599	0.029185	1.596688	0.1112
DM2L2?	-0.006478	0.003430	-1.888704	0.0598
LDIST?	0.006740	0.004261	1.581739	0.1146
DUMH?	-0.065591	0.025463	-2.575907	0.0104
DUMI?	-0.088258	0.059994	-1.471114	0.1422
DUMJ?	-0.052025	0.024501	-2.123353	0.0344
DUMK?	-0.025730	0.043134	-0.596515	0.5512
DUMM?	-0.046460	0.028600	-1.624501	0.1052
DUMP?	-0.030576	0.032816	-0.931752	0.3521
DUMS?	0.075547	0.046554	1.622784	0.1055
DUMT?	0.007019	0.035624	0.197029	0.8439
DUMTH?	0.029195	0.030854	0.946242	0.3447

Weighted Statistics

R-squared	0.365311	Mean dependent var	0.098823
Adjusted R-squared	0.332387	S.D. dependent var	0.265531
S.E. of regression	0.216959	Sum squared resid	16.33371
Durbin-Watson stat	2.183128		

Unweighted Statistics

R-squared	0.283981	Mean dependent var	0.085360
Sum squared resid	16.76198	Durbin-Watson stat	2.177336

Appendix 8-R Panel Error Correction Estimations for the Import Model

Dependent Variable: DI?
Method: Pooled EGLS (Cross-section weights)
Sample (adjusted): 1968 1998
Included observations: 31 after adjustments
Cross-sections included: 10
Total pool (balanced) observations: 310
Linear estimation after one-step weighting matrix
White cross-section standard errors & covariance (no d.f. correction)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
DY?	-0.040192	0.771195	-0.052116	0.9585
DYF?	-0.601741	0.226550	-2.656104	0.0083
DYP?	1.236367	1.368927	0.903165	0.3672
DYPF?	1.019113	0.328532	3.102024	0.0021
DP?	1.263255	0.683355	1.848608	0.0655
DPF?	0.531782	0.264782	2.008381	0.0455
DO?	0.597492	0.504036	1.185414	0.2368
DML2?	0.046489	0.023730	1.959123	0.0511
DM2L2?	-0.006532	0.003602	-1.813576	0.0708
LDIST?	0.004999	0.004666	1.071406	0.2849
RESID?(-1)	-0.092120	0.023072	-3.992651	0.0001
DUMH?	-0.088954	0.025754	-3.454038	0.0006
DUMI?	-0.112181	0.076114	-1.473852	0.1416
DUMJ?	-0.057225	0.027036	-2.116632	0.0351
DUMK?	-0.042636	0.037611	-1.133602	0.2579
DUMM?	-0.023891	0.024668	-0.968495	0.3336
DUMP?	-0.047974	0.034720	-1.381716	0.1681
DUMS?	0.071487	0.033180	2.154529	0.0320
DUMT?	-0.010283	0.032487	-0.316516	0.7518
DUMTH?	0.026248	0.028613	0.917336	0.3597

Weighted Statistics

R-squared	0.484870	Mean dependent var	0.090719
Adjusted R-squared	0.451120	S.D. dependent var	0.264187
S.E. of regression	0.195727	Sum squared resid	11.10960
Durbin-Watson stat	2.140441		

Unweighted Statistics

R-squared	0.400828	Mean dependent var	0.078280
Sum squared resid	11.70203	Durbin-Watson stat	2.151649

APPENDIX TO CHAPTER 9

Appendix 9-A VEC with Three Lags for the Export Model

Vector Error Correction Estimates
Sample (adjusted): 1967 2000
Included observations: 340 after adjustments
Standard errors in ( ) & t-statistics in [ ]

Cointegrating Eq: CointEq1

Cointegrating Eq:	CointEq1
E(-1)	1
M(-1)	-0.37288
	-0.05722
	[-6.51711]
M2(-1)	0.031991
	-0.00643
	[4.97726]

Error Correction:	D(E)	D(M)	D(M2)		D(E)	D(M)	D(M2)
CointEq1	-0.39139	0.045439	-1.53865	YF	-0.08515	0.039662	-0.78034
	-0.04024	-0.09839	-1.04012		-0.03666	-0.08963	-0.9475
	[-9.72585]	[0.46183]	[-1.47930]		[-2.32274]	[0.44252]	[-0.82358]
D(E(-1))	0.019132	-0.07573	-0.50756	YP	-1.87831	0.515453	12.68807
	-0.03646	-0.08915	-0.94246		-0.33689	-0.82367	-8.70741
	[0.52468]	[-0.84948]	[-0.53855]		[-5.57541]	[0.62580]	[1.45716]
D(E(-2))	0.014522	-0.08632	-0.73129	YPF	0.33087	-0.19792	2.390748
	-0.02996	-0.07325	-0.77436		-0.09017	-0.22046	-2.33058
	[0.48471]	[-1.17843]	[-0.94439]		[3.66939]	[-0.89775]	[1.02582]
D(E(-3))	0.018297	0.005648	0.162706	P	0.235938	0.266284	-0.4929
	-0.02267	-0.05543	-0.58597		-0.13822	-0.33794	-3.57246
	[0.80705]	[0.10189]	[0.27767]		[1.70698]	[0.78797]	[-0.13797]
D(M(-1))	-0.12521	0.24143	2.866822	PF	-0.01628	-0.18459	-0.8228
	-0.05073	-0.12402	-1.31107		-0.05717	-0.13978	-1.47763
	[-2.46839]	[1.94670]	[2.18662]		[-0.28483]	[-1.32062]	[-0.55683]
D(M(-2))	-0.06197	-0.12992	-0.95981	O	1.638691	-0.48124	-12.2343
	-0.05051	-0.12349	-1.3055		-0.2547	-0.62272	-6.58305
	[-1.22689]	[-1.05200]	[-0.73520]		[6.43383]	[-0.77281]	[-1.85845]
D(M(-3))	0.059754	0.028704	0.647315	LDIST	0.748365	-0.11356	-9.03687
	-0.05061	-0.12373	-1.30798		-0.29733	-0.72695	-7.68491
	[1.18076]	[0.23199]	[0.49490]		[2.51695]	[-0.15621]	[-1.17592]
D(M2(-1))	0.009225	-0.02212	-0.23705	DUMH	-0.94672	0.614836	-9.27053
	-0.00482	-0.01178	-0.12455		-0.30225	-0.73898	-7.81206
	[1.91427]	[-1.87716]	[-1.90325]		[-3.13225]	[0.83201]	[-1.18669]
D(M2(-2))	0.006948	-0.00024	-0.07019	DUMI	-0.22154	0.097686	-5.75814
	-0.00481	-0.01177	-0.12439		-0.14304	-0.34973	-3.69713
	[1.44360]	[-0.02036]	[-0.56428]		[-1.54879]	[0.27932]	[-1.55746]

D(M2(-3))	-0.00411	-0.00834	-0.122	DUMJ	0.228059	0.457769	-3.79769
	-0.00489	-0.01196	-0.12639		-0.19078	-0.46644	-4.93091
	[-0.83984]	[-0.69761]	[-0.96529]		[1.19542]	[0.98142]	[-0.77018]
Y	0.487441	-0.17305	0.633507	DUMM	-0.72061	0.367911	-8.25176
	-0.16373	-0.40031	-4.23188		-0.24073	-0.58856	-6.22192
	[2.97707]	[-0.43228]	[0.14970]		[-2.99347]	[0.62510]	[-1.32624]
DUMP	-0.58304	0.191621	-7.58282	DUMT	-0.46499	0.568455	-4.10769
	-0.18462	-0.45139	-4.77181		-0.19575	-0.47859	-5.05939
	[-3.15800]	[0.42452]	[-1.58909]		[-2.37547]	[1.18777]	[-0.81189]
DUMS	-0.92003	0.645914	-10.2546	DUMTH	-0.91723	0.308551	-6.68926
	-0.33717	-0.82435	-8.7146		-0.18931	-0.46286	-4.89305
	[-2.72868]	[0.78354]	[-1.17671]		[-4.84504]	[0.66663]	[-1.36709]
DUMSK	-0.55688	0.518949	-3.27669				
	-0.17296	-0.42288	-4.47049				
	[-3.21963]	[1.22717]	[-0.73296]				
R-squared	0.373497	0.082347	0.087371				
Adj. R-squared	0.321456	0.006121	0.011562				
Sum sq. resids	12.14465	72.59645	8113.047				
S.E. equation	0.196979	0.481599	5.091196				
F-statistic	7.176877	1.080295	1.15251				
Log likelihood	84.01062	-219.954	-1021.73				
Akaike AIC	-0.33536	1.452671	6.168984				
Schwarz SC	-0.03129	1.756734	6.473047				
Mean dependent	0.072248	0.108184	1.118428				
S.D. dependent	0.239128	0.48308	5.120885				
Determinant resid covariance (dof adj.)			0.044432				
Determinant resid covariance			0.034665				
Log likelihood			-875.773				
Akaike information criterion			5.645722				
Schwarz criterion			6.591697				

Appendix 9-B Johansen Cointegration Test for Immigrant Intake Variable and Export to Vietnam Variable

Sample (adjusted): 1977 2004
Included observations: 28 after adjustments
Trend assumption: Linear deterministic trend
Series: EVI MVI MVI2
Lags interval (in first differences): 1 to 1

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.820595	62.09308	29.79707	0.0000
At most 1	0.381614	13.98609	15.49471	0.0833
At most 2	0.018684	0.528103	3.841466	0.4674

Trace test indicates 1 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None *	0.820595	48.10699	21.13162	0.0000
At most 1	0.381614	13.45798	14.26460	0.0667
At most 2	0.018684	0.528103	3.841466	0.4674

Max-eigenvalue test indicates 1 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Cointegrating Coefficients (normalized by b'*S11*b=I):

EVI	MVI	MVI2
-0.184326	-33.31328	1.962027
-0.701023	8.455413	-0.621640
0.580967	3.311184	-0.212149

Unrestricted Adjustment Coefficients (alpha):

D(EVI)	-0.016739	0.337818	-0.070575
D(MVI)	0.198820	0.122316	0.009768
D(MVI2)	2.929895	2.097162	0.180724

1 Cointegrating Equation(s): Log likelihood -26.66887

Normalized cointegrating coefficients (standard error in parentheses)

EVI	MVI	MVI2
1.000000	180.7300	-10.64432
	(18.2229)	(1.09404)

Adjustment coefficients (standard error in parentheses)

D(EVI)	0.003085
	(0.02891)
D(MVI)	-0.036648
	(0.00884)
D(MVI2)	-0.540057
	(0.14960)

2 Cointegrating Equation(s): Log likelihood -19.93988

Normalized cointegrating coefficients (standard error in parentheses)

EVI	MVI	MVI2
1.000000	0.000000	0.165347
		(0.03057)
0.000000	1.000000	-0.059811
		(0.00029)

Adjustment coefficients (standard error in parentheses)

D(EVI)	-0.233733	3.414009
	(0.10157)	(4.81586)
D(MVI)	-0.122394	-5.589103
	(0.02946)	(1.39689)
D(MVI2)	-2.010215	-79.87206
	(0.49559)	(23.4990)

Appendix 9-C VEC Estimates with Two Lags for the Export Model

Vector Error Correction Estimates
Sample (adjusted): 1978 2004
Included observations: 27 after adjustments
Standard errors in ( ) & t-statistics in [ ]

Cointegrating Eq:	CointEq1
EVI(-1)	1
MVI(-1)	709.1432
	-138.04
	[5.13722]
MVI2(-1)	-42.3304
	-8.2377
	[-5.13862]
C	-2954.07

Error Correction:	D(EVI)	D(MVI)	D(MVI2)
CointEq1	0.041693	-0.00335	-0.04248
	-0.01488	-0.00453	-0.07758
	[2.80115]	[-0.74051]	[-0.54755]
D(EVI(-1))	-0.28582	0.031889	0.537789
	-0.21675	-0.06591	-1.12971
	[-1.31870]	[0.48380]	[0.47604]
D(EVI(-2))	-0.28172	0.004682	0.058579
	-0.17813	-0.05417	-0.92847
	[-1.58149]	[0.08643]	[0.06309]
D(MVI(-1))	-14.5167	-0.02777	-4.34014
	-5.87803	-1.78757	-30.6373
	[-2.46965]	[-0.01553]	[-0.14166]
D(MVI(-2))	-8.21593	2.714404	45.35828
	-6.68238	-2.03218	-34.8297
	[-1.22949]	[1.33571]	[1.30229]
D(MVI2(-1))	0.872176	0.022033	0.634788
	-0.37092	-0.1128	-1.9333
	[2.35138]	[0.19532]	[0.32834]
D(MVI2(-2))	0.528087	-0.17396	-2.9098
	-0.41217	-0.12535	-2.1483
	[1.28124]	[-1.38783]	[-1.35447]
C	0.175671	-0.0585	-0.96065
	-0.15206	-0.04624	-0.79254
	[1.15530]	[-1.26499]	[-1.21212]
R-squared	0.446183	0.469321	0.487308
Adj. R-squared	0.242145	0.273808	0.298422
Sum sq. resids	9.95397	0.920574	270.4166
S.E. equation	0.723805	0.220116	3.772592
F-statistic	2.186767	2.400456	2.579901
Log likelihood	-24.8402	7.299692	-69.4171
Akaike AIC	2.432604	0.051875	5.734596
Schwarz SC	2.816556	0.435826	6.118548
Mean dependent	0.053341	-0.03326	-0.54177
S.D. dependent	0.831435	0.258301	4.504036

Determinant resid covariance (dof adj.)	0.001271
Determinant resid covariance	0.000443
Log likelihood	-10.6831
Akaike information criterion	2.791338
Schwarz criterion	4.087175

Appendix 9-D VEC Estimates with Two Lags for the Import Model

Vector Error Correction Estimates
Sample (adjusted): 1978 2003
Included observations: 26 after adjustments
Standard errors in ( ) & t-statistics in [ ]

Cointegrating Eq:	CointEq1
IVI(-1)	1
MVI(-1)	55710.59
	-10401.4
	[5.35606]
MVI2(-1)	-3133.35
	-614.148
	[-5.10195]
C	-246208

Error Correction:	D(IVI)	D(MVI)	D(MVI2)		D(IVI)	D(MVI)	D(MVI2)
CointEq1	-0.0872	-1.24E-06	-4.05E-05	D(MVI(-2))	930.5445	1.745605	32.56609
	-0.01033	-3.40E-05	-0.00059		-426.885	-1.41638	-24.3845
	[-8.44462]	[-0.03606]	[-0.06872]		[2.17985]	[1.23244]	[1.33552]
D(IVI(-1))	-0.81743	0.000154	0.002487	D(MVI2(-1))	-13.5296	0.028923	0.660729
	-0.15071	-0.0005	-0.00861		-30.9755	-0.10277	-1.76938
	[-5.42380]	[0.30862]	[0.28891]		[-0.43678]	[0.28142]	[0.37342]
D(IVI(-2))	-1.16087	0.000612	0.009384	D(MVI2(-2))	-59.7076	-0.10997	-2.06431
	-0.15475	-0.00051	-0.00884		-26.1016	-0.0866	-1.49097
	[-7.50173]	[1.19169]	[1.06163]		[-2.28751]	[-1.26985]	[-1.38454]
D(MVI(-1))	145.7525	-0.1122	-4.33693	C	125.5187	-0.08501	-1.39144
	-495.663	-1.64458	-28.3132		-16.6392	-0.05521	-0.95046
	[0.29406]	[-0.06822]	[-0.15318]		[7.54354]	[-1.53986]	[-1.46396]

R-squared	0.82023	0.525497	0.537477
Adj. R-squared	0.750319	0.340968	0.357607
Sum sq. resids	74733.19	0.822718	243.8482
S.E. equation	64.4348	0.213791	3.680641
F-statistic	11.73257	2.847776	2.988145
Log likelihood	-140.419	7.999694	-65.9922
Akaike AIC	11.41684	2.36E-05	5.691711
Schwarz SC	11.80395	0.38713	6.078817
Mean dependent	54.20197	-0.03436	-0.55992
S.D. dependent	128.952	0.263352	4.592226

Determinant resid covariance (dof adj.)	12.95505
Determinant resid covariance	4.298693
Log likelihood	-129.635
Akaike information criterion	12.04887
Schwarz criterion	13.35535

APPENDIX TO CHAPTER 10

The Shortcoming of the Brownian motion Simulation

We conducted a number of simulations, varying the values of *k* and *T*, and the results are shown in this appendix, Tables 1 and 2. In order to make a comparison, we also included the simulation results in McCoskey and Kao (1998, Table I. Means and Variances for given T and K) into the first row of Appendix Tables 10.1 and 10.2, which *T* = 4,000 and replications = 50,000 are used in their simulations. When we change the *T* from 4,000 to 1,000 and the replications from 50,000 to 10,000, the values of μ_v and σ_v^2 are slightly reduced, e.g. with *k* = 5, the value of μ_v decreased from 0.044 to 0.04356 which is a very small change. However, when *k* increases from 4 to 5, μ_v decreased from 0.05318 to 0.04356. When *T* decreases from 10,000 to 50, the change (decrease) of μ_v and σ_v^2 is minimal, but when *k* increases from 1 to 5, the decreases in μ_v and σ_v^2 are very substantial.

Table 10.1 Brownian motion Simulations for μ_v up to Five Variables

T	Replications	k=1	k=2	k=3	k=4	k=5
4000	50000	0.1162	0.085	0.0658	0.0533	0.044
1000	10000	0.11509	0.08461	0.06486	0.05318	0.04356
100	10000	0.11494	0.08727	0.06578	0.05259	0.04404
50	10000	0.11493	0.08544	0.06535	0.05245	0.04325

Table.10.2 Brownian Motion Simulations for σ_v^2 up to Five Variables

T	Replications	k=1	k=2	k=3	k=4	k=5
4000	50000	0.0109	0.0055	0.0028	0.0016	0.0009
1000	10000	0.01073	0.00513	0.00256	0.00154	0.0008
100	10000	0.01036	0.00609	0.00277	0.00152	0.00093
50	10000	0.01086	0.00541	0.00285	0.00162	0.00081

REFERENCES

Adams, W. (Ed.). (1968). *The Brain Drain*. New York: Macmillan.

Addison, T., & Worswick, C. (2002). The Impact of Immigration on the Labour Market Outcomes of Natives: Evidence from Australian Micro Data. *Economic Record (Australia), 78*(240), 68-78.

Aislabie, C., Lee, J., & Stanton, J. (1994). *Australian Cultural Diversity and Export Growth*. Canberra: AGPS.

Aitken, N. D. (1973). The Effect of the EEC and EFTA on European Trade: A Temporal Cross-Section Analysis. *American Economic Review, 63*(5), 881-892.

Aitken, N. D., & Obutelewicz, R. S. (1976). A Cross-Sectional Study of EEC Trade with the Association of African Countries. *Review of Econometrics and Statistics, 58*(4), 425-433.

Al-Atrash, H., & Yousef, T. (2000). Intra-Arab Trade: Is It Too Little? : International Monetary Fund.

Anderson, J. E. (1979). A Theoretical Foundation for the Gravity Equation. *American Economic Review, 69*(1), 106 - 116.

Arrow, K. (1972). Gifts and Exchanges. *Philosophy and Public Affairs, I*, 343-362.

Atkinson, A. (2001). Free Settler before 1851. In J. Jupp (Ed.), *The Australian People: An Encyclopedia of the Nation, Its People and Their Origins* (pp. 25-30). Cambridge, UK: Cambridge University Press.

Bai, J., & Ng, S. (2004). A PANIC Attack on Unit Roots and Cointegration. *Econometrica, 72*(4), 1127-1177.

Balassa, B. (1966). Tariff Reductions and Trade in Manufactures among the Industrial Countries. *American Economic Review, 56*(3), 466-472.

Balassa, B. (1967). Trade Creation and Trade Diversion in the European Common Market. *Economic Journal, LXXVII*(305), 1-21.

Baldwin, R. (1993). The Potential for Trade Between the Countries of EFTA and Central and Eastern Europe: CEPR Discussion Paper.

Baltagi, B. H. (2005). *Econometric Analysis of Panel Data* (3 ed.). West Sussex: John Wiley & Sons.

Banerjee, A., Dolado, J. J., & Mestre, R. (1998). Error-Correction Mechanism Tests for Cointegration in a Single-Equation Framework. *Journal of Time Series Analysis, 19*, 207-229.

Barro, R. J. (1990). *Macroeconomics* (3rd ed.). New York: John Wiley & Sons.

Becker, G. S. (1974). A Theory of Social Interaction. *Journal of Political Economy, 82*(6), 1063-1093.

Becker, G. S. (1976). Altruism, Egoism, and Genetic Fitness: Economics and Sociobiology. *Journal of Economic Literature, 14*(3), 817-826.

Bennett, N. (1992). Japanese Emigration Policy, 1880-1941. In C. Inglis, S. Gunasekaran, G. Sullivan & C.-T. Wu (Eds.), *Asians in Australia: The Dynamics of Migration and Settlement* (pp. 23-43). Singapore: Institute of Southeast Asian Studies.

Bergstrand, J. H. (1985). The Gravity Equation in International Trade: Some Microeconomic Foundations and Empirical Evidence. *Review of Econometrics and Statistics, 67*, 474 - 481.

Bergstrand, J. H. (1989). The Generalized Gravity Equation, Monopolistic Competition, and the Factor-Proportions Theory in International Trade. *Review of Economics and Statistics, 71*(1), 143-153.

Bergstrand, J. H. (1990). The Heckscher-Ohlin-Samuelson Model, the Linder Hypothesis and the Determinants of Bilateral Intra-Industry Trade. *The Economic Journal, 100*(403), 1216-1229.

Berry, R. A., & Soligo, R. (1969). Some Welfare Aspects of International Migration. *Journal of Political Economy, 77*(5), 778-794.

Bikker, J. A. (1987). An International Trade Flow Model with Substitution: An Extension of the Gravity Model. *Kyklos, 40*(3), 315-337.

Blavy, R. (2001). Trade in the Mashreq: An Empirical Examination: International Monetary Fund.

Blomqvist, H. C. (1993). Determination of Bilateral Trade Flows in East Asia: A Gravity Approach: The University of Queensland.

Blomqvist, H. C. (1994). Determination of Bilateral Trade Flows in East Asia: A Gravity Approach. In D. T. Nguyen & K. C. Roy (Eds.), *Economic Reform, Liberalisation and Trade in the Asia-Pacific Region*. New Delhi: Wiley Eastern.

Blomqvist, H. C. (2004). Explaining Trade Flows of Singapore. *Asian Economic Journal, 18*(1), 25-43.

Bowen, H. P., Leamer, E. E., & Sveikauskas, L. (1987). Multicountry, Multifactor Tests of the Factor Abundance Theory. *American Economic Review, 77*(5), 791-809.

Brada, J. C., & Mendez, J. A. (1983). Regional Economic Integration and the Volume of Intra-regional Trade: A Comparison of Developed and Developing Country Experience. *KYKLOS, 36*(4), 589-603.

Brander, J. A. (1981). Intra-Industry Trade in Identical Commodities. *Journal of International Economics, 11*(1), 1-14.

Brander, J. A., & Spencer, B. J. (1981). Tariffs and the Extraction of Foreign Monopoly Rents under Potential Entry. *Canadian Journal of Economics, 14*(3), 371-389.

Brander, J. A., & Spencer, B. J. (1985). Export Subsidies and International Market Rivalry. *Journal of International Economics, 18*(1/2), 83-100.

Breitung, J. (2000). The Local Power of Some Unit Root Tests for Panel Data. *Advances in Econometrics, 15*, 161-177.

Breitung, J. (2002). Nonparametric Tests for Unit Root and Cointegration. *Journal of Econometrics, 108*, 343-363.

Campbell, J. (1992). The new New Englanders. *Regional Review, 2*(1), 12-18.

Casella, A., & Rauch, J. E. (2002). Anonymous Market and Group Ties in International Trade. *Journal of International Economics, 58*(1), 19-47.

Casson, M. (1982). *The Entrepreneur: An Economic Theory*. Oxford: Martin Robertson.

Castles, S. (1991). From Migrant Worker to Ethnic Entrepreneur. In D. Goodman, D. J. O'Hearn & C. Wallace-Crabbe (Eds.), *Multicultural Australia: the Chellenges of Change* (pp. 179-191). Newham: Scribe.

Chandler, A. D. J. (1994). *Scale and Scope: The Dynamics of Industrial Capitalism*. Cambridge, Massachusetts: The Belknap Press of Harvard University Press.

Chao, C.-C., & Yu, E. S. H. (2002). Immigration and Welfare for the Host Economy with Imperfect Competition. *Journal of Regional Science, 42*(2), 327-338.

Chen, B., McCoskey, S., & Kao, C. (1999). Estimation and Inference of a Cointegrated Regression in Panel Data: A Monte Carlo Study. *American Journal of Mathematical and Management Sciences, 19*(1-2), 75-114.

Chenery, H. B. (1960). Pattern of Industrial Growth. *American Economic Review, 50*(4), 624-654.

Chiang, M.-H., & Kao, C. (2002). *Nonstationary Panel Time Series Using NPT 1.3 - A User Guide*.Unpublished manuscript, Centre for Policy Research.

Chiang, N. (2001). Taiwanese. In J. Jupp (Ed.), *The Australian People: An Encyclopedia of the Nation, Its People and Their Origins* (pp. 700-701). Cambridge, UK: Cambridge University Press.

Chin, K.-S., Yoon, I.-J., & Smith, D. (1996). Immigrant Small Business and International Economic Linkage: A Case of the Korean Wig Business in Los Angeles, 1968-1977. *International Migration Review, XXX*(2), 485 - 510.

Chipman, J. S. (1965). A Survey of the Theory of International Trade: Part 1, The Classical Theory. *Econometrica, 33*, 477-519.

Choi, I. (2002). Instrumental Variables Estimation of a Nearly Nonstationary, Heterogeneous Error Component Model. *Journal of Econometrics, 109*, 1-32.

Choi, I. (2004). *Improving Empirical Size of the KPSS Test of Stationarity*.Unpublished manuscript, Department of Economics, Hong Kong University of Science and Technology, Hong Kong.

Christernson, B. (1994). World Trade in Apparel: An Analysis of Trade Flow Using the Gravity Model. *International Regional Science Review, 17*(2), 151-166.

Christin, D. E. (1996). The Long-term Volume of East Europe's Foreign Trade: An Estimate. *Economics of Planning, 29*(1), 1-24.

Chu, C. (1995). *The Asian Mind Game: Unlocking the Hidden Agenda of the Asian Business Culture: A Westerner's Survival Manual*. St. Ives, NSW: Stealth.

Clarke, H. R., & Ng, Y.-K. (1993). Immigration and Economic Welfare: Resource and Environmental Aspects. *The Economic Record, 69*(206), 259-273.

Coke, R. (1670). *A Discourse of Trade*. London: H. Brome.

Coleman, J. S. (1988). Social Capital in the Creation of Human Capital. *American Journal of Sociology, 94*(1), s95 - s120.

Coughlan, J. E. (1997). Korean Immigrants in Australia. In J. E. Coughlan & D. J. McNamara (Eds.), *Asians in Australia: Patterns of Migration and Settlement* (pp. 171-197). South Melbourne: MacMillan Education.

Curtin, P. D. (1984). *Cross-Cultural Trade in World History*. Cambridge: Cambridge University Press.

Cyrus, T. L. (2002). Income in the Gravity Model of Bilateral Trade: Does Endogeneity Matter? *The International Trade Journal, XVI*(2), 161-180.

Dascal, D., Mattas, K., & Tzouvelekas, V. (2002). An Analysis of EU Wine Trade: A Gravity Model Approach. *IAER, 8*(2), 135-148.

Davidson, J. (2000). *Econometric Theory*. Oxford: Blackwell.

Delbrdige, A., Bernard, J., Blair, D., Butler, S., Peters, P., & Yallop, C. (Eds.). (1999). *The Macquarie Dictionary* (3 ed.). New South Wales: Macquarie University.

Department of Foreign Affairs and Trade. (2002). Direction of Trade Time Series, 2000-1 One Hundred Years of Trade. Retrieved 21 July, 2004, from http://www.dfat.gov.au/publications/statistics.html

Department of Foreign Affairs and Trade. (2006). Australia's Trade with East Asia. Retrieved 04 April, 2008, from http://www.dfat.gov.au/publications/stats-pubs/downloads/EA_2006.pdf

Department of Immigration and Multicultural Affairs. (2001, 10 March 2004). Immigration: Federation to Century's End 1901-2000. Retrieved 21 July, 2004, from http://www.immigration.gov.au/statistics/publications/federation/index.htm

Department of Immigration and Multicultural and Indigenous Affairs. (2004). The Viet Nam-born Community: Historical background. Retrieved 14 September, 2004, from www.immi.gov.au/stastistics/infosummary/textversion/vietnam.htm

Diamond, P. A. (1971). A Model of Price Adjustment. *Journal of Economic Theory, 3*(2), 156-168.

Dickey, D. A., & Fuller, W. A. (1979). Distribution of the Estimators for Autoregressive Time Series with a Unit Root. *Journal of the American Statistical Association, 74*, 427-431.

Dixit, A., & Skeath, S. (1999). *Games of Strategy*. New York: W. W. Northon.

Dixit, A. K., & Kyle, A. S. (1985). The Use of Protection and Subsidies for Entry Promotion and Deterrence. *American Economic Review, 75*(1).

Dixit, A. K., & Norman, V. (1980). *Theory of International Trade: A Dual, General Equilibrium Approach*. Welwyn: James Nisbet.

Doroodian, K., & Jung, C. (1995). Factor Price Equalization: Revisited. *Applied Economics Letters, 2*, 223-226.

East Asia Analytical Unit, D. o. F. A. a. T. (1995). *Overseas Chinese Business Networks in Asia*. ACT: AGPS Press.

Egger, P. (2002). An Econometric View on the Estimation of Gravity Models and the Calculation of Trade Potentials. *World Economy, 25*(2), 297-312.

Engle, R. F. (1987). On the Theory of Cointegrated Economic Time Series: mimeographed, University of California, San Diego.

Engle, R. F., & Granger, C. W. J. (1987). Co-Integration and Error Correction: Representation, Estimation, and Testing. *Econometrica, 55*(2), 251-276.

Entorf, H. (1997). Random Walks with Drifts: Nonsense Regression and Spurious Fixed-effect Estimation. *Journal of Econometrics, 80*, 287-296.

Ethier, W. J. (1996). Theories About Trade Liberalisation and Migration: Substitutes or Complements? In P. J. Lloyd & L. S. Williams (Eds.), *International Trade and Migration in the APEC Region* (pp. 50 - 68). Melbourne: Oxford University Press.

Ethier, W. J., & Svensson, L. E. O. (1986). The Theorems of International Trade with Factor Mobility. *Journal of International Economics, 20*, 21-42.

Evans, R. (2001). The White Australia Policy. In J. Jupp (Ed.), *The Australian People: An Encyclopedia of the Nation, Its People and Their Origins* (pp. 44-49). Cambridge, UK: Cambridge University Press.

Evenett, S. J., & Keller, W. (2002). On Theories Explaining the Success of the Gravity Equation. *Journal of Political Economy, 110*(2), 281-316.

Fawcett, J. T. (1989). Networks, Linkages, and Migration Systems. *International Migration Review, 23*(3), 671-680.

Feenstra, R. C., Markusen, J. R., & Rose, A. K. (1998). Understanding The Home Market Effect and The Gravity Equation: The Role of Differentiating Goods: NBER.

Flam, H., & Flanders, M. J. (Eds.). (1991). *Heckscher-Ohlin Trade Theory*. Cambridge, Massachusetts: MIT Press.

Frankel, J. A., Romer, D., & Cyrus, T. (1996). Trade and Growth in East Asian Countries: Cause and Effect? MA: Cambridge.

Frankel, J. A., Stein, E., & Wei, S.-j. (1995). Trading Blocs and the Americas:The Natural, the Unnatural, and the Supper-Natural. *Journal of Development Economics, 47*(1), 61-69.

Frankel, J. A., & Wei, S.-j. (1993). Is There a Currency Bloc in the Pacific? In A. Bundell (Ed.), *The Exchange Rate and the Balance of Payment*. Sydney: Reserve Bank of Australia.

Gardner, R. (1995). *Games for Business and Economics*. New York: John Wiley & Sons.

Geraci, V. J., & Prewo, W. (1977). Bilateral Trade Flows and Transport Costs. *Review of Economics and Statistics, 59*(1), 67-74.

Geraci, V. J., & Prewo, W. (1982). An Empirical Demand and Supply Model of Multilateral Trade. *Review of Economics and Statistics, 64*(3), 432-441.

Glejser, H. (1968). An Explanation of Differences in Trade-Products Ratios Among Countries. *Cahiers Economiques De Bruxelles, 37*(1), 47-58.

Godley, M. R. (1992). China's Policy Towards Migrants, 1842-1949. In C. Inglis, S. Gunasekaran, G. Sullivan & C.-T. Wu (Eds.), *Asians in Australia: The Dynamics of Migration and Settlement* (pp. 1-21). Singapore: Institute of Southeast Asian Studies.

Gould, D. M. (1994). Immigrant Links to the Home Country: Empirical Implications for U. S. Bilateral Trade Flows. *Review of Econometrics and Statistics, 76*(2), 302-316.

Gould, D. M. (1996). *Immigration Links to the Home Country: Implications for Trade, Welfare, and Factor Returns*. New York & London: Garland.

Granger, C. W. J. (1969). Investigating Causal Relations by Econometric Models and Cross-Spectral Methods. *Econometrica, 37*(3), 424-438.

Granger, C. W. J. (1981). Some Properties of Time Series Data and Their Use in Econometric Model Specification. *Journal of Econometrics, 16*(1), 121-130.

Granger, C. W. J., & Newbold, P. (1974). Spurious Regressions in Econometrics. *Journal of Econometrics, 2*(2), 111-120.

Granovetter, M. S. (1973). The Strength of Weak Ties. *American Journal of Sociology, 78*(6), 1360-1380.

Greenaway, D., & Milner, C. (2002). Regionalism and Gravity. *Scottish Journal of Political Economy, 49*(5), 574-585.

Greene, W. H. (2000). *Econometric Analysis* (4th ed.). Upper Saddle River, N. J.: Prentice-Hall.

Grieco, E. M. (1998). The Effects of Migration on the Establishment of Networks: Caste Disintegration and Reformation Among the Indians of Fiji. *International Migration Review, 32*(3), 704-736.

Griffiths, W. E., Hill, R. C., & Judge, G. G. (1993). *Learning and Practicing Econometrics*. New York: John Willey & Sons.

Groen, J. J. J., & Kleibergen, F. (2003). Likelihood-based Cointegration Analysis in Panels of Vector Error-Correction Models. *Journal of Business and Economic Statistics, 21*(2), 295-318.

Grossman, G. M. (1986). Strategic Export Promotion: A Critique. In P. R. Krugman (Ed.), *Strategic Trade Policy and the New International Economics* (pp. 47-68). Cambridge, Massachusetts: The MIT Press.

Grubel, H. B., & Scott, A. D. (1966). The International Flow of Human Capital. *American Economic Review, 56*(2), 268-274.

Grubel, H. G. (1967). Intra-Industry Specialization and the Pattern of Trade. *Canadian Journal of Economics and Political Science, 33*, 374-388.

Grubel, H. G., & Lloyd, P. J. (1975). *Intra-Industry Trade: The Theory and Measurement of International Trade in Differentiated Products*. London: Macmillan.

Gruber, W., Mehta, D., & Vernon, R. (1967). The R & D Factor in International Trade and International Investment of United States Industries. *Journal of Political Economy, 75*(1), 20-37.

Gujarati, D. N. (2003). *Basic Econometrics* (4th ed.). Boston: McGrawHill.

Gunawardana, P. J. (2005). The Asian Currency Crisis and Australian Exports to East Asia. *Economic Analysis and Policy, 35*(1&2), 73-90.

Gunawardana, P. J., & Hewarathna, R. (2000). The Asian Crisis and Australia-East Asia Trade Flows: A Modified Gravity Approach: School of Business, La Trobe University, Discussion Papers, Series A00.13, October.

Gurak, D. T., & Caces, F. (1992). Migration Networks and the Shaping of Migration Systems. In M. M. Kritz, L. L. Lim & H. Zlotnik (Eds.), *International Migration Systems: A Global Approach*. New York: Oxford University Press.

Güth, W., Schmittberger, R., & Schwarze, B. (1982). An Experimental Analysis of Ultimatum Bargaining. *Journal of Economic Behavior & Organization, 3*(4), 367-388.

Hadri, K. (2000). Test for Stationarity in heterogenous Panel Data. *Econometrics Journal, 3*, 148-161.

Han, G. S. (2001). Koreans. In J. Jupp (Ed.), *The Australian People: An Encyclopedia of the Nation, Its People and Their Origins* (pp. 547-549). Cambridge, UK: Cambridge University Press.

Harris, D., & Inder, B. (1994). A Test of the Null Hypothesis of Cointegration. In C. P. Hargreaves (Ed.), *Non-stationary Time Series Analysis and Cointegration* (pp. 133-152). New York: Oxford University Press.

Hashemzadeh, N. (1997). The Impact of NAFTA on US Employment: A Preliminary Assessment of Job Gains and Losses from Expanded Trade with Mexico. *International Journal of Social Economics, 24*(10), 1080-1093.

Head, K., & Ries, J. (1998). Immigration and Trade Creation: Econometric Evidence from Canada. *Canadian Journal of Economics, 31*(1), 47-62.

Heckscher, E. F. (1949). The Effect of Foreign Trade on the Distribution of Income. In A. E. Association (Ed.), *Readings in the Theory of International Trade* (pp. 272-300). Homewood, Illinois: Richard D. Irwin, Inc.

Helliwell, J. F. (1996). Do National Borders Matter for Quebec's Trade? *Canadian Journal of Economics, 29*(3), 507-522.

Helpman, E. (1975). Intra-Industry Trade: The Theory and Measurement of International Trade in Differentiated Products. *Journal of International Economics, 11*(3), 305-340.

Heston, A., Summers, R., & Aten, B. (2002, October). Penn World Table. Version 6.1. Retrieved 7 Dec, 2005, from http://pwt.econ.upenn.edu/php_site/pwt61_form.php

Hochman, H. M., & Rodgers, J. D. (1969). Pareto Optimal Redistribution. *American Economic Review, 59*(4), 542-557.

Horiba, Y., & Kirkpatrick, R. C. (1983). U.S. North-South Labor Migration and Trade. *Journal of Regional Science, 23*(1), 93-103.

Hsiao, C. (1986). *Analysis of Panel Data*. Cambridge: Cambridge University Press.

Hua, C.-i., & Porell, F. (1979). A Critical Review of the Development of the Gravity Model. *International Regional Science Review, 4*(2), 97-126.

Hutchinson, W. K. (2002). Does Ease of Communication Increase Trade? Commonality of Language and Bilateral Trade. *Scottish Journal of Political Economy, 49*(5), 544-556.

Im, K. S., Pesaran, M. H., & Shin, Y. (2003). Testing for Unit Roots in Heterogeneous Panels. *Journal of Econometrics, 115*, 53-74.

Irwin, D., A. (1996). *Against the Tide: An Intellectual History of Free Trade*. Princeton, New Jersey: Princeton University Press.

Johansen, S. (1991). Estimation and Hypothesis Testing of Cointegrating Vectors in Gaussian Vector Autoregressive Models. *Econometrica, 59*(6), 1551-1580.

Johansen, S. (1995). *Likelihood-based Inference in Cointegrated Vector Autoregressive Model*. Oxford: Oxford University Press.

Johns, B. L., Dunlop, W. C., & Sheehan, W. J. (1974). *Taxation and the Small Firm in Australia: A Report to the Taxation Review Committee*. Newcastle: University of Newcastle.

Johnson, C. A. (2000). *Social Capital and Conventions: A Social Networks Perspective.* Unpublished Doctor of Philosophy in Economics, Virginia Polytechnic Institute and State University, Blacksburg, Virginia.

Jolley, A. N. E. (1971). Immigration and Australia's Post-war Economic Growth. *The Economic Record, 47*(117), 47-59.

Jones, R. W. (1975). Income Distribution and Effective Protection in a Multicommodity Trade Model. *Journal of Economic Theory, 11*, 1-15.

Jones, R. W., & Scheinkman, J. A. (1977). The Relevance of the Two-Sector Production Model in Trade Theory. *Journal of Political Economy, 85*(5), 909-935.

Jupp, J. (Ed.). (2001). *The Australian People: An Encyclopedia of the Nation, Its People and Their Origins*. Cambridge, UK.: Cambridge University Press.

Jupp, J., & York, B. (1995). *Birthplaces of the Australian People: Colonial & Commonwealth Censuses, 1828-1991*. Canberra: Centre for Immigration & Multicultural Studies, ANU.

Kahneman, D., Knetsch, J. L., & Thaler, R. H. (1986). Fairness and the Assumptions of Economics. *Journal of Business, 59*(4, pt. 2), s285-s300.

Kalirajan, K. (1999). Stochastic Varying Coefficients Gravity Model: An Application in Trade Analysis. *Journal of Applied Economics, 26*(2), 185-193.

Kao, C. (1999). Spurious Regression and Residual-based Tests for Cointegration in Panel Data. *Journal of Econometrics, 90*, 1-44.

Kao, C., & Chiang, M.-H. (2000). On the Estimation and Inference of a Cointegrated Regression in Panel Data. *Advances in Econometrics, 15*, 179-222.

Karemera, D., Oguledo, V. I., & Davis, B. (2000). A Gravity Model Analysis of International Migration to North America. *Applied Economics, 32*, 1745 - 1755.

Kau, J. B., & Sirmans, C. F. (1979). The Functional Form of the Gravity Model. *International Regional Science Review, 4*(2), 127-136.

Kim, J. M. S. (1988). Koreans. In J. Jupp (Ed.), *The Australian People: An Encyclopedia of the Nation, Its People and Their Origins* (pp. 659-660). North Ryde: Angus & Robertson.

King, M. L., & Hillier, G. H. (1985). Locally Best Invariant Tests for the Error Covariance Matrix of the Linear Regression Model. *Journal of the Royal Statistical Society. Series B (Methodological), 47*(1), 98-102.

Knack, S., & Keefer, P. (1997). Does Social Capital have an Economic Payoff? A Cross-Country Investigation. *Quarterly Journal of Economics, 112*(4), 1251-1288.

Knott, J. W. (2001). Imperial Settlement: Arrival and Settlement 1851-1880. In J. Jupp (Ed.), *The Australian People: An Encyclopedia of the Nation, Its People and Their Origins* (pp. 35-39). Cambridge, UK: Cambridge University Press.

Koo, W. W., & Karemera, D. (1991). Determinants of World Wheat Trade Flows and Policy Analysis. *Canadian Journal of Agricultural Economics, 39*(3), 439-455.

Krugman, P. R. (1979). Increasing Returns, Monopolistic Competition, and International Trade. *Journal of International Economics, 9*(4), 469-479.

Krugman, P. R. (1980). Scale Economies, Product Differentiation, and the Pattern of Trade. *American Economic Review, 70*(5), 950-959.

Krugman, P. R. (1986). Introduction: New Thinking about Trade Policy. In P. R. Krugman (Ed.), *Strategic Trade Policy and the New International Economics* (pp. 1-22). Cambridge, Massachusetts: The MIT Press.

Krugman, P. R. (1987). Is Free Trade Passe? *Economic Perspectives, 1*(2), 131-144.

Krugman, P. R., & Obstfeld, M. (1994). *International Economics: Theory and Policy* (3 ed.). New York: HarperCollins.

Kulendran, N., & Wilson, K. (2000). Is There a Relationship between International Trade and International Travel? *Applied Economics, 32*(8), 1001-1009.

Kurz, M. (1978). Altruism as an Outcome of Social Interaction. *American Economic Review, 68*(2), 216-222.

Kuznets, S. (1966). *Morden Economic Growth: Rate, Structure, and Spread,* . New Haven: Yale University Press.

Kwiatkowski, D., Phillips, P. C. B., Schmidt, P., & Shin, Y. (1992). Testing the Null Hypothesis of Stationarity against the Alternative of a Unit Root. *Journal of Econometrics, 54*(1-3), 159-178.

Lancaster. (1966). A New Approach to Consumer Theory. *Journal of Political Economy, 74*(2), 132-157.

Larsson, R., Lyhagen, J., & Lothgren, M. (2001). Likelihood-Based Cointegration Tests in Heterogeneous Panels. *Econometric Journal, 4*(1), 109-142.

Le, Q. P., Nguyen, D. T., & Bandara, J. S. (1997). Vietnam's Foreign Trade in the Context of ASEAN and the Asia-Pacific Region: A Gravity Approach. *ASEAN Economic Bulletin, 13*(2), 185-199.

Leamer, E. E. (1974). The Commodity Composition of International Trade in Manufactures: An Empirical Analysis. *Oxford Economic Papers, 26*(3), 350-374.

Leamer, E. E. (1984). *Sources of International Comparative Advantage: Theory and Evidence*. Cambridge: MIT Press.

Leontief, W. (1954). Domestic Production and Foreign Trade: The American Capital Position Re-examined. *Economia Internazionale*.

Lever-Tracy, C., Ip, D., Kitay, J., Phillips, I., & Tracy, N. (1991). *Asian Entrepreneurs in Australia: Ethnic Small Business in the Chinese and Indian Communities of Brisbane and Sydney: A Report to the Office of Multicultural Affairs, Department of the Prime Minister and Cabinet*. Canberra: Australian Government Publishing Service.

Levin, A., Lin, C.-F., & Chu, C.-S. J. (2002). Unit Root Test in Panel Data: Asymptotic and Finite Sample Properties. *Journal of Econometrics, 108*(1), 1-25.

Light, I., & Rosenstein, C. (1995). *Race, Ethnicity, and Entrepreneurship in Urban America*. New York: Aldine De Gruyter.

Linnemann, H. (1966). *An Econometric Study of International Trade Flows*. Amsterdam: North-Holland Publishing Company.

Lomnitz, L. (1976). Migration and Networks in Latin America. In A. Portes & H. L. Browning (Eds.), *Current Perspectives in Latin American Urban Research*. Austin: University of Texas Press.

Loungani, P., Mody, A., & Razin, A. (2002). The Global Disconnect: The Role of Transactional Distance and Scale Economies in Gravity Equations. *Scottish Journal of Political Economy, 49*(5), 526-543.

Lung, S. M. (1998). *Australia's Alcoholic Beverages Trade with APEC Participants and Non-APEC Countries: An Analysis Using the Gravity Model.* Unpublished Honours Thesis, Victoria University, Melbourne.

Lung, S. M., & Gunawardana, P. J. (2000). The Gravity Model and International Trade Flow Analysis: A Survey. Melbourne, Australia: School of Applied Economics Working Paper Series, 7/00, Victoria University.

Lutz, J. M., & Green, R. T. (1983). The Product Life Cycle and the Export Position of the United States. *Journal of International Business Studies*, 77-93.

Mabogunje, A. L. (1970). Systems Approach to a Theory of Rural-Urban Migration. *Geographical Analysis, 2*(1), 1-18.

Mahmood, M. (2001). *The Export Behaviour of Australian Manufacturing SMEs.* Paper presented at the Creating Innovative Growth Companies /14th Conference of the Small Enterprise Association of Australia and New Zealand, Wellington, New Zealand.

Maizels, A. (1968). *Exports and Economic Growth of Developing Countries*. Cambridge: Cambridge University Press.

Markusen, J. R. (1983). Factor Movements and Commodity Trade as Complements. *Journal of International Economics, 14*, 341 - 356.

Markusen, J. R., & Svensson, L. E. O. (1985). Trade in Goods and Factors with International Differences in Technology. *International Economic Review, 26*(1), 175 - 192.

Martin, P. (1996). Effects of NAFTA on Labour Migration. In P. J. Lloyd & L. S. Williams (Eds.), *International Trade and Migration in the APEC Region* (pp. 101 - 120). Melbourne: Oxford University Press.

Martinez-Zarzoso, I. (2003). Gravity Model: An Application to Trade Between Regional Blocs. *Atlantic Economic Journal, 31*(2), 174-187.

Martinez-Zarzoso, I., & Nowak-Lehmann, F. (2002). Augmented Gravity Model: An Empirical Application to MERCOSUR-European Union Trade Flows. *Journal of Applied Economics, 6*(2), 291-316.

Massey, D. S. (1988). Economic Development and International Migration in Comparative Perspective. *Population and Development Review, 14*(3), 383-413.

Mátyás, L. (1997). Proper Econometric Specification of the Gravity Model. *The World Economy, 20*(3), 363-368.

Mátyás, L., Konya, L., & Harris, M. N. (1997). Modelling Export Activity in a Multicountry Economic Area: The APEC Case. Clayton: Department of Economics and Business Statistics, Monash University.

McCoskey, S., & Kao, C. (1998). A Residual-Based Test of The Null of Cointegration in Panel Data. *Econometric Reviews, 17*, 57-84.

McCrohan, D., & Lung, S. (2001). *The Long Term Economic Impact of Thai Overseas Students on Australia/Thailand Bilateral Trade Flows.* Paper presented at the First Apheit International Conference: "Trends in Higher Education and Benchmarking", Bangkok, Thailand.

Mill, J. (1995). *Elements of Political Economy*. London: Routledge.

Moon, H. R., & Perron, B. (2004). Efficient Estimation of the Seemingly Unrelated Regression Cointegration Model and Testing for Purchasing Power Parity. *Econometric Reviews, 23*(4), 293-323.

Moullor-Sebastian, A. (1983). The Product Life Cycle Theory: Empirical Evidence. *Journal of International Business Studies*, 95-105.

Mundell, R. A. (1957). International Trade and Factor Mobility. *American Economic Review*(47), 321-335.

National Imagery and Mapping Agency. (2001). *Distances between Ports* (11th ed.). Bethesda, Maryland: National Imagery and Mapping Agency.

O'Rourke, K. H., & Williamson, J. G. (1999). The Heckscher-Ohlin Model between 1400 and 2000: When it Explained Factor Price Convergence, When it Did Not, and Why. (7411).

Oguledo, V. I., & MacPhee, C. R. (1994). Gravity Models: A Reformulation and an Application to Discriminatory Trade Arrangements. *Applied Economics, 26*(2), 107-120.

Ohlin, B. (1933). *Interregional and International Trade*. Cambridge: Harvard University Press (Published in 1957).

Oliver, P. (2001). Japanese under White Australia. In J. Jupp (Ed.), *The Australian People: An Encyclopedia of the Nation, Its People and Their Origins* (pp. 523-524). Cambridge, UK: Cambridge University Press.

Oslington, P. (2001). Migration, Jobs and Welfare: A General Equilibrium Analysis. *Pacific Economic Review, 6*(3), 331-344.

Oxley, D., & Richards, E. (2001). Convict and Free Immigrant Women before 1851. In J. Jupp (Ed.), *The Australian People: An Encyclopedia of the Nation, Its People and Their Origins* (pp. 30-34). Cambridge, UK: Cambridge University Press.

Parks, R. W. (1967). Efficient Estimation of a System of Regression Equations When Disturbances Are Both Serially and Contemporaneously Correlated. *Journal of the American Statistical Association, 62*(318), 500-509.

Pedroni, P. (1995). Panel Cointegration; Asymptotic and Finite Sample Properties of Pooled Time Series Tests, with an Application to the PPP Hypothesis: Indiana University Working Paper in Economics.

Pedroni, P. (1997). Panel Cointegration; Asymptotic and Finite Sample Properties of Pooled Time Series Tests, with an Application to the PPP Hypothesis: New Results.

Pedroni, P. (1999). Critical Values for Cointegration Tests in Heterogeneous Panels with Multiple Regressors. *Oxford Bulletin of Economics and Statistics, 61*(Special Issue), 653-670.

Pedroni, P. (2000). Fully Modified OLS for Heterogeneous Cointegrated Panels. *Advances in Econometrics, 15*, 93-130.

Pedroni, P. (2001). Purchasing Power Parity Tests in Cointegrated Panels. *Review of Econometrics and Statistics, 83*(4), 727-731.

Pedroni, P. (2004). Panel Cointegration: Asymptotic and Finite Sample Properties of Pooled Time Series Tests with an Application to the PPP Hypothesis. *Econometric Theory, 20*, 597-625.

Pelzman, J. (1976). Trade Integration in the Council of Mutual Economic Assistance: Creation and Diversion 1954-1970. *The ACES Bulletin, 18*(3), 39-59.

Pelzman, J. (1977). In Defense of the Gravity Model with Pooled Cross-Section and Time-Series Observations: A Reply to Jozef M. Brabant. *The ACES Bulletin, 19*(1), 99-108.

Penny, J., & Gunawan, T. (2001). Indonesians. In J. Jupp (Ed.), *The Australian People: An Encyclopedia of the Nation, Its People and Their Origins* (pp. 439-441). Cambridge, UK: Cambridge University Press.

Pesaran, M. H. (2003). A Simple Panel Unit Root Test in the Presence of Cross Section Dependence. Cambridge: Trinity College.

Pesaran, M. H. (2004). General Diagnostic Tests for Cross-Section Dependence in Panels. Cambridge: Trinity College.

Peter, M. W., & Verikios, G. (1996). The Effect of Immigration on Residents' Incomes in Australia: Some Issues Reconsidered. *The Australian Economic Review, 2nd Quarter*(114), 171-188.

Phillips, P. C. B., & Hansen, B., E. (1990). Statistical Inference in Instrumental Variables Regression with I(1) Processes. *Review of Economic Studies, 57*(1), 99-125.

Phillips, P. C. B., & Moon, H. R. (1999). Linear Regression Limit Theory for Nonstationary Panel Data. *Econometrica, 67*(5), 1057-1111.

Phillips, P. C. B., & Ouliaris, S. (1990). Asymptotic Properties of Residual Based Tests for Cointegration. *Econometrica, 58*(1), 165-193.

Phillips, P. C. B., & Perron, P. (1988). Testing for a Unit Root in Time Series Regression. *Biometrika, 75*, 335-346.

Polak, J. J. (1996). Is APEC a Natural Regional Trading Bloc? A Critique of the 'Gravity Model' of International Trade. *The World Economy, 19*(5), 533-543.

Poot, J. (1996). Information, Communication and Networks in International Migration Systems. *The Annals of Regional Science, 30*(1), 55-72.

Pope, D., & Withers, G. (1993). Do Migrants Rob Jobs? Lessons of Australian History, 1861-1991. *The Journal of Economic History, 53*(4), 719-742.

Portes, A. (1995). Economic Sociology and the Sociology of Immigration: A Conceptual Overview. In A. Portes (Ed.), *The Economic Sociology of Immigration : Essays on Networks, Ethnicity, and Entrepreneurship* (pp. 1-41). New York: Russell Sage Foundation.

Pöyhönen, P. (1963). A Tentative Model for the Volume of Trade between Countries. *Weltwirtschaftliches Archiv, 90*(1), 93-99.

Pugel, T. A., & Lindert, P. H. (2000). *International Economics* (11th ed.). Boston: McGraw-Hill.

Pulliainen, K. (1963). A World Trade Study: an Econometric Model of the Pattern of the Commodity Flows in International Trade in 1948-1960. *Ekonomiska Samfundets Tidskrift, 2*, 78-91.

Purvis, D. D. (1972). Technology, Trade and Factor Mobility. *The Economic Journal, 82*(327), 991-999.

Quiggin, J. (1987). Egoistic Rationality and Public Choice: A Critical Review of Theory and Evidence. *The Economic Record, 63*(180), 10-21.

Rajapakse, P., & Arnuatilake, N. (1997). Would a Reduction in Trade Barriers Promote Intra-SAARC Trade?: A Sri Lankan Perspective. *Journal of Asian Economics, 8*(1), 95-115.

Ralston, B. (1983). The Dynamic of Communication:. In D. A. Griffith & A. C. Lea (Eds.), *Evolving Geographical Structures : Mathematical Models and Theories for Space-Time Processes* (pp. 130-167). The Hague: Martinus Nijhoff.

Ramsey, A. S. (1964). *An Introduction to the Theory of Newtonian Attraction*. London: Cambridge University Press.

Rauch, J. E. (1996). Trade and Search: Social Capital, Sogo Shosha and Spillovers. Cambridge, MA: National Bureau of Economic Research.

Rauch, J. E. (1999). Networks Versus Markets in International Trade. *Journal of International Economics, 48*, 7 - 35.

Rauch, J. E., & Trindade, V. (2002). Ethnic Chinese Networks in International Trade. *Review of Econometrics and Statistics, 84*(1), 116-130.

Razin, E. (1993). Immigrant Entrepreneurs in Israel, Canada and California. In I. Light & P. Bhachu (Eds.), *Immigration and Entrepreneurship* (pp. 97 - 124). New Brunswick, NJ: Transaction Publisher.

Razin, E., & Light, I. (1998). Ethnic Entrepreneurs in America's Largest Metropolitan Areas. *Urban Affairs Review, 33*(3), 332 - 360.

Redding, G. (1995). Overseas Chinese Networks: Understanding the Enigma. *Long Range Planning, 28*(1), 61-69.

Ricardo, D., 1772-1823. (1971). *On the Principles of Political Economy, and Taxation*. Ringwood, Victoria, Australia: Penguin.

Ries, A., & Trout, J. (1986). *Positioning: The Battle for Your Mind*. New York: McGraw-Hill.

Rivera-Batiz, F. L. (1986). Can Border Industries Be a Substitute for Immigration? *American Economic Review, 76*(2), 263-268.

Rod, T., & Webster, E. (1995). *Immigration and Trade with East Asia in the Food Industry: The Contribution of Immigrants*. Canberra: Australian Government Publishing Service.

Root, F. R. (1990). *International Trade and Investments* (6th ed.). cincinnati, Ohio: South-Western.

Rothschild, M. (1973). Models of Market Organisation with Imperfect Information: A Survey. *Journal of Political Economy, 81*, 1283-1308.

Rothschild, M. (1974). Searching for the Lowest Price When the Distribution of Prices Is Unknown. *Journal of Political Economy, 82*(4), 689-711.

Ruffin, R. J. (1999). The Nature and Significance of Intra-Industry Trade. *Economic and Financial Review*, 2-8.

Saikkonen, P. (1991). Asymptotically Efficient Estimation of Cointegrating Regressions. *Econometric Theory, 7*(1), 1-21.

Salop, S., & Stiglitz, J. (1977). Bargains and Ripoffs: A Model of Monopolistically Competitive Price Dispersion. *Review of Economic Studies, 44*, 493-510.

Samuelson, P. A. (1948). International Trade and Equalization of Factor Price. *Economic Journal, 58*, 163 - 184.

Samuelson, P. A. (1949). International Factor-Price Equalization Once Again. *The Economic Journal*, 181-197.

Sargan, J. D., & Bhargava, A. S. (1983). Testing Residuals from Least Squares Regression for being Generated by Gaussian Random walk. *Econometrica, 51*(1), 153-174.

Schiff, M. (1998). Trade, Migration and Welfare: The Impact of Social Capital, *World Bank Staff Working Paper, 2044*: Development Economics Department, The World Bank.

Schneeweis, T. (1985). A Note on International Trade and Market Structure. *Journal of International Business Studies*, 139-152.

Shan, J., Morris, A., & Sun, F. (1999). Immigration and Unemployment: new evidence from Australia and New Zealand. *International Review of Applied Economics, 13*(2), 253 - 260.

Sharma, K. (2000). The Pattern and Determinants of Intra-Industry Trade in Australian Manufacturing. *The Australian Economic Review, 33*(3), 245-255.

Shin, Y. (1994). A Residual Based Test of the Null of Cointegration Against the Alternative of No Cointegration. *Econometric Theory, 10*, 91-115.

Silberberg, E., & Suen, W. (2001). *The Structure of Economics: A Mathematical Analysis* (3rd ed.). Boston: Irwin McGraw-Hill.

Sims, C. A. (1972). Money, Income, and Causality. *American Economic Review, 62*(4), 540-552.

Sims, C. A. (1980). Macroeconomics and Reality. *Econometrica, 48*(1), 1-48.

Skeldon, R. (1996). Trade and Migration: The Effects on Economic Transformation in China. In P. J. Lloyd, & Lynne S. Williams (Ed.), *International Trade and Migration in the APEC Region*. Melbourne: Oxford University Press.

Smith, A., 1723-1790. (1937). *An Inquiry into the Nature and Causes of the Wealth of Nations*. N.Y.: The Modern Library.

Smith, A., 1723-1790. (1976). *The Theory of Moral Sentiments*. Indianapolis: Liberty Classics.

Spencer, B. J., & Brander, J. A. (1983). International R and D Rivalry and Industrial Strategy. *Review of Economic Studies, 50*(163), 707-722.

Spudic, I. (1996). *Statistical Focus: Settler Arrivals by Region/Country of British Historical Series: Oct 1945 - June 1995* (Vol. M10): Bureau of Immigration, Multicultural and Population Research (BIMPR).

Stewart, J. (1947). Empirical Mathematical Rules Concerning the Distribution and Equilibrium of Population. *Geographical Review, 37*, 461-485.

Stigler, G. J. (1961). The Economics of Information. *Journal of Political Economy, LXIX*(3), 213 - 225.

Stigler, G. J. (1962). Information and the Labour Market. *Journal of Political Economy, 70*(5), 94-105.

Stock, J. H., & Watson, M. W. (1993). A Simple Estimator of Cointegrating Vectors in Higher Order Integrated Systems. *Econometrica, 61*(4), 783-820.

Strahan, K. W. (1990). *Immigrant Small Business: Addressing our Balance of Payment Problems*. Canberra: Office of Multicultural Affairs.

Strahan, K. W., & Williams, A. J. (1988). *Immigrant Entrepreneurs in Australia: A Report to the Office of Multicultural Affairs*. Canberra: Office of Multicultural Affairs.

Svensson, L. E. O. (1984). Factor Trade and Goods Trade. *Journal of International Economics, 16*, 365-378.

Taneerananon, S. (2001). Thais. In J. Jupp (Ed.), *The Australian People: An Encyclopedia of the Nation, Its People and Their Origins* (pp. 704-705). Cambridge, UK: Cambridge University Press.

Tang, D. (2003). The Effect of European Integration on Trade with the APEC Countries: 1981-2000. *Journal of Economics and Finance, 27*(2), 262-278.

Taylor, R. (1979). Migration and the Residual Community. *Sociological Review, 27*(3), 475-489.

Thursby, J. G., & Thursby, M. C. (1987). Bilateral Trade Flows, The Linder Hypothesis, and Exchange Risk. *Review of Economics and Statistics, 69*(3), 488-495.

Tian, G. G., & Shan, J. (1999). Do Migrants Rob Jobs? New Evidence from Australia. *Australian Economic History Review, 39*(2), 133142.

Tinbergen, J. (1962). Appendix VI An Analysis of World Trade Flows. In *Shaping the World Economy* (pp. 262-293). New York: The Twentieth Century Fund.

Torrens, R. (1829). *An Essay on the External Corn Trade* (New ed. ed.). London: Longman.

Vernon, R. (1966). International Investment and International Trade in the Product Cycle. *Quarterly Journal of Economics, 80*(2), 190-207.

Vido, E., & Prentice, B. E. (2003). The Use of Proxy Variables in Economic Gravity Models: A Cautionary Note. *Journal of Transportation Research Forum, 57*(1), 123-137.

Wang, S.-W. (2001). Chinese Immigration 1840s-1890s. In J. Jupp (Ed.), *The Australian People: An Encyclopedia of the Nation, Its People and Their Origins* (pp. 197-204). Cambridge, UK: Cambridge University Press.

Wei, S.-j. (1996). Intra-National Versus International Trade: How Stubborn are Nations in Global Integration? Cambridge, MA: NBER.

Weidenbaum, M. L., & Hughes, S. (1996). *The Bamboo Network: How Expatriate Chinese Entrepreneurs are Creating a New Economic Superpower in Asia*. New York: Martin Kessler Books.

Westerlund, J. (2005a). New Simple Test for Panel Cointegration. *Econometric Reviews, 24*(3), 297-361.

Westerlund, J. (2005b). A Panel CUSUM Test of the Null of Cointegration. *Oxford Bulletin of Economics and Statistics, 67*(2), 231-262.

Westerlund, J. (2006a). Reducing the Size Distortions of the Panel LM Test for Cointegration. *Economics Letters, 90*, 384-389.

Westerlund, J. (2006b). Testing for Panel Cointegration with Multiple Structural Breaks. *Oxford Bulletin of Economics and Statistics, 68*(1), 101-132.

Westerlund, J. (2007). Testing for Error Correction in Panel Data. *Oxford Bulletin of Economics and Statistics, 69*(6), 709-748.

Westerlund, J., & Edgerton, D. L. (2007). A Panel Bootstrap Cointegration Test. *Economics Letters, 97*(3), 185-190.

Winters, P., De Janvry, A., & Sadoulet, E. (2001). Family and Community Networks in Mexico-U.S. Migration. *Journal of Human Resources, 36*(1), 159-184.

Withers, G. (1986). Immigration and the Labour Market: Australian Analysis: Centre for Economic Policy Research, ANU.

Withers, G. (2003). Core Issues in Immigration Economics and Policy. *Economic Papers, 21*(1), 12-23.

Withers, G., & Pope, D. (1985). Immigration and Unemployment. *Economic Record (Australia), 61*(173), 554-563.

Wong, K. Y. (1986). Are International Trade and Factor Mobility Substitutes? *Journal of International Economics, 21*, 25 - 43.

Wong, K. Y. (1988). International Factor Mobility and the Volume of Trade: An Empirical Study. In R. C. Feenstra (Ed.), *Empirical Methods for International Trade* (pp. 231-250). Cambridge, Mass: MIT Press.

The World Book : Multimedia Encyclopedia. (1999). [CD-ROM]: IVID Communitcation, Inc.

Xiao, Z. (1999). A Residual Based Test for the Null Hypothesis of Cointegration. *Economics Letters, 64*(2), 133-141.

Xiao, Z., & Phillips, P. C. B. (2002). A CUSUM Test for Cointegration Using Regression Residuals. *Journal of Econometrics, 108*(1), 43-61.

Yu, C.-M. J., & Zietlow, D. S. (1995). The Determinants of Bilateral Trade Among Asia-Pacific Countries. *ASEAN Economic Bulletin, 11*(3), 298-305.

Yule, G. U. (1926). Why Do We Sometimes Get Nonsense Correlations Between Time Series? A Study in Sampling and the Nature of Time Series. *Journal of the Royal Statistical Society, 89*, 1-64.

Zellner, A. (1962). An Efficient Method of Estimating Seemingly Unrelated Regressions and Tests of Aggregation Bias. *Journal of the American Statistical Association, 57*(298), 348-368.

Zhang, J., & Kristersen, G. (1995). A Gravity Model with Variable Coefficients: The EEC Trade with Third Countries. *Geographical Analysis, 27*(4), 307-320.

Zipf, G. K. (1946). The P1*P2/D Hypothesis: On the Intercity Movement of Persons. *American Sociological Review, 11*(6), 677-686.