MODELLING FOREIGN DIRECT INVESTMENT IN CHINA

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Thesis Summary

This thesis consists of three empirical and one theoretical studies. While China has received an increasing amount of foreign direct investment (FDI) and become the second largest host country for FDI in recent years, the absence of comprehensive studies on FDI inflows into this country drives this research.

In the first study, an econometric model is developed to analyse the economic, political, cultural and geographic determinants of both pledged and realised FDI in China. The results of this study suggest that China's relatively cheaper labour force, high degree of international integration with the outside world (represented by its exports and imports) and bilateral exchange rates are the important economic determinants of both pledged FDI and realised FDI in China.

The second study analyses the regional distribution of both pledged and realised FDI within China. The econometric properties of the panel data set are examined using a standardised 't-bar' test. The empirical results indicate that provinces with higher level of international trade, lower wage rates, more R&D manpower, more preferential policies and closer ethnic links with overseas Chinese attract relatively more FDI.

The third study constructs a dynamic equilibrium model to study the interactions among FDI, knowledge spillovers and long run economic growth in a developing country. The ideas of endogenous product cycles and trade-related international knowledge spillovers are modified and extended to FDI. The major conclusion is that, in the presence of FDI, economic growth is determined by the stock of human capital, the subjective discount rate and knowledge gap, while unskilled labour can not sustain growth.

In the fourth study, the role of FDI in the growth process of the Chinese economy is investigated by using a panel of data for 27 provinces across China between 1986 and 1995. In addition to FDI, domestic R&D expenditure, international trade and human capital are added to the standard convergence regressions to control for different structural characteristics in each province. The empirical results support endogenous innovation growth theory in which regional per capita income can converge given technological diffusion, transfer and imitation.

Key Words: FDI, determinants, regional distribution, economic growth, P. R. China

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1.1 Background

It is generally agreed that foreign direct investment (FDI) provides host developing countries with advanced technologies, superb management skills as well as financial capital. FDI has been recognised as an important source of economic development in developing countries. However, for historical and ideological reasons, FDI in China was highly restricted until 1979 when China initiated economic reform and opening-up policies. To realise its ambitious objective of modernising industry, agriculture, national defence and science and technology, China since 1979 has regarded the introduction of FDI as one of the key development strategies and offered various incentives to encourage inward FDI.

China's FDI policy and the corresponding growth of inward FDI can be categorised into three stages. In the first stage (1979 - 1985), the Chinese government encouraged FDI in coastal areas. Immediately after the initiation of the opening-up policy, four special economic zones (SEZs) were established at Shenzhen, Zhuhai, Shantou and Xiamen, and the Law on Sino-Foreign Joint Ventures was promulgated. In 1984, the State Council further established Hainan Island as a SEZ and opened fourteen coastal cities for foreign investment. In 1985, the opening-up policy was extended to the Pearl River Delta, the Yangtze River Delta, and the Zhangzhou-Quanzhou-Xiamen region.

In the second stage (1986 - 1991), China opened its entire coastal areas and began to encourage FDI into inland areas. During this period, the opening-up policy was extended to coastal cities with populations of over 2 million, and to Liaoning and Jiaodong peninsulas. Foreign invested firms are encouraged to locate in inland cities.

Finally, in the third stage (1992-), the Chinese government adopted the nation-wide opening-up policy. During his visit to southern China in January 1992, Deng Xiaoping argued for more rapid progress in opening up China to the outside world. During the same year, the State council decided to open six cities along the Yangtze River as well as thirteen border cities and eighteen capitals of inland provinces for FDI. In that year, both pledged projects and the value of FDI in that year surpassed the figures for the entire previous period of 1979-1991. In 1994, the Chinese government adopted explicit guidelines for FDI. During this period, some of the special provisions which were only available in SEZs in the late 1970s and early 1980s were widely introduced in the central and western regions.

In addition to the preferential treatments provided by the central government, the local authorities has also provided various incentives to compete for FDI in order to develop their own local economies. Because of China's active FDI policies, its relatively attractive investment environment and special connections with overseas Chinese, inward FDI in China has grown quickly, especially in the late 1980s and the 1990s. Since 1993, China has remained second only to the United States as the largest host country for FDI [Liu et al. 1997; *The People's Daily*, Overseas Edition, 20 September 1997; UNCTAD, 1998]. By the end of August 1997, more than 140,000 foreign invested firms were already in operation, and the realised value of investment made by foreign investors was US$ 204.4 billion. The share of FDI in China's total social investment in fixed assets increased from 4.2% in 1991 to 14.7% in 1996 [*The People's Daily*, Overseas Edition, 6 October 1997].

It is widely observed that FDI has been beneficial to China via its direct impact such as the provision of technologies and marketing skills and creation of jobs and its indirect impact such as technology spillovers from demonstration and competition with local firms. During the whole period of economic reform and opening to the outside world, China achieved quiet phenomenal rates of growth, with real GNP growing on average by early 10 per cent a year. FDI has played an increasingly important role in improving productivity and economic growth in China [Hu and Khan, 1997; Sun, 1998].

Though massive inflows and important economic impact of FDI in China have attracted much attention in the academic as well as the business sector, few theoretical models have been constructed for the relationships among FDI, knowledge spillovers and long run economic growth. In addition, very limited empirical studies with sound methodology have been found on the determinants, regional distribution and effects of FDI.

The current research aims to formulate systematic and in-depth studies of FDI in China. First, an attempt is made to identify factors entering into MNCs' decisions to invest in China. Second, the determinants which affect location choices of FDI in every region of China are explored. Third, a theoretical model is developed for the impact of FDI in a human capital short and unskilled labour surplus economy. Finally, the essential points addressed in the theoretical model are incorporated into standard convergence regressions for endogenous innovation growth models to assess the impact of FDI on economic growth in China.

1.1.1 The Determinants of FDI

An extensive empirical literature has arisen to evaluate the relative importance of various determinants of FDI. However, little systematic econometric work has been conducted for China. As an exception, Wang and Swain (1995) provide an econometric analysis of factors influencing foreign capital inflows into China using time-series data for the period 1978 to 1992. Their study suffers from problems of inconsistencies in some numerical results and a lack of degrees of freedom. One of the purposes of the current research is to provide robust evidence on the main hypotheses proposed in the literature to analyse the economic, political, cultural and geographic determinants of FDI in China from a macroeconomic perspective.

1.1.2 The Regional Distribution of FDI

Though FDI has flowed into every province, autonomous region or central municipality, the geographical distribution of FDI in China is characterised by its concentration in coastal areas. Since every province is promoting further inward FDI, an understanding of regional characteristics influencing locational decisions is essential for improved policies to encourage FDI. In the current research, international trade, wage rates, R&D manpower, market size, infrastructure, agglomeration and preferential policies are used to explain the regional distribution of FDI in China. To examine whether there is a long run economic relationship, a standard 't-bar' test for unit root is applied.

1.1.3 The Theoretical Framework of FDI and Economic Growth

Economic theory on the subject of what determines the long run rate of economic growth has undergone a rapid development. In the context of neo-classical growth frameworks, the potential impact of FDI on economic growth is confined to the short run. On the other hand, endogenous growth theory changes the logically coherent explanations of sustained long run growth to focus towards knowledge spillovers, instead of exogenous factors of production. Since economies of scale, imperfect competition, strategic considerations, technological progress and knowledge spillovers emphasised by the FDI literature are central to endogenous growth theory, FDI might be deemed to be a catalyst for economic growth in the long run. Given that the existing research on the relationship between FDI and economic growth in the long run is relatively limited, a dynamic general equilibrium model is built to study the interactions among FDI, knowledge spillovers and long run economic growth in a human capital short and unskilled labour surplus developing country. Three ways through which FDI may affect growth are highlighted.

1.1.4 The Impact of FDI on Economic Growth

One of the most remarkable events in global economic development in the last two decades is China's achievement of high and sustained rates of economic growth. During the period 1979 to 1996, China achieved a remarkably high average growth rate of 9.9% per annum. It has been recognised that FDI has contributed to advancing market oriented economic reforms that have helped to bring about China's rapid economic growth. FDI is viewed to be an important driving force behind economic growth through increasing capital supply, diffusing and assimilating superior knowledge, creating opportunities for domestic-owned firms to strengthen their capacities to produce new and/or high quality products, and augmenting local human capital stock. Due to data limitations, the impact of FDI on long run economic growth in China is not entirely based on the theoretical model developed in the current research, but on an augmented convergence regression within an endogenous innovation growth framework. Some important ideas developed in the theoretical model are incorporated into the framework.

The merit of econometric analysis lies in its ability to identify statistically significant factors and provides direct quantitative indications. Though China began to receive

FDI from 1979, official data on inward FDI by country of origin are available only from 1983 onwards. As a result, all the three empirical studies on the determinants, regional distribution and impact of FDI employ pooled time-series and cross-sectional data sets. This increases the degree of freedom and improves efficiency of estimation, and is an appropriate method for this kind of research.

1.2 Structure of the Thesis

In chapter 2, a systematic empirical study of factors influencing foreign capital inflows into China is carried out. It focuses on analysing the relative home and host country characteristics as the determinants. A brief introduction of inward FDI in China is given in the first section. Section 2.2 reviews the literature and outlines hypotheses. The economic, political, cultural and geographic determinants identified for this study include market size, costs of borrowing, wage rates, trade, exchange rates, political risk, geographic distance and cultural difference. Then section 2.3 describes an econometric model and section 2.4 reports the data sources. Section 2.5 offers discussion of the methodology. The basic features of ordinary least squares (OLS), fixed effects (FE) and error correction (EC) models are briefly discussed, and the methods for choice of models are described. Then, empirical findings are given in section 2.6. In the case of pledged FDI the data used cover the time period of 1983 to 1994, and 22 home countries/regions. In the case of realised FDI, the data used cover the time period of 1984 to 1994 and 17 home countries/regions. Since FDI is pledged and realised at different times, the factors which are important in explaining pledged FDI may become statistically insignificant when used to interpret realised FDI. Finally, section 2.7 provides concluding remarks and suggestions for further research.

While chapter 2 deals with the influences on inward FDI in China as a whole, chapter 3 is devoted to the determinants of the regional distribution of both pledged and realised FDI within China. A panel of data for 27 provinces over the period 1985 to 1995 (1986 to 1995) for pledged FDI (realised FDI) is used for the empirical study. It begins with an assessment of the existing studies on the spatial patterns of FDI in China in section 3.1 and follows with hypothesis formation and model specification in section 3.2. This empirical study tends to draw on various fields of economics and includes factors which are thought to be important in explaining the regional distribution of FDI in China. These include such regional characteristics as the level of international trade, wages, R&D manpower, GDP growth, infrastructure, agglomeration externalities, investment incentives and links with foreign investors. Then, section 3.3 reports the data sources. In section 3.4, a standardised 't-bar' test for unit root is carried out to examine the econometric properties of the panel data set and determine whether there exists a long run relationship between the spatial distribution of FDI and a number of regional characteristics. In addition, a possible problem of autocorrelation is also taken into consideration when a statistical model is selected. The empirical results are presented in section 3.5. The final section summarises the results and provides some concluding observations. The results are also compared with those from chapter 2.

After accessing the determinants of inward FDI at both national and regional levels, chapter 4 provides a theoretical model of the impact of FDI on economic growth with endogenous technological progress in the long run. Section 4.2 reviews the literature. Section 4.3 specifies the evolution equations for the stock of knowledge capital with emphasis on knowledge spillovers from FDI. In addition, in this section such equilibrium conditions are derived as pricing equations for the traditional and modern goods, no-arbitrage conditions relating equilibrium asset returns and the human capital market clearing condition. In section 4.4, conditions are imposed for a steady-state equilibrium in which all variables grow at constant rates. Key linkages between variables of interest in a steady-state equilibrium are established. Furthermore, since the model generates an endogenous rate of long run growth, the comparative steady-states of the model are analysed and several important propositions about the determinants of the growth rate of the developing country are generated. Policy implications of the model are also explored in section 4.5. Finally, section 4.6 summarises the findings and provides some concluding observations. In addition, limitations and the directions of possible extensions of the model are stated in this section.

In chapter 5, endogenous innovation growth theory is tested with particular attention to the role of FDI in economic growth. Some key ideas of the theoretical model developed in chapter 4 are incorporated, and R&D expenditure, international trade, human capital and FDI are added to the standard convergence regressions to control for different structural characteristics in each province. After assessing the existing studies on the convergence of regional income in China in section 5.1, the literature review is offered in section 5.2. A conceptual model is then developed and the techniques of econometric analysis used are briefly discussed in section 5.3. Section 5.4 discusses the data set. By allowing for differences in the aggregate production function across regions and using a panel of annual data for 27 provinces across China between 1986 and 1995, the empirical results concerning growth and convergence of per capita GDP across Chinese provinces are presented in section

5.5. The final section draws conclusions on whether the results support the endogenous innovation growth model in which regional per capita income can converge given technological diffusion, transfer and imitation.

Finally, chapter 6 offers overall conclusions and policy implications.

Chapter 2: Country Characteristics and Foreign Direct Investment in China

Abstract

While China has received an increasing amount of foreign direct investment (FDI) and become the second largest host country for FDI in recent years, few systematic empirical studies have been carried out on the factors influencing foreign capital inflows into the country. In this chapter an econometric model is developed to analyse the economic, political and cultural determinants of both pledged and realised FDI in China. The panel data cover the time period of 1983-1994 and 22 home countries/regions in the case of pledged FDI, and the time period of 1984-1994 and 17 home countries/regions in the case of realised FDI. The results of this study indicate that bilateral trade, cultural differences, and relative real changes in market size, wage rates, and exchange rates, are important determinants for pledged FDI, and that bilateral trade, relative changes in wage rates and exchange rates affect the level of realised FDI in China.

Chapter 2: Country Characteristics and Foreign Direct Investment in China

2.1 Introduction

As mentioned in chapter 1, because of its large size and important role in economic development, inward FDI in China has been a topic of considerable interest in the economics and business literature. For instance, Kamath (1990, 1994) and Promfret (1991, 1994) review the evolution of China's open door policy and discuss some lessons which can be drawn from China's experience with FDI. Schroath et al. (1993) investigate the role of country-of-origin in explaining the pattern of FDI in China. Zhan (1993) and Chen et al. (1995) assess the role of FDI in market-oriented reforms and economic development in China. Zhang (1994) argues that governments of developing countries can not only activate existing, but also create new, location-specific advantages (LSAs). The success of Guangdong Province as the main local host in China for FDI is determined jointly by three natural advantages i.e. geographic proximity to Hong Kong and Macao, its historical and ethnic connections with overseas Chinese, and a degree of experience in dealing with the outside world, and four government directed efforts i.e. entrepreneurial government, infrastructure development, development planning and industrial specialisation, and the transformation of economic structure. Ma (1996) compares FDI in China with in Mexico which is one of the large recipient developing countries over the period 1986 - 1994 and concludes that the entry and expansion of FDI in China are a response to such sustainable factors as the country's market size, the rapid growth rate of the domestic economy, the attractiveness of its comparatively cheap labour and land costs, its far-reaching new economic policies, and its high saving rates. Leung et al. (1996) adopt an *ex ante* managers' opinion survey and show that 'Guanxi' which can be loosely translated into 'special relationship' or 'connections', is indeed a very important determinant in investing successfully in China.

Though the above descriptive statistical studies help to shed light on some determinants of FDI in China and have important policy implications for FDI in other developing countries, a more systematic empirical study is needed. The merit of econometric analysis lies in its ability to identify statistically significant factors and provides quantitative indication. Using time-series data for the period 1978 and 1992, Wang and Swain (1995) provide an econometric analysis of factors influencing foreign capital inflows into both Hungary and China. However, their study suffers problems of inconsistencies in some numerical results and a lack of degrees of freedom as noted by Matyas and Korosi (1996). Wei (1995) uses a data set that covers over a hundred recipient countries and five major source countries to investigate whether China has achieved a fair share of total FDI in the world. Nevertheless, his study specifies four factors - GNP, per capita GNP, literacy level and geographical distances which are important in attracting outward FDI from the five largest source countries including Japan, UK, U.S., France and Germany in the period 1987 - 1990. Pan (1996) examines the determinants of FDI of a particular form - an equity joint venture (EJV) in China. Based on 4223 international EJVs in China from 1979 to the end of 1992, eleven variables that impact foreign ownership preferences and concessions are examined including industry advertising intensity, foreign capital input, country risk of China, total EJV investment amount, EJV contractual duration, cultural distance, industry competitive intensity, local partner state ownership, local partner alignment, foreign partner alignment and EJV location. In addition, the equity ownership strategies of various source countries including the U.S., Europe and Japan are compared in his paper.

The aim of this study is to provide some more robust evidence on the main hypotheses proposed in the literature to analyse the economic, political, cultural and geographic determinants of FDI in China from a macroeconomic perspective. Specially, the roles of relative home and host country characteristics as determinants of FDI in China are focused. Furthermore, panel data are used, which cover twenty-two countries over the period of 1983 - 1994 for pledged FDI and seventeen countries over the period of 1984 - 1994 for realised FDI. The rest of this chapter is organised as follows. Section 2.2 reviews the relevant literature and outlines hypotheses to be tested. Then the econometric model used as the basis for empirical analysis is discussed in section 2.3. Sections 2.4 and 2.5 describe data and methodology. An overview of the general features of FDI in China is also given in section 2.4. The main empirical results are reported in section 2.6. Finally, section 2.7 draws the conclusions. In addition, limitations and extensions of the model are discussed in this section.

2.2 Literature Review and Hypothesis Formation

FDI is conventionally defined as investment outside the investor's country in which the investor intends to establish or increase some kind of permanent participation in an enterprise so as to exert a certain degree of influence or control over the management of the enterprise [Mainardi, 1987]. Normally, the investor in such a case is not an individual, but a corporation called a multinational corporation (MNC), sometimes referred as the multinational enterprise (MNE), the transnational corporation (TNC), or the transnational enterprise (TNE). Since the 1950s, a large body of theories/paradigms has been developed to explain why MNCs undertake FDI in a particular host country. Lall (1978), Agarwal (1980), Dunning (1981, 1988, 1993), Cantwell (1991) and Liu (1993) have provided general literature surveys in the area. In particular, the market power theory, the currency area approach, internalisation or transaction cost theory and the eclectic paradigm are commonly emphasised in empirical analyses. These theoretical contributions all treat FDI as a response to market imperfections.

The market power theory, originally set up by Hymer (1960), draws much on the theories of industrial organisation and/or market structure. It asserts that MNCs undertaking FDI possess certain monopolistic advantages or ownership advantages in terms of firm-specific knowledge-based assets[1] over and above their host country's competitors. These advantages act as a source of market power for MNCs to penetrate a host country's market and to outweigh the existing natural disadvantages and costs of operating outside their countries of origin. The additional disadvantages and costs of FDI are more associated with language, culture, information asymmetry and other related problems. A number of studies then attempt to examine the precise nature of these monopolistic advantages, assessing the role of knowledge-based assets. One characteristic of these knowledge-based assets is that they often involve a 'public goods[2]' aspect with respect to the firm's various production facilities. For example, once an innovation is made, it can be incorporated into any number of additional plants without reducing the marginal product of that innovation in existing plants.

Fascinated by Hymer's approach, Aliber (1970) recognises that FDI is a response to imperfections in cross-border capital and foreign exchange markets. His theoretical framework is so-called currency area approach. Given other conditions being equal, firms in the strong currency country will be able to capitalise the same amount of expected earnings at a higher rate or to obtain loans for financing their operations at cheaper interest rates than host country's firms. This currency premium implies that a possible depreciation of the weak currency favours the inflow of FDI towards that country. However, this approach has failed to explain the facts such as FDI flows between countries belonging to the same currency area. Therefore, it is argued that the exchange rate is only one of the factors determining FDI.

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[1] Knowledge-based assets consist of factors such as firm-specific processes or product innovations as well as intangible assets and should be more marked in marketing, technology, management skills, reputation, access to market and scale-intensive activities (or economies of scale).

[2] The 'public goods' nature of knowledge-based assets implies that their marginal usage cost is zero or minimal. Hence, they may act as a joint input across plants in the MNC, giving economies of scale at the level of the firm.

Differentiating from the market power theory which focuses on the final product markets, internalisation theory, in the idea of market failure, is more related to intermediate goods markets. Building on the organisational theory of transaction cost economics, the internalisation theory argues that MNCs allow the absorption of transactions when the costs of an administered exchange including searching, contracting, negotiating and policing agreements are lower than those of a market exchange. An MNC can be viewed as a hierarchy that supersedes the market for cross-border intermediate products so as to capitalise more fully on their firm-specific ownership advantages. Accordingly, it gives rise to efficiency. One of the internalisation advantages is that MNCs avoid uncertainties involved in the transfer of skills or technologies used in the management and production processes that exist in the alternative market solution such as export or licence. The theoretical work of extending the application of the concept of internalisation has been undertaken by Buckley and Casson (1976), Rugman (1981), Hennart (1991a) and Kay (1991). Further, Hennart and Park (1994) argue that strategic interaction theory is complementary to internationalisation theory in explaining a firm's decision to invest abroad. The behaviour of a firm's competitors - follow-the-leader or exchange-of-threat [Graham, 1978] simultaneously determines FDI together with the firm's own internalising capabilities.

As the name suggests, the eclectic paradigm developed by Dunning (1977) combines various different theoretical approaches including the market power and internalisation theories within the structure of one framework in such a way that they are compatible with each other. It sets out to explain the level and pattern of FDI in terms of three advantages - OIL advantages: (1) ownership (O) advantage, i.e. MNCs' capacity to engage competitively in the foreign value-added activities *vis-à-vis* host country's competitors; (2) internalisation (I) advantage, i.e. MNCs' desire and opportunity to internalise the market for the ownership advantage; (3) locational (L) advantage, i.e. MNCs' wish to locate these foreign value-added activities and/or those relating to the creation of competitive advantage in a host country.

New approaches are emerging in the more recent literature. The evolutionary theory of Kogut and Zander (1993, 1995) contends that the firm does not arise out of market failure. Rather, it can be viewed as a social community whose productive knowledge defines a comparative advantage. Pitelis (1996) argues demand-side deficiencies can provide an inducement for outward investments by MNCs. Using outward U.S. FDI data, he also takes a direct econometric test of this demand-side perspective and provides clear support for it.

There has so far been no single approach that can sufficiently explain all types of FDI. The various theories described above and in the literature have just posed different questions, with varying degrees of power to explain FDI, and in doing so different levels of analysis have been appropriate [Cantwell, 1991]. Therefore, it is possible that each of these alone and in conjunction with the others explain FDI.

Many of the determinants identified by the above theories/paradigms have been tested in various empirical studies. The most commonly tested determinants include market size, costs of borrowing, wage rates, bilateral trade, tariffs, exchange rates, inflation rates, strikes, country risk, R&D expenditure, size of the firm, government policies [see Brewer, 1993] including intellectual property protection, geographic distance and cultural differences. Given the wide range of potential motives for FDI in China and for the purposes of this study, the literature review and hypothesis formation will focus on market size, costs of borrowing, wage rates, trade, exchange rates, political risk, geographic distance and cultural differences.

2.2.1 Market Size

The market size hypothesis argues that inward FDI is a function of the size of the host country's market, usually measured by either GDP or GNP. Two variables are often used either separately or together in empirical studies: the change in GDP/GNP in absolute terms and the growth rate of GDP/GNP.

Davidson (1980), Moore (1993) and Braunerhjelm and Svensson (1996) indicate that the variable of market size in the host country can be supposed to capture demand and scale effects. For intermediate or final goods to be produced in a host country there must exist significant demand for them in that country. In other words, sufficient potential demand warrants production. Alternatively, a larger market size is necessary to allow for the attainment of economies of scale. Since foreign investors are economically and strategically sensible, FDI occurs only when they anticipate that sales or output volumes can possibly exceed, at least, the various costs of operating in an unfamiliar environment. Given there is a cost advantage producing outside the home country of the investor, market size in a host country would be expected to positively influence the level of FDI. Bajo-Rubio and Sosvilla-Rivero (1994) and Loree and Guisinger (1995) argue that different types of FDI will be influenced to different degrees by the host market. Market-oriented FDI may be more concerned with the market size than export-oriented FDI. This hypothesis has received support in most empirical analyses [see, for example, Lee and Mansfield, 1996; Pain, 1997; Pain and Lansbury, 1997].

In terms of the market size in the home country, there are two completely opposite opinions. Ajami and BarNiv (1984) and Grosse and Trevino (1996) argue that it is positively related to the amount of FDI in the host country. In their studies, market size is used as a proxy for the number of home country's firms that could pursue international expansion. On the other hand, Pitelis (1996) regards domestic demand deficiencies as an important reason for the home country's firms to invest abroad. Since market size can be used as a proxy for aggregate demand, then the size of the home country's market may be negatively related to the amount of FDI in the host country.

One plausible way for MNCs to consider FDI is, as Pain (1993) and Barrell and Pain (1996) suggest, to take the total demand, i.e. the overall level of demand in both the home and the host countries into account. An alternative way is to compare the relative change in size of the home and host country's markets. A rise in demand in the host country will lead to a shift of resources away from production in the home country, or vice versa. Given that gaining access to the rapidly growing host country's market is one of many potential advantages in launching foreign as opposed to domestic investment, if the host country's market expands more rapidly than the home country's market, the host country's market becomes more attractive and home country's firms become more willing to enter the host country. Accordingly, if the ratio of the host country's market size (growth rate) to the home country's market size (growth rate) is higher, the higher is inward FDI in the host country. Because this study focuses on a comparison between home and host countries' characteristics, the latter proposition is adopted.

2.2.2 Costs of Borrowing

In the FDI theory put forward by Aliber (1970), MNCs are primarily seen as engaging in capital cost arbitrage in a world with imperfect capital markets. FDI is originally financed in the home country. Tighter financial conditions in a country are associated with a lower level of capital outflow. In contrast, the firm in a good financial position is more likely to be able to contribute sizeable capital into the formation of FDI. Therefore, if the cost of borrowing in the home country is lower than in the host country, the home country's firms can have a cost advantage over the host country's competitors, and are in a better position to enter the host country's market by means of FDI. Thus, the higher the ratio of the host country's borrowing cost to the home country's cost, the higher will be inward FDI in the host country.

Such a pattern is consistent with the findings of Pain (1993, 1997) on inward and outward FDI of the UK, respectively, Grosse and Trevino (1996) and Barrell and

Pain (1996) on inward and outward FDI of the U.S., respectively and Pain and Lansbury (1997) on the German FDI outflow. However, the empirical results of Belderbos and Sleuwaegen (1996) do not offer clear supporting evidence. Using a proxy for the availability of internally generated funds for investment abroad, they find that borrowing cost contributes to the explanation of investment decisions of Japanese electronics firms in western industrialised countries, but not in Asia.

2.2.3 Wage Rates

As one way of obtaining potential advantages home country's firms may launch FDI to make use of the abundant supply of skilled and unskilled low wage labour and, in turn, to reduce their labour costs. Labour cost is an important part of total production costs, especially in labour intensive manufacturing. Incorporating this viewpoint, Frobel et al. (1980) develop the theory of new international division of labour to explain why MNCs relocate certain types of manufacturing operations away from home bases, especially into developing countries. The standardisation of production processes allows operations to be fragmented with minimal skills according to the most desirable combinations of capital and labour. This gives MNCs opportunities to manage production units across countries to exploit international differences in factor prices [Kumar, 1994].

Braunerhjelm and Svensson (1996) argue that the average wage rates in the home country parts of the MNCs should be correlated with the human capital within the company and, therefore, can capture ownership advantages. In accordance with this argument, wage rates in the home country are likely to exert a positive impact on the propensity to invest in a host country. Culem (1988) claims that the labour cost differential between home and host countries is crucial in capturing the fact that domestic investment is the opportunity cost of FDI. Consequently, the lower the labour cost in the host country related to the home country of investors, the more attractive the host country is.

This is confirmed by, for example, Woodward and Rolfe (1993), Pain (1993) and Kumar (1994). Moore (1993) only finds weak evidence on the presence of a relatively low wage rate as an important factor in explaining German manufacturing FDI from 1980 to 1988. However, in the study of Meyer (1995), the evidence from both survey data and regression analysis shows that FDI in central and eastern Europe is mostly not motivated by low labour costs in that area. More surprisingly, the studies of Swedenborg (1979), Dunning (1980) and Veugelers (1991) yield a positive relationship between the host country's wage rates and FDI flows. They argue that wage rates may reflect manpower qualification, specialisation and skill intensity (or labour quality) or productivity, which acts as a locational advantage and would be positively related to FDI flows.

Therefore, after all wages are productivity-adjusted, the economic logic behind the negative relationship between wage rates and FDI should stand. For the given productivity levels, the lower the ratio of the host country's wage rates to the home country's wage rates, the higher will be the inward FDI in the host country. This is in line with the results obtained by Pain (1997) and Pain and Lansbury (1997).

2.2.4 Bilateral Trade

For an individual home country firm, exports and FDI can be viewed as the two alternative entry modes. Moore (1993) argues that, provided that the production cost disadvantages do not overwhelm the marketing savings, the firm might undertake FDI to set up production facilities in the host country to replace exports so as to obtain marketing cost savings. Savings obtained through FDI might include avoiding various tariff barriers and transportation costs. If other things remain the same, then the higher the tariff/non-tariff trade barriers and the international transportation costs, the more the firm will undertake FDI. FDI caused by the host country's tariff/non-tariff trade barriers is consistent with the 'tariff jumping' hypothesis. In addition, the ownership advantages of MNCs allow a gradual substitution of FDI for exports [Barrell and Pain, 1997a, b]. With the firm-specific, knowledge-based assets which serve as the ownership advantages *vis-à-vis* the host country's competitors, MNCs can exploit any economies of scale arising from the 'public goods' nature of such assets and have a cost advantage to dominate the higher fixed costs of locating production in a host country. In other words, MNCs which undertake horizontal direct investment, like multiplant domestic firms, may set up a number of different plants with little increase in the associated costs of production on creating knowledge. Therefore, if tariff/non-tariff trade barriers are low or absent, and if there are no other cost advantages in the host country, the home country firm may export its product. This export represents an equal amount of imports to the host country.

Otherwise, FDI will be chosen as the alternative entry mode. Thus, for an individual firm, trade and FDI can be substitutes.

However, they can also be expected to be complements from a microeconomic perspective. As Barrell and Pain (1997a, b) and Pain (1993) stress, FDI may be undertaken in order to help promote market access and export sales by offering improved customer support. In other words, there is sales-related FDI. Once the level of exports reaches some point, firms producing tradable goods may at that time invest abroad in consumer-orientated service facilities. In addition, exports may represent parent companies' supplies of intermediate goods such as machinery or product lines for their subsidiaries in the host country. Similarly, imports from the host to home country may represent supplies of inputs or final products by the subsidiaries for the home country's market. This argument applies in particular for export-orientation FDI [Kumar, 1994]. What is more, Kogut and Chang (1996) put forth a platform entry argument. Exports can serve as platforms for future expansion. Because firms with strong exports to the host country invest in distribution channels and establish brand labels, they have motivation to seek to preserve the value of these assets by shifting manufacturing investment into the host country when a higher valued currency makes exports more expensive to host country's purchasers. Banerji and Sambharya (1996) also argue that firms which have international business exposure and can overcome their initial inhibition against expanding into a foreign market through export, are more willing to move into newer markets. Thus, a steady rise in the volume of the bilateral trade will generate additional FDI for an individual firm.

Also, at an aggregate level, the impact of bilateral trade on FDI is not clear-cut. Studies of Horst (1972) and Jeon (1992) indicate a negative relationship between imports and inward FDI in the host country because growing imports imply lower tariff/non-tariff trade barriers and therefore lead to a temporary fall in FDI. Wakasugi (1994) shows that Japan's export of passenger cars toward the U.S. was replaced by FDI, and a major reason for this was a market distortion caused by a kind of trade barrier - voluntary export restraint (VER). The Japanese government imposed a quota on exports for each automobile manufacturer in order to voluntarily restrain the quantity of passenger car exports to the U.S. to below a certain level. Through the time-series evidence, Blomstrom and Lipsey (1989) illustrate that, on average, FDI will substitute for and may ultimately eliminate trade flows in the case of U.S. and Swedish MNCs.

On the other hand, Ray (1989), Ajami and BarNiv (1994), Maskus and Webster (1995), Grosse and Trevino (1996) and Milner and Pentecost (1996) all argue that bilateral trade and FDI may be viewed as complementary. First of all, more bilateral trade implies a higher level of integration between the home and host countries. This may enable the home country's firms as a whole to obtain more information on investment opportunities in the host market. Greater exports may encourage greater FDI into the host country. Secondly, given an incentive to internalise the ownership advantage, it could be argued that MNCs have a greater incentive to invest where internalisation provides greater access to specific sources of comparative advantage in the host country [Maskus and Webster, 1995 and Milner and Pentecost, 1996].

Since, to a certain extent, comparative advantage can be revealed by trade performance, FDI could be expected to be positively related to bilateral trade. If these lines of reasoning can be followed, then the higher the bilateral trade (exports and imports), the higher will be inward FDI in the host country.

2.2.5 Exchange Rates

In the currency area approach, chiefly reflected in the writings of Aliber (1970), the pattern of FDI can be explained in terms of the existence of different currency areas. A rise in the exchange rate in terms of the host country's currency over the home country's currency implies a depreciation of the host country's currency. A depreciation is associated with inflow of FDI and an appreciation with outflow of FDI in the currency area concerned. Furthermore, Mann (1993) develops a hybrid model of FDI based on an asset portfolio approach and a theory of industrial organisation of investment to support the above argument. An exchange rate change will alter real rates of return and the value of savings in terms of the host country's currency and will lead to capital gains or losses on existing asset holdings and shifts in portfolio shares.

The majority of investigations into the correlation between FDI and exchange rate have come out in favour of the above discussion. For example, the studies of Dewenter (1995), Grosse and Trevino (1996) and Kogut and Chang (1996) on inward FDI of the U.S. point out that the real exchange movements significantly affect investment decisions to enter the U.S. market. Using a cross-section, time-series approach to study the determinants of U.S. and Japanese FDI in the European Union (EU), Aristotelous and Fountas (1996) find strong evidence of a real exchange rate effect. Bayoumi and Lipworth (1997) also show the significant impact of the real exchange rate on Japanese FDI outflows over the period 1982 - 1995. However, Bajo-Rubio and Sosvilla-Rivero (1994) find negative and significant effects for total FDI inflows in Spain in the short run, but insignificant effects in the long run. The results in Campa (1995) show that exchange rate has no significant effect on the probability of investment by MNCs in the chemical processing industries, although it does have a negative effect on capacity expansions by domestic firms.

On the other hand, Lin (1996) argues that changes in the real exchange rate may have a relatively positive effect in terms of the host country's assets because the anticipation of the fluctuation of exchange rate is important in the investment decision. An expectation for overvaluation of the host country's currency increases the expected returns on the host country's assets converted to the home country's currency as well as the demand for the host country's currency. MNCs may foresee that any investment they make in the host country will increase in value as the local currency appreciates and accordingly they expand the investment. In other words, the appreciation of the currency of a country encourages the inflow of FDI and discourages the outflow of FDI in a host country. However, only a few studies are in line with this hypothesis. For example, Hultan and Mcgee (1988) find that, during the time period 1970 - 1986, FDI in the U.S. is encouraged when the US$ is overvalued.

In addition to the relationship between exchange rates and FDI, there are several channels through which FDI can be affected. Froot and Stein (1991) have discussed the relative wealth effect of exchange rates. A real depreciation of the host country's currency favours the home country's purchasers of the host country's assets and therefore it leads to an increase in inward FDI in the host country. Cushman (1985, 1987, 1988) and Culem (1988) emphasise the effect of exchange rate changes on relative labour costs. A real depreciation of the host country's currency allows the home country's investors to take advantage of the relatively cheaper host country's labour. In other words, for a given amount of the home country's currency, at that time, MNCs can hire more labour, and therefore a real depreciation is associated with an increase in inward FDI in the host country. The study of Klein and Rosengren (1994) supports the significance of the relative wealth effect and fails to support the relative labour cost effect in the U.S.. Overall, these two perspectives predict qualitatively the same result - the higher the ratio of the host country's currency/US$ exchange rate to the home country's currency/US$ exchange rate, the higher will be the inward FDI in the host country.

2.2.6 Country Risk

It may be obvious that internal political, economic, and social instability in the host country and the unfriendly attitude of the host country's government increases the uncertainty for potential investors, and thereby has a negative impact on FDI inflows. Firms tend to avoid any uncertainty including country risks. In relative terms, the higher the degree of home country risk in relation to the host country, the higher will be the inward FDI in the host country.

However, the empirical evidence can only be judged as mixed. Loree and Guisinger (1995) demonstrate a statistically significant relationship between the flow of FDI from the U.S. and the composite risk variable in 1982, but not in 1977. In the study of Tu and Schive (1995), political stability is no longer considered as a significant determinant of FDI in Taiwan in the regression analysis, although it is ranked at the top of the list by foreign affiliates managers. Therefore, Tu and Schive interpret that political stability might be only a precondition for FDI, but is far less important in determining the amount invested. Nigh (1985) finds that the effect of political events on U.S. manufacturing FDI depends on whether the host country is a developed country or a less developed country. FDI in developed countries appears to be influenced only by inter-nation conflict and cooperation, however, for the less developed countries, both inter-nation and intra-nation conflict and cooperation have an effect on FDI. Kobrin (1979) and Tallman (1988) have failed to confirm the significance of, and Grosse and Trevino (1996) have only found weak evidence for, the negative effect of country risk on inward FDI in the host country. Jun and Singh (1996) employ two proxies to capture different aspects of country risk. They are political risk indices developed by Business Environment Risk Intelligence, S. A. (BERI) and work days lost in production. The significance of the former is greater for developing countries with high average FDI flows including China. In contrast, the latter is more significant for developing countries with low average FDI flows.

2.2.7 Geographic Distance

In the recent literature of economic geography, proximity to market or geographic distance is considered to be an important determinant of the choice of location of the production activity since market accessibility is one of the principle motivations for MNCs to invest abroad. Solocha and Soskin (1990, 1994) and Davidson (1980) argue that geographic proximity reduces informational and managerial uncertainty, lowers monitoring costs and allows the MNC to become less exposed to risk. Solocha and Soskin (1994) also stress that the importance of geographic proximity is due to the fact that some raw materials and intermediate products are often supplied from home countries' sources. In terms of transportation costs, MNCs should prefer to invest in nearby countries. Therefore, the greater the geographic distance between the home and host country, the higher will be the cost of obtaining information and managing an affiliate in the host market, and the smaller will be inward FDI in the host country. Nevertheless, given the trend towards a more global business environment and the technological progress in communications and transport, this effect is expected to diminish over time.

2.2.8 Cultural Differences

As in the case of geographic distance, the greater the cultural differences between the home and host countries, the more difficult will be the acquisition of information and the management and monitoring of an affiliate in the host market, and therefore the smaller will be the inward FDI in the host country. Davidson (1980) and Loree and Guisinger (1995) offer a detailed explanation about how cultural similarity encourages FDI. For instance, MNCs need to hire and train more local personnel to serve the new market. With cultural similarity, the time and investment required to bring these people to full efficiency may be less. In turn, MNCs' ability to seek more profits and to save more costs can be possibly increased. Based on the internationalisation process approach which is rooted in the behavioural theory of the firm, Benito and Gripsrud (1992) also highlight the importance of cultural differences on the location decisions of FDI. They suppose that FDI undertaken by a MNC typically takes place in a country that is culturally close to the home market.

Previous findings by Grosse and Trevino (1996) have supported this relationship between cultural differences and FDI. The study of Lin (1996) indicates that relatively large cultural difference does disadvantage new Japanese FDI in 11 types of U.S. manufacturing industries for the time period 1976 - 1990. Loree and Guisinger (1995) confirm that cultural difference has a significant effect on new U.S. FDI in 1977 but not in 1982.

2.3 The Empirical Model of FDI Determinants for China

The discussion of hypotheses in section 2.2 points to the following economic relationship:

$$FDI_{it} = f(RW_{it}, RGDP_{it}, RER_{it}, REX_{it}, RIM_{it}, RBC_{it}, RCR_{it}, TCD_{it}, GEOD_{it}) \quad [2.1]$$

where i and t denote cross-sectional unit and time respectively,

FDI = the annual inflow of real foreign direct investment in China,

RW = the ratio of real Chinese wage rates to the real home country's wage rates,

RGDP = the ratio of real Chinese GDP to real home country's GDP,

RER = the ratio of the real RMB/US$ exchange rate to real home country's currency/US$ exchange rate,

REX = real Chinese exports to the home country,

RIM = real Chinese imports from the home country,

RBC = the ratio of China's real lending interest rates to the home country's real lending interest rates

RCR = the ratio of country risk ratings for China to country risk ratings for the home country,

TCD = total cultural difference between China and the home country,

GEOD = geographic distance between China and the home country.

Instead of assuming a simple linear relationship between the dependent and independent variables, the model is of the form:

$$FDI_{it} = RW_{it}^{\beta_1} RGDP_{it}^{\beta_2} RER_{it}^{\beta_3} REX_{it}^{\beta_4} RIM_{it}^{\beta_5} RBC_{it}^{\beta_6} RCR_{it}^{\beta_7} TCD_{it}^{\beta_8} GEOD_{it}^{\beta_9} e_{it} \qquad [2.2]$$

where e denotes a composite term including both intercept and the error term. As the impacts of all independent variables in the model on FDI are expected to occur either simultaneously with FDI or with a lag of less than a year, no lag is considered. In other words, it is supposed that there is no decision lags in the investment process. All factors could be seen as (weakly) exogenous, allowing for standard panel estimation techniques to be applied.

The log-linear form of Equation (2.2) can be expressed as:

$$\begin{aligned} \ln FDI_{it} = {} & \beta_1 \ln RW_{it} + \beta_2 \ln RGDP_{it} + \beta_3 \ln RER_{it} + \beta_4 \ln REX_{it} + \beta_5 \ln RIM_{it} \\ & + \beta_6 \ln RBC_{it} + \beta_7 \ln RCR_{it} + \beta_8 \ln TCD_{it} + \beta_9 \ln GEOD_{it} + v_{it} \end{aligned} \qquad [2.3]$$

where $v_{it} = \ln e_{it}$.

There are several advantages of adopting a log-linear functional form. First, in the case of FDI in China, there are extreme values arising from surges of inflows in some years and from Hong Kong as the dominant investor. The use of logarithms may counteract this problem statistically. Second, it can transform a likely non-linear relationship between inward FDI in China and the explanatory variables into a linear one. Finally, the β_is in the log-linear model (2.3) directly measure FDI elasticities with respect to the explanatory variables. Alternatively, these coefficients may be interpreted as the partial derivatives of the growth rate of FDI with respect to the growth rate of the explanatory variables.

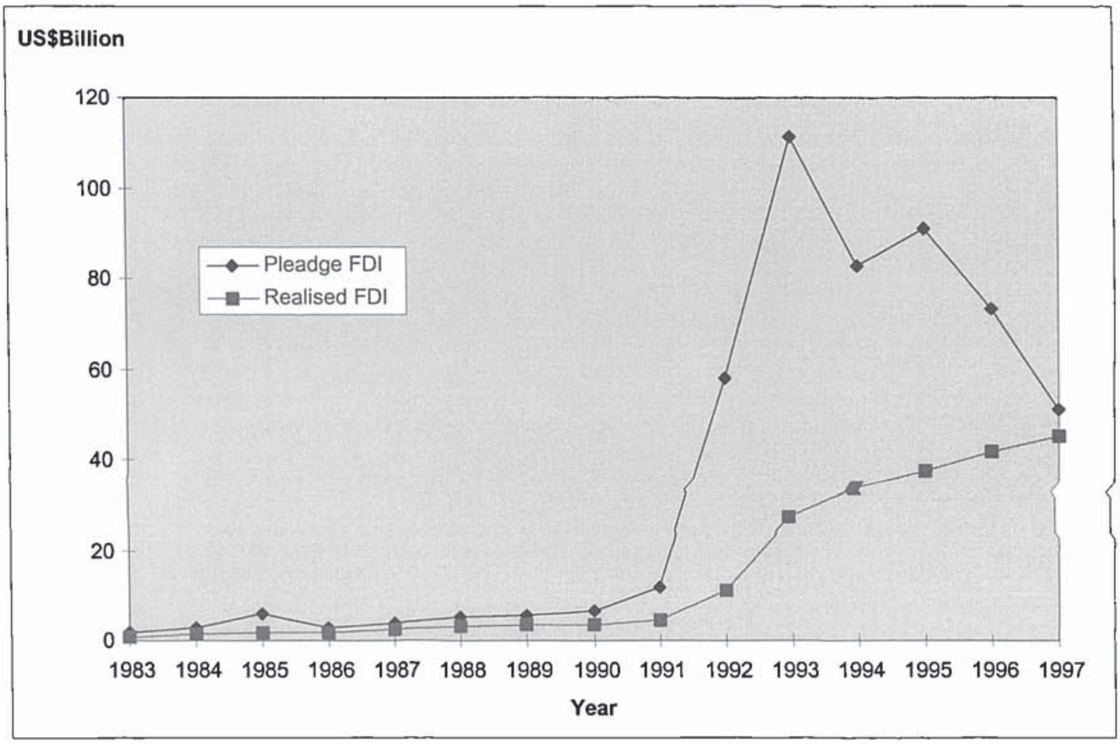
Two types of data on FDI are typically reported in Chinese statistics: pledged (or contracted) and realised (or actual) values. Pledged FDI inflows represent foreign firms' planned or intended direct investment in China at the time that the investment is approved by the Chinese government [Wei, 1995]. In this study two specifications of Equation (2.3) are estimated. In Specification (I), pledged FDI is employed as the dependent variable. In Specification (II), realised FDI is used as the independent variable.

There is a marked difference between the amounts of pledged and realised FDI inflows for any particular year [see Figure 2.1]. This is partially because in many cases, FDI is to be realised over a period of several years and/or part of pledged FDI never materialises due to the cancellation of some planned projects. There are also some bogus pledged investments intended to take advantage of a privileged fiscal regime for foreign investment [Wu and Strange, 1997, pp. 208]. Therefore, the political, economic and social conditions in both home and host countries which make a firm commit itself to planned FDI can differ from those when FDI is actually realised. This creates a time lag between the signing of a contract and the subsequent realisations of pledged amounts. The question of whether to use pledged or realised

FDI as the dependent variable in the model specification is determined empirically in section 2.6.

Figure 2.1 Inflows of Foreign Direct Investment in China

1983-1997



2.4 Data

Though China began to receive FDI from 1979, official data on inward FDI by country of origin are available only from 1983 onwards. The regression analyses in this study are based on the data generated from 22 countries/regions over a period of 12 years. A list of these home countries/regions of FDI is presented in Table 2.1. Pledged direct investments by these 22 countries/regions accounted for over 88% of total inward FDI in China in the period of 1983 - 1994. Realised direct investments by 17 countries/regions during the period of 1984 - 1994 accounted for about 85%. A few missing values for some observations (mainly from developing countries) are extrapolated. To remove the influence of inflation, all variables except cultural differences, country risk and geographic distance are adjusted by the relevant price indexes.

Table 2.1 List of Home Countries/Regions in the Samples

22 home countries/regions are included in the sample for Specification (I): United States, Canada, Australia, Japan, New Zealand, Austria, Belgium, Denmark, France, Germany, Italy, Netherlands, Norway, Spain, Sweden, Switzerland, United Kingdom, Indonesia, Hong Kong, Malaysia, Singapore, Thailand. 17 home countries/regions are included in the sample for Specification (II): United States, Canada, Australia, Japan, New Zealand, Belgium, Denmark, France, Germany, Italy, Netherlands, Spain, Sweden, Indonesia, Hong Kong, Singapore, Thailand.

It has been argued that the official data on the nationality breakdown of FDI in China can be somewhat biased. First, there is pseudo-FDI by indigenous Chinese firms which team up with Chinese residents abroad to invest in China, thereby receiving the privileges and protection accorded to foreign investors [see for example, Mee-kau 1993; Liu 1993; UNCTD, 1995, 1996]. This process is sometimes termed "round-tripping" investment. This flow, as the World Bank has guessed, might have been as much as 25% of foreign investment in 1992 [Lardy, 1995].

Second, it is partly because of the multinationality of overseas Chinese investors. Hong Kong (including Macao) has played an overwhelmingly dominant role in investment in China. FDI from Hong Kong not only reflects investing interests from Hong Kong itself but also combines some investment flow from Taiwan, Southeast Asian countries and some other countries. This is because some firms penetrate the Chinese market by means of their offices/subsidiaries registered in Hong Kong/Macao [see, for example Chen et al. 1995]. This is partially because investing in China is politically sensitive in some countries or areas, such as Indonesia. In order to avoid scrutiny from their home countries some wealthy overseas Chinese and Taiwan executives invest through Hong Kong/Macao.

Third, before 1986, Hong Kong could not be separated from Macao in published FDI figures. However, as is known, Macao only accounts for only a minute share whereas most of the flow of FDI is from Hong Kong [see Table 2.2]. The share of

FDI from Macao over the period 1987 - 1994, takes 3% or so of total FDI from Hong Kong and Macao together on both pledged and realised sides. Therefore, it would be reasonable to use FDI figures between 1983 and 1986 for Hong Kong and Macao to represent Hong Kong only.

Table 2.2 Foreign Direct Investment from Hong Kong and Macao

1987-1994

(millions of U.S. dollars at year-end)

Year	Hong Kong		Macao	
	Pledged FDI	Realised FDI	Pledged FDI	Realised FDI
1987	194.7	158.8	2.7	1.0
1988	346.7	206.8	11.7	2.8
1989	316.0	203.7	8.4	4.1
1990	383.3	188.0	11.0	3.3
1991	721.5	240.5	29.2	8.2
1992	4004.3	750.7	148.7	20.2
1993	7393.9	1727.5	281.5	58.7
1994	4697.1	1966.5	172.1	50.9
Total	18057.5	5442.5	665.3	149.2

Sources: Almanac of China's Foreign Economic Relations and Trade, 1988-1995

Fourth, it should also be pointed out that the tremendous recent influx of capital from Taiwan and South Korea into China has not been taken into account due to data limitations. Investment figures from Taiwan and South Korea are published only after 1990 and 1992, respectively. Taiwanese investment in China was officially prohibited by the Taiwan government before 1987. Since 1988, Taiwan's investment has grown dramatically. By the end of 1994, Taiwan made direct investment of US$ 8.3 billion in China. South Korea has become an important investor in China since diplomatic relations between the two countries were officially normalised in 1991. By 1994, realised FDI by South Korea amounted to US$ 1.2 billion in China. Consequently, a degree of caution must be used when interpreting the empirical results. Detailed information on the measurement of variables and sources of the data is given in Table 2.3.

Before proceeding further, it would be of interest to briefly describe the general trends of FDI in China by country of origin since this analysis of the changing pattern of flows of FDI can provide a direct perception. Tables 2.4 and 2.5 present the flows of pledged and realised FDI by nine leading countries/areas, respectively.

Hong Kong together with Macao was the biggest source of FDI and accounted for around 63% of both pledged FDI, during the period of 1983 - 1994, and realised FDI, during the period of 1984 - 1994. Then the U.S., Japan, Singapore and UK were the second, third, fourth and fifth largest sources. Their combined amounts represented 16% and 19% of China's cumulative pledged and realised FDI, respectively. In addition to these five countries, Thailand, Germany, Australia and Canada were also important source countries of FDI.

Table 2.3 Variable Definitions and Data Sources

Variable	Measurement and sources of data
FDI	The real annual inflow of FDI in China, derived from nominal FDI inflows deflated by the GDP index. Source: *Almanac of Foreign Economic Relations and Trade of 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 and 1994 only in China.
RW	The relative real wage rate, defined as the ratio of the change in real Chinese wage rates to real home country wage rates. Source: *Yearbook of Labour Statistics.* All wages are productivity-adjusted, and are expressed in a common currency . The data on productivity of Singapore and Thailand are obtained from *World Tables*, and those of China from the *China Statistical Yearbook.* The source of productivity for all other countries is the *International Financial Statistical Yearbook.*
RGDP	The relative real GDP, defined as the ratio of real Chinese GDP to real home country GDP. Source: *International Financial Statistical Yearbook* and *World Tables.*
RER	The relative real exchange rate, defined as the ratio of the real Ren-Min-Bi (RMB)/US$ exchange rate to the real home country's currency/US$ exchange rate. Source: *International Financial Statistical Yearbook.* The data on Hong Kong are obtained from *Hong Kong (Annual Review).*
REX and RIM	China's real exports to, and real imports from, the home country. Source: *China Statistical Yearbook.*

Table 2.3 (Continued)

Variable	Measurement and sources of data
RBC	Relative real borrowing costs defined as the ratio of China's real lending interest rate to the home country's real lending interest rate. Sources: *International Financial Statistical Yearbook*. Hong Kong data is from the *Monthly Statistical Bulletin*.
RCR	Relative country risk defined as the ratio of annual country risk ratings for China to annual country risk ratings for the home country. The ratings are scaled from 0 (very high risk) to 100 (very low risk). The higher the rating, the lower the chance of banking default. Source: *Institutional Investor*.
TCD	Total cultural differences. This is the total cultural difference between China and the home country. Hofstede (1980) developed indices to measure four dimensions of cultural difference related to management. These include power distance, uncertainty avoidance, individuality and masculinity/femininity. As constructed by Grosse and Goldberg (1991) and Grosse and Trevino (1996), the total cultural difference is the sum of the absolute values of the four-dimensional differences. This measure is similar to the one developed by Kogut and Singh (1988) who divide the squares of the four-dimensional differences by their variances and sum these values. Since China was not in Hofstede's sample, the ratings for Taiwan are used as a surrogate measure for China as in Pan (1996).
GEOD	The geographic distance between China and the home country/region. It is measured by the geographic distance between the home country's capital and China's capital Beijing. Source: *Atlas of the World*.

Table 2.4 Pledged Foreign Direct Investment in China, 1983-1994

Nine Largest Countries

(millions of U.S. dollars at year-end)

Nine Largest Countries	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
Total	1732	2651	5932	2834	3709	5297	5600	6596	11977	58124	111436	82680
HK/ Macao	642	2175	4134	1449	1947	3467	3160	3833	7215	40044	73939	46971
U.S.	477	165	1152	527	342	370	641	358	548	3121	6813	6010
Japan	94.5	203	471	210	301	276	439	457	812	2173	2960	4440
Singapore	16.3	62.6	75.5	137	69.8	137	111	104	155	997	2954	3778
U. K.	304	12.6	44.3	42.8	24.7	41.6	31.8	119	132	287	1988	2748
Thailand	22.4	233	14.6	13.2	4.53	37.7	56.8	41.7	108	723	1074	781
Germany	0.6	105	20.3	12.6	133	47.1	149	45.6	558	13	249	1233
Australia	79.6	4.2	14.1	31.5	45.3	17.4	83.6	17.4	44	276	638	849
Canada	64.9	0.02	8.7	88.1	25.5	39.5	42.3	15	30.9	316	1184	89

Sources: Almanac of China's Foreign Economic Relations and Trade, 1984-1995

Table 2.5 Realised Foreign Direct Investment in China, 1984-1994

Nine Largest Countries

(millions of U.S. dollars at year-end)

Nine Largest Countries	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
Total	1258	1661	1874	2314	3194	3392	3487	4366	11007	27515	33767
HK/ Macao	748	956	1132	1588	2095	2077	1913	2487	7709	17861	20175
U.S.	256	357	315	263	236	284	456	323	511	2063	2491
Japan	225	315	201	220	515	356	503	533	710	1324	2075
Singapore	1.2	10.1	13	21.6	27.8	84.1	50.4	58.2	122	490	1180
UK	98	71.4	26.8	4.6	34.2	28.5	13.3	35.4	38.3	221	689
Germany	7.6	24.1	19.3	3.2	14.9	81.4	64.3	161	88.6	56.3	259
Thailand	4.5	8.8	9.1	11.2	6.1	12.7	6.7	19.6	196	83	233
Australia	0.4	14.4	60.2	5	4.2	44.4	24.9	14.9	35	110	188
Canada	--	9.4	--	10.2	6	17	8	10.8	58.2	137	216

Sources: Almanac of China's Foreign Economic Relations and Trade, 1985-1995

2.5 Methodology

So far, issues associated with hypotheses, the econometric model and data have been discussed. In this section, methodology will be discussed. Because in China where officially published data for annual changes in FDI by country of origin are available for only 12 years or so, a time-series analysis of the data is obviously inappropriate. Simple cross-sectional estimation may not be sufficiently efficient either, if a relatively large number of explanatory variables are involved. Further, Nigh (1985) acknowledges that the cross-sectional studies seem to give little thought to a longitudinal and time sensitive phenomenon. Since international production is a dynamic process [Dunning, 1993], the use of panel data may be the most appropriate way for a systematic and efficient analysis of the determinants of FDI in China. This is also because a panel data set possesses several major advantages over conventional cross-sectional or time-series data [Hsiao 1986, Baltagi 1995]. It gives more informative data, more variability, less collinearity among the variables, more degrees of freedom and more efficiency. Consequently, the reliability of the estimates of the regression parameters can be greatly increased.

However, using panel data gives rise to possibilities that the regression parameters are heterogeneous across different countries/regions. A simple ordinary least squares regression of a straightforward pooling of all observations without considering heterogeneity could lead to an unacceptable degree of aggregation bias or even meaningless results. Generally, there are three statistical models related to panel data set: the ordinary least squares (OLS) model, the fixed effects (FE) or least squares dummy variables (LSDV) model, and the random effects (RE) or error components (EC) model. As is well known, the three statistical models differ mainly in the assumption of the intercept and error term. In Equation (2.3), v_{it} can be decomposed into two independent terms:

$$v_{it} = u_i + \varepsilon_{it} \qquad [2.4]$$

where u_i is time-invariant, and accounts for any unobservable individual specific effect not included in the regression. These country-specific factors might include such variables as investment grants and tax advantages. The ε_{it} term denotes the remaining disturbance, and varies with individuals and time. It can be thought of as the usual disturbance in the regression and is assumed to be normally distributed with a mean of zero and finite variance.

In the OLS model, the u_is are treated as one of the regressors, and constrained into one constant u. In other words, the u_is take the same value for all countries/regions. A problem with this assumption is that the unobservable individual effect may not be always the same.

Unobservable heterogeneity is accommodated by both the FE and the EC models. In the FE model the u_is are treated as fixed parameters to be estimated, while in the EC model, u_is are assumed to be random, independent and identically distributed, i.e. $u_i \sim IID(0, \sigma_u^2)$. From this point of view, the FE model is less efficient than the EC model because of the lost degrees of freedom. In addition, the FE model cannot directly identify the reason why the regression line shifts over individuals. In other words, this model cannot estimate the effect of any time-invariant variable. Unlike the FE model, the EC model relegates unobservable effects into the error term and assumes that they are uncorrelated with regressors. However, violation of this assumption may lead the EC model to produce biased and inconsistent estimates [Judge et al., 1985]. Therefore, standard restriction tests should be carried out so that an appropriate statistical model can be chosen.

Due to introducing two time-invariant variables - total cultural differences and geographic distance as explanatory variables, the application of the fixed effects model will lead to a problem of perfect multicolinearity. Therefore, only the EC and the OLS models are estimated and compared with each other. The procedure for restriction tests and model selection is discussed in, for example, Judge et al. (1985), Hsiao (1986), Baltagi (1995) and Greene (1997). The basic idea behind the statistical test is as follows: if individual effects do not exist, OLS estimators are best linear unbiased, and GLS estimators are inefficient and vice versa. To choose between the OLS and EC, Breusch and Pagan (1980) have derived a Lagrange Multiplier (LM) test for the null hypothesis $\sigma_u^2 = 0$. They show that

$$LM = \frac{NT}{2(T-1)}[1 - \frac{\varepsilon'(I_N \otimes J_T)\varepsilon}{\varepsilon'\varepsilon}]^2 \qquad [2.5]$$

is asymptotically distributed as $\chi^2(1)$, where ε 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 ⊗ denotes Kronecker product. A large value of the LM statistic argues in favour of the EC model against the OLS model.

Furthermore, model selection is based on both the economic interpretation of the estimates and the properties of the data generated. Hsiao (1986) notes that the fixed-effects model is normally used to make inferences conditional on the effects that are in the sample, while the random-effects model is applied to make unconditional or marginal inferences with respect to the population of all effects. The current study aims to investigate the country characteristics of FDI in China, but due to data constraints only a sample of the countries/regions is selected. For instance, Taiwan is an important direct investor in Mainland China, but official FDI data for Taiwan are available only for 1990 onwards. South American countries are also excluded because of the lack of data. The omission of these regions/countries may have introduced instability to the system. These effects are likely to be random.

Based on data availability and the above discussion of methodology, Specification (I) is estimated using a pooled cross-section and time series data set of 22 home countries/regions for the period of 1983 - 1994, and Specification (II) of 17 home countries /regions for the period of 1984 - 1994. For both specifications, the general to specific approach is adopted to determine the final specific models.

The general to specific approach is a commonly used methodology in econometrics. Essentially, it comprises two steps. First, the initial general model should be formulated to include as many theoretically relevant variables as possible. Then, the testing-down procedure determines the final model in which only those significant variables in the first step remain as explanatory variables.

2.6 Empirical Results

The task for the present empirical study is to assess the relative importance of various determinants of FDI in China. The econometric results with the country/region specific effects omitted in EC models (ECM) are summarised in Tables 2.6 and 2.7 for pledged and realised FDI respectively. Country-specific intercepts are omitted and subscripts on explanatory variables are dropped for ease of exposition. Based on the theoretical model discussed in section 2.3, Specifications (I) and (II) of Equation (2.3) are estimated using the ordinary lest squares method for OLS models (OLSMs) and the generalised least squares (GLS) method for EC models. In Specification (I), the dependent variable is pledged FDI, whereas in Specification (II), realised FDI is employed as dependent variable. Specification (a) is of the same form as Equation (2.3). In Specification (b), those explanatory variables which are not significant in Specification (a) are excluded according to the general to specific methodology. The LM test outlined in section 2.5 is carried out to select an appropriate statistical model. It is also worth noting that there is no surprise that different significance levels and parameter magnitudes are obtained from two different statistical models, since they are normally sensitive to the assumption of unobservable heterogeneity. In addition, the Ramsey RESET which is a regression specification error test for functional form mis-specification is carried out to avoid biased or misleading results.

Table 2.6 Estimates of Elasticities for Pledged FDI

Variable	Specification (Ia)		Specification (Ib)	
	ECM	OLSM	ECM	OLSM
Constant	-1.6533	-3.3234	-1.5409	-2.3087
(Common Mean)	(-0.5396)	(-1.5558)	(-0.7023)	(-1.4525)
Relative real wage rates	-0.9918***	-0.8576***	-0.9208***	-0.8319***
(LRW)	(-4.7389)	(-4.9019)	(-5.3933)	(-5.9465)
Relative real GDP	0.29995*	0.3452**	0.3324***	0.3341***
(LRGDP)	(1.8016)	(2.8636)	(2.4575)	(3.3393)
Relative real exchange	1.7809***	1.6254**	1.7936***	1.7973***
rates (LRER)	(3.0906)	(2.8724)	(6.6230)	(6.7491)
Real exports	0.7367***	0.8542***	0.7274***	0.8236***
(LREX)	(4.0919)	(5.7254)	(4.5477)	(6.1963)
Real imports	0.6442***	0.5997**	0.6596***	0.5982***
(LRIM)	(2.8730)	(3.1387)	(3.0947)	(3.2825)
Real borrowing costs	-0.1023	-0.2582		
(LRBC)	(-0.1267)	(-0.3334)		
Relative country risk	0.6233	0.2650		
rating (LRCR)	(0.5827)	(0.2896)		
Total cultural difference	-1.4876***	-1.3268***	-1.4651***	-1.2757***
(LTCD)	(-3.0594)	(-3.9038)	(-3.3493)	(-3.9806)
Geographic distance	0.0356	0.1915		
(LGEOD)	(0.0901)	(0.7058)		
R-squared	0.67345	0.6474	0.67073	0.6466
Adjusted R-square	0.66188	0.6350	0.66304	0.6383
LM test:	2.06		2.55	
ECM vs. OLSM	(1 df, prob = 0.15)		(1 df, prob = 0.11)	

Note: (1) Number of observations = 264.

(2) The t-statistics are in parentheses.

(3) ***, ** and * indicate that the coefficient is significantly different from zero at the 1%, 5% and 10% levels respectively.

(4) High values of LM test favour ECM over OLSM.

The results from Specification (I) are generally consistent with expectations. These equations are able to explain over 64% of the variation in pledged FDI in China. The small values of the LM statistics with 2.06 and 2.55 in (Ia) and (Ib) favour the OLS models against the EC models. However, the probability values of 15% and 11% suggest that there are no big differences between these two models. Finally, the F value for the Ramsey RESET statistic was 0.6709, which is not statistically significant. This means that the null hypothesis that the model is correctly specified can not be rejected.

In Specification (Ia), the correctly signed and statistically significant coefficients on relative wage rates (LWR), relative GDP (LRGDP), relative real exchange rates (LREX), and exports (LREX) and imports (LRIM) indicate a strong economic relationship between these explanatory variables and pledged inward FDI in China. This suggests that China's relatively cheaper labour force, its more rapidly expanding market, high degree of international integration with the outside world (represented by its exports and imports) and bilateral exchange rates are the four important economic determinants.

The borrowing costs variable (LRBC) has a negative sign. As defined, the LRBC is the natural logarithm of real Chinese interest rates minus the natural logarithm of real home-country interest rates. An alternative way of measuring LRBC is to take the natural logarithm of the ratio of Chinese with the addition of unity to home-country interest rates with the addition of unity. Since very similar outcomes are obtained, the results from the first definition are reported in this study. The test result implies that the lower the borrowing costs in China, the greater will be inward FDI in China. This may suggest that foreign businesses attempt to use not only their own, but also Chinese capital to finance their production in China. Therefore, the borrowing cost advantage on the part of the home country's firm as one economic determinant of FDI is not supported by Chinese evidence. In fact, this is not a surprising result. First of all, this result is much in line with the descriptive statistical study of Ma (1996) in which it is also argued that changes in foreign interest rates play a much less important role in determining FDI in China. In addition, Krugman and Obstfeld (1994) and Markusen et al. (1995) all state, although MNCs are often expected as a vehicle for international capital inflow into the host countries, another relevant observation is that MNCs sometimes raise money for the expansion of their subsidiaries in the country where the subsidiary operates rather than in their home country. Dunning (1988) also argues that FDI involves the transfer of other resources than capital only. Since the coefficient on the borrowing cost variable is not statistically significant, it can be simply said that this variable does not contribute significantly to the explanation of inward FDI in China.

The country risk variable has the expected sign but its coefficient is not statistically significant. This may suggest, first, while the Institutional Investor's ratings are a good indicator for credit risk assessment in the banking sector, they may not be the ideal proxy for country risk evaluation in relation to FDI. In other words, factors which affect the chance of banking default may not be entirely the same as those which affect the willingness to undertake FDI. Second, although foreign investors realise that there might be some uncertainty, they cannot afford not to invest in

China - a rapidly growing country with the billion people domestic market and almost an unlimited supplies of natural resources and unskilled labour [Pomfret, 1990]. Under this kind of situation, foreign investors' behaviour may become less conservative with respect to country stability. Third, MNCs based in different countries can vary significantly in the importance they attach to different aspects of the political environment.

The coefficient on the cultural differences variable has the expected sign and is statistically significant at the 1% level. This indicates the importance of cultural influences on inward FDI in China. It is worth noting that, among the top five biggest sources of FDI, Hong Kong, Japan and Singapore occupy the first, the third and the fourth positions during the sample period, respectively. Compared with the U.S. and UK, which are the second and the fifth largest sources of FDI respectively, these Asian countries/regions have more cultural relations with mainland China.

The coefficient on the geographic distance variable is statistically insignificant. However, it seems to be positively related to inward FDI in China. The tentative interpretation for the apparently wrong sign is as follows. First, the insignificance of the variable may be caused by a problem of multicollinearity since the pair-wise correlation between the cultural differences and geographic distance variables is 0.4247. Second, another plausible explanation is that the progress in communications and transport technologies allows better co-ordination of cross-border activities so that geographic distance has become less and less important in international business. Thus, the growth of FDI in China can not be attributed to geographic distance. On the other hand, with the exception of Japan, technical knowledge in home countries seems to be inversely proportional to their geographic distances from China. Thus, the geographic distance variable might be acting as a proxy for the level of technology in the home country. The higher the level of technology in the home country, the more able the home country's firm will be to overcome the cost caused by geographic distance. This interpretation should be viewed with caution, however, since it is not consistent with the fact that Hong Kong, as the biggest investor in China, has the smallest geographic distance from mainland China. This may partially explain why the geographic distance coefficient is not statistically significant.

In Specification (Ib), the borrowing cost, country risk and geographic distance variables are excluded because none of them is statistically significant. Formal exclusion tests for deleted variables provide F values of 0.1153 and 0.2057 for ECM and OLSM respectively in the Specification (Ib). Since they are not statistically significant at the 10% level, the hypothesis is confirmed that the borrowing cost, country risk and geographic distance variables have little explanatory power on pledged FDI in China. After removing these three variables, all the remaining explanatory variables are highly statistically significant (at the 1% significance level).

The results from estimation of Specification (II) are reported in Table 2.7. As far as realised FDI is concerned, the results are not as strong as those of pledged FDI. Compared with Specification (I), Specification (II) provides fewer correctly signed and statistically significant coefficients. The LM tests suggest that EC models are the best statistical models for this specification.

While relative wage rates, exports and imports, and relative exchange rates remain important economic determinants of realised inward FDI in China, the relative market size variable (relative real GDP) has the opposite sign to that expected and is statistically insignificant. This may indicate that while the rapidly expanding Chinese market attracts pledged inward FDI, actual inflows of pledged FDI are not correlated with these relative changes in the market size. In other words, pledged FDI is strongly market driven as suggested earlier. It may include spurious pledges to improve market access.

As in the case of Specification (I), the coefficient on the borrowing costs variable has a negative sign and is statistically insignificant in Specification (II), and the coefficient on the country risk variable has the expected positive sign but is not statistically significant. The cultural difference variable has the expected sign as in Specification (I), but its coefficient is marginally insignificant (with a probability of 14.85%). Finally, unlike Specification (I), the geographic distance variable now has the expected negative sign, though its coefficient is still statistically insignificant. The values of the formal exclusion F test in this specification are only 0.9877 and 0.9140 for ECM and OLSM respectively, which are not significant at the 10% level. This suggests that the market size, borrowing cost, country risk, cultural differences and geographic distance variables have little explanatory power on realised FDI in China.

The empirical results from Specifications (I) and (II) of Equation (2.3) indicate that, while relative wage rates, relative exchange rates, and exports and imports are the common determinants of both pledged and realised FDI inflows in China, relative GDP and total cultural differences are the specific determinants of pledged FDI. It is no surprise that pledged and actual FDI each has its own set of the determinants, since the political, economic and cultural conditions under which FDI is planned are likely to be different from those under which FDI is realised. In addition, the diagnostic statistical tests suggest that in the case of pledged FDI, there is no clear effect of country of origin since the null hypothesis of no heterogeneity among countries/regions can not be rejected, while in the case of realised FDI, there exists heterogeneity among home countries. This may be partially because different data sets for the two specifications are used.

Table 2.7 Estimates of Elasticities for Realised FDI

Variable	Specification (IIa)		Specification (IIb)	
	ECM	OLSM	ECM	OLSM
Constant (Common Mean)	1.9248 (0.4098)	-5.0410** (-2.1812)	-6.8085*** (-6.6792)	-6.8588*** (-11.3476)
Relative real wage rates (LRW)	-0.8116*** (-2.6873)	-0.4195** (-2.1172)	-0.4798*** (-2.5628)	-0.2773** (-2.3093)
Relative real GDP (LRGDP)	-0.1355 (-0.5840)	0.0984 (0.8141)		
Relative real exchange rates (LRER)	1.0788* (1.8710)	1.0359* (1.7201)	1.5192*** (4.5714)	1.6263*** (5.1270)
Real exports (LREX)	0.4961** (2.0552)	0.8578*** (4.7833)	0.7591*** (3.8997)	0.9672*** (6.7630)
Real imports (LRIM)	0.4992** (1.9334)	0.5050*** (2.4480)	0.5129** (2.3135)	0.4063** (2.3842)
Real borrowing costs (LRBC)	-0.4324 (-0.5246)	-0.5115 (-0.6532)		
Relative country risk rating (LRCR)	0.3438 (0.2961)	-0.5507 (-0.5908)		
Total cultural difference (LTCD)	-1.1538 (-1.4511)	-0.6020 (-1.6020)		
Geographic distance (LGEOD)	-0.4812 (-0.8148)	0.0723 (0.2658)		
R-squared Adjusted R-square	0.76519 0.75325	0.7016 0.6865	0.74906 0.74354	0.6939 0.6872
LM test: ECM vs. OLSM	17.79*** (1 df, prob = 0.00)		19.15*** (1 df, prob = 0.00)	

Note: (1) Number of observations = 187.

(2) The t-statistics are in parentheses.

(3) ***, **, and * indicate that the coefficient is significantly different from zero at the 1%, 5% and 10% levels respectively.

(4) High values of LM test favour ECM over OLSM.

2.7 Conclusions

An extensive empirical literature has arisen to evaluate the relative importance of each of the determinants of FDI in various countries. However, little systematic econometric work has been conducted on what factors enter into FDI decisions in China. This provides the decisive stimulus for the current study. The empirical analysis is based on pooled cross-section and time series data for 22 home countries/regions during the period of 1983 - 1994 in the case of pledged FDI, and for 17 home countries/regions during the period of 1984 - 1994 in the case of realised FDI. Investments from these countries/regions accounted for over 88% (85%) of the total inward pledged (realised) FDI in China during the sample time period. Therefore, the conclusions generated could be viewed as relatively general.

In this study, where appropriate, the explanatory variables are measured in relative terms on the grounds that rational investors compare the home and host economic, political, cultural and geographic conditions before they undertake any FDI. The OLS and the EC models of the determinants of pledged and realised inward FDI in China are estimated and the general to specific approach is applied. The standard diagnostic tests show that, in the case of pledged FDI, the OLS model should be selected, whereas in the case of realised FDI, the EC model is favoured. The results from the estimation of the model support the hypotheses that inward FDI is determined by relative real wage rates, relative exchange rates, and economic integration represented by real exports and imports. In the case of pledged FDI in

China, relative market size and total cultural differences are also two significant determinants. The present analysis fails to support the hypotheses that relative borrowing costs, country risk and geographic distance influence inward FDI, since the coefficients on these variables are all statistically insignificant.

This study focuses on the relative home and host country's characteristics. Firm and industry-specific influences are beyond the scope of the present analysis. Specification (I) explains about 64% of the variation in pledged FDI in China, and Specification (II) explains about 75% in realised FDI in China. As suggested by Moore (1993) and Grosse and Trevino (1996), the inclusion of industry and firm-specific factors may further enhance the explanatory power of the model. In other words, the propensity of MNCs to invest in a particular host country not only depends on the economic and other characteristics of the home and host countries, but also varies according to the range and type of products they intend to produce and their underlying management and organisational strategies [Dunning, 1988]. Especially, in recent literature, the role of R&D intensity or knowledge-based assets is identified as the basis for the existence of MNCs, it would be very important to highlight this variable in further studies. Currently, data limitations prevent such an assessment for China.

The findings from this study have an important implication for the future development of FDI in China. According to Wei (1995), although China may receive an adequate share of Japanese FDI, it is obvious that China still has great potential capacity to attract FDI from many major source countries such as the U.S., Germany, France and UK. Therefore, this study illuminates several ways through which FDI can be best attracted to flow into China. First, rapid economic growth and foreign trade expansion are expected to continue. These might encourage FDI in China. Second, labour costs are expected to remain competitive for the foreseeable future in China. Although rapid economic growth in China since 1983 has significantly raised the wage rates in China's coastal areas including Beijing [Broadman and Sun, 1997], the empirical results here suggest that the vast supply of cheap labour in the inland areas can efficiently prevent China from losing the comparative advantage of its labour endowment. Therefore, China should expect to continue experiencing a rapid increase in inward FDI.

Chapter 3: The Regional Distribution of Foreign Direct Investment in China

Abstract

This chapter analyses the determinants of the regional distribution of pledged and realised foreign direct investment (FDI) within China using a panel of data for 27 provinces over the periods 1985-1995 and 1986-1995 respectively. To overcome the problem of low power of conventional unit root tests for a short time span, the econometric properties of the panel data set are examined using a standardised 't-bar' test for unit root proposed by Im, Pesaran and Shin (1995). The empirical results indicate that there exists a long run relationship between the spatial distribution of FDI and a number of regional characteristics. Provinces with higher level of international trade, lower wage rates, more R&D manpower, higher GDP growth rates, quicker improvement in infrastructure, more rapid advances in agglomeration, more preferential policies and closer ethnic links with overseas Chinese attract relatively more pledged FDI. Since FDI is pledged and materialised at different times, several of the regional characteristics become statistically insignificant when used to interpret realised FDI.

Chapter 3: The Regional Distribution of Foreign Direct Investment in China

3.1 Introduction

In the preceding chapter, the determinants of foreign direct investment (FDI) inflows into China as a whole were analysed. As an integral part of the research, this chapter examines the factors influencing the regional distribution of FDI within China. Though inward FDI has registered an enormous growth, its geographical distribution in China is characterised by its concentration in coastal areas. It is true that FDI has flowed into every province, autonomous region or central municipality, but relative values in inland areas are still not significant [see Figure 3.1]. During the period 1990 to 1996, 88.1% of total realised FDI in China was located in the coastal region, and the share of realised FDI in the central and western regions was only 8.5% and 3.1%, respectively. Since every province is promoting further inward FDI, an understanding of regional characteristics influencing locational decisions is essential for improved policies to encourage FDI.

Previous studies of spatial patterns of FDI in China can be divided into two groups. The first group provides detailed descriptive analysis. Kueh (1992) and Mee-kau (1993) discuss the causes of shifts in the regional distribution of FDI and their policy implications. Schroath et al. (1993) demonstrate that the facilitating, geo-cultural, and economic factors influence investors from different countries/regions to choose particular locations within China. Zhang (1994) and Leung (1996) analyse the determinants of the sub-regional distribution of foreign investment within Guangdong province which are related to the open and favourable policies, good infrastructure and pre-existing social ties with overseas Chinese. Lee (1997) examines FDI in China from a 'policy' perspective and suggests that, to a great extent, the control side of government policies effectively shaped the spatial patterns of FDI during the period of 1979 to 1995. Sit and Yang (1997) outline the major spatial characteristics of FDI in the Pearl River Delta in China.

The second group focuses on econometric estimation. Gong (1995) carries out cross-section regression analyses of the determinants of foreign investment inflows including foreign loans, FDI and other foreign investment in 174 Chinese cities. In Gong's study, the spatial patterns of foreign investment are attributed to infrastructure, the relative population size, investment incentives and the agglomeration effect. Eng and Lin (1996) investigate the locational choice of MNCs in coastal provinces. The capital-labour ratio used as a measure of capital intensity and technological sophistication, foreign investors' experience in China, openness of the market conditions and the number of local firms in the same sector and location employed to represent economic competition are identified as four major determinants of FDI. Head and Ries (1996) examine the influences on locational decisions of 931 FDI projects in 54 Chinese cities using a conditional logit regression model. The main proposition of the model is that foreign investors will be attracted to areas that have a large existing pool of potential input suppliers, an existing stock of foreign investors, tax incentive government polices, good infrastructure and higher average productivity. In the study of Broadman and Sun

(1997), five variables that impact on foreign ownership locational preferences in China's 29 provinces are investigated. The empirical results show that FDI in China goes to the location which has larger market size, better development of basic infrastructure and greater extent of general education. In addition, a province which has a coastal location and thus is in close proximity to major shipping ports has more potential capability to accumulate FDI than others.

This study provides some more robust evidence on analysing the determinants of the regional distribution of FDI within China. Efforts have been made to expand on past knowledge and to incorporate additional considerations in an attempt to provide a more precise and comprehensive assessment of the subject. A panel data set has been employed to cover 27 out of 30 of China's provinces during the period of 1985 - 1995 for pledged FDI and seventeen countries during the period of 1986 - 1995 for realised FDI. As indicated in chapter 1, the use of pooled time-series and cross-sectional data increases degrees of freedom and improves efficiency of estimation, and is an appropriate method for this kind of research. However, there are few applications of the method in the literature. One exception is Gerlowski et al. (1994) who use a random effects model to analyse the locational preferences of investors from Canada, Japan and the United Kingdom for U.S. real estate.

Panel data analysis can suffer from a spurious regression problem when time series data on variables trend consistently upwards over the sample period. The current study aims to improve on the previous panel data analyses in this area by examining the econometric properties before a statistical model is chosen. Section 3.2 of this study presents the literature review and model specification. Section 3.3 describes the data. Methodology is then discussed in section 3.4. A newly proposed method by Im, Pesaran and Shin (1995) for a unit root test for panel data is used to examine the econometric properties of the data (thereafter denoted as the IPS test). Compared with conventional time-series tests, the IPS test has substantially higher power [Coakley and Kulasi, 1997; Lee et al. 1997]. Given the relatively short sample periods employed, conventional time-series tests are unlikely to be powerful enough to distinguish between unit root and near unit root behaviour. The IPS test is based on the average value of the Augmented Dickey-Fuller (ADF) statistics. Im et al. (1995) argue that the IPS test procedure is superior to two existing panel data unit root test approaches advanced by Quah (1992, 1994) and Levin and Lin (1993) and is simple as compared with other test approaches. Empirical results are reported in section 3.5. Finally, section 3.6 provides a summary and conclusions.

3.2 Hypothesis Formation and Model Specification

Various approaches have been attempted in the literature to explain regional patterns of FDI within a host country. Firm specific advantages emphasised by Hymer (1960), Kindleberger (1969), Caves (1971) and Lall (1980) and internalisation advantages stressed by Buckley and Casson (1976) and Rugman (1981) are usually either explicitly or implicitly assumed to be given. Locational advantages are then the main concern of multinational corporations when they evaluate their FDI programmes. Traditional industrial location theory explains the geographical distribution of FDI in terms of transport costs, wages and infrastructure. New location theory focuses on 'pecuniary' externalities or agglomeration associated with demand and supply linkages [Krugman, 1991a, b; Venables, 1993]. Dunning's eclectic paradigm, (Dunning, 1977) provides a detailed analysis of the impact of the ownership, internalisation and locational advantages on the behaviour of multinational corporations.

New growth theory also emphasises agglomeration effects from knowledge spillovers among firms within and between industries [Griliches, 1979; Romer, 1986; Sala-I-Martine, 1990]. One recent development is the information costs approach which treats the conduct and hierarchical structures of multinational enterprises as the result of a rational response by economic agents to the existence of information costs [Casson, 1994a, b; Radner 1992; Mariotti and Piscitello, 1995].

In the theoretical literature on the geographical distribution of FDI a number of hypotheses have been discussed. Although different approaches focus on different influences, empirical studies tend to draw on various fields of economics and include all factors which are thought to be important in explaining the regional distribution of FDI. For the purpose of this study, relationships between FDI inflows and such regional characteristics as the level of international trade, wages, R&D manpower, GDP growth, infrastructure, agglomeration externalities, investment incentives and links with foreign investors are examined. Each one of these variables is discussed before specifying and testing the model.

3.2.1 International Trade

The level of international trade is often used as an important indicator of a country's degree of openness. An alternative measure of openness is the ratio of international trade to GDP. This latter measure takes into consideration the relative economic size of each region. Frequent trading activities enable business partners to know more about economic, cultural, political and social situations in each other's regions, and facilitate quick flows of information on investment opportunities. Though some cross-country studies indicate that international trade and FDI are substitutes and negatively related [Horst, 1972; Jeon, 1992], many others find that they are complementary and are positively correlated [Ajami and BarNiv, 1984; Ray, 1989; Grosse and Trevino, 1996; Liu et al., 1997]. In this study whether there exists a positive or negative relationship between FDI and international trade is tested using a time-series and cross-region panel data set.

3.2.2 Wage Rates

There may be a negative relationship between wage rates or labour costs and inward FDI. Higher wage rates are expected to deter FDI. This is confirmed by, for example, Culem (1988), Yamawaki (1991), Hill and Munday (1991, 1995, 1996) and Liu et al. (1997). However, a positive relationship between the two is found in Swedenborg (1979), Dunning (1980) and Veugelers (1991) who argue that wage rates could be treated as a proxy for labour quality. Higher wage rates imply higher skills which foreign investors are seeking. In the case of China, Head and Ries (1996) and Broadman and Sun (1997) fail to confirm the significance of wage rates on the regional distribution of FDI. According to Broadman and Sun, once the choice is made to locate an investment in China, then because wage differentials may not be significant in provinces, finding the cheapest possible labour may be less important. Controversy on the relationship between inward FDI and labour costs may partly be caused by different measures of wage rates. It is reasonable to assume that qualifications, skills and experience of workers are positively related to productivity. If high money wage rates reflect high monetary labour costs, then the productivity adjusted wage rates are the effective labour costs. If levels of productivity are the same, a high money wage rate implies a high labour cost. Alternatively, if the levels of both productivity and money wage rates are higher in region A than in region B, but the productivity is not sufficiently larger to compensate for the higher money wage rate in region A, then region B will have an effective labour cost advantage. Thus, if other things are equal, the higher the *effective* wage rates, the less FDI a region will attract.

3.2.3 R&D Manpower

R&D manpower measures the relative endowment of skilled labour in the host region. It is widely accepted that a significant amount of R&D work by multinational corporations is carried out in their home countries. The main task of R&D in foreign subsidiaries is to adapt technologies developed in home countries to local needs. However, some recent studies indicate that setting up R&D activities in foreign branches is also an important motive for FDI [Pearce and Singh, 1992]. Either to adapt existing technologies or to develop new technologies in subsidiaries, the local availability of R&D manpower is essential. If other things remain unchanged, the more R&D manpower a region has, the more attractive a region will be to foreign investors.

3.2.4 GDP Growth

GDP and its growth are often used in the literature as proxies for the size and growth of market demand. Many cross-country studies indicate that inward FDI is positively related to market demand in host countries [see, for example, Ajami and BarNiv, 1984; Grosse and Trevino, 1996; Liu et al., 1997]. This kind of relationship may well be expected at a local level within a host country. The plausibility of this argument is reinforced by the evidence in the studies of Coughlin et al. (1991), Friedman et al. (1992) and Broadman and Sun (1997). On the contrary, it is sometimes argued that the GDP variable may lose some of its explanatory power because of relatively easy access to neighbouring regions [Mariotti and Piscitello, 1995].

3.2.5. Infrastructure

Infrastructure is another frequently mentioned regional factor attracting FDI. Infrastructure covers many aspects, including seaports, highways, railways and telecommunications. Investors will probably differ in the importance they attach to the aspects of infrastructure, depending on the special requirements of their industries. Overall, a positive relationship between infrastructure and inward FDI is to be expected since an economy with good infrastructure investment is made more attractive. Similar to the international trade variable, an alternative measure of infrastructure is the relative one, i.e., the ratio of infrastructure to GDP. Empirical support for the importance of infrastructure in FDI location decisions is provided by Bartik (1985), Glickman and Woodward (1988), Coughline et al. (1991), Gong (1995), Hill and Munday (1991, 1995) and Broadman and Sun (1997), although Peck (1996) argues that inward investors may be interested not only in the general modernity of the infrastructure of a region, but in the degree to which they can exercise control over its present and future development.

3.2.6 Agglomeration

The agglomeration effect is associated with externalities. Concentration of production and urbanisation facilitate quick spillovers of knowledge and the use of joint networks of suppliers and distributors. This helps firms enhance their levels of technology and reap economies of scale and scope. Investment in a region with substantial clustering of industrial activities is likely to involve relatively lower costs than in a region with a dispersed manufacturing sector. Thus, agglomeration will be positively correlated with inward FDI. This relationship is confirmed by a number of empirical studies including Coughlin et al. (1991), Wheeler and Mody (1992), Gong (1995), Braunerhjelm and Svensson (1996) and Lee and Mansfield (1996).

3.2.7 Information Costs

Mariotti and Piscitello (1995) suggest that foreign investors suffer from a condition of adverse asymmetry in information costs compared with domestic investors. Thus, foreign investors' locational decisions on their activities within a country reflect a rational response to the existence of information costs. Information costs are more related to location-specific observation, market and event observation costs and the communication, monitoring and control of the internal activities of the MNCs. The measures of information costs include the distance from the country 'core', age of first FDI, presence of the top 500 multinational enterprises and a "border effect". Basically, the smaller the distance of a region from the country core defined as the gravitational pole of the national economy, the older the age of the first FDI, the higher the presence of the top 500 multinational enterprises and the closer geographical and/or cultural links a region has with foreign investors, the smaller the information costs will be.

In the case of China, coastal areas can be identified as low information cost regions. First, these areas have traditionally been the industrial and commercial centres. As calculated by Kueh (1992), with a population of only 19.5% of the national total, the municipalities and counties in the 11 "opened coastal provinces" of Liaoning, Hebei, Tianjin, Shandong, Jiangsu, Shanghai, Zhejiang, Fujian, Guangdong, Hainan, and Guangxi accounted for almost 40% of national gross value of industrial output, 33.4% of GDP and 25.9% of all local budget revenue in China. Second, these areas were designated as first target regions for attracting FDI. The Shenzhen, Zhuhai, Shantou and Xiamen Special Economic Zones (SEZs) were established in 1980. Dalian, Tianjin, Qinhuangdao, Yantai, Nantong, Lianyungang, Shanghai, Ningbo, Wenzhou, Fuzhou, Guangzhou, Zhanjiang and Beihai were assigned as 14 coastal open cities (COCs) in 1984. SEZs and COCs have longer histories of hosting FDI than other regions of China. Third, the presence of the top 500 multinational enterprises in the coastal areas is much higher than in inland areas. Finally, the coastal areas have closer links with foreign investors. Liu and Song (1997) report that 66.7% of the total contracted foreign investment in China for the period 1979 to 1994 was accounted for by Asian newly industrialised countries, among which the most important grouping was overseas Chinese from Hong Kong, Macao and Taiwan. Many of these overseas Chinese have close family links with residents in the coastal areas. In addition, these areas are geographically closer to the main sources of FDI.

The above discussion leads to the formation of the seventh argument: since investment in the coastal areas in China involves lower information costs, foreign investors prefer to locate their businesses there. This hypothesis may be tested by applying a dummy variable equal to 1 for all coastal areas and 0 for other regions. A positive coefficient on the dummy is expected.

3.2.8 Investment Incentives

Preferential investment incentives in the attraction of FDI is practised widely among developing countries. These incentives tend to reduce the cost of production and hence add to the attractiveness of the region. Therefore, a positive relationship is expected between the incentives and the inflow of FDI. Empirical studies have generated inconclusive evidence. While McAleese (1985) concludes that incentives offered by local governments are positively related with inward FDI in Ireland, Lim (1983) finds a negative relationship between investment incentives and the presence of FDI in 27 developing countries. According to Lim, generous fiscal incentives could be interpreted by potential foreign investors as a danger signal rather than a lure. Loree and Guisinger (1995) point out that the effect of investment incentives on FDI flows differ between developing and developed countries. In terms of their empirical study on U.S. FDI abroad, the investment incentive variable alone is insignificant, however, the interaction between incentives and the developed country dummy variable is positively significant.

Since the coastal areas were specially assigned as the main regions to attract FDI, various fiscal incentives, such as lower income tax and reduced tariffs for imports used in the production for exports, were offered there by the Chinese government. As pointed out by Gong (1995), since available incentives vary over time and by region, it is very difficult to quantify them. Instead, a dummy variable is needed to capture the effect of investment incentives. Because this variable takes on the same values as the information cost dummy, the two have to be combined.

In summary, the arguments discussed above under the eight headings will be tested based on the following model:

FDI = f (TRAD, WAIP, RDMP, GDPG, INFR, AGGO, TDM92, CDM) [3.1]

That is, foreign direct investment (FDI) in a region is influenced by the level of international trade (TRAD), industrial productivity adjusted (effective) wage rates (WAIP), R&D manpower (RDMP), GDP growth rates (GDPG), infrastructure (INFR), an agglomeration effect (AGGO), a time dummy (TDM92) whose value is 1 from 1992 onwards and 0 before 1992, and a combined cross-sectional dummy (CDM) to capture the effects of low information cost and high investment incentives in the coastal regions. *It should be noted that in the preceding chapter, GDP level is* employed to capture the size of whole Chinese market. The focus of this chapter is on regions within a country. Since it is easy to obtain access to neighbouring regions, the absolute level of GDP may be less important than its growth rate. The rate of growth may be a better proxy for changes in economic activities in a region. Thus, GDP growth rate rather than level is used in this chapter. The reason for including the time dummy lies in the change in scale of FDI following Deng Xiaoping's confirmation of the need for more rapid progress in opening up China to the outside world, in 1992.

3.3 Data

The current empirical work is based on a panel of data for 27 out of 31 of China's provinces over the period 1985 to 1995 for pledged FDI and 1986 to 1995 for realised FDI. The spatial coverage is of 11 provinces in the coastal areas (Guangdong, Jiangsu, Shanghai, Fujian, Shandong, Liaoning, Tianjin, Zhejiang, Hebei, Beijing and Guangxi) and 16 provinces in the inland areas (Henan, Shanxi, Hubei, Heilongjiang, Jilin, Shaanxi, Anhui, Hunan, Sicuan, Jiangxi, Yunnan, Inner Mongolia, Guizhou, Xinjiang, Gansu and Ningxia). Two provinces, Tibet and Qinghai, are omitted because of lack of reliable data. Hainan was part of Guangdong province before the end of 1987. In order to keep consistency, the data for Hainan and Guangdong provinces are combined from 1988 onwards. Similarly, Chongqing and Sicuan provinces are not separate throughout the data period and have therefore been included as one combined province.

The data are mainly compiled from various volumes of Chinese statistical and economic yearbooks at both central and provincial level and include pledged FDI and realised FDI. Pledged investment is the value of signed agreements and contracts and realised FDI represents the actual inflows from MNCs. When figures conflict, the central and latest available sources are used. A more detailed description of the sources of data and the measurement of variables is given in Table 3.2. In addition, the proxy variable used for infrastructure is, admittedly, a weak one. But there is no reasonably reliable alternative infrastructure figure in Chinese official statistics. Other proxy variables, such as length of roads, were tried but proved inadequate.

An important characteristic of FDI in China is its concentration in the coastal areas (including Beijing) [see Figure 3.1]. During the period of 1979 to 1989, 91.9% of total pledged FDI in China was located in the coastal areas, and despite the huge increase in the total during the period of 1990 to 1996, this proportion declined only slightly to 88.8%. Table 3.1 presents the geographical distribution of FDI in China in 1996 and in 1997 in terms of both amounts and percentage shares. It clearly reveals coastal areas were still the main destinations of FDI in 1997. In 1997, they accounted for 86.25% of total amount of pledged FDI, of which over 15% of total FDI was made in Guandong province, whereas the combined shares of FDI in all inland provinces were less than 13%. The realised FDI has the same distribution pattern. During the period of 1983 to 1989, 90.7% of realised FDI flowed into the coastal areas, 88.1% during the period of 1990 to 1996 and 85.2% in 1997, while the central and western regions collectively received a mere 9.3%, 11.6% and 14% respectively in the three periods.

Figure 3.1 Regional Distribution of Realised

Foreign Direct Investment in China

1986-1997

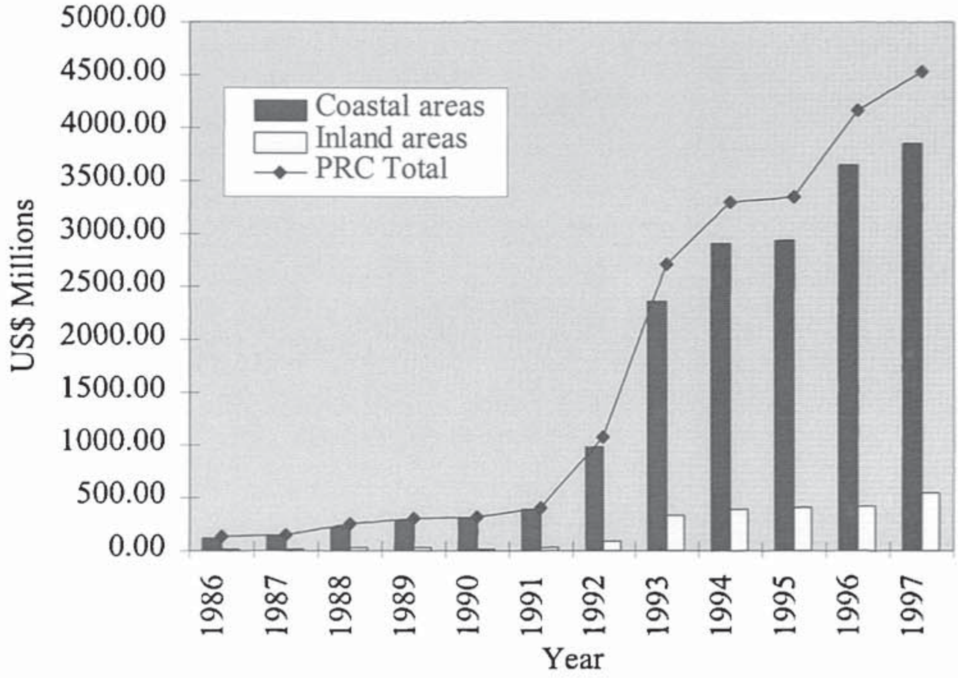


Table 3.1 Foreign Direct Investment in 1996 and 1997, by province

(millions of U.S. dollars at year-end and percentages)

Region	1996				1997			
	Pledged FDI		Realised FDI		Pledged FDI		Realised FDI	
	Value	(%)	Value	(%)	Value	(%)	Value	(%)
PRC Total	7328	100	4173	100	5100	100	4526	100
Coastal areas		87.98		87.55		86.25		85.20
Guangdong	1557	21.25	1162	27.85	769	15.08	1171	25.88
Jiangsu	1068	14.58	521	12.49	920	18.04	544	12.02
Shanghai	1007	13.74	394	9.44	532	10.43	423	9.35
Fujian	654	8.93	408	9.78	454	8.90	420	9.28
Shandong	542	7.40	259	6.21	325	6.37	249	5.50
Liaoning	424	5.79	174	4.17	439	8.61	220	4.86
Tianjin	391	5.34	200	4.79	385	7.55	251	5.55
Zhejiang	313	4.27	152	3.64	121	2.37	150	3.31
Hebei	207	2.83	83	1.99	111	2.18	110	2.43
Beijing	179	2.44	155	3.72	168	3.29	159	3.51
Guangxi	76	1.04	66	1.58	147	2.88	88	1.94
Hainan	27	0.37	79	1.89	28	0.55	71	1.57
Inland areas		11.09		11.82		12.96		13.99
Henan	121	1.65	52	1.25	61	1.20	69	1.52
Shanxi	121	1.65	14	0.34	29	0.57	27	0.60
Hubei	97	1.32	68	1.63	64	1.25	79	1.75
Heilongjiang	70	0.96	55	1.32	59	1.16	73	1.61
Jilin	67	0.91	45	1.08	49	0.96	40	0.88
Shaanxi	57	0.78	33	0.79	66	1.29	63	1.39
Anhui	50	0.68	51	1.22	39	0.76	43	0.95
Hunan	47	0.64	70	1.68	86	1.69	92	2.03
Sicuan	46	0.63	23	0.55	27	0.53	25	0.55
Jiangxi	39	0.53	30	0.72	64	1.25	48	1.06
Chongqing	23	0.31	19	0.46	46	0.90	39	0.86
Yunnan	20	0.27	7	0.17	27	0.53	17	0.38
Inner Mongolia	20	0.27	7	0.17	13	0.25	7	0.15
Guizhou	11	0.15	3	0.07	10	0.20	5	0.11
Xinjiang	10	0.14	6	0.14	4	0.08	2	0.04
Gansu	9	0.12	9	0.22	11	0.22	4	0.09
Ningxia	4	0.05	0.6	0.01	1	0.02	0.7	0.02
Qinghai	2	0.03	0.1	0.00	5	0.10	0.2	0.00

Source: http://203.207.119.3/economy/text/data/BDA/98yearbook/bda61148.txt

Table 3.2 Variable Definitions and Data Sources

Variable	Measurement
FDIP	The pledged annual inflow of foreign direct investment in China, deflated by the GDP deflator. Sample period: 1985 - 1995.
FDIR	The realised annual inflow of foreign direct investment in China, deflated by the GDP deflator. Sample period: 1986 - 1995.
TRAD	Trade (Export + Import), deflated by the GDP deflator. Sample period: 1985 - 1995.
WAIP	The real average wage rate (RMB per worker), adjusted by industrial productivity that is defined as the ratio of industrial output to the employee in industry. Sample period: 1985 - 1995.
RDMP	The R&D manpower, defined as the number of scientists and researchers in total employment. Sample period: 1985 - 1995.
GDPG	The GDP growth rate. Sample period: 1985 - 1995.
INFR	Infrastructure, proxied by the post and telecommunication services output which is deflated by the GDP deflator. Sample period: 1985 - 1995.
AGGO	The agglomeration effect, defined as the ratio of the population to the land area (see, e.g. Mariotti and Piscitello, 1995). The total population refers to the total number of people at the end of a year. Sample period: 1985 - 1995.
TDM92	The time dummy variable. It equals to one from 1992, and zero before 1992.
CDM	The combined dummy variable. It is used to capture the information costs and investment incentives. The following provinces are defined to one: Beijing, Tianjing, Hebei, Liaoning, Shanghai, Jiangsu, Zhejiang, Fujian, Shandong, Guangdong, Guangxi.

3.4 Methodology

From Equation (3.1) above a log-linear functional form is adopted to transform a likely non-linear relationship between the regional distribution of FDI and the explanatory variables into a linear one. In addition, the logarithm transformation enables us to directly obtain FDI elasticities with respect to various explanatory variables. The model is of the form:

$$\begin{aligned} \ln FDI_{it} = {} & \beta_1 \ln TRAD_{it} + \beta_2 \ln WAIP_{it} + \beta_3 \ln RDMP_{it} + \beta_4 \ln GDPG_{it} \\ & + \beta_5 \ln INFR_{it} + \beta_6 \ln AGGO_{it} + \beta_7 TDM92 + \beta_8 CDM + v_{it} \end{aligned} \qquad [3.1']$$

where i and t denote cross-sectional unit and time respectively and v represents a composite term.

As at the national level, there is a marked difference between the figures for pledged and realised FDI at the provincial level [see Table 3.1]. As explained in chapter 2, this difference arises from some bogus pledged investments intended to take advantage of a privileged fiscal regime for foreign investment, as well as from the cancellation of some planned projects. It is also because in many cases, FDI is to be realised over a period of several years. As a result, two specifications of Equation (3.1') are estimated. In the first case, pledged FDI is used as the dependent variable, whereas in the second case, realised FDI is employed as the dependent variable. This allows us to learn whether the same set of regional characteristics influence pledged and realised FDI in the same way.

There are three statistical models for a pooled time-series and cross-sectional data set: ordinary least squares (OLS) model, error components (EC) or random effects (RE) model, and least squared dummy variable (LSDV) or fixed effect (FE) model. As in the analysis of the determinants of FDI in China in chapter 2, the possibility of the use of the FE model is excluded. This is because two dummy variables are included in the current econometric model and the application of this model for the estimation will lead to a problem of perfect multicolinearity. The choice between OLS and EC models is made based on a conventional Lagrange multiplier (LM) test. A possible problem of autocorrelation should also be taken into consideration when a statistical model is selected.

This chapter is concerned with the long run relationship between FDI and all its explanatory variables. To avoid possible spurious correlation, it is essential to identify the order of integration of each variable before any sensible regression analysis can be performed. Basic econometric theory suggests two common situations where long run relationships can be identified. First, all variables are cointegrated. In general, a set of variables is cointegrated if (a) each such variable is integrated of order unity, and (b) there exists some linear combination of the variables that is integrated of order zero (i.e. stationary). Second, there is no reason why a long run relationship would not exist between I(0) variables. In this case, the question of cointegration would not then rise. However, in neither case, there would be the problem of spurious correlation. It should be emphasised that, even if there is a cointegration or long run relationship among certain variables in the statistic sense, this does not necessarily mean that the relationship makes economic sense. The interpretation of regression results should be guided by economic theory.

To examine the order of integration of variables, the unit root test for a panel structure of the data employed is proposed by Im, Pesaran and Shin (1995). The IPS test statistic - t-bar statistic is based on the average value of the ADF test statistics. Because almost all the time series exhibit clear trends, the ADF with trend regression of order p_i is used which can be determined by the Akaike Information Criterion (AIC), Schwarz Bayesian Criterion (SBC) or Adjusted-R^2 criterion. The standardised t-bar statistic takes the form:

$$\bar{Z}_{NT} = \frac{\frac{1}{N}\sum_{i=1}^{N} t_{iT}(p_i, \hat{\gamma}_i) - \frac{1}{N}\sum_{i=1}^{N} E[t_T(p_i, 0)]}{\sqrt{\frac{1}{N^2}\sum_{i-1}^{N} V[t_T(p_i, 0)]}} \qquad [3.2]$$

where, $t_{iT}(p_i, \hat{\gamma}_i)$ is the ADF statistic, i = 1, 2, ..., N (=27), and $\hat{\gamma}_i$ is the estimated vector of coefficients on the augmented lagged changes in the ADF with trend regression, the values of $E[t_T(p_i,0)]$ and $V[t_T(p_i,0)]$ are tabulated in Im et al. (1995) and T is the number of time-periods. Under the null hypothesis of a unit root, the t-bar statistic has a standard normal distribution. Under the alternative hypothesis of stationarity, the statistic diverges to negative infinity.

Given that there is a long run relationship among all variables, the main difference between the OLS and EC model lies in the assumption of v_{it}. As explained in chapter 2 the OLS model assumes that v_{it}s have constant mean and variance, and are independent of regressors. In the EC model, v_{it} is decomposed into two terms:

$$v_{it} = u_i + \varepsilon_{it} \qquad [3.4]$$

where u_i denotes the ith individual, year-invariant unobserved heterogeneity which is assumed to be random, independent and identically distributed, i.e. $IID(0, \sigma_u^2)$, and ε_{it} is the remainder disturbance which varies with individuals and time and is normally distributed with a mean of zero and constant variance.

The following Lagrange multiplier test - LM1 test is applied to identify the existence of heterogeneity:

$$\lambda_{LM1} = \frac{NT}{2(T-1)}[1 - \frac{\varepsilon'(I_N \otimes J_T)\varepsilon}{\varepsilon'\varepsilon}]^2 \qquad [3.5]$$

where the statistic λ_{LM1} is asymptotically distributed as $\chi^2(1)$, ε is a vector of residuals, I_N is an identity matrix of dimension N, J_T is a matrix of ones of dimension T and $\otimes$ is Kronecker product. Under the null hypothesis of no heterogeneity, a large value of the test statistic is in favour of the EC model against the OLS model.

As is well known, autocorrelation of the error term is likely to be a problem with time-series data. Since the data pools the cross-section units over years, the possible problem of autocorrelation is handled under the assumption that disturbances follow a first-order autoregressive scheme. Baltagi (1995) gives a summary of all tests for serial correlation and individual effects. For the purpose of the current analysis, two LM test statistics - LM2 and LM3 are shown:

$$\lambda_{LM2} = \frac{NT^2}{2(T-1)(T-2)}\{[1-\frac{v'(I_N \otimes J_T)v}{v'v}]^2 - 4*[1-\frac{v'(I_N \otimes J_T)v}{v'v}]*\frac{v'v_{-1}}{v'v} + 2*T*(\frac{v'v_{-1}}{v'v})^2\} \qquad [3.6]$$

which is asymptotically distributed for large N as $\chi^2(2)$ under the null hypothesis of no autocorrelation and random individual effects;

and

$$\lambda_{LM3} = \sqrt{\frac{NT^2}{T-1}} * \frac{\varepsilon'\varepsilon_{-1}}{\varepsilon'\varepsilon} \qquad [3.7]$$

which is asymptotically distributed as the standard normal distribution under the null of no autocorrelation against the alternative of positive autocorrelation. Likewise, large values of LM2 and LM3 suggest that there is autocorrelation.

In the presence of the autocorrelation, the OLS and RE specifications are estimated by two-step generalised least squares (GLS) procedure to make autocorrelation adjuestment. In the first step, the model is estimated ignoring the autocorrelation for the purpose of obtaining a consistent estimate of coefficient of autocovariance - ρ. In the second step, with the estimate of ρ in hand, the data are transformed using the Cochrane-Orcutt transformation to remove the autocorrelation. Then based on the transformed data, GLS estimates can be computed.

Based on data availability and the above discussion of methodology, first, the order of integration of each variable is identified before any sensible regression analysis is performed. Given there is the long run relationship between FDI and all its explanatory variables, the two specifications are estimated using a panel data set.

3.5 Empirical Results

To test for unit roots for individual provincial time series data, the ADF tests are first applied and few time series are found to be stationary. However, as is well known, unless the number of observations is quite large, ADF tests always fail to reject the null hypothesis of no unit root. With only 11 annual observations in the time series, the IPS test is applied to re-examine the properties of the data in a panel framework. The AIC criterion is used to determine p_i, because it is more suitable than other criteria for a short time span.

Table 3.3 Results from Panel Unit Root Tests

Variables	LFDIP	LRDMP	LGDPG	LTRAD	LFDIR
t-bar statistic	-4.2389***	-2.2256***	-5.7363***	-3.2810***	-3.8287***
Variables	LWAIP	LAGGO	LINFR	DLAGGO	DLINFR
t-bar statistic	-4.1540***	-0.5703	0.9906	-4.2615***	-3.7935***

Note: 1. There are 297 observations for all variables expect LFDIR for which only 270 observations are included.
2. *** = 1% level. The critical value at the 1% confidence level is -1.96.
3. L indicates logged values.
LFDIP = pledged FDI;
LRDMP = R&D manpower;
LGDPG = GDP growth rate;
LTRAD = level of international trade;
LFDIR = realised FDI;
LWAIP = industrial productivity adjusted wage rates;
LAGGO = agglomeration effect;
LINFR = infrastructure;
DLINFR = first difference infrastructure variable;
DLAGGO = first difference agglomeration effect variable.

From Table 3.3 the null hypothesis of having unit root is strongly rejected at the 1% level for the panels of variables: LFDIP, LRDMP, LGDPG, LTRAD, LFDIR, LWAIP - where the prefix L indicates a logged variable (LFDIP = pledged FDI; LRDMP = R&D manpower; LGDPG = GDP growth rate; LTRAD = level of international trade; LFDIR = realised FDI; LWAIP = industrial productivity adjusted wage rates). However, little evidence of stationarity can be found for LAGGO and LINFR (LAGGO = agglomeration effect; LINFR = infrastructure) at even the 10% level of significance. Further unit root tests for the first differences of LAGGO and LINFR indicate that both variables are I(1) processes. As Oh (1996) and Coakley and Kulasi (1997) suggest, a panel unit root test has substantially higher power than a conventional time-series test. Thus, the conclusion should be in favour of the panel framework when conflicting results are obtained from performing the ADF tests and IPS tests.

The results from the unit root tests indicate that there exists a long run relationship among LFDIP, LRDMP, LGDPG, LTRAD, LFDIR, LWAIP, and the first differences of LAGGO and LINFR since they are all stationary. As discussed in section 3.2, economic theory does suggest that there are either positive or negative relationships between the dependent and all explanatory variables. The results from estimating the specifications for pledged and realised FDI using this long run regression equation are presented in Tables 3.4 and 3.5 respectively.

Following the discussion of the methodology in the preceding section, the large value of the LM1 statistics argues in favour of the EC models against the OLS models. The LM3 statistics of 1.89 and 3.48 are statistically significant at the 5% and 1% level, respectively. This suggests that the error terms from the EC models in column (3) of Tables 3.4 and 3.5 are first-order autocorrelated. The LM2 statistics confirm this conclusion.

The results from the autocorrelation adjusted OLS and EC models are presented in columns (4) and (5) in Tables 3.4 and 3.5 respectively. Since the LM1 test results suggest that the EC models are statistically superior to the OLS models, the autocorrelation adjusted models given in column (5) of Tables 3.4 and 3.5 are the preferred models. Thus, the economic interpretation of the results in Tables 3.4 and 3.5 will be focused on column (5) of both tables.

The results from column (5) of Table 3.4 are generally consistent with expectations. The coefficients of all explanatory variables have the expected signs and are statistically significant at either the 1% or 5% level. The estimated coefficient on LTRAD indicates that, other things remaining constant, a 1% increase in international trade would raise the pledged FDI by 0.29%. As mentioned in section 3.2, an alternative measure of openness/infrastructure is the ratio of international trade/infrastructure to GDP. When replacing the level variable of international trade by the corresponding ratio variable, similar regression results are obtained (detailed regression results are not reported). In the case of international trade, the coefficient is still statistically significant (at the 10% level) and it takes the value of 0.237. The positive relationship between international trade and pledged FDI supports the

Table 3.4 Parameter Estimates of OLS and EC Models:

Pledged FDI in China

(Dependent variable = LFDIP)

(1)	OLS (2)	EC (3)	OLS + Auto. (4)	EC + Auto. (5)
LTRAD	0.5695 (0.1006)***	0.0817 (0.1326)	0.5977 (0.1066)***	0.2877 (0.1386)**
LWAIP	-0.2585 (0.0624)***	-0.4735 (0.0978)***	-0.2728 (0.0666)***	-0.4364 (0.0961)***
LRDMP	0.4492 (0.1156)***	0.5618 (0.2117)***	0.3548 (0.1270)***	0.4402 (0.2003)**
LGDPG	7.0364 (1.4115)***	5.8297 (1.2848)***	4.2839 (1.5950)***	3.4454 (1.5007)**
DLINFR	0.4560 (0.1871)***	0.4571 (0.1588)***	0.5053 (0.1719)***	0.5026 (0.1543)***
DLAGGO	7.6621 (4.9448)	7.6856 (4.3030)*	8.9405 (4.6171)**	8.6754 (4.2213)**
TDM92	1.9917 (0.1347)***	2.2018 (0.1282)***	2.2093 (0.1484)***	2.3287 (0.1412)***
CDM	0.9908 (0.1776)***	1.6491 (0.2950)***	1.0164 (0.1893)***	1.4027 (0.2840)***
Constant	-30.682 (6.5167)***	-19.967 (6.1019)***	-18.761 (6.5235)***	-11.638 (6.9213)*
Observations	297	297	270	270
R-squared	0.8333	0.8175	0.8352	0.8287
Tests:	LM1: 3 vs. 2	LM3: 4 vs. 2	LM1: 5 vs. 4	LM2: 5 vs. 2
	χ^2 [1]=42.9***	z = 1.89**	χ^2 [1]=13.45***	χ^2 [2]=43.9***

Note: (1) Standard errors are in parentheses.

(2) ***, ** and * indicate that the coefficient is significantly different from zero at the 1%, 5% and 10% levels, respectively.

(3) CDM = cross sectional dummy. For other terms see Table 3.3.

hypothesis that high volumes of trade have a positive effect on FDI, though the magnitude of this coefficient is relatively small. The fit is better for absolute volumes of trade than trade as a proportion of GDP. Information on investment opportunities is one possible explanation as suggested in section 3.2.

The negative coefficient on LWAIP suggests that effective wage rates move inversely with FDI inflows. The result shows that a 1% increase in the wage rates would lead to 0.44% decrease in pledged FDI. The positive and significant coefficient on the R&D manpower variable indicates that FDI in different regions is also attracted by human capital. The higher the proportion of scientists and researchers in total employees, the higher the R&D capabilities, and the more productive the work force. However, as in the case of wage rates, the absolute magnitude of the coefficient on R&D manpower (or elasticity) is only 0.44. That is, 1% increase in R&D manpower would result in less than 0.5% increase in pledged FDI inflows. This is consistent with the result from Broadman and Sun (1997), although they use different measurement for human capital. The FDI elasticities of both wage rates and R&D manpower reflect the comparative advantage that China offers to foreign investors. The wage rate elasticity indicates that one of the motives for foreign businesses to invest in China is to seek low labour costs. The bulk of FDI in China has been from Asian newly-industrialised economies and focused on the production of and exporting of labour-intensive products. This may explain the low FDI elasticity with respect to R&D manpower. Nevertheless, the positive R&D manpower elasticity reflects the need of foreign investors for some highly skilled technical staff represented by the R&D manpower in the current model.

The growth rate of the Chinese domestic market seems to be a more powerful explanatory variable than international trade, effective wage rates and R&D manpower. The coefficient of 3.44 indicates that a 1% acceleration in the market growth rate would result in more than 3% increase in pledged FDI. Similarly, the agglomeration effect is also very powerful and this implies that FDI tends to locate in urbanised areas in China to take advantages of quick knowledge spread and of economies of scale and scope.

The growth rate of infrastructure also has a significant impact on FDI inflows to various regions. However, the FDI elasticity with respect to this variable is only 0.5. The elasticity with respect to the growth rate of infrastructure-to-GDP ratio measure is statistically significant at the 5% level, but has an even lower value (0.275).

Column (5) of Table 3.4 also shows that both the combined and time dummy variables are statistically significant. These suggest that foreign investors would seek locations with low information cost and high investment incentives, and that the growth patterns of FDI in China's regions were statistically different before and after 1992, i.e. the increase in FDI in the post-1992 period was much faster. Government policy could have a significant effect on FDI.

The evidence from column (5) of Table 3.4 shows that a region with higher international trade, lower real effective wage rates, more R&D manpower, higher GDP growth, quicker improvement in infrastructure, faster advances in agglomeration, lower information costs and/or higher investment incentives attract relatively more pledged FDI. While all explanatory variables in the preferred model are statistically significant, GDP growth rate, agglomeration externalities, low information costs and/or higher investment incentives are more powerful determinants than others in terms of the magnitude. As discussed above, general FDI policy is also a very important determinant of FDI.

From column (5) of Table 3.5 it is clear that the results for realised FDI are not as robust as those for pledged FDI. The coefficient on advances in agglomeration does not have the expected sign, but it is statistically insignificant. All other explanatory variables are signed as expected. However, the coefficients on GDP growth, improvement in infrastructure and advances in agglomeration are no longer statistically significant. Put another way, these three variables have lost their power when used to explain realised FDI.

The international trade variable is statistically significant at the 10% level, and its magnitude is similar to that found in the regression equation for pledged FDI. The wage rates and R&D manpower variables are both statistically significant at the 1% level, and their magnitudes are slightly greater than their counterparts in the regression equation for pledged FDI. All this suggests that the openness, labour costs and human capital continue to be the significant determinants of realised FDI.

The time and combined dummy variables are also highly significant, indicating that the growth pattern of realised FDI from 1992 was significantly different from that

Table 3.5 Parameter Estimates of OLS and EC Models:

Realised FDI in China

(Dependent variable = LFDIR)

(1)	OLS (2)	EC (3)	OLS + Auto. (4)	EC + Auto. (5)
LTRAD	0.7669 (0.1175)***	0.0758 (0.1547)	0.6909 (0.1259)***	0.2946 (0.1611)*
LWAIP	-0.3310 (0.0731)***	-0.7263 (0.1192)***	-0.3774 (0.0800)***	-0.6042 (0.1165)***
LRDMP	0.6283 (0.1379)***	0.7985 (0.2636)***	0.5596 (0.1556)***	0.6238 (0.2466)***
LGDPG	2.9512 (1.8633)	1.5023 (1.5549)	3.4581 (1.7721)**	2.4487 (1.6193)
DLINFR	0.2716 (0.2120)	0.2699 (0.1648)*	0.1825 (0.1788)	0.1798 (0.1561)
DLAGGO	1.8286 (5.6003)	1.9397 (4.4793)	-0.8625 (4.8488)	-1.0297 (4.3086)
TDM92	1.5932 (0.1675)***	1.8319 (0.1459)***	1.4912 (0.1686)***	1.6239 (0.1562)***
CDM	0.7850 (0.2063)***	1.5984 (0.3646)***	0.8412 (0.2318)***	1.3328 (0.3524)***
Constant	-18.617 (8.4757)**	-4.9172 (7.2336)	-20.505 (6.5364)***	-11.962 (7.5882)
Observations	270	270	243	243
R-squared	0.8043	0.7722	0.7786	0.7670
Tests:	LM1: 3 vs. 2	LM3: 4 vs. 2	LM1: 5 vs. 4	LM2: 5 vs. 2
	χ^2 [1]=73.4***	z = 3.48***	χ^2 [1] =16.6***	χ^2 [2]=73.5***

Note: (1) Standard errors are in parentheses.

(2) ***, ** and * indicate that the coefficient is significantly different from zero at the 1%, 5% and 10% levels, respectively.

before 1992, and that low information costs/high investment incentives remain to be an important determinant of realised FDI.

After removing the insignificant variables, the regression results provide similar magnitudes for those significant variables in the original equations. One major difference is that the level of significance of international trade has been raised to about 1% in the regression without the insignificant variables.

As pointed out in chapter 2, it may be no surprise that the regression results for realised FDI are not as good as those for pledged FDI. Foreign investors make their decisions and pledge their investments based on a certain set of favourable political, economic and social conditions (or investment environment). Pledged FDI is normally realised over a time period. For various reasons some pledged FDI is never materialised. Thus, such regional characteristics as the economic, social and political conditions under which FDI is pledged may well be different from those under which FDI is actually materialised. Another possible explanation is that pledged FDI is strongly market driven. As suggested earlier, it may include spurious pledges to improve market access. Realised FDI is primarily influenced by comparative advantages related variables such as the volume of trade, labour costs and human capital advantages. However, the significant difference in the explanatory powers of variables for pledged and realised FDI clearly requires further research.

After interpreting the results contained in Tables 3.4 and 3.5, it is appropriate to confirm if there is a long-run relationship in the variables used in the analysis. Even though the IPS test results indicate that all variables in the estimation equations are stationary, keeping in mind the ADF test results which suggest the existence of unit roots for most time series of the data set, the residuals from the estimation equations are examined to see whether they are stationary. Applying the IPS test, with the test statistic values -3.56715 and -6.41749 for residuals in the pledged and realised FDI specifications respectively, it is confirmed that the panel unit root tests support the existence of at least a cointegrating or long run relationship across all 27 provinces.

3.6 Conclusions

This study improves on previous studies of the regional distribution of FDI within a country by examining the econometric properties of the dataset within a panel framework. An IPS test for unit root has been employed and a long run relationship between the spatial distribution of FDI and a number of regional characteristics in China has been found. There is strong evidence in this study suggesting that pledged FDI is positively influenced by the level of international trade, R&D manpower, GDP growth, preferential investment policy, improvement in infrastructure, and advances in agglomeration. High effective wage rates and high information costs act as deterrents to FDI. Among all explanatory variables, GDP growth, agglomeration externalities, information costs/investment incentives and government FDI policies seem to be more powerful determinants than others in terms of their magnitudes.

International trade, effective wage rates, R&D manpower, information costs/investment incentives and government FDI policies remain significant determinants of realised FDI. However, because FDI is contracted and materialised at different times and because there may be a spurious market seeking element in pledged FDI, such regional characteristics as GDP growth, improvement in infrastructure and advances in agglomeration have lost their power in explaining realised FDI.

The results from this chapter can be interestingly compared with those from the preceding chapter. There are three common explanatory variables in the regression analyses of the determinants and regional distribution of FDI in China. They are wage rates, international trade and market size. In both regression analyses, the three common explanatory variables are all statistically significant in explaining pledged FDI, but the market size variable loses its explanatory power in explaining realised FDI. This demonstrates that some common factors influence both FDI inflows in China as a whole and their regional distribution within China, and that pledged FDI is market-size driven and realised FDI is not.

The empirical results from this chapter have important policy implications for economic development of individual provinces in China. The coastal areas have attracted a dominant proportion of FDI especially because of their long commercial and industrial traditions and geographical and ethnic links with Hong Kong, Macao and Taiwan. While the coastal areas are expected to absorb an increasing amount of FDI, the inland areas may exploit their advantage of relatively lower labour costs, and enhance other regional characteristics to attract more FDI. Since the Chinese government is in the process of providing national treatment for foreign investors, differences in investment incentives between the coastal and inland areas are likely to diminish. As noted by Gong (1995) and Broadman and Sun (1997), FDI has already begun to penetrate into inland areas. This study suggests that improvements in physical and scientific infrastructure and enhancements in economic activities and agglomeration will make inland areas more attractive to foreign investors.

Chapter 4: Foreign Direct Investment, Knowledge Spillovers and Economic Growth

Abstract

A dynamic general equilibrium model is constructed in this chapter to examine the interactive relationships among foreign direct investment (FDI), knowledge spillovers and long run economic growth in a developing country. The ideas of endogenous product cycles and trade-related international knowledge spillovers of Grossman and Helpman (1991a, c) are modified and extended to FDI. Unlike the FDI-innovation-growth model of Walz (1997), this study explicitly recognises the learning costs of local firms and the impact of knowledge gap. A steady-state equilibrium is derived for the developing country. It is concluded that economic growth in the presence of FDI is determined by the stock of human capital, the subjective discount rate and knowledge gap, while unskilled labour can not sustain growth.

Chapter 4: Foreign Direct Investment, Knowledge Spillovers and Economic Growth

4.1 Introduction

In chapters 2 and 3, the determinants and regional distribution of inward foreign direct investment (FDI) in China were empirically assessed. This and the next chapter are concerned with the impact of FDI on economic growth. More specifically, this chapter provides a theoretical model for FDI and growth, and chapter 5 deals with an empirical investigation.

In the context of endogenous growth theory, technological progress is the engine of long run economic growth. Because of the non-rival feature of knowledge, the stock of knowledge capital can be accumulated without bound [Romer, 1990]. Knowledge creation and spillovers lead to technological progress and sustain long run growth.

Many of the growth promoting factors identified by endogenous growth theory can be initiated and nurtured to promote growth through FDI [Balasubramanyam et al., 1996]. The existence of multinational corporations (MNCs) is to a large extent attributed to the creation and utilisation of intangible assets or knowledge [Fors, 1997]. MNCs are not able to capture all quasi-rents from their knowledge creation and corresponding productive activities. Indeed, knowledge spillovers from FDI have been recognised as a major benefit accruing to host countries [Blomstrom and

Kokko, 1998]. Therefore, FDI can be deemed to be a catalyst for long run economic growth.

While considerable efforts have been devoted to the subject of long run rate of economic growth, few theoretical models are formulated to explicitly discuss the dynamic impact of FDI on growth with endogenous technological progress. One exception is Walz (1997) who incorporates FDI in a dynamic general equilibrium model. This study aims to build a dynamic general equilibrium model to examine the interactive relationships among FDI, knowledge spillovers and long run economic growth in a developing country. The ideas of endogenous product cycles and trade-related international knowledge spillovers of Grossman and Helpman (1991c) are modified and extended to FDI. Different from the FDI-innovation-growth model of Walz (1997), the current study explicitly incorporates the costs of learning efforts and the impact of knowledge gap between foreign and local firms. In addition, the usual assumption of full employment in the unskilled labour market of the developing country is relaxed while the human capital market clearing condition is still imposed.

The remainder of this chapter is organised as follows. Section 4.2 reviews the literature on the determinants of FDI, its relationships with knowledge spillovers, and its impact on long run economic growth. Section 4.3 describes the basic features of the theoretical model. In section 4.4, the conditions for a steady-state equilibrium are imposed for the developing country. The comparative steady-states of the model are analysed and main propositions about the determinants of economic growth are generated. Policy implications of the model are discussed in section 4.5. Finally, in section 4.6, a summary of the findings and some concluding observations are provided. Limitations and possible extensions of the model are also discussed in this section.

4.2 Literature Review

There is an enormous volume of studies on theories of economic growth and of FDI. However, literature surveys have remained largely independent of each other, with only the notable exception of de Mello (1997) who reviews the impact of FDI on the growth process for developing countries. For the purpose of this chapter, the review is a selective one, focusing narrowly on FDI, knowledge spillovers and economic growth in developing countries.

4.2.1 Determinants of FDI

There are inherent disadvantages and higher costs for foreign-owned firms (thereafter "foreign firms") to operate in a relatively unfamiliar host country market. These disadvantages and costs include having little knowledge, relative to local firms, of the host country's market, consumer preferences and business practices, communication and transport costs, higher costs of stationing personnel abroad, barriers due to language, customs and being outside the local business and government networks. Therefore, foreign firms must possess advantages and will undertake FDI under some specific conditions.

Dunning (1977) puts forward the concept of the eclectic paradigm which is also known as OLI advantages to explain the existence and development of FDI, where O, L, and I stand for ownership, locational and internalisation, respectively. As discussed in chapter 1, the major difference between foreign and local firms lies in the fact that foreign firms always own some amount of the proprietary advanced knowledge which consists of factors such as firm-specific process or product know-how, managerial and marketing skills, reputation and trademarks. Such knowledge-based firm-specific assets can be generally characterised as 'knowledge capital' and serve as a foreign-owned firm's *ownership advantage* to outweigh the disadvantages and costs of doing business in a host country. The host country offers *locational advantage* such as low factor prices. Then, given that markets for technology are typically imperfect, the effective exploitation of ownership advantage requires the foreign-owned firm, owner of knowledge-based assets, to *internalise* the international operations by establishing affiliates (FDI) in the host country rather than serving the host country's market by means of exports and/or licensing which involves relatively high transaction costs. Horstman and Markusen (1996) argue that there are two risks associated with licensing. First, product quality may not be maintained. Second, potential competitors can acquire technical secrets. In addition, Markusen (1995) gives two reasons why the knowledge-based firm-specific assets are more likely to give rise to FDI. First, such assets can be transferred easily back and forth across space at low cost. Second, knowledge often has a non-rival character, like a public good, in that it can be supplied to additional production plants with little increase in the associated costs, giving economies of scale at the level of the firm rather than individual plant.

4.2.2 FDI and Knowledge Spillovers

Knowledge is a non-rival and partially excludable good. It can be distinguished into two components. One is the more general information with wider applicability (the non-appropriable output). Like a 'public good', the application of the same knowledge in one activity does not preclude the simultaneous use by other agents. Hence, the non-rival part of knowledge contributes to a stock of general knowledge capital. The other component is the tacit and specific technical information (the appropriable output) which is the firm-specific element. The firm-specific technical information is proprietary and excludable, which implies that owners of knowledge can partially prevent others from using it. These two features of knowledge suggest the existence of 'knowledge spillovers'. Owners of knowledge are not able to internalise the full values of rewards. Knowledge of how to produce a new good disseminates gradually [Ethier and Markusen, 1996]. Therefore, other agents can acquire full or part of knowledge by devoting resources to imitate and do not need to pay the owners.

Knowledge spillovers can take place through a variety of channels that involve the transmission and diffusion of ideas and new technologies. Imports of high-tech products, machinery and equipment, adoption of foreign technology and acquisition of human capital through international study are certainly important conduits for the international diffusion of knowledge. However, FDI by MNCs is considered to be a major channel for the access to advanced technologies by developing countries. Mansfield and Romeo (1980) find that knowledge transferred through FDI is much newer than through licensing agreements. Blomstrom (1989) argues that the most significant channel for the dissemination of modern technology is 'spillovers' from FDI, rather than formal technology transfer agreements.

An important benefit of knowledge spillovers from FDI is an increase in the stock of knowledge capital in local firms in host countries. Because of this, a number of studies focus on the impact of FDI on the stock of knowledge capital in local firms in host countries. Caves (1974) identifies three mechanisms for knowledge spillovers. First, foreign-owned firms may raise the stock of knowledge capital of the host country's resources by improving their allocation. Given that FDI tends to occur in industries with high entry barriers, monopolistic distortions and their associated inefficiencies are reduced. Second, through either the foreign-owned firm's competitive force or demonstration effect, domestic-owned firms operating in imperfect markets may be induced to a higher level of technical efficiency. Finally, the presence of foreign-owned firms in an industry may speed the process or lower the cost of the transfer and diffusion of technology. The threat of competition may spur firms which might otherwise have been laggards to adopt best practice technology sooner. Imitation effects and the movement of personnel trained by multinational subsidiaries also enhance the transfer and diffusion of technology to domestic-owned firms.

Other potential sources of spillover efficiency benefits to the host country are the augmentation of domestic stock of human capital through labour training, the introduction of alternative management practices and organisational arrangements, and the influence of domestic-owned firms as a result of backward or forward linkages [Blomstrom and Kokko, 1998].

Some theoretical models on the interaction between FDI and knowledge spillovers emphasise two ideas: 'catch-up' [Findlay, 1978a; Wang, 1990; Wang and Blomstrom, 1992; Borensztein et al., 1998] and 'contagion' [Findlay, 1978a; Das, 1987; Walz, 1997]. It is sometimes argued that the wider the relative knowledge gap between foreign and local-owned firms, the greater the presence of foreign firms, then the greater spillovers will be and the greater the opportunities for local firms to achieve higher levels of knowledge. However, how can stone-age communities 'catch up' on modern societies especially when they are confronted with the most advanced technologies? And how can people know everything without making any effort?

According to Cantwell (1992/93), it is possible for one firm to imitate the firm-specific assets of another, but the degree of successful imitation depends upon its own past technological experience as encapsulated in its existing routines and team skills. If local firms do not lag too far behind MNCs, they will be in a position to embark on a catch-up process and benefit from the presence of FDI. However, if local firms are so far behind foreign firms, then it is impractical for them to benefit substantially from foreign firms' knowledge and they may fall even further behind. In other words, knowledge transferred by means of FDI may be too advanced to leave any mark on local firms. In this case, foreign firms may displace local firms. Therefore, foreign firms' activities in the developing country can generate both vicious and virtuous impacts. Taking an evolutionary theory, Perez (1997) argues that the capacity of domestic-owned firms to 'catch up' depends on their level of competitiveness which is characterised by 'path-dependency': the absorptive capacity of local firms depends on their stock of knowledge capital and knowledge gap with foreign firms in the country.

It is suggested that 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]. This is often referred to as 'contagion' effect. In other words, FDI provides an effective channel of communication that stimulates host country firms' learning activities. Wang and Blomstrom (1992) point out that the majority of spillovers do not arise automatically from the foreign presence. Instead, to achieve rewards from the presence of FDI requires domestic-owned firms to invest in 'learning activities' which involves a substantial commitment of real resources, e.g. searching for information, training personnel for new production methods, continuing incremental technological change to modify imitated technology for suiting local conditions and attaining higher standards of production. Put another way, the accumulation of knowledge capital stock is a costly and knowledge-intensive process.

4.2.3 FDI, Knowledge Spillovers and Long Run Economic Growth

In neo-classical growth theory, set up by Solow (1956), the possibility of sustained economic growth is ascribed to exogenous factors of production - technological progress and/or population/labour force growth driven only by time. As far as FDI is concerned, it would only have a level effect (i.e., a one-shot gain), but not a growth effect (i.e., a permanent change in the growth rate). Thus the potential impact of FDI on economic growth is confined to the short run.

Departing from neo-classical growth theory, endogenous growth theory relates sustained long run growth to a host of processes. These include human as well as physical capital accumulation [see, for example, Jones and Manuelli, 1990; Rebelo, 1991], learning by doing [see, for example, Arrow, 1962; Romer, 1986], government provision of public services [see, for example, Barro, 1990] and intentional accumulation of human capital [see, for example, Lucas, 1988; Young, 1991, 1993; Sjogren, 1998] and knowledge capital [Romer, 1990; Grossman and Helpman, 1991a, b; Segerstrom, 1991; Aghion and Howitt, 1992]. Grossman and Helpman (1994) argue, indeed, that commercially oriented R&D efforts that correspond to economic incentives and lead to improvements in knowledge level are the real engine of economic growth. Because knowledge, the result of cumulative R&D experience, is non-rival and partially non-excludable, the stock of knowledge capital can be accumulated without bounds, which allows later generations of researchers to proceed with a lower resource cost than their predecessors. Therefore, knowledge spillovers can sustain long run growth. Many recent theoretical models [see, for example, Romer, 1990; Grossman and Helpman, 1990a, 1991a; Rivera-Batiz and Romer, 1991a, b; Frenkel and Trauth, 1997] specify the process of knowledge capital accumulation, in which such non-appropriable benefits are embodied by assuming that the accumulation of knowledge capital depends on the amount of human capital or employment devoted to research and the total stock of knowledge capital to which researchers have access. Recognising knowledge spillovers from international trade, Grossman and Helpman (1991b) explore the hypothesis that the accumulation of knowledge capital will increase with the cumulative volume of international trade in tangible commodities.

In so far as it generates increasing returns in production through knowledge spillovers, FDI might be deemed to be a catalyst for economic growth in the long run. In addition, other features, such as economies of scale, imperfect competition, strategic considerations and technological progress emphasised by endogenous growth theory are entirely consistent with the spirit of FDI literature. Therefore, as Balasubramanyam et al. (1996) state, endogenous growth theory provides powerful support for the thesis that FDI could be a potent factor in promoting growth.

de Mello (1997) highlights four ways by which FDI can be expected to affect economic growth in a theoretical model: knowledge spillovers associated with FDI, the value added content of FDI-related production, FDI as a source of human capital augmentation and technological change. It is also argued that FDI may affect economic growth in host countries through other important channels. For example, Rodriguez-Clare (1996) explores how MNCs affect developing countries through the generation of backward and forward linkages. Dutt (1997) focuses on different sectoral patterns of FDI and their impact on growth.

Though there is a large volume of literature on FDI and economic growth, little research has been carried out on the implications of FDI for economic growth, especially through knowledge spillovers in the long run. One notable exception is Walz (1997) where technological progress is assumed to be in the form of introducing higher-quality goods by FDI. However, knowledge spillovers from FDI in his model are assumed to happen automatically. As is discussed above, knowledge can not be automatically transferred to developing host countries. In order to master the production process, some amount of resources needs to be devoted. Therefore, knowledge diffusion through FDI is by no means costless.

4.3 Theoretical Model of FDI, Knowledge Spillovers and Growth

In this section a simple theoretical model of FDI, knowledge spillover and growth is presented. The ideas of endogenous product cycles and trade-related international knowledge spillovers of Grossman and Helpman (1991a, c) are modified and extended to incorporate the literature on the role of FDI in knowledge spillovers and economic growth.

4.3.1 Basic Features

The main building blocks of the model are the innovation related R&D activities of foreign firms in a developed country, and imitation related R&D activities in local firms in a human capital short and unskilled labour surplus developing country. Foreign firms innovate new products which will be copied by local firms after these products are introduced into the developing country for some periods. The model addresses the idea that local firms' capacity to absorb advanced knowledge transferred through FDI depends on their learning efforts, the knowledge gap with foreign firms and the stock of knowledge capital in the developing country. The main features of the model are as follows:

First, following Malley and Moutos (1994), Walz (1997) and Glass and Kaggi (1998), foreign firms can geographically separate R&D activities from the production process and undertake FDI by establishing a production plant in the developing country. R&D activities are human capital intensive and responsible for producing knowledge-based firm-specific assets. The production process which puts the output of R&D activities - knowledge capital to use is relatively unskilled labour intensive. Therefore, provided the extra costs associated with penetrating the developing country's market do not exceed the production cost advantage, foreign firms through FDI can exploit factor price difference in the world economy, locating their production plants in a low cost developing country. Put another way, in the model, FDI is driven by both knowledge based assets and relative factor price differences between its home and the developing countries. The ownership and locational aspects of Dunning's (1977) OLI framework are emphasised.

Second, R&D activities lead to the acquisition of know-how needed to produce a new variety of modern goods. These activities can be distinguished into two types: innovation in which a completely new product is created, and imitation in which the product which already exists in the world is copied. Following Krugman (1979b) and Grossman and Helpman (1991a), it is assumed that the developing country's productivity in product innovation is sufficiently low that local firms can not develop new products. In other words, local firms' R&D activities are confined to imitation only, while foreign firms have the ability of innovation. This assumption may be most valid for developing countries, since innovation requires more critical conditions than imitation. Therefore, the presence of FDI is a necessary condition for the acquisition of advanced knowledge in the developing country. By their very nature, the innovation and imitation rates are both set to be endogenously determined.

Third, in the model, the costs of learning activities of local firms (imitation) are explicitly recognised in the developing country. A successful learning process (as an externality) of the developing country firms from MNCs involves real resource inputs [Wang and Blomstrom, 1992]. Accordingly, how many resources should be devoted to learning is essentially an investment decision.

Fourth, as mentioned earlier, in the presence of FDI, technological competition between foreign and local firms can generate both vicious and virtuous impacts on the economy of the developing country. Following Perez (1997), a knowledge gap is used as a proxy for local firms' level of competitiveness. Knowledge spillovers increase with the gap up to a certain critical level. Beyond this point, local firms will generally have no ability to absorb advanced knowledge. In this way, the hypotheses 'catch-up' and 'success breeds success' are both taken into account.

Another reason for incorporating a knowledge gap into the model is the interaction between foreign and local firms. Barrell and Pain (1997a) argue that any study of the impact of FDI on economic growth should seek to allow for the role of local firms' R&D activities before conclusions can be drawn. In other words, it is not simply the level of FDI but the interaction between local institutions and FDI that affects economic growth.

Fifth, human capital is included as one of the developing country's endowments. The existing stock of domestic human capital is important for attracting and adopting new knowledge, because the stock of human capital in the developing country is the pre-requisite for FDI, and the developing country firms need to have capacity to absorb new knowledge and therefore benefit from knowledge spillovers. MNCs possess more advanced knowledge than local firms, which allows them to introduce new goods. However, the application of advanced knowledge requires human capital with a minimum level of efficiency in the developing country, so that foreign investors can use local non-reproducible inputs and labour of the quality level to set up operations there. The stock of human capital in the developing country, therefore, limits the absorptive capability of a developing country [Borensztein et al., 1998]. An increase in the growth rate can only be achieved if there is already a sufficiently high level of human capital in the developing economy [de Mello, 1997]. Balasubramanyam et al. (1996) argue that the low volume of human capital endowment explains why technological progress accounts for a relatively low proportion of growth experienced in many developing countries. The low level of human capital constrains developing countries to undertake innovative R&D and take advantage of modern knowledge transferred by means of FDI.

Sixth, in the model, no physical capital is mentioned. For the reasons of simplicity and emphasis on the role of FDI in the process of knowledge skillovers, physical capital is left aside in the model. Therefore, FDI is assumed not to be driven by the imperfect capital market, but by knowledge based assets and relative factor price differences.

Finally, full employment of unskilled labour is not assumed, since the excess supply of unskilled labour is one important characteristic of many developing countries.

4.3.2 The Economy

Consider a developing country which is the host of FDI operating under fixed exchange rates. By an appropriate choice of units, exchange rates are pegged at unity. The infinitely lived consumers in the economy have identical preferences and share the same utility function. There are two classes of the final goods: a homogeneous traditional good Y such as an agricultural good, and a large number of differentiated, modern goods such as high-tech products. The specification of preferences for modern products is of the Spence (1976) and Dixit-Stiglitz (1977) formulation of horizontal product differentiation. That is, a demand function facing a firm of a single variety is of the constant elasticity type, and innovative products perform perfectly new functions and are in no way superior to older varieties. Put another way, the development of new goods does not tend to make any existing varieties obsolete, which implies that new and old goods are completely symmetrical and all goods actually produced will be produced in the same quantity and at the same price. Therefore, technological progress is equivalent to the expansion of the number of varieties of modern goods.

The economy is endowed with two factors: unskilled labour - L, and human capital – H. They are perfectly mobile among sectors of the country and internationally immobile. In order to simplify the dynamic analysis and highlight the effects of interest, it is assumed that L and H are in fixed and constant supply. This is consistent with Romer (1990). Therefore, an equilibrium allocation is reached when factor prices for L and H paid by the same type of firms are equal among sectors of the country, respectively. However, they do not need to be the same as the rest of the world. As a matter of fact, the factor price for L, i.e. wage rate is lower in developing countries than in developed countries.

Y is produced with L and H under constant returns to scale and perfectly competitive conditions by local firms. Modern goods are produced with increasing returns to scale and monopolistic competition. The production of a modern good comprises two stages. In the first stage, it is essential for a firm using H to acquire the know-how needed to produce a variety of modern goods. In the second stage, this variety can be assembled using L. By this assumption, the geographical fragment of R&D and production activities is allowed for. There are two kinds of firms producing modern goods – foreign and local firms. As the FDI literature stresses, MNCs often provide for much of their needs from local factor markets. In order to isolate the role of FDI in the developing country, it is assumed that MNCs have to hire factors of production from the local market as local firms do. The main difference between these two kinds of firms lies in their R&D activities. Foreign firms innovate, while local firms imitate. Foreign firms have absolute advantage in producing new products. However, this proprietary advantage is temporary. The complete absence of protection for 'intellectual property' is assumed in the developing country. Once a new product is produced in the market of the developing country, it will be targeted for imitation by a local firm under a positive probability. Then, as long as imitation efforts of a local firm succeed, the foreign firms' stream of monopoly profits ceases and further sales are impossible.

All final goods are assumed to be non-tradable. Therefore, the production technique of a variety of modern products is available in the country if, and only if, it is produced in the country. Then the analysis will only involve FDI. International trade and licensing are excluded. In other words, internalisation advantage is taken for granted. This assumption of non-tradable final goods can be justified by the argument that the developing country's market size is sufficient large, both foreign and local firms have already made decisions to serve the market by local production. In addition, according to Markusen (1995), most FDI in production facilities seems to be 'horizontal' in the sense that a majority of production outputs of foreign firms are sold in the developing country.

Factor price differences provide a preference for foreign-owned firms to relocate their production plants so as to take advantage of cheap unskilled labour available in the developing country. However, as discussed earlier, local firms always know the market, consumer preferences and business practices better than foreign firms in the developing country. This implies that foreign firms undertaking FDI have to incur costs for overseas operations. In fact, some of the costs are probably best modelled as fixed costs of entry, while others can be considered as those that raise average production costs.

First, consider an initial sunk cost to acquire all the information necessary to install a new manufacturing plant in the developing country market. This information cost can be seen as the outlays in learning the local language, getting information on local demand and understanding laws, customs and regulations of the developing country [Motta, 1992]. In accordance with the literature of FDI, it is supposed that this information disadvantage can be outweighed by firm-specific advantages. Otherwise, it would be non-profitable for foreign firms to produce in the developing country. To capture this notion, it is assumed as in Walz (1997) that most of these initial extra costs fall directly or indirectly on human capital in the developing country. Then, they can be measured in units of H.

Second, following Findley (1978b), Perez (1997) and Glass and Saggi (1998), it is assumed that foreign firms pay higher wage rates than local firms to the same labour in the developing country. That is

$$w_F = (1+\zeta)w_D \text{, with } \zeta > 0 \qquad [4.1]$$

where w represents the nominal wage rate and ζ denotes the cost disadvantage that foreign firms sustain in the developing country's market for production. From now on, subscripts (D, F) are used to designate a variable as referring to local and foreign firms (MNCs) respectively.

4.3.3 Consumers

Consider a population of infinitely lived consumers who have identical, homothetic preferences and derive their utility from the consumption of final goods - a traditional good together with a number of horizontally differentiated, modern goods. Suppose the representative consumer has a time-separable intertemporal utility function of the form

$$U = \int_t^{\infty} e^{-\rho(\tau - t)} \log u(\cdot) d\tau \qquad [4.2]$$

where $\rho > 0$ represents the constant subjective discount rate or the rate of time preference and $u(\cdot)$ is an instantaneous subutility function. This formulation assumes that the consumer's utility at time t is a weighted sum of all future flows of utility. A positive value of ρ means that utilities are valued less the later they are received. Assume that $u(\cdot)$ is non-decreasing, strictly quasi-concave and homogeneous of degree one in its arguments. The concavity assumption generates an eagerness to a smooth the consumption path over time. Put another way, consumers prefer a relatively uniform pattern of consumption to one which has some deviations. More precisely, the representative consumer's instantaneous subutility function is given by a Cobb-Douglas form

$$u = Y^{1-\theta} X^{\theta},$$

$$X = [\int_0^{n_D} x_D(\omega)^{\eta} d\omega + \int_0^{n_F} x_F(\omega)^{\eta} d\omega]^{1/\eta} \qquad \theta, \eta \in (0,1) \qquad [4.2']$$

where n_D and n_F are the number of varieties that have been produced by local and foreign firms (MNCs) respectively, Y is the consumption level of the traditional good, $x_D(\omega)$ is the consumption of the locally produced variety ω, and $x_F(\omega)$ is the consumption of the modern product ω manufactured by a foreign firm. n = n(t) = $n_D + n_F$ is the total number (i.e. varieties) of modern goods available on the market at time t and is assumed to be a large number, although small relative to the number of potential products. η is a parameter which characterises different tastes for variety. A higher value of η indicates that modern goods can be more easily substituted for each other. η = 1 implies that modern goods are perfect substitutes and there will be no room for monopolistic competition. Lower values of η correspond to greater 'product differentiation' within the modern goods sector, which means that consumers have a strong preference for variety. It is straightforward to show that the elasticity of substitution between any two differentiated products is constant, $\varepsilon = 1/(1-\eta) > 1$. ε is restricted to be greater than unity in order to guarantee the existence of an equilibrium.

Assume the representative consumer can borrow or lend freely on the local capital market with instantaneous rate of interest $r(t)$ which is exogenous and is set by the central bank. Hence $R(t) = \int_0^s r(s)ds$ represents the cumulative interest rate up to time t. The consumer discounts the stream of total expenditure and factor income by the interest rate. The present value of spending does not exceed the present value of factor income plus the value of the initial asset holdings. The intertemporal budget constraint is

$$\int_t^{\infty} e^{-[R(\tau)-R(t)]}E(\tau)d\tau \leq \int_t^{\infty} e^{-[R(\tau)-R(t)]}I(\tau)d\tau + A(t) \qquad [4.3]$$

where $E(\tau)$ and $I(\tau)$ are the consumer's total expenditure and factor income in period τ, respectively, A(t) is the value of his accumulated assets at t, with A(0) = 0.

The infinitely lived representative consumer seeks to maximise total lifetime utility subject to the intertemporal budget constraint. This maximisation problem can be broken down into two stages: first, choose Y, $x_D(\omega)$ and $x_F(\omega)$ to maximise $u(\cdot)$ given E(t), prices, n_D and n_F, and second, solve for the time pattern of expenditures that maximises U subject to the intertemporal budget constraint, i.e. Equation (4.3).

The first stage of this dynamic optimisation problem yields instantaneous demand functions for $x_D(\omega)$, $x_F(\omega)$ and Y

$$x_D(\omega) = \theta E \frac{p_D(\omega)^{-\varepsilon}}{\int_0^{n_D(t)} p_D(\omega')^{1-\varepsilon} d\omega' + \int_0^{n_F(t)} p_F(\omega')^{1-\varepsilon} d\omega'} \qquad [4.4a]$$

$$x_F(\omega) = \theta E \frac{p_F(\omega)^{-\varepsilon}}{\int_0^{n_D(t)} p_D(\omega')^{1-\varepsilon} d\omega' + \int_0^{n_F(t)} p_F(\omega')^{1-\varepsilon} d\omega'} \qquad [4.4b]$$

$$Y = (1-\theta)E / p_Y \qquad [4.4c]$$

where p_Y is the price of the traditional good, and $p(\omega)$ is the price of differentiated modern good ω.

In the second stage, the solution requires the following optimal expenditure path:

$$\frac{\dot{E}}{E} = r - \rho \qquad [4.5]$$

where a dot over a variable, such as $\dot{E}$, denotes differentiation with respect to time. This equation implies that the growth rate of expenditure depends on the difference between the nominal interest rate r and the subjective discount rate ρ. Expenditure (Consumption) rises ($\dot{E} > 0$) when the rate of return on capital is greater than the time preference ($r > \rho$). In other words, current savings will produce future consumption and future consumption is higher than current consumption. Proofs for the consumer's problem appear in the Appendix A.

4.3.4 Firms

I. The traditional good sector

A homogeneous product Y is produced by local producers only. The production technology in the traditional good sector has constant returns to scale, using L and H.

$$Y = A_Y H_Y^{1-\varsigma} L_Y^{\varsigma}, \qquad \varsigma \in (0,1) \qquad [4.6]$$

where A_Y is a constant reflecting the choice of units, H_Y, L_Y stand for human capital and unskilled labour employed in the traditional good production, respectively, and ς is a constant.

Additionally, suppose perfect competition prevails in the market for the traditional good. Therefore, the price of this good p_Y equals its marginal production cost. By a suitable choice of units (i.e., A_Y), a pricing equation for the traditional good can be derived:

$$p_Y = h_D^{1-\varsigma} w_D^{\varsigma} \qquad [4.7]$$

where h_D is the rate of return of human capital and w_D denotes the wage rate in the developing country.

Using Shephard's lemma and Equation (4.4c), the following aggregate demands for H_Y and L_Y are obtained from Equation (4.7):

$$H_Y = (1-\varsigma)\frac{p_Y Y}{h_D} = (1-\varsigma)\frac{(1-\theta)E}{h_D} \qquad [4.8a]$$

$$L_Y = \varsigma\frac{p_Y Y}{w_D} = \varsigma\frac{(1-\theta)E}{w_D} \qquad [4.8b]$$

Hence, the relative factor pricing equation is yielded,

$$\frac{w_D}{h_D} = \frac{\varsigma}{1-\varsigma}\frac{H_Y}{L_Y} \qquad [4.9]$$

II. The modern-goods sector

Firms in the modern-goods sector undertake two distinct activities. First, they use H to learn know-how for varieties of differentiated products. This learning process can be either innovation or imitation. The learning costs that occur in this stage are fixed sunk costs F which are of a firm-specific nature and can be interpreted as the outlays in R&D, since they are only borne once, and their size is independent of the number of units that are subsequently produced. The knowledge-based firm-specific assets result from the bearing of the fixed costs. Second, products are manufactured using L subject to a simple technology of constant returns to scale. Suppose each additional unit of $x(\omega)$ is produced from a_X units of L. The specified technology implies that scale economies are internal to firms. Therefore, perfect competition is no longer possible. Instead, the market structure emerges as one of Chamberlinian monopolistic competition [Krugman, 1979a]. The firms are a set (continuum) of monopolistic competitors. In addition, since all varieties require the same technology and enter the consumption symmetrically, another implication of fixed learning costs is that instantaneous efficiency does not require all varieties of the infinitely many modern goods to be made available at a given point in time. In other words, only a subset of existing goods is produced at any one time.

As mentioned above, in the second stage, foreign-owned firms have an additional sunk cost ψ to acquire all the information which is necessary when establishing a new manufacturing plant in the developing country. This non-recoverable start-up cost can be measured by H, i.e. $\Psi = \lambda H$ where $\lambda \in (0,1)$ is constant. Suppose $\psi < F$ which implies the knowledge based firm-specific advantage offsets information disadvantage.

In accordance with the above descriptions, the optimisation problem faced by the firm can be decomposed into two stages. First, given other firms' R&D activities, the firm chooses its own R&D intensity in order to maximise its discounted stream of profits. Once successful in R&D, the firm then behaves like a Bertrand competitor. Taking the prices of other firms' products and the level of aggregate expenditure as given, every firm maximises instantaneous operating profits by equalling marginal revenue to marginal cost. The demand function is then what the firm of each specialised modern goods takes as given in choosing the profit-maximising price to set. It is well known that with a constant elasticity of substitution between varieties and Bertrand competition, a price is set to be a constant mark-up over marginal costs.

Consider first the production activity. The marginal cost of production for a local firm is $a_X w_D$, while for a foreign-owned firm, it is $a_X w_F$. Then the pricing equations are as follows:

$$p(\omega)_i = p_i = a_X w_i / \eta \qquad i = D, F \qquad [4.10]$$

where p_i represents the price set up by firm i. Since a_X and η are both constant, firms of the same type set up the same price. The firm i's instantaneous profit is

$$\pi_i = (1-\eta)p_i x_i \qquad i = D, F \qquad [4.11]$$

where x_i stands for the equilibrium output level by firm i.

In equilibrium, the market structure is such that a single local firm as an imitator competes with a single foreign firm in the developing country for any specific variety of the differentiated products. In Bertrand competition, if firms are selling identical products, the equilibrium turns out to be the one where price equals marginal cost. Due to the difference of marginal costs faced by local and foreign firms, it is possible that local firms attracted by profits then engage in imitation to copy new products from foreign firms. If, as it happens, there are two local firms copying a product in common, then in Bertrand competition, they would earn zero profits, and would be unable to cover the positive fixed learning costs. Similarly, it can be justified that no foreign firm would ever invest resources to learn how to produce a product existing in the world. The possibilities are ruled out that imitation takes place within foreign firms, and that two local firms copy the same new product at the same time. In addition, once a product developed by a foreign firm is copied by a local firm, the latter uses its cost advantage to capture the whole market so that the former experiences a complete capital loss. Therefore, each known variety of the differentiated product is considered to be produced by a single firm at any time.

Turning to learning activities, there is free entry into the business of being an inventor or imitator (R&D), so that anyone can pay a price to secure the net present value of the profit stream. The decision to devote resources into R&D depends on a comparison of the net present value V(t) and the fixed sunk cost of the initial investment in learning know-how F. If V(t) > F, then an infinite amount of resources would be input into R&D at time t. Hence this case can not arise in equilibrium. Similarly, if V(t) < F, then no resources would be devoted into R&D at time t. Therefore, there would be no technological progress and the number of modern products in the economy remains unchanged. Then, with the presence of technological progress, the discussions will focus on the equilibrium with positive R&D investment and hence the growing number of goods at all points in time. In these cases, the condition that V(t) = F holds for all t.

To find the present value of profits, the flow of instantaneous profits for each type of firms is discounted. Suppose a local firm chooses at random one of the existing, not previously imitated, products to imitate. In an equilibrium, the present value for a domestic-owned firm $V_D(t)$ can be derived straightforward. It takes the form of

$$V_D(t) = \int_t^{\infty} e^{-[R(\tau)-R(t)]}\pi_D(\tau)d\tau \qquad [4.12a]$$

For foreign firms, the chance needs to be accounted for that their monopoly rents will be terminated due to imitation. Suppose that a new product brought out into the market by a foreign firm at time t will be copied by a local firm at time T, where $T \in (t,\infty)$. Then the innovator's stream of monopoly profits ends at T. Following

Grossman and Helpman (1991a), let $\phi(t,T)=1-e^{-\int_t^T \mu(\tau)d\tau}$ and $\mu(T)=\frac{\dot{n}_D(T)}{n(T)}$, where $\phi(t,T)$ denotes that cumulative distribution function for T for a product innovated at t (i.e. the probability that monopoly power will be lost to a imitator before time T), and $\mu(T)$ is the instantaneous rate of imitation, then the expected present value for a foreign-owned firm is

$$V_F(t)=\int_t^{\infty}\phi_T(t,T)\{\int_t^T e^{-[R(\tau)-R(t)]}\pi_F(\tau)d\tau\}dT \quad [4.12b]$$

Differentiating the above equations [4.12a] and [4.12b] with respect to time t and rearranging them, the following two no-arbitrage equations are obtained,

$$\dot{V}_D=-\pi_D+rV_D \quad [4.13a]$$

$$\dot{V}_F=-\pi_F+(r+\mu)V_F \quad [4.13b]$$

These equations equate the sum of the instantaneous profit (first term on the right-hand side) and the rate of capital gain (second term on the right-hand side) to the instantaneous risk adjusted interest rate. For a local firm, the risk premium is just zero, while for a foreign firm, it is equal to the rate of imitation.

Consider now the initial *fixed sunk cost of learning* F. *The imitation of a product* requires a_D / K_D units of labour, where a_D is a fixed productivity parameter and K_D denotes the knowledge stock of the developing country. Let H_D represents human capital employed in the imitation. Then, the number of varieties that can be produced by local firms grows according to the following equation:

$$\dot{n}_D = \frac{H_D}{a_D / K_D} \qquad [4.14a]$$

Similar to the imitation, the innovation of a new product requires a_F / K_F units of labour, where a_F is a fixed productivity parameter and K_F represents the stock of disembodied knowledge capital in the home countries of MNCs. Let H_F be the aggregate amount of human capital hired in the innovation. Note that H_F is not a fraction of H, since MNCs conduct R&D activities only in their home countries. Then, a flow of new products is given by

$$\dot{n} = \frac{H_F}{a_F / K_F} \qquad [4.14b]$$

Under these specifications, the initial fixed sunk costs in R&D for imitation and innovation are $F_D = h_D a_D / K_D$ and $F_F = h_F a_F / K_F$, respectively. In addition, the constant costs in R&D imply that h_i and K_i, i = D, F grow at the common rate in the equilibrium, i.e. $\frac{\dot{h}_i}{h_i} = \frac{\dot{K}_i}{K_i}$. Recall that in the equilibrium, the condition that V(t) = F holds. Then $\frac{\dot{V}(t)}{V(t)} = \frac{\dot{F}}{F}$. After rearranging equations, the following equations are obtained:

$$r = \frac{\pi_D}{h_D * \frac{a_D}{K_D}} \quad [4.15a]$$

$$r + \mu = \frac{\pi_F}{h_F * \frac{a_F}{K_F}} \quad [4.15b]$$

These two equations imply that at every point in time the instantaneous profit must be just sufficient to cover the risk-adjusted interest cost on the initial investment in R&D.

4.3.5 Knowledge Capital Accumulation

Now the process for the accumulation of knowledge capital is considered in which technological progress is embodied in the developing country. In the presence of FDI, technological progress is possibly promoted not only by local firms' R&D activities but also knowledge spillovers from FDI. According to the assumption that foreign firms innovate while domestic-owned firms imitate, the indirect transfer of knowledge through FDI provides the decisive stimulus for active research in the developing country. In view of the detailed discussions in section 4.2, a plausible hypothesis is explored that whether local firms can possibly benefit from the spillovers of each local R&D project and foreign knowledge depends on the economy's instantaneous stock of knowledge capital, local firms' initial level of technological competence represented by the knowledge gap, and learning efforts proxied by human capital employed in R&D. Accordingly, the evolution of the aggregate stock of knowledge capital can be specified as:

$$\dot{K}_D = \Phi(K_D, H_D, x) = H_D(\frac{x-1}{e^{\vartheta x}})K_D \quad [4.16]$$

where x stands for the knowledge gap. This equation implies that the more human capital employed in the process of knowledge accumulation, the more knowledge can firms absorb. The $e^{\vartheta x}$ here is used to capture the nonlinear relationship between the accumulation of knowledge capital and knowledge gap. Details have been described in section 4.3.1.

From Equations (14) and (16), the following can be derived:

$$\dot{K}_D = \dot{n}_D a_D(\frac{x-1}{e^{\vartheta x}}) \quad [4.17]$$

If x is supposed to be exogenous, by carefully choosing units, then the total knowledge stock of the developing country can be written as

$$K_D = n_D a_D(\frac{x-1}{e^{\vartheta x}}) \quad [4.18a]$$

As in Grossman and Helpman (1990a, 1991a), the knowledge stock of the home countries of foreign firms K_F is taken to be proportional to cumulative experience in innovation. By choosing units for K_F so that the factor of proportionality is a_F, the following is obtained:

$$K_F = a_F n \qquad [4.18b]$$

4.3.6 Resource Constraints

The theoretical model described above incorporates the phenomenon of FDI in a human-capital short and unskilled labour surplus economy. There are two factors of production, unskilled labour and human capital. It is assumed that at any point in time there is an excess supply of unskilled labour. This assumption is a characteristic of many developing countries. Unskilled labour is employed by local firms to produce the traditional goods, and by both local firms and foreign firms to manufacture modern goods. The demand by producers of the traditional goods is given by Equation (4.8b). Define $X_D = n_D x_D$ and $X_F = n_F x_F$ which represent the aggregate output of modern products manufactured by local and foreign firms, respectively. The demand by local producers of modern goods is $a_x X_D$, while by foreign producers of modern goods is $a_x X_F$. They are written by Equations (4.19a) and (4.19b), respectively.

$$a_x X_D = \theta E(\frac{\eta}{w_D})\frac{\mu(1+\zeta)^{\varepsilon-1}}{\mu(1+\zeta)^{\varepsilon-1}+g} \qquad [4.19a]$$

$$a_x X_F = \theta E(\frac{\eta}{w_D})\frac{g(1+\zeta)^{-1}}{\mu(1+\zeta)^{\varepsilon-1}+g} \qquad [4.19b]$$

The unskilled labour market condition is satisfied by the following expression.

$$L_Y + a_X(X_D + X_F) \leq L \qquad [4.20a]$$

Human capital is required by local firms in the processes of production of traditional goods and imitation of modern goods. Moreover, the start-up costs of foreign firms are measured by human capital. Let H stand for the total human capital available in the developing country. Hence, the factor-market clearing condition equates demand and supply:

$$H_Y + H_D + \lambda H = H \qquad [4.20b]$$

Substituting (4.14a) and (4.18a) into (4.20b) yields

$$H_Y = (1-\lambda)H - \frac{e^{\vartheta x}}{x-1}\frac{\dot{n}_D}{n_D} \qquad [4.20b']$$

So far, the preferences, endowments and basic features of the production structure have been described, and the evolution equations for the stock of knowledge capital have been specified. In addition, some of the equilibrium conditions have been derived. These include the pricing equations for the traditional and modern goods, and no-arbitrage conditions relating equilibrium asset returns and the human capital market clearing condition. In the remainder of this study, the discussion focuses on a steady state equilibrium with positive rates of growth and imitation. The steady state equilibrium is also referred to as the balanced growth equilibrium in which all variables grow at constant rates.

4.4 Steady-State Equilibrium and Determinants of Long Run Growth

In this section, conditions are imposed for a steady-state equilibrium. Key linkages between variables of interest are established in the steady-state equilibrium. Furthermore, the model described above generates an endogenous rate of long run growth. The determinants of the growth rate of the developing country are discussed. Proofs for all propositions appear in the Appendix B.

In the steady state, the rate of growth in the number of varieties that have been produced by local and foreign firms, is equal to the rate of innovation denoted as g,

$$\frac{\dot{n}_D}{n_D} = \frac{\dot{n}_F}{n_F} = \frac{\dot{n}}{n} = g \qquad [4.21]$$

It is easy to show that, in the steady state, the ratio of the number of varieties produced by foreign firms to the number of varieties produced by local firms is constant and equal to the ratio of the growth rate to the rate of imitation,

$$\frac{n_F}{n_D} = \frac{g}{\mu} \qquad [4.22]$$

The share of local firms in the total output of modern products is calculated as $\sigma_D = \frac{X_D}{X_D + X_F} = \frac{\mu(1+\zeta)^{\varepsilon}}{g+\mu(1+\zeta)^{\varepsilon}}$, and that of foreign firms as $\sigma_F = \frac{X_F}{X_D + X_F} = \frac{g}{g+\mu(1+\zeta)^{\varepsilon}}$. In the steady state they are constant.

Comparing Equations (4.8b) and (4.19a) yields the following:

$$\frac{X_D}{L_Y} = \frac{\theta}{1-\theta}\frac{\eta}{a_X\varsigma}\left(\frac{\mu(1+\zeta)^{\varepsilon-1}}{\mu(1+\zeta)^{\varepsilon-1}+g}\right) \quad [4.23]$$

Therefore, the ratio of labour employed in producing modern goods to labour employed in producing traditional goods by local firms is constant in the long run, which implies that the steady-state intersectoral allocation of labour remains constant.

PROPOSITION 1. In the steady-state, the stock of disembodied knowledge capital in both host and home countries, and all product and factor prices grow at the common rate g, as does the aggregate consumer expenditure. $\frac{\dot{K}_i}{K_i} = \frac{\dot{h}_i}{h_i} = \frac{\dot{w}_i}{w_i} = \frac{\dot{p}_Y}{p_Y} = \frac{\dot{p}_i}{\dot{p}_i} = \frac{\dot{E}}{E} = g$. The growth rate of instantaneous utility is $\frac{\dot{u}}{u} = \frac{\theta(1-\eta)}{\eta}g$. Hence, the factors that affect g influence the steady-state growth in utility.

Since the rate of return on human capital in the developing country grows at the same rate as in the home countries of foreign-owned firms, it is supposed that

$$h_F = h_D \qquad [4.24]$$

Combining Equations (4.1), (4.9), (4.10), (4.11), (4.18a), (4.18b), (4.20b'), (4.23), and (4.24) into Equations (4.15a) and (4.15b), the following equations are derived:

$$r = \Lambda_1[(1-\lambda)H\Theta(x) - g][\frac{\mu\Lambda_2}{\mu\Lambda_2 + g}] \qquad [4.25a]$$

$$r + \mu = \Lambda_1[(1-\lambda)H - g\Theta^{-1}(x)][\frac{\mu + g}{\mu\Lambda_2 + g}] \qquad [4.25b]$$

where $\Lambda_1 = \frac{1-\eta}{1-\varsigma}\frac{\theta}{1-\theta} > 0$, $\Lambda_2 = (1+\zeta)^{\varepsilon-1} > 1$, $\Theta(x) = \frac{x-1}{e^{\vartheta x}}$ and $\Theta(x) \in (0,1)$.

To close the model, the relation between the growth rate g and the interest rate r implied by the consumer side needs to be imposed. In view of Equation (4.5), the steady-state interest rate is equal to the growth rate plus the consumer's subjective discount rate, i.e. $r = g + \rho$. Substituting this equation into Equations (4.25a) and (4.25b) and rearranging terms, the steady state equilibrium can be summarised in terms of the relations between the rate of growth and the rate of imitation that hold along a balanced growth path.

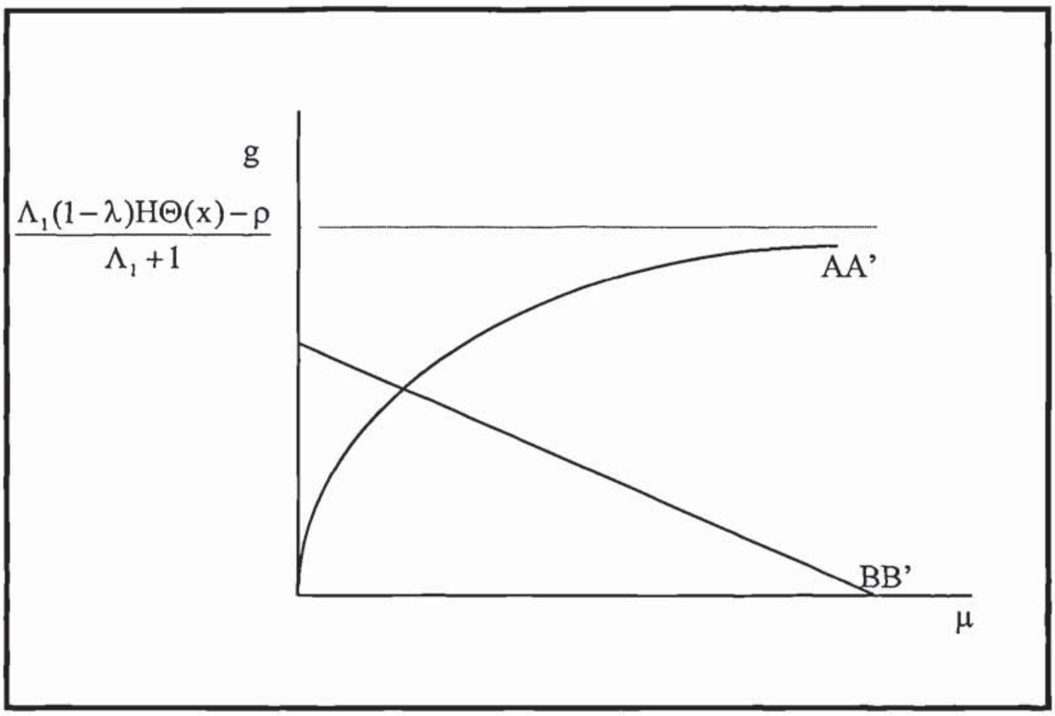
$$F^1 = \mu[\Lambda_1\Lambda_2(1-\lambda)H\Theta(x) - \Lambda_2\rho - (\Lambda_1 + 1)\Lambda_2 g] - g(g+\rho) = 0 \qquad [4.26a]$$

$$F^2 = \mu\Lambda_2\Theta(x) - \Lambda_1(1-\lambda)H + \rho[\Lambda_2\Theta(x) + \Lambda_2 - 1] + g[\Lambda_2\Theta(x) + \Lambda_2 - 1 + \Lambda_1\Lambda_2] = 0 \qquad [4.26b]$$

Equations (4.26a) and (4.26b) form a system of two equations to determine two unknown endogenous variables, g - the growth rate and μ - the rate of imitation with η, ς, θ, ζ, x, ρ, λ, ϑ and H as parameters. Therefore, the steady-state equilibrium will be conditional on the developing country's economic conditions.

PROPOSITION 2. There exists a unique steady-state equilibrium, characterised by a pair of positive constants ($\bar{g},\bar{\mu}$) such that $F^1(\bar{g},\bar{\mu}) = F^2(\bar{g},\bar{\mu}) = 0$.

Figure 4.1 The Steady-State Equilibrium in the Model



Obviously, it is difficult to solve the system explicitly for $\overline{g}$ and $\overline{\mu}$. The steady-state relationship between the growth rate and the rate of imitation can be depicted in Figure 4.1. The horizontal axis shows the imitation rate while the vertical axis shows the rate of growth. Equations (4.26a) and (4.26b) are expressed by curves AA' and BB', respectively. In fact, Equation (4.26a) represents a hyperbola. However, the steady state rate of imitation should be positive, which makes economic sense. Using the implicit-function theorem, it can be found that the slope of AA' is always bigger than zero. It can easily be yielded that BB' is a downward sloping straight line. The intersection of AA' and BB' determines the steady state rates of growth and imitation.

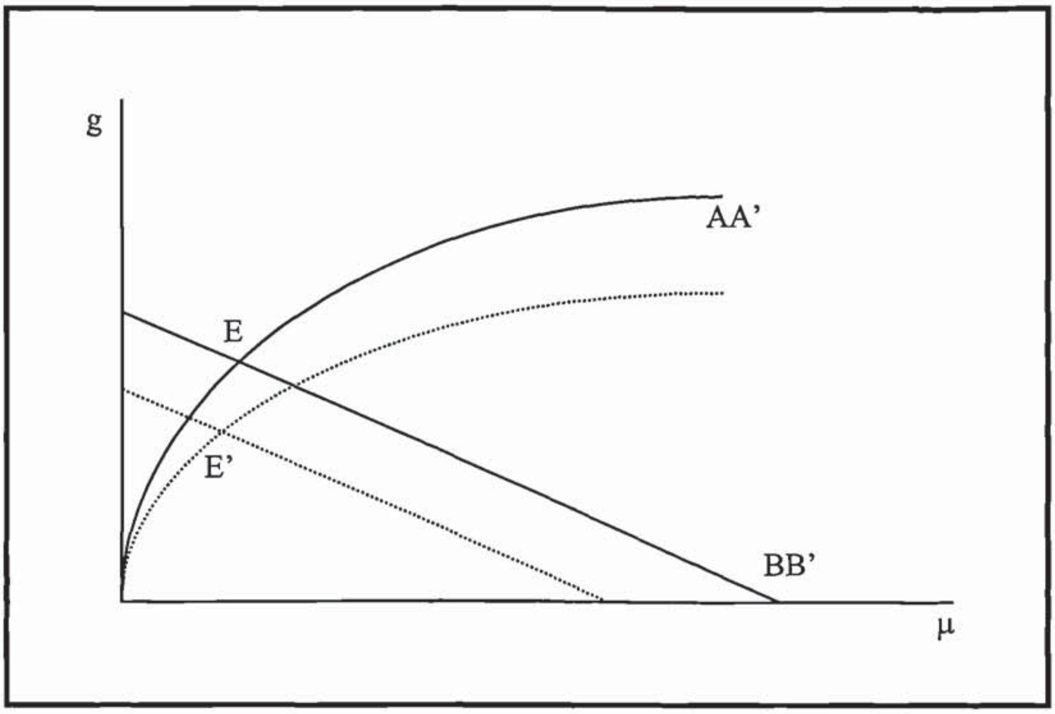
The description of the steady-state equilibrium has been completed in the human capital short and unskilled labour surplus developing economy. It is now appropriate to examine the effects of various parameters on the endogenous variables in order to find what forces lead to a greater extent of economic growth in the developing country. First, the implication of the features of the country will be derived such as the subjective discount rate, the stock of human capital, the unskilled labour and sectoral productivity levels for the steady state growth rate. Second, the influence of FDI on the country will be analysed.

PROPOSITION 3. The rate of growth declines with the subjective discount rate and increases with the stock of human capital. However, the rate of growth is independent of unskilled labour and the coefficients that determine absolute productivity in production and learning activities.

In fact, this proposition shares much in common with that derived by Romer (1990) for a closed economy. The subjective discount rate ρ measures how much the consumer favours consumption today over tomorrow. The higher the value of ρ, the less patient is the consumer. Therefore, a greater willingness to save raises the growth rate. Because of the fact that human capital is a scale variable, a relative abundance of human capital leads the economy to grow quickly.

Figure 4.2a Effects of the Subjective Discount Rate

on the Rates of Growth and Imitation

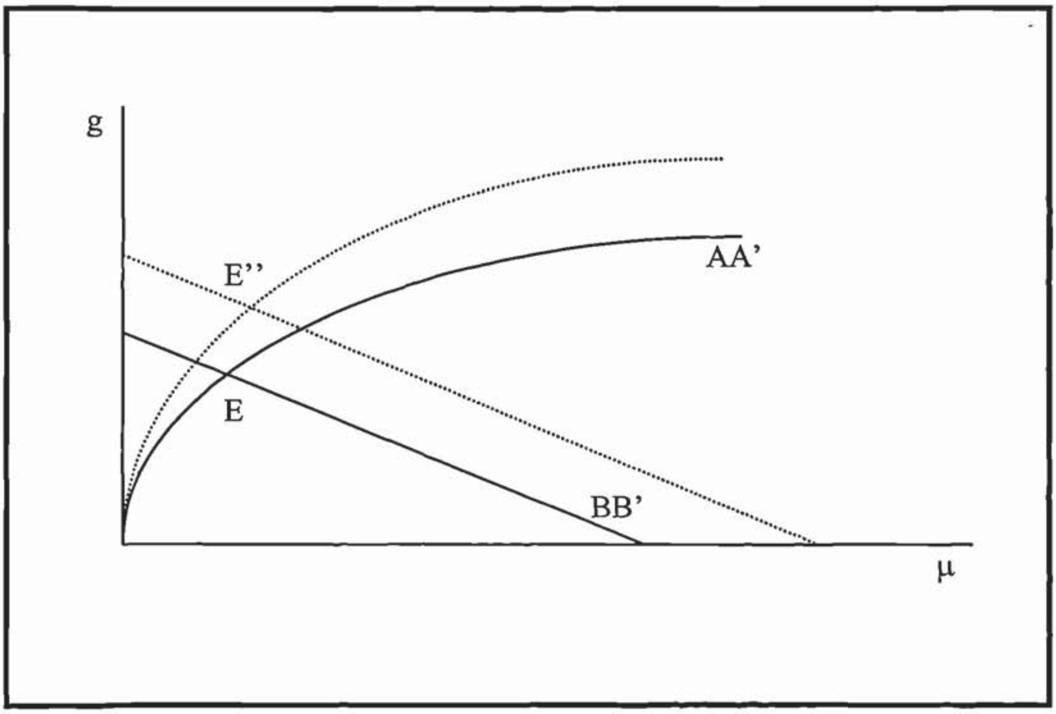


Figures 4.2a and 4.2b illustrate the effects of the subjective discount rate and the stock of human capital on growth. Before the increase in the subjective discount rate,

the steady state equilibrium is at E. By referring back to Equations (4.26a) and (4.26b), an increase in the subjective discount rate causes curves AA' and BB' to shift to the left. The new equilibrium is at E'. Thus, the steady state growth rate falls, while the situation of the imitation rate is uncertain. In contrast, curves AA' and BB' both shift to the right in response to an increase in the stock of human capital. The new equilibrium is at E''. Therefore, the rate of growth increases and the imitation rate is still uncertain.

Figure 4.2b Effects of the Stock of Human Capital

on the Rates of Growth and Imitation



PROPOSITION 4. Knowledge gap is one of the important determinants of economic growth. The growth rate is greater, the wider the knowledge gap between local and foreign firms up to a certain critical level $\bar{x} = \frac{\vartheta + 1}{\vartheta}$, thereafter it declines.

The developing country might benefit from knowledge spillovers in the presence of FDI. However, FDI does not always stimulate the growth rate of the developing economy to rise in the long run. The impact depends on the knowledge gap between local firms and foreign firms which undertake FDI.

PROPOSITION 5. The growth rate decreases when the information costs measured by human capital are higher.

The developing country is relatively human capital short. The more the human capital required by foreign firms, the less local firms can use. In turn, local firms' learning efforts fall. This obviously leads to negative impact on economic growth.

4.5 Policy Implications

A few important policy implications of the model emerge from Propositions 3, 4 and 5. From Proposition 3, high domestic savings, inward FDI and quick accumulation of human capital need to be encouraged. One of the main causes of the "East Asian Miracle" was the allocation of physical and human resources to highly productive investment [World Bank, 1993]. In a closed economy, saving is the only source of investment. In an open economy, inward FDI and investment financed by borrowing from abroad are the two additional sources. An improvement of education and training directly contributes to the creation and augmentation of human capital. All this helps speed up long run economic growth.

Proposition 4 implies the importance of technological capabilities of local firms in developing countries. Successful imitation requires not only the availability of advanced technologies from foreign firms, but also an adequate absorptive ability of local firms. Local firms with well-established technological capabilities are generally able to assimilate foreign technologies and mobilise resources to compete with foreign firms in their own home market. Government policy of developing countries needs to encourage R&D activities in local firms.

Proposition 5 reveals the significance of transparency of investment environment in developing countries. If government policy of a developing country helps potential foreign investors to be well informed of the investment environment which includes laws, customs and regulations, the information costs occurred by foreign investors could be reduced. Thus, human capital which would otherwise be required to compensate the information disadvantage can be applied to productive or imitative activities, and therefore enhance economic growth.

4.6 Summary, Conclusions and Limitations

This chapter examines the relationship between FDI and knowledge spillovers in an endogenous growth setting. A two-sector model is constructed in which FDI is carried out by profit-maximising MNCs in a human capital short and unskilled labour surplus developing country. In response to the existing difference in factor price across countries, MNCs make cost-minimising choices for plant location to explore their private knowledge-based assets.

In the presence of FDI, the developing country has the potential opportunity to obtain access to the advanced knowledge. Since foreign firms have cost disadvantages compared with local firms in the developing country, there is a chance for local firms to engage in imitation. Successful imitators can set a lower price than the one set by foreign firms to capture the developing country's market and gain profits. Given knowledge spillovers from both the imitative activities of local firms and the productive activities of foreign firms, the endogenously determined growth rate is generated.

The model not only incorporates FDI into endogenous growth theory but also provides valuable predictions. Though it is difficult to explicitly express the steady state growth rate with exogenous parameters only, the model is still technically manageable. The steady-state equilibrium is summarised by the intersection of local and foreign firms' learning activities in Figure 4.1. A comparative steady state analysis is then applied to illustrate how various factors influence the long run growth rate. The analysis reveals that FDI enables the developing country to learn more advanced knowledge and probably benefit from knowledge spillovers. However, FDI does not always stimulate economic growth of the developing country in the long run. It depends on the knowledge gap between local and foreign firms. The growth rate is greater with a wider knowledge gap between local and foreign firms up to a certain critical level, thereafter a wider knowledge gap causes the growth rate to decline. In addition, a greater willingness to save and a relative abundance of human capital raise the growth rate.

The model presented in the chapter has provided a theoretical background for the impact of FDI on the long run economic growth in developing countries. However, the model is abstracted from many real world considerations hence much remains to be done in future work. In this study the stock of human capital is taken as given and the exogenous feature of knowledge gap is assumed so as to avoid a more complicated task of solving a nonlinear system of differential equations and intractable analysis. Obviously, these two assumptions are extreme. There are also doubts about the realism of the assumption of identical consumer preferences. Consumers differ in their valuations of various varieties. It is hoped that in future work these considerations can be accommodated.

Basically, there are two different types of technological progress. As in Romer (1990) and Grossman and Helpman (1991c), technology based growth in this study is treated as a process of generating an over-expanding variety of horizontally differentiated products. The other type of technological progress is expressed as 'quality-ladder' - a quality improvement of the existing products. It is common practice to use either of these two types of technological progress [see, Barro and Sala-i-Martin, 1995; Grossman and Helpman, 1991c], with the one exception of Verberne, Zon and Muysken (1996) who combine both types in one framework. When technological progress is expressed in a different way, the impact of FDI on economic growth will differ.

In this study, FDI is thought to result from knowledge-based firm-specific assets and differences in factor prices across countries, while the possession of internalisation advantage is taken for granted and the external market options are ruled out by assumption. Different conclusions of the impact of FDI on growth could probably be reached when the internalisation decision is endogenised. In addition, there are alternative explanations of FDI. These include proximity advantages [Brainard, 1993] and strategic determinants which identify the following types of FDI - 'absorb the rival' FDI [Acocella, 1992], 'entry pre-emption' FDI [see, for example, Smith, 1987 and Horstmann and Markusen, 1987], and 'exchange of threats' FDI [Graham, 1978]. When FDI is driven by different factors, the questions addressed in the model developed in this chapter require further discussion.

Appendix A

This appendix derives (4a), (4b), (4c) and (5). As discussed in the text, the consumer's maximisation problem can be broken down into two stages. In the first stage, $u(\cdot)$ is maximised by choosing Y, $x_D(\omega)$ and $x_F(\omega)$, given E(t), prices and n_D and n_F. (4a), (4b) and (4c) can be obtained from this process. In the second stage, the time pattern of expenditures (5) can be derived by maximising U subject to the intertemporal budget constraint, i.e. (3).

A.1. Proof of (4a), (4b) and (4c).

$\max\ u = Y^{1-\theta}X^{\theta}$ and $X = [\int_0^{n_D} x_D(\omega)^{\eta}d\omega + \int_0^{n_F} x_F(\omega)^{\eta}d\omega]^{1/\eta}$

given $E = p_Y Y + \int_0^{n_D(t)} p_D(\omega')x_D(\omega')d\omega' + \int_0^{n_F(t)} p_F(\omega')x_F(\omega')d\omega'$

To solve the optimisation problem, first set up the Lagrangian and introduce a Lagrange multiplier - ν

$$L = Y^{1-\theta}[\int_0^{n_D} x_D(\omega)^{\eta}d\omega + \int_0^{n_F} x_F(\omega)^{\eta}d\omega]^{\frac{\theta}{\eta}}$$
$$+ \nu[E - p_Y Y - \int_0^{n_D(t)} p_D(\omega')x_D(\omega')d\omega' - \int_0^{n_F(t)} p_F(\omega')x_F(\omega')d\omega']$$

Now, take the derivative of the Lagrangian with respect to Y, $x_D(\omega)$ and $x_F(\omega)$ and set them equal to zero.

$$\frac{\partial L}{\partial Y} = \frac{(1-\theta)Y^{1-\theta}X^{\theta}}{Y} - \nu p_Y = 0$$

$$\Rightarrow \qquad Yp_Y = \frac{(1-\theta)Y^{1-\theta}X^{\theta}}{\nu} \qquad [A1]$$

$$\frac{\partial L}{\partial x_D(\omega)} = \frac{\theta Y^{1-\theta} X^{\theta} x_D(\omega)^{\eta-1}}{\int_0^{n_D} x_D(\omega')^{\eta} d\omega' + \int_0^{n_F} x_F(\omega')^{\eta} d\omega'} - \nu p_D(\omega) = 0$$

$$\Rightarrow \qquad \frac{p_D(\omega)[\int_0^{n_D} x_D(\omega')^{\eta} d\omega' + \int_0^{n_F} x_F(\omega')^{\eta} d\omega']}{x_D(\omega)^{\eta-1}} = \frac{\theta Y^{1-\theta} X^{\theta}}{\nu} \qquad [A2]$$

$$\frac{\partial L}{\partial x_F(\omega)} = \frac{\theta Y^{1-\theta} X^{\theta} x_F(\omega)^{\eta-1}}{\int_0^{n_D} x_D(\omega')^{\eta} d\omega' + \int_0^{n_F} x_F(\omega')^{\eta} d\omega'} - \nu p_F(\omega) = 0$$

$$\Rightarrow \qquad \frac{p_F(\omega)[\int_0^{n_D} x_D(\omega')^{\eta} d\omega' + \int_0^{n_F} x_F(\omega')^{\eta} d\omega']}{x_F(\omega)^{\eta-1}} = \frac{\theta Y^{1-\theta} X^{\theta}}{\nu} \qquad [A3]$$

From [A2] and [A3], the following equation is given

$$[\frac{x_D}{x_F}]^{\eta-1} = \frac{p_D}{p_F} \qquad [A4]$$

Therefore,

$$\frac{p_D(\omega)[\int_0^{n_D} x_D(\omega')^{\eta} d\omega' + \int_0^{n_F} x_F(\omega')^{\eta} d\omega']}{x_D(\omega)^{\eta-1}} \qquad [A5]$$
$$= \int_0^{n_D} p_D(\omega') x_D(\omega') d\omega' + \int_0^{n_F} p_F(\omega') x_F(\omega') d\omega'$$

Substituting [A5] into [A2], and summing it with [A1],

$$E = \frac{Y^{1-\theta} X^{\theta}}{\nu} = \frac{u}{\nu} \qquad [A6]$$

Substituting [A6] into [A1], [A2] and [A3],

$$Y = \frac{(1-\theta)E}{p_Y} \qquad [A7]$$

$$p_D(\omega) = \theta E \frac{x_D(\omega)^{\eta-1}}{\int_0^{n_D(t)} x_D(\omega')^{\eta} d\omega' + \int_0^{n_F(t)} x_F(\omega')^{\eta} d\omega'} \qquad [A8]$$

$$p_F(\omega) = \theta E \frac{x_F(\omega)^{\eta-1}}{\int_0^{n_D(t)} x_D(\omega')^{\eta} d\omega' + \int_0^{n_F(t)} x_F(\omega')^{\eta} d\omega'} \qquad [A9]$$

[A7] is (4.4c) in the text.

It can be proved that

$$\frac{p_D(\omega)[\int_0^{n_D(t)} x_D(\omega')^{\eta} d\omega' + \int_0^{n_F(t)} x_F(\omega')^{\eta} d\omega']}{x_D(\omega)^{\eta-1}}$$
$$= \frac{x_D(\omega)[\int_0^{n_D(t)} p_D(\omega')^{1-\varepsilon} d\omega' + \int_0^{n_F(t)} p_F(\omega')^{1-\varepsilon} d\omega']}{p_D(\omega)^{-\varepsilon}} = \theta E \qquad [A10]$$

Then, [A8] and [A9] can be easily transformed into following equations.

$$x_D(\omega) = \theta E \frac{p_D(\omega)^{-\varepsilon}}{\int_0^{n_D(t)} p_D(\omega')^{1-\varepsilon} d\omega' + \int_0^{n_F(t)} p_F(\omega')^{1-\varepsilon} d\omega'} \qquad [A11]$$

$$x_F(\omega) = \theta E \frac{p_F(\omega)^{-\varepsilon}}{\int_0^{n_D(t)} p_D(\omega')^{1-\varepsilon} d\omega' + \int_0^{n_F(t)} p_F(\omega')^{1-\varepsilon} d\omega'} \qquad [A12]$$

[A11] and [A12] are (4.4a) and (4.4b) in the text.

A.2. Proof of (5).

$$\max\ U = \int_t^{\infty} e^{-\rho(\tau-t)} \log u(\cdot) d\tau$$

$$\text{s.t.}\ \int_t^{\infty} e^{-[R(\tau)-R(t)]} E(\tau) d\tau \le \int_t^{\infty} e^{-[R(\tau)-R(t)]} I(\tau) d\tau + A(t)$$

Substituting [A6] into (2),

$$U = \int_t^{\infty} e^{-\rho(\tau-t)} \log u(\cdot) d\tau = \int_t^{\infty} e^{-\rho(\tau-t)} \log \nu E d\tau$$

As is well known (see Barro and Sala-I-Martin, 1995 chapter 2 and appendix; Grossman and Helpman, 1991c), the basic condition for choosing expenditure over time is

$$r = \rho - \frac{d\tilde{u}/dt}{\tilde{u}}$$

where $\tilde{u} = \dfrac{d(\log u)}{dE} = \dfrac{1}{E}$

It can be easily obtained that

$$\frac{d\tilde{u}/dt}{\tilde{u}} = \frac{-\frac{1}{E^2} * \dot{E}}{\frac{1}{E}} = -\frac{\dot{E}}{E}$$

Therefore,

$$r = \rho - \frac{d\tilde{u}/dt}{\tilde{u}} = \rho + \frac{\dot{E}}{E}$$

This equation immediately leads to (5).

Appendix B

This appendix proves all propositions.

B.1. Proof of Proposition 1.

(i) From (4.18) and (4.2), it can be shown that $\frac{\dot{K}_i}{K_i} = g$.

(ii) Since $\frac{\dot{h}_i}{h_i} = \frac{\dot{K}_i}{K_i}$, $\frac{\dot{h}_i}{h_i} = g$.

(iii) Substituting (4.10) and (4.1) into (4.4a) ,

$$x_D = \theta E(\frac{\eta}{a_X w_D})[\frac{1}{n_D + n_F(1+\zeta)^{1-\varepsilon}}]$$

Then, the growth rate of the equilibrium output is obtained for any local firm.

$$\frac{\dot{x}_D}{x_D} = \frac{\dot{E}}{E} - \frac{\dot{w}_D}{w_D} - [\frac{\dot{n}_D + \dot{n}_F(1+\zeta)^{1-\varepsilon}}{n_D + n_F(1+\zeta)^{1-\varepsilon}}] = \frac{\dot{E}}{E} - \frac{\dot{w}_D}{w_D} - [\frac{\mu n_F + g n_F(1+\zeta)^{1-\varepsilon}}{\frac{\mu}{g} n_F + n_F(1+\zeta)^{1-\varepsilon}}] = \frac{\dot{E}}{E} - \frac{\dot{w}_D}{w_D} - g.$$

In the long run, the allocation of factors remains constant. Accordingly, the total output of modern products manufactured by local firms $X_D = n_D x_D$ is constant. Hence

$$\frac{\dot{X}_D}{X_D} = \frac{\dot{n}_D}{n_D} + \frac{\dot{x}_D}{x_D} = g + \frac{\dot{E}}{E} - \frac{\dot{w}_D}{w_D} - g = \frac{\dot{E}}{E} - \frac{\dot{w}_D}{w_D} = 0.$$

i.e. $\frac{\dot{E}}{E} = \frac{\dot{w}_D}{w_D}$.

In the steady state, the consumption level of the traditional good is also constant.

Using (4.4c) and (4.7),

$$\frac{\dot{Y}}{Y}=\frac{\dot{E}}{E}-\frac{\dot{p}_Y}{p_Y}=\frac{\dot{E}}{E}-(1-\varsigma)\frac{\dot{h}_D}{h_D}-\varsigma\frac{\dot{w}_D}{w_D}=\frac{\dot{E}}{E}-(1-\varsigma)g-\varsigma\frac{\dot{w}_D}{w_D}=(1-\varsigma)(\frac{\dot{w}_D}{w_D}-g)=0.$$

Since $\varsigma\in(0,1)$, $\frac{\dot{E}}{E}=\frac{\dot{w}_D}{w_D}=g$.

In addition, since $w_F=(1+\zeta)w_D$, $\frac{\dot{w}_F}{w_F}=\frac{\dot{w}_D}{w_D}=g$.

(iv) From (4.7), $\frac{\dot{p}_Y}{p_Y}=(1-\varsigma)\frac{\dot{h}_D}{h_D}+\varsigma\frac{\dot{w}_D}{w_D}=(1-\varsigma)g+\varsigma g=g$.

(v) From (4.10), $\frac{\dot{p}_i}{p_i}=\frac{\dot{w}_i}{w_i}=g$.

B.2. Proof of Proposition 2

Define $J_{11}=\frac{\partial F^1}{\partial\mu}$, $J_{12}=\frac{\partial F^1}{\partial\mu}$, $J_{21}=\frac{\partial F^2}{\partial g}$, and $J_{22}=\frac{\partial F^2}{\partial g}$. All the partial derivatives are evaluated at the steady state.

$$J_{11}=\frac{\partial F^1}{\partial g}=-\mu\Lambda_2(1+\Lambda_1)-2g-\rho<0$$

$$J_{12}=\frac{\partial F^1}{\partial\mu}=\Lambda_2[\Lambda_1(1-\lambda)\Theta(x)H-\rho-(\Lambda_1+1)g]>0$$

$$J_{21}=\frac{\partial F^2}{\partial g}=\Lambda_2\Theta(x)+\Lambda_1\Lambda_2+\Lambda_2-1>0$$

$$J_{22}=\frac{\partial F^2}{\partial g}=\Lambda_2\Theta(x)>0$$

Then the relevant Jacobian determinant is

$$|J|=\begin{vmatrix}J_{11} & J_{12}\\ J_{21} & J_{22}\end{vmatrix}=\begin{vmatrix}- & +\\ + & +\end{vmatrix}<0$$

Therefore, the point that satisfies the system is an equilibrium solution relating to the growth and imitation rates in the steady state. The slopes of the two curves AA' and BB' are $-\frac{J_{11}}{J_{21}} > 0$ and $-\frac{J_{12}}{J_{22}} < 0$, respectively. The shape of AA' can be further determined by differentiating the slope of the curve AA', $\frac{d^2\mu}{dg^2} > 0$.

B.3. Proof of Proposition 3

To find the partial derivatives of $\frac{\partial g}{\partial H}$ and $\frac{\partial g}{\partial \rho}$, the partial derivatives of the two F functions at the steady state of the model are first evaluated.

$$J_{H1} = -\frac{\partial F^1}{\partial H} = -\mu\Lambda_1\Lambda_2(1-\lambda)H\Theta(x) < 0$$

$$J_{H2} = -\frac{\partial F^2}{\partial H} = \Lambda_1\Lambda_2(1-\lambda)H\Theta(x) > 0$$

$$|J_1|_H = \begin{vmatrix} J_{H1} & J_{12} \\ J_{H1} & J_{22} \end{vmatrix} = \begin{vmatrix} - & + \\ + & + \end{vmatrix} < 0$$

$$J_{\rho 1} = -\frac{\partial F^1}{\partial \rho} = \mu\Lambda_2 + g > 0$$

$$J_{\rho 2} = -\frac{\partial F^2}{\partial \rho} = -[\Lambda_2\Theta(x) + \Lambda_2 - 1] < 0$$

$$|J_1|_\rho = \begin{vmatrix} J_{\rho 1} & J_{12} \\ J_{\rho 1} & J_{22} \end{vmatrix} = \begin{vmatrix} + & + \\ - & + \end{vmatrix} > 0$$

Since $\frac{\partial g}{\partial H} = \frac{|J_1|_H}{|J|} > 0$ and $\frac{\partial g}{\partial \rho} = \frac{|J_1|_\rho}{|J|} < 0$, the growth rate is positively related to the stock of human capital in the developing country and is negatively related to the subjective discount rate.

B.4. Proof of Proposition 4

The procedure of calculating the partial derivatives of $\frac{\partial g}{\partial x}$ is similar to that in B.3.

$$J_{x1} = -\frac{\partial F^1}{\partial x} = -\mu\Lambda_1\Lambda_2(1-\lambda)H\widetilde{\Theta}(x)$$

$$J_{x2} = -\frac{\partial F^2}{\partial x} = -\Lambda_2[g+\rho+\mu-\Lambda_1(1-\lambda)H]\widetilde{\Theta}(x)$$

$$|J_1|_x = \begin{vmatrix} J_{x1} & J_{12} \\ J_{x1} & J_{22} \end{vmatrix} = \Lambda_2{}^2\widetilde{\Theta}(x)\{-\mu\Lambda_1(1-\lambda)H\Theta(x)+[g+\rho+\mu-\Lambda_1(1-\lambda)H]$$
$$*[\Lambda_1(1-\lambda)H\Theta(x)-\rho-(\Lambda_1+1)g]\} = \Lambda_2{}^2\widetilde{\Theta}(x)\Gamma$$

where $\widetilde{\Theta}(x) = \frac{d\Theta(x)}{dx} = \frac{1-\vartheta(x-1)}{e^{\vartheta x}}$ and

$$\Gamma = -\mu\Lambda_1(1-\lambda)H\Theta(x)+[g+\rho+\mu-\Lambda_1(1-\lambda)H]*[\Lambda_1(1-\lambda)H\Theta(x)-\rho-(\Lambda_1+1)g]$$

The sign of $|J_1|_x$ is determined as follows. First, from (26a) and (26b),

$$\Lambda_1(1-\lambda)H\Theta(x)-\rho-(\Lambda_1+1)g>0$$

$$g+\rho+\mu-\Lambda_1(1-\lambda)H = -\frac{(\Lambda_2-1+\Lambda_1\Lambda_2)g+(\Lambda_2-1)\rho}{\Lambda_2\Theta(x)}<0$$

Therefore the term $\Gamma<0$ and the sign of $|J_1|_x$ depends on the sign of $\widetilde{\Theta}(x)$. In turn, $\frac{\partial g}{\partial x} = \frac{|J_1|_x}{|J|} = \frac{\Lambda_2{}^2\widetilde{\Theta}(x)\Gamma}{|J|}$ is positively related to $\widetilde{\Theta}(x)$. If $x<\frac{\vartheta+1}{\vartheta}$, then $\widetilde{\Theta}(x)>0$, thereafter, $\frac{\partial g}{\partial x}>0$ and if $x>\frac{\vartheta+1}{\vartheta}$, then $\widetilde{\Theta}(x)<0$, thereafter $\frac{\partial g}{\partial x}<0$. The knowledge gap is not linearly associated with the growth rate.

B.5. Proof of Proposition 5

The partial derivative of $\frac{\partial g}{\partial \lambda}$ needs to be found.

$$J_{\lambda 1} = -\frac{\partial F^1}{\partial \lambda} = \mu[\Lambda_1 \Lambda_2 H \Theta(x)] > 0$$

$$J_{\lambda 2} = -\frac{\partial F^2}{\partial \lambda} = -\Lambda_1 H < 0$$

$$|J_1|_\lambda = \begin{vmatrix} J_{\lambda 1} & J_{12} \\ J_{\lambda 1} & J_{22} \end{vmatrix} = \begin{vmatrix} + & + \\ - & + \end{vmatrix} > 0 \text{ Therefore, } \frac{\partial g}{\partial \lambda} = \frac{|J_1|_\lambda}{|J|} < 0 .$$

Chapter 5: Endogenous Innovation Growth Theory and Regional Income Convergence in China

Abstract

This chapter tests endogenous innovation growth theory using a panel of data for 27 provinces across China between 1986 and 1995. Foreign direct investment (FDI), R&D expenditure, human capital and openness (measured by international trade) are added to the standard convergence regressions to control for different structural characteristics in each province. A standardised 't-bar' test for unit roots is applied to examine the properties of data and identify a long-run relationship among variables. By allowing for differences in the aggregate production function across regions, it is found that regional per capita income can converge given technological diffusion, transfer and imitation. In addition, the empirical results support the endogenous innovation growth model in which FDI, R&D and international trade appear to be important in explaining long-run economic growth.

Chapter 5: Endogenous Innovation Growth Theory and Regional Income Convergence in China

5.1 Introduction

In chapter 4, a theoretical model was constructed to examine the interactive relationships among FDI, knowledge spillovers and long run economic growth in a developing country. The current chapter provides an empirical examination of factors influencing economic growth and income convergence in China. The specific relationship between chapters 4 and 5 are as follows.

First, the empirical examination is not entirely based on the theoretical model due to data limiations. As will be seen shortly, the currenct emprical study aims to assess income convergence using a panel of annual data covering 27 provinces across China between 1986 and 1995. Though both the theoretical modelling and the empirical investigation are conducted within similar endogenous growth settings, the latter does not include such important explanatory variables as identified by the theoretical model, i.e. the subjective discount rate and the knowledge gap between China and the rest of the world. Reliable data for these variables are not available.

Second, some other important ideas contained in the theoretical model are well incorporated and tested in the convergence regressions. In chapter 5, the issue of income convergence is empirical examined within an endogenous innovation growth framework. In addition to international trade, three important explanatory variables specified in the theoretical model, i.e. FDI, human captial and domestic R&D expenditure are added to the standard convergence regressions. As from chapter 4, FDI is an attractive source of investment. FDI and domestic R&D help the creation and accumulation of knowledge capital. FDI, human capital and domestic R&D can have positive impacts on economic growth. These ideas are important and are now tested in the current empirial study.

As is well known, one of the most remarkable events in world development in the last two decades is China's achievement of high and sustained rates of economic growth. Since starting the process of economic reform and opening to the outside world in 1979, China's real GNP has grown on average by around 9% a year. While there is a large literature on the determinants of economic growth in general, relatively few studies have been conducted on whether poor regions tend to converge towards rich ones in China. An understanding of whether regional income gaps have widened or narrowed in the post-reform period has important theoretical and policy implications for Chinese decision makers.

A widely used method for assessing whether economic growth leads to increasing income inequality is the application of standard or augmented convergence regressions. In the case of China, Jian et al. (1996) conclude that market-oriented reforms beginning in 1978 helped equalise regional incomes sharply. The convergence was strongly associated with the rise in rural productivity, and was particularly strong in those provinces allowed to integrate with the outside world. Using an augmented Solow growth model with cross section and panel data, Chen and Fleisher (1996) identify conditional convergence of regional per capita income from 1978 to 1993. Mody and Wang (1997) find evidence of absolute convergence of the growth of industrial output during 1985 to 1989, and of the log of per capita GDP in 1995, both in seven coastal regions.

This study differs from the existing literature on economic growth in China in three ways. First, the study is explicitly based on the endogenous growth theory with particular interest in the impact of FDI. Second, a panel data set is employed to allow for the substantial heterogeneity in unobserved variables across regions. Third, a standardised 't-bar' test for unit roots suggested by Im, Pesaran and Shin (1995) is applied to examine the econometric properties of the panel data and to identify a long run relationship between the dependent and explanatory variables.

The rest of this chapter is organised as follows. Section 5.2 reviews the literature on economic convergence. In section 5.3, a conceptual model is developed and the techniques of econometric analysis used are briefly discussed. Section 5.4 discusses the data. The empirical results concerning growth and convergence of per capita GDP across Chinese provinces are presented in section 5.5. The final section draws conclusions.

5.2 Literature Review

Convergence as one of the main issues in growth theory has attracted a large number of studies. In the empirical literature, there are several different definitions of convergence. The concept used in the analysis is a fairly popular one - "β-convergence" - which exists if there is a negative and significant relationship between the growth rate of per capita income and its level in the previous year [see, for example, Barro, 1991; Barro and Sala-i-Martin, 1991, 1992a; Sala-i-Martin, 1994, 1996]. Convergence may be conditional if additional explanatory variables have a significant impact on the growth rate. Convergence can also be absolute if those additional variables individually and jointly have no impact on the growth rate.

Other hypotheses about convergence include σ-convergence which focuses on the behaviour of the cross-section variance of output over time [see, for example, Dowrick and Nguyen, 1989; Sala-i-Martin, 1996; Lee et al., 1997] and stochastic convergence developed by Bernard and Durlauf (1995, 1996) and Evans and Karras (1996) who suggest that convergence happens only when economies share a long run common trend, either deterministic or stochastic [for empirical applications see Bernard and Jones, 1996, Carlino and Mills, 1993, 1996 and Loewy and Papell, 1996][1]. Different from determininistic models, Lee et al. (1997) develop an empirical

[1] Some authors, such as Loewy and Papell (1996) also classify convergence into two groups: cross-section convergence, which includes β-convergence and σ-convergence, and time-series or stochastic convergence.

versiohn of a stochastic Solow growth model to consider the issue of convergence. This chapter examines β-convergence only.

Rooted in competitive equilibrium economics, neo-classical theory, set up by Solow (1956), emphasises the existence of the steady state and diminishing returns to physical capital. This implies that poor regions with low capital-output ratios grow systematically faster than their rich counterparts, so there is a tendency towards regional convergence. Put another way, since the rate of return is negatively related to the stock of physical capital, an integrated economy will experience general convergence of regional incomes over time, provided that there are no major barriers to the operation of market processes. Regional disparities are only short-run phenomena and automatically disappear in time. This is especially true of regions within a single country because differences in technology, preferences and institutions across regions are likely to be smaller than those across countries. In addition, factors of production tend to be more mobile across regions than across countries.

New or endogenous growth theory emphasises the importance of investment in physical and human capital and R&D for economic growth. Crafts (1996) distinguishes two major types of endogenous growth theory. The first uses endogenous broad capital models, which emphasise externalities generated by investment in physical and human capital and relate technological characteristics to 'learning by doing' and 'knowledge spillovers'. The second uses endogenous innovation growth models, which postulate that technological progress results from deliberate innovation. A standard production function for endogenous innovation growth models is as follows [see Romer, 1990; Grossman and Helpman 1991c]:

$$Y = AK^{\alpha_1} L^{\alpha_2} D^{\alpha_3} \qquad [5.1]$$

where A is a constant and D is an index of the creation of intermediate goods which embody technological knowledge and which are augmented by innovative activity. The labour is employed with constant returns in the production of intermediate goods. Therefore, D is a positive function of the amount of labour allocated to R&D because of the spillover effects of increased technological knowledge.

Since different countries have their own social, political and economic environments and different firms have their own capabilities to undertake R&D, innovation processes differ across countries. Thus rates of growth diverge across economies. The more resources allocated to R&D, the higher the incentive for firms to innovate, the greater the firms' abilities to create new technological ideas, and the higher the rate of growth a country will enjoy. In endogenous innovation growth models there can be multiple steady states and persistent divergence.

However, endogenous innovation growth theory does not exclude the possibility of convergence. If a 'leading edge' economy innovates, and if its innovations are effectively imitated, diffused and assimilated into production in 'follower' economies at very low costs, then there can be a process of convergence between interdependent economies. As Romer (1993) emphasises, rapid growth is a positive function of both access to new technological ideas and the diffusion of these ideas through the production structure.

Access to, and imitation of, new ideas can be facilitated by means of R&D, FDI, international trade and investment in human capital. It is beyond doubt that R&D is crucial for economic development. R&D may be divided into two types. The first leads to product innovation, and the second to product imitation. R&D can enhance technological capabilities which are found to be positively correlated with economic growth. Individual domestic firms invest in R&D to acquire advanced know-how and to create valuable rent-yielding and intangible assets, which will increase output in society as a whole. If some countries have capabilities to imitate, it is possible for them to catch up.

As Balasubramanyam et al. (1996) argue, many of the growth promoting factors identified by new growth theory can be initiated and nurtured to promote growth through FDI. In most cases, what FDI transfers is not only capital and managerial skills, but also embodied and tacit technologies. The special role that FDI plays in tacit technology transfer and diffusion can not be replaced by any other forms of international integration. In addition, numerous studies have shown that the output of local firms improves when a country hosts FDI. Multinational corporations (MNCs) may develop new products and technologies earlier than local firms, exert competitive pressure on them and force them to imitate or innovate. MNCs always try to preserve their own knowledge and technology, but spill-over through 'learning by doing' or 'learning by watching' to domestic firms creates economic growth.

Another route for the diffusion of new ideas is the switch of labour from foreign subsidiaries to local firms. Because of the above reasons, FDI is recognised as a major source of rapid growth, especially in developing countries.

International trade is another important means of facilitating technology creation and transfer. Grossman and Helpman (1991), Coe and Helpman (1995) and Coe et al. (1997) identify several channels related to international trade through which growth rates of countries are inter-related. International trade enables a country to use a large variety of technologically advanced physical capital, which enhances the productivity of its own resources. International trade promotes across-the-board learning in product design, facilitates the diffusion and imitation of foreign technologies and helps the creation of innovations.

As in the case of domestic R&D expenditure, increases in human capital affect the ability of firms to learn and absorb new technology. A high level of human capital allows tangible inputs to be used effectively. The role of human capital in the empirical analysis of growth has been strongly emphasised [see, for example. Lee and Lee, 1995]. Mankiw et al. (1992) contend that the quantitative implications of different saving and population growth rates are biased upward if human capital is not accounted for in the model. The contribution of human capital to economic growth is by now part of received knowledge. Since innovations and their imitation are positively related to the size and quality of human capital, increased investment in education and on-the-job training will lead to rapid innovative progress, and help a country to catch up.

Because R&D, FDI, international trade and human capital are important means for the development and diffusion of technological ideas, these variables may be used to replace the index of innovation creation in the basic endogenous innovation growth model. Thus, Equation (5.1) can be modified as follows:

$$Y = AK^{\alpha_1} L^{\alpha_2} FDIR^{\alpha_3} EX^{\alpha_4} IM^{\alpha_5} RDE^{\alpha_6} HC^{\alpha_7} \qquad [5.2]$$

where *FDIR, EX, IM, RDE* and *HC* represent realised FDI, exports, imports, R&D expenditure and human capital respectively. These factors are expected to have a positive impact on the rate of technological progress and hence growth. Given technology transfer and adoption, club and conditional convergence can occur among interdependent countries. It is obvious that, though both neo-classical theory and endogenous innovation models accept the possible existence of convergence, their reasons for catch up are different.

There is a large body of empirical literature on regional convergence. Barro and Sala-i-Martin (1991, 1992a, 1992b, 1995) find evidence for absolute β-convergence for the regions of the United States (48 contiguous states, 1880-1990), Canada (10 provinces, 1961-1991), Japan (47 prefectures, 1955-1990) and Europe (90 regions, 1950-1990). The speed with which regions of different countries converge to their respective national means is very similar, approximately 2 percent per year. Barro and Sala-i-Martin (1995) also find conditional β-convergence for a large sample of developed and developing countries. The speed of conditional convergence is identical to that of absolute convergence. Sala-i-Martin (1994), Barro and Sala-i-Martin (1995) and Miller (1996) argue that regions within a country or within OECD countries share similar structural characteristics and are therefore more likely to converge.

However, the speed of convergence of 2 percent is quite slow. This implies that it will take a region 35 years to eliminate half the initial gap from its steady state. Reasons provided in the literature for the low convergence rate include the high costs of imitation and implementation of new technologies [Sala-i-Martin, 1994], inappropriate measurement of variables and application of estimation techniques [Murthy and Chien, 1997], and omission of some medium term macroeconomic variables [Andres et al., 1996]. Islam (1995) notes that the speed of convergence increases when the panel data approach is used. Using panel data sets, Andres et al. (1996) find that the estimated speeds of convergence increase dramatically when such variables as public consumption, variance of M1 growth, export growth, budget surplus and inflation are included in the model.

Hofer and Worgotter (1995) investigate regional per capita income convergence in Austria. Mankiw et al. (1992), Miller (1996), Andre et al. (1996) and Murthy and Chien (1997) deal with economic growth in OECD (Organisation for Economic Co-operation and Development) countries. All these studies provide clear evidence of long run regional convergence, especially conditional β-convergence.

5.3 Empirical Models and Methodology

This chapter employs a modified endogenous innovation growth model to investigate regional growth and per capita income convergence in China. Since a panel dataset is used here, by following Knight et al. (1993), Brander, and Dowrick (1994), Islam (1995) and Miller (1996), a model with heterogeneity across regional economies is specified. This panel data approach is superior to a cross section approach. The cross section approach implicitly assumes that regions possess similar structural characteristics such as production technologies and institutional patterns. In the presence of substantial heterogeneity in unobserved variables across regions, a straightforward pooling of all observations is flawed. However, the panel data approach attempts to accommodate region-specific structural differences that may be significant in explaining economic growth.

In this study, attempts to control for the differences between regions are made by allowing for unobservable individual regional effects A_i. In the context of the panel data approach, Equation (5.2) can be expressed as follows:

$$Y_{it} = A_i K_{it}^{\alpha_1} L_{it}^{\alpha_2} FDIR_{it}^{\alpha_3} EX_{it}^{\alpha_4} IM_{it}^{\alpha_5} RDE_{it}^{\alpha_6} HC_{it}^{\alpha_7} \varepsilon_{it} \quad [5.3]$$

where *i* and *t* denote the cross-section and time series observations respectively, the αs are the elasticities of output, Y denotes real per capita GDP and ε_{it} is a disturbance term which varies across individuals and time and possesses the usual properties. Full definitions and sources of the variables are given in the next section.

A log transformation of Equation (5.3) leads to the following linear regression:

$$\begin{aligned}\ln Y_{it} &= \ln A_i + \alpha_1 \ln K_{it} + \alpha_2 \ln L_{it} + \alpha_3 \ln FDIR_{it} + \alpha_4 \ln EX_{it} \\ &+ \alpha_5 \ln IM_{it} + \alpha_6 \ln RDE_{it} + \alpha_7 \ln HC_{it} + \ln \varepsilon_{it}\end{aligned} \quad [5.4]$$

Based on the assumption that convergence to the steady-state occurs at a rate equal to λ, the following endogenous innovation growth convergence regression is derived,

$$\begin{aligned}\Delta \ln Y_{it} &= \gamma \ln Y_{i,t-1} + \delta_i + \zeta_1 \ln K_{it} + \zeta_2 \ln L_{it} + \zeta_3 \ln FDIR_{it} + \zeta_4 \ln EX_{it} \\ &+ \zeta_5 \ln IM_{it} + \zeta_6 \ln RDE_{it} + \zeta_7 \ln HC_{it} + v_{it}\end{aligned} \quad [5.5]$$

where $\gamma = -(1 - e^{-\lambda})$, $\zeta_j = \frac{\alpha_j}{1 - e^{-\lambda}}$, $\delta_i = \frac{\ln A_i}{1 - e^{-\lambda}}$ and $v_{it} = \ln \varepsilon_{it}$ with $j = 1, \ldots, 7$.

Following Sala-i-Martin (1994) the explanatory variables in Equation (5), excluding lagged per capita GDP, can be interpreted as the determinants of long-run economic growth. In addition, as Miller (1996) indicates, a convergence test based on the above equation is superior to the conventional cross section test because the initial level of output per capita is updated each year[2]. First, absolute convergence is

[2] Lichtenberg (1994) argues that the conventional cross-section test in which growth rates are usually the average across the whole time-series sample captures 'regression to the mean' rather than the convergence hypothesis.

considered. If there is no absolute convergence, it is discussed that conditional convergence with FDI, exports, imports, R&D expenditure, human capital, capital and labour included in the model.

To avoid possible spurious correlation[3], it is necessary to distinguish stationary from non-stationary variables. The unit root test employed in this chapter is the same as in chapter 3, i.e. the IPS test proposed by Im, Pesaran and Shin (1995) since it has high power compared with the augmented Dickey-Fuller (ADF) test in the case of panel data [Oh, 1996]. Based on the average values of ADF test statistics, the IPS test statistic (or t-bar statistic) takes the form:

$$\bar{Z}_{NT} = \frac{\frac{1}{N}\sum_{i=1}^{N} t_{iT}(p_i, \hat{\gamma}_i) - \frac{1}{N}\sum_{i=1}^{N} E[t_T(p_i, 0)]}{\sqrt{\frac{1}{N^2}\sum_{i-1}^{N} V[t_T(p_i, 0)]}} \qquad [5.6]$$

where, $t_{iT}(p_i, \hat{\gamma}_i)$ is the ADF statistic from the ADF test with trend regression of order p_i determined by the Akaike Information Criterion (AIC), $\hat{\gamma}_i$ is the estimated vector of coefficients on the augmented lagged changes, the values of $E[t_T(p_i,0)]$ and $V[t_T(p_i,0)]$ are tabulated in Im et al. (1995), and T is the number of time-periods (= 10). Under the null hypothesis of a unit root, the t-bar statistic has a standard normal distribution. Under the alternative hypothesis of stationarity, the statistic diverges to negative infinity.

[3] In fact, most studies on the determinants of output growth are based on a first-difference specification to avoid the spurious correlation problem. However, this specification discards the information embodied in the long run relationship between the levels of the variables.

A panel dataset can be estimated in any of three ways, depending on whether the individual cross section effects are considered to be constant, fixed or random. The corresponding statistical models are the ordinary least squares (OLS), fixed effects (FE) and random effects (RE) models. In assessing the determinants and regional distribution of inward FDI in China in chapters 2 and 3, the choice of the statistical models was restricted between the OLS and RE models because of the inclusion of dummy variables in the econometric models. In the current convergence regressions, the choice can be made among all three statistical models. Three tests are usually applied to identify the best statistical model. They are the likelihood ratio (LR) test for the FE model against the OLS model, the Lagrange multiplier (LM) test for the RE model against the OLS model, and the Hausman specification (HS) test for the FE model against the RE model. Since standard econometric books for panel data analysis [see for example, Judge et al., 1985, Baltagi, 1995 and Greene, 1997] offer full descriptions of the estimation techniques, only a brief review is provided here.

As mentioned above, the three statistical models differ mainly in the assumptions concerning δ_i which is time-invariant and accounts for any unobservable individual-specific effect not included in the regression. In the OLS model, the δ_i s are treated as an intercept which is held constant across the individual cross-section units. The FE model allows the δ_i s to vary between units, and treats them as parameters to be estimated. In other words, dummy variables are employed to capture the unobserved heterogeneity. In the RE model, the δ_i s are assumed to be a random variable that is independent and identically distributed, i.e. $\delta_i \sim \text{IID}(0, \sigma_\delta^2)$.

These three models have their own advantages and disadvantages. The OLS model is simple to estimate, but the assumption that the unobservable individual-specific effects do not differ is very strong and unlikely to hold in most cases. The FE model allows variation in these effects, but including dummy variables as extra regressors makes it less efficient than the RE model because of the loss of degrees of freedom. Finally, the RE model relegates the unobservable individual-specific effects into the error term and assumes that they are uncorrelated with the regressors. Violation of this assumption may cause the RE model to produce biased and inconsistent estimates [Judge et al., 1985]. Therefore, the three tests above are applied to determine the appropriate model.

The LR test statistic, under the null hypothesis of constant individual-specific effects is:

$$LR = NT * \log(1 + \frac{RSS_r - RSS_u}{RSS_u}) \sim \chi^2(N-1) \qquad [5.7]$$

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

To choose between the OLS and RE models, Breusch and Pagan (1980) derive an LM test for the null hypothesis that the OLS estimators are best linear unbiased. They show that:

$$LM = \frac{NT}{2(T-1)}[1 - \frac{v'(I_N \otimes J_T)v}{v'v}]^2 \qquad [5.8]$$

is asymptotically distributed as $\chi^2(1)$, 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 is based on the Wald criterion:

$$HS = [b_{fe} - b_{re}]' Var[b_{fe} - b_{re}]^{-1}[b_{fe} - b_{re}] \sim \chi^2(k) \qquad [5.9]$$

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. 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.

5.4 Data

The data used in this chapter are pooled cross-section and time-series data (panel data), covering 27 provinces within China over a ten-year period from 1986 to 1995. The data are mainly compiled from various volumes of standard Chinese statistical and economic yearbooks at both central and provincial levels (1986-1996), including the *China Statistical Yearbook* (Zhongguo tongji nianjian), and the corresponding provincial yearbooks. When figures conflict, the central and latest available sources are adopted. A more detailed description of the sources of data and the measurement of variables is given in Table 5.1.

Mainland China consists of 31 provinces. The spatial coverage is of 12 provinces in the coastal areas (Guangdong, Jiangsu, Shanghai, Fujian, Shandong, Liaoning, Tianjin, Zhejiang, Hebei, Beijing, Guangxi and Hainan) and 19 provinces in the inland areas (Henan, Shanxi, Hubei, Heilongjiang, Jilin, Shaanxi, Anhui, Hunan, Sicuan, Jiangxi, Yunnan, Inner Mongolia, Guizhou, Xinjiang, Gansu, Ningxia, Chongqing, Tibit and Qinghai). Because of data imperfections for realised FDI for Tibet and Qinghai, these two regions are removed from the sample. In addition, Hainan was part of Guangdong before the end of 1987 and Chongqing can not be separated from Sicuan in its published figures until 1996. In order to keep consistency, the data for Hainan and Guangdong and the data for Chongqing and Sicuan are combined respectively.

As noted in Table 5.1, the variable K is not usual capital stock, but investment. The Chinese government has traditionally set up high rates of depreciation to encourage upgrade in capital equipment. It is generally observed that GDP growth is closely associated with investment in fixed assets. That is why investment rather than capital stock is used in this study.

Table 5.1 Variable Definitions and Data Sources

Variable	Measurement and sources of data
Y	The real GDP per capita. The real GDP growth rate per capita is then defined as the ratio of the real per capita GDP index in a given year to that in the previous year. Total population refers to the total number of people at the end of a year. Nominal GDP is deflated by the overall GDP deflator to obtain real GDP.
FDIR	The realised annual inflow of FDI per capita, deflated by the overall GDP deflator.
EX	Total exports per capita, deflated by the overall GDP deflator.
IM	Total imports per capita, deflated by the overall GDP deflator.
RDE	Total R&D expenditure of state-owned institutions per capita, deflated by the overall GDP deflator.
K	Investment in fixed assets per capita, deflated by the overall GDP deflator.
L	The ratio of the labour force to the total population.
HC	Human capital, defined as the ratio of secondary school enrolments to the total population.

5.5 Empirical Results

The Chinese Economy: an aggregate analysis

The empirical work deals with the regional economic growth processes of 27 provinces of China over the period 1986 to 1995. Table 5.2 presents descriptive statistics and panel data unit root test results for each variable (in log form) involved in the analysis. The explanatory variables ln*HC* and ln*L* are first difference stationary, whilst the remaining variables are stationary. In order to achieve a

Table 5.2 Descriptive Statistics and Unit Root Test Results

Variable	Maximum	Minimum	Mean	S. D.	C. V.	IPS Test
$\Delta\ln Y$	0.2229	-0.0527	0.0793	0.0494	1.6053	-6.7975***
$\ln Y(-1)$	7.8900	4.2819	5.7265	0.7548	7.5868	-4.3793***
$\ln FDIR$	14.4231	4.3434	9.5660	2.1676	4.4132	-5.8399***
$\ln EX$	15.4703	10.1583	12.5675	1.1457	10.9690	-2.0917***
$\ln IM$	16.3192	8.6471	11.6022	1.4963	7.7539	-2.7272***
$\ln RDE$	15.6070	10.0475	11.7199	1.1058	10.5986	-3.7346***
$\Delta\ln HC$	0.12362	-0.1913	-0.0028	0.0524	-0.0534	-4.5595***
$\ln K$	8.5703	4.4972	5.7266	0.7876	7.2710	-7.1015***
$\Delta\ln L$	0.0581	-0.1209	0.0073	0.0170	0.4294	-3.9362***

Notes: 1. *** denotes significance at the 1% level.

2. S. D. and C. V. represent the standard deviation and the coefficient of variation respectively.

3. Δ indicates the first difference

balanced regression and thus avoid the problem of spurious regression results, ln*HC* and ln*L* are included in the regressions in their first difference (or growth rate) form. The null hypothesis of non-stationary is strongly rejected at the 1% level for all the variables in Table 5.2, suggesting the existence of a long run relationship between them.

Table 5.3 presents the results from the estimation of four convergence models. Regression of per capita GDP growth against the lagged per capita GDP is shown as Specification (I1) for analysing absolute convergence. Specifications (I2), (I3) and (I4) deal with conditional convergence. While Specification (I2) includes all the determinants of economic growth discussed in sections 5.2 and 5.3, Specifications (I3) and (I4) make alternate use of exports and imports to avoid possible multicollinearity between the two variables.

Following the discussion in the previous section, three tests are performed to compare the OLS, FE and RE models. The LR statistics of 141.06, 169.39 and 144.36 for Specifications (I2), (I3), and (I4) respectively are all statistically significant at the 1% level, indicating that the FE model is preferred to the OLS model. The significant values of the HS statistics of 109.07, 146.46 and 115.27 favour the FE model against the RE model. The conclusion is that the FE model is the appropriate one for Specifications (I2), (I3) and (I4). Finally, the statistical significance of the LM statistics of 8.62, 5.71, and 7.2 suggest that the RE model is better than the OLS model.

Table 5.3 Fixed Effects Estimation Results for all Provinces in China

(Dependent variable = $\Delta \ln Y$)

Variables	(I1)	(I2)	(I3)	(I4)
ln*Y*(-1)	-0.0036 (0.0040)	-0.1218 (0.0179)***	-0.1108 (0.0170)***	-0.1130 (0.0183)***
ln*FDIR*		0.0094 (0.0022)***	0.0081 (0.0021)***	0.0110 (0.0023)***
ln*EX*		0.0146 (0.0079)*	0.0236 (0.0513)***	--
ln*IM*		0.0211 (0.0053)***	--	0.0228 (0.0078)***
ln*RDE*		0.0397 (0.0111)***	0.0398 (0.0112)***	0.0502 (0.0111)***
Δln*HC*		0.0261 (0.0418)	0.0281 (0.0420)	0.0211 (0.0431)
ln*K*		0.0623 (0.0112)***	0.0592 (0.0111)***	0.0786 (0.0107)***
Δln*L*		0.9153 (0.1272)***	0.8933 (0.1273)***	0.8828 (0.1309)***
R-squared	0.0030	0.6989	0.6914	0.6753
S.E.of regression	0.0494	0.0292	0.0293	0.0300
Implied λ	0.0036	0.1299	0.1174	0.1200
Half-life (Years)	192.5	5.3	5.9	5.8
Obs.	270	270	270	270
Hypothesis Tests		LR: $\chi^2[26]$ = 141.06***	LR: $\chi^2[26]$ = 169.39***	LR: $\chi^2[26]$ =144.36 ***
		LM: $\chi^2[1]$ = 8.62***	LM: $\chi^2[1]$ = 5.71**	LM: $\chi^2[1]$ = 7.2***
		HS: $\chi^2[8]$ = 109.07***	HS: $\chi^2[8]$ = 146.46***	HS: $\chi^2[8]$ = 115.27***

Notes: 1. Standard errors are in parentheses.

2. *, ** and *** denote significant at the 10%, 5% and 1% level, respectively.

The coefficient on the lagged per capita GDP variable is negative in specification (1), but insignificant. This indicates that there is no evidence of absolute or unconditional convergence. After controlling for the determinants of growth, the regression coefficient on the lagged per capita GDP variable become negative and highly significant in Specifications (I2), (I3) and (I4). Therefore, there exists conditional convergence of regional per capita income within China. The conditional convergence rate λ is around 0.12 for the 27 provinces in China, which is much higher than those reported elsewhere in the literature. It implies that the time required to eliminate half of an initial gap from the steady state is 5-6 years or so.

In Specification (I2), the (unreported) estimates for the province-specific effects are all significant at least at the 5% level. Clearly, there is significant heterogeneity across regional economies. Ignoring these cross-region effects would lead to biased results.

The coefficients of $\ln FDIR$, $\ln EX$, $\ln IM$, $\ln RDE$, $\ln K$, $\Delta \ln L$ all have the expected sign and are strongly significant. These results lend support to endogenous innovation growth theory. Human capital also has the correct sign, but it is insignificant. The overall fit of the regressions is quite good, explaining up to 70 percent of the variation in the growth rate of per capita GDP over the ten year span.

The estimated coefficients on FDIR, exports and imports implies that, holding other things constant, a 1% increase in FDIR, exports and imports would raise economic growth by about 0.01%, 0.015% and 0.02% per year respectively. The statistical significance suggests they are important sources of GDP growth, though the magnitudes of these coefficients are relatively small.

Human capital is insignificant in all cases, with the coefficient being 0.02 to 0.03. It is sometimes argued in the literature that the secondary school enrolment rate may not be an appropriate proxy for human capital[4]. In addition, three other factors may be used to explain the insignificance of the HC variable. First, because FDI has captured some part of the spill-over effects and externalities associated with human capital, introducing these two variables at the same time may cause the HC variable to be insignificant. Second, as Cellini (1997) and Miller (1996) note, the fixed effects model may capture differences in the stock of human capital. Finally, Shaw (1992) argues that technological progress can only account for a relatively small proportion of the growth experienced by developing countries in general because most of these countries are endowed with relatively low volumes of human capital.

The results for domestic R&D expenditure are different to those for human capital. The RDE coefficient is statistically significant at the 1% level, which again supports the endogenous innovation growth model. R&D expenditure has a significant impact

[4] Coe et al. (1997) indicate that suitable measures of human capital are scarce. School enrolment indices or the annual flow of new university graduates are the most popular indicators used. Such proxies are not ideal, since they narrowly focus on human capital investment in the form of education. Accumulation of the current flows of education is only one part of the available human capital [Engelbrecht, 1997]. Empirical results are mixed. De Gregorio (1992) finds that primary and secondary school enrolment indices or college enrolment in engineering and science do not appear to have significant effects on growth, and in a few specifications they are even negatively correlated with growth. On the other hand, Murthy and Chien (1997) find that human capital plays a significant positive role in both the augmented and fully extended Solow model with conditional convergence. However, in the absence of better measurements, we have to use the school enrolment rate.

on innovation and imitation and hence on economic growth.

The coefficients of ln*K* and Δln*L* are positive and highly significant across all regressions, implying that domestic physical investment and the size of the labour force are powerful driving forces in the growth process. This result is well-established in the literature. It should be noted that the magnitudes of the coefficients of lnK all exceed those of lnFDIR. This seems to indicate that domestic capital investment makes an even more important contribution to economic growth than FDI in China. There may be two reasons for this result. The first is the scale effect. Though it has increased rapidly in China, inward FDI still accounts for a small proportion of total investment in China. It is widely recognised that technology transfer and spillovers from FDI are a very important source for economic growth in developing countries. However, the current empirical model does not capture these impacts. The second is China's special trade regime. As Balasubramanyam et al. (1996) note, FDI can play more important role in export-promotion (EP) countries than in import-substitution (IS) countries. China purses neither pure export-promotion nor pure import-substitution trade policies. Rather, China's trade regime has evolved in the direction of the so-called "protected export-promotion" (PEP) paradigm (World Bank, 1994, p. 81). This regime is between pure export-promotion and import substitution. Thus, FDI may have not played its full role in stimulating economic growth in China.

The Chinese Economy: coastal and inland provinces

In Specification (I2), the (unreported) estimates for the province-specific effects are all significant at the 5% level at least. Clearly, there is significant heterogeneity across regional economies, and it may be useful at this point to examine some of the reasons for these regional differences. Growth patterns vary across Chinese provinces because of a number of factors including resource endowment, location, culture, stage of economic development and government policies. For instance, prior to implementing reform and opening to the outside world in late 1978, the central government carried out vertical division of labour among the provinces: the coastal areas developed the manufacturing industries while the inland areas provided low priced raw materials. In the initial period of economic reforms, the central government gave priority to the coastal areas and the inland areas lagged behind the coastal areas in terms of developing international trade and attracting FDI [Fu and Li, 1996]. It is sometimes suggested, therefore, that the income growth of the privileged coastal areas was based on the slower growth of the less privileged inland areas.

However, with the deepening of economic reform and opening to the outside world, preferential government policies and strategies of openness have spread to the inland areas. Taking advantage of their natural resource endowment and making use of the industrial capabilities initially established by the so called 'Third Front Construction' during the 1960s and 1970s, the inland areas have also developed downstream manufacturing. During the process of the liberalisation of price controls, the prices of raw materials rose in the inland areas and made them more willing to co-operate with the coastal areas. The inland areas have benefited from technology transfers and spillovers via their accelerated integration with both the coastal areas and the outside world. They have established various offices in the coastal areas to spread information, and a number of R&D and production collaboration agreements have been signed by local governments and enterprises between the inland and coastal areas. The inland areas have also provided favourable working and living conditions to attract many retired managers and engineers from the coastal areas. International trade and inflows of FDI in the inland areas also help enhance technological capabilities there. In addition, the central government has used both fiscal and financial policies to support poor areas [Fu and Li, 1996].

The overall impact of these developments is manifested in a tendency for the inland areas to catch up with the coastal areas. These considerations imply that further insights into the growth experiences of the Chinese provinces may be obtained by disaggregating the sample. Accordingly, the full sample of 27 provinces is classified into two groups. The first includes coastal provinces - Tianjing, Hebei, Liaoning, Shanghai, Jiangsu, Zhejiang, Fujian, Shandong, Guangdong and Guangxi plus Beijing. The remaining provinces constitute the second group. Tables 5.4 and 5.5 give the estimation results for these two sub-samples.

The results in Table 5.4 are similar to those in Table 5.3 except that ln*IM* is insignificant in Specification (II2). However, in Table 5.5 the export coefficients are insignificant in Specifications (III2) and (III3), implying that only FDIR, imports, domestic R&D expenditure, physical capital investment and the labour force are the determinants of economic growth in inland areas. This may suggest that inland areas are still relatively inward-oriented so that the exports variable loses its explanatory power.

The magnitudes of the FDIR coefficients are far greater in coastal areas than in inland areas, suggesting that FDIR has more influence upon growth in coastal areas. This is consistent with the fact that FDI is concentrated in the coastal provinces.

The estimated values for the conditional convergence rate λ are around 20% a year for the sample containing the coastal provinces and around 11% a year for the inland provinces, implying that they move half way to the steady state in about 3.5 and 6.5 years respectively.

Table 5.4 Fixed Effects Estimation Results for the Coastal Provinces

(Dependent variable = $\Delta \ln Y$)

Variables	(II1)	(II2)	(II3)	(II4)
ln*Y*(-1)	-0.0091 (0.0070)	-0.1887 (0.0304)***	-0.1915 (0.0304)***	-0.1677 (0.0285)***
ln*FDIR*		0.0258 (0.0055)***	0.0284 (0.0051)***	0.0217 (0.0051)***
ln*EX*		0.0225 (0.0124)*	0.0296 (0.0111)***	--
ln*IM*		0.0116 (0.0092)	--	0.0191 (0.0083)**
ln*RDE*		0.0571 (0.0189)***	0.0613 (0.0187)***	0.0567 (0.0192)***
Δln*HC*		0.0237 (0.0667)	0.0251 (0.0669)	0.0247 (0.0675)
ln*K*		0.0779 (0.0181)***	0.0879 (0.0163)***	0.0720 (0.0180)***
Δln*L*		0.8326 (0.1686)***	0.7902 (0.1658)***	0.8367 (0.1707)***
R-squared	0.0155	0.7901	0.7864	0.7825
S.E. of regression	0.0581	0.0292	0.0293	0.0296
Implied λ	0.0091	0.2091	0.2107	0.1836
Half-life (Years)	76.2	3.3	3.3	3.8
Obs.	110	110	110	110
Hypothesis Tests		LR: $\chi^2[10]$ = 71.11***	LR: $\chi^2[10]$ = 78.19***	LR: $\chi^2[10]$ =85.67***
		LM: $\chi^2[1]$ = 0.02	LM: $\chi^2[1]$ = 0.46	LM: $\chi^2[1]$ = 1.53
		HS: $\chi^2[8]$ = 52.09***	HS: $\chi^2[8]$ = 79.63***	HS: $\chi^2[8]$ = 51.15***

Notes: 1. Standard errors are in parentheses.

2. *, ** and *** denote significant at the 10%, 5% and 1% level, respectively.

3. The sample includes Tianjing, Hebei, Liaoning, Shanghai, Jiangsu, Zhejiang, Fujian,, Shandong, Guangdong, Guangxi plus Beijing.

Table 5.5 Fixed Effects Estimation Results for the Inland Provinces

(Dependent variable = $\Delta \ln Y$)

Variables	(III1)	(III2)	(III3)	(III4)
ln*Y*(-1)	0.0005 (0.0044)	-0.1091 (0.0223)***	-0.0975 (0.0227)***	-0.1015 (0.0214)***
ln*FDIR*		0.0072 (0.0025)***	0.0084 (0.0025)***	0.0066 (0.0024)***
ln*EX*		0.0123 (0.0105)	0.0148 (0.0108)	--
ln*IM*		0.0202 (0.0065)***	--	0.0207 (0.0065)***
ln*RDE*		0.0273 (0.0131)**	0.0373 (0.0131)***	0.0277 (0.0131)**
Δln*HC*		0.0206 (0.0529)	0.0076 (0.0543)	0.0177 (0.0529)
ln*K*		0.0587 (0.0137)***	0.0712 (0.0135)***	0.0562 (0.0135)***
Δln*L*		0.8110 (0.2083)***	0.8394 (0.2145)***	0.7896 (0.2078)***
R-squared	0.0001	0.5947	0.5660	0.5906
S.E.of regression	0.0402	0.0276	0.0285	0.0276
Implied λ		0.1156	0.1026	0.1070
Half-life (Years)		6.0	6.8	6.5
Obs.	160	160	160	160
Hypothesis Tests		LR: $\chi^2[15]$ = 72.32***	LR: $\chi^2[15]$ = 65.95***	LR: $\chi^2[15]$ =80.32 ***
		LM: $\chi^2[1]$ = 5.54**	LM: $\chi^2[1]$ = 4.16**	LM: $\chi^2[1]$ = 6.87***
		HS: $\chi^2[8]$ = 52.00***	HS: $\chi^2[8]$ = 49.51***	HS: $\chi^2[8]$ = 57.27***

Notes: 1. Standard errors are in parentheses.

2. *, ** and *** denote significant at the 10%, 5% and 1% level, respectively.

3. The sample includes Shanxi, Inner Mongolia, Jilin, Heilongjiang, Anhui, Jiangxi, Henan, Hunan, Hubei, Sicuan, GuiZhou, Yunan, Shaanxi, Gansu, Ningxia and Xinjiang.

Overall, the above estimation results provide support for the endogenous innovation growth theory since all the explanatory variables have the expected sign and (apart from HC) are significant in the full sample. The coefficient on the lagged per capita GDP is highly significant in both the full sample and the two sub-samples, implying conditional convergence in all these samples. The results are not consistent with previous empirical findings of a convergence rate around 2%. The lower convergence rate found in previous studies may be due to the omission of some growth-promoting factors identified by "new" growth theory, i.e. FDI, international trade and R&D.

5.5 Conclusions

Using a panel dataset for 27 provinces over the period 1986 to 1995 in China, this study provides empirical evidence in support of the endogenous innovation growth model in two key respects. First, the importance of R&D, FDI and international trade for innovations and imitation and hence economic growth is confirmed. Second, given technological diffusion, transfer and imitation, regional per capita incomes do converge. The overall convergence rate is approximately 0.13 which is much higher than those reported in previous studies.

Furthermore, since the patterns of income growth differ across provinces and especially between the coastal areas and inland areas, we have made separate estimations for these two groups and found that each group converges to its own steady state. However, it takes coastal areas less time to approach their steady state than inland areas. For the group of inland areas, the export variable does not seem to have a significant impact on growth. This may be caused by the fact that inland areas are relatively more inward-oriented than coastal areas. The volumes and therefore the significance of export in inland areas are smaller than in coastal ares.

The policy implications of our findings are as follows. Since economic growth is sensitive to R&D and integration into the world economy, government policies aiming to encourage international trade, FDI and innovations and their diffusion should sustain economic growth and promote convergence between regional per capita incomes. In addition, since FDI plays a greater role in economic growth in export-promotion countries than in import-substitution countries, developing-country governments can enhance the impact of FDI by adopting more export oriented policies. As always, care should be taken not to rely too heavily on a simplistic interpretation of the sample results, which are conditional on certain historical growth processes in the Chinese economy. There is no guarantee that the future will be like the past and, to the extent that new growth processes occur in the Chinese economy which are not accounted for in our present sample, the above policy conclusions may require modification.

Chapter 6: Overall Conclusions and Policy Implications

Chapter 6: Overall Conclusions and Policy Implications

This thesis contains three empirical investigations and one theoretical model. The main features, findings and policy implications of these studies are as follows.

The first empirical investigation is concerned with the determinants of FDI. As reported in chapter 2, the study is based on a panel data set covering the time period of 1983 to 1994 (1984 to 1994) and 22 (17) home countries/regions for pledged (realised) FDI. The roles of relative home and host country characteristics as the determinants of FDI in China are focused on the grounds that rational investors would compare the home and host economic, political, cultural and geographic conditions before they undertake any FDI. There is strong evidence suggesting that both pledged and realised FDI are determined by relative real wage rates, relative exchange rates, and economic integration represented by real exports and imports. However, relative market size and total cultural differences are the two further significant determinants of pledged FDI. The present analysis fails to support the hypotheses that relative borrowing costs, country risk and geographic distance influence inward FDI.

These findings have an important implication for the future development of FDI in China. According to Wei (1995), although China may receive an adequate share of Japanese FDI, it is obvious that China still has great potential capacity to attract FDI from many major source countries such as the U.S., Germany, France and UK. This study illuminates several ways through which FDI can be best attracted to China. First of all, rapid economic growth and foreign trade expansion are expected to continue. Second, labour costs are expected to remain competitive for the foreseeable future in China. Therefore, China should expect to continue experiencing a rapid increase in inward FDI.

An important characteristic of FDI in China is its concentration in the coastal areas including Beijing. Therefore, an understanding of regional characteristics influencing locational decisions is essential for improved policies to promote further inward FDI into individual provinces in China. This is the central theme of chapter 3. By using panel data for 27 provinces within China over the periods 1985 to 1995 and 1986 to 1995 for pledged and realised FDI respectively, it is found that both pledged FDI and realised FDI are positively influenced by the level of international trade, R&D manpower and preferential investment policy. High effective wage rates and high information costs act as deterrents to FDI. However, such regional characteristics as GDP growth, improvement in infrastructure and advances in agglomeration have lost their power in explaining realised FDI. In addition, an IPS test for unit root confirms a long run relationship between the spatial distribution of FDI and a number of regional characteristics in China.

The empirical results suggest the coastal areas have attracted a dominant proportion of FDI especially because of their long commercial and industrial traditions and geographical and ethnic links with Hong Kong, Macao and Taiwan. While the coastal areas are expected to absorb an increasing amount of FDI, the inland areas may exploit their advantage of relatively lower labour costs, and enhance other regional characteristics to attract more FDI. Since the Chinese government is in the process of providing national treatment for foreign investors, differences in investment incentives between the coastal and inland areas are likely to diminish. As noted by Gong (1995) and Broadman and Sun (1997), FDI has already begun to penetrate into inland areas. Improvements in physical and scientific infrastructure and enhancements in economic activities and agglomeration will make inland areas more attractive to foreign investors. Therefore, fiscal support for major infrastructure construction in less-developed areas should be put on the government agenda.

A comparison of the empirical results from chapters 2 and 3 reveals that wage rates, international trade and market size are the common variables influencing both inflows and regional distribution of pledged FDI, and that market size variable loses its explanatory power in explaining both inflows and regional distribution of realised FDI. This may suggest that pledged FDI is more market-size driven than realised FDI.

While chapters 2 and 3 look at the determinants and regional distribution of inward FDI, chapter 4 provides a dynamic general equilibrium model to examine the interactive relationships among FDI, knowledge spillovers and long run economic growth in a developing country. The ideas of endogenous product cycles and trade-related international knowledge spillovers of Grossman and Helpman (1991a, c) are modified and extended to FDI. Unlike the FDI-innovation-growth model of Walz

(1997), this study explicitly recognises the learning costs of local firms and the impact of knowledge gap. A steady-state equilibrium is derived for the developing country. It is concluded that economic growth in the presence of FDI is determined by the stock of human capital, the subjective discount rate and knowledge gap, while unskilled labour can not sustain growth.

A few important policy implications emerge from the model for developing countries. First, high domestic savings, inward FDI and quick accumulation of human capital need to be encouraged. Second, government policy of developing countries needs to encourage R&D activities in local firms since technological capabilities of local firms in developing countries is important. Successful imitation requires not only the availability of advanced technologies from foreign firms, but also an adequate absorptive ability of local firms. Third, if government policy of a developing country helps potential foreign investors to be well informed of the investment environment, which includes laws, customs and regulations, the information costs occurred by foreign investors could be reduced. Thus, human capital, which would otherwise be required to compensate the information disadvantage, can be applied to productive or imitative activities, and therefore enhance economic growth.

In assessing the impact of FDI on economic growth, the theoretical model developed in chapter 4 has not been directly employed due to data limitations. Instead, some important ideas of the theoretical model have been incorporated into income convergence regressions, and the effect of FDI is tested in the context of an endogenous innovation growth model with technological diffusion, transfer and imitation. A panel of data for 27 provinces across China between 1986 and 1995 is used. By allowing for differences in the aggregate production function across regions, it is found that regional per capita income can converge given technological diffusion, transfer and imitation. The empirical results seem to support the endogenous innovation growth theory in which FDI, R&D and international trade appear to be the significant determinants of long-run economic growth.

Furthermore, if China is divided into coastal areas and inland areas - each group converges to its own steady state. However, it takes coastal areas less time to approach their steady state than inland areas. For the group of inland areas, the export variable does not seem to have a significant impact on growth. This may be caused by the fact that volumes of exports in inland areas are very low compared with coastal areas. In terms of the impact of FDI, the magnitudes of the FDI coefficients are far greater in coastal areas than in inland areas, suggesting that realised FDI has more influence upon growth in coastal areas. This is consistent with the fact that FDI is concentrated in the coastal provinces.

The policy implications of the findings in chapter 5 are straightforward. There are two important policy implications of the findings in chapter 5. First, since economic growth is sensitive to R&D and integration into the world economy through both FDI and international trade, government policies aiming to encourage international trade, FDI and innovations and their diffusion will accelerate economic growth and promote convergence between regional per capita incomes. Second, since the relatively smaller role of FDI than domestic investment in economic growth may be caused by China's protected export-promotion regime, the Chinese government may enhance the impact of FDI by adopting more export-oriented policies.

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

1. A number of important ideas identified in the FDI and economic growth literature are synthesised into a dynamic general equilibrium model.
2. Sound econometric techniques are applied to systematically assess the determinants and regional distribution of inward FDI, and its impact on economic growth and income convergence.
3. A number of policy implications from both theoretical and empirical studies are discussed.

This research can be important to both business practitioners and academics. Investors may be interested in the results because they explain political, economic, social and cultural factors influencing FDI decisions. 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. The current research also discusses policy implications in terms of determinants and impact of FDI, and should be of some use to Chinese policy makers. For example, in chapter 4, it is argued that a sufficiently transparent policy regime is important for a developing country's economic development. In the case of China, the FDI policies involve excessive levels of governmental approval. As many other developing countries continue to improve the policy climate for FDI, China must make commensurate improvements so as to keep her attractiveness as a host. In addition, China's experience in utilising FDI may provide valuable lessons for other host developing countries. For instance, to attract more FDI and further enhance its role in economic growth, one important element of government policy is to encourage domestic R&D and improvement of technological capabilities in local firms.

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