OPENNESS AND ECONOMIC GROWTH

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Doctor of Philosophy

ASTON UNIVERSITY

20 May 2003

Dedication

To my beloved wife

Aston University

Openness and Economic Growth
by
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Doctor of Philosophy

20 May 2003

Thesis Summary

The themes of this thesis are that international trade and foreign direct investment (FDI) are closely related and that they have varying impacts on economic growth in countries at different stages of development.

The thesis consists of three empirical studies. The first one examines the causal relationship between FDI and trade in China. The empirical study is based on a panel of bilateral data for China and 19 home countries/regions over the period 1984-98. The specific feature of the study is that econometric techniques designed specially for panel data are applied to test for unit roots and causality. The results indicate a virtuous procedure of development for China. The growth of China's imports causes growth in inward FDI from a home country/region, which in turn causes the growth of exports from China to the home country/region. The growth of exports causes the growth of imports. This virtuous procedure is the result of China's policy of opening to the outside world. China has been encouraging export-oriented FDI and reducing trade barriers. Such policy instruments should be further encouraged in order to enhance economic growth.

In the second study, an extended gravity model is constructed to identify the main causes of recent trade growth in OECD countries. The specific features include (a) the explicit introduction of R&D and FDI as two important explanatory variables into an augmented gravity equation; (b) the adoption of a panel data approach, and (c) the careful treatment of endogeneity. The main findings are that the levels and similarities of market size, domestic R&D stock and inward FDI stock are positively related to the volume of bilateral trade, while the geographical distance, exchange rate and relative factor endowments, has a negative impact. These findings lend support to new trade, FDI and economic growth theories.

The third study evaluates the impact of openness on growth in different country groups. This research distinguishes itself from many existing studies in three aspects: first, both trade and FDI are included in the measurement of openness. Second, countries are divided into three groups according to their development stages to compare the roles of FDI and trade in different groups. Third, the possible problems of endogeneity and multicollinearity of FDI and trade are carefully dealt with in a panel data setting. The main findings are that FDI and trade are both beneficial to a country's development. However, trade has positive effects on growth in all country groups but FDI has positive effects on growth only in the country groups which have had moderate development. The findings suggest FDI and trade may affect growth under different conditions.

Key Words: Economic growth, Openness, International Trade and FDI

Acknowledgements

Completing this thesis would have been almost an impossible task for me without the guidance and support from a number of people. First and foremost, I would like to thank Dr. Xiaming Liu. As a supervisor, he has not only provided me with help, encouragement and comments to finish this thesis, but also assisted me in many other aspects which helped me moving forward. I also would like to express my appreciation to Dr. David S. Saal, Professor Jim Love and Mr. Kirit Vaidya in Aston University. Part of the thesis was presented in conferences and seminars. I would like to thank those who provided valuable suggestions and comments.

I am grateful to the Strategic Management Group, Aston Business School for occasional financial support and to Aston University for the provision of facilities.

I would like to specially thank those who have kindly helped me in one way or another during the last three years.

Last, but not least, I acknowledge with my deepest gratitude my wife – Yingqi, my family as well as hers for their love and indefatigable moral and financial support. It is no exaggeration to say that without their constant encouragement, this thesis could never have been completed. These words alone cannot express adequately my gratitude to them.

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Chapter 1. Introduction

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I.1 Background

The association between openness to trade and economic growth is a topic of little disagreement among economists, though different measures for openness have been used in the literature (Table I.1). The observed average increase in trade exposure in OECD countries during the 1980-1998 period has been estimated to have resulted in about a 4 per cent increase in output per capita (Bassanina et al., 2001). For developing countries, Sachs and Warner (1995) find that those countries with open door policies grew by 4.5 per cent a year, on average, in the 1970s and 1980s, while those relatively closed economies grew only by 0.7 per cent a year, on average. A recent study conducted by Edwards (1998), using a wide range of openness indicators, lends further support to the view that openness boosts a country's economic growth. This view prevails not only in the economics profession but also in policy circles. Multilateral institutions such as the World Bank, the IMF and the OECD regularly promulgate advises based on the belief that openness to trade generates positive consequences for countries. For example, the IMF (1997) claims that 'policies toward foreign trade are among the important factors promoting economic growth and convergence in developing countries'.

Theoretically, this commonly accepted view is mainly derived from the new trade and endogenous growth theories. According to the neoclassical growth and trade

theories, international trade would only have a level effect (i.e., a one-shot gain), not a growth effect (i.e., a permanent change in the growth rate). Thus the potential impact of international trade on economic growth is confined to the short run. In contrast, with the settings of such assumptions as economies of scale, imperfect competition, strategic considerations and endogenous technological progress, endogenous growth theory and new trade theory argue that openness to trade can have an impact on growth in the long run by increasing the rate of technology transfer and diffusion, improving allocative efficiency, expanding production possibility frontiers and inducing higher technical efficiency (Grossman and Helpman, 1991, 1994; Barro and Sala-i-Martin, 1995; Obstfeld and Rogoff, 1996).

However, such a view does not immediately stand out from the data. First of all, it has been argued that whether or not openness to trade acts as an engine of growth may depend on certain conditions, including the structural characteristics of a country and its technological absorptive capability[1]. Using the dynamic general equilibrium model, Buffie (1992) argues that trade does not inevitably stimulate economic growth in a country. This is the case only if the sector producing non-tradable intermediates is more capital-intensive than the sector with imported goods. Keller (1996) demonstrates that openness to trade acts as an engine of growth if there are knowledge spillovers through trade, but this occurs only if the country's technological absorptive capability is high.

[1] At the national level, technological absorptive capacity reflects the ability of a country to integrate its existing and exploitable resources into the production chain, and the foresight to anticipate potential and relevant technological trajectories available to other economic actors.

Secondly, an inverse relationship may run from economic growth to trade. Economic growth causes trade growth if innovation and technical progress result in well-developed markets which improve export performance in the trade sector (Vernon, 1966; Ghartey, 1993). If domestic production increases faster than domestic demand, then producers are likely to sell their goods in the foreign market (Sharma and Dhakal, 1994). Economic growth may also cause import growth in a country if its development requires resources and intermediate inputs that can not be produced by the country itself.

Thirdly, benefits from international trade may be overestimated since a large amount of technology transfer and diffusion or technology spillovers are actually via other channels of openness especially FDI (Hejazi and Safarian, 1999). It is generally agreed that FDI brings into host countries advanced technologies and know-how as well as financial capital (Balasubramanyam et al., 1999; de Mello, 1999). FDI is a powerful and effective means of disseminating technology from developed to developing countries, and is often the only source of advanced technologies that are usually unavailable through market. Theoretical explanations of the birth and growth of multinational enterprises (MNEs), the principal purveyors of FDI, are cast in terms of their monopolistic advantages of possessing advanced technologies and know-how and their desire to exploit the rents inherent in these advantages in international markets using international production to overcome the disadvantages of being foreign (Dunning, 1993). However, despite of every effort made by MNEs to try to preserve their proprietary rights over their firm-specific assets, but locally owned firms in the host country still benefit from spillovers through 'learning by doing', 'learning by watching', or the movement of labour from subsidiaries of

MNEs to locally owned firms (Blomström and Kokko, 1998). Other benefits associated with FDI inflows include an increase in the production base, the introduction of marketing skills and the creation of employment. Although the recent literature has attempted to highlight the positive role played by FDI in economic growth (see, for example, de Mello, 1999), many studies fail to take into account trade as a simultaneous determinant of growth. A complementary relationship between trade and FDI identified by Brainard (1993), Markusen (1984) Horstman and Markusen (1992) among others may undermine the results from the studies on either the relationship between international trade and growth or that between FDI and growth. Therefore, a full understanding of the interactions between trade, FDI and economic growth is essential for obtaining a complete picture of the role played by openness in the economic development process.

Empirically, the above arguments have not been fully addressed. In relation to the first issue, if openness to trade promotes growth only under certain conditions, these conditions need to be taken into account in empirical estimations through various ways such as introducing new control variables (e.g. human capital and patent rights among others (Edwards, 1998)); dividing countries into groups in terms of trade orientation (e.g. Balasubramanyam et al., 1996) or a country's development stage; and adopting panel data approach (the country effects can be controlled for in this case).

In relation to the second issue, as well documented in the literature and econometric textbooks, failing to address the issues of endogeneity may lead to biased estimation results. Therefore, the possible two-way relationship between openness to trade and

growth needs to be addressed carefully and tackled by adopting appropriate econometric techniques if endogeneity exists (e.g. using instrumental variables).

Finally, the role of FDI in the existing openness and growth studies has often been omitted, despite the fact that FDI flows have been growing at a pace far exceeding the volume of international trade. Between 1975 and 2001, the aggregate stock of FDI rose from 4.5 per cent to 20.6 per cent of world GDP, with sales of foreign affiliates of MNEs substantially exceeding the value of world exports (Barrell and Pain, 1997; UNCTAD, 2002). In this context, FDI is clearly significant. As a result focusing only on trade as a proxy for openness may flaw the estimation results.

To address these three issues appropriately is not only of interest to academics but also has important practical implications. Properly understanding the relationships between FDI, international trade and growth aids governments and multinational institutions for their policy formations.

I.2 Research Framework

This thesis aims to examine the relationships between openness and long-run economic growth from an empirical perspective. Traditionally, openness and growth studies considered only international trade as a dimension of openness. This is a rather narrow concept. According to Grossman and Helpman (1991), an economy is 'open' when it trades with other countries in goods, services, financial assets and ideas. They identify three sets of implications of an open economy status: international transmission of ideas; international flows of goods and services; and international movements of capital. International transmission of ideas can be realised through technology transfer such as licensing agreements directly, or through 'international spillovers of knowledge' from international flows of capital, goods and services indirectly. International flows of goods and services simply refer to international trade. International movements of capital include FDI, foreign portfolio investment (FPI) and foreign aid. Licensing, FPI and foreign aid are not examined in this thesis for two reasons: they are small relative to international trade and FDI and there are not sufficient data for these variables to be included in the study. Therefore, international trade and FDI are the two main channels considered in the thesis.

In the existing literature, considerable efforts have been devoted to the subject of long run economic growth by taking into account either international trade or FDI, but few papers explicitly place international trade, FDI and economic growth in a single framework (Table I.2). This is quite surprising given that the new trade, FDI

and endogenous growth theories consistently suggest the importance of both trade and FDI in economic growth. Furthermore, in a study of FDI and the multilateral trading system, Ruggiero (1996) maintains that FDI plays a particularly important role in facilitating an international division of labour and increases the mobility of factors of production – not only capital but also, probably more importantly, technology, management skills and other know-how. FDI also brings with it market access for exports of components to the global production system and for exports of finished products to the distribution system. Therefore, FDI and international trade are not merely increasingly complementary and mutually supportive, but also increasingly inseparable as two sides of the coin of the process of economic development.

In summary, this thesis considers openness and growth in a framework with the following characteristics. Firstly, openness is identified to have two dimensions including FDI and international trade, and the inter-relationship between them is carefully dealt with. Secondly, the assumptions of non-diminishing returns to reproducible factors of production, imperfect competition and endogenous technological change are imposed throughout the thesis. Thirdly, a possible two-way relationship between openness and growth is addressed. Finally, only the long-run effects are considered between openness and growth or between trade and FDI.

Table I.1: A Summary of Openness and Growth Studies

Openness Measures	Countries	Period	Impact	Sources
Trade share based:			**Coefficient on openness**	
Deviation from predicted trade [Leamer, 1988];	45	73-78	Significant > 0	Balassa [1985]
Change in trade shares;		1982	Significant > 0	Edwards [1992]
Trade shares	19	60-85	Significant > 0	Helliwell & Chung [1990]
Predicted trade share*log(1+tariff)	81 LDCs	60-85	Weakly Significant > 0	Quah & Rauch [1992]
		60-85	Significant < 0	Lee [1993]
Price-based:				
The relative price of tradeables to international price;	60	60-87	Raised GDP growth	Bhalla & Lau [1992]
Relative domestic price of investment goods to international price;	98	60-65	Raised GDP growth per capita	Barro [1991]
Relative price of traded goods	95 LDCs	60-85	Raised GDP growth per capita	Dollar [1991]

Openness Measures	Countries	Period	Impact	Sources
Administrative measures: Effective rate of protection in manufacture;	47	50-80	Lower protection raise GDP growth	Heitger [1986]
Trade liberalisation index from Thomas et al. [1991]	35 LDCs	75-85	Export incentives positively affect GDP per capita, insignificant impact of import restrictiveness	Lopez [1990]
Trade liberalisation index from Thomas et al. [1991]		78-88	Trade reform positively affects GDP growth	Thomas & Nash [1991]
Sach & Warner's [1995] composed openness indictor dummy		70-89	Positive relationship between openness and growth	Sach & Warner [1995]
Wacziarg's index of trade policy	57	70-89	Openness increases growth though investment channel	Wacziarg [1998]
Robust analysis: Harrison [1996] panel data approach and causality test			Positive relationship between GDP growth and different measures and causality in both direction	Harrison [1996]
Edwards principle component approach	93	60-90	Positive relationship between TFP growth and different measures and composite index	Edward [1998]

Table I.2: A Summary of Studies into the Relationship between FDI and Trade

Study	Dataset	FDI Variable	Trade Variable	Other Control Variables	Estimation Technique	Conclusion
Lipsey & Weiss [1981]	Cross-section; Firm-level; 14 industries U.S. to 13 countries [1970]	Various measures of U.S. & foreign affiliate activity	U.S. and 13-country industry export;	Market size; Host country membership in EEC; Distance	Multiple regression equations by industry	FDI activity promotes home country's export to host country
Lipsey & Weiss [1984]	Cross-section; Firm-level; 14 industries U.S. to 13 countries [1970]	Production and sales of U.S foreign affiliates	Firm-level export from U.S.	Income of host country; The size of parent company	Multiple regression equations by industry	Positive relationship between foreign production and foreign sales
Pfaffermayr [1994]	Time series; Austria	Outward FDI	Export	None	Granger causality test & cointegration test	Complementary relationship between FDI and exports
Pfaffermayr [1996]	Panel data; 7 Austrian industries over 13 years	Outward FDI	Export	Capital; R&D; Labour and skill intensity	Simultaneous equations; Two step GMM	Complementary relationship between FDI and exports

Study	Dataset	FDI Variable	Trade Variable	Other Control Variables	Estimation Technique	Conclusion
Pain & Wakelin [1998]	Panel data; 11 OECD countries 1971-1992	Inward and Outward FDI	Export	Relative price; Product quality; World demand	A demand model; mean group & within group estimator	Outward FDI has negative & inward FDI has positive impact on trade
Goopinath, Pick and Vasavada [1999]	Panel data; U.S. food processing industry from 10 countries for 1982-1994	Outward FDI	Export	Affiliate employment; Foreign affiliate sales; GNP per capita; Interest rate, Exchange rate	A four-equation system	Foreign sales and foreign exports are substitutes

I.3 An Overview and Thesis Structure

In the thesis, a country study for China is first made to fill in the gap in the literature on the relationship between FDI and international trade in the largest emerging economy in the world. Second, in order to investigate the determinants of trade, an extended gravity model is tested for the OECD countries in which R&D, FDI and GDP are all treated endogenously. Third, the roles of international trade and FDI in countries' economic growth at different development stages are compared.

I.3.1 Causal Links between International Trade and FDI in China

Before conducting a study into the relationship between openness and economic growth, what needs to be addressed is the relationship between FDI and international trade. In the international economics and business literature, the following two aspects of possible linkages between FDI and international trade are often discussed:

(1) whether FDI is a substitute for, or a complement to, international trade;

(2) whether FDI causes international trade or the other way round.

Existing studies on the relationship between FDI and international trade generally indicate a positive complementary relationship at the country level, but their focus is mainly on developed countries (see Table I.2). Therefore, an unanswered research question is whether such a relationship exists in developing countries. Furthermore, there may exist two-way causal links between FDI and international trade. Studies such as Nicholas (1982), Johanson and Vahnle (1993) and UNCTD (1996) suggest

that many firms in the manufacturing sector still follow the traditional step-by-step sequence of servicing foreign markets. They trade in a foreign market in the first instance because trade is easier and less risky than FDI. After learning more about the economic, political and social conditions of the foreign market and gaining more experience of serving the foreign market, these firms may establish subsidiaries for production in the foreign market. Finally, their foreign subsidiaries may eventually begin to export to another foreign market. This is also consistent with Vernon's product life cycle hypothesis.

Chapter II carries out the first empirical investigation which takes China as an example of the developing countries. China's hyper-growth of inward FDI and international trade has demonstrated that a country with a large population can promote economic growth through openness which usually happens in small countries such as those newly industrialised economies in East Asia. In this study, the causality between FDI and trade (both exports and imports) is tested in a vector autoregressive model.

The chapter II is arranged as follows. A brief introduction of the recent trend of inward FDI and trade growth in China is given in the first section. Section II.2 reviews the literature. The two possible linkages between FDI and international trade are discussed theoretically and empirically. Section II.3 describes the data and methodology. A brief description of variable definitions and data sources are also given in this section, while the detailed information is supplied in Appendices II.1, II.2 and II.3. The main part of section II.3 consists of presentations of the two econometric methods: the multivariate Granger causality test based on the vector

autoregressive representation, and the unit root test of the t-bar and LM-bar statistics for a short period panel. Empirical findings are then discussed in section II.4. Finally, section II.5 provides concluding remarks and policy implications.

I.3.2 Sources of Recent Trade Growth in OECD Countries

While chapter II deals with the relationship between FDI and trade in a particular developing country - China, chapter III is devoted to the determinants of recent trade growth. International trade promotes competition, specialisation and scale economies, and helps to allocate resources efficiently based on comparative advantage. It is an important channel for knowledge spillovers across boarders (Grossman and Helpman, 1991). International trade has grown faster than income in the post-war period (Hill, 2001). The identification of the main sources of international trade growth has been a subject of considerable interest to academics for many years including an early contribution by Prewo (1978) and a recent one by Baier and Bergstrand (2001). This identification also relates to the studies of openness and economic growth. One way of constructing an openness index is to use a simplified gravity model to predict levels of trade in the absence of protection and then take the difference between real trade and predicted trade as the openness measure. If such an approach can not predict the trade accurately, this openness measure fails.

The existing empirical literature on international trade growth tends to focus on income convergence, transport costs and trade liberalisation as the main

determinants of trade. However, the new trade, FDI and endogenous growth theories suggest that trade growth is also determined by R&D and FDI stocks. The second empirical investigation in chapter III attempts to identify the main sources of trade growth in 19 OECD countries over the period 1980-1998. It differs from Baier and Bergstrand (2001) and many other studies in the following main aspects. Firstly, it empirically tests hypotheses that are eclectically synthesized from the new trade, FDI and new growth theories by extending the standard gravity model to incorporate R&D and FDI stocks. Secondly, it takes into consideration the possible endogeneity of income, R&D and FDI stocks to avoid any estimation bias. Thirdly, it employs a panel data approach, which has several advantages over the cross-sectional approach that is used in most of the empirical literature on gravity models.

The chapter III is arranged as follows. It begins with an assessment of the existing studies on the main causes of trade growth in section III.1 and the discussion of hypotheses formation is offered in section III.2. Various hypotheses are developed from new trade, FDI and growth theories. The concerned determinates are relative factor endowment; level and similarity of GDP; R&D accumulation and similarity; FDI accumulation and similarity; and geographical distance and exchange rate. Then, section III.3 presents the empirical model, data and methodology. In section III.3.1, an augmented simple gravity model is constructed. More specifically, modifications are made to take into account of R&D and FDI stock discussed in the proceeding section. In section III.3.2, the description of data is given and statistical tests for model specification and exogeniety are discussed. The empirical results are presented in section III.4. The final section summarises the results and provides

some concluding observations. The results further confirm the two-way relationship between FDI and international trade as found in chapter II.

I.3.3 Impact of Openness on Growth in Different Country Groups

After assessing the inter-relationship between FDI and international trade, chapter IV investigates the impact of FDI and trade on economic growth. Most empirical research in the area of openness and growth studies has tested earlier growth models rather than endogenous growth theory itself. Moreover, most of the empirical work has utilized observations across countries and imposed extremely strong assumptions on countries' production functions. Based on the framework discussed in the previous section, openness to trade and openness to FDI are both considered, and the assumptions of diminishing returns to reproducible production factors and identical technologies across countries are relaxed in the third empirical study.

This study explores evidence on a number of subjects in the context of openness and economic growth. By dividing countries into groups in terms of their development stages, the assumption that the effect of openness on growth is conditional on a country's technological capability is tested. The roles of FDI and international trade are explicitly examined in each country group. Furthermore, the possible endogeneity of FDI and international trade are carefully dealt with.

The chapter IV is arranged as follows. Section IV.1 gives an introduction which emphasises that the existing openness and growth studies have provided inconclusive results on the impact of FDI and trade on economic growth. Section

IV.2 reviews the literature. In section IV.3, an econometric model is presented. The main features are that the assumption of identical technology across countries is relaxed by dividing countries into groups; no assumption is imposed on returns to production factors; and both FDI and trade are introduced in as two different channels of openness. Data and methodologies are discussed in section IV.4. The results are discussed in section IV.5. Finally, section IV.6 summarises the findings and provides some concluding observations.

Chapter V offers overall conclusions and policy implications.

Chapter II. Causal Links between Foreign Direct Investment and Trade in China

This chapter examines the causal relationship between FDI and trade in China. The empirical study is based on a panel of bilateral data for China and 19 home countries/regions over the period 1984-98. The specific feature of the study is that econometric techniques designed specially for panel data are applied to test unit root and causality. The results indicate a virtuous procedure of development for China: the growth of China's imports causes the growth in inward FDI from a home country/region, which in turn causes the growth of exports from China to the home country/region. The growth of exports causes the growth of imports. The results have important policy implications. This virtuous procedure is the result of China's policy of opening to the outside world. China has been encouraging export-oriented FDI and reducing trade barriers. Such policy instruments should be further encouraged in order to enhance economic growth.

Chapter II. Causal Links between Foreign Direct Investment and Trade in China

II.1 Introduction

As noted by UNCTD (1996), conceptual models of FDI and international trade have traditionally been developed separately. The integration of FDI and trade theories is still at its infant stage. As a result, though the importance of FDI or international trade as an individual variable in economic growth has been widely documented, their possible linkages are relatively understudied. Are FDI and trade substitutes or complements? Are there any causal relations between FDI and trade? An understanding of these linkages helps governments harmonise their FDI and trade policies for growth and development.

In terms of FDI-trade relations, China offers an interesting case. In 1978 when China had just begun to open its economy to the outside world, there was little inward FDI, and China ranked 32nd in the world league table for foreign trade (Ministry of Foreign Economic Relations and Trade, 1995/6, p. 19). By the end of 2000, however, China had already approved more than 364,345 foreign invested firms, and the pledged level of FDI had reached US$ 676.7 billion (People's Daily, Overseas Edition, 18 January 2001). China is now among the world's largest host of FDI inflows. In 2000, China's total foreign trade reached US$ 474.3 billion (People's Daily, Overseas Edition, 11 January 2001). China became the ninth largest trading

country in the world in 1999 (People's Daily, Overseas Edition, 13 March 2000). China has experienced so rapid expansion both in FDI and trade, an examination of their linkages, therefore, is motivated.

Despite this co-movement of impressive growth in both trade and FDI, there is lack of systematic investigation of the causal linkage between trade and FDI. One exception is Pfaffermayr (1994) who adopts a time series approach and uses Granger causality test to investigate the relationship between outward FDI and exports using aggregate flow data from the Austrian economy. In contrast, the current study employs a panel data approach in its assessment of possible substitutive/ complementary causation between inward FDI stock and trade in China. The remainder of this chapter is structured as follows. Section II reviews both the theoretical and empirical literature on FDI-trade relations. The data and methodology are described in Section III. The results will be discussed in Section IV and Section V provides conclusions and policy implications.

II.2 Literature Review

II.2.1 Theoretical Considerations

In the international economics and business literature, the following two aspects of possible linkages between FDI and international trade are sometimes discussed: (1) whether FDI is a substitute for or a complement to international trade (FDI); and (2) whether FDI causes international trade or the other way round.

As for the first aspect, the Heckscher-Ohlin-Samuelson model suggests that international trade can substitute for the international movement of factors of production and therefore FDI. This model implies that international commodity trade involves an indirect exchange of factors between countries. For instance, by exporting capital-intensive commodities in exchange for labour-intensive commodities, the capital-abundant country indirectly exports a net amount of capital in exchange for a net amount of labour. Thus under the assumption that factors are perfectly immobile between countries, factors do eventually migrate between countries indirectly through exports and imports of commodities. On the other hand, in the Mundell (1957) model, production functions are assumed to be identical in all countries and regions. Thus, international trade and the international mobility of factors of production which includes FDI are substitutes rather than compliments for each other.

Recently there have been attempts to integrate FDI and trade theories and provide explanations of possible replacement and complementary effects between the two ways of serving a foreign market. Helpman (1984) and Helpman and Krugman (1985) illustrate that the degree of specialisation is a positive function of relative factor endowments. If differences in factor endowments are not substantial, a capital-abundant country will produce capital-intensive differentiated goods at home and exchange them for the labour-intensive homogeneous good from a labour-abundant country. However, if there are substantial differences in factor endowments, the capital-abundant country tends to export headquarters services (such as R&D) into the labour-abundant country in exchange for finished varieties of differentiated good and homogeneous good rather than simply export the differentiated good. Thus, FDI generates complementary trade flows from the labour-intensive country. In addition, parent firms may export intermediate inputs to their subsidiaries if vertical integration is involved. As noted by Markusen and Maskus (1999), the model developed by Helpman (1984) captures the notion of vertically-integrated firms, but does not allow FDI to happen between very similar countries.

Based on the assumption that countries are symmetric in terms of size, factor endowments, and technologies, Brainard (1993), Markusen (1984) and Horstman and Markusen (1992) develop models which distinguish between plant and firm-level scale economies and acknowledges the existence of trade barriers such as tariffs and transport costs. They argue that the choice between horizontal FDI and international trade at both firm and country levels depends on the trade-off between proximity and concentration. Proximity means that firms have incentive to overcome

various barriers to trade by launching FDI in a foreign market. Multi-plant economies of scale generated by high fixed costs of R&D and other headquarters activities also justify FDI. Concentration refers to increasing returns to scale at the plant level. If proximity advantages overweigh concentration advantages, there will be more FDI instead of trade. Therefore, there can be a substitution relationship between FDI and trade.

Given the fact that countries differ in relative endowments, Markusen and Venables (1995, 1996, 1998) and Markusen (1998) introduce countries' asymmetries in explaining the choice between international trade and FDI. For convenience, firms tend to be national and located in the advantaged countries. As the disadvantaged country develops in terms of local market size, factor endowments and technological efficiency, more and more firms from the advantaged country will establish subsidiaries in the disadvantaged country. Thus, FDI and trade will exist simultaneously. Multinationals become more important relative to trade as countries become more similar in the size, relative endowments, and as world income grows. Brainard (1997) also suggests that multinational activity is more likely the more similar are the home and foreign markets. This suggests that multinational production will substitute for trade when countries are similar.

As can be seen from the above, the linkages between FDI and trade are complex. It is very difficult, if not impossible, to predict whether FDI and trade are substitutes or complements. Dunning (1998) suggests that the relationship between trade and FDI is conditional on the kind of trade and FDI being considered, and the conditions under which each takes place. Gray (1998) specifies that market-seeking production

affiliates can displace international trade and efficiency-seeking production affiliates will increase the volume of trade.

In terms of causality, the extant literature suggests that many firms in manufacturing still follow the traditional step-by-step sequence of servicing foreign markets: they trade in a foreign market in the first instance because trade is easier and less risky than FDI. After knowing more about the economic, political and social conditions and gaining more experience, home-country firms may establish producing subsidiaries in the foreign market. But foreign subsidiaries may eventually begin to export (Nicholas, 1982; Johanson and Vahnle, 1993; UNCTD, 1996). Thus, there can be a two-way causal links: trade will first cause FDI, and FDI may eventually cause trade. This is consistent with Vernon's product life cycle hypothesis.

As in the case of the substitution-complementary issue, the causal relationship between trade and FDI is complicated, and depends largely on the types of trade and FDI being considered. It is basically country-, industry- and even firm- specific. This suggests the importance of empirical investigations in assessing true FDI-trade relationships.

II.2.2 Empirical Evidence

Existing empirical studies use different data and estimation techniques, and it is not surprising that the results are mixed. Lipsey and Weiss (1981, 1984) estimate trade and affiliate productions using cross-sectional firm level data. Their trade equations include several other variables such as the size of the parent company and the

income of the involved area. They find a positive relationship between US firms' outputs in a foreign area and the firms' exports from the United States to that area. Using trade equations and US and Swedish firm level data, Blomstrom et al. (1988) find that the relationship between FDI and export sales is complementary.

Pfaffermayr (1996) argues that outward FDI and exports can have common determinants such as capital, labour, skill and R&D intensities. Within this endogenous framework Pfaffermayr estimates a simultaneous equations system using industry level panel data from Austrian manufacturing, and finds a significant complementary relationship between FDI and exports in the eighties and early nineties.

Using bilateral data for Japan and its 20 major trading partners for the period 1982-95, Bayoumi and Lipworth (1997) regress trade flows on the stock and flow of FDI from Japan, aggregate demand in foreign (home) market and relative prices between the export and import markets. They use the size and significance of the coefficient on the stock of FDI as a measure of the long-run impact of FDI on trade, and that on the flow of FDI as more temporary trade effects, and conclude that outward FDI from Japan has a temporary impact on exports but a permanent effect on imports.

Using an augmented export demand model and a panel data set at the economy level for eleven OECD countries for the period 1971-1992, Pain and Wakelin (1998) find evidence of heterogeneity in the relationships between FDI and exports. In general however, outward FDI has a negative impact on trade shares while inward FDI has a positive one.

Based on a panel data for ten countries for the period 1982-1994, Gopinath et al. (1999) use a four-equations system with foreign affiliate sales, exports, affiliate employment and FDI as endogenous variables to assess the relationship between FDI and trade in the U.S. food industry. Their results indicate that foreign sales and exports are substitutes in the industry.

While some attention has been paid to the substitution-complement relationships, explicit testing for causality between FDI and trade is extremely rare. Adopting a time series approach, Pfaffermayr (1994) examines the characteristics of the quarterly data for outward FDI and trade from the Austrian economy for the period 1969-1990. It is found that there exists significant causality of Austrian outward FDI and exports in both directions.

II.3 Data and Methodology

Though China began to receive FDI from 1978, official data on inward FDI by country of origin are available only from 1983 onwards. Given this relatively short time series, the unit root and causality tests in this study are based on the panel data set generated from 19 countries/regions over the period 1984-1998. A list of these home countries/regions of FDI is presented in Appendix II.1. Several missing values for some observations are extrapolated. To remove the influence of inflation, all variables are adjusted by the GDP deflator of China. In addition, all variables are in logarithm form. Detailed information on variables and data are provided in Appendices II.2 and II.3. Table II.1 presents the descriptive statistics for the three variables.

The concept of causality was initially defined by Granger (1969). In a bivariate framework, the variable x_{1t} is said to cause the variable x_{2t} in Granger's sense if the forecast for x_{2t} improves when lagged variables for x_{1t} are taken into account in the equation. Granger causality tests in a strictly bivariate framework are computationally simple, but the omission of other relevant variables could result in spurious causality (see Granger, 1969, p. 429). Caporale et al. (1998) show that the omission of an important variable results in invalid inference about the causality structure of the system, unless causality runs to the omitted variable but not vice-versa.

In the current study, multivariate Granger causality tests are conducted to examine possible causal relationships among three variables - FDI (LFDI), exports (LEX) and imports (LIM). The research could have been carried out differently, e.g. by employing a simultaneous equation approach as an alternative estimation technique. The latter approach allows the simultaneous fit of three equations to include a set of other economic, political, and socio-cultural variables which are suggested by existing theoretical and empirical studies as the determinants of FDI, exports and imports. The inclusion of the whole ensemble of explanatory variables in the estimation procedure may improve the accuracy of model fitting and allows the investigation of how the processes actually work. However, for the time period under study, at best only rudimentary data are available. The current study focuses on answering the questions: how much of the variation in one variable over time is explained by movement in another and what is the direction of such influence? To achieve this, it is essential to include lagged variables in the model. With the data at hand, it is not possible to use a simultaneous equation approach to include other variables in the estimation. In addition, the main purpose of this study is to shed light on the issue of how FDI, exports and imports interact with each other, not on their determinants. The multivariate Granger causality tests, allowing for the simultaneity of all included variables, are suitable for this kind of study. Future research might use other statistical techniques to reveal the inter-temporal relationships between FDI, exports and imports or attempt to identify other main determinants of FDI, exports and imports.

The multivariate Granger causality tests are based on the following vector autoregressive (VAR) representation:

$$\begin{bmatrix} x_{1t} \\ x_{2t} \\ x_{3t} \end{bmatrix} = \begin{bmatrix} c_1 \\ c_2 \\ c_3 \end{bmatrix} + \begin{bmatrix} \Phi_{11}(L) & \Phi_{12}(L) & \Phi_{13}(L) \\ \Phi_{21}(L) & \Phi_{22}(L) & \Phi_{23}(L) \\ \Phi_{31}(L) & \Phi_{32}(L) & \Phi_{33}(L) \end{bmatrix} \begin{bmatrix} x_{1t} \\ x_{2t} \\ x_{3t} \end{bmatrix} + \begin{bmatrix} \varepsilon_{1t} \\ \varepsilon_{2t} \\ \varepsilon_{3t} \end{bmatrix} \quad (1)$$

where the series x_{1t}, x_{2t} and x_{3t} denote three potentially endogenous variables – FDI, exports and imports, respectively. x_{1t}, x_{2t} and x_{3t} are assumed to be stationary processes. ε_{1t}, ε_{2t} and ε_{2t} are the residual and Gaussian white noise with zero mean and constant variance. L is a lag operator. The idea of the multivariate Granger causality approach is: if $\Phi_{12}(L)$ are jointly significantly different from zero, it is said that x_{2t} Granger causes x_{1t}, given x_{3t}. The causality between x_{1t} and x_{3t}, given x_{2t}, and the causality between x_{2t} and x_{3t} given x_{1t} can be examined in a similar way. The restrictions can be tested by employing Wald-tests.

However, the conventional Granger causality test based on a standard VAR model is only defined with stationary processes. If variables are non-stationary or non-integrated, the implications drawn from the usual Wald test statistics are invalid. Phillips and Durlauf (1986), Park and Phillips (1989) and Sims, Stock, and Watson (1990) among others show that the conventional asymptotic theory is, in general, not applicable to hypothesis testing in VARs in levels, if the variables are non-stationary. More specifically, the Wald test statistics for Granger causality based on estimations in levels not only have non-standard asymptotic distributions but also depend on nuisance parameters in general. To provide valid empirical evidence, it is

essential to identify the order of integration of each variable before any sensible analysis can be performed.

Considerable evidence exits that time series unit root tests can be misleading in small samples (see, for example, Dickey and Fuller, 1979). Given that there are only 15 observations for each country in this study, the conventional time series unit root tests are unlikely to distinguish between unit root and near-unit-root behaviour. Indeed, the ADF results show that it is frequently impossible to reject the unit root hypothesis for each individual time series in this study. To explore the panel structure of the data, the unit root tests proposed by Im, Pesaran and Shin, 1997 (thereafter denoted as IPS) are therefore employed to examine the orders of integration of variables. Two tests are proposed by IPS: the t-bar and the LM-bar statistics. The t-bar statistic is constructed from a group mean Augmented Dickey-Fuller (ADF) test statistic, while the LM-bar statistic is based on the average value of the Lagrange Multiplier (LM) statistics for testing the null hypothesis of a unit root in ADF regressions of order p_i. One advantage of the IPS methods over previous panel unit root tests, including Quah (1992, 1994) and Levin and Lin (1992, 1993), is that the coefficients and errors are allowed to be heterogeneous across countries in ADF equations.

The ADF test is based on the following equation

$$\Delta y_{i,t} = \beta_i y_{i,t-1} + \sum_{j=1}^{p_i} \rho_{ij} \Delta y_{i,t-j} + c_i + \varepsilon_{it} \qquad i = 1, \ldots, N; t = 1, \ldots, T \qquad (2)$$

where $y_{i,t}$ is the variable under consideration. Δ is the first order difference operator. j = 1, 2, ... p_i is the lag length of Δy_{it}. ρ_i is the estimated vector of coefficients on the augmented lagged differences. The null hypothesis of unit roots then becomes $\beta_i = 0$ for all i.

The standardised t-bar and LM-bar statistics developed by IPS are expressed in the following equations:

$$\bar{\Psi}_{\bar{t}} = \frac{\frac{1}{N}\sum_{i=1}^{N} t_{iT}(p_i,\rho_i) - \frac{1}{N}\sum_{i=1}^{N} E[t_{iT}(p_i,0) \mid \beta_i = 0]}{\sqrt{\frac{1}{N^2}\sum_{i-1}^{N} V[t_{iT}(p_i,0) \mid \beta_i = 0]}} \tag{3.1}$$

$$\bar{\Psi}_{\overline{LM}} = \frac{\frac{1}{N}\sum_{i=1}^{N} LM_{iT}(p_i,\rho_i) - \frac{1}{N}\sum_{i=1}^{N} E[LM_{iT}(p_i,0) \mid \beta_i = 0]}{\sqrt{\frac{1}{N^2}\sum_{i-1}^{N} V[LM_{iT}(p_i,0) \mid \beta_i = 0]}} \tag{3.2}$$

where i = 1, 2, ..., N and T is the number of time-periods. $t_{iT}(p_i,\rho_i)$ is the individual ADF statistic for testing restrictions $\beta_i = 0$. $LM_{iT}(p_i,\rho_i)$ is the LM statistic for testing $\beta_i = 0$. The values of $E[t_T(p_i,0) \mid \beta_i = 0]$, $V[t_T(p_i,0) \mid \beta_i = 0]$, $E[LM_T(p_i,0) \mid \beta_i = 0]$ and $V[LM_T(p_i,0) \mid \beta_i = 0]$ are tabulated in IPS. Under the null hypothesis of a unit root, both t-bar and LM-bar statistics have a standard normal distribution. Under the alternative hypothesis of stationarity, the t-bar statistic diverges to negative infinity, while the LM-bar statistic diverges to positive infinity.

As is often mentioned in the literature, one important methodological issue is to set the appropriate lag length in the ADF equations (see, for example, McCoskey and Selden, 1998). The optimal selection of lag length should be determined by the fact that the residuals are white noise process. The procedure used in the chapter is to start with an upper bound, p_{max} which is set to 4 and then choose p_i according to the values of the AIC criterion, which varies across countries. With the knowledge from the IPS-test results, VAR techniques with a panel data set to test for interdependencies between variables are then conducted with stationary variables.

II.4 Empirical Results

As shown in Table II.1, the LM-bar and t-bar statistics consistently accept the null hypothesis of non-stationarity for LFDI and LEX and reject the null for LIM at the 1 per cent level. After first differencing, the unit root null for LFDI and LEX is rejected at the 1 per cent level. It can be concluded that LFDI and LEX are I(1) while LIM is I(0). Given the information on the integration orders, all variables are differenced once and causality tests are carried out for the series of *ΔLFDI*, *ΔLEX* and *ΔLIM*. Since *ΔLIM* is still a stationary series, the causality tests for *ΔLFDI*, *ΔLEX* and *ΔLIM* are valid (Canova, 1995). Though LIM itself is I(0), an examination of the causal relationships between the growth rates of FDI, exports and imports may be more appropriate than between the growth rates of FDI and exports and the level of imports.

Though questions about optimal lags are raised in the literature, the issue of the best statistical method to use in determining the optimal lags in Granger's causality test is unsolved (Amoateng and Amoako-Adu, 1996). Instead of choosing the order of the lag using such information criteria as Akaike Information Criterion and Schwarz Criterion, the Wald-test statistics for various lag structures with the maximum lag set at 4 will be reported.

Table II.1: Descriptive Statistics and Unit Root Test Results

Variable		*LFDI*	*LEX*	*LIM*
Maximum		11.1244	10.3114	10.3790
Minimum		-0.7502	3.6220	4.11842
Mean		4.97920	6.7297	7.0103
Standard deviation		2.4621	1.4745	1.2414
t-bar Test				
	Levels	1.9783	0.4307	-5.3278***
	First Differences	-7.7274***	-7.5929***	-8.6046***
LM-bar Test				
	Levels	-2.0034	-1.5564	3.0458***
	First Differences	6.4121***	6.6051***	6.0186***

Notes:

1. *LFDI*, *LEX* and *LIM* stand for logarithms of FDI, exports and imports respectively.
2. There are 285 observations for all three variables over the period 1984-1998.
3. ***, **, * denote significance at the level of 1 per cent, 5 per cent, and 10 per cent, respectively.
4. For LM-bar test, the critical values are 2.57, 1.96 and 1.65, at the 1 per cent, 5 per cent and 10 per cent confidence levels respectively. The LM-bar statistic should be positive to reject the null hypothesis of unit root(s). For t-bar test, the critical values are -2.57, -1.96 and -1.65, at the 1 per cent, 5 per cent and 10 per cent confidence levels respectively. The t-bar statistic should be negative to reject the null hypothesis.

From Table II.2, though different lag lengths are applied, a clear pattern emerges for the causal links between inward FDI stock, exports and imports in China. Firstly, the hypothesis that the growth of China's imports (ΔLIM) Granger-causes the growth of FDI (ΔLFDI) from the home country cannot be rejected at the 1 or 5 per cent level of significance. The positive signs on the sum of the estimated coefficients suggest complementary causal linkages from ΔLIM to ΔLFDI. The reverse hypothesis is rejected because of the insignificance of the Wald-test statistics.

This first finding is generally consistent with Vernon's type of the step-by-step sequence: the home country conducts easier and less risky exports to China, and then launches FDI in China. One question which may arise is that the current analysis is at the economy level, but the traditional internationalising sequence mainly applies to the manufacturing industry. It is true that, because of data limitations, it is not able to relate the home country's trade and FDI activities to individual industries in China. However, given that the majority of inward FDI and trade in China take place in manufacturing, the traditional consequence of servicing a foreign market is largely relevant at the economy level for China. For instance, in 1998, 83.6 per cent of China's imports, 88.8 per cent of China's exports and 56.2 per cent of inward FDI happened in Chinese manufacturing industries (China Statistical Yearbook, 1999).

Table II.2: Causality Tests for FDI, Exports and Imports

Test for Causality Of	By	(no. of lags: 4)		(no. of lags: 3)		(no. of lags: 2)		(no. of lags: 1)	
ΔLFDI	*ΔLEX*	(–)	0.7207	(–)	0.3756	(+)	0.0860	(+)	0.0769
	ΔLIM	(+)	12.1143**	(+)	13.1363***	(+)	11.6547***	(–)	0.9920
ΔLEX	*ΔLIM*	(+)	5.9285	(+)	5.7299	(+)	4.6298	(+)	0.2003
	ΔLFDI	(+)	23.6180***	(+)	19.7447***	(+)	17.6944***	(–)	9.3836***
ΔLIM	*ΔLEX*	(+)	16.1645***	(+)	13.1729***	(+)	12.4645***	(+)	2.3032
	ΔLFDI	(+)	5.3777	(+)	3.7493	(+)	3.7736	(+)	0.0167

Notes:

1. *ΔLFDI*, *ΔLEX* and *ΔLIM* stand for the first differences of *LFDI*, *LEX* and *LIM* respectively.
2. ***, ** and * denote significance at the 1 per cent, 5 per cent and 10 per cent level, respectively.
3. [a] The sign in the parentheses is the sign of the sum of the estimated coefficients.
4. [b] The figures are the values of Wald-test statistics.

As indicated in Table II.2, the causality from ΔLFDI to ΔLLEX is achieved at the 1 per cent level of significance with any lag length. When lag one is applied, the sign of the sum of the estimated coefficients is negative. However, from lag two onwards, the signs are consistently positive. This may suggest that lag one is not an appropriate lag length. The reverse hypothesis can be rejected since the Wald test statistics are not significant. The results suggest a second finding of the current study: there is a one-way complementary causal link from ΔLFDI to ΔLEX.

The second finding is largely consistent with the predictions by Vernon (1966), Helpman (1984) and Helpman and Krugman (1985). Though separate data on horizontal and vertical FDI in China are unavailable, it is clear from the above theoretical models that complementary trade can result from FDI, if there exist relatively large differences in resource endowments between the home country and China. Inward FDI is a package of technology, management and marketing skills as well as financial capital. China is a labour abundant developing country. One important attraction of China as a host country is its relatively cheap labour (Liu and Song, 1997; Liu, Song, Wei and Romilly, 1997; Wei et al., 1999). The combination of foreign technology, managerial and marketing expertise with China's labour force and other endowments makes foreign subsidiaries more competitive and able to export back to their parent countries. In this sense, inward FDI at the economy level in China can be regarded as efficiency seeking, which increases the volume of trade.

The causation from inward FDI to China's export growth may also reflect China's special FDI policy which encourages foreign-invested firms to export their products. Many firms from newly industrialised economies treat mainland China as their

export platform (United Nations, 1994, Liu and Song, 1997). They produce labour-intensive products in mainland China, and then transport the products back to their home economies. Some of these products are re-packed and re-exported to Western countries. This partly explains why Hong Kong has a high volume of *entrepot* trade from China (Strange, Slater and Wang, 1998)[2].

Though the focus of this chapter is on the FDI-trade relationship, a third finding is directly related to trade: positive causation is identified from export growth to import growth at the 1 per cent level of significance. This may reflect the fact that China has to export its products and earn sufficient foreign exchange in order to finance imports from its trading partner. The reverse hypothesis that import growth Granger-causes export growth is rejected because of the insignificance of the Wald-test statistics.

The findings from this chapter seem to differentiate the contributions made by imports and inward FDI to exports. As is sometimes discussed in the literature, the Chinese government has followed the development strategy of protected export-promotion (United Nations, 1994; Liu, Song and Romilly, 1997). Exports are positively encouraged while imports are used to ensure the supply of key materials

[2] Hong Kong's position in China's trade with the rest of the world is unique. Some China's exports to other countries are channelled through Hong Kong. Hong Kong firms import products from China, add values to them via repackage, redistribution, and readvertising and then distribute them to a final destination. This kind of activities is also called re-export. Our empirical results could be affected if re-export activities are excluded. However, such issue is not considered in the study because values are added during the process the re-export. According to Hanson and Feenstra (2001), the average markup on Hong Kong re-exports of Chinese goods was 24 per cent over the period of 1988 to 1998. Therefore, such kind of trade between China and Hong Kong should be classified into the catalogue of China-Hong Kong trade.

and embodied technology, so that import substitution and economic growth can be promoted and new exports developed. The positive role of China's total imports in promoting its total exports is indeed confirmed in a time series investigation by Liu, Song and Romilly (1997). However, in their investigation FDI is excluded. The current panel data study seems to suggest that inward FDI stock plays a more important role than imports in generating China's exports. While the growth of China's imports from the trading partner promotes the growth of inward FDI from that partner, it is the growth of inward FDI stock rather than imports that directly and positively causes the growth of exports.

II.5 Conclusions

This chapter examines causal linkages between FDI and trade in China based on a panel of data covering 19 home countries/ regions over the period 1984-1998. The standard t-bar and LM-bar tests are carried out to test for unit roots for the variables involved. Granger causality tests are then conducted based on a standard VAR model with stationary time series of the variables. The main findings are as follows.

(1) There is a one-way complementary causal link from the growth of China's imports to the growth of inward FDI stock from the home country/region.

(2) There exists a one-way complementary causal link from the growth in inward FDI stock in China to the growth of China's exports to the home country/region.

(3) There is a one-way complementary causal link from the growth of China's exports to imports.

Of course, these results should be interpreted with caution since Granger causality does not imply that one variable is the effect or the result of another. Granger causality only refers to the precedence of one variable over the others.

The empirical results indicate a virtuous procedure of development for China: more imports into China will lead to more inward FDI from the home country, which in turn will lead to more exports from China to the home country. Furthermore, more exports will lead to more imports. Because of synergies created by this procedure, China's inward FDI and trade have expanded very rapidly in the last two decades or so.

The study also reveals other important relations: firstly, there is a positive linkage from the growth of imports to the growth of exports, though the impact is not significant. Secondly, there is a positive linkage from the growth of FDI to the growth of imports, but the influence is not significant.

Because of the data limitation, this research is carried out at the economy level only. It would be much more desirable to carry out causality tests at the detailed industry or even firm level, given that the FDI-trade linkage can be industry- and even firm-specific.

Despite the limitation, the findings from the current research do have important implications. The virtuous procedure of development is the result of China's policy of opening to the outside world. As for FDI, China's policy has explicitly encouraged export-oriented foreign-invested firms. Consequently, China's export growth has been largely driven by foreign-invested firms. They accounted for almost half of China's total foreign exports in 2000, compared to 1 per cent in 1985, 12.6 per cent in 1990 and 31.5 per cent in 1995 (Wei and Liu, 2001; http://www.chinafdi.org.cn/english). It should be pointed out that the involvement of FDI in China's exports would certainly raise productive efficiency and international competitiveness in these industries. In a situation where those industries are still in their early development stage[3], export-oriented FDI should be continuously encouraged.

[3] Those industries mainly involved in the activities making using of China's supply of low cost-labour.

Secondly, China is often being criticised for its higher tariff and non-tariff barriers against foreign investors. Though China has started to undertake trade reforms since the late 1970s, the processes have two distinctive characteristics. On the one hand, there has been a continuous liberalisation process with regard to export activities. On the other hand, import restrictions had remained the same and occasionally increased before 1992. However, a more liberal trade regime which is close to the international economic norms has been established since then. Given the indication revealed in this study that more imports into China will lead to more inward FDI from the home country which in turn will lead to more exports from China to the home country, China should continuously reform her import regime, reducing or eliminating barriers in order to promote more FDI.

Since its accession into the WTO, China has further opened its market to foreign trade, and experienced more imports, inward FDI and exports despite the Asian Financial Crisis in 1997 and the recent slowdown in the world economy. It is too early to assess the definite impact of China's WTO accession. However, based on the findings of this study and the argument of Dunning (1998) and Gray (1998), policy- and technologically- created reductions of impediments to international trade and investment are likely to promote more efficiency-seeking investment and lead to more trade-creating activities than to increases in marketing-seeking FDI which will supplant trade. As a result, one can say that accession provides China with important gains on the export side by securing current market access, improving market access in areas such as textiles and clothing where China's exports are tightly constrained. On the FDI side, China's accession to the WTO implies the commitments by Chinese government to improve further investment environment in China. Despite the annual

flow of FDI of US$ 40 billion in recent years, China is still an underachiever of FDI from such countries as US and EU. As a result, accession provides China an opportunity to attract more FDI from western countries which often concentrates in capital-intensive and high-tech sectors. This is important to China because her goal of achieving the modernisation of industry, agriculture, national defence and science technology requires China to obtain advanced technologies and know-how. On the basis of the Chinese experience one important lesson which could be drawn in a more general context is the importance of the continuous liberalisation not only in exports, but also in imports and FDI.

Appendix II.1 List of Home Countries/Regions in the Samples

19 home countries/regions are included in the sample: United States, Canada, Australia, Japan, New Zealand, Belgium, Denmark, France, Germany, Italy, Netherlands, Spain, Sweden, United Kingdom, Indonesia, Hong Kong, Malaysia, Singapore, and Thailand.

Appendix II.2 Variable Definition and Data Sources

Variable	Measurement and sources of data
FDI	The real annual stock of FDI in China. The construction of the data on real FDI stock is conducted in a two-step procedure. First, annual nominal FDI inflows are deflated by the GDP index to convert to constant price (1990 price). Second, the data of the annual stock of FDI in China are obtained by accumulating over years, with adjustments of depreciation. The depreciation rate is set to 10 per cent. Sources: Almanac of Foreign Economic Relations and Trade of China; China Foreign Economic Statistical Yearbook; China Statistical Yearbook and Comprehensive Statistical Data and Materials on 50 Years of New China. A better deflator is possibly the capital goods index as used in Moore (1993), but a similar index (the price index of investment in fixed assets) is available for 1993 onwards only in China.
Exports and Imports	China's real exports to, and real imports from, the countries with adjustments of deflation. Sources: China Foreign Economic Statistical Yearbook; China Statistical Yearbook and Comprehensive Statistical Data and Materials on 50 Years of New China.

Appendix II.3 Data

(I) Realised FDI in China

Unit: US$ Million

	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
Australia	0	14	60	5	4	44	25	149	35	110	188	233	194	314	272
Belgium	8	8	9	8	4	6	8	1	4	26	32	54	45	33	28
Canada	9	10	8	10	6	17	8	108	58	137	216	257	338	344	317
Denmark	4	6	1	2	20	8	10	11	12	4	2	35	29	17	63
France	20	33	42	16	23	5	21	99	45	141	192	287	424	475	715
Germany	8	24	19	3	15	81	64	1611	89	56	259	386	518	993	737
Hong Kong	748	956	1132	1588	2095	2078	1913	24869	7709	17861	19665	20060	20677	20632	18508
Indonesia	0	0	0	0	0	1	1	22	20	66	116	112	94	80	69
Italy	18	19	23	16	31	30	4	282	21	100	206	263	167	215	275
Japan	225	315	201	220	515	356	503	5325	710	1324	2075	3108	3679	4326	3400
Malaysia	0	0	0	0	1	0	1	20	25	91	201	259	460	382	340
Netherlands	1	0	2	0	21	18	16	67	28	84	111	114	125	414	719
New Zealand	0	0	1	5	0	5	9	8	3	9	9	21	22	53	27
Singapore	1	10	13	22	28	84	50	582	122	490	1180	1851	2244	2626	3404
Spain	0	3	0	0	0	2	7	9	2	10	10	26	21	39	54
Sweden	4	4	3	2	3	3	0	8	2	15	24	14	57	43	133
Thailand	4	9	9	11	0	6	13	7	196	83	235	288	323	194	205
UK	98	71	27	5	34	28	13	354	38	221	689	914	1301	1858	1175
US	256	357	315	263	236	284	456	3232	511	2063	2491	3083	3443	3239	3898

(II) Exports from China

Unit: US$ Million

	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
Australia	512	187	210	298	362	423	455	554	661	1061	1488	1626	1673	2055	2342
Belgium	312	161	212	252	250	250	327	417	540	606	813	1033	1042	1360	1641
Canada	591	234	307	409	390	412	430	555	653	1198	1397	1533	1616	1905	2128
Denmark	123	72	91	111	113	101	127	152	152	199	260	309	288	372	457
France	539	224	321	436	515	528	645	733	764	1290	1424	1842	1907	2329	2823
Germany	2012	847	1227	1478	1794	1940	2034	2356	2448	3968	4761	5671	5843	6490	7354
Hong Kong	15389	7206	9785	13778	18269	21916	26650	23137	37512	22050	32361	35983	32906	43781	38753
Indonesia	162	125	142	188	236	223	379	481	471	692	1052	1438	1428	1841	1171
Italy	706	294	363	556	746	715	835	932	1095	1305	1591	2067	1836	2237	2239
Japan	11946	6109	4779	6398	7922	8395	9011	10219	11699	15780	21579	28467	30886	31820	29692
Malaysia	459	188	203	254	308	352	341	528	645	704	1118	1281	1370	1920	1596
Netherlands	741	326	464	608	749	759	908	1063	1200	1609	2267	3232	3537	4405	5162
New Zealand	72	32	28	44	39	40	50	66	87	131	188	232	231	282	275
Singapore	2902	2080	1206	1327	1485	1692	1975	2014	2031	2245	2558	3501	3749	4319	3930
Spain	155	54	62	103	116	158	187	237	329	534	749	985	968	1245	1524
Sweden	142	61	75	98	120	139	141	173	215	322	500	396	392	527	628
Thailand	591	117	159	305	510	500	823	848	895	750	1159	1752	1255	1500	1148
UK	773	354	1433	532	659	635	643	728	923	1929	2414	2798	3201	3813	4632
US	5375	2340	2632	3037	3380	4410	5179	6159	8594	16965	21461	24714	26683	32695	37976

(II) Exports to China

Unit: US$ Million

	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
Australia	2123	1134	1403	1322	1108	1472	1354	1558	1671	1950	2452	2585	3434	3248	2688
Belgium	494	274	340	277	366	375	331	415	449	786	1041	1097	1023	918	878
Canada	2490	1159	1011	1398	1856	1078	1478	1646	1927	1375	1849	2681	2573	2007	2237
Denmark	219	106	147	179	142	137	136	98	139	235	277	318	319	347	319
France	839	713	732	899	987	1420	1663	1572	1496	1641	1939	2648	2240	3243	3205
Germany	3306	2688	3842	3423	3822	3718	2937	3049	4023	6040	7137	8038	7324	6180	6994
Hong Kong	6765	4797	5610	8437	11973	12540	14258	17463	20538	10456	9442	8591	7827	6990	6658
Indonesia	525	332	324	591	682	582	803	1403	1554	1469	1589	2052	2280	2674	2457
Italy	1052	910	1138	1238	1549	1835	1070	1458	1748	2737	3069	3115	3246	2450	2277
Japan	19418	15035	12438	10074	11057	10534	7588	10032	13681	23283	26327	29005	29181	28993	28207
Malaysia	468	200	180	302	57	692	835	804	830	1084	1622	2071	2244	2494	2668
Netherlands	391	273	280	231	367	450	399	429	508	714	707	818	919	1073	834
New Zealand	323	162	215	216	407	304	126	169	279	264	316	346	403	349	410
Singapore	361	243	553	618	1018	1499	858	1063	1236	2646	2492	3398	3601	4465	4224
Spain	503	551	388	336	310	340	320	373	355	473	900	906	517	555	480
Sweden	378	260	298	294	300	284	264	340	476	671	827	1000	1380	1297	2046
Thailand	416	262	286	405	633	756	370	422	424	601	864	1611	1890	2014	2413
UK	1190	746	1011	900	898	1084	1384	942	1014	1664	1770	1972	1881	1978	1952
US	9173	5090	4717	4831	6631	7863	6588	8008	8900	10687	13894	16118	16155	16298	16961

Chapter III. Sources of Recent Trade Growth in OECD Countries

In this chapter, an extended gravity model is constructed to identify the main causes of recent trade growth in OECD countries. The specific features include (a) the explicit introduction of R&D and FDI as the two important explanatory variables into an augmented gravity equation; (b) the adoption of a panel data approach, and (c) the careful treatment of endogeneity. The main findings are that the levels and similarities of market size, domestic R&D stock and inward FDI stock are positively related to the volume of bilateral trade, while the distance between trading countries measured by geographical distance, exchange rate and relative factor endowments, have a negative impact. These findings lend support to new trade, FDI and economic growth theories.

Chapter III. Sources of Recent Trade Growth in OECD Countries

III.1 Introduction

International trade plays an important role in economic growth. It promotes competition, specialisation and scale economies, and improves resource allocation through the effects of comparative advantage. It is an important channel for knowledge spillovers across boarders (Grossman and Helpman, 1991). International trade has grown faster than income in the post-war period (Hill, 2001). The identification of the main sources of international trade growth has been a subject of considerable interest to academics for many years including an early contribution by Prewo (1978) and a recent one by Baier and Bergstrand (2001).

Despite decades of efforts, there is still no general consensus on "why international trade has grown". Krugman (1995) highlights two main approaches to answering the question: journalists tend to argue that it is due to technology-led declines in transportation costs, while economists believe that it is caused by trade liberalisation. Feenstra (1998) adds two more reasons for trade growth: income convergence and increased outsourcing by multinational enterprises (MNEs).

To empirically investigate the relative contributions of the above recognised sources of international trade growth, Baier and Bergstrand (2001) estimate gravity equations for the mean growth in real bilateral trade flows in 16 OECD countries between the

late 1950s and the late 1980s. The study is based on a standard general equilibrium model of international trade in final goods, and they find that income growth explains the large share of the average trade growth, followed by tariff-rate reductions and then transport-cost declines. Income convergence is virtually an insignificant explanatory variable. In their study, the role of MNEs has been overlooked.

The current chapter attempts to identify the main sources of trade growth in OECD countries in the 1980s and the 1990s. It differs from Baier and Bergstrand (2001) and many other studies in the following main aspects. Firstly, it empirically tests the hypotheses that are eclectically synthesised from new trade, foreign direct investment (FDI)[4] and endogenous growth theories, more specifically, though extending the standard gravity model to incorporate R&D and FDI stocks. Secondly, it takes into consideration the possible endogeneity of income, R&D and FDI stocks to avoid any endogeneity bias. Thirdly, it employs a panel data approach, which has several advantages over cross-sectional analysis as used in most of the empirical literature on gravity models.

One of the main findings is that income similarity contributes significantly to the growth of international trade in OECD countries, which is contrary to the finding by Baier and Bergstrand (2001). The results also show that R&D and FDI stocks and similarity are the important determinants. All these findings are consistent with the theoretical expectations.

[4] The terms of MNE and FDI are often used interchangeably because, by definition, MNE is a firm engaging in FDI.

The rest of the chapter is organised as follows. Section III.2 considers the guidance from new trade, FDI and endogenous growth theories regarding the sources of international trade growth. Section III.3 extends the standard gravity model to incorporate R&D and FDI stocks. Section III.4 presents the empirical results, and finally conclusions are offered in Section III.5.

III.2 Theoretical Considerations

The existing empirical literature on international trade growth tends to focus on income convergence, transport costs and trade liberalisation as the main determinants, while new trade, FDI and endogenous growth theories suggest that it is also determined by R&D and FDI stocks. This section focuses discussions on the roles of these driving forces behind international trade and develops the corresponding hypotheses. The role of tariff and non-tariff barriers is not considered in this study since bilateral trade barriers data are not easily collected, especially over time. However, given that the trade barriers between OECD countries are relatively small and the fact there are no trade barriers between EU countries[5], the possibility of the bias in the empirical results due to omitting variables is expected to be small.

III.2.1 Relative Factor Endowment

Based on the assumptions of constant returns to scale and perfect competition, neo-classical trade theory represented by the Heckscher-Ohlin (H-O) model concludes that international trade is explained by comparative advantages resulting from differences in factor endowments[6] (including labour, capital, natural resources and technology) among nations. Capital rich countries should export capital-intensive

[5] 12 out of 19 OECD countries under study are EU countries. They are Austria, Belgium, Luxemboug, Denmark, Finland, France, Ireland, Italy, Netherlands, Spain, Sweden and United Kingdom.

[6] In this analysis, factor endowments are measured by factor proportions, i.e. the capital - labour ratio. Throughout the study, the terms factor endowment, factor intensity and capital/labour ratio are therefore used interchangeably.

goods and import labour-intensive good, while labour rich countries should do the opposite. The popularity of this theory is mainly due to its success in explaining inter-industry trade which is the main part of North-South trade (Wood, 1994).

The H-O theory has been challenged by the well known Leontief paradox which states that US exports were less capital intensive than US imports. Baldwin (1971) also finds that US net exports were negatively related to the capital intensity of production using 1962 US trade data. Bowen et al. (1987) investigate a sample of 27 countries and 12 factors of production and confirm the Leonief paradox on a broader level. In addition, today more than half of international trade takes place among industrialised countries (WTO, 2002). Another important phenomenon in modern economies is that the dominant part of trade involves the exchange of differentiated products in the same industry, i.e. intra-industry trade (Table III.1). The failure of the H-O model in providing a general explanation of patterns of trade has led researchers to seek for alternative approaches to the determinants of trade. One way is to relax the restrictive assumptions imposed by the H-O model.

Helpman (1981), Krugman (1980), and Lancaster (1980), among others, developed various theoretical models based on product differentiation (as oppose to homogenous products in the H-O model), economies of scale (as oppose to constant return to scale in the H-O model) and imperfect competition (as oppose to perfect competition). They argue that intra-industry trade is likely to be larger among economies of similar size and factor proportion. This is mainly due to economies of scale. International trade allows exporting countries to benefit from larger markets. By specialising in producing certain varieties of goods instead of producing the full

range, a country can produce each at larger scale, with higher productivity and lower costs. If countries have similar size and factor proportion, they are more likely to exchange differentiated goods with each other. However, if they have very different factor endowments, they may produce differentiated goods at different levels of quality. The demand for low quality goods (produced by countries with lower capital-labour ratio) in countries with higher capital-labour ratio and higher income is low. The same can be said about the demand for high quality goods (produced by countries with high capital-labour ratio) in countries with lower capital-labour ratio and lower income. As a result, the intra-industry trade is likely to be smaller between countries of different factor endowments. As a substantial proportion of trade in OECD countries is intra-industry trade, the volume of total trade tends to be positively associated with that of intra-industry trade. As a result, the difference in factor endowments is likely to be negatively related to the volume of total trade in OECD countries. Put another way, the larger the difference in factor endowments, the smaller the volume of intra-industry and therefore total trade.

Table III.1: Intra-industry Trade Index[a] for OECD 22

by commodity and by year

Unit: per cent

COMMODITY	1993	1994	1995
0 FOOD LIVE ANIMALS	97.8	97.9	98.3
1 BEVRGS TOBACCO	95.2	94.7	96.0
2 CRUDE MATRLS	94.4	94.8	96.0
3 MINERAL FUELS	93.9	95.0	95.1
4 ANIMAL VEG OIL	97.1	96.9	96.2
5 CHEM PRODS	98.0	98.3	96.0
6 BASIC MANUFACT	96.1	97.4	98.0
7 MACHS TRNSPT EQPT	99.1	98.9	98.7
8 MISC MANUFACT	96.4	97.1	97.5
9 GOODS NOT BY KIND	92.3	93.2	97.7

Source: NAPES Database[7]

[7] Note: [a]Intra-Industry Trade Index (by commodity) is defined as:

$$IIT_{ij}^{k} = \frac{\left(\sum(X_{ij}^{k} + M_{ij}^{k}) - \sum\left|X_{ij}^{k} - M_{ij}^{k}\right|\right)}{\left(X_{ij}^{k} + M_{ij}^{k}\right)}$$

where X_{ij}^{k} are exports from country j to country k in industry i and M_{ij}^{k} are imports into country j from country k in industry i.

III.2.2 Level and Similarity of GDP

Basic macroeconomic theory suggests that a country's imports are positively determined by its national income. In the case of bilateral trade, the levels of GDP in both countries should positively affect their total trade. New trade theory regards economies of scale as a very important determinant of international trade (Helpman, 1981; Krugman, 1980). The level of GDP can also be used as a rough proxy for a country's scale economies[8]. At a larger scale of operation a greater division of labour and specialisation becomes possible. This may permit the introduction of more specialised and productive machinery than would be feasible at a smaller scale of operation.

From the demand side, Linder's (1961) "preference similarity" or "overlapping demands" hypothesis argues that trade in manufactures is likely to be largest among countries with similar tastes and income levels. With an increase in the volume of international trade, demand patterns in trading partners become similar. If income distribution and tastes in trading partners are similar, trade is positively related to similarity in income. Helpman and Krugman (1985), Helpman (1988) and Hunter and Markusen (1988) also suggest that convergence in levels of income leads to increased international trade. Bergstrand (1990) indicates that the scope for exchange of product diversity is broadened the smaller the inequality between two

[8] The proxy is commonly used in the empirical works including Bergstrand (1990), Egger (2000) and Baier and Bergstrand (2001). Of course it may not be as accurate at the aggregate level as it is at the disaggregated level.

countries' economic sizes.

The positive relationship between international trade growth and the level and similarity of GDP has been confirmed in a number of empirical studies (for a recent example, see Egger 2000). From both the theoretical and empirical literature, the higher the levels of GDP, the higher the total trade between the trading partner; and the more similar in terms of GDP, the higher the intra-industry trade and hence the total trade between the trading partner.

III.2.3 R&D Accumulation and Similarity

The explicit treatment of technology (R&D) as a determinant of trade flows was first made by Posner (1961) who argues that the country hosting a particular invention or innovation activity will have a technological lead over other countries. This country will be able to export the good concerned even though it may not have an apparent comparative advantage in terms of relative factor endowments.

In the case of bilateral trade, if both partner countries are similar in technological capabilities, a high volume of intra-industry trade will be expected. This similarity hypothesis is consistent with predictions by both neo-classical and new trade theories. Within a H-O framework, Davis (1995) concludes that intra-industry trade arise quite naturally in a constant returns setting due to excellent substitution possibilities across goods in production. More recently, new trade theorists such as Grossman and Helpman (1991) suggest that if R&D efforts are directed towards horizontal product differentiation, innovation will consist in products serving new

functions and, consequently, expanding the possibility of variants, or in specialising production, which are the two determinants of utility value of consumption. The higher the utility, the larger the trade volume could be. By contrast, if R&D efforts are directed towards vertical product differential, innovation will consist in scientific breakthroughs, leading to more efficient production processes or products of a higher quality. Trade in vertically differentiated products leads to intra-industry trade. Brander (1981) develops an idea of 'reciprocal trade': trade is two-way in identical products. The phenomenon is sometimes called 'cross-hauling' or 'reciprocal dumping'. It will occur under a wide variety of cases, including Berstrand and Cournot imperfect competitions. Furthermore, increasing return to scales can account for trade in goods that are technological alike but differentiated in the eyes of consumers (Krugman, 1979).

As the main source of technological enhancement is R&D, increased R&D investment has a positive effect on trade performance due to increased product variety and quality. If partner countries are similar in R&D efforts, their technological capabilities will be similar. In summary, R&D accumulation and similarity induce high volume of international trade because they not only are responsible for improvement on the quality of goods or increased number of variety, but also account for the reciprocal intra-industry trade. Surprisingly, few empirical studies use technological capabilities and similarity to explain international trade.

III.2.4 FDI Accumulation and Similarity

Early trade theories did not provide an explicit discussion of FDI, although the importance of MNEs in the conduct of international trade had been recognised for decades. Helpman (1984, 1985) incorporates MNEs in his new trade theory and concludes that the existence of these firms has a significant effect on the volume of trade and the share of intra-firm trade when compared with the results obtained for the single product firm. Markusen (1983) demonstrates that along the dynamic path of adjustment, FDI and exports grow simultaneously as complements over time if trade is not based on different factor endowments.

Based on the assumption that countries are symmetric in terms of size, factor endowments and technologies, Brainard (1993) and Horstman and Markusen (1992) show that if proximity advantages outweigh concentration advantages, FDI and trade can be substitutes. However, if concentration advantages outweigh proximity advantages, FDI and trade can be complements. Brainard (1993) further points out that multinational activities are more likely the more similar are the home and foreign markets.

Baier and Berstrand (2001) suggest that greater vertical specialisation and outsourcing may have contributed to greater international trade. As the production process 'disintegrates' internationally and MNEs become more vertically specialised, trade in intermediate goods across borders increases substantially relative to output. FDI not only directly contributes to intra-firm trade, but also introduces more varieties of products. According to Helpman (1984), when the

relative country size is given, the volume of trade increases with the number of varieties in the exporting country which is proxied by the number of MNEs. Thus, international trade is positively related to inward FDI stock.

Furthermore, if trade partners have similar volumes or patterns of FDI stock, relatively balanced trade can be expected. The trade created in this way may be higher than the trade when inward FDI stocks are unevenly distributed among the trading partners. Markusen (1998) summarises that MNEs are associated with high ratios of R&D relative to sales, and therefore with relatively new and/or technically complex products. If the sizes of inward FDI stock are similar between the trading partners, similar varieties and volumes of bilateral export can be expected from each partner. Thus, the import capabilities of both countries are similar, and this allows for a relatively large bilateral trade. If FDI is accumulated unevenly, the partner with a small FDI stock and therefore small export capabilities will have small import capabilities. This negatively affects its trading partner's exports and therefore total bilateral trade.

While it is possible that FDI and trade substitute for each other, a number of theoretical and empirical studies tend to suggest a positive relationship between the two variables (examples of such empirical studies include Pfaffermayr, 1996; Pain and Wakelin, 1998; Gopinath et al, 1999). Thus, it can be argued that the larger and the more similar the FDI stocks accumulated in the trading partners, the higher the bilateral trade will be between them.

III.2.5 Geographical Distance

Many studies using gravity models confirm that geographical distance matters greatly for international trade (e.g. Egger, 2000). Geographical distance can be used as a proxy for transportation and transaction cost. In the economic geography literature, the proximity to market or small geographic distance is considered to be an important determinant of the choice of trade activities. The greater the geographical distance between the trading partners, the higher are the transportation costs and the lower are the profits made by trading firms. Thus, a negative relationship between bilateral trade and geographical distance is expected.

Geographic distance can also be employed as a proxy for international transaction costs. Transaction cost can be defined as the cost of exchange. The higher the transaction costs involved, the lower are the trading activities between parties. Transaction costs have many dimensions. The most important one is the information costs. As argued by Petri (1994), geographic distance is 'at least partly a proxy for the information costs of doing business abroad, including knowledge of the partner's culture and economy'.

There are other alternative approaches to the measurement of transaction costs in international trade. One approach simply consists of the calculation of individual components, that is, of all individual components of transaction costs that are relevant for a particular product, and adding them up. Another one is to employ foreign trade statistics where exports are generally reported as *fob* (free on board) and imports as *cif* (cost, insurance, freight). The difference between reported exports

and imports thus potentially provides information about important components of transaction costs in international trade like general trading costs, transport insurance and freight. For those types of transaction costs, of which no reliable data exist, corresponding substitutes are used. For example, as a proxy for transportation costs, the geographical distance between the most important trading ports or capitals of two countries is used if trading routes of distribution and means of transportation cannot be clearly determined. However, due to data availability, only geographical distance is included in the study to measure transportation and transaction costs.

In summary, geographical distance directly increases transportation and transactions costs because of the costs of shipping products, the costs of acquiring information about other economies, and the costs of finding a partner and contracting at a distance. Therefore, the greater the geographic distance between the trading partners, the higher will be the cost of trading activities.

III.2.6 Exchange rate

As in the case of geographic distance, exchange rate captures one aspect of transaction costs incurred in international trade activities. A rise in the exchange rate in terms of the exporting country's currency over the importing country's currency implies a depreciation of the exporting country's currency, while a decline implies an appreciation of the exporting country's currency. An exchange rate change will alter the relative value of products being traded and will lead to capital gains or losses. In other words, an exchange rate movement reflects a country's price or cost

competitiveness relative to its trading partners. The effect of currency depreciation can be seen either as an increase in the nominal product price, expressed in exporting country's currency faced by the exporting firm or as a decrease in the firm's cost of purchasing products in the domestic market, expressed in importing country's currency. Either way, it creates incentives to firms in exporting countries to undertake more exports. On the other hand, a real depreciation of exporting country's currency favours its trading partners of purchasing its goods and services and therefore leads to an increase in imports from the importing country. By the same token, a real appreciation of exporting country's currency is more likely to be associated with a decrease of exports.

III.3 Empirical Model, Data and Methodology

The hypotheses developed in the preceding section are to be tested in a gravity equation framework. The gravity model has been widely used in explaining bilateral trade flows. It is sometimes seen as the most successful empirical trade model (Anderson 1979) and is one of the great success stories in empirical economics (Feenstra et al, 2001). Formal theoretical foundations have already been provided by Anderson (1979), Bergstrand (1985, 1989, 1990), Helpman and Kurgman (1985, ch 8), Deardorff (1998), and Feenstra et al (2001), among others. The current study augments the simple gravity model into a more comprehensive one in order to explain recent trade growth in OECD countries. More specifically, the modification will be made to incorporate the R&D and FDI stock variables discussed in the proceeding section.

III.3.1 Extension of Gravity Model and Measurement of Variables

In its simplest form, a gravity function contains GDP and the transaction and transportation cost variables only and is conventionally specified as

$$EX_{ij} = \frac{A(GDP_i GDP_j)^{\gamma_1}}{D_{ij}^{\gamma_2}} \qquad (1)$$

where γs are elasticities. EX_{ij} is the value of exports from country i to j. GDP_i and GDP_j are GDP of countries i and j respectively. D_{ij} is a measure of the distance

between the two countries, which captures transaction and transportation costs. A is treated as a constant.

The treatment of A as a constant in equation (1) may be inappropriate because of the existence of heterogeneity across countries. In this study, individual country effects are allowed and are specified as a function of its exporting capabilities to its trading partner j. Thus, A_{ij} can be seen as a function of the interaction between its own R&D activities and its partner country's R&D activities (Coe and Helpman, 1995; Coe et al, 1997). Furthermore, a country's R&D activities depend on its domestic R&D efforts and inward FDI (Balasubramanyam et al, 1996). As explained in the preceding section, R&D efforts and inward FDI are closely related to a country's export capabilities. Thus,

$$A_{ij} = e^{r_1}(DRDS_i DRDS_j)^{r_3}(FDS_i FDS_j)^{r_4} \tag{2}$$

where $DRDS_{i(j)}$ and $FDS_{i(j)}$ are country i(j)'s domestic R&D stock and total inward FDI stock, respectively.

Substituting equation (2) into equation (1) and taking logs yield,

$$\begin{aligned} \ln EX_{ij} = {} & r_i + r_1 \ln GDP_i GDP_j - r_2 \ln D_{ij} + \\ & r_3 \ln DRDS_i DRDS_j + r_4 \ln FDS_i FDS_j \end{aligned} \tag{3}$$

The second term of equation (3) can be arranged as follows:

$$\ln GDP_i GDP_j = -\ln 2 + 2\ln GDPT_{ij} + \ln SIMGDP_{ij} \quad (4)$$

where $GDPT_{ij} = GDP_i + GDP_j$ and

$$SIMGDP_{ij} = 1 - \frac{GDP_i^2}{(GDP_i + GDP_j)^2} - \frac{GDP_j^2}{(GDP_i + GDP_j)^2}$$

Similarly, the fourth and fifth terms of equation (3) can be expressed as follows:

$$\ln DRDS_i DRDS_j = -\ln 2 + 2\ln DRDST_{ij} + \ln SIMDRDS_{ij} \quad (5)$$

$$\ln FDS_i FDS_j = -\ln 2 + 2\ln FDST_{ij} + \ln SIMFDS_{ij} \quad (6)$$

where $DRDST_{ij} = DRDS_i + DRDS_j$,

$$SIMDRDS_{ij} = 1 - \frac{DRDS_i^2}{(DRDS_i + DRDS_j)^2} - \frac{DRDS_j^2}{(DRDS_i + DRDS_j)^2}$$

$FDST_{ij} = FDS_i + FDS_j$ and

$$SIMFDS_{ij} = 1 - \frac{FDS_i^2}{(FDS_i + FDS_j)^2} - \frac{FDS_j^2}{(FDS_i + FDS_j)^2}$$

Because the transaction and transportation costs can be measured by the differences in relative factor endowments (RLFAC), exchange rates (ER) and geographical distances (GD) between countries i and j, these variables may be used to replace the distance index D.

$$\ln D_{ij} = r_5 RLFAC_{ij} + r_6 \ln ER_{ij} + r_7 GD_{ij} \quad (7)$$

Thus, equation (3) can be rewritten as follows:

$$\begin{aligned} \ln EX_{ij} = {} & \beta_1 RLFAC_{ij} + \beta_2 \ln GDPT_{ij} + \beta_3 \ln SIMGDP_{ij} + \\ & \beta_4 \ln DRDST_{ij} + \beta_5 \ln SIMDRDS_{ij} + \beta_6 \ln FDST_{ij} + \\ & \beta_7 \ln SIMFDS_{ij} + \beta_8 \ln ER_{ij} + \beta_9 GD_{ij} + \zeta_i \end{aligned} \quad (8)$$

where $\beta_1 = -\gamma_5$, $\beta_2 = 2\gamma_1$, $\beta_3 = \gamma_1$, $\beta_4 = 2\gamma_3$, $\beta_5 = \gamma_3$, $\beta_6 = 2\gamma_4$, $\beta_7 = \gamma_4$, $\beta_8 = -\gamma_6$, $\beta_9 = -\gamma_7$, and $\zeta_i = \gamma_i - (\gamma_1 + \gamma_3 + \gamma_4)\ln 2$.

Matyas (1997) suggests that the correct gravity specification should be a three-way model. One dimension is the time effects, capturing the common business cycle or globalisation process over the whole sample of countries. The other two dimensions are the fixed effects, reflecting the time invariant export- and import- country effects. Because a time invariant geographical distance variable is used in this study, one dimension of fixed effects is dropped in order to avoid any multicollinearity problem. As a result, equation (8) under a panel data framework becomes:

$$\begin{aligned} LEX_{ijt} = {} & \beta_1 RLFAC_{ijt} + \beta_2 LGDPT_{ijt} + \beta_3 LSIMGDP_{ijt} + \beta_4 LDRDT_{ijt} + \\ & \beta_5 LSIMDRDS_{ijt} + \beta_6 LFDST_{ijt} + \beta_7 LSIMFDS_{ijt} + \beta_8 GD_{ij} + \\ & \beta_9 LER_{ijt} + \zeta_i + \zeta_t + \varepsilon_{ijt} \end{aligned} \quad (9)$$

where L indicates logged values. βs represent elasticities. ζ_i and ζ_t are the country-specific fixed and time effects respectively. GD_{ij} is the geographical distance between countries i and j. It captures the impact of other time invariant variables such as transaction and transportation costs.

Now, one is in a position to explain how the other explanatory variables introduced in equations (8) or (9) are measured.

$$RLFAC_{ijt} = |\ln(K_{jt}/L_{jt}) - \ln(K_{it}/L_{it})| \tag{10}$$

where K and L denote capital stock and labour force, respectively. RLFAC measures the similarity in capital-labour ratios, or the distance between the export and import countries in terms of relative factor endowments. If it equals 0, this implies that the two countries have the same proportion of factor endowments.

$$LGDPT_{ij} = \ln(GDP_i + GDP_j) \tag{11}$$

It is clear that the total volume of trade should be higher, the larger the overall market size, which is equivalent to the average GDP, for given relative size and factor endowments.

$$LSIMGDP_{ij} = \ln\left(1 - \frac{GDP_i^2}{(GDP_i + GDP_j)^2} - \frac{GDP_j^2}{(GDP_i + GDP_j)^2}\right) \tag{12}$$

SIMGDP measures the similarity in the levels of GDP in the trading partners, capturing the relative size of two countries in terms of GDP. This variable may vary within the range of 0 (absolute divergence in size) and 0.5 (equal country size). The larger this measure is, the more similar the two countries in terms of GDP, the higher the share of intra-industry trade.

$$LFDST_{ij} = \ln(FDS_i + FDS_j) \tag{13}$$

where $FDS_{i(j)t}$ is i(j) country's total inward FDI stock. The overall rather than bilateral FDI stock is used for the following reasons. Firstly, most MNEs are located in several countries rather than in the trading partner country only. Secondly, FDI not only contributes to intra-firm trade but also accounts for product variety enlargement and quality improvement since FDI is treated as one main conduit of technology spillovers. Finally, No data are available for bilateral FDI stocks.

$$LSIMFDS_{ij} = \ln\left(1 - \frac{FDS_i^2}{(FDS_i + FDS_j)^2} - \frac{FDS_j^2}{(FDS_i + FDS_j)^2}\right) \tag{14}$$

It measures the similarity in inward FDI stocks in the trading partner countries. Similar to the argument for LGDPT and LSIMGDP, when the total inward foreign direct investment stock is given, the intra-firm trade and the number of varieties consumed between two countries would be higher if the size of two countries' inward FDI stocks are more similar.

$$LDRDST_{ij} = \ln(DRDS_i + DRDS_j) \tag{15}$$

$$LSIMDRDS_{ij} = \ln\left(1 - \frac{DRDS_i^2}{(DRDS_i + DRDS_j)^2} - \frac{DRDS_j^2}{(DRDS_i + DRDS_j)^2}\right) \tag{16}$$

Here, $DRDS_{i(j)t}$ is i(j) country's domestic R&D capital stock. SIMDRDS is total R&D stock of the bilateral trading partners, stressing the role of domestic knowledge accumulation in determining bilateral trade. It captures the technological difference or similarity between the bilateral trading countries. Again, theoretically, it varies from 0 to 0.5.

$$LER_{ijt} = \ln(1 + ER_{it}/ER_{jt}) \tag{17}$$

In equations (8) or (9), ER_i is country i's real exchange rate against US dollar. ER_{it}/ER_{jt} is the ratio of the export country's exchange rate to the import country's exchange rate. The larger the LER, the weaker is country i's currency against country j's, and therefore the larger is the volume of export from i country to j country.

III.3.2 Data and Methodology Issues

The data set employed in the chapter covers 19 OECD countries with Belgium and Luxembourg being treated as a single country over the period of 1980-1998. All variables are in constant dollar prices with 1990 as the base year. The variable measurement and data sources are listed in appendixes. It should be noted that the

commonly used set-up of a gravity equation is unbalanced, as no country exports to itself. Because of this, the data set consists of 5184 observations for the estimation.

Generally, there are three statistical models related to panel data set: the ordinary least squares (OLS) model, the fixed effects (FE) model, and the random effects (RE) model. As is well known, the three statistical models differ mainly in the assumption of ζ_i, ζ_t, and ε_{ijt} in equation (9). In the OLS model, the ζ_is and ζ_ts take the same value for all countries/regions and across time, respectively. Since it is unlikely that the unobservable cross-country effects and time effects are always the same, the FE and the RE models which accommodate unobservable heterogeneity should be considered. In the FE model the ζ_is and ζ_ts are treated as fixed parameters to be estimated, while in the RE model, ζ_is and ζ_ts are assumed to be random, independent and identically distributed. The FE model is less efficient than the EC model because of the lost degrees of freedom. However, the EC model imposes the assumption that unobservable effects relegated into the error term are uncorrelated with regressors. Violation of this assumption may lead the EC model to produce biased and inconsistent estimates (Judge et al., 1985).

Fixed effects vs. Random effects model

There are only very limited applications of a panel framework in the estimation of the gravity equation. Egger (2000) suggests that the proper econometric specification of the gravity model in most applications would be one of fixed country and time effects. These fixed effects are due to the omitted variables specific to cross-sectional units (Hsiao, 1986). They can be tariff policy measures and export driving

or impeding "environmental" variables. They are not random but deterministically associated with certain historical, political, geographical and other facts (Egger 2000). However, Baldwin (1994) employs a random effects model and Matyas (1997, 1998) does not give preference to the fixed over random effects model or vice versa. Following the discussion of Baltagi (1995) and Greene (2000), this study employs a Hausman (HS) test to decide statistically whether a random or fixed effects model would be more appropriate for our data set.

The HS test is based on the Wald criterion:

$$HS = [b_{fe} - b_{re}]' Var[b_{fe} - b_{re}]^{-1} [b_{fe} - b_{re}] \sim \chi^2(k) \qquad (18)$$

where b_{fe} and b_{re} are estimators of the regressors in the FE and RE models respectively, k is the number of regressors and Var is the variance-covariance matrix. The null hypothesis of the HS test is that the RE model is the correct specification.

Tests for exogeneity

New trade, FDI and endogenous growth, theories suggest that GDP, FDI and domestic R&D stock are likely to be endogenous variables. If this is the case, a straightaway estimation of equation (9) will be biased. Therefore, the Wu-Hausman test for endogeneity will be applied. The test procedure is as follows:

First, we estimate the equation with a suspected endogenous variable on the left hand side and all exogenous variables on the right hand side and obtain the residual named R. Second, we re-estimate the equation including R as an extra independent variable. If the coefficient of R, denoted as λ, is statistically different from zero, then the suspected variable (LGDPT, LFDST or LDRDT) should be treated as endogenous. In this case, generalised instrumental variable estimation (GIVE) techniques should be applied.

III.4 Empirical Results

The empirical results are summarized in three tables. Tables III.2 presents the results without considering endogeneity while Tables III.3 and III.4 include results based on GIVE techniques. In all tables, the OLS, the one-way fixed and random effects, and two-way fixed and random effects results are given.

III.4.1 Preliminary Results

In Table III.2, the results derived from the ordinary least squares (OLS), FE1 (one-way fixed effects include only country effects), RE1 (one-way random effects include only country effects), FE2 (two-way fixed effects include country and time effects) and RE2 (two-way random effects include country and time effects) models are given in order.

From the Lagrange multiplier and likelihood ratio test statistics of 1661.235 and 38731.05, respectively, the assumption of no groupwise heteroscedaticity is rejected. This suggests that there is heterogeneity among each country's export activities. A simple OLS regression of a straightforward pooling of all observations without considering heterogeneity will lead to an unacceptable degree of aggregation bias or even meaningless results. In addition, according to the Lagrange multiplier and likelihood ratio test statistics of 54032.81 and 2639.83, respectively, time effects should be considered in the estimation. Finally the insignificant Hausman statistic of

8.40 indicates that the two-way random effects model performs better than the two-way fixed effects model.

The results in Table III.2 are consistent with expectations. In any regression, the coefficients of all the variables are highly significant and have the expected signs. The results suggest that the economic similarity, market size, R&D and FDI stocks and similarity are the powerful determinants of bilateral trade. The geographical distance remains important in explaining bilateral trade, which is consistent with the results from most gravity model based empirical studies. The distance in relative endowment has a negative sign and is highly significant in all regressions. This is consistent with new trade theory as intra-industry trade plays a more important role than inter-industry trade in OECD countries. The coefficient on the relative exchange rate variable is quite small but significant. It suggests that there is a long-run relationship between bilateral trade volume and the exchange rate. The most noticeable variable is domestic R&D investment. The result indicates that R&D accumulation may play a distinctive role in promoting the bilateral trade in OECD countries. It promotes more varieties and a higher volume of trade than economic scope.

III.4.2 Results with Consideration of Endogeneity

A large amount of literature in economic growth shows a two-way relationship between GDP, inward FDI and domestic R&D stock. The Wu-Hausman tests for endogeneity with null hypothesis of exogeneity is performed. The significant test

statistics of 33.16 and 7.03 indicate that without proper treatment of endogeneity, the estimation would be biased. Therefore, the GIVE technique is applied.

Tables III.3 and III.4 present the results with different sets of instrumental variables. In Table III.3, the instrumental variables include lagged once variables, while in Table III.4, the instrumental variables include lags up to two. In fact, the results are quite similar when lags up to three are included. Comparing with the preliminary results, the final results are quite consistent. The only difference is that when GIVE techniques are applied, the two-way fixed effects model is preferred over the two-way random effects model.

The results from the two-way fixed effects specifications in Tables III.3 and III.4 are quite encouraging. The specifications have a very high explanatory power. All coefficient estimates have signs consistent with theory and are statistically significant. The values of the coefficients on RLFAC are between -0.24 and -0.25, indicating that, when the difference in factor endowment between the trading partners reduces by 1 per cent, bilateral trade will increase by about 0.25 per cent. As the bulk of bilateral trade in OECD countries is intra-industry trade, this negative relationship is well expected by new trade theory.

The coefficients of around 0.25 and around 0.17 on LGDPTF and LSIMGDP respectively indicate that both the level and the similarity of GDP are the positive determinants of trade growth in OECD countries. These results are consistent with several gravity model based empirical studies including Egger (2000).

One is particularly interested in the impact of FDI and R&D on trade growth. The values of the coefficients on the total FDI stock and the similarity variable in the two-way fixed effects specifications are around 0.17 and around 0.28 respectively, showing a positive relationship between FDI and export growth. The results suggest that FDI and trade are generally complements in these countries during the sample period. Domestic R&D plays an important role along with FDI in promoting bilateral trade. The values of the coefficients on the total domestic R&D stock and the similarity variable in the two-way fixed effects specifications are around 0.94 and around 0.38 respectively. These results lend strong support to endogenous growth theory. Finally, the exchange rate variable also appears to be important in determining OECD countries' bilateral trade.

Table III.2: Main Sources of Trade Growth in OECD Countries

(OLS, FE and RE Estimations)

	OLS	FE1	RE1	FE2	RE2
RLFAC	-0.3160 (0.0378)***	-0.2471 (0.0356)***	-0.2483 (0.0356)***	-0.2448 (0.0328)***	-0.2452 (0.0328)***
LGDPT	0.1274 (0.0172)***	0.2699 (0.0220)***	0.2663 (0.0218)***	0.2760 (0.0203)***	0.2747 (0.0202)***
LSIMGDP	0.0477 (0.0237)**	0.1701 (0.0234)***	0.1676 (0.0234)***	0.1752 (0.0216)***	0.1743 (0.0216)***
LFDST	0.2081 (0.0159)***	0.0351 (0.0171)**	0.0380 (0.0171)**	0.2213 (0.0191)***	0.2195 (0.0190)***
LSIMFDS	0.2824 (0.0197)***	0.1721 (0.0183)***	0.1739 (0.0183)***	0.2933 (0.0183)***	0.2921 (0.0183)***
LDRDT	0.8713 (0.0155)***	0.8528 (0.0184)***	0.8537 (0.0183)***	0.9368 (0.0178)***	0.9362 (0.0177)***
LSIMDRDS	0.2994 (0.0173)***	0.2719 (0.0171)***	0.2726 (0.0171)***	0.3796 (0.0164)***	0.3787 (0.0164)***
LER	0.0500 (0.0070)***	0.0683 (0.0081)***	0.0678 (0.0080)***	0.0590 (0.0075)***	0.0590 (0.0075)***
GD	-1.1325 (0.0133)***	-1.2584 (0.0143)***	-1.2560 (0.0142)***	-1.2782 (0.0132)***	-1.2772 (0.0132)***
Constant	-19.1319 (0.4702)***		-20.5630 (0.5524)***	-24.6006 (0.5208)***	-24.5350 (0.5493)***
R^2	0.7470	0.8099	0.7470	0.8394	0.7470
		LR[17]= 1661.235***	LM[1]= 38731.05*** HS[9]= 22.19***	LR[18]= 978.59*** LR[36]= 2639.83***	LM[2]= 54032.81*** HS[9]= 8.40

Notes:

1. Country and time effects are not reported.
2. Standard errors are in parentheses, and values of degrees of freedom are in square brackets.
3. ***, **, and * indicate that the coefficient is significantly different from zero at the 1 per cent, 5 per cent and 10 per cent levels respectively.
4. The likelihood ratio (LR) statistic is applied to test the country and time fixed effects.
5. The Lagrange multiplier (LM) statistic is applied to test the country and time random effects.
6. The Hausman statistic is applied to test between fixed effects and random effects.

Table III.3: Main Sources of Trade Growth in OECD Countries

(GIVE Estimation 1)

	OLS	FE1	RE1	FE2	RE2
RLFAC	-0.3206 (0.0380)***	-0.2567 (0.0356)***	-0.2579 (0.0356)***	-0.2474 (0.0335)***	-0.2482 (0.0335)***
LGDPTF	0.1139 (0.0173)***	0.2589 (0.0221)***	0.2552 (0.0219)***	0.2593 (0.0208)***	0.2561 (0.0207)***
LSIMGDP	0.0427 (0.0238)*	0.1661 (0.0235)***	0.1635 (0.0234)***	0.1705 (0.0221)***	0.1683 (0.0220)***
LFDSTF	0.1817 (0.0169)***	-0.0075 (0.0183)	-0.0042 (0.0182)	0.1804 (0.0204)***	0.1838 (0.0204)***
LSIMFDS	0.2654 (0.0204)***	0.1492 (0.0188)***	0.1510 (0.0188)***	0.2792 (0.0192)***	0.2815 (0.0192)***
LDRDTF	0.9390 (0.0166)***	0.9378 (0.0196)***	0.9384 (0.0195)***	0.9840 (0.0192)***	0.9838 (0.0191)***
LSIMDRDS	0.3633 (0.0183)***	0.3455 (0.0183)***	0.3462 (0.0182)***	0.4081 (0.0177)***	0.4084 (0.0177)***
LER	0.0408 (0.0070)***	0.0584 (0.0081)***	0.0580 (0.0081)***	0.0521 (0.0077)***	0.0517 (0.0076)***
GD	-1.1337 (0.0133)***	-1.2654 (0.0143)***	-1.2629 (0.0142)***	-1.2790 (0.0134)***	-1.2768 (0.0134)***
Constant	-20.1632 (0.4750)***		-21.8949 (0.5559)***	-24.9210 (0.5335)***	-24.8702 (7.8997)***
R^2	0.7587	0.8204	0.7587	0.8415	0.7587
	F[3, 5462]= 33.16***	LR[17]= 1626.772***	LM[1]= 36567.93*** HS[9]= 22.46***	LR[17]= 689.50*** LR[35]= 2316.27***	LM[2]= 46150.60*** HS[9]= 14.85*

Notes:

1. Country and time effects are not reported.
2. Standard errors are in parentheses, and values of degrees of freedom are in square brackets.
3. ***, **, and * indicate that the coefficient is significantly different from zero at the 1 per cent, 5 per cent and 10 per cent levels respectively.
4. The likelihood ratio (LR) statistic is applied to test the country and time fixed effects.
5. The Lagrange multiplier (LM) statistic is applied to test the country and time random effects.
6. The Hausman statistic is applied to test between fixed effects and random effects.
7. The instrument variable set includes all exogenous variables and their lagged one variables.

Table III.4: Main Sources of Trade Growth in OECD Countries

(GIVE Estimation 2)

	OLS	FE1	RE1	FE2	RE2
RLFAC	-0.3283 (0.0378)***	-0.2623 (0.0353)***	-0.2636 (0.0353)***	-0.2427 (0.0339)***	-0.2436 (0.0339)***
LGDPTF	0.1184 (0.0172)***	0.2452 (0.0220)***	0.2420 (0.0218)***	0.2535 (0.0211)***	0.2504 (0.0210)***
LSIMGDP	0.0592 (0.0237)***	0.1625 (0.0233)***	0.1604 (0.0232)***	0.1720 (0.0224)***	0.1700 (0.0223)***
LFDSTF	0.1670 (0.0168)***	-0.0377 (0.0181)**	-0.0337 (0.0180)*	0.1647 (0.0208)***	0.1689 (0.0207)***
LSIMFDS	0.2520 (0.0204)***	0.1388 (0.0187)***	0.1407 (0.0187)***	0.2773 (0.0196)***	0.2799 (0.0196)***
LDRDTF	0.9863 (0.0168)***	1.0219 (0.0202)***	1.0214 (0.0200)***	1.0044 (0.0198)***	1.0038 (0.0196)***
LSIMDRDS	0.4069 (0.0187)***	0.4074 (0.0188)***	0.4076 (0.0188)***	0.4162 (0.0183)***	0.4162 (0.0182)***
LER	0.0422 (0.0070)***	0.0475 (0.0081)***	0.0474 (0.0080)***	0.0485 (0.0078)***	0.0482 (0.0077)***
GD	-1.1346 (0.0132)***	-1.2734 (0.0141)***	-1.2705 (0.0141)***	-1.2791 (0.0136)***	-1.2765 (0.0135)***
Constant	-21.2993 (0.4780)***		-23.2614 (0.5570)***	-25.1386 (0.5410)***	-25.0843 (0.8974)***
R^2	0.7743	0.8329	0.7743	0.8466	0.7743
	F[3, 5157]= 7.03**	LR[17]= 1565.96***	LM[1]= 33489.17*** HS[9]= 23.71***	LR[16]= 443.37*** LR[34]= 2009.33***	LM[2]= 38820.81*** HS[9]= 16.21*

Notes:

1. Country and time effects are not reported.
2. Standard errors are in parentheses, and values of degrees of freedom are in square brackets.
3. ***, **, and * indicate that the coefficient is significantly different from zero at the 1 per cent, 5 per cent and 10 per cent levels respectively.
4. The likelihood ratio (LR) statistic is applied to test the country and time fixed effects.
5. The Lagrange multiplier (LM) statistic is applied to test the country and time random effects.
6. The Hausman statistic is applied to test between fixed effects and random effects.
7. The instrument variable set includes all exogenous variables and their lagged one and two variables.

III.5 Conclusions

This chapter attempts to forward our understanding and knowledge on the main causes of recent trade growth in OECD countries. Various hypotheses are developed from new trade, FDI and economic growth theories. The simple gravity equation, which contains the GDP and the transaction and transportation cost variables only, is extended to incorporate such important variables as R&D and FDI. A panel data approach is applied to the estimation of the augmented gravity equation. The data set covers 19 OECD countries over the period 1980-1998.

The results indicate such variables as R&D similarity, inward FDI similarity, level of GDP, factor endowment similarity, GDP similarity, total inward FDI stock, and relative exchange rates are all very important causes of trade growth among OECD countries. As all the coefficients are statistically significant, the findings lend support to new trade, FDI and economic growth theories.

The introduction of other measures of transportation and transaction costs such as *fob* and *cif* into the gravity model reduces the sample size because observations on such variables are only available from 1980 to 1994. The findings from this sub-sample suggest that trade growth is negatively related to costs. This change has little impact on the general findings obtained from the full sample estimation. Consequently, the results are not reported in this chapter, but are available on request. As the regression results only experience very small changes when the

number of explanatory variables and the sample size change, the econometric model specified can be regarded as stable and robust.

The main features of this study include (1) the explicit introduction of R&D and FDI as the two important explanatory variables; (2) the extension of the standard gravity model; (3) the adoption of a panel data approach, and (4) the careful treatment of the endogeneity problem. With these the current study should contribute to the theoretical and especially empirical literature on trade growth.

The results from this study have important implications for policy makers. Endogenous growth theory suggests that domestic R&D, international trade, inward FDI and economic growth can be closely inter-related. This study confirms that GDP, R&D and FDI are the important determinants of international trade, and that the two-way relationship exists between these variables. R&D and FDI are concentrated in OECD countries. In addition, there are great similarities in the GDP levels, FDI stock and factor endowments in these countries. This explains why international trade is concentrated in these countries.

National governments in OECD countries may need to further encourage R&D and inward FDI. This not only helps increase productivity and promote economic growth directly, but also leads to an increase in bilateral trade, which will in turn stimulates economic growth. Furthermore, if all OECD countries adopt similar policies, then not only the levels of FDI and R&D increase, but also the similarities in these variables and hence factor endowments in these countries will be consolidated.

Country similarities increase trade volume. Thus, the virtuous circle of R&D/FDI → country similarities → trade → economic growth → R&D/FDI will be enhanced.

While the current study helps in understanding the determinants of trade in OECD countries, it uses aggregated data and therefore may be subject to aggregation bias. Research on international trade at the regional, industry or sector level which may provide more fruitful findings are very limited. This is mainly due to data unavailability. One exception is McCallum (1995) who uses data on trade between Canadian provinces, and between these provinces and individual states in the US to estimate a gravity model. McCallum finds that 'national borders mater' and so do a region's economic size and geographical distance between regions.

Appendix III.1. Country list

19 OECD countries are included in the sample: Australia, Austria, Belgium-Luxembourg, Canada, Denmark, Finland, France, Ireland, Italy, Japan, Netherlands, New Zealand, Norway, Spain, Sweden, Switzerland, United Kingdom, United States.

Appendix III.2. Variable Measurement and Data Sources

Variable	Measurement and Source
EX	Exports of goods and services (constant 1990 US$), Source: Direction of Trade Statistics Yearbook, IMF. Deflator: GDP deflator, Source: World Development Indicator CD-ROM, 2000.
K	Gross domestic fixed investment (constant 1990 US$)
L	Total labour force, Source: World Development Indicator CD-ROM, 2000.
GDP	GDP at market prices (constant 1990 US$)
FDS	FDI stock, from The World Investment Report, The International Direct Investment Statistics Yearbook and The World Investment Directory.
R&D	Domestic R&D stock (constant 1990 US$)
ER	Exchange rate, The relative exchange rate, defined as the ratio of the export country currency/US$ to the import country currency/US$.
GD	Geographical distance (in radians of the unit circle between country centroids, based on Joseph Hirschberg's calculation using the SAS-Graph dataset), Source: Boisso and Ferrantino (1997).

Appendix III.3: Estimations of Capital Stocks (K) and R&D Stocks (R&D)

Capital stocks and R&D stocks are estimated mainly from available gross domestic fixed investment and R&D expenditure flows data from World Development Indicator CD-ROM by the standard perpetual inventory calculation method. Data for gross domestic fixed investment for some countries in some years were missing from World Development Indicator CD-ROM which are then calculated from gross domestic fixed investment (constant 1987 price) from Nehru and Dhareshwar (1993). As in Miller and Upadhyay (2000), the following procedure was taken to estimate the capital stock series:

Step 1: Initialise the capital stock by setting

$$K_0 = I_0/(\lambda g_d + (1-\lambda)g_w+\delta) \qquad (A.1)$$

where the initial year is 1960; g_d is the average growth rate of the GDP series for the country in question; g_w is the world growth rate estimated at 4 per year; $\lambda = 0.25$, is a measure of mean reversion in the growth rates, following Easterly et al. (1993) and $\delta = 0.5$, is the assumed rate of depreciation.

Step2: Estimate the capital stock using the standard perpetual inventory method

$$K_t = I_t + (1-\delta)K_{t-1} \qquad (A.2)$$

R&D stock data in 1980 are taken from Coe and Helpman (1995). Note, because their data is for the beginning of the year, while the data used here are all for the end of the year., their data in 1981 are used for 1980. Then the perpetual inventory method is applied with the depreciation rate assumed to be 5. The data are in 1990 prices, based on PPP exchange rates.

Appendix III.3: GDP Data, 1980-1998

Year	Australia	Austria	Belgium	Canada	Denmark	Finland
1980	231	168	213	404	132	95
1981	237	168	211	416	130	97
1982	232	171	214	404	134	100
1983	246	175	214	415	138	103
1984	258	176	219	439	144	106
1985	269	180	221	463	150	110
1986	276	184	224	475	155	112
1987	289	187	230	495	156	117
1988	300	193	240	519	158	122
1989	310	201	249	531	158	129
1990	308	211	257	532	160	129
1991	309	218	261	522	162	120
1992	319	221	265	527	164	116
1993	335	222	261	540	166	115
1994	351	227	267	562	175	120
1995	365	231	274	573	181	126
1996	376	236	277	580	187	130
1997	390	242	286	602	193	138
1998	410	249	294	620	199	145
Year	France	Italy	Ireland	Japan	Netherlands	New Zealand
1980	1150	34	825	3230	289	44
1981	1170	35	829	3330	288	46
1982	1190	36	833	3440	284	46
1983	1200	36	843	3520	289	48
1984	1220	38	865	3650	299	50
1985	1240	39	889	3810	308	50
1986	1270	39	914	3920	317	52
1987	1300	40	942	4090	321	52
1988	1360	43	979	4340	329	52
1989	1420	45	1010	4550	345	52
1990	1450	49	1030	4780	359	52
1991	1470	50	1040	4960	367	51
1992	1480	52	1050	5010	375	52
1993	1460	54	1030	5030	377	55
1994	1500	59	1060	5060	390	58
1995	1540	66	1090	5140	398	60
1996	1560	71	1100	5400	411	62
1997	1600	79	1110	5470	426	63
1998	1650	87	1130	5320	442	62

Year	Norway	Sweden	Spain	Switzerland	US	UK
1980	98	393	185	252	4890	800
1981	98	392	185	256	4970	790
1982	101	399	187	252	4870	802
1983	107	407	190	253	5040	830
1984	113	413	198	261	5340	851
1985	117	420	202	270	5520	881
1986	119	434	206	274	5680	920
1987	119	458	213	276	5830	964
1988	120	482	218	285	6050	1010
1989	122	505	223	297	6250	1030
1990	126	524	226	308	6330	1040
1991	130	535	223	306	6260	1020
1992	134	539	220	306	6440	1010
1993	141	533	215	304	6600	1030
1994	147	545	223	306	6840	1080
1995	155	560	231	307	7040	1110
1996	160	573	234	307	7340	1130
1997	163	593	238	313	7720	1170
1998	287	616	245	319	8020	1200

Appendix III.4: FDI Stock Data, 1980-1998

Year	Australia	Austria	Belgium	Canada	Denmark	Finland
1980	12704	3375	10608	52786	4475	458
1981	15518	2889	11960	55557	3466	1213
1982	27468	2964	13350	55794	2645	1146
1983	26426	2962	14621	62834	3036	1057
1984	27961	2947	14981	64390	3001	1130
1985	25690	2990	15938	63902	3057	1170
1986	27229	4480	16569	66476	4167	1589
1987	38468	5917	18907	77143	5017	2352
1988	50859	6935	20239	90024	5601	3030
1989	65274	9237	25947	100997	6242	3890
1990	71079	9884	36644	107403	8578	5132
1991	76315	10786	45768	110272	10747	3266
1992	79709	11726	57094	121665	11762	3672
1993	82721	11685	67957	105957	13475	4217
1994	91082	12994	73983	105606	15187	5610
1995	107419	18636	86847	122469	22620	8465
1996	123853	19886	100767	129150	23393	9401
1997	100773	17810	143204	137658	25139	9530
1998	104977	25386	164093	141772	31762	15523
Year	France	Italy	Ireland	Japan	Netherlands	New Zealand
1980	16518	9661		2979	20532	2392
1981	15276	8156	2302	3411	18209	2475
1982	14207	7469	2542	4161	17669	2364
1983	13893	7997	2710	4973	18173	2320
1984	14324	12743	2829	5467	20137	2065
1985	16152	16685	2988	6397	20693	2026
1986	23720	23276	2945	7007	30687	2361
1987	31966	28287	3034	8460	39945	2835
1988	39440	36991	3125	12794	45260	3305
1989	46377	45737	3210	15654	49655	3247
1990	86513	54701	3468	18432	73188	4997
1991	101343	59530	4636	20238	79740	5237
1992	119198	62740	5880	21524	83733	5749
1993	125163	52499	6730	16884	87554	15874
1994	142089	60349	7150	17772	89701	17659
1995	147623	63455	7771	17814	112336	26237
1996	168432	74991	13953	18029	118626	32858
1997	141135	81145	17051	27080	127426	31509
1998	179186	105397	23871	30272	169552	34093

Year	Norway	Sweden	Spain	Switzerland	US	UK
1980	813	2097	5682	8950	83046	61401
1981	743	1948	5265	8452	108714	60314
1982	749	2129	6086	8227	124677	56431
1983	721	1486	5767	8099	137061	56438
1984	778	1708	6828	8426	164583	53339
1985	876	1990	8106	8501	184615	55583
1986	1315	4211	12706	16789	220414	72325
1987	2101	6151	20293	20900	263394	96787
1988	2470	7345	39510	26008	314754	128787
1989	6178	9005	52437	24526	373763	152662
1990	7985	11759	66276	30907	403735	189361
1991	8640	13730	84536	33551	400304	205387
1992	8484	14199	97888	32554	419526	173254
1993	13644	12886	105094	37099	445268	196811
1994	14325	21126	113310	38844	504401	214231
1995	19652	36521	98580	57073	560088	314650
1996	23076	42007	104976	59607	644717	344703
1997	20705	42402	100805	56390	681651	276258
1998	24303	53790	118926	60096	875026	326809

Appendix III.4: R&D Stock Data, 1980-1998

Year	Australia	Austria	Belgium	Canada	Denmark	Finland
1980	5419	4513	12412	20878	4102	3457
1981	7316	5579	14218	25265	4746	4088
1982	9129	6609	15868	29476	5375	4725
1983	10954	7587	17376	33271	5999	5375
1984	12847	8575	18898	37330	6657	6073
1985	14867	9586	20484	41838	7368	6852
1986	17342	10706	22165	46771	8202	7758
1987	19917	11897	23983	51849	9157	8804
1988	22636	13112	25839	56959	10177	9927
1989	25291	14363	27678	61769	11148	11052
1990	27810	15538	29413	66640	12112	12141
1991	30543	16909	31039	71265	13104	13171
1992	33744	18268	32613	75952	14131	14202
1993	37123	19576	34012	80482	15174	15179
1994	40667	20960	35381	85856	16374	16276
1995	44400	22338	36834	91209	17720	17461
1996	48197	23656	38292	96220	18919	18858
1997	52046	24920	39769	101258	19957	20363
1998	55952	26106	41207	106075	20802	21949
Year	France	Italy	Ireland	Japan	Netherlands	New Zealand
1980	101288	659	38505	140760	718	36711
1981	111916	833	43536	172293	4702	34979
1982	122387	990	48227	203106	8222	33355
1983	132862	1126	52882	233971	11557	31838
1984	143069	1281	57860	266268	14760	30435
1985	153814	1454	63896	302381	18237	29142
1986	165364	1652	70473	340372	22179	27975
1987	178129	1869	78035	383073	26489	26930
1988	191761	2080	86179	429363	30689	25996
1989	205209	2290	94022	476313	34441	25140
1990	218652	2519	101872	524336	37824	24371
1991	231352	2784	108751	570978	40822	23624
1992	244145	3106	115151	615848	44029	22938
1993	256262	3491	120473	656738	47160	22326
1994	267630	3958	124976	694844	50399	21753
1995	278729	4524	129180	736388	53792	21218
1996	289366	5161	133435	775310	57187	20698
1997	298941	5872	149345	808119	60531	20200
1998	307193	6660	180567	831344	63683	19695

Year	Norway	Sweden	Spain	Switzerland	US	UK
1980	3608	5657	16744	31556	859733	171238
1981	4168	6964	18764	32862	925235	179651
1982	4710	8363	20731	33923	986006	186467
1983	5255	9629	22701	34855	1045084	192335
1984	5871	10927	24890	35844	1113884	198426
1985	6590	12414	27314	36929	1192324	205203
1986	7510	14252	29979	38147	1278140	213509
1987	8472	16411	32936	39487	1372074	222717
1988	9415	19046	35911	40958	1468431	232426
1989	10278	21714	38618	42348	1551493	241387
1990	11069	24747	41034	44788	1630487	249603
1991	11833	27820	43192	46796	1704485	256272
1992	12670	31034	45561	48520	1777772	262912
1993	13524	34029	48006	49913	1842996	270267
1994	14407	36626	50724	51000	1904627	277179
1995	15310	39244	53793	51898	1975088	283706
1996	16178	41966	56996	53558	2050264	289411
1997	16953	44684	60339	56113	2126950	294276
1998	17598	47344	63753	59466	2197816	297796

Note: 1980 data are taken from Coe and Helpman (1997).

Chapter IV. The Impact of Openness on Growth in Different Country Groups

This chapter evaluates the impact of openness on growth in different country groups. This research distinguishes itself from many existing studies in three aspects: First, both trade and FDI are included in the measurement of openness. Second, countries are divided into three groups according to their development stages to compare the roles of FDI and trade in different groups. Third, the possible problems of endogeneity and multicollinearity of trade and FDI are carefully dealt with in a panel data setting. The main findings are that FDI and trade are both beneficial to a country's development. However, trade has positive effects on growth in all country groups but FDI has positive effects on growth only in the country groups which have had moderate development. The findings suggest that trade and FDI may affect growth through different channels and under different conditions.

Chapter IV. The Impact of Openness on Growth in Different Country Groups

IV.1 Introduction

An important strand of the empirical growth literature in recent years has been research into the relationship between openness to the world economy and a country's growth rate. In this literature, it is widely accepted that open economies have higher growth rates than closed economies. This explains why a number of multilateral organisations, including the World Bank, the International Monetary Fund and the World Trade Organisation, often recommend countries to adopt more liberalised policies with regard to foreign trade and investment.

Grossman and Helpman (1991) identify three sets of implications of an open economy status: international transmission of ideas; international flows of goods and services; and international movements of capital. Both neoclassical and endogenous growth theories claim that technology is the engine of long run economic growth. International transmission of ideas can be achieved directly through licensing, or indirectly through international trade of goods and services and foreign direct investment (FDI). International trade is expected to augment the existing stock of knowledge by introducing new or high-quality goods and services, while FDI can do so through labour training and skill acquisition, and the introduction of alternative

management practices and organisational arrangements. The quantity of technologies transferred via licensing is relatively insignificant compared with those via international trade and FDI. This chapter will focus discussion on international trade and FDI.

In addition to augmenting the existing stock of knowledge of a country, FDI and international trade may exert an impact on a country's growth through other mechanisms, e.g. efficiency improvement through resource re-allocation and market expansion, greater capacity utilisation and economies of scale, increased competition and the reduction of distortions. Empirically, the roles of international trade and FDI in economic growth have been investigated separately and much less attention has been paid to the conditions under which trade and FDI have positive effects on growth. One of the few exceptions is Balasubramanyam et al. (1996) who argue that the inflows and impact of FDI in an export-promoting country would be greater than in an import-substituting country. One major objective of this chapter is to examine the impacts of trade and FDI along this line but with different emphasis: by means of categorising countries into different groups according to their stages of development. It is argued that countries at a low stage of development may lack the absorptive capacity to benefit from the externalities generated by trade and FDI. As a result, for the best, trade and FDI may have no net effect; and for the worst, they may exert a negative impact. On the other hand, countries at a high stage of development may be in better position to take advantage of the spillovers associated with trade and FDI.

This chapter presents an empirical study of the effects of international trade and FDI on economic growth under a single framework based on endogenous growth theory.

It differs from many existing studies in the following three aspects. First, openness is interpreted to have two dimensions – international trade and FDI. Second, countries are divided into three groups according to their stages of development - the technological leaders, the technological followers and the technological laggards in order to assess whether the roles of FDI and trade vary across different groups. Third, as far as econometrics is concerned, the possible endogeneity problems of trade and to FDI are carefully dealt with in a panel data setting.

The chapter is organised in the following way. Section IV.2 reviews the literature on the relationship between growth and its determinants, especially, trade and FDI. Sections IV.3 and IV.4 discusses the model and methodology, respectively. Section IV.4 presents the estimation results and makes some inferences from the results. The final section offers conclusions and policy implications.

IV.2 Literature Review

Endogenous growth theory emphasises that knowledge spillovers generate increasing returns that contribute to long run growth. It is suggested that if knowledge spillovers are international in scope, then openness to trade and FDI serves to increase the rates of economic growth (see, for example, Romer, 1990; Rivera-Batiz and Romer, 1991a, b; and Grossman and Helpman, 1991). This section therefore, focuses on the relationships between trade and growth and FDI and growth.

IV.2.1 International Trade and Growth

There exists a vast literature on the relationship between international trade and economic growth. Overall, openness to trade is paramount in promoting economic growth by increasing the rate of technology transfer and diffusion, improving allocative efficiency, expanding production possibilities and inducing higher technical efficiency (see, for example, Grossman and Helpman, 1991, 1994; Barro and Sala-i-Martin, 1995; Obstfeld and Rogoff, 1996).

International trade is an important means of facilitating technology creation, transfer and diffusion (see, for example, Grossman and Helpman, 1991; Coe and Helpman, 1995; Coe et al., 1997). Integration into the world economy enables firms to access a large variety of goods and services which embody new or advanced technologies. It also enables a country to copy foreign technologies and adjust them to domestic

uses. By doing so, a country's capability in imitation and innovation will be enhanced. Moreover, exposure to international competition may bring about higher quality products (Krueger, 1985) and alleviate duplication of research and development efforts (Rivera-Batiz and Romer 1991a,b; Grossman and Helpman, 1994; Yaghmaian, 1994). Helpman and Krugman (1985) and Romer (1989) argue that more open economies can take advantage of larger markets, increasing their degree of efficiency, and achieving economies of scale, and as a result, increasing their rates of growth.

The support for the above argument, however, is not universal. Some analysts have argued that protectionism may help economic performance. Grossman and Helpman (1991, Ch. 9) show in a theoretical framework that whether a country gains from openness to trade depends on a number of factors, including its comparative advantage vis-à-vis the rest of the world. Intervention in trade could raise long-run growth if protection encourages investment in research-intensive sectors for countries with an international disadvantage in these kinds of goods. Buffie (1992) shows that whether an export boom acts as an engine of growth depends on the structural characteristics of the economy. Krugman (1994) and Rodrik (1995) argue that the effect of openness on growth is, at best, very tenuous, and at worst, doubtful.

IV.2.2 FDI and Growth

The impact of FDI on the host-country economy has attracted increasing attention in recent years. In particular, as recounted by de Mello (1997), FDI is expected to affect economic growth in four ways: the value-added content of FDI-related production;

FDI as a source of human capital augmentation; knowledge spillovers associated with FDI; and finally FDI as a source of technological change.

The first point is straightforward. FDI, similar to domestic investment, through capital accumulation, generates economic growth by encouraging the use of new inputs and advanced technologies in the production function of the host country. The second point is associated with the fact that local employees employed in foreign subsidiaries are often trained, which in turn augment the stock of human capital of the host country. The third and fourth points can be explained together. In most cases, what FDI transfers is not only capital, but also embodied and tacit technologies and managerial skills. The special role that FDI plays in technology transfer and diffusion can not be replaced by any other forms of international integration. Knowledge is most effectively learned when there is personal contact between those who already hold it and those who are to obtain it (Findley, 1978; Baron, 1990 and Ethier and Markusen, 1996). Numerous studies have shown that the productivity of local firms improves when a country hosts FDI. Multinational enterprises (MNEs), the principal agent of FDI, may develop new products and technologies earlier than local firms. Through either foreign firms' competitive force or demonstration effect, local firms may be induced to pursue new and distinctive ideas and technologies in order to be competitive. MNEs always try to preserve their own knowledge and technology, but can hardly prevent spillovers to local firms through 'learning by doing', 'learning by watching' and the switch of labour from foreign subsidiaries,.

It is also argued that FDI may affect host countries through other important channels. For example, Rodriguez-Clare (1996) explores how MNEs, through FDI, affect developing countries through the generation of backward and forward linkages. Backward linkages imply that the presence of FDI may increase the demand for locally produced intermediate inputs. Production of an increased variety of specialized inputs may be initiated, thus generating a positive externality to other local final-good producers. Forward linkages are normally between MNEs and their customers. Spillovers from FDI may amount to the development of their local distributors or sales representatives.

In summary, it is theoretically argued that FDI is beneficial to the host country via the provision of technologies and marketing skills, the creation of jobs and the generation of technology spillovers from demonstration and competition with local firms. However, empirical studies on this topic have failed to lend consistent support to this belief. Such a hypothesis seems to be dependent on a set of conditions in the host economy. For example Balasubrmanyam et. al (1996) argue that the impact of FDI on growth depends on the trade orientation of the host country. The positive relationship between FDI and growth exists only in export-promotion (EP) countries where FDI can play a key role in improving the capacity of the host country to respond to the opportunities offered by global economic integration (OECD, 1998).

Two more explanations can be offered to the existence of mixed results. Firstly, benefits from FDI rely on the development stage of the host country. Secondly, as far as econometrics is concerned, many studies have failed to take into consideration the possibility that FDI may be endogenous.

IV.3 The Model

This chapter follows a conventional methodology, i.e. the use of a general production function, with GDP modelled as a function of capital stock, labour force, human capital and technological change.

Human capital is included as one input because it is an alternative to the improvement in technology and it can lead to long-term growth even in the absence of technological progress (Lucas, 1988). The role of human capital in the empirical analysis of growth has been strongly emphasised. Mankiw et. al (1992) find that human capital is significant in explaining long run growth in a cross-section setting. They further argue that, if human capital is not accounted or, the quantities of different saving and population growth rates are biased upward. Barro and Sala-I-Martin (1995) explain how investment in education and human capital raises skills and efficiency in production through the adoption and development of new technology. A high level of human capital allows tangible inputs to be used effectively. Furthermore, the fruitiness of technological diffusion aroused through international trade and FDI depends crucially on the quality of human capital.

Following discussions in the preceding section, two variables are introduced into the production function to replace technological change. The first is the traditional trade/GDP ratio (i.e. (export + import)/GDP) (see, e.g. Pritchett, 1996). The second is the inward FDI stock/GDP ratio.

The black market premium is also included in the estimation since it is not only a direct measure of the extent of rationing in the foreign currency market but also can be understood as a proxy for market distortion (Fischer, 1993; Levine and Renelt, 1992; Barro and Sala-I-Martin, 1995; Harrison and Hanson, 1999). A currency black market may arise due to a number of reasons, but mainly due to the imposed government restrictions on legally holding foreign assets. Despite such restrictions, some agents in the economy may want to diversify their asset portfolio, which creates incentives to establish and maintain the black market. Because of the black market premium, agents allocate some of their savings to the black market rather than to domestic assets. This has a negative impact on domestic capital accumulation and economic growth. The black market premium can also affect economic growth through its impact on international trade because government restrictions on foreign exchange can act as trade barriers.

A panel data set is used here. Therefore, the production function is specified as follows for country i at time t:

$$Y_{it} = A_{it}f(K_{it}, L_{it}, H_{it}, TR_{it}, FDI_{it}, BMP_{it}) \quad (1)$$

The term A_{it} is the composition of two effects: (1) a country-specific effect δ_i, which does not change over time and can be treated heterogenously due to the structural differences across economies (Islam, 1995 and Miller, 1996); (2) a common disturbance term e_{it}, which varies across individuals and time. K, L are

capital stock and labour force respectively; H is human capital, TR is the ratio of total trade to GDP; FDI is the inward FDI stock divided by GDP; BMP is the black market premium.

After the log-transformation, the estimating equation becomes:

$$LGDP_{it} = LK_{it} + LL_{it} + LH_{it} + LTR_{it} + LFDI\delta_{it} + LBMP_{it} + \delta_i + e_{it} \qquad (2)^9$$

When empirically testing the relationship between growth and its determinants, most existing studies tend to take the world as a whole or focus on a particular country group such as OECD only. Although such studies contain some useful information, it is unclear whether the impacts of FDI and trade vary across countries at different development stages. In this study, income is used to proxy a country's development stage since generally, countries with high income are at a high development stage and *vice versa*. The advantages of doing so are as follows. First, the assumption of identical technologies across country groups can be relaxed. More specifically, the share of physical capital in real output may vary across country groups. It is suggested that this parameter is lower in developing than in developed countries (IMF WP/99/77). Second, trade- or FDI-led growth may only arise after a threshold level of development has been achieved. Third, although both FDI and trade are responsible for technology diffusion, they may play different roles when levels of development of countries are different. Advanced economies are both the main net exporters and the main recipients of FDI while the rising volumes of trade and FDI

[9] LBMP here is measured by taking the natural logarithm of BMP with the addition of unity.

are just a recent story for many developing countries. Thus, one would expect the impact of trade and FDI on growth to be stronger in developed countries.

The distinction between developed and developing countries can also be proxied by the distinction between technology leaders and technology followers. Technology followers can be further divided into two groups. One is the catch-up group and the other is the laggard group. Available empirical evidence suggests that many less developed countries are unable to benefit from the growth-inducing effects of trade and FDI, as they have weak institutions, poor governance (both public and private), unsound macroeconomic policies and insufficient human capital (OECD 2001). In this sense, technological leaders, followers and laggards are equivalent to high-, middle- and low-income countries as specified in the World Development Report (2000).

IV.4 Data and Methodologies

This empirical work is based on an unbalance panel of data on 79 countries over the period 1970-1998. A detailed description of data sources and variable measurement is given in Appendix IV.1. Appendix IV.2 lists countries included in the sample. The calculation of capital stock is given in Appendix IV.3.

IV.4.1 Model Specification Test

This analysis is based on a panel data approach. Generally, a panel data set can be estimated in three ways, depending on whether the individual cross-sectional effects are considered to be constant, fixed or random. The corresponding statistical models are the ordinary least squares (OLS), fixed effects model (FE) or random effects model (RE). Following Baltagi (1995) and Greene (2000), the Likelihood ratio (LR), the Lagrange multiplier (LM) and Hausman tests are applied to choose an appropriate model between them.

The LR test statistic is

$$LR = NT * \log(1 + \frac{RSS_r - RSS_u}{RSS_u}) \qquad (3)$$

where RSS_r and RSS_u represent the residual sums of squares in the OLS and FE models respectively.

The LM test statistics is

$$LM = \frac{NT}{2(T-1)}[1 - \frac{v'(I_N \otimes J_T)v}{v'v}]^2 \quad (4)$$

where v is the vector of residuals, I_n is an identity matrix of dimension N, J_t is a matrix of ones of dimension T and $\otimes$ denotes the Kronecker product.

Finally, the HS test statistic is:

$$HS = [b_{fe} - b_{re}]'Var[b_{fe} - b_{re}]^{-1}[b_{fe} - b_{re}] \quad (5)$$

where b_{fe} and b_{re} are estimators of the regressors in the FE and RE models respectively. *Var* is the variance-covariance matrix. Large values of the LR, LM and HS statistics argue in favour of the FE model against the OLS model, the RE model against the OLS model and the FE model against the RE model respectively.

IV.4.2 Test for Exogeneity

According to new trade, FDI and endogenous growth theories, there plausibly exists a two-way relationship between FDI, trade and growth. If, for example, an economy

enjoys a surge in growth, more local firms may attain the size to break into export markets or more foreign firms may invest directly into that economy, so that trade or FDI increases. If this is the case, a straightaway estimation of equation (2) may be biased. Therefore, the Wu-Hausman test for endogeneity will be applied. If the null hypothesis of exogeneity is rejected, LFDI and LTR should be treated as endogenous variables. In this case, generalised instrumental variable estimation (GIVE) techniques will be applied. The test procedure is similar to the one described in chapter 4.

IV.4.3 Control for Multicollinearity

In the international economics and business literature, the following two aspects of possible linkages between FDI and international trade are discussed: (1) whether FDI is a substitute for, or a complement to, international trade (FDI); and (2) whether FDI causes international trade or the other way round. Research on the relationship between FDI and international trade has generally found a positive complementary relationship at the country level. Since international trade and FDI are highly correlated (see, for example, Pfaffermayr, 1996; Brainard, 1997; and United Nations, 1996), then excluding FDI will result in attributing to trade those spillovers that are actually occurring through FDI. In this model, as trade and FDI are both introduced, such a bias can be avoid. On the other hand, the problem of multicollinearity may be introduced. However, after checking the data, it is not found. The simple correlation coefficient between the trade and FDI variables is only –0.0925.

IV.5 Empirical Results

The estimation results are summarised in four tables. Tables IV.1 presents the regression results for the whole world sample. Tables IV.2, IV.3 and IV.4 present the results for different country groups – the high, middle and low income respectively. In all tables, the results from all OLS, FE, RE and GIVE models are reported for comparison.

The World Sample

Following the discussion in the previous section, three tests are performed to compare the OLS, FE and RE models. The LR and LM test statistics in Table IV.1 suggest the assumption of a common slope for different panel groups in pooled regressions is invalid. A simple OLS regression of a straightforward pooling of all observations without considering heterogeneity will lead to biased results. The significant Hausman statistic of 378.77 indicates that the FE model performs better than the RE model. Finally, the insignificant Wu-Hausman statistic indicates that the null hypothesis of exogeneity of trade and FDI can not be rejected. Therefore, further discussion will focus on the results of the FE model.

The first important thing to notice is that the signs of coefficients on all explanatory variables are consistent with expectations. Among all factors, labour and capital are the most statistically significant. The black market premium is negatively and significantly associated with growth. Human capital is significant only in the OLS

estimation. When the country effects are accounted for, it becomes insignificant. This may be due to the correlation between the secondary school enrolment rate and the fixed effects. In addition, the secondary school enrolment rate may be a very crude measure of human capital. After controlling for capital, labour, human capital and black market premium, the two openness measures – trade and FDI are significantly and positively associated with growth.

Table IV.1: Impact of Openness on Economic Growth: the World Sample

	OLS	FE	RE	GIVE
LK	0.8774 (0.0111)***	0.5255 (0.0180)***	0.7070 (0.0140)***	0.5874 (0.0170)***
LL	0.0959 (0.0105)***	0.3169 (0.0352)***	0.2013 (0.0214)***	0.2870 (0.0389)***
LTR	-0.2268 (0.0191)***	0.1382 (0.0162)***	0.0183 (0.0146)	-0.0058 (0.0020)***
LFDI	0.0021 (0.0025)	0.0099 (0.0015)***	0.0091 (0.0014)***	0.0060 (0.0020)***
LBMP	-0.0567 (0.0057)***	-0.0103 (0.0023)***	-0.0121 (0.0023)***	-0.0123 (0.0024)***
LH	0.0941 (0.0215)***	0.0260 (0.0180)	-0.0114 (0.0164)	0.0174 (0.0180)
	LR[80] = 2958.12*** LM[1] = 4544.23*** HS[6] = 378.77*** WH[2, 1069] = 1.03			

Notes:

1. Total number of observations is 1180.
2. Intercept and country effects are not reported.
3. Standard errors are in parentheses, and values of degrees of freedom are in square brackets.
4. ***, **, and * indicate that the coefficient is significantly different from zero at the 1 per cent, 5 per cent and 10 per cent levels respectively.
5. The likelihood ratio (LR) statistic is applied to test the country fixed effects.
6. The Lagrange multiplier (LM) statistic is applied to test the country random effects.
7. The Hausman statistic is applied to test between fixed effects and random effects.
8. The Wu-Hausman test is based on F statistic, which is applied to test endogeneity. Instrumental variables used are lagged explanatory variables up to 2 lags.

The sub-samples:

As can be seen from Tables IV.2, IV.3 and IV.4, the significant LM, LR and Hausman statistics suggest that the FE models perform better than the RE models in all three sub-samples. In addition, the insignificant Wu-Hausman test statistics suggest that the hypothesis of endogeneity of trade and FDI is rejected. Therefore, further discussion will focus on the results of the FE model.

The coefficients of capital stock and labour force all have the positive sign and are highly significant in all three different country groups. The elasticity of GDP with respect to capital stock is the highest in the high-income group and lowest in the low-income group. The elasticity with respect to labour displays an opposite trend in the corresponding groups. This result suggests that economic growth is mainly driven by its labour force growth in developing countries, while in developed countries physical capital plays the central role.

The trade and FDI variables are significant in all groups. However, the coefficients of trade are positive in all groups but those of FDI are positive in the high income and middle income groups, and negative in the low income group. The findings suggest that the positive effect of FDI on a host country only held when a certain level of development is reached in the host country.

The coefficient of FDI is the highest in the high-income group and lowest in the low-income group. This may indicate that the effect of FDI on growth crucially depends

on the ability of a country's technology absorptive ability. With the large volumes of trade and inward FDI, developed countries benefit the most from openness.

On the other hand, the coefficient of trade variable is lowest in the high-income group and highest in the low-income group. This may indicate that the importation of capital goods from the world market is essential for domestic production in developing countries. In addition, by engaging in exporting activities, developing countries may promote specialization in production by re-allocating resources from the inefficient non-trade sector to the higher productive export sector, and loose the capital constraint through enlarged demands for its low-tech or labour-intensive products. For developed countries, these benefits from international trade may be less important. Furthermore, negative effects such as low labour cost competition from trade with developing countries may be severe. If technology diffusion depends on the amount of technology embodied in the traded goods, developed countries' imports from developing countries are relatively embodied with low technologies. On the other hand, developing countries' imports normally contain higher technologies according to their standards.

The black market premium variable is significant in the middle- and high-income group and carries expected negative sign. However, it is insignificant in the high-income group. The black market premium is expected to impede efficient allocations of resource, and thereby hamper growth. The exception in the high-income country is caused by the little variation in the data. In the sample, the black market premium data in 17 out of 24 countries are zero over the whole sample time period. These countries are Australia, Austria, Belgium, Canada, Denmark, Finland, France,

Ireland, Italy, Luxembourg, Netherlands, New Zealand, Norway, Sweden, Switzerland, United Kingdom and United States.

The human capital variable is significant only in the high- and middle- income countries. This may be due to two factors. Firstly, it may be caused by measurement errors. Since the variable used here is secondary school enrolment, other forms of education and job training are neglected. Therefore, this measurement may not capture the true value of human capital. Also it is often the case that the data quality for the least developed countries is quite poor. Secondly, the agriculture and labour intensive sectors are the backbone of an economy in many least developed countries. The accumulation of human capital is unlikely to promote growth in these economies, since the production in those sectors requires unskilled labour only.

Table IV.2: Impact of Openness on Economic Growth: High Income Countries

	OLS	FE	RE	GIVE
LK	0.7407 (0.0149)***	0.6685 (0.0247)***	0.6763 (0.0200)***	0.7106 (0.0233)***
LL	0.3120 (0.0151)***	0.1314 (0.0647)**	0.3257 (0.0289)***	0.1626 (0.0686)***
LTR	0.0361 (0.0154)**	0.0716 (0.0320)**	-0.0167 (0.0226)	-0.0188 (0.0082)**
LFDS	0.0231 (0.0054)***	0.0166 (0.0048)***	0.0178 (0.0047)***	0.0193 (0.0083)**
LBMP	-0.0485 (0.0108)***	0.0104 (0.0066)	0.0071 (0.0065)	0.0122 (0.0068)*
LH	0.0296 (0.0352)	0.0336 (0.0262)	0.0339 (0.0252)	0.0766 (0.0237)***
	LR[20] = 585.36*** LM[1] =1143.47*** HS[6] = 38.59*** WH[2, 306] = 0.54			

Notes:

1. Total number of observations is 356.
2. Intercept and country effects are not reported.
3. Standard errors are in parentheses, and values of degrees of freedom are in square brackets.
4. ***, **, and * indicate that the coefficient is significantly different from zero at the 1 per cent, 5 per cent and 10 per cent levels respectively.
5. The likelihood ratio (LR) statistic is applied to test the country fixed effects.
6. The Lagrange multiplier (LM) statistic is applied to test the country random effects.
7. The Hausman statistic is applied to test between fixed effects and random effects.
8. The Wu-Hausman test is based on F statistic, which is applied to test endogeneity. Instrumental variables used are lagged explanatory variables up to 2 lags.

Table IV.3: Impact of Openness on Economic Growth: Middle Income Countries

	OLS	FE	RE	GIVE
LK	0.7475 (0.0207)***	0.5904 (0.0265)***	0.6143 (0.0243)***	0.5973 (0.0278)***
LL	0.2005 (0.0188)***	0.1636 (0.0466)***	0.2875 (0.0346)***	0.1633 (0.0455)***
LTR	-0.2877 (0.0230)***	0.1089 (0.0232)***	0.0207 (0.0207)	0.1595 (0.0514)***
LFDS	-0.0002 (0.0026)	0.0054 (0.0016)***	0.0062 (0.0016)***	0.0046 (0.0018)**
LBMP	-0.0577 (0.0067)***	-0.0151 (0.0030)***	-0.0162 (0.0029)***	-0.0163 (0.0030)***
LH	0.1222 (0.0358)***	0.1557 (0.0311)***	0.0756 (0.0255)***	0.1443 (0.0317)***
	LR[30] = 1064.987*** LM[1] = 2103.95*** HS[6] = 80.52*** WH[2,404] = 0.41			

Notes:

1. Total number of observations is 458.
2. Intercept and country effects are not reported.
3. Standard errors are in parentheses, and values of degrees of freedom are in square brackets.
4. ***, **, and * indicate that the coefficient is significantly different from zero at the 1 per cent, 5 per cent and 10 per cent levels respectively.
5. The likelihood ratio (LR) statistic is applied to test the country fixed effects.
6. The Lagrange multiplier (LM) statistic is applied to test the country random effects.
7. The Hausman statistic is applied to test between fixed effects and random effects.
8. The Wu-Hausman test is based on F statistic, which is applied to test endogeneity. Instrumental variables used are lagged explanatory variables up to 2 lags.

Table IV.4: Impact of Openness on Economic Growth: Low Income Countries

	OLS	FE	RE	GIVE
LK	0.3871 (0.0354)***	0.4415 (0.0375)***	0.4538 (0.0351)***	0.5851 (0.0537)***
LL	0.4896 (0.0324)***	0.4096 (0.0782)***	0.5236 (0.0454)***	0.5685 (0.1215)***
LTR	-0.3270 (0.0505)***	0.2147 (0.0389)***	0.1837 (0.0377)***	0.0438 (0.0205)**
LFDS	0.0470 (0.0111)***	-0.0189 (0.0103)*	-0.0140 (0.0097)	-0.0441 (0.0207)**
LBMP	-0.0399 (0.0092)***	-0.0088 (0.0046)*	-0.0060 (0.0044)	-0.0083 (0.0049)*
LH	0.2955 (0.0354)***	-0.0092 (0.0340)	-0.0373 (0.0275)	-0.0214 (0.0352)
	LR[23] = 672.752*** LM[1] = 820.19*** HS[6] = 26.40*** WH[2,259] = 1.52			

Notes:

1. Total number of observations is 312.
2. Intercept and country effects are not reported.
3. Standard errors are in parentheses, and values of degrees of freedom are in square brackets.
4. ***, **, and * indicate that the coefficient is significantly different from zero at the 1 per cent, 5 per cent and 10 per cent levels respectively.
5. The likelihood ratio (LR) statistic is applied to test the country fixed effects.
6. The Lagrange multiplier (LM) statistic is applied to test the country random effects.
7. The Hausman (HS) statistic is applied to test between fixed effects and random effects.
8. The Wu-Hausman test is based on F statistic, which is applied to test endogeneity. Instrumental variables used are lagged explanatory variables up to 2 lags.

IV.5 Conclusion

In the existing literature, the roles of international trade and FDI in economic growth have been intensively, but largely separately investigated. Furthermore, the relationship between openness and growth in countries within different development stages is yet to be analysed. Building on the recent development of growth, FDI and international trade theories, the study investigates the relationship between openness and economic growth in different country groups based on a panel of dataset on 79 countries over the period 1970-98.

The current study distinguishes itself from many existing studies in several ways. It includes both trade and FDI in the measurement of openness; examines the roles of trade and FDI in countries at different development stages; and carefully deals with the possible problems of multicollinearity and endogeneity by proper diagnostic tests and the application of GIVE techniques.

The results indicate that FDI and trade play different roles at different development stages. FDI is relatively more beneficial to the technologically advanced countries, while international trade is more important for the low-tech countries. Furthermore, economic growth is hampered by market distortions measured in terms of the black market premium in the mid- and low-income countries. The results suggest that openness is not a single-, but a multiple-dimension process. Whether openness has positive effects on economic growth relies on which openness channels are used and what economic conditions prevail.

The results from this study have important implications for policy makers. New growth theory suggests that international trade and FDI are both responsible for technological diffusion and have positive effects on economic growth. However, the effectiveness of trade and FDI depends on the technological absorbing capabilities of a country. Our empirical results lend support to this view. Governments and international development organizations may re-evaluate the different roles of international trade and FDI in technological diffusion and growth enhancement for countries at different development stages so that proper external economic policies can be formulated.

This study implies that, while both international trade and FDI are the determinants of economic development, low-income country governments need to focus more on the encouragement of international trade than FDI. This is because low-income countries, given the technical capabilities, can benefit more from international trade than FDI in terms of learning and imitating foreign technologies. Similarly, for technologically advanced countries, governments may pay more attention to attract inward FDI than international trade in order to further enhance their technological capabilities.

Appendix IV.1: Data Source

Variable	Measurement and Source
EX	Exports of goods and services (constant 1995 US$); World Development Indicator CD-ROM, 2000 [WDI 2000]
IM	Imports of goods and services (constant 1995 US$); WDI 2000
L	Total labour force; WDI 2000
K	Capital Stock (constant 1995 US$)
GDP	GDP at market prices (constant 1995 US$); WDI 2000
FDS	FDI stock; The World Investment Report, The International Direct Investment Statistics Yearbook and The World Investment Directory.
H	Secondary school enrolment rate; WDI 2000
BMP	Black market exchange rate premium; Global Development Network Growth Database, the World Bank.
GDPD	GDP deflator; WDI 2000.

Appendix IV.2: Country list

High Income Country Group	Middle Income Country Group	Low Income Country Group
Australia	Argentina	Bangladesh
Austria	Bolivia	Burkina Faso
Belgium	Brazil	Burundi
Canada	Chile	Cameroon
Denmark	Colombia	China
Finland	Costa Rica	Congo, Rep.
France	Dominican Republic	Ghana
Hong Kong, China	Ecuador	Honduras
Ireland	Egypt, Arab Rep.	India
Israel	Greece	Kenya
Italy	Guatemala	Madagascar
Japan	Indonesia	Malawi
Korea, Rep.	Iran, Islamic Rep.	Mali
Luxembourg	Jamaica	Mauritania
Netherlands	Jordan	Mozambique
New Zealand	Lesotho	Niger
Norway	Malaysia	Pakistan
Portugal	Mauritius	Rwanda
Singapore	Mexico	Senegal
Spain	Morocco	Sri Lanka
Sweden	Panama	Togo
Switzerland	Paraguay	Yemen, Rep.
United Kingdom	Peru	Zambia
United States	Philippines	Zimbabwe
	Syrian Arab Republic	
	Thailand	
	Tunisia	
	Turkey	
	Uruguay	
	Venezuela, RB	
	El Salvador	

Appendix IV.3: Computing the capital stock

There are no capital stock data available straightaway. Similar to the method used in chapter III, capital stocks are estimated mainly from available gross domestic fixed investment (constant 1995 price) data from WDI CD-ROM by the standard perpetual inventory calculation method. Data for some countries in some years were missing from WDI CD-ROM which are then calculated from gross domestic fixed investment (constant 1987 price) from Nehru and Dhareshwar (1993). The following procedures, as suggested by Miller and Upadhyay (2000) in estimating the capital stock series, are followed.

Step 1: Initialize the capital stock by setting

$$K_0 = I_0/(\lambda g_d + (1-\lambda)g_w+\delta) \qquad (A.1)$$

where g_d is the average growth rate of the GDP series for the country in question; g_w is the world growth rate estimated at 4 per cent per year; $\lambda = 0.25$, is a measure of mean reversion in the growth rates, following Easterly et al. (1993) and $\delta = 0.5$, is the assumed rate of depreciation.

Step 2: Estimate the capital stock using the standard perpetual inventory method

$$K_t = I_t + (1-\delta)K_{t-1}. \qquad (A.2)$$

Appendix IV.4: GDP growth (annual %)

Year	World	High Income Countries	Middle Income Countries	Low Income Countries
1970	4.78	4.33	7.54	6.06
1971	4.03	3.70	6.28	3.36
1972	5.74	5.81	6.04	0.95
1973	6.47	6.25	8.46	4.38
1974	1.33	0.58	6.04	4.90
1975	0.90	0.25	4.48	5.16
1976	4.97	4.77	6.39	3.75
1977	3.87	3.65	4.90	6.07
1978	4.32	4.34	4.02	5.43
1979	4.11	3.97	5.46	0.53
1980	1.92	1.35	4.77	5.60
1981	1.79	1.69	1.86	5.24
1982	0.53	0.29	1.53	2.93
1983	2.76	2.85	1.84	5.37
1984	4.50	4.48	4.72	3.74
1985	3.38	3.40	3.11	4.49
1986	3.32	3.05	4.70	4.36
1987	3.60	3.49	4.17	3.77
1988	4.61	4.67	3.91	6.41
1989	3.73	3.94	2.33	5.08
1990	2.74	2.92	1.70	3.09
1991	1.37	1.17	2.48	0.81
1992	1.84	1.86	1.87	1.12
1993	1.47	1.07	3.53	1.62
1994	3.07	2.94	3.90	2.47
1995	2.75	2.39	4.00	5.52
1996	3.21	2.80	4.81	5.57
1997	3.45	3.13	4.91	3.99
1998	2.16	2.43	1.17	0.58

Appendix IV.5: Trade as % of GDP

Year	World	High Income Countries	Middle Income Countries	Low Income Countries
1970	27.87	28.65	25.53	20.37
1971	28.00	28.68	26.01	21.07
1972	28.95	29.52	27.14	22.51
1973	31.56	31.95	30.76	24.52
1974	37.90	38.50	36.19	29.79
1975	35.16	35.49	34.57	28.73
1976	36.46	37.21	33.81	29.50
1977	36.42	37.11	34.18	28.80
1978	35.44	36.03	33.55	28.59
1979	38.14	38.79	35.67	32.79
1980	40.71	41.21	39.24	34.43
1981	41.18	41.80	39.37	33.56
1982	39.83	40.65	37.03	31.83
1983	39.12	39.67	37.49	32.44
1984	40.95	41.83	38.18	31.03
1985	40.45	41.34	37.88	29.17
1986	37.00	37.37	36.72	27.90
1987	37.33	37.38	38.40	30.04
1988	38.37	38.30	40.20	30.40
1989	39.68	39.81	39.93	35.16
1990	39.84	39.52	41.70	37.56
1991	39.24	38.73	41.92	37.23
1992	40.07	38.13	48.97	39.60
1993	39.22	37.63	46.13	40.85
1994	40.68	38.97	47.90	43.71
1995	42.68	40.92	49.80	47.58
1996	43.02	41.55	49.01	46.73
1997	45.00	43.49	51.33	47.70
1998	45.49	43.37	53.38	54.92

Chapter V. Overall Conclusions and Policy Implications

Chapter V. Overall Conclusions and Policy Implications

The current research aims to evaluate the interactions between openness and economic growth from an empirical perspective. It distinguishes itself from many existing studies in three aspects: FDI is treated as one dimension of international openness in addition to international trade; the endogeniety problem of the openness variables is explicitly considered, and all empirical investigations are based on a panel data approach. This thesis contains three empirical investigations. The main features, findings and policy implications of these studies are as follows.

The first empirical investigation is concerned with the causal relationship between export, import and inward FDI. As reported in chapter II, the study is based on a panel data set covering 19 home countries/regions over the period 1984-1998. The standard t-bar and LM bar tests are carried out to test for unit root for the three variables involved. Then Granger causality tests are conducted based on a standard VAR model with the stationary time series of the corresponding variables. The following empirical evidence is found.

(1) There is a one-way complementary causal link from the growth of China's imports to the growth of inward FDI stock from the home country/region.

(2) There exists a one-way complementary causal link from the growth in inward FDI stock in China to the growth of China's exports to the home country/region.

(3) There is a one-way complementary causal link from the growth of China's exports to imports.

Of course, these results should be interpreted with caution since Granger causality does not imply that one variable is the effect or the result of another. Granger causality only refers to the precedence of one variable over the others.

These findings have an important implication for the development of China. First of all, rapid increases of inward FDI and foreign trade are expected to continue due to their positive complementary relationship. Secondly, the current panel data suggest that inward FDI stock plays a more important role than imports in generating China's export. While the growth of China's imports from the trading partner promotes the growth of inward FDI from the partner, it is the growth of inward FDI stock rather than imports that directly and positively causes the growth of exports.

The policy implications of the findings in chapter II are straightforward. The virtuous procedure of development identified in the investigation is in fact the results of China's policy of opening to the outside world. More specifically, it is due to China's export-promotion strategy and policies that encourage multinational firms into the Chinese market. Given the indications revealed in this study, China should continuously encourage the export-oriented FDI and reform her import regime by reducing or eliminating both tariff and non-tariff barriers in order to promote more FDI and therefore more export. This is important to China because her goal of modernisation in industry, agriculture, national defence and science technology requires advanced technologies, management skilles and know-how originated from FDI, imported products and service, and trade activities.

Since its accession into the WTO in 2001, China has opened its market further to foreign trade and experienced more imports, and this in turn has promoted more inward FDI and exports. The reductions of impediments to international trade and foreign investment are likely to promote more efficiency-seeking investment and lead to more trade-creating activities. The gains by China after accession are expected to be great.

The findings in the study regarding the relationship between FDI and international trade show that the possible complementary relationship indicated by FDI, new trade and growth theories can be found in developing countries such as China. This complementary relation is also confirmed in a later study by Cuadros et al. (2001) for Latin America. With other research findings for some developed countries (see section II.2.2) a general conclusion can be drawn that FDI and international trade are virtually supportive to each other. This view is taken seriously in the following studies.

The limitations of this study have two folds. First, because of the data limitation, this research is carried out at the economy level only. It would be much more desirable to carry out causality tests at the industry or firm level. Trade-FDI linkage can be industry- and even firm-specific as indicated by Brainard (1993), Horseman and Markusen (1992) among others. Second, since causality test involves three variables only, the problem of omission of other important variable is unavoidable. For example, economic growth may have impact on both trade and FDI.

Chapters III looks at the determinants of bilateral trade in OECD countries. Krugman (1995) highlights two main approaches to answering the question: journalists tend to argue that trade growth is due to technology-led declines in transportation costs, while economists believe that it is caused by trade liberalisation. Feenstra (1998) adds two more reasons for trade growth: income convergence and increased outsourcing by multinational enterprises (MNEs).

Baier and Bergstrand (2001) and many others attempt to incorporate the above four sources in the studies of trade growth in OECD countries. However, they fail to combine all four possible sources in a single framework. The current study provides an augmented simple gravity model which is synthesised from new trade, FDI and growth theories and tested in a two-way panel data setting. Furthermore, it takes into consideration possible endogeniety of income, R&D and FDI stock to avoid any estimation bias. The panel data set of 19 OECD countries over the period 1980-1998 is applied to the estimation of the augmented gravity equation. The importance of the following variables in explaining trade growth in OECD counties is examined: relative factor endowment, the level and similarity of GDP, R&D accumulation and similarity, FDI accumulation and similarity, and exchange rate.

The results indicate R&D similarity, inward FDI similarity, level of GDP, factor endowment similarity, GDP similarity, total inward FDI stock, and relative exchange rates are all very important causes of trade growth among OECD countries. The findings lend support to new trade, FDI and economic growth theories. Endogenous growth theory suggests that domestic R&D, international trade, inward FDI and economic growth can be closely inter-related. This study confirms that GDP, R&D

and FDI are the important determinants of international trade, and that the two-way relationship exists between these variables. R&D and FDI are concentrated in OECD countries. In addition, there are great similarities in the GDP levels, FDI stock and factor endowments in these countries. This explains why international trade is concentrated in these countries.

A few important policy implications emerge from the model. First, both R&D and inward FDI directly enhance trade performance and therefore indirectly raise economic growth. Thus the impact of R&D and FDI on economic growth is not just via one single channel only. The mechanisms can be thought that R&D and FDI increase a country's competitiveness in the world market, and therefore promote trade and growth. Government promotion of domestic R&D and FDI implies the introduction of the two powerful driving forces for economic growth. Furthermore, if all OECD countries adopt similar policies, then not only the levels of FDI and R&D increase, but also the similarities in these variables and hence factor endowments in these countries will be consolidated. Country similarities increase trade volume. Thus, the virtuous circle of R&D/FDI → country similarities → trade → economic growth → R&D/FDI will be enhanced.

In assessing the impact of FDI and international trade on economic growth, an empirical specification in this chapter is derived from a general production function, with output (GDP) as a function of capital stock, labour force, human capital and technological change. Some extreme assumptions including the identical technology across countries, heterogenity across countries, diminishing returns to production factors imposed by many other researchers are relaxed. This empirical work is based

on an unbalanced panel of data on 79 countries over the period 1970-98. Furthermore, in this study, countries are grouped in terms of their income levels for the following reasons. Firstly, the assumption of the identical technology across countries can be relaxed. Second, trade- or FDI-led growth may only arise after a certain level of development (usually proxied by income) has been achieved. Third, although both FDI and trade are responsible for technology diffusion, they may play different roles in countries at different levels of development.

The grouping strategy proves to be sensible by the results. After endogeneity and multicollinearity of FDI and trade are controlled for, the results indicate that FDI and trade play different roles at different development stages. FDI is beneficial to the technologically-advanced countries, while international trade is still essential for the low-tech countries. Furthermore, except developed countries, economic growth is hampered by market distortions measured by the black market premium. The results suggest that openness is not a single-dimension status, but a multiple-dimension process. The effectiveness of openness on growth relies on which channel is applied and what conditions prevail in that particularly country.

The results from this study have important implications for policy makers. Endogenous growth theory suggests that international trade and FDI are both responsible for technological diffusion and economic growth, and that the effectiveness of openness depends on the technological absorption ability of a country. The results lend support to this view. Governments and international development organizations may re-evaluate the different roles of international trade and FDI in technological diffusion and growth enhancement for countries at different

development stages so that proper external economic policies can be formulated. More specifically, low-income country governments should encourage more international trade than attract more FDI, while countries at the high level of development should pay more attention on attracting FDI in order to further enhance their technological capabilities.

From the above discussion the original contributions of this PhD thesis can be summarised as follows:

- A number of important ideas identified in the literature on openness and economic growth are synthesised into a single analytical framework.
- Sound econometric techniques are applied to systematically assess the FDI–trade relationship, the determinants of trade growth, and the impacts of FDI and trade on economic growth.
- A number of policy implications from these empirical studies are discussed.

This research can be important to both governments and academics. Governments may be interested in the results because they explain the relationships between trade and FDI, the political, economic, geographic and social factors influencing the growth of international trade, and the channels and conditions through/under which openness promotes economic growth. Academics may find the results useful because they provide not only a number of interesting findings from both theoretical and empirical analyses but also the directions for future study. For example, in chapter 4, it is argued that trade and FDI are both important factors that promote economic growth but they play quite different roles at different development stages. In the case of developed countries, FDI plays a significant part in technology transfer and hence

economic growth, while trade is still the prime openness channel for upgrading industries in the least developed countries. As economic growth in many least developed countries continues lagging behind the world average, multinational organisations such as World Bank, IMF and national governments should concentrate on the establishment of sound domestic and international policies instead of simply promoting them to open their markets. In addition, these countries also need to consider improving the conditions that can help them benefit more from spillover effects from either trade or FDI. More specifically, government policy of developing countries needs to encourage R&D activities in local firms since technological capabilities of local firms in developing countries are important. Successful imitation requires not only the availability of advanced technologies from foreign firms, but also an adequate absorptive ability of local firms.

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