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PROVINCIAL ECONOMIC GROWTH, INTER-PROVINCIAL AND COASTAL-INLAND INCOME INEQUALITY IN CHINA FROM 1991 TO 1999

BY
ZHENG WANG

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To my family and my dear husband Yong ZHANG

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ABSTRACT

DEPARTMENT OF ECONOMICS, FACULTY OF SOCIAL SCIENCE

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This thesis investigates provincial economic growth patterns in China, focusing on the 1990s. During this period the most distinctive characteristic is the inter-provincial and the inter-regional income inequality.

The thesis is divided into six chapters.

Chapter 1 introduces the goals of the thesis and reviews some fundamental literature. The problems addressed in this thesis include the income distribution, the coastal-inland development gap, and the development of ownership structure; all three are linked with each other.

It has been noted that the linked problems affecting China's economic development are induced by many entangled factors; in particular, economic policy. Hence, Chapter 2 provides an overview of institutional change during the 1990s and its impact on the provincial economic growth pattern in China. The quantification of preferential policies and degrees of openness at provincial level is also given, together with a discussion of institutional rigidity and restrictions on factor mobility.

Before proceeding to the theoretical and empirical investigation of provincial economic growth patterns in China, we describe our data set and the empirical method in Chapter 3. The data is from the China Statistical Yearbook for various years. After explaining how to deflate the GDP data using GDP indices, we show that the GMM estimator is the most consistent and efficient estimator in a dynamic panel data model.

Therefore, using provincial data in China during the 1990s, Chapter 4 investigates provincial economic growth patterns and inter-provincial income inequalities. We find that a province takes around 8 years to halve the deviation from its balanced growth path. Based on the Solow growth model, GMM estimation results imply that physical capital investment contributes positively to economic growth. However, the existence of *conditional* convergence cannot be used to predict whether poor provinces can catch up with rich provinces. We apply sigma and beta *absolute* convergence analysis and find no evidence of catching up between the initially poor provinces and the initially rich provinces.

In Chapter Five, we focus on the enlarging coastal-inland income gap. It is found that, by using the distance by railway of each province's capital city to its nearest port city as a proxy for transportation costs, there are significant differences across provinces. Distance has negative effects on economic development but its marginal effects become less as distance increases. Disaggregating capital investment by source: public, foreign and domestic private: helps to disentangle the effects of policy from those of geography. The impact of public investment on growth is insignificant in our panel data for 29 provinces; that of foreign investment is significant; domestic private investment is more influential.

Finally chapter 6 offers some final remarks.

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CHAPTER ONE

INTRODUCTION AND LITERATURE REVIEW

China is a country of great interest to the world. It offers an unusual case study in many respects. For economists, this large country is moving from a planned economy to a market system. The piecemeal reform process has proceeded pragmatically, which triggers many debates and extensive comparisons with the "big bang" approach typical of East European countries and the constituent parts of the former Soviet Union. People have different views about China's reform process. At one stage the world regarded China, under its communist regime, as a threat. Subsequently observers consider that China is weak, taking into consideration that the statistical data of GDP growth in China should be discounted by perhaps as much as one third (Rawski (2001)). For businessmen, China has particular attractions, firstly because the potential rewards in China may be higher than in any other parts of the world. The Economist (05-04-2001) claimed, "*China is the largest untapped market in the world*". Secondly because, investors and analysts claim to recognise in China a political will to change that is unmatched in other developing countries. All these arguments lead to various opinions about China, different from, and even contradictory of, each other. Therefore, a clear and objective description of economic activity in China is desirable. This thesis will thus be aimed at the analysis of problems relating to China's economic development, focusing on provincial economic growth, inter-provincial and inter-regional development gaps during the 1990s.

The 1990s is the second decade of China's economic reform. Detailed comparisons between China's reform process and that of other transitional economies have been

made by many leading economists. Sachs and Woo (1997) is representative. They argue that while both China and the East European countries are in transition from a centrally planned economy to a market-oriented economy, their paths vary, resulting in different implications for the future. The Eastern European countries adopted "shock therapy", which includes measures like rapid and comprehensive price and trade liberalization, macroeconomic stabilization, alignment of the official exchange rate to the market rate and the ending of legal discrimination against all types of non-state enterprises. These reforms have swept through these countries within a short period of time. In contrast, the piecemeal reform process in China has been characterised by the gradual introduction of polices, which would be carried out only after progressive experiments had been made in the economy. The authors' conclusion is that, even though China's economy has developed well in many aspects, this is not to the credit of the gradualist policies. The fast economic growth during China's reform process should be attributed to the growth in the towns-and-village-owned-enterprises (TVEs) and to the development of the agricultural sector. The success of TVEs' development and the agricultural sector reform was based on the one-shot improvement in productivity that followed the liberalization of the agricultural sector. The endowment of a large rural population of working age in China allows the country to develop the rural enterprises without absorbing the labor force from the state sector. In contrast, this rural population is much smaller in the Eastern European countries because almost 100% of their labor force was employed in the state sector. Therefore, China's reform experience cannot be shared by the Eastern European countries since the specific endowment features of its production factors are not comparable to other transitional economies. Nevertheless, the gradual reform process in China could induce more serious problems in the future, since

the nature of partial reform indicates the postponing of tensions instead of offering a full solution.

On the other hand, some economists have expressed different opinions, for example, Qian, Lau and Roland (2000). They demonstrate that while the "big-bang" approach, characterised by full market liberalization within a short period, is able to lead to efficiency under the usual assumptions of profit maximization and perfect competition, it does not guarantee a Pareto-improving result. That is, when the economic reform brings better living standards to some people, many others find their welfare levels worse off. In contrast, the gradual reform approach adopted by China used to be characterised as "dual-track", meaning that the liberalizing of the market has been carried out simultaneously with the continued enforcement of the existing planned system. This approach offered a useful way to implement a reform without losers while achieving improved efficiency at the same time. They argue, "*the dual-track approach minimized political opposition to reform ex ante and maximizes political opposition to reversal of reform ex post*". (p. 122).

Nevertheless, China's economic reform should not be regarded as a very well designed process so that there are "no losers", nor should it be considered as a complete failure because the problems that existed in China's economy have been deferred or only partially solved.

In fact, most economists consider that China's economic reform has achieved great success while severe problems still deserve serious attention. Some researchers have focused on more specific economic problems that have occurred during China's reform process, in particular during the 1990s. Among the various problems of China's economy, income distribution, the coastal-inland development gap, and the development

of ownership structure are considered to have important influences on sustained economic reform. Moreover, most problems are entangled with each other and cannot be dealt with separately. However, we will try to discuss the sources, features and possible solutions of these problems one after another. The discussion here will determine the structure of this thesis.

1.1 INCOME INEQUALITY

At the start of China's economic reform, Deng Xiaoping had told the Chinese people: "*it is glorious to get rich*" and "*let some people get rich first*". By announcing that economic growth is the major objective of the reform process, China's development course has been changed completely. However, after two decades of reform, it is also the idea of "*let some people get rich first*" that leads to the severe income distribution problem, which constitutes one of the most important factors that may impact sustained economic development. The income gaps between poor and rich in the urban areas, between urban areas and rural areas, and between coastal region and inland region, may pose a threat to China's social stability. In particular, the Gini coefficient, which is a main indicator for income distribution inequality, officially reached 0.39 (Economist (31-05-2001)) in 1999 and is close to the internationally recognized danger level (0.40). Living in a country that has adopted socialism for more than 50 years, Chinese people may find it harder to tolerate income inequality than people in other capitalist economies.

In 1978 when China's reform was just launched, urban residents, since they were employees or relatives of employees of State-Owned Enterprises (SOEs) or State-Owned institutions, used to enjoy social welfare securities such as guaranteed jobs, free

housing, free education and free health care, among others. Income was in general low but income distribution was rather even. Full employment was achieved in urban areas when rural residents were banned from moving to urban areas. However, even though economic reform brings welfare improvements to almost everybody, some people with special resources manage to obtain much higher income levels than others and the income gap is increasing. According to the Economist (31/05/2001), "*by the mid-1990s, 9% of urban residents were living below the official poverty line of 1,800 yuan (USD 217) per year*" and "*the richest 20% of urban households receive 42% of total urban income, whereas the poorest 20% receive only 6.5%*". It is also noted that in some cities the proportion below poverty line is even higher. For example, Xi'an, the most important city in northwest China, has 30% of its urban residents living under poverty line. Many northeastern cities, home of China's poor-performing SOEs, have even higher proportion under poverty line. The same article claims "*60% of Shuangyashan's 1.8 million inhabitants are living in poverty*".

In addition to income inequality within the urban areas of China, the urban-rural income gap is a more substantial source of income disparity. In general rural residents are much poorer than urban residents. According to OECD (2002), per capita income of rural households constitutes only 40% of those in urban areas. Development in the rural areas of China, such as reform in the agricultural sector, is an interesting and important research topic; however, it is beyond the scope of this thesis. Nevertheless, as we mentioned, it is noticeable that development in the agricultural sector and the TVEs was the engine for economic growth at the early stage of the reform.

Employing about 50% of the country's labor force, China's agricultural sector is characterised by small-scale, labor-intensive and low-technique production. It is widely

reckoned that fundamental breakthroughs in the productivity of agriculture depended upon substantial reallocation of resources away from land-intensive products to labor-intensive products[1]. According to OECE (2002), the labor-intensive products concentrate in the coastal region. The development of agriculture thus coincided with the development of the coastal region. Indeed, Jian, Sachs and Warner (1996) have identified the catching up of poor coastal provinces to rich coastal provinces in the 1980s due to the agricultural reform success. The OECD (2002) suggests that "*the increase in agricultural productivity provided the first major impulse to the take-off in China's growth during the first half of the 1980s.*" (p. 10). On the other hand, rural residents contributed greatly to China's economic growth by developing TVEs, most of which are medium and small sized enterprises in rural areas specializing in producing labor-intensive products. TVEs used to be the major means to absorb extra workers from the agricultural sector. Their growth from mid 1980s to early 1990s contributed significantly to economic growth in China.

However, the influences of agriculture and the development of TVEs faded from the mid 1990s. On the one hand, the physical constraints on China's land and environmental resources make it difficult to increase productivity further within the existing pattern of agricultural production. On the other hand, TVEs are suffering from financial problems and operating inefficiencies due to vague ownership structure. Furthermore, the situation of rural residents is exacerbated by unfavorable macroeconomic policies. During China's development, in addition to a much lower endowment of education resources and other infrastructure constructions, rural residents have no guarantee of

[1] OECD (2002) gives examples of land-intensive and labor-intensive products. Land-intensive products can be represented by wheat, corn, soybeans and cotton, which are produced mainly in the northern part of the country, and rice and sugar, which are produced mainly in the southern half. Cultivation of

social benefits such as pensions, health, or child care. Above all, China's household registration system impedes labor migration from rural to urban areas. Since it is rather difficult for rural residents to search for any job opportunity in urban areas, very often they have to accept the lowest paid jobs with the least security. Nevertheless, floating migrants still make significant contributions to urban areas' development, which further enlarges the rural-urban income disparity.

1.2 THE COASTAL-INLAND DEVELOPMENT GAP

When inland rural residents migrate to prosperous urban areas to search for a job, they can choose from moving to the capital cities of their own province or to the much richer coastal cities. In particular, when in general rural areas are poorer than urban areas, the inland rural areas are even poorer than the coastal rural areas. Therefore, the rural-urban income gap is entangled with the coastal-inland income gap; an obvious tendency of labor migration from the poor inland region to the rich coastal region further enlarges the coastal-inland development gap.

By administrative division, China has 31 regions at provincial level; hereafter we will use the term "province" to denote these regions. And the term "region" will be used to represent coastal region and inland region.

It is easy to understand that different provinces may grow at different rates, but whether the difference has positive or negative influences on the overall development process is debatable. This may be affected by the scale of integration of China's economy at provincial level. There is considerable amount of literature arguing this issue. In Qian and Xu (1993), the authors contend that the difference in China's

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vegetables, an example of the labor-intensive products, is concentrated in coastal provinces and in areas

provincial economic growth rates is induced by the flexibility of China's administrative structure. They claim that the flexibility, resulted from the "M-form" hierarchy in China, may benefit the whole economy since it encourages the development of non-state owned enterprises in some parts of the country without interrupting development in other parts. The term "M-form" refers to the multi-layer-multi-regional administrative hierarchy and contrasts with "U-form", which refers to the unitary hierarchical structure. Qian and Xu point out that the M-form administrative structure in China leads to less interdependence between provinces since provinces are more "self-contained" than under the U-form administrative structure of the former Soviet Union. Under the M-form structure, local governments in China have had considerable responsibility for coordination within a province. Each province becomes relatively self-sufficient and the economic reform can be carried out on a much smaller scale with less cost to the whole country.

Young (2000) argues to the contrary. He claims that provinces' self-sufficiency has a negative influence on the country's economic development. In his argument, the negative effect is reinforced by price distortions. In China price used to be controlled by the central government, when "price scissors" distorted to a great extent the relative prices of intermediate inputs and processed products. Prices for agricultural products and raw materials were lowered purposefully to reduce the production cost for processing industries, which benefited significantly the high profit margins on their products. Price distortions under the planned scheme still affected China's economic development after the economic reform started. When price controls were lifted, processing industry development became the main objective of many local

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adjacent to cities. (p. 9)

governments, because the new price structure, in which price levels are adjusted by demand and supply relations in the market, took time to become established, and the profit distorted by the former price structure is too huge to be ignored. To put it another way, when prices become less controlled by the central government, local governments would start rent seeking by setting up high margin industries. "*Continued reform and growing inter-regional competition between duplicative industries threatened the profitability of these industrial structures, leading local governments to impose a variety of interregional barriers to trade*" (Young (2000)). Thus the price reform process has resulted in the fragmentation of the domestic market and a distorted structure of provincial production, while the nature of provincial "self-sufficiency" aggravates inter-provincial trade barriers. As the result, production factors are no longer allocated according to their marginal productivity. For example, Shanghai, which has been equipped with the most up-to-date technology for processing industries, finds it difficult to procure raw materials from inland provinces; instead, it has to import these intermediate inputs from abroad. On the other hand, the inland provinces that produce those raw materials set up their own processing industries, but with much less modern production technology and narrower marketing channels. Consequently, these inter-provincial barriers give rise to enlarged disparities among provinces' economic development.

Apart from the inter-provincial trade barriers, the low scale of factor mobility also contributes to the increasing inter-provincial income gap. As we mentioned above, household registration system impedes labor to flow both from labor-abundant province to labor-scarce province, and from rural areas to urban areas. In addition to goods and labor, capital flow is not free as well. Capital-scarce province may be reluctant to

receive investments from capital-abundant provinces, since they feel the rich provinces may grab all the profitable opportunities for their local investment. According to Huang (2001), he suggests that the economic fragmentation leads to the increase in FDI inflows to China, since local province may prefer to receive investments from abroad, rather than from other provinces.

In fact, the inter-provincial income gap used to be higher when People's Republic of China was first established. According to Wang and Hu (1999), "*when the Chinese Communists came to power in 1949, they inherited an extremely lopsided economy. Industrial activities were to a large extent concentrated in Manchuria and a few major coastal cities. ... The new government made a strong commitment to achieve a balanced distribution of productive capacity and income.*" (p. 3). They claim that, before economic reform, China's central government adopted an egalitarian policy to try to distribute production capacities more evenly. In addition to this egalitarian concern, China distributed a large number of large and medium sized SOEs to the Third Front[2] for security reasons. "*Altogether, between 1956 and 1978, more than two thousand large and medium sized enterprises were established in West and Central China.*" (p. 4). However, in spite of all these efforts that the government made to achieve a more even distribution of social wealth among provinces, inter-provincial disparities enlarged during the 1990s, as an effect of the country's transition from a planned to a market system. In particular, when SOEs are trapped in financial difficulties, those inland provinces with relatively high proportion of SOEs in their economy face serious problems in their economic development process.

[2] The Third Front included two geographic areas, both are located in the west part of China. One is the Southwest Front, the other is the Northwest Front. An alternative division is into the 'Major third line' and the 'minor third line'.

For these reasons and others, China's economy has again been described as a "*dual-track*" economy, but the usage by some researchers is ironic, making the observation that the inland region lags far behind during the economic reform process while coastal region has developed at two-digit speed for most of the reform years. The enlarging income inequality, within urban areas, between rural and urban areas, and between coastal region and inland region, is becoming a more and more serious concern since it could lead to social upheaval.

1.3 OWNERSHIP STRUCTURE DEVELOPMENT

Nevertheless, it is noted that both the income inequalities in China and the development gap between the coastal region and the inland region are closely linked to the development of ownership structures; in particular, to the poor performance of the state-owned sectors and the vigorous growth of the non-state owned sectors in the 1990s.

The huge losses in the state-owned sectors are an important concern in China's economy. Lardy (1998) argues that the debt problems of SOEs could make the reform process unsustainable. He attributes the poor performance of SOEs to the following factors. The first factor accounting for SOEs' losses is price system reform, rather than competition from non-state owned enterprises as advocated by Naughton (1994 b). In the same way as Young (2000), Lardy considers that the high profits in processing industries, which depended upon low prices for agricultural products and other raw materials, reflect long-term price distortions. The indirect taxing of the agricultural and raw material production sectors has been imposed through unfavourable terms of trade. During China's economic reform, the central government aimed to lift almost all of the

price controls; in OECD (2002), it has been estimated that "*nearly 90 percent of retail prices are now completely market determined, the main exceptions being energy and other utility prices*" (p. 13). Therefore, with the lifting of price control, when prices for the intermediate inputs have to be set by the market, it is inevitable that profit margins fall in the processing industries.

The second factor is the accounting and tax system reform after 1993. In fact the SOEs performance used to be poor and many SOEs were operating in loss already; the implementation of the new accounting system only reveals their massive losses. The third factor is the different pace of real wage increase and productivity increase in SOEs. Due to problems arising from insider control, SOEs tend to maximize their employees' welfare instead of profits. Therefore real wage always increases faster than productivity. This factor is entangled with the fourth factor, which is the overstaffing problem in these SOEs. Being owned by the state, these enterprises find their labor employment far beyond their real demand. Lack of a social security system contributes to excessive employment and the heavy burden of employees' welfare on SOEs. Furthermore, these SOEs are the major taxpayers even though their own expenditures on health, education and other welfare are already high. In addition to these burdens, SOEs also face serious asset stripping problems. Lardy has described the typical asset stripping process of state property in the following way. "*Given the uncertainty of property rights, managers of some state owned firms have moved assets of state-owned firms into new non-state enterprises, leaving the original state-owned firm only as the holder of liabilities. Subsequently, the original firm may declare bankruptcy and default on its outstanding financial obligations, notably loans from banks. These cases are referred to as 'false bankruptcies'. Alternatively the managers of state-owned*

enterprises lease or contract out the use of assets to workers. But the lease payments or profits transferred back to the state firm may be so small that the latter cannot amortize the loans that it took out to finance the original purchase of the equipment. Some firms transfer funds to their workers who then deposit in personal savings accounts. This apparently is not uncommon scheme enterprises use to conceal income and avoid taxes. Even if the funds are eventually returned to the firm, in the short run the practice may result in an understatement of the firm's assets." (p. 51).

However, Naughton (1994 b) believes that the declining profit trend in SOEs should be best explained by the termination of the state monopoly over industries. Hence, the competition from the non-state owned enterprises weakens the original advantageous position of SOEs. Woo et al (1994) compares the total factor productivity (TFP) growth rates of SOEs and TVEs. They find zero TFP growth in SOEs, which suggests that the positive TFP growth in SOEs found by other researchers may be due to under-deflation of gross output and over-deflation of intermediate inputs. Nonetheless, they also argue that the criterion for SOEs' reform should include intertemporal efficiency and SOEs' contribution to macroeconomic stability. Qian (1996) attributes the plight of SOEs to their social responsibilities. He argues that SOEs need to take care of pension, health, housing and other social services such as nursery and elementary schools. Therefore, on the one hand, SOEs often use their social burdens as an excuse for asking for more subsidies; on the other hand, the central and local governments also use these burdens as an excuse for intervention.

Contrary to the slow development and big losses of the State-owned sector, non-state owned sectors developed very fast during the economic reform era. Non-state owned enterprises include collective-owned enterprises, domestic private-owned enterprises

and foreign-owned enterprises, with the last two also categorized as private owned enterprises. In 1999 China passed a constitutional amendment giving formal recognition to its emerging private sector. This formal recognition, however, is propelled by the development in the private sector itself. According to IFC (2000), "*more than half of economic activity in China is in the private sector*[3]." (p. 1). IFC (2000) reported that between 1991 and 1997, the output of domestic private firms grew on average "*71 percent a year*", and employment grew at "*41 percent per year*" (p. 1). In fact, while the state sector stagnated and foreign invested enterprises were affected by international economic shocks, domestic private enterprises continued to be the main engine for economic growth.

The development of the foreign sector in China has been closely related to both domestic policy and the international environment. However, the concentration of foreign direct investment (FDI) in coastal region exacerbates the coastal-inland income gap. While the northeast provinces of China, where clusters of SOEs are located, faced large layoffs of workers and increasing protests in their streets, the coastal provinces developed faster since they are the centre of non-state owned enterprises.

1.4 STRUCTURE OF THE THESIS

Therefore the structure of the thesis will be as follows. Chapter One is the introduction, with literature reviews and outline of the structure. China's reform process has been compared with those of other transitional economies. The gradual reform process has obtained some credit due to the fast economic growth achieved by the Chinese economy. However, the success that happened at the early stage of reform may

[3] "Private sector" in their report refers to domestic private sector, which is defined as "*business*

not have continued through the 1990s. Many problems occurred in the economy during the 1990s, which could stop China's growth in the future if no proper measures are to be taken. The enlarging income inequality, increasing gap between coastal region and inland region, and the uneven development of state-owned sectors and non-state owned sectors lead to the objective of this thesis: to analyze the provincial economic growth, the inter-provincial and the inter-regional income inequality during the 1990s objectively. Clear analysis of a problem precedes effective solutions.

We will discuss the reform process of public, domestic private and foreign invested sectors in Chapter Two, covering institutional change in China, especially the economic reform and the opening process in the 1990s. In this chapter we are going to explain why we concentrate on the economic growth problems in China during the 1990s. To anticipate, the reason is that this period is considered to show the most rapid increase in the inter-provincial and the inter-regional income gap after economic reform started in 1978. Further, the most fundamental reform measures are enacted in this period and the majority of the progress is made in opening the economy to the outside world.

Chapter Three provides data description and an explanation of the analytical methods; in particular a detailed illustration of the empirical method we will employ in this thesis and of the data from the China Statistical Yearbook. The enlarging inter-provincial income gap, which is determined by the factors contributing to provincial economic growth, is the topic of Chapter Four, where GMM estimation based on a Solow growth model will be used to measure the income disparity between provinces. Then we start to deal with factors accounting for this enlarging income inequality. The roles of policy and geography in provincial economic growth will be included in

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enterprises under the effective private control of resident Chinese private persons, whatever the legal

Chapter Five. The enlarging gap between coastal region and inland region in China raises the main question for this chapter: what is the function of geography in the provinces' economic growth pattern, taking policy influence into consideration. Conclusions and future work will be given in Chapter Six.

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status of the enterprise or formal ownership rights" (p. 75).

CHAPTER TWO

INSTITUTIONAL CHANGE IN CHINA DURING THE 1990S

Abstract:

Institutional change in China during the 1990s is reviewed. Economic reform and the open door policies in the 1990s affect provinces' economic growth patterns in China to a great extent. Fiscal policy reform and monetary policy reform have changed the central-local fiscal relationship, while the open door policies shape the current horizontal relationship among provinces. On the other hand, reforms in ownership structures lead to developments in the public, foreign and domestic private sectors. We show that SOEs cannot maximize their profits subject to the burden of being the main provider of social welfare. TVEs development is slow after the mid 1990s due to their vague ownership structure. Different sources of, and different incentives for, foreign investment exert different influences on provincial economic growth. During the 1990s, domestic private investment turns out to be the most important. A quantification of preferential policies at provincial level is also given, together with the illustration of degrees of openness and the involvement of foreign investment in international trade and domestic market.

2.1 INTRODUCTION

The famous economic reform in China, which was launched in 1978, is actually comprised of two processes happening simultaneously, namely the economic reform process and the "open to the outside world process". Entangled with each other, these two processes exert great influence on China's economic development and provincial economic activities, through changes to the institutional structures. Reform measures in the 1980s have been studied by many researchers. However, in overviewing the reform and the opening processes, here we focus on the institutional changes during the 1990s. The reasons that we are particularly interested in the 1990s are that, firstly, the inter-provincial income inequality, which is the subject of this thesis, enlarges quickly after 1990 and becomes the main source of the income disparity in China. Secondly, many fundamental reform measures, which have great influence on China's economy, have been carried out during the 1990s. Thirdly, the adoption of the policy that changes China's economy from a central planning structure to a market mechanism started from 1993. In sum, the pattern of reform and openness during the 1990s is very different from the pattern during the 1980s; therefore, the influences on provincial economic growth are also different.

Economic reform measures can be classified into a variety of categories. From the point of view of the central government, reform could be divided into fiscal policy reform and monetary policy reform. From the point of view of the production sectors, reform is comprised of agricultural reform, manufacturing industry reform and service industry reform. From the point of view of property rights, we have public sector reform, foreign sector reform and domestic private sector reform. From the point of view of society, we have security system reform, health system reform and education

system reform, among others. Reform measures in some categories have been proved to be efficient during specific periods. For example, agricultural reform was very effective between 1978 and 1984, during which period agriculture became the engine of economic growth in China. However, it is also noted that, the "contract responsibility system", which was the major reason for the success of agriculture, turned out not to be so efficient after 1984, when the inefficiency from small-scale agricultural production became important. On the other hand, some other reform measures are in difficulties and further improvements are needed. An example is enterprise reform, where the SOEs continue to sustain big losses and exhibit inefficiency over a rather long period. More over, some reform measures are under way and it is still uncertain whether there will be some positive response from the economy either in the short run or in the medium term. Some economic problems are so tough that people hardly believe these reform measures can succeed in the foreseeable future.

Since the economic development process depends upon a series of factors, all reform measures have affected provincial economic development to some extent. However, in addition to the open door policy that we will address later, the reform of the central-local relationship has had the most influence on provincial economic growth patterns.

Thus, the objective of this chapter is to investigate the effects of the economic reform and open door measures; in particular, those measures which have affected the provincial economic growth patterns to the greatest extent. The structure of the investigation will be as follows. Section-II explains the effects of reform on the central-local relationship, in which context influential measures of fiscal policy reform and monetary policy reform will be discussed. Section-III considers the open door process, including the preferential policies granted to the coastal provinces and the later

extension of these policies to the inland provinces. Section-IV describes the ownership reform, which could be interpreted as the major consequence of interaction of economic reform and the open door process. Our conclusions are given in section-V.

2.2 REFORM AND THE CENTRAL-LOCAL RELATIONSHIP

Because China used to have a centrally planned economy, some economists regard decentralization as the most important effect of the reform on the central-local relationship. In fact, there are two different strands of reform creating a new relationship between the central government and local governments, namely the *decentralization* and the *recentralization* processes. The current pattern of the central and local relation is the final result of the balance of these two forces.

Specifically, "*decentralization*" refers to the relaxation of the central government's control over local governments, by which local governments will possess a higher level of decision-making responsibilities. Opposite measures are characterized as "*Recentralization*", which occurs when the central government faces fading control over local governments, in particular, a lower share of revenues accruing to the central government as compared to the localities. The central government responds to its strengthening or weakening position by imposing macroeconomic policies – either the fiscal or monetary policies. According to some studies, common fiscal or monetary policies are important contributor to income convergence across economies. The following study is going to reveal that different provinces in China have not been granted "common" fiscal or monetary policies. These policy measures, especially those used during the 1990s, will be discussed in detail as follows.

2.2.1 Fiscal Policy Reform

It is worth noticing that fiscal policy in China had no real importance in the pre-reform period when government revenues came mainly from enterprises' remittances instead of taxes. Before 1980, all the enterprises' remittances were first sent to the central government; then the central government would transfer a proportion of those revenues back to local governments according to their demands for investment, subject to the central government's approval. After economic reform, several steps taken in the fiscal policy reform have affected central-local fiscal relations.

Firstly, in 1980, the originally highly centralized system was replaced by a revenue-sharing system following the direction of *decentralization*, and this was carried out via a "contract responsibility system". Under this system, the central government would receive certain categories of revenue, and local governments would receive other categories, while the central and local governments would share the remaining categories in a uniform ratio. According to Ma (1997), "*during the 1980-4 period, about 80 percent of the shared revenues were remitted to the central government and 20 percent were retained by local governments*". (p. 10). During this period, local institutions collected almost all revenues; while the bases and ratios of all remittances were determined by the central government.

Nevertheless, this ratio of shared revenues between the central and local governments had led to wealth accumulation in relatively richer provinces and deficits in relatively poorer provinces. To narrow the inter-provincial gap, a second revenue-sharing arrangement was used from 1985. Under this arrangement, a relatively poor province could retain more of its revenues while a relatively rich province needs to pay more to the central government. Based on the previous year's financial performance among the

provinces, the classification between "*poor*" and "*rich*" was made. This new arrangement, however, dampened the enthusiasm of the relatively rich provinces' governments to increase their tax base, which led to the consequence that tax revenues of the central government declined considerably.

To mitigate this decrease, in 1988, the State Council decided to adopt a new system that introduced six types of central-provincial revenue-sharing method, each applied to a number of specific provinces. This 1988 system was intended to increase the central government's revenue by improving the cooperation with local governments, which was supposed to be achieved by increasing the share of revenue retained by local governments. The intention was good; however, the implementation was not as effective as expected. The intention was undermined because different provinces tried to negotiate with the central government individually to reduce their financial burdens and to retain more local revenues, at the same time trying to obtain more investment from the centre. In order to reverse the trend of decreasing revenue shares of the central government, this method was terminated in 1993 when the central government decided to implement a tax system reform.

Therefore, the tax system reform was based on the previous experience of the revenue-sharing arrangements. The tax system reform employed in 1994 includes the following components. The first element is the tax assignment scheme. Similar to the revenue-sharing mechanism, taxes are divided into central-fixed taxes, local-fixed taxes and shared taxes. Under this system, the tax revenues belonging to the central government include customs duties; a consumption tax also collected by customs; a value added tax (VAT) and an income tax on centrally owned state enterprises; turnover taxes on railway, banks, and insurance companies; and income taxes from financial

institutions set up by the central bank (People's Bank of China). At the same time the majority of business tax (except for turnover taxes of banks, railways, and insurance companies), income tax of locally owned state enterprises, and personal income tax are revenues for local governments. As before, there is the third proportion of tax, which will be divided by the central and local governments. These include VAT other than for SOEs, securities trading tax and natural resources tax.

The second element is the means of tax collection. In contrast to the previous arrangement when all taxes were collected by local governments and then submitted to the central government, the central government now sets up its own tax collection agency, the National Tax Service, with its own local branches. The intention is to gain more control for the central government, while retaining the self-sufficiency of local governments.

Furthermore, to mitigate any possibility of decreasing local revenues, the central government has made agreements with local governments so that the vested interests of the local governments under the old system would be guaranteed. That is, the revenue-sharing formula under the new system was designed to give assurances that a province would retain no less revenue than it did in 1993. Thus the retained revenue of a province in 1993 would be used as the basis for calculating the amount of shared revenues returned from the central government to the local governments after 1994. In fact, the central government would increase its share of total government revenues only from the increase in the shared revenues, in particular, from VAT.

On the other hand, the adoption of the Budget Law in 1994 greatly affected the central-local relationship. The Budget Law hardens both the central and local governments' budget constraints. The central government is no longer allowed to

borrow from the central bank and has to finance its deficits by selling bonds. Local governments have to consolidate their budgets with the central government and the state budget has to be formulated in a coherent framework. The central government is no longer responsible for any deficit faced by local governments: localities have to balance their own budgets through accumulated budgetary surpluses or extra-budgetary funds. Furthermore, local governments are not allowed to finance their deficits with bond issues or bank borrowing.

2.2.2 Monetary Policy Reform

Officially China's central bank, the PBC, is a ministry-level organization under the State Council. As Xie (2000) points out, the central bank is weak in formulating monetary policies, but it is strong in implementing these policies. Since all major monetary policies are subject to the approval of the State Council, it is easy to understand that the central bank's function is to carry out the central government's monetary policy and make sure all the financial institutions follow the financial rules formulated by the government.

The relation between banks and government has also been reflected in the history of establishing banking system in China. In September 1983 the People's Bank of China (PBC) started to function as a central bank. In the February 1979, the Agricultural Bank of China was re-established as a separate bank, reflecting the government's emphasis on agricultural reform at the early stage of the economic reform process. One month later, the Bank of China was separated from the PBC to support the open door policies, which were just being launched in some Special Economic Zones. In October 1979 the Construction Bank was removed from the administrative control of the Ministry of Finance, to support investment projects. These changes in the banking system led to

fundamental institutional changes in China's monetary system. By 1993, in addition to the Agricultural Bank, the Bank of China and the Construction Bank, China's banking system mainly consisted of the following specialized banks and non-bank institutions: the Industrial and Commercial Bank, the Rural Credit Cooperatives, the Urban Credit Cooperatives, the Bank of Communications, the China International Trust and Investment Corporation (CITIC), the Guangda Finance Corporation and the People's Insurance Company.

The interdependence between bank system and government has also been revealed by the central bank's tools to carry out central government's monetary policies. For example, the most important tool is the credit plan, which decides the total loans a specialized bank and its own local branches can extend within a year. It is worth noticing that before 1983 most investments in fixed assets were direct transfers or grants from the government budget. After that year direct grants were replaced by interest-bearing loans, in order to harden the soft budget problem facing the SOEs. Subject to the State Council's approval, the central bank formulates credit plans in two steps. The first step is carried out from the top to the bottom; the money supply is calculated by the central bank and this estimate is passed to each specialized bank and its own local branches. The second step, therefore, is from the bottom to the top. The local branches summarize their provincial plans and then submit these to the central bank. Based on this feedback, the central bank revises its original estimation and finalizes the overall credit plan.

The other tools that the central bank uses to carry out monetary policy are more indirect. They include the control over reserve ratios, interest rates, inter-bank lending and operations in the open market, among others.

However, serious steps have been taken to make the banking system as independent as possible, in particular by disentangling the relationship between local banks and local governments. Some local governments used to do all kinds of things for the development of their local economy, and their influence on the local branches of the central bank made it difficult to conduct a unified monetary policy. Therefore, in October 1998, the PBC implemented a significant step: replacing the original 31 provincial branches of the central bank with 9 trans-provincial regional branches. The objective of this reform was to reduce the interference from provincial governments.

In sum, these illustrations of fiscal policy reform and monetary policy reform have shown that some of the reform measures tend to strengthen the central government's power while others tend to increase the independence of local governments. An example of *recentralization* is the tax collection method, which changes from being collected by the localities to being collected both by the localities and by the national tax service. Local governments' negotiating power has thus been reduced since they are now in a subordinate position. An example of *decentralization* is the adoption of the budget law, which tends to increase the independence of local governments, since they have to be more independent in their own budgetary plans and cannot rely any more on the central government to finance local deficits. However, both the fiscal policy reform process and the monetary policy reform process accelerated in the early 1990s. These macroeconomic reform measures contribute significantly to institutional change and thus to the current central-local relationship.

2.3 OPENING TO THE OUTSIDE WORLD

If we look at the reform of the central-local relationship as a vertical link connecting central government at the top and the localities at the bottom, the open door policy can be viewed as a horizontal link across provinces, which has not only determined the distribution pattern of foreign investments, but also affected the distribution pattern of public investment and domestic private investment.

China's opening to the outside world has been speeded up after 1992. While the 1980s were characterised by establishing a few experimental links in coastal region, the 1990s saw a much wider scale implementation of open door measures and more emphasis on inland development. Whether the opening of the inland provinces has generated any significant progress in their development requires further examination. But the distribution of preferential policies is the issue we are interested in, since it may partly explain disparities in inter-provincial development. We will study the open door process in a chronological order, since many preferential policies applied to the coastal region during the 1980s have been extended to inland cities after 1990.

2.3.1 Special Economic Zones

The establishment of four Special Economic Zones (SEZs) in 1979 marked the start of the "open to the outside world" process. Three of the four SEZs: Shenzhen, Shantou and Zhuhai; are located in Guangdong province, which was a province at the average national income level before the economic reform. The fourth SEZ, Xiamen, is a small city in Fujian province, which used to be one of the poorest provinces before 1979. The most obvious characters of these SEZs are that, firstly, they are located close to Hong Kong or Macao, with close cultural or family ties with overseas Chinese. Secondly, they

are located on the coast of China, with little endowment of state owned economy. Therefore, they could be used as experimental fields with little influence on the rest of the country, especially if the experiments failed.

The intention of establishing these SEZs was to absorb foreign direct investment with higher technology or more advanced management skills. The central government hoped that the inflow of foreign capital would promote economic growth in these SEZs. If they achieved economic success, their experience could be shared by the rest of the country. But if they ran into some unforeseen difficulties hampering their development, the rest of the country could learn from their failure and try to avoid making similar mistakes. Thus these SEZs could function as experimental fields.

To achieve the goal of faster economic growth by absorbing foreign investment, SEZs were the subject of preferential policies, which were later extended to other parts of China, by the central government. These preferential policies for SEZs included the following components. Firstly, SEZs have more autonomy power. In contrast to other parts of the country, SEZs' governments have actually no real upper limit for approving foreign investment projects; even though investments as much as $30 million were officially recorded. Besides, any foreign exchange obtained from exporting goods were allowed to be fully retained by enterprises located in SEZs, whereas in the early 1980s in other parts of the country foreign exchange could not be kept by localities.

Secondly, SEZs enjoyed tax incentives to attract foreign investment, which were also not shared by the rest of the country during the early 1980s. The 1980 regulation offers a 15% rate of income tax for foreign-invested enterprises in the SEZs, which was very low comparing with a rate of 33% in the other parts of the country. Tax holidays were also offered in SEZs; income tax on foreign-invested enterprises, with a scheduled

investment plan for more than 10 years, was zero for the first profit-making year and reduced by 50% for the second and third years. In 1984, this tax holiday extended to an exemption for the first two years and 50% reduction for the next three years. Moreover, there were exemptions from import duties for production inputs and exemptions from income tax on profits and reinvestment from 1980 to 1996.

Thirdly, SEZs strengthened their attractions to foreign investors, through other incentives such as cheap labor costs and lower land use fees. Besides, there was no restriction on foreign enterprises' export performance. As a consequence, SEZs developed very fast during the 1980s and the living standards for these cities' residents are still among the highest in the country.

One noticeable feature of the investments absorbed by SEZs is that they were not mainly composed of "foreign" investments, as they include to a large extent investments from Hong Kong, Macao, Taiwan and other overseas Chinese owned enterprises, as well as investments from the rest of the country, including some inland provinces. By investing in SEZs instead of their own province in the form of joint ventures, inland capital could make more profits from the preferential policies granted to SEZs.

2.3.2 14 Open Coastal Cities

The success of SEZs encouraged the central government to open more cities to the outside world. In 1984, fourteen coastal cities[1] were added to the open door experiment list. Similar to SEZs, these 14 open coastal cities were also granted more decision-making powers. They could approve certain projects involving foreign investment while their upper investment limits were lower than SEZs' in most cases. Most of the tax incentives used in SEZs were also extended to these coastal cities. Within each of the 14

coastal cities, there was one ETDZ (economic and technological development zone). Preferential policies in ETDZs were almost the same as those in SEZs, while tax concessions in other parts of the city were relatively limited. Based on the 1984 regulations, income tax was reduced to 15% for all foreign-invested enterprises in ETDZs and for technology intensive enterprises with foreign capital of US$30 million or more in other parts of the cities.

Nevertheless, economic development in these 14 cities varied. During 1984 to 1990, eight of the 14 cities grew at an annual rate higher than the national average. However, two big metropolitan cities in this group, Shanghai and Tianjin, grew at lower rates in terms of per capita GDP. Their strong weight in the national economy and their slow growth rates put the average growth rates of the 14 cities even below the national average level during the period from 1984 to 1990. Tianjin's economic growth rate has not improved much subsequently; however, Shanghai has become the engine of economic growth in China after the opening of the Pudong new area in 1990. Before we explain Pudong's case, we first describe the fifth SEZ, which is also the biggest SEZ in China, Hainan Island.

2.3.3 The Establishment of the Biggest SEZ in China: Hainan Province

Until 1988 Hainan was one of the poorest areas in China. It was then declared to be a province and China's biggest Special Economic Zone. According to the 1988 regulations, Hainan was granted very similar tax incentives to attract foreign investments as the other 4 SEZs. Moreover, more aggressive tax concessions were provided in this island. For investment in infrastructure in certain fields (such as seaports, docks, airports, roads, railways, power plants, and coal mining), more

[1] The 14 open coastal cities are: Dalian, Qinhuangdao, Tianjin, Yantai, Qingdao, Lianyungang, Nantong,

favourable treatments in income tax were offered. Enterprises which export more than 70% of their output and enterprises employing high technology were even permitted to deduct another 10 percent income tax after the three-year reductions in their tax holidays. In addition, foreign investment was allowed not only in manufacturing enterprises, but also in bonds and stocks, in bidding or leasing state-owned enterprises, in real-estate and in mining.

The foreign investment inflow into Hainan Island increased rapidly in 1988 due to the open door policy. However, the inflow of foreign capital stopped growing so quickly in the following year because of the event in June 1989. The inflow re-accelerated after 1992, which was accompanied by the fast economic growth in this island province.

Even though Hainan is the biggest Special Economic Zone in China, its influence for the country is far less than the opening of the Pudong new area, an area in Shanghai, which also promoted Shanghai's role in the national economy.

2.3.4 The Opening of the Pudong New Area

Pudong's importance lies in its geographical location: it is one part of Shanghai, the economic centre of China. Therefore the opening of Pudong was designed to support Shanghai as an international financial centre, high technology development area and leading force for the development in Yangtze River Delta. The preferential policies in Pudong are essentially the same as in other SEZs, but the scope of openness is even wider.

In 1990, the open door policies in Pudong encouraged foreign-invested enterprises to produce more exports or use high technology by allowing firms fulfilling appropriate conditions to deduct another 10 percent from income tax after the three-year tax

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Shanghai, Ningbo, Wenzhou, Fuzhou, Guangzhou, Zhanjiang and Beihai.

reduction. The eligible activities included not only manufacturing industries as in other SEZs, but also financial and retail industries. In addition, Pudong has developed a number of free trade zones and export processing zones that offered good infrastructure and additional incentives to trading companies and export-oriented firms. The opening of Pudong has marked a new era of Shanghai's development, which emphasizes its status as the centre of economic activity in China and the engine for the coastal region's economic growth. After seeing the rapid development in the coastal region, inland region also asked for favoured conditions to attract foreign investment.

2.3.5 The Opening of the Inland Provinces

Before 1990, the inland region was almost ignored by foreign investors. As a consequence, the distribution of foreign investment displays an obvious pattern of concentration in the coastal region of China while the inland region takes only a tiny percentage. The reason for the lack of foreign investment in the inland region lies partly in geographical location; the land-locked feature of the inland essentially implies high transportation costs and leads to less convenience in international trade, both of which are obstacles to investment. The influence of policy also weakened the inland region's attractions for foreign investors. According to the foreign enterprises investment regulation in 1980, income tax on net exports of joint ventures from inland region was 33 percent, much higher than the 15 percent in SEZs. Furthermore, local governments in inland region had limited powers to approve foreign investment projects; they also usually have poorer infrastructure construction levels and less human resource endowments.

However, after 1990, the central government noticed the enlarging coastal-inland income gap and intended to improve the inland region's situation by shifting preferential

policies from the coast to the inland. In June 1992, the State Council declared the opening of ten major inland cities[2] along the Yangtze River and granted them the same preferential policies as the 14 open coastal cities. Furthermore, the opening of six comprehensive development zones[3] along the Yangtze River was also declared. At the same time, the central government was enthusiastic to open the inland border area as well. In 1992, border cities[4] in Northeast China and Inner Mongolia gained preferential policies from the central government. Trade between the border cities in China and neighbouring countries has been encouraged and many administrative restrictions have been lifted.

In addition to the measures taken by the central government to attract foreign investment, local governments in inland region set up their own special economic zones with the same policies as the five SEZs on the coast. Inland region complained that the special policies applied to the coastal region were responsible for the increasing inter-regional disparity. They believed that inland region deserved more preferential policies since geographically they are in a disadvantageous position. At the same time, local governments in coastal region are trying to keep their favoured conditions by setting up ETDZs and free trade zones. However, the contentions in offering preferential policies by local governments are not agreed by the central government. To end all these competitions, which produce nothing but inefficiency and confusion, the central government adopted measures to eliminate policy differences after 1996. As a

[2] 10 Open inland cities: Nanjing (Jiangsu), Zhenjiang (Jiangsu), Wuhu (Anhui), Tonglin (Anhui), Anqing (Anhui), Maanshan (Anhui), Jiujiang (Jiangxi), Yueyan (Hunan), Wuhan (Hubei), and Chongqing (Sichuan).

[3] 6 Comprehensive development zones are Shanghai-Nanjing zone, Wuhan Development zone, Hunan-Hubei-Jiangxi zone, Chongqing-Yichang zone, Wujiang Hydropower and mineral resource development zone, and the Panxi-Liupanshui comprehensive resource development zone.

consequence, the 100 percent revenue retention policy for SEZs has been stopped. Also the exemption from custom duties on imported materials and equipment was abolished. Some other preferential policies relating to tax incentives and tax holidays are also being phased out. The objective of all these measures is to move preferences from coastal region since they have already taken the lead in the economy and their role in spreading wealth and more advanced technology to the inland region seems not that successful. Inland region became the focus of regional policies after the late 1990s, when the income gap between coastal region and inland region had become so big that the central government has to reduce it to avoid any jeopardy to China's social stability.

The open door process so far can be summarized by a map and a table. Map 2.1 shows the distribution of SEZs, ETDZs and other economic development zones. Their concentration in coastal region is rather clear. Table 2.1 records aspects of those preferential policies, which have been adopted during China's "open to the outside world" process. "Standard" means "national level", uninfluenced by preferential policies, and thus can be taken as the situation for inland region, in particular before 1990. We list preferential policies in SEZs, open coastal cities, Hainan and Pudong in terms of their advantageous position in approving foreign-investment projects, the power to retain their foreign exchange earnings, their tax incentives and tax holidays. Even though these terms cannot provide a complete picture of the coastal region's favourable conditions, they give a flavour of the policy incentives offered to attract foreign investment.

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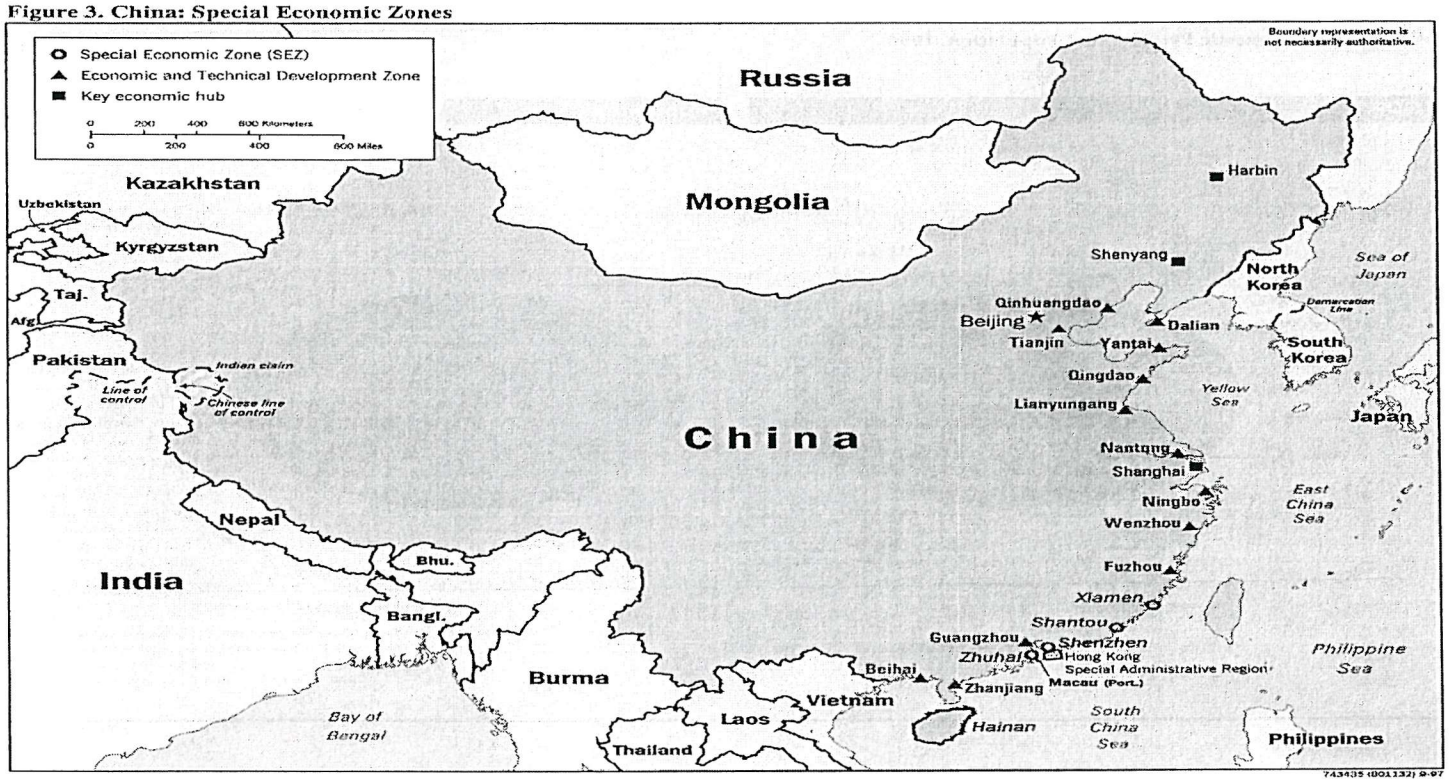
[4] Open of inland border cities: Heihe, Suifenhe, Hunchun, and Manzhouli. Trade and other economic cooperation between China's border provinces and Russia, Mongolia, Myanmar, India, and Vietnam are being encouraged.

However, while the inflow of foreign investment improves economic growth on the one hand, it also promotes the development of enterprises in other ownership structures on the other hand. We will argue now that non-state owned enterprises have played a significant role in the provincial economic growth.

Map 2.1 China's Open Policy



http://www.lib.utexas.edu/maps/middle_east_and_asia/china_specialec_97.jpg

Table 2.1 Preferential Policies: Before 1996

Preferential policies	Standard	SEZ	COC	Hainan	Pudong
Definition	Inland region before 1990.	Special Economic Zones	Coastal open city	Hainan Island	Pudong New Area
Number		4	14	1	1
Set up year		1979	1984	1988	1990
Income tax	33% (JVs) 20-40% (FOEs)	15%	15% for ETDZs and 24% for other parts	15%	15%
Tax holidays		Exemption for the first two years and 50% reduction for the further 3 years	Exemption for the first two years and 50% reduction for the further 3 years	Exemption for the first two years and 50% reduction for the further 3 years And 10% for another year.	Exemption for the first two years and 50% reduction for the further 3 years And 10% for another year.
Scope of business		Manufacture	Manufacture	Manufacture, bonds and stock markets, real-estate	Manufacture, financial industry, service industry
Right to approve foreign investments	Real upper limit	No real upper limit	Real upper limit	No real upper limit	No real upper limit
Right to retain and use own foreign exchange earnings	25%	100%	50%	100%	100%

Note: JV: Joint-ventures

FOE: Foreign-owned enterprises.

2.4 REFORM IN OWNERSHIP STRUCTURES

Among the factors influencing economic growth, capital investment is regarded as very important. In this thesis we will investigate the role played by capital investment in determining provincial economic growth patterns in China; moreover, a decomposition of capital investment helps us to make a detailed investigation of the functions of public, foreign and domestic private investment. Thus it is necessary to give a clear account of the reform process in the public, foreign and domestic private sectors.

2.4.1 The Reform Process in the Public Sector

Enterprises in the public sector comprise state-owned enterprises (SOEs) and collective-owned enterprises (COEs). Collective-owned enterprises include urban collectives and rural collectives; the latter are also known as township-and-village-owned enterprises (TVEs).

The reform of SOEs is always one of the main focuses in China's economic reforms, since it exerts extraordinary importance to social stability. There are various schemes designed to improve the incentives and performances of SOEs, such as the revenue retention system, the corporate income tax system, the contract responsibility system, the establishments of modern enterprise system, and the "Holding the large, letting the small go" system, among others. The essential idea of SOEs' reform in the 1990s was to grant the enterprises more powers of self-decision so as to motivate the SOEs to operate more efficiently. However, the result is generally not satisfactory; in particular, SOEs have not made much progress in profit gains, technology development levels and efficiency improvements, among others. For example, the share of SOEs' production in total industrial output declined from more than 77% in 1978, to less than 30% in 1999.

Nevertheless, the role of SOEs in macroeconomic stability is too important to be ignored. In a country lacking a conventional social security system, SOEs take the role of providing social welfare. They offer various types of subsidies to their employees, such as housing, pensions, medical coverage, childcare, food and recreational facilities. Besides, SOEs' remittance used to be the only source of government revenues before reform started; and they are still the most important taxpayers. Moreover, for a long period, SOEs have been required by the government to take redundant workers to meet the "full-employment" target. As a consequence, overstaffing constitutes 1/4 to 1/3 of all employees in the SOEs. According to Economic Highlight (29/09/2000), the decline of SOEs' employment did not start until 1995, when the number employed by SOEs reached its record high at 112.61 million. After that employment started to fall year by year. For example, the number for 1998 is 20 million less than that of 1995, which indicates that about 7 million people have been laid off each year. However, even though millions of workers have been laid off by SOEs after 1995, overstaffing still remains one of their main financial burdens. Furthermore, SOEs are required by the government to set up re-employment centres for laid off workers, which further aggravates the financial situation of SOEs. Therefore, having to take up the role of social welfare provider makes it rather hard for the SOEs to operate efficiently.

On the other hand, the performance of rural collectives, TVEs, was very impressive during the 1980s and the first half of 1990s. In 1978 the output of TVEs constituted 7.2% of the total value of industrial output in China, while this percentage increased to 38.1% in 1993. Yao (1998) concluded that the total factor production levels in collective and private owned firms were respectively 22% and 57% higher than in SOEs. Naughton (1994 a) attributed the success of TVEs to a set of external conditions to

which the TVE is an effective adaptation: "*TVEs are responses to one of the most distinctive characteristics of the Chinese transition as a whole; the early creation of product markets, which exists for a prolonged period without well-developed markets for factors of production or assets. TVE is a flexible and effective but basically ordinary adaptation to this environment.*" (p. 266). However, with the deepening of the economic reform, the external conditions are changing, and the advantages of the TVEs gradually transform to disadvantages. At the beginning of economic reform, TVEs were more flexible than SOEs; this flexibility accounted for their higher efficiency. Essentially, some TVEs were private owned enterprises, whose private owners had to combine their enterprises with local governments since pure private ownership was considered illegal at that time. The involvement of local governments provided protection and access to local markets, which helped their development at the early stage of the economic reform. However, the mixed ownership structure impedes their long-term development, when private ownership is allowed and develops fast; TVEs realize that the vagueness in their ownership structure holds back their development. Thus the clarification of ownership structure became an issue that is inevitable for TVEs' further development from the second half of 1990s.

2.4.2 The Reform Process in the Foreign Invested Sector

Foreign investment refers to the investments made by foreign-funded enterprises and Overseas Chinese-funded enterprises. Before the economic reform, there was almost no foreign capital inflow into China. After the economic reform, China opened its market gradually to the international world. However, the overall openness was not so substantial before 1990. The opening of the Pudong New Area in 1990 rejuvenated Shanghai, the economic center of China. After that, foreign direct investment increased

rapidly, from 4.4 billion US$ in 1991 to 11 billion US$ in 1992. Pledged FDI from 1991 to 1993 almost equaled the amount pledged for the entire period from 1979 to 1990.

Although both foreign-funded enterprises and overseas Chinese-funded enterprises are influenced by the open door policy, the degree of influence is different. The reasons accounting for the difference are that, firstly, the source of investments is different. Foreign-funded enterprises mainly refer to multinational corporations with investments from developed countries such as US, Japan and the European countries. Overseas Chinese-funded enterprises refer to enterprises funded by investors mainly from Hong Kong, Macao and Taiwan. Secondly, their geographical distribution is different. Foreign-funded enterprises concentrate in the eastern coastal region, with Shanghai acting as its center. When Shanghai's position as the economic center of China strengthens after 1990, its surrounding areas benefit too. Overseas-funded enterprises, on the other hand, are mainly located in the southern coastal region of China, which is close to and has cultural affinities with investment sources. It is noted that most overseas Chinese are originally from Guangdong or Fujian provinces, the south coastal provinces in China; they speak the same dialects and have family connections. These cultural affinities reduced entry barriers for overseas Chinese investors when China began to open its door to the outside world. At the same time as western investors were afraid of political risks and economic uncertainties in China, overseas Chinese investors took the advantage of their cultural links. Thirdly, and because of different entry barriers, the starting time of their entry is different. Foreign-funded investment did not start to flow in on a large scale until 1990. As mentioned previously, it is the opening of Pudong that boosted the foreign investment inflow. However, overseas Chinese started to invest in China immediately after China opened its door in 1979. Before that, the south coastal

region was relatively poor due to the lack of state-owned enterprises, and this region had little importance to the central government. As explained before, this is one of the major reasons why all of the four earliest established SEZs are located in these two provinces, and acted as the experimental field for economic reform and the open door policy. Institutional flexibility, permitted to offset these provinces initial disadvantages, offered chances for overseas Chinese investors to make profits.

The incentives for foreign investment categorize foreign-invested enterprises into two groups, export-oriented enterprises and domestic market-oriented enterprises. Both groups are concentrated in the coastal region. The reasons are, for the export-oriented enterprises, multinational corporations make their investments to take the advantage of lower costs, including labor cost, transportation cost, production cost and marketing cost, among others. With more convenient transportation facilities, better infrastructure, more educational facilities and more flexible institutions, the coastal region is preferred to the inland region. For the domestic market-oriented enterprises, multinationals make their investment to acquire bigger shares in China's domestic market. Again the coastal region is preferred. One reason is that its geographical location and better infrastructure give rise to easier access to both international and domestic markets; another reason is that the higher GDP in the coast indicates coastal region has higher purchasing power than the inland region. Therefore the coastal region is more favored for both types of foreign-funded investment.

Provincial data for these two types of investment are available from 1993. We measure a province's ability to attract investment from abroad by the investment to GDP ratio, whose cross-sectional distribution is given in table 2.2. As it shows, over the period from 1993 to 1999, the province having the highest foreign investment to GDP

ratio is Beijing, which is also in the top position in terms of the ratio of overseas Chinese investment. Beijing does not itself neighbor the coast, however, it is identified as a coastal metropolitan city since it is the capital of China and located just next to a main coastal port city, Tianjin; these factors contribute to its being one of the favorites of foreign investors. Guangdong province ranks second in attracting investment from overseas Chinese and fifth in attracting foreign investment. One of the reasons that foreign investors prefer this province is that it neighbors Hong Kong and thence has convenient access to the international market. Another important reason is the favorable policies being granted by the central government; this province has 3 out of the 4 SEZs. Moreover, the table shows that overseas Chinese investment ranks even higher, which may be attributed to cultural ties as explained above. In contrast to Guangdong, Shanghai ranks fifth in attracting overseas Chinese investment and second in attracting foreign investment. Being the economic center of China, there is no doubt that Shanghai is very attractive to foreign investors. In addition to the advantages stemming from geographical location and policy, this metropolitan city is rich in human resource endowment, which is another important factor in attracting foreign investment. It might be useful to point out that, nowadays Shanghai has become the number one in attracting investment not only from foreign investors, but also from overseas Chinese investors. Cultural affinity does not count for very much after entry barriers drop down.

Table 2.2 Cross-Section Distribution of Foreign and Overseas Chinese Funded Investments to GDP Ratios

Province	Investment to GDP Ratios by Foreign-funded enterprises (sfoe)	Investment to GDP Ratios by Overseas Chinese-funded enterprises (shmt)	rank sfoe	rank shmt
Beijing	0.068	0.042	1	1
Shanghai	0.068	0.022	2	5
Hainan	0.066	0.025	3	4
Tianjin	0.055	0.014	4	6
Guangdong	0.045	0.035	5	2
Jiangsu	0.035	0.010	6	8
Fujian	0.034	0.033	7	3
Liaoning	0.028	0.008	8	9
Jilin	0.023	0.003	9	21
Hubei	0.019	0.011	10	7
Zhejiang	0.019	0.007	11	10
Guangxi	0.019	0.005	12	13
Hebei	0.015	0.004	13	18
Shandong	0.015	0.005	14	14
Shanxi	0.011	0.002	15	28
Gansu	0.010	0.004	16	17
Anhui	0.010	0.002	17	26
Sichuan	0.009	0.005	18	12
Henan	0.008	0.007	19	11
Yunnan	0.008	0.004	20	15
Ningxia	0.007	0.003	21	24
Hunan	0.007	0.003	22	22
Xinjiang	0.007	0.004	23	19
Shaanxi	0.007	0.002	24	25
Guizhou	0.006	0.002	25	27
Jiangxi	0.006	0.003	26	23
Heilongjiang	0.005	0.003	27	20
Inner Mongolia	0.004	0.001	28	29
Qinghai	0.002	0.004	29	16

2.4.3 The Reform Process in the Domestic Private Sector

Here, the definition of domestic private investment refers only to investment made by individual-owned enterprises and private-owned enterprises, any foreign ownership should be excluded. The process of domestic private sector development started from the same time as China launched its economic reform. However, from 1978 to 1986, only a few individual-owned enterprises at very small scale existed. These individual owned businesses had a strong flavor of being "experimental". The government intended them to play a marginal role, to act as the supplement to the public sector, and to fill the gaps left by the state and collective sectors, "*particularly in the distribution of consumer goods and services and in employment*" (IFC 2000 p. 8).

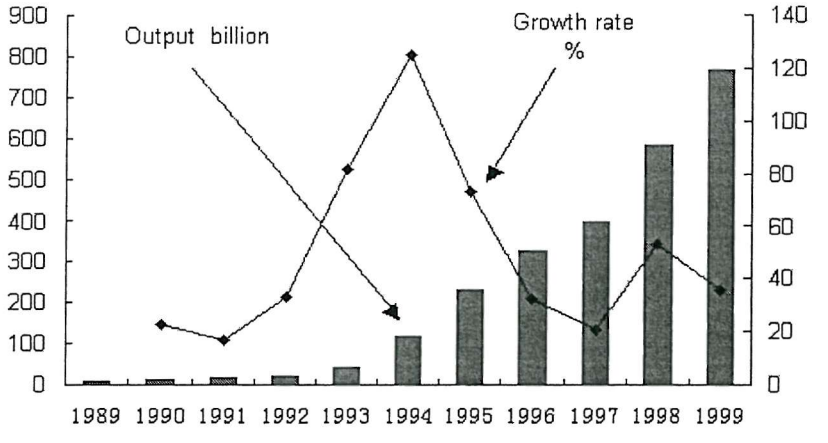
It was only after 1987 that private-owned enterprises started to emerge; by definition, they are those individual-owned enterprises with more than eight employees. However, the private sector suffered a setback in 1989 due to the political upheaval, and their role in the economy was again reckoned as supplementary[5] to the public sector. According to IFC (2000), the number of registered individual firms "*declined from 23.1 million at the end of 1988 to 19.4 million at the end of 1989, and the number of registered private firms declined from 90,600 at the end of 1988 to 88,000 in June 1990*" (p. 10). A considerable number of the private firms have been either transformed into collective firms or reduce the number of their employees to be less than 8.

The boom in private sector development started from 1993. The famous southern tour of Deng Xiaoping in September 1992 triggered a significant ideological breakthrough in China. A strategy for transition from a planned economy to a market

[5] Private sector was intended to play a marginal, stop-gap role and to act as a "supplement" to the state and collective sectors; then it was recognized as a supplement to the socialist, public owned economy and enjoyed the protection of the state. From 1993 to present, private enterprises are recognized as an important component of the economy."

economy was then designed by the central government in 1993. This strategy addressed enterprise reform issues in terms of property rights and ownership; private enterprises develop dramatically, in particular after the privatization of small and medium sized state-owned enterprises was permitted[6]. This can be seen from figure 2.1. As it shows, the growth rate in output by the private sector came to its peak in 1994, which led to a doubling of output from the previous year. The comparison of the changes of enterprises by ownership is given in table 2.3, which shows that the growth rate of private enterprises only dropped a little in 1997. It increases at a rate of 25% annually afterwards, which confirms that the private sector is the most vigorous one in the late 1990s. Table 2.3 also clearly shows that the SOEs drop most while domestic private-owned enterprises increase most.

Figure 2.1 Output increase in private sector



Data source: "China Business Administration Year Book 1992-2000". Graphed by Yushi Mao, Yuren Zhang, "Private sector development process and future expectation in China", 20/06/2001, http://forum50.cei.gov.cn

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[6] Since Deng Xiaoping's pronouncement, during his 1992 Nanxun, that leftism was more harmful to China than rightism, full-scale sales of **small** and **medium**-size **SOEs** have increased steadily. The best known example is Zhucheng city in Shandong province, which started privatizing **SOEs** in 1992 when two-thirds of its **SOEs** were losing money or just breaking even. Other provinces, including Sichuan, Guangdong, and Heilongjiang, have also joined in privatising **SOEs** since 1994.

Table 2.3 Changes of Enterprises by Ownership

	State-owned enterprises		Foreign-invested enterprises		Private-owned enterprises	
Year	Number (1,000)	Growth rate (%)	Number (1,000)	Growth rate (%)	Number (1,000)	Growth rate (%)
1996	2,163	-3	240	3	819	25
1997	2,078	-4	236	-2	961	17
1998	1,836	-12	228	-3	1,201	25
1999	1,649	-10	212	-7	1,509	26

Data source: "China Business Administration Statistics 1992-2000". Tabled by Yushi Mao, Yuren Zhang, "Private sector development process and future expectation in China", 20/06/2001, http://forum50.cei.gov.cn

2.5 QUANTIFICATIONS OF PREFERENTIAL POLICIES AND PROVINCIAL OPENNESS

The above discussion gives a qualitative analysis of preferential policies that different provinces have been granted. A quantification analysis will be helpful to clearly explain why biased policies may lead to increasing inter-provincial inequalities. In Demurger, Sachs, Woo, Bao, Chang and Mellinger (2001), they suggest that "*the implementation of preferential policies in coastal provinces as early as the beginning of the 1980s led to a rapid integration into the world markets, huge inflows of FDI, and the development of modern industrial sectors in these provinces.*" (p. 23). They construct a preferential policy index for each province to show the extent of biased policies. Similar to their way of constructing a preferential policy index, we also assigned to provinces the following weight, then multiplying with years of openness to obtain our index:

Weight = 3: SEZ and Shanghai Pudong New Area;
Weight = 2: ETDZ
Weight = 1: Open coastal cities and open border cities
Weight = 0: No open zone.

The preferential policies' index and the degrees of openness at provincial level are displayed in table 2.4. The first two columns give the names of provinces and their geographical locations. There are altogether twelve provinces located in the coastal region, 9 located in the middle and 8 located in the west, while both the middle and the west belong to the inland. The calculation of the third column is based on table 11 of Demurger et al (2001); in which they give detailed record of preferential policies in terms of open scale. The fourth to the last columns are based on China Statistical Yearbook. Their calculations are as follows. Openness index is the share of provincial export to total provincial GDP. This index indicates how open a province is to international trade; however, it may be correlated with the geographical locations of the province since a coastal province has cheaper transportation costs to export. Foreign share in international trade is calculated by first summing up provincial export and import by foreign owned enterprises, then dividing it to provincial export plus import. This index can function as an indicator for the involvement of foreign investment in processing industries. A multinational corporation may invest to take the advantage of cheaper production cost, in which case their products will be aimed at international market. Similarly, after summing up provincial export and import by foreign owned enterprises, dividing it by provincial GDP will yield foreign share in local GDP. This indicator may have a different function here. Combined with openness index, we could tell whether a province is actively engaged in international trade; however, it may be interesting to see some province with a lower degree of openness have a relative higher ratio in foreign shares in GDP, suggesting the province may have rather strong provincial protectionism, which impact trade with other provinces. The examples include Jiangsu, Hainan, Hebei, Hubei, Anhui, Jiangxi, Sichuan and Henan, among others.

Table 2.4 Index of Preferential Policies and Foreign Influences

	Location	Preferential policy	Openness index	Foreign Shares in international trade	Foreign Shares in Provincial GDP
Beijing	Coast	16	0.257	0.198	0.144
Tianjin	Coast	32	0.340	0.520	0.378
Hebei	Coast	28	0.061	0.257	0.026
Shanxi	Middle	8	0.102	0.090	0.012
Inner Mongolia	Middle	16	0.051	0.117	0.012
Liaoning	Coast	28	0.173	0.393	0.130
Jilin	Middle	16	0.099	0.245	0.044
Heilongjiang	Middle	16	0.138	0.106	0.018
Shanghai	Coast	40	0.375	0.432	0.335
Jiangsu	Coast	32	0.151	0.457	0.133
Zhejiang	Coast	32	0.181	0.257	0.073
Anhui	Middle	15	0.049	0.194	0.017
Fujian	Coast	60	0.285	0.577	0.309
Jiangxi	Middle	8	0.051	0.165	0.015
Shandong	Coast	32	0.131	0.377	0.090
Henan	Middle	8	0.034	0.189	0.011
Hubei	Middle	15	0.052	0.261	0.026
Hunan	Middle	8	0.049	0.143	0.011
Guangdong	Coast	63	0.845	0.475	0.751
Guangxi	Coast	28	0.075	0.246	0.035
Hainan	Coast	36	0.115	0.281	0.120
Sichuan	West	15	0.038	0.190	0.015
Guizhou	West	8	0.043	0.119	0.009
Yunnan	West	16	0.059	0.096	0.011
Shaanxi	West	8	0.069	0.145	0.019
Gansu	West	8	0.043	0.098	0.007
Qinghai	West	8	0.052	0.031	0.003
Ningxia	West	8	0.072	0.107	0.011
Xinjiang	West	16	0.048	0.065	0.008

2.6 CONCLUSIONS

In sum, fiscal policy and monetary policy reforms have followed trends of *decentralization* and *recentralization*. Based on the unsuccessful experience of the remittance revenue-sharing system between the central and local governments, a tax system reform was designed and carried out after the mid 1990s. Under this system, the central government improved its ability to control tax revenue by setting up a National Tax Service, while local governments sustain their fiscal interests. Both the central and local governments have achieved more financial independence. On the other hand, monetary policy reform has been made possible by reform of China's banking system.

Apart from the "vertical" reform measures, China opened gradually to the outside world, which affected provincial economic growth patterns across the country. The preferential policies granted first to SEZs have been extended to the other coastal cities, and further extended to some inland cities. Open door policies in 1980s have been discussed in detail here since they paved the way for policy measures in the 1990s, which resulted in significant changes in China's economic development.

Reforms in public, foreign and domestic private ownership are affected significantly by both the vertical reform measures and horizontal open door policies. Firstly, SOEs development is not as satisfactory as one might expect, due to its extra obligations as a social welfare provider. TVEs development is held back from the second half of the 1990s by the vagueness in their property rights. Secondly, foreign investment started to flow substantially in 1990, while different sources of and different incentives for investment need to be distinguished. Thirdly, domestic private investment is the most vigorous sector; its rapid growth rate makes it more and more important for provincial economic growth.

After quantifying the degrees of openness at provincial level, it can be observed that coastal provinces benefit most from preferential policies. Their openness degree is also higher than inland provinces.

In Boldrin and Canova (2001), they argue that trade and common fiscal and monetary policies, together with high factor mobility, induce income convergence in US states. So far we could tell that degrees of openness are very different from each other in China's provinces; they have not been granted common fiscal and monetary policies as well. The reform and open process have emphasized the development of certain provinces first, via biased policy measures. Indeed, apart from institutional rigidity, factors of production have also been restricted to flow between provinces, and flow between urban and rural areas. It is well known that labor migration in China has been controlled by household registration system, which aggravates the urban-rural income gap. It is also noted that China's domestic market is segregated, due to provincial protectionism. For capital mobility, it has been noticed that inland capital has flowed to the SEZs, disguised as investment from Overseas Chinese, to take the advantage of preferential policies. However, it is still difficult for capital to flow from the coast to the inland, since inland provinces are reluctant to let the coastal companies to grab profits. Therefore, institutional rigidity and controlled factor mobility are prevailing in China's provincial economy.

In this chapter, we have reviewed the economic reform measures in fiscal and monetary policies, the opening to the outside world process, and reform in enterprise ownership structures. We have thus related the macroeconomic environment to provincial economic growth patterns in China during the 1990s. It is noted that reform measures in the 1980s provided a foundation for the further reform in the 1990s, which

lead to the institutional changes at a macroeconomic level. This chapter has investigated institutional changes during the 1990s, which form one major aspect of the economic development process in China. Inter-provincial income inequality and the coastal-inland disparity will be explored from now on.

CHAPTER THREE

DYNAMIC PANEL DATA ESTIMATION AND THE GENERALIZED METHOD OF MOMENTS ESTIMATOR

Abstract:

The investigation of different provinces' economic growth patterns in China indicates that our empirical studies will be based on panel data analysis. Being the combination of time-series and cross-sectional data sets, panel data has its own advantages and drawbacks, which affect the estimation methods used. The GMM estimator is a consistent estimator, and arguably, the most efficient for a dynamic panel data model. Omitted variable bias can be reduced by the first-difference transformation and endogeneity bias can be reduced by employing instrumental variables.

3.1 INTRODUCTION

It is noted that after economic reform, different provinces in China have developed at noticeably different paces, and this has led to different levels of development. In comparison with the 1980s, these differences have become more severe during the 1990s. As argued by many researchers, the enlarging inter-provincial income disparity, which has resulted from the provincial economic growth differences, could lead to considerable economic and social problems. Thus to investigate differences in provinces' economic growth rates turns out to be an important issue, if one is aiming at reducing inter-provincial income inequality.

According to Bernard and Durlauf (1994), the neoclassical growth model, "*originating with Solow (1956), has profoundly affected the way in which economists conceptualize long run interrelationships between macro economies*". (p. 1). Therefore, in our investigation of provincial economic growth patterns in China, the Solow growth model will be used as a benchmark theoretical model, based on which we are able to analyze the different growth patterns in different provinces in detail. Furthermore, it also enables us to explore which factors account for the performance differences in provincial economic development.

However, once the foundation of the theoretical exploration has been paved, the way to carry out empirical study varies. Therefore, in this chapter we will explain why using Generalized Method of Moments (GMM) estimation to do a dynamic panel data analysis allows us to reach consistent and efficient estimation results. The structure of the chapter is as follows. After a short explanation of our data sets in section-II, we will make a detailed investigation of panel data analysis. By enumerating the advantages and disadvantages of panel data sets, various ways of reducing bias will be explained. The

merits and shortcomings of different estimators will be illustrated; this leads naturally to the application of GMM. The detailed discussion of GMM is given in section-IV while our conclusions are summarized in section-V.

3.2 DATA EXPLANATION

The data we are going to use is from the China Statistical Yearbook for various years. We use per capita GDP to represent income levels, and thus to measure economic development levels and the income disparity among provinces. Provincial population for different years has been used as the denominator to obtain GDP at per capita level. However, in order to calculate real GDP for each province, we need to transform GDP indices from the statistical yearbook to acquire deflated GDP.

GDP data at current price and GDP indices at comparable prices from 1991 to 1999 can be obtained directly from the Yearbook. The definition of comparable prices indicates that output of products have been multiplied by their constant prices of a certain year. In particular, the 1990 prices are used for output produced after year 1991[1]. Therefore, $\frac{\sum P_{90}Q_t}{\sum P_{90}Q_{90}}$ is a GDP index for year t during the 1990s. Hence to obtain real GDP at 1990 price level, we need

$$\left(\frac{\sum P_{90}Q_t}{\sum P_{90}Q_{90}}\right)\cdot\sum P_{90}Q_{90}=\sum P_{90}Q_t \qquad (3.1)$$

[1] See China Statistical Yearbook –Explanatory Notes for Chapter 2, "*since 1949, with the changes in general price level, the Statistical Bureau has issued nationally unified constant prices five times: the 1952 constant prices for 1949 – 1957; the 1957 constant prices for 1958 – 1970; the 1970 constant prices for 1971 – 1981; the 1990 constant prices have been used since 1991.*"

By using GDP in 1990, we are able to obtain deflated GDP at 1990 constant price for the following years. This deflated GDP, and later the deflated per capita GDP, are the ones we are going to use to measure provincial income.

3.3 PANEL DATA ESTIMATION

The employment of provincial data sets across the 1990s indicates that the empirical analysis in this thesis will be based on panel data. It is more and more common to see the application of panel data in empirical work. Panel data has the advantage of being the combination of time-series and cross-sectional data sets. The availability of repeated observations on the same units allows economists to specify and estimate more complicated and more realistic models than a single cross-section or a single time-series would permit. Some influential econometricians have argued the advantages and disadvantages of using panel data, for example, Baltagi (1999) refers to the reviews in Hsiao (1985, 1986), Klevmarken (1989) and Solon (1989). In the following we will illustrate some of its merits while pointing out some of its drawbacks. We will concentrate on those points that are able to affect significantly the choice of an estimator.

3.3.1 Advantages and Disadvantages of Panel Data Estimation

Firstly, in comparison with time-series or cross-sectional data sets, an important advantage of panel data is that it allows identification of certain parameters, without extra restrictive assumptions. The possibility of analyzing individual level changes makes it a proper choice to model not only why individual units behave differently but also why a given unit behaves differently at different time periods.

Secondly, since a panel data set is the combination of time-series data set and cross-sectional data set, it is usually larger and contains more information than either of its components. In particular, the explanatory variables vary over two dimensions. Therefore estimators based on panel data are often more precise[2] than those obtained using time-series or cross-sectional data sets.

Thirdly, estimation of panel data reduces identification problems. For example, omitted variables can be considered not to be a problem in panel data, since an appropriate transformation of the data set may still yield consistent and efficient estimation results. To put this example in another way, "*Estimators from a panel data set may be more robust for an incomplete model specification*". (Verbeek (2000) p. 312).

The disadvantages of panel data also arise from the way that a panel is constructed: because repeated observations for an individual unit have been recorded, it will be inappropriate to assume that different data points are independent upon each other. This may make the analysis more complicated.

3.3.2 Different Ways to Analyze a Panel Data Set

The application of panel data has been carried out in different ways and the estimation methods are still developing. At the early stage of panel data estimation, four methods have been used widely. Suppose we have N groups of observations covering T periods. If T is large enough, to obtain the average effect of some exogenous variables on a dependent variable, firstly, one could run separate regressions for each group, and then average the coefficients over groups. Secondly, one could run pooled regressions by combining data sets, and then use dummies to derive different coefficients for different groups. Thirdly, pure time-series estimation could be carried out by averaging

[2] Not necessarily more efficient. Efficiency relates to how well one uses information but here we are talking about the amount of information.

data over different groups. Fourthly, as used by Barro (1991) and many other economists, cross-section estimation could be employed after averaging data over time.

However, all of the above methods have shortcomings. For example, both the third and the fourth methods suffer from loss of observation numbers to a significant extent. By averaging data over either groups or time, a considerable amount of information has been lost. Besides, the first and third methods require a long time horizon, which is often not the case for panel data since a panel has the merits of using big N to compensate for small T. Therefore time-series analysis will suffer from a lack of observations. Moreover, all the methods above ignore biases arising from unobserved heterogeneity and/or endogeneity problems. The sources and features of these two biases will be discussed below; the drawbacks of these methods mean that more appropriate methods need to be designed to obtain consistent and more efficient estimation results.

3.3.3 Omitted Variable Bias and Different Transformations

Panel data estimation methods have developed to solve the problems that economists encounter when using panel data to carry out their empirical analysis. One of the most important sources of bias originates from omitted variables, which will be illustrated as follows.

Consider two simple models, both of which describe the conditional expectation of y_i given x_i and z_i. The second model is nested in the first one and assumes that the coefficient for z_i, γ, equals zero. Then we can write the two models as:

$$y_i = \beta_1' x_i + \gamma' z_i + \varepsilon_i \tag{3.2}$$

$$y_i = \beta_2' x_i + \upsilon_i \tag{3.3}$$

Now suppose that model (3.2) is the correct model but we are using model (3.3) instead to conduct the empirical study; what is going to happen?

The OLS estimator for β_2, the coefficient for x_i in model (3.3), can be obtained as:

$$\hat{\beta}_2 = \left(\sum_i^N x_i x_i^{'}\right)^{-1} \cdot \left(\sum_i^N x_i y_i\right) \tag{3.4}$$

But if we substitute y_i from equation (3.2), we obtain:

$$\hat{\beta}_2 = \beta_1 + \left(\sum_i^N x_i x_i^{'}\right)^{-1} \cdot \left(\sum_i^N x_i \gamma z_i\right) + \left(\sum_i^N x_i x_i^{'}\right)^{-1} \cdot \left(\sum_i^N x_i \varepsilon_i\right) \tag{3.5}$$

Under conventional assumptions and given model (3.2), the last term on the right hand side of this equation has an expectation or probability limit of zero. But the second term on the right hand side will not equal zero unless γ equals zero; otherwise it leads to the omitted variable bias caused by estimating a wrong model.

Since a panel data model is based on repeated observations, there may be unobserved characteristics which will lead to omitted variable bias. However, this source of bias can be reduced by properly transforming the data set.

For example, consider an unrestricted model:

$$y_{it} = \alpha_i + \beta' x_{it} + u_{it} \qquad i = 1, \ldots, N; t = 1, \ldots, T \tag{3.6}$$

where α_i stands for the unobserved individual specific effect while i represents the identification of each unit and t denotes the time-series dimension. It is noted that the unobserved α_i is time invariant. Therefore, to reduce bias arising from unobserved α_i, one could use various means to transform the data set.

The first method is the first-difference transformation, through which the one-period lag has been deducted. Equation (3.6) becomes:

$$y_{it} - y_{i,t-1} = \beta'(x_{it} - x_{i,t-1}) + (u_{it} - u_{i,t-1}) \tag{3.7}$$

The second method is to use the within-group transformation, by which the time average of each group is deducted:

$$y_{it} - \bar{y}_{i.} = \beta'(x_{it} - \bar{x}_{i.}) + (u_{it} - \bar{u}_{i.}) \tag{3.8}$$

where $\bar{y}_{i.} = \frac{1}{T_i}\sum_{s=1}^{T} y_{is}$; $\bar{x}_{i.} = \frac{1}{T_i}\sum_{s=1}^{T} x_{is}$; $\bar{u}_{i.} = \frac{1}{T_i}\sum_{s=1}^{T} u_{is}$ are the time means of y, x and u. Again α_i vanishes since it is time invariant.

The third method of transformation is an orthogonal transformation, which is based on orthogonal deviations:

$$y_{it}^{o} = (y_{it} - \frac{1}{T_i - t}\sum_{s=t+1}^{T_i-1} y_{is})(\frac{T_i - t}{T_i - t + 1})^{1/2}, \qquad t = 1,...,T_i - 2 \tag{3.9}$$

$$x_{it}^{o} = (x_{it} - \frac{1}{T_i - t}\sum_{s=t+1}^{T_i-1} x_{is})(\frac{T_i - t}{T_i - t + 1})^{1/2}, \qquad t = 1,...,T_i - 2 \tag{3.10}$$

$$u_{it}^{o} = (u_{it} - \frac{1}{T_i - t}\sum_{s=t+1}^{T_i-1} u_{is})(\frac{T_i - t}{T_i - t + 1})^{1/2}, \qquad t = 1,...,T_i - 2 \tag{3.11}$$

The orthogonal transformation expresses each observation as the deviation from the average of future observations in the sample for the same unit, and weights each deviation to standardize the variance.

These transformations are essentially equivalent leading to the same estimator when one uses the transformed data. Orthogonal deviations have been popularized by Arrellano and Bover (1995) and these tidy the theoretical exposition as they avoid introducing correlation in the transformed disturbances.

However, in static panel data estimation, the most popularly applied estimators are the Fixed-effects estimator and the Random-effects estimator. As they correspond to different transformations, these two estimators exhibit their strengths under different assumptions.

3.3.4 Static Panel Data Models

Suppose we have a static panel data model as in equation (3.6); furthermore, if α_i stands for the unobserved individual specific effect, then we have a typical fixed-effect model.

$$y_{it} = \alpha_i + \beta' x_{it} + u_{it} \qquad i = 1, \ldots, N; t = 1, \ldots, T \qquad (3.6)$$

Allowing α_i to be expressed by $N - 1$[3] dummy variables d_{ij}, which equals 1 if $i = j$ and 0 otherwise, the above equation can be rewritten as:

$$y_{it} = \sum_{j=1}^{N} \alpha_j d_{ij} + \beta' x_{it} + u_{it} \qquad (3.12)$$

This model can be estimated using the **Least Square Dummy Variables (LSDV)** estimator. However, this fixed-effects least squares estimator suffers from loss of degrees of freedom, since we are estimating $N - 1$ extra parameters. In particular, the number of extra parameters becomes larger as N increases. Often interest is centered on the β vector rather than the α. Therefore, we need a more convenient estimator.

3.3.4.1 The Fixed-Effects Estimator or Within-Group Estimator

The fixed-effects estimator is an improvement over LSDV estimator, since the within-group transformation insures that one can obtain the same estimates for β without being troubled by too many dummies. As illustrated in equation (3.8), deviations from individual means will drop the unobserved heterogeneity α_i. Furthermore, if it has been assumed that all explanatory variables are independent of the error term, then one can show that the fixed-effect estimation for β is unbiased. This indication can be verified by the following procedure: first, in equation (3.8):

$$y_{it} - \bar{y}_{i.} = \beta'(x_{it} - \bar{x}_{i.}) + (u_{it} - \bar{u}_{i.}) \qquad (3.8)$$

We will obtain our fixed-effects estimator

$$\begin{aligned}\hat{\beta}_{FE} &= \left(\sum_{i=1}^{N}\sum_{t=1}^{T}(x_{it}-\bar{x}_{i.})(x_{it}-\bar{x}_{i.})'\right)^{-1}\sum_{i=1}^{N}\sum_{t=1}^{T}(x_{it}-\bar{x}_{i.})(y_{it}-\bar{y}_{i.}) \\ &= \beta+\left(\sum_{i=1}^{N}\sum_{t=1}^{T}(x_{it}-\bar{x}_{i.})(x_{it}-\bar{x}_{i.})'\right)^{-1}\sum_{i=1}^{N}\sum_{t=1}^{T}(x_{it}-\bar{x}_{i.})(u_{it}-\bar{u}_{i.})\end{aligned} \tag{3.13}$$

which is unbiased under the assumption that

$$E\{(x_{it}-\bar{x}_{i.})u_{it}\}=0 \tag{3.14}$$

Therefore, when the explanatory variables are strictly exogenous, the fixed-effects estimator is unbiased, and is released from the burden of too many dummy variables. In fact the estimator of β is identical to the LSDV estimator and is a computationally efficient implementation thereof.

Nonetheless, it is important to remember that the estimation results are based on the within transformation, which means it is good at explaining to what extent y_{it} differs from $\bar{y}_{i.}$ but is not able to explain why $\bar{y}_{i.}$ is different from $\bar{y}_{j.}$. In contrast, we have the Between estimator which ignores any information within individual units.

3.3.4.2 Between Estimator

The exploitation of the between dimension of the panel data, i.e. the differences between individuals, gives rise to the between estimator. Different from the within-transformation, the between-estimator uses regression of the individual averages of the dependent variable on individual averages of the explanatory variables.

Suppose we again consider the panel data model (3.6):

$$y_{it}=\alpha_i+\beta' x_{it}+u_{it} \qquad i=1,\ldots,N;\ t=1,\ldots,T \tag{3.6}$$

then obtaining individual means of each variable leads to:

---

[3] Whether there are N dummies or N-1 dummies depends presence/absence of intercept in the x vector.

$$\bar{y}_i = \alpha_i + \beta' \bar{x}_i + \bar{u}_i \qquad i = 1, \ldots, N. \tag{3.15}$$

Therefore, the between estimator is derived as:

$$\hat{\beta}_B = \left(\sum_{i=1}^{N} (\bar{x}_{i.} - \bar{x})(\bar{x}_{i.} - \bar{x})' \right)^{-1} \sum_{i=1}^{N} (\bar{x}_{i.} - \bar{x})(\bar{y}_{i.} - \bar{y}) \tag{3.16}$$

which is unbiased under the assumption that

$$E\{(\bar{x}_{i.} - \bar{x})\alpha_i\} = 0 \qquad \text{and} \qquad E\{(\bar{x}_{i.} - \bar{x})u_i\} = 0 \tag{3.17}$$

Hence, a between estimator will be unbiased if the explanatory variables are strictly exogenous and uncorrelated with the individual specific effect α_i. However, it is worth noticing that this estimator suffers from loss of information since the number of observations reduces from $N \times T$ to N.

3.3.4.3 The Random-Effects Estimator

A weighted combination of the fixed-effects estimator and the between estimator gives the random-effects estimator, which is more efficient in large samples than any other transformations if the unobserved α_i are random. Consider:

$$y_{it} = \mu + x'_{it}\beta + \alpha_i + u_{it} \qquad u_{it} \sim IID(0, \sigma_u^2) \text{ and } \alpha_{it} \sim IID(0, \sigma_\alpha^2). \tag{3.18}$$

The transformed model will be:

$$(y_{it} - \theta \bar{y}_{i.}) = \mu(1-\theta) + (x_{it} - \theta \bar{x}_{i.})'\beta + \alpha_i(1-\theta) + (u_{it} - \theta \bar{u}_i) \text{ where } 0 \le \theta \le 1 \tag{3.19}$$

Thus, the random-effects estimator will be the weighted combination of the fixed-effects estimator and the between estimator. If $\theta = 1$, it will be the same as fixed-effects estimator. Since $0 \le \theta \le 1$, a fixed proportion of the individual means is subtracted from the data to obtain the transformed model. For efficiency, we require

$$(1-\theta)^2 = \frac{\sigma_u^2}{\sigma_u^2 + T\sigma_\alpha^2}. \tag{3.20}$$

In practice, this has to be estimated, and the resulting feasible Generalized Least

Squares estimator is efficient for large N.

However, it is not easy to determine whether the fixed-effects or the random-effects estimator is more efficient. The comparison depends on the assumption about α_i; that is, whether this unobserved heterogeneity is correlated with other explanatory variables.

In many empirical studies a Hausman test is carried out to check which of the estimators will be the more appropriate one to use. This test is an implementation of the Hausman (1978) specification test, which compares an estimator that is known to be consistent (say, fixed-effects), with an estimator that is efficient (say, random-effects) under the assumption being tested. The null hypothesis is that the efficient estimator (RE) is a consistent and efficient estimator of the true parameters. If the null is true, there should be no systematic difference between the coefficients of the efficient estimator (RE) and the consistent estimator (FE). Otherwise, the null will be rejected and the efficient estimator (RE) will not be consistent and efficient for the true parameters.

However, all of the estimators above produce biased results for small T when the model under estimation is a dynamic panel data model. If this is the case, in addition to the unobserved heterogeneity, biased results also come from auto-correlation or endogeneity problems. In particular, when a lagged dependent variable has been included as one of the explanatory variables, the assumption of strict exogeneity of the explanatory variables collapses.

3.4 THE DYNAMIC PANEL DATA MODEL AND THE GMM ESTIMATOR

One of the most important merits of panel data compared with cross-sectional data is the possibility to model dynamics. This makes panel data sets more and more used in

economic modeling. In a considerable proportion of economic studies, history matters so much that past experience has profound influence on current economic performance. In particular, in this thesis, we will see that current year provincial income levels depend upon last period per capita income, which leads our convergence investigation to a dynamic panel data model. However, there are drawbacks in dynamic panel data models, resulting either from heterogeneity or auto-correlation problems, or from endogeneity problems. These drawbacks could well affect the estimation results for the ordinary least squares (OLS) estimator. For example, the following simple model can clarify the sources of bias when an OLS estimator is applied to a dynamic panel data set:

$$y_{it} = X_{it}\beta + \varepsilon_{it} \tag{3.21}$$

We know that OLS is minimum variance in the class of linear unbiased estimators (MVLUE) for β under Gauss-Markov assumptions, when the following two conditions meet:

$$\text{I:} \quad V\{\varepsilon|X\} = V\{\varepsilon\} = \sigma^2 I \tag{3.22}$$

$$\text{II:} \quad E\{\varepsilon|X\} = E\{\varepsilon\} = 0 \tag{3.23}$$

The conditions state that the conditional distribution of the errors given the matrix of explanatory variables has zero means, constant variances and zero co-variances. However, both are easily violated in panel data estimation, especially in a dynamic panel data model. Condition (I) will be violated if heterogeneity or auto-correlation arises. In particular, heterogeneity will arise if different error terms do not have identical variances, so that the diagonal elements of the covariance matrix are not identical. This is easily observed in cross-sectional data sets, since different individual units in the sample may have different variances. Auto-correlation will arise in any time-series data set, when observations over a period for the same individual units are involved in the

analysis. Panel data combines time-series and cross-sectional data, which inherits heterogeneity and auto-correlation accordingly.

Condition (II), on the other hand, will be violated by either auto-correlation in the error term, combined with the inclusion of a lagged dependent variable, or endogeneity in the model, which is very possible in dynamic panel data. For example, in the model:

$$y_{it} = \alpha_i + \beta' x_{it} + \beta_0 y_{i,t-1} + u_{it} \tag{3.24}$$

the lagged dependent variable is included as one of the explanatory variables. If this is the case, and if error term is subject to first order auto-correlation:

$$u_{it} = \rho u_{i,t-1} + v_{it} \tag{3.25}$$

then the model can be rewritten and we see condition (II) is violated:

$$y_{it} = \alpha_i + \beta' x_{it} + \beta_0 y_{i,t-1} + \rho u_{i,t-1} + v_{it} \tag{3.26}$$

since:

$$y_{it-1} = \alpha_i + \beta' x_{it-1} + \beta_0 y_{i,t-2} + u_{it-1} \tag{3.27}$$

which indicates that $E\{y_{it-1}u_{it}\} \neq 0$. Thus if $\rho \neq 0$, OLS will no longer be the MVLUE.

The breaking of conditions (I) and (II) in a dynamic panel data model will easily introduce two sources of bias, omitted-variable bias and endogeneity bias. As explained, unobserved heterogeneity means there are some individual specific characteristics that have not been modeled in the estimation. Different transformations will help to reduce bias from this source. Endogeneity is going to arise if $E\{X_{it}u_{it}\} \neq 0$, which is another way of saying that the explanatory variables are not strictly exogenous. In growth equations, it is easy to see that some right-hand-side variables may be correlated with the error term in the model. If the dependent variable and some independent variables are determined simultaneously, we cannot interpret estimation results in terms of the

usual causal relationship, and OLS will no longer produce unbiased results. Nevertheless, it is noted that the fixed-effects estimator is also not consistent in dynamic panel data models, if T is fixed. Therefore, we examine an alternative estimator.

To reduce bias stemming from these two sources, a Generalized Method of Moments estimator is going to be used to analysis our dynamic panel data set. The GMM estimator of Arellano and Bond (1991) involves transformation of the data set and the use of instrumental variables. Firstly, omitted-variable bias could be reduced by employing first-difference transformation:

$$y_{i,t} - y_{i,t-1} = \beta_y (y_{i,t-1} - y_{i,t-2}) + \beta_x' (x_{i,t} - x_{i,t-1}) + (\varepsilon_{i,t} - \varepsilon_{i,t-1}) \tag{3.28}$$

or
$$\Delta y_{i,t} = \beta_y \Delta y_{i,t-1} + \beta_x' \Delta x_{i,t} + \Delta \varepsilon_{i,t} \tag{3.29}$$

Secondly, endogeneity bias could be reduced by constructing an instrumental variable matrix. An instrumental variable is by definition a variable that can be assumed to be uncorrelated with the model's error ε_i, but correlated with the explanatory variables.

In particular in the dynamic panel data model, if we suppose the error terms are serially un-correlated, then $y_{i,t-2}$ is a valid instrument because although it is correlated with $(y_{i,t-1} - y_{i,t-2})$, it is not correlated with $(\varepsilon_{i,t} - \varepsilon_{i,t-1})$. Also $y_{i,t-3}$, $y_{i,t-4}$...till y_{i1} are all qualified instrumental variables. We can construct our IV matrix following this criterion:

$$Z_i = \begin{pmatrix} y_{i,1} & 0 & 0 & .. & .. & .. & .. & .. & .. & .. & .. & 0 \\ 0 & y_{i,1} & y_{i,2} & .. & .. & .. & .. & .. & .. & .. & .. & 0 \\ .. & .. & .. & .. & .. & .. & .. & .. & .. & .. & .. & 0 \\ .. & .. & .. & .. & .. & .. & .. & .. & .. & .. & .. & 0 \\ 0 & .. & .. & .. & .. & .. & .. & y_{i,1} & y_{i,2} & y_{i,3} & .. & y_{i,T-2} \end{pmatrix} \tag{3.30}$$

and Z is defined as

$$Z = (Z_1', Z_2', ...Z_i', ...Z_N')' \tag{3.31}$$

Then the moment equations are given by $E(Z_i'\Delta\varepsilon_i) = 0$. Note that here we have 1,2,3,...T-2 conditions; thus the number of moment conditions equals to (T-1)(T-2)/2.

Pre-multiplying equation (3.29) in vector form by Z', we get

$$Z'\Delta y = Z'(\Delta y_{-1})\beta_y + Z'(\Delta x)\beta_x + Z'\Delta\varepsilon \tag{3.32}$$

which yields the one-step GMM estimator:

$$\begin{pmatrix}\hat{\beta}_{y1}\\ \hat{\beta}_{x1}\end{pmatrix} = \left((\Delta y_{-1}\Delta x)'Z(Z'(I_N \otimes G)Z)^{-1}Z'(\Delta Y_{-1}\Delta x)\right)^{-1}\left((\Delta y_{-1}\Delta x)'Z(Z'(I_N \otimes G)Z)^{-1}Z'\Delta y\right) \tag{3.33}$$

where

$$G = \begin{pmatrix} 2 & -1 & 0 & .. & 0 & 0 \\ -1 & 2 & -1 & .. & 0 & .. \\ 0 & -1 & 2 & .. & .. & .. \\ .. & .. & -1 & .. & .. & .. \\ .. & .. & .. & .. & .. & -1 \\ 0 & .. & .. & .. & -1 & 2 \end{pmatrix}. \tag{3.34}$$

If we replace $Z'(I_N \otimes G)Z$ with W_N, which is defined as

$$W_N = \sum_{i=1}^{N} Z_i'(\Delta\hat{\varepsilon}_{i1})(\Delta\hat{\varepsilon}_{i1})'Z_i \tag{3.35}$$

while $\Delta\hat{\varepsilon}_{i1}$ is obtained by one-step estimation results, we will get more efficient two-step estimation results:

$$\begin{pmatrix}\hat{\beta}_{y2}\\ \hat{\beta}_{x2}\end{pmatrix} = \left((\Delta y_{-1}\Delta x)'ZW_N^{-1}Z'(\Delta Y_{-1}\Delta x)\right)^{-1}\left((\Delta y_{-1}\Delta x)'ZW_N^{-1}Z'\Delta y\right) \tag{3.36}$$

However, there is one shortcoming of this two-step GMM estimation method: from Monte Carlo simulations, it has often been found that the estimated asymptotic standard errors of two-step estimation results are severely downward biased in small

samples, while the asymptotic standard errors of one-step GMM estimators are unbiased. One-step GMM estimators use weight matrices that are independent of estimated parameters, whereas the efficient two-step GMM estimator weights the moment conditions by a consistent estimate of their covariance matrix. This weight matrix is constructed using an initial consistent estimate of the parameters in the model. According to Windmeijer (2000), "*it is shown that the extra variation due to the presence of these estimated parameters in the weight matrix accounts for much of the difference between the finite sample and the asymptotic variance of the two-step GMM estimator that utilizes moment conditions that are linear in the parameters. This difference can be estimated, resulting in finite sample corrected estimates of the variance.*" (p. 2). "*A simple first order Taylor series expansion generates an extra term as a function of these initial parameter estimates, which vanishes with increasing sample size, but provides a more accurate asymptotic approximation in the case of linear moment conditions.*" (p. 20). The corrected standard errors are reported in PcGive 10, which is the software we use for the empirical analysis.

3.5 CONCLUSIONS

The provincial economic growth pattern and the resulting enlarging inter-provincial income disparity is the focus of the thesis. The investigation of such a research topic involves the employment of provincial data from the China Statistical Yearbook for various years. Therefore, as in many recent econometric studies of macroeconomic performance, panel data will be used to conduct the empirical analysis.

As a combination of time-series and cross-sectional data, panel data has its own advantages. But the economic application in this field is relatively new and the methods

of panel data analysis are under development. At the beginning, economists took advantage of panel data by regressing different groups separately and then averaging, or making pooled regression, or alternatively carrying out pure time-series or cross-sectional regressions after averaging data on either the group dimension or the time dimension. All of these methods needed improvement, which lead to fixed-effects and random-effects estimators for static panels and GMM for dynamic panels.

It is noted that the bias stemming from omitted variables can be reduced by different transformations of the data set; therefore the fixed-effects estimator and the random-effects estimator have been applied widely in static panel data analysis. A Hausman test is often carried out to see which one is more efficient. However, the dynamic nature of our growth equations demands a more appropriate estimator, since endogeneity bias, arising from simultaneity, cannot be reduced by data transformation. Thus instrumental variables are employed. Therefore, the possible biases existing in empirical models guide the development of econometric methods. The GMM estimator is thus designed to obtain the most efficient estimator in a dynamic panel data model. By transforming data sets with a first-difference transformation, bias originating from unobserved heterogeneity is reduced; by using lagged variables as instruments, endogeneity bias is reduced. Furthermore, PcGive 10 gives the corrected two-step standard errors as Windmeijer's adjustments have been incorporated in the software.

CHAPTER FOUR

PROVINCIAL ECONOMIC GROWTH PATTERNS AND THE INTER-PROVINCIAL INCOME INEQUALITY IN CHINA FROM 1991 TO 1999

Abstract:

Using China's provincial data from 1991 to 1999, this chapter investigates provincial economic growth patterns and the inter-provincial income inequalities. GMM estimation has been used to explore a dynamic panel data model based on the Solow growth model. We find that provinces conditionally converge to their own steady states at an annual rate of 8%, indicating around 8 years for a province to halve the deviation from its balanced growth path. This indicates that different provinces have their own steady states, which is resulted from institutional rigidity and inter-provincial trade barriers. However, the panel data exploration of convergence could not explain the catching up phenomenon. To see whether poorer provinces can grow faster than richer ones, sigma and absolute beta divergence have been employed. We find that when the inter-provincial income gap enlarges during the 1990s, the initially poor provinces do not catch up with the initially rich provinces.

4.1 INTRODUCTION.

China has been growing rapidly since 1978. However, different provinces have grown at different rates. Income levels for the 31 regions at provincial level (that is, 22 provinces, 5 autonomous regions, and 4 metropolitan cities) vary so much that, in 1995, the Party Congress has to admit "*for many reasons, regional economic inequalities have been widened somewhat.*"[1]

Thus the objective of this chapter is to investigate inter-provincial income inequalities in China during the 1990s. We seek the factors accounting for provincial economic growth patterns and the reasons why provinces develop at different speeds, which lead in turn to inter-provincial income inequality. Therefore, convergence or non-convergence is the focus of this chapter. We will show that inter-provincial income disparity increased during the 1990s and give reasons for this. The period of analysis, 1991 to 1999, is a period of deepening of the economic reform process in China. Even though China's reform started from 1978, the country has developed so fast that reform measures in the 1990s differ significantly from those in the 1980s. Before 1990, reform was concentrated in the agricultural sector and the development of the towns-and-village-owned enterprises (TVEs), which helped poor provinces in coastal region to develop fast and hence reduced income inequality within the coastal region. The decreased gap within the coastal region again accounted for the decreased inequality at the national level. This is why Jian et al (1996) have identified 1978-1990 as the only period showing strong evidence of a shrinking inter-provincial income gap in China, since 1952.

[1] People's Daily Overseas Edition, Oct. 5, 1995. P.4.

However, the effect of agricultural reform faded in the 1990s. The reform shifted its focus to open more to the outside world and to the initiation of market-oriented reforms. The year 1991 was still under the shadow of the 1989 Tiananmen Square incident. Economic reform restarted in 1992 after the famous Southern tour of Deng Xiaoping. Even though before this year China had used the slogan of "combining plan and market together" and "planning supplemented by the market", it is from this year that China declared a "socialist market economy" as its reform goal. In 1993, at the Third Plenum of the 14th Party Congress, this issue was made clear. The core of all of the policy measures is to establish a market economy and open China more to the outside world. Together with the introduction of a market economy, many institutional reforms have been carried out, which have shaped and will influence China's economic development to a great extent. Nevertheless, during the establishment of a socialist market economy, inter-provincial inequality becomes a more and more important issue, and deserves great attention from economists.

The structure of this chapter is as follows. Section-II summarizes the main features of China's economic development pattern during the 1990s: inter-provincial income inequality increases while the national economy grows fast. Inter-provincial income inequality has been considered to exert an important influence on social stability and economic development. Section-III explains the convergence argument. There are various versions of convergence in the growth literature. Conditional convergence, absolute beta convergence and sigma convergence are the major concepts under exploration by economists. In section-IV we present the Solow growth model, which we use to find factors contributing to provincial economic growth patterns. We describe our dynamic panel-data model here and explain our empirical tools. To

reduce biases due to omitted variables and endogeneity problems, Generalized Method of Moments (GMM) estimation has been applied. Sargan test and AR tests are carried out to test our assumptions and the validity of our instrumental variables. Section-V describes our data set and explains the empirical model in detail, including the role of capital investment and population growth, and the definition of a time dummy. Section-VI interprets our estimation results for conditional convergence. We find provinces spend around 8-9 years to converge half way to their own balanced growth paths. Since panel data analysis on conditional convergence is not able to explore the catching up phenomenon, we employ sigma and beta convergence definitions to check whether poorer provinces catch up with richer ones during the period of investigation. Section-VII also explains the relationship between sigma divergence, absolute beta divergence and conditional convergence. We prove that absolute beta divergence is a sufficient but not necessary condition for sigma divergence. While conditional convergence fits the predictions of the Solow growth model, absolute beta divergence proves no catching up has occurred in the Chinese economy. We summarize our chapter in section-VIII.

4.2 INTER-PROVINCIAL INCOME INEQUALITY IN CHINA: THE 1990S.

Per capita real GDP has been used in our analysis as the indicator of provinces' income levels. During the 1990s, when the country as a whole was growing fast in per capita GDP, the inter-provincial income gap changes. It is easy to understand that not all provinces in China were growing at the same speed. Some grew faster while others lagged behind. However, if the initially richer ones grew faster than the initially poorer ones, the gap between them would have been increased.

Among the 31 provinces in China, Tibet is excluded from our data set for lack of

data. Data about Chongqing are included in Sichuan province's data set since it has changed status from an ordinary city in that province to a metropolitan city with provincial status in 1997. First we look at the income levels of the other 29 regions from 1991 to 1999.

Figure 4.1

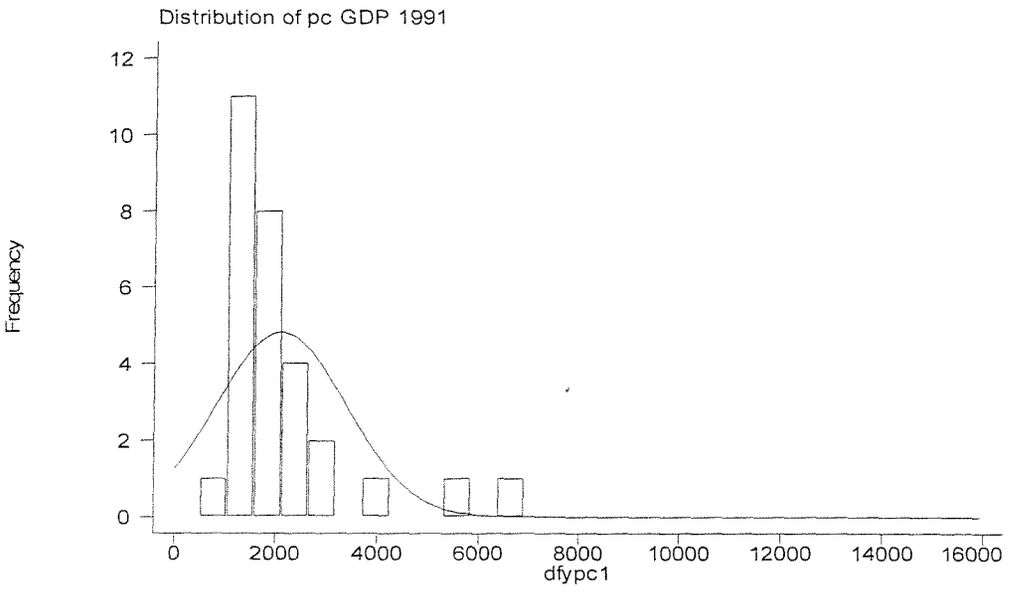
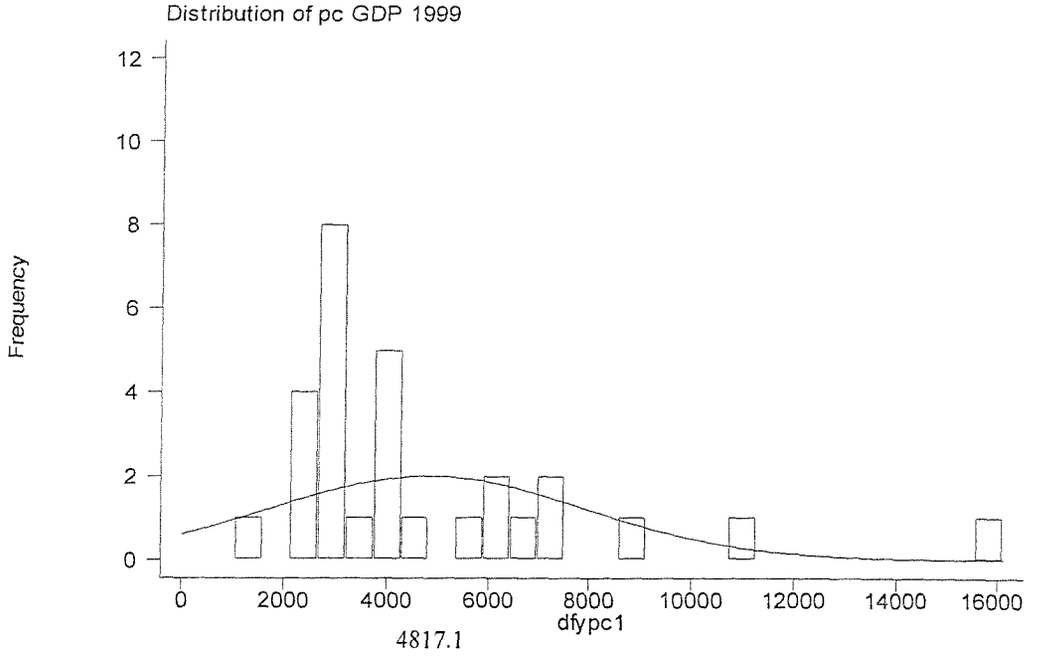


Figure 4.2 2097.8



4817.1

Figure 4.1 graphs the distribution of provincial per capita GDP in 1991 while figure 4.2 graphs the income distribution in 1999, with the unit of RMB Yuan. GDP is deflated by the GDP index to give real GDP at 1990 prices. The first observation apparent from comparing these two figures is that there is rapid economic development during the 9 years; average per capita GDP rises from 2097.8 yuan in 1991 to 4817.7 yuan in 1999 (at 1990 prices). Second, the gap between rich and poor provinces enlarged during the 1990s. Compared with figure 4.1, the distribution in figure 4.2 is more scattered. When taking per capita GDP in the poorest province as a percentage of the richest province, Guizhou compared with Shanghai, there was a drop from 13.38% in 1991 to 9.6% in 1999.

The fast growth of China's economy has also been displayed in table 4.1, which lists economic growth rates during the 1990s for China and the other fast-growing Southeast Asian economies. The 8 fast-growing economies include Rep. of Korea, Singapore, Hong Kong and Taiwan, the so-called "four dragons"; and Indonesia, Malaysia, Philippines and Thailand, the so-called "four tigers". Comparing with the growth rates of these 8 economies, China's economic growth rates were at the top from 1992 to 1998; only in 1999 Rep. of Korea grew faster than China. Such fast growth rates bring significant welfare improvements to Chinese people. However, together with the impressive growth rates, China's annual growth rates also display a slowing down across 1990s. We see that yearly growth rates in per capita real GDP dropped all the way from 14.2% in 1992 to 7.1% in 1999, which, even though still high, is much lower.

Table 4.1 **Economic Growth Rates in The 1990s for China and Southeast Asian Economies**

Nations	1992	1993	1994	1995	1996	1997	1998	1999
China	14.2%	13.5%	12.6%	10.5%	9.6%	8.8%	7.8%	7.1%
Rep. of Korea	5.1%	5.8%	8.6%	8.9%	7.1%	5.5%	-6.7%	10.7%
Singapore	6.2%	10.4%	10.5%	8.7%	6.9%	7.8%	1.5%	5.4%
Hong Kong	6.3%	6.1%	5.4%	3.9%	5%	5.2%	-5.1%	2.9%
Taiwan	7.4%	6.1%	5.7%	6.5%	5.2%	5.9%	4.6%	5.7%
Indonesia	7.2%	7.3%	7.5%	8.2%	7.8%	4.9%	-13.2%	0.2%
Malaysia	7.8%	8.3%	9.2%	9.5%	8.6%	7.8%	-7.5%	5.4%
Philippines	0.3%	2.1%	4.4%	4.7%	5.8%	5.2%	-0.5%	3.2%
Thailand	8.1%	8.4%	8.9%	8.8%	5.5%	-0.4%	-10.8%	4.1%

Data resource:
Original data from World Bank and table from Hu (13/11/2000), "About Economic Growth Model Transformation in the Ninth Five-Year-Period", "50 forum in China Economic Information Network", http://www1.cei.gov.cn/forum50/.

When the nation as a whole grows fast during the 1990s, different provinces grow at different speeds. If we group provinces according to their income levels and compare the income distribution patterns across years, we will have a clear observation on different provinces' growth rates.

Table 4.2 Ratio of Provincial Per Capita GDP to National Average

		Province	Ratio 1991 (%)	Province	Ratio 1999 (%)
Above National Mean Group: Rich Club		Shanghai	317.9	Shanghai	334.8
		Beijing	260.9	Beijing	228.6
		Tianjin	179.8	Tianjin	187.9
		Liaoning	143.4	Zhejiang	154.7
		Guangdong	131.8	Guangdong	153.2
		Zhejiang	122.7	Jiangsu	144.7
		Jiangsu	111.5	Fujian	133.1
		Heilongjiang	109.9	Liaoning	126.9
		Xinjiang	102.9	Shandong	118.5
		Shandong	100.7		
Below National Mean Group	Middle	Fujian	96.3	Hebei	92.4
		Jilin	88.0	Hainan	88.5
		Hainan	85.2	Heilongjiang	87.4
		Hebei	82.2	Jilin	84.0
		Hubei	78.9	Hubei	84.0
		Qinghai	78.8	Xinjiang	80.4
		Inner Mongolia	78.5		
		Shanxi	75.9		
		Ningxia	71.3		
	Poor	Shaanxi	66.2	Inner Mongolia	68.1
		Yunnan	65.2	Shanxi	66.2
		Hunan	63.9	Anhui	65.1
		Sichuan	60.5	Guangxi	61.3
		Jiangxi	59.1	Hunan	61.1
		Guangxi	57.2	Jiangxi	60.6
		Henan	56.9	Henan	58.7
		Gansu	56.6	Qinghai	58.7
		Anhui	54.9	Ningxia	57.9
		Guizhou	42.6	Shaanxi	55.1
				Yunnan	54.5
				Sichuan	54.1
				Gansu	47.2
				Guizhou	32.0

Table 4.2 lists provinces according to the deviations of provincial per capita GDP from the national mean. The "Above-mean" group has provinces with per capita GDP greater or equal to the simple average at national level. Therefore the group is also called a "Rich club". There were altogether 10 provinces belonging to the rich club in 1991: Shanghai, Beijing, Tianjin, Liaoning, Guangdong, Zhejiang, Jiangsu, Heilongjiang, Xinjiang and Shandong province. In 1999, only nine provinces belong to this club, since Heilongjiang and Xinjiang provinces dropped out, and Fujian province joined in. Fujian raised its position from the originally middle club, which hosts those provinces with per capita GDP equaling 71-100% of the national average level. In 1991, in addition to Fujian, there were 8 other provinces in this club, namely Jilin, Hainan, Hebei, Hubei, Qinghai, Inner Mongolia, Shanxi and Ningxia. Economic growth patterns for this club's members vary so much that only 3 provinces keep their membership in 1999. Fujian, as we mentioned, raised its position to the rich club after eight years of reform. Four members dropped to the "Poor club" in 1999. The four members are Qinghai, Inner Mongolia, Shanxi, and Ningxia, who's per capita GDP to national average dropped from 78.8%, 78.5%, 75.8% and 71.2% respectively in 1991, to 58.7%, 68.1%, 66.2% and 57.9% respectively in 1999.

The last club is called as "Poor" since it consists of all the provinces with per capita GDP less than 70% of national mean. Shaanxi, Yunnan, Hunan, Sichuan, Jiangxi, Guangxi, Henan, Gansu, Anhui and Guizhou were the ten candidates of this club in 1991. Its members increased to 14 in 1999 with the joining of the four provinces degraded from the "Middle". Both middle and poor clubs belong to "Below National Mean Group". In general, the shrinkage in the middle club indicates that the inter-provincial income structure becomes less stable and the expansion in the poor club

indicates enlarging inter-provincial income disparity.

The fast speed of economic development and the enlarged inter-provincial income gap are the major features of China's economic growth pattern during the 1990s. This chapter hopes to discover the forces leading to this pattern. The concept of conditional convergence helps us to uncover the factors accounting for the provincial economic growth patterns.

4.3 CONVERGENCE IN PER CAPITA GDP

There are several definitions of convergence in per capita GDP, for example absolute convergence and conditional convergence; sigma convergence and beta convergence. The concept of convergence in per capita income is based on the neoclassical growth model, in particular, the Solow growth model. As Bernard and Durlauf (1994) suggest, "*the neoclassical model makes very strong predictions concerning the behavior of economies over time*" (p. 1), because factors contributing to the economic growth pattern are attributed to exogenous technical change and the capital investment ratio, when the economy under study is characterized by diminishing returns to scale. Therefore, economies that have similar technological development levels and concave production functions will display cross-sectional convergence in income levels. This leads to the definition of absolute β-convergence, which refers to the hypothesis that poor economies tend to grow faster per capita than rich ones, without conditioning on any other characteristics of the economy. The definition is checked by doing univariate growth regression. If the coefficient of initial income level, denoted by β, is negative and significant, there is absolute β-convergence.

Furthermore, Barro and Sala-i-Martin (1995) describe the concept of conditional β-convergence. "*We can accommodate the theory to the empirical observations on convergence if we allow for heterogeneity across economies, in particular, if we drop the assumption that all economies have the same parameters, and therefore, the same steady-state positions. If the steady states differ, then we have to modify our analysis to consider a concept of conditional convergence.*" (p. 28). Hence conditional convergence means economies converge to their own steady states once we control for the determinants of the steady states. Besides absolute and conditional beta convergence, we have another convergence concept, sigma convergence. According to Sala-i-Martin (1996), if the dispersion of real per capita income across groups of economies tends to fall over time, there is σ-convergence. It implies that economies' differences in economic development tend to be smaller as time passes.

Based on the Solow growth model, Barro and Sala-i-Martin (1990) give a detailed analysis of income convergence in the U.S. (48 states), Canada (10 provinces), Japan (47 prefectures) and Europe (90 regions). They find both σ convergence and absolute β convergence in these economies, with an annual convergence speed around 2%. Mankiw, Romer, and Weil (1992) run OLS regressions in a cross-section setting to examine the Solow growth model. They find that holding population growth and capital accumulation constant, countries conditionally converge at about the rate the augmented Solow model predicts. However, using the same data set, Caselli, Esquivel and Lefort (1996) obtain very different results in terms of convergence speed by applying the GMM estimator, and they reject the Solow model. By claiming that most empirical studies of convergence speed obtained biased results due to omitted variables or endogeneity problems, they prove per capita incomes converge to their

own steady states at a rate around 10% annually. Lee, Pesaran and Smith (1997) conclude annual convergence rates are approximately 30%, when one allows for heterogeneity in all the parameters.

Using provincial data from China, Jian, Sachs and Warner (1996) examined China's provincial growth trends during 1952-1993. They found that China's provinces display strong absolute sigma convergence only from 1978 to 1990, 12 years after economic reform. From 1952-1965, there was weak sigma convergence. From 1965-1978, strong evidence of absolute sigma divergence was found. Between 1990 and 1993 the inter-provincial income gap started to increase again. Wang and Hu (1999) discovered that China's provinces showed absolute divergence, both β and σ, from 1990 to 1994. Chen and Feng (2000) revealed conditional convergence in China's provincial economic growth from 1978 to 1989. Furthermore, Yao and Zhang (2001), Chen and Fleisher (1996), Cai (2001) and Kanbur and Zhang (1999) have focused their studies on coastal-inland income disparities and concluded that the enlarging gap between coastal and inland development levels accounted for the major source of income inequality in China.

The concept of conditional convergence allows one to look at forces accounting for growth, like capital investment, human resource accumulation, the labor growth rate and the technology development level, among others. However, in terms of empirical work in this field, as already noted by some researchers, most studies obtain biased results due to omitted variables or endogeneity problems. There are unobserved provincial-specific characteristics which are related to right hand side variables in growth regressions. At the same time, some right hand side variables may be determined simultaneously with the provinces' growth rates, leading to endogeneity bias. Using provincial data from

China from 1991 to 1999, we intend to reduce omitted-variable bias and endogeneity bias by applying the Generalized Method of Moments (GMM) estimator.

Nevertheless, the concept of conditional convergence will not help to predict whether or not poor provinces can catch up with rich provinces. We test whether the inter-provincial gap is increasing or decreasing by looking at sigma and absolute beta convergence.

4.4 MODEL ESTIMATION

To address convergence issues, we first look at the Solow growth model. The augmented Solow model will not be analyzed in the thesis since we do not have data on human capital accumulation. Therefore, we start from a Cobb-Douglas production function without human capital:

$$Y_t = K_t^{\alpha}(A_t L_t)^{1-\alpha} \qquad 0 < \alpha < 1 \tag{4.1}$$

where Y_t is output level, K_t is capital stock and L_t is the labor force. The term A_t depicts the level of technology development. After some algebra (see Appendix 4.A), we obtain the steady state per capita income as:

$$\ln y_t = e^{-\lambda\tau} \ln y_{t-\tau} + (1 - e^{-\lambda\tau})(\frac{\alpha}{1-\alpha})[\ln s - \ln(n + g + \delta)] \tag{4.2}$$

Here g is Total Factor Productivity growth rate, n is labor growth rate, and δ is capital depreciation rate. s describes the share of capital investment in output and t represents time. $\lambda = (1-\alpha)(n + g + \delta)$, the speed of convergence. Hence we can use a dynamic model of the level of per capita GDP as growth regression. However, as we

do not have data on g^2 and δ, the following equation has to be used as a proxy for the equation (4.2) above.

$$\ln(Y/L)_{it} = \alpha_i + \beta_0 \ln(Y/L)_{i,t-1} + \beta_1 \ln s_{it} + \beta_2 \ln p_{it} + \nu_t + \varepsilon_{it} \qquad (4.3)$$

We take time difference $\tau = 1$ in our regressions. p is the population growth rate and α_i stand for unobserved provincial characteristics such as geographical features, cultural characteristics, economic development levels, and others, some of which may be related to other right-hand-side variables. Correlation becomes inevitable in a dynamic panel-data model because these unobserved heterogeneities are highly related with the lagged dependent variable. For instance:

$$E[\ln(\frac{Y}{L})_{i,t-1}\alpha_i] = E[\alpha_i\{\alpha_i + (1+\beta_0)\ln(\frac{Y}{L})_{i,t-2} + \beta_1 \ln s_{it-1} + \beta_2 \ln p_{it-1} + \nu_{t-1} + \varepsilon_{it-1}\}] \quad (4.4)$$

which one would not expect to be 0. Therefore, these omitted variables will bias OLS estimation results.

There are a number of ways to reduce this bias by data transformation, such as the within-group transformation and the first-difference transformation. The within-group transformation is used to remove Fixed-effects (FE) and takes deviations with respect to individual means, like:

$$y_{it} - \bar{y} = \beta_y(y_{i,t-1} - \bar{y}_{-1}) + \beta_x(x_{i,t} - \bar{x}_{i,\cdot}) + (\varepsilon_{i,t} - \bar{\varepsilon}_{i,\cdot})$$

where

$$\bar{y} = \frac{1}{T}\sum_{t=t_0+1}^{t_0+T} y_{it} \qquad (4.5)$$

$$\bar{y}_{-1} = \frac{1}{T}\sum_{t=t_0}^{t_0+T-1} y_{it}$$

and so on.

---

[2]. There are various versions of TFP estimates in the literature. All of them are different from each other because of differences in the assumptions, data sets, estimation methods et al. Hence we only include

Even though provincial heterogeneities are dropped in this equation, another problem arises. Due to its dynamic feature, the FE estimator gives inconsistent estimates. For T fixed, the inconsistency comes from the correlation between the within transformed lagged dependent variable and the within transformed error term.

As we mentioned before, another transformation to reduce omitted-variable bias is the first-difference transformation. The most appropriate estimator for the first-difference transformation in a dynamic-panel-data model is the Generalized Method of Moments (GMM) estimator of Arellano and Bond (1991). The idea of GMM is to estimate model parameters directly from the moment conditions that are imposed by the model. First we use the first-difference transformation to remove the omitted provincial effects in the model:

$$y_{i,t} - y_{i,t-1} = \beta_y (y_{i,t-1} - y_{i,t-2}) + \beta_x' (x_{i,t} - x_{i,t-1}) + (\varepsilon_{i,t} - \varepsilon_{i,t-1}) \tag{4.6}$$

$$\text{or } \Delta y_{i,t} = \beta_y \Delta y_{i,t-1} + \beta_x' \Delta x_{i,t} + \Delta \varepsilon_{i,t} \tag{4.7}$$

Next we can construct an instrumental variable matrix to reduce endogeneity bias. If we suppose the error terms are serially un-correlated, then $y_{i,t-2}$ is a valid instrument because it is related to $(y_{i,t-1} - y_{i,t-2})$ and not correlated with $(\varepsilon_{i,t} - \varepsilon_{i,t-1})$. Also $y_{i,t-3}, y_{i,t-4}$ ...till y_{i1} are all qualified instrumental variables. Hence more than two-year lags of dependent variable are qualified variables to include in the instrumental variable matrix.

However, we have more moment conditions than we need to identify the parameters. Thus we can carry out Sargan's over-identification test. The aim of the test

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labor growth rates in the regression to avoid unnecessary problems. And labor growth rate is approximated by population growth rate.

is to make sure our moment conditions are valid. According to Arellano and Bond (1991), the Sargan statistic is given by:

$$Sargan = (\Delta\hat{\varepsilon}_2)'Z(\sum_{i=1}^{N} Z_i'(\Delta\hat{\varepsilon}_{i2})(\Delta\hat{\varepsilon}_{i2})'Z_i)^{-1}Z'(\Delta\hat{\varepsilon}_2) \quad (4.8)$$

where $\Delta\hat{\varepsilon}_{i2}$ are two-step estimated residuals. Under the null hypothesis that the instrumental matrix is valid, the Sargan statistic is asymptotically distributed as χ^2_{R-K}, where K is the number of coefficients to be estimated and R is the number of moment conditions. The rejection of Sargan test is interpreted as implying the invalidity of the instruments.

Remember that one assumption of GMM estimation is the serial un-correlation of the error term. This assumption is of key importance to guarantee the validity of our estimation results. AR tests are applied to test this assumption. We follow Doornik, Arellano and Bond (1999): "*If the disturbances are not serially correlated, there should be evidence of significant negative first order serial correlation in differenced residuals, and no evidence of second order serial correlation in the differenced residuals.*" (p. 8). Therefore a significant and negative AR(1) test result together with an insignificant AR(2) test result support our assumption of serial un-correlation in the error term.

4.5 DATA EXPLANATION

The data we used are from the China Statistical Yearbook from 1992 to 2000. Per capita real GDP is used to measure provincial income instead of output per efficient worker, which would have been closer to the model. GDP indices are used to deflate GDP in current prices to 1990 prices.

Equation (4.3) is our regression model and in this dynamic panel data model, (Y_t/L_t) stands for per capita real GDP at 1990 price level while p is population growth. For the capital investment ratio s, we use the total investment in fixed assets to GDP ratio as a proxy, then add foreign direct investment (FDI) to total investment in fixed assets and obtain an alternative aggregated capital investment ratio. The construction of two capital investment to GDP ratios are recorded in equation (4.9).

lns = ln(total investment in fixed assets / total GDP) (4.9a)

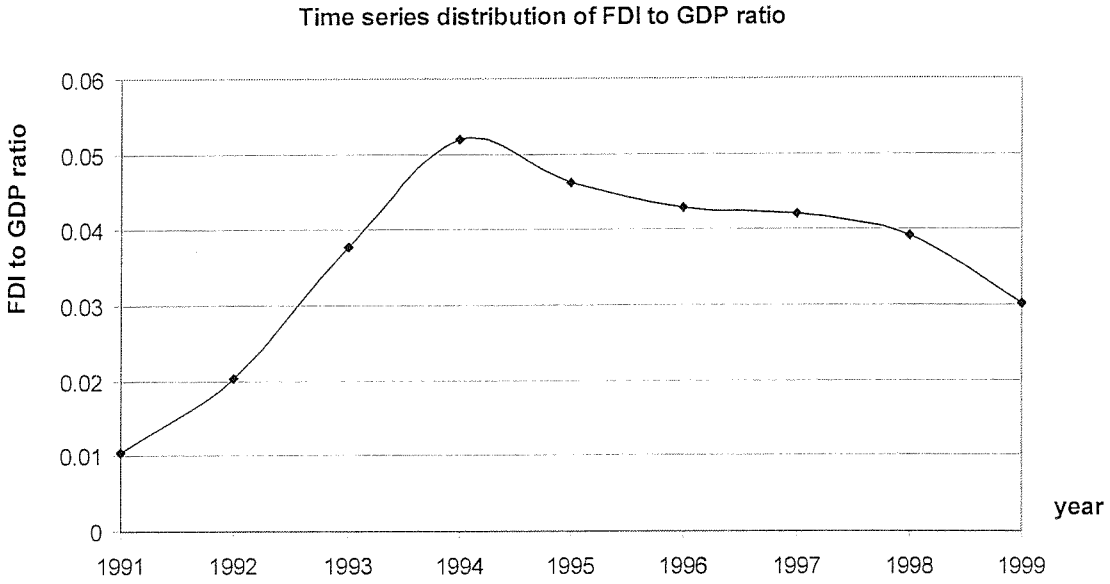
Lnsfdi =ln((total investment in fixed assets + foreign direct investment)/total GDP) (4.9b)

A time dummy is included in our regression. We also interact the dummy with the explanatory variables to allow for slope changes. Our time dummy is generated to be equal to 1 if years are between 1994 and 1996 and 0 otherwise:

$$\gamma_0 = 1 \text{ if years} \in [1994, 1996] \quad \& \ \gamma_0 = 0 \text{ otherwise} \tag{4.10}$$

The reason for this time dummy lies in the reform and opening process that China has experienced during the 1990s. Though China started to encourage foreign investment inflows from the establishment of Special Economic Zones in 1979, FDI did not occur on a large scale until the 1990s. Figure 4.3 graphs FDI to GDP ratios during the 1990s. The ratio increased greatly up to 1994, but started to decrease from 1994 to 1996 and the decrease speeded up after 1997. Because of the opening of the Pudong New Area in 1990, the FDI inflow increased dramatically from 1991 to 1993, leading to the sharp increase of the FDI to GDP ratio. Between 1994 and 1996, the FDI inflow kept growing at a steady speed, although not as fast as in the early 1990s. At the same time, GDP was increasing more rapidly, resulting in the reduction of the FDI to GDP ratios. After 1997, due to the influence of the Asian Financial Crisis, the growth rate of FDI dropped. Hence the FDI to GDP ratio dropped more steeply.

Figure 4.3



The 1997 financial crisis reduced not only foreign investment into China, but also China's exports. The change in the international economic environment caused changes in the elasticity of per capita GDP level to capital investment ratio. Based on these changes in the macroeconomic environment, we modify our regression equation to the following equation:

$$\ln(Y/L)_{it} = \alpha_i + \beta_0 \ln(Y/L)_{i,t-1} + \beta_0^* \gamma_0 \ln(Y/L)_{i,t-1} + \beta_1 \ln s_{it} + \beta_1^* \gamma_0 \ln s_{it} + \beta_2 \ln p_{it} + \beta_2^* \gamma_0 \ln p_{it} + \gamma_0 + \varepsilon_{it} \quad (4.11)$$

The results are recorded in table 4.3.

4.6 CONDITIONAL CONVERGENCE

Table 4.3 lists the GMM estimation results. The GMM estimator is considered to be the most efficient and consistent estimator in a dynamic panel-data model. The

estimator is implemented in PcGive 10 following Arellano and Bond (1991). We use lags of more than two years of the dependent variable to construct the Instrumental Variable matrix, and regress on first-differences. Using lagged variables as instrumental variables will reduce endogeneity bias; and the first-difference transformation will reduce omitted-variable bias. A robust variance-covariance matrix is used. Our only assumption is that the error terms are serially uncorrelated.

However, it has been suggested by Monte Carlo simulations that the estimated asymptotic standard errors of the efficient two-step GMM estimator are severely downward biased in small samples. Arellano and Bond (1991) have pointed out the standard errors of the two-step estimation results are not "trustworthy". Windmeijer (2000) suggests a way to correct this bias. First he reveals the source of the bias: "*The weight matrix used in the calculation of the efficient two-step GMM estimator is based on initial consistent parameter estimates...*" However the extra variation due to the presence of these estimated parameters in the weight matrix accounts for much of the difference between the finite sample moment conditions that are linear in the parameters. Then he proposes that "*this difference can be estimated, resulting in a finite sample corrected estimate of the variance.*" Supported by Monte Carlo simulations, this corrected estimate of the variance has been carried out in PcGive 10, giving more accurate two-step GMM standard errors.

Table 4.3 GMM Estimation Results

Ln per capita real GDP_{it}		I		II	
		GMM-1	GMM-2	GMM-1	GMM-2
Ln per capita real GDP_{it-1}		**0.924 (53.6)*** **	**0.927 (79.9)*** **	**0.916 (60.4)*** **	**0.920 (102)*** **
	γ_0	*0.0001 (0.534)*	*0.0001 (-0.071)*	*0.0001 (0.49)*	*0.0001 (0.135)*
Ln total investment in fixed asset to GDP ratio		**0.116 (5.04)*** **	**0.115 (5.37)*** **		
	γ_0	-0.036 (-0.941)	-0.044 (-1.6)		
Ln (total investment in fixed asset + FDI) to GDP ratio				**0.114 (5.80)*** **	**0.113 (5.33)*** **
	γ_0			**-0.048 (-1.74)***	**-0.042 (-2.64)*** **
Ln Population growth		0.032 (0.914)	**0.045 (1.72)***	0.019 (0.644)	0.034 (1.26)
	γ_0	**-0.065 (-1.81)***	**-0.068 (-3.92)*** **	**-0.056 (-1.85)***	**-0.064 (-5.37)*** **
γ_0		**-0.346 (-2.49)** **	**-0.369 (-4.32)*** **	**-0.311 (-2.59)** **	**-0.346 (-6.17)*** **
Sargan test		Chi^2(21) = 19.89 [0.528]		Chi^2(21) =21.17 [0.449]	
AR(1)		N(0,1)=-2.219[0.026]**		N(0,1)=-2.160[0.031]**	
AR(2)		N(0,1) = 0.4139 [0.679]		N(0,1) = 0.3171 [0.751]	
Number of Observations		**202**[3]		**200**[4]	
λ-calculated		**0.0790**	**0.0758**	**0.0877**	**0.0834**
t-calculated		8.77	9.14	7.90	8.31

Note:
***Significant at the 0.01 level.
** Significant at the 0.05 level.
* Significant at the 0.10 level.
t-values in ( ) parenthesis and p-values in [ ] parenthesis.
Both one-step and two-step GMM estimation results are listed.
Sargan and AR(1) and AR(2) tests are based on the two-step results.

[3] 202 = 7 * 29 -1 = 203 – 1: One missing observation since population growth rate for Beijing in 1997 is negative, so the number of observations of $\ln p_{1997}$ is 28.
[4] 200 = 7 * 29 – 3: In addition to the missing observation due to negative population growth in Beijing 1997, Qinghai misses an observation for FDI data in 1998 and Xinjiang misses an FDI observation in 1992.

In the table both one-step and two-step GMM estimation results are listed. Moreover, the entire set of test results, including the Sargan test and AR(1) and (2) tests, are based on two-step estimation results. Before interpreting any estimation results, we must make sure these results make sense by checking these test results. From the Sargan tests, we find that we cannot reject the null hypothesis in the over-identification tests, indicating the validity of the instrumental variables. The AR(1) tests in both groups have negative and significant results while the AR(2) tests have insignificant results, supporting our assumption of serial error un-correlation. Therefore we can interpret the estimation results.

Firstly we look at convergence speed λ, which is calculated by:

$$e^{-\lambda\tau} = \beta_0 \Rightarrow \lambda = -\ln \beta_0 / \tau = -\ln \beta_0 \tag{4.12}$$

And the time needed to reach half way of a province's balanced growth path, t, is calculated by:

$$1 - e^{-\lambda t} = 1/2 \Rightarrow t = {-\ln(1/2)}/{\lambda} = \ln 2 / \lambda \tag{4.13}$$

From table 4.3, β_0 is around 0.92 in both groups and including the time dummy does not obtain significantly different estimation results. Substituting β_0 into equation (4.12) and (4.13), we are going to have a convergence speed around 8% annually, meaning provinces need 8-9 years to reach half way to their own balanced growth paths.

This result is interesting since the convergence speed is much higher than the findings of both Barro and Sala-i-Martin (1990) and Mankiw Romer and Weil (1992). Even though it is close to the 10% convergence speed of Caselli Esquivel and Lefort (1996), the observation that a province needs 8 to 9 years to reach the half way of its balanced growth path indicates the province is close to its own steady state. Therefore,

an important finding is uncovered: transitional dynamics are a less important component of the divergent process that have been documented; steady states moving further away accounts for the increasing inter-provincial inequalities.

Secondly, the time dummy has significantly negative estimation results, showing that economic growth slows down during the period from 1994 to 1996. In addition to intercept changes, the inclusion of our time dummy γ_0 indicates slope changes as well. In group-I, when capital investment is approximated by total investment in fixed assets, the elasticity of the dependent variable with respect to the capital investment/GDP ratio has its coefficient as 11.5% when γ_0 equals 0 and is insignificantly different when γ_0 equals 1. This elasticity is not very much different from the elasticity estimated in group-II when γ_0 equals 0, but the change is now significant. In group-II, capital investment is approximated by total investment in fixed assets plus FDI, and capital investment to GDP ratio has its coefficient as 11.3% in years other than 1994 to 1996, and 11.3–4.2=7.1% coefficient in years between 1994-1996. The reduction with the time dummy indicates the inefficiency of FDI between 1994 and 1996, which coincides with the slow down of FDI inflows. In group I, since the elasticity equals 11.5% from 1991 to 1999, fixed assets to GDP ratio has positive effects to economic growth; in group II, since the elasticity equals 11.3% in years other than (1994, 1996), and equals 7.1% in years from 1994 to 1996, the fixed assets plus FDI to GDP ratio also has positive effects to economic growth. Therefore, the capital investment has positive effects to economic growth.

Finally, the elasticity of provincial economic growth with respect to population growth is also changing across the years. The estimated elasticity equals 4.5% in group-I and becomes insignificant in group-II with time dummy 0, and changes by –6.8% and

-6.4% respectively with time dummy 1. Thus population growth reduces the provincial economic growth rate from 1994 to 1996, but has weakly positive influence outside this period.

In general, provinces converge to their own balanced growth paths at a rate around 8% annually. Capital investment to GDP ratio has positive effects on economic growth while population growth has ambiguous effects.

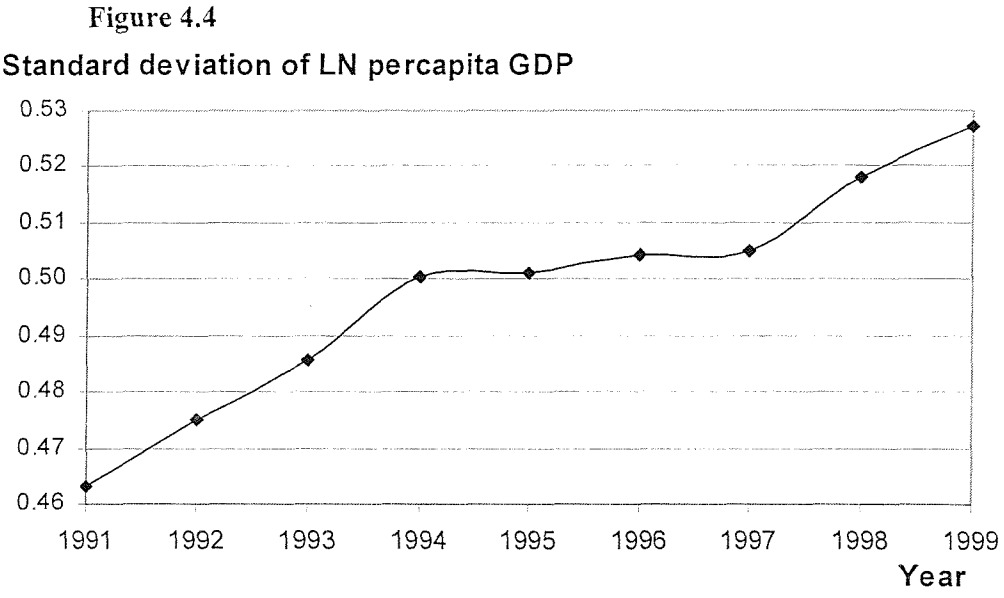
However, these estimation results are not enough for us to tell whether the inter-provincial income gap is increasing or decreasing; in other words, whether the initially poorer provinces are catching up with the richer provinces. This is the shortcoming of panel-data analysis. According to Durlurf and Quah (1998), the use of panel data in convergence arguments could cause misleading conclusions because, if we assume that economies have different initial technology development levels, "*finding a convergence to an underlying steady-state path says nothing about whether catching up occurs between poor and rich.*" They claim that "*By leaving free those individual heterogeneities, the researcher gives up hope of examining whether poor economies are catching up with rich ones*". (p. 52) Nonetheless, we can check whether poor provinces catch up with rich ones by measuring sigma-convergence and absolute beta-convergence.

4.7 SIGMA-DIVERGENCE AND BETA-DIVERGENCE

σ-convergence is measured by income disparity across provinces. When the standard deviation across provinces of the logarithm of a measure of real income, such as GDP per capita, tends to drop over time, there will be σ-convergence. Figure 4.4 graphs the standard deviations of the logarithm of per capita GDP for all 29 provinces.

The line is upward sloping, suggesting the opposite of convergence, which we will call σ-divergence. From 1991 to 1999 inter-provincial inequality is enlarged. Standard deviations here rise from 0.463 to 0.527.

Figure 4.4



Having discovered that provinces in China display sigma-divergence in the national level during the 1990s, we are not certain whether these provinces will display absolute beta-divergence or convergence. According to Sala-i-Martin (1996), beta-convergence is the necessary but not sufficient condition for sigma-convergence. The holding of sigma-convergence will imply the existence of beta-convergence. Furthermore, the same algebra leading to this relationship implies the relationship between sigma-divergence and beta-divergence. Suppose a group of economies i, $i = 1,...N$, have beta-divergence in their annual per capita income growth, which is explained by the following equation:

$$\left\{\ln(y_{it}) - \ln(y_{i,t-1})\right\} = \alpha + \beta \ln(y_{i,t-1}) + \varepsilon_{it} \qquad (4.14)$$

α is a constant and $\beta > 0$ implies beta-divergence. Then real per capita income in year t for economy i can be approximated as

$$\ln(y_{it}) = \alpha + (1+\beta)\ln(y_{i,t-1}) + \varepsilon_{it} \qquad (4.15)$$

It means initially rich economy will tend to grow faster. ε_{it} are the disturbance term with mean zero and variance σ_{ε}^2 for all i and t. The positive beta also implies the evolution of income dispersion,

$$\sigma_t^2 \cong (1+\beta)^2 \sigma_{t-1}^2 + \sigma_{\varepsilon}^2 \tag{4.16}$$

where σ_t^2 measures variance of log per capita income in year t

$$\sigma_t^2 = \frac{\sum_{i=1}^{N} [\ln(y_{it}) - \mu_t]^2}{n} \tag{4.17}$$

and μ_t is the mean of $ln(y_t)$. From equation (4.16), if β is positive, σ_t^2 will increase over time. The standard deviation of log income will also increase over time, which leads to sigma-divergence. This illustrates the logical implication of Sala-i-Martin (1996)'s proposition that sigma-convergence implies beta-convergence: we have directly that beta-divergence implies sigma divergence.

However, it is not clear whether sigma-divergence will lead to beta-divergence or not. Examples in Sala-i-Martin (1996) suggest that the existence of sigma-non-convergence tells one nothing about beta-convergence or divergence. Indeed, sigma divergence might occur because of increases in the $var(\varepsilon_{it})$. So absolute beta divergence is the sufficient but not necessary condition for sigma divergence.

Therefore we have to use cross-section regression to check whether provinces in China display beta-convergence or divergence patterns. Figure 4.5 shows the relationship between the growth rate and year 1991's log per capita GDP. The trend line is upward sloping; indicating that provinces with higher per capita GDP in the initial period have higher growth rates. The OLS equation for this trend line is

$$growthrate = 0.0098 \ln(pcGDP_{i,1991}) + 0.0264 \tag{4.18}$$

For details see table 4.4. Provincial growth rates in per capita GDP are generated by:

$$growthrate_i = \frac{\ln(pcdeflatedGDP_{i,1999}) - \ln(pcdeflatedGDP_{i,1991})}{8} \qquad (4.19)$$

Figure 4.5

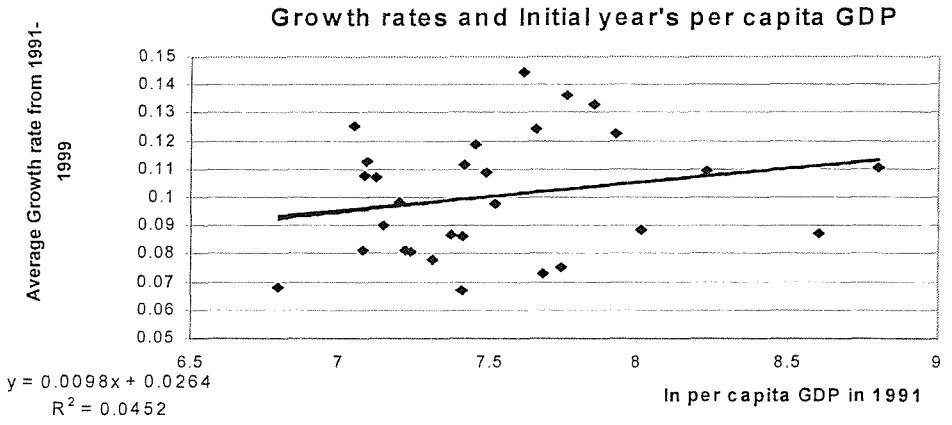


Table 4.4 OLS Estimation Results on Absolute Beta-Divergence.

Dependent variable: Growth rate			
	Coefficient	t	P>|t|
$\ln(pcGDP_{i,1991})$	**0.0098**	**3.50**	**0.001**
Constant	0.0264	1.25	0.214
R-squared	0.0452		

From table 4.4, we could see that coefficient of initial period per capita income is positive and significant, which supports absolute β-divergence, meaning that provinces will not converge to a common steady state. Instead, provinces with higher initial levels in per capita GDP grow faster during the sample years than their poorer counterparts. Thus inter-provincial disparity is increasing during the 1990s.

4.8 CONCLUSIONS

This chapter investigates provincial growth patterns in 29 provinces in China from 1991 to 1999 and explores the convergence issue in inter-provincial income inequality. Using the Solow growth model, we obtain GMM estimates for a dynamic panel-data model to investigate conditional convergence. Capital investment promotes provincial growth while population growth has ambiguous effects on economic growth.

We find that provinces spend around 8 years to reach half way to their own balanced growth paths. Our convergence speed is around 8% annually, indicating different provinces have different steady states. The finding reveals that provinces' steady states are moving further away during the 1990s, which accounts for the enlarging inter-provincial income inequalities. As Boldrin and Canova (2001) put, "*The experience of the USA shows that free trade, common fiscal and monetary policies and free mobility of factors induce income convergence quite quickly.*" (p. 208). Here we observe that institutional rigidity and inter-provincial trade barriers make it difficult to reduce inter-provincial income gap.

In fact, conditional convergence has been predicted by the Solow growth model, since it only predicts convergence after controlling for the determinants of the steady state. Because this convergence tells one nothing about inter-provincial inequalities, we measure sigma and absolute beta-convergence to see whether the inter-provincial gap increased or decreased in the 1990s. Both sigma and absolute beta-divergence suggest that the income gap between provinces does not decrease, that is, poor provinces do not catch up with rich ones. Inter-provincial income inequality grows.

Absolute beta convergence, on the other hand, has been connected with two characteristics of the neo-classical growth model: diminishing returns to scale and the

Inada conditions, both predicting that poor economies tend to grow faster than richer ones. Therefore, the finding of conditional convergence and absolute beta divergence in this chapter is not a contradiction. While provinces conditionally converge to their own steady state paths, no catching up occurs between the poor and the rich.

APPENDIX 4.A:

DERIVATION OF THE SOLOW GROWTH MODEL

To address convergence issues, we first look at the Solow growth model based on a Cobb-Douglas production function:

$$Y_t = K_t^{\alpha}(A_t L_t)^{1-\alpha} \qquad 0 < \alpha < 1 \tag{4A.1}$$

where Y_t is output level, K_t is capital stock and L_t is labor. The term A_t depicts the technology development level while L_t and A_t are assumed to grow at rate n and g respectively:

$$\begin{aligned} L_t &= L_0 e^{nt} \\ A_t &= A_0 e^{gt} \end{aligned} \tag{4A.2}$$

Let $k_t = K_t/A_tL_t$, $y_t = Y_t/A_tL_t$, then the reduced form of the production function is:

$$y_t = \left(\frac{Y_t}{A_t L_t}\right) = \left(\frac{K_t^{\alpha}(A_t L_t)^{1-\alpha}}{A_t L_t}\right) = k_t^{\alpha} \tag{4A.3}$$

If we suppose s is the share of capital investment to output and δ is depreciation rate, then the evolution function of K_t will be:

$$\begin{aligned} & K_{t+1} = K_t(1-\delta) + sY_t \\ \Rightarrow & \frac{dK_t}{dt} = sY_t - \delta K_t \end{aligned} \tag{4A.4}$$

From which we can get:

$$\frac{dk_t}{dt} = \frac{d(K_t/A_tL_t)}{dt} = \frac{A_tL_t \cdot \frac{dK_t}{dt} - K_t\left(\frac{dA_t}{dt}L_t + \frac{dL_t}{dt}A_t\right)}{(A_tL_t)^2} = \frac{sY_t - \delta K_t}{A_tL_t} - \frac{K_t}{A_tL_t}(g+n) \tag{4A.5}$$

$$\Rightarrow \frac{dk_t}{dt} = sy_t - k_t(n+g+\delta) = sk_t^{\alpha} - k_t(n+g+\delta)$$

The steady state value of k_t is determined by

$$\frac{dk_t}{dt} = 0 \Rightarrow k^* = \left[s/(n+g+\delta)\right]^{1/(1-\alpha)} \tag{4A.6}$$

Whenever a shock happens to an economy, say any change in the savings rate or the other parameters of the model, the economy will shift away from its steady state. Our question here is how quickly can the economy come back to its own steady state after the shock; or, to put it another way, how fast does the convergence occur?

We can write down the evolution of the capital stock in equilibrium as:

$$\frac{dk_t}{dt} = \varphi(k_t) \tag{4A.7}$$

where $\varphi(k_t)$ is defined by the right hand side of equation (4A.5). Since it is a non-linear differential equation, we focus on its linear approximation by using the first order Taylor-series approximation of $\varphi(k_t)$ around the steady state k^*:

$$\frac{dk_t}{dt} \approx \frac{dk^*}{dt} + \frac{\partial\varphi(k_t)}{\partial k_t}\cdot(k_t - k^*) + \ldots = 0 + \left[s\alpha k^{*(\alpha-1)} - (n+g+\delta)\right](k_t - k^*) + 0 \tag{4A.8}$$

Since steady state capital per efficient unit of labor k^* satisfies equation (4A.6), which means $\left[sk^{*\alpha} - (n+g+\delta)k^*\right] = 0$, then equation (4A.8) could be written as:

$$\frac{dk_t}{dt} \approx \left[s\alpha k^{*(\alpha-1)} - (n+g+\delta)\right](k_t - k^*) = (\alpha-1)(n+g+\delta)(k_t - k^*) \tag{4A.9}$$

If we let $z_t \equiv (k_t - k^*)$, then $\frac{dz_t}{dt} = \frac{dk_t}{dt} - 0 = \frac{dk_t}{dt}$. Hence equation (4A.9) becomes:

$$\frac{dz_t}{dt} = (\alpha-1)(n+g+\delta)z_t \tag{4A.10}$$

It has a unique solution:

$$z_t = z_{t-\tau}e^{(\alpha-1)(n+g+\delta)\tau} \tag{4A.11}$$

Therefore, we have:

$$k_t - k^* \approx (k_{t-\tau} - k^*)e^{-(1-\alpha)(n+g+\delta)\tau} \tag{4A.12}$$

This result means that the gap between k_t and the steady state value k^* vanishes exactly at the constant rate $(1-\alpha)(n+g+\delta) = \lambda$, say, which is interpreted as the speed of convergence to the steady state. Output per efficiency units of labor y_t approaches y^* at the same rate:

$$\frac{d \ln y_t}{dt} \approx -\lambda[\ln y_t - \ln y^*] \tag{4A.13}$$

Equation (4A.13) implies that $\ln y_t$ approaches $\ln y^*$ exponentially:

$$\begin{aligned} &\ln y_t - \ln y^* \approx e^{-\lambda\tau}[\ln y_{t-\tau} - \ln y^*] \\ &\Rightarrow \ln y_t \approx e^{-\lambda\tau} \ln y_{t-\tau} + (1 - e^{-\lambda\tau}) \ln y^* \end{aligned} \tag{4A.14}$$

We know that steady state output per efficient unit of worker is

$$y^* = k^{*\alpha} = \left[s/(n+g+\delta)\right]^{\alpha/(1-\alpha)} \tag{4A.15}$$

Then we obtain the steady state output per efficient unit of worker:

$$\begin{aligned} &\ln y_t \approx e^{-\lambda\tau} \ln y_{t-\tau} + (1 - e^{-\lambda\tau}) \ln y^* \\ &\Rightarrow \ln y_t = e^{-\lambda\tau} \ln y_{t-\tau} + (1 - e^{-\lambda\tau})\left(\frac{\alpha}{1-\alpha}\right)[\ln s - \ln(n+g+\delta)]. \end{aligned} \tag{4A.16}$$

Hence we can use a dynamic model on the level of per capita GDP as a growth regression.

CHAPTER FIVE

THE COASTAL-INLAND INCOME GAP IN CHINA FROM 1991 TO 1999: THE ROLE OF GEOGRAPHY AND POLICY

Abstract:

We investigate the enlarging coastal-inland income gap in China during the 1990s, using GMM estimation of a Solow growth model. Disaggregating capital investment by source: public, foreign and private: helps to disentangle the effect of policy from those of geography. The impact of public investment on growth is insignificant in our panel data for 29 provinces; that of foreign investment is significant; private investment is the most influential. We also use the distance by railway of each province's capital city to its nearest port city as a proxy for transportation costs, and find significant differences across provinces. Distance has negative effects on economic development but its marginal effects become less as distance increases. The coastal-inland gap will grow in the foreseeable future, if inland region is not able to benefit from an increase in private investment and infrastructure improvements (to reduce transport costs).

5.1 INTRODUCTION

China receives attentions from the world for obvious reasons. It is a transitional economy, turning from plan to market system; it is a country with the largest population and the third largest area in the world. The 9.6 million kilometer-squared land is divided into 31 administrative regions at provincial level, which are comprised of 5 autonomous regions, 4 metropolitan cities and 22 provinces. However, the provinces are very different from each other in terms of geographical locations, natural conditions, cultural features and educational levels, among others. Therefore, the heterogeneity in the provincial development process during the reform period attracts the attention of economists in many aspects. In this chapter, the inequality between coastal region and inland region in economic growth is our subject.

After the inception of economic reform, both coastal region and inland region in China developed very rapidly. However, one of the most distinguishable features of economic development in China is the increasing gap between coastal region and inland region in terms of economic performance. Many facts show that a typical inland province lags far behind as a typical coastal province gets more and more prosperous. Is this due to the geographical location difference?

The relationship between geographical location and economic development has been investigated by many researchers. Typically, controlling for economic policies and institutions, Gallup, Sachs and Mellinger (1998) study the possible channels through which geographical effects can influence economic growth and policy choices. Their finding shows that geography has large influence on economic development via channels such as transportation costs, agricultural productivity, and natural resource endowments among others; while transportation costs are proxied by

CIF/FOB margins in international trade. They suggest that there is no adequate measures of transport costs for a large sample of developed and developing countries and the CIF/FOB margin is the "*best*" that they can obtain. At the same time, geography itself is a factor in the choice of economic policy. On the other hand, Krugman (1998) employs the tension between "centripetal" and "centrifugal" forces acting on economic activity to study this problem. He concluded that different responses to these forces could make relatively similar locations end up with quite different market powers. The above two approaches are compared by Gallup, Sachs and Mellinger (1998), in which they conclude that Krugman's model shows "*how increasing returns to scale, agglomeration economies, transportation costs and product differentiation can lead to a highly differentiated spatial organization of economic activity, even when the underlying physical geography is undifferentiated.*" (p. 12). In particular, the role of "self-enforcing" in spatial patterns is emphasized in his model. However, the starting point in the model of Gallup, Sachs and Mellinger is that, "*the physical geography is in fact highly differentiated*", (p. 12), which has the advantage of matching well for the case of coast-inland studies.

The problem of the enlarging income gap between coastal region and inland region in China has been studied extensively; our summary is not exhaustive. Jian, Sachs and Warner (1996) attribute the convergence phenomenon during the 1980s to the catching up of the initially poorer southern coastal provinces to the initially richer northern coastal provinces. Kanbur and Zhang (1999) compare the urban-rural and the coastal-inland income gap in China during the 1980s and the 1990s. They draw the conclusion that the former has not changed much over time, while the latter has increased several fold and thus becomes the dominant source of income inequality in China after 1990.

Fleisher and Chen (1997) consider that the lower factor productivity of inland region compared with coastal region contributes to the persistent income gap between them, while investment in higher education and the concentration of foreign direct investment (FDI) helps to explain the productivity gap. In another paper, using provincial data for China from 1978 to 1993, Chen and Fleisher (1996) conclude that the income gap between coastal region and inland region is likely to increase in the near future and to focus solely on investment by rural collectives is insufficient to narrow the gap. In Demurger (2001), it is found that geographical locations and infrastructure endowment account significantly for the observed differences in growth performance across China's provinces. In this paper, provincial infrastructure includes both transportation and telecommunication endowments, while transportation costs are represented by averaging transport network density, including railways, highways and inland waterways, across years, at provincial level. Wang and Hu (1999) argue that preferential policies generate higher growth for coastal provinces. Their logic is as follows: first, capital input has positive effects on provincial economic growth; second, foreign capital is an important contributor of capital inputs; third, infrastructure endowments, approximated by the density of transportation routes (including navigable inland waterways, railways and highways in 1990), has insignificant effects on attracting FDI while policy has significant positive effects. Therefore, policy promotes provincial economic growth. However, they use an ordinal variable to reflect the degree of preferential policy, which coincides with the observation that during the period of study, all preferential policies have been applied to coastal provinces only. Therefore, the policy variable also reflects the province's geographical location. This, they admit, may produce erroneous results. More recently,

to explain the causes of the coastal-inland income gap, Demurger et al (2001) employ a model that disentangles policy factors and geographical factors in provincial economic growth and a set of preferential policy indices has been used to capture policy effects on growth. Transportation costs are represented by different variables: the major one is the proportion of provincial population in 1994 living within 100 kilometers of the coast or navigable rivers; the others include distance from the coast, percentage of area within a province with a slope higher than 10%, average slope of a province and average elevation. Since both policy and geography variables are statistically significant, they conclude that, in contrast to Wang and Hu (1999), the absence of favored polices in the coastal region would not affect the economic growth rates of both the coastal region and the inland region.

It is noted that both of the last two papers consider policy effects, yet different methods are employed for the analysis and different results have been obtained. In fact, the advantages of coastal region relative to inland region in China arise not only from their easier access to and cheaper transportation costs when accessing both international and domestic markets, but also from more favored conditions granted by "open door" policies. This suggests that policy should play an important role in the economic development process. Therefore, in this chapter, apart from geographical factors, the policy factor is also taken into consideration, and we attempt to disentangle the influences of these two factors. In particular, the policy influence has been picked up by provincial distribution of capital investment in different ownership structures; while the geographical influence has been picked up by railway distance from each province's capital city to its nearest port city. These two methods are explained in detail as follows.

Firstly, it has been shown in Wang (2004) that capital investment has a positive and significant effect on provincial economic growth. Thus, the more investment in physical capital a province receives the higher economic growth rate it will achieve. However, the different performance of different ownership structures might not be captured by this aggregated capital investment, which is represented by total investment in fixed assets. Therefore, in order to capture the different effects exhibited by different ownerships on economic growth, we disaggregate capital investment in accordance with its ownership structure. The decomposition relaxes the underlying assumption that different ownership structures of capital investment affect economic growth to the same degree. Thus we will investigate the different impacts of the components of capital investment, on provincial economic growth; foreign, domestic private and public investments are the components we consider. Furthermore, the geographical distribution of disaggregated capital investments has been affected by government policies to a large extent. In particular, the open door policy has granted coastal region more favored conditions than inland region to attract foreign investment; this has contributed to the concentration of foreign investment in the coastal region. On the other hand, public investment has been decided and allocated by both the central and local governments, therefore it is more evenly distributed between the coastal region and the inland region. Thus, distinguishing public investment from other investment removes some of the overlap between policy and geographical effects.

Secondly, a comparison of the freight handling ability of China's three most important transportation methods is shown in table 5.1. It shows that waterway is the largest carrier; however, distance by water is not a good indicator for transportation cost since provinces far from rivers cannot benefit from water transport. Highway

transport is becoming more and more important but distances by road and railway are highly correlated. Road improvements and the building of "expressways" reduce transport costs; but unless one disaggregate by product, it is not easy to model the effects of the evolving combination of transport modes. Therefore, as a first approximation we use railway mileage as proxy for transportation cost; it is thence assumed that transportation costs for a province can be proxied by the distance (by railway) between the province's capital city and its nearest port city. Such a distance can be used to model part of the cost of investment goods.

Table 5.1 Freight Ton-Kilometers

(100 million ton-km)

Year	Railways	Highways	Waterways
1991	10972.00	3428.00	12955.40
1992	11575.55	3755.39	13256.20
1993	11954.64	4070.50	13860.80
1994	12457.50	4486.30	15686.60
1995	12870.25	4694.90	17552.20
1996	12970.46	5011.20	17862.50
1997	13253.30	5271.50	19235.00
1998	12517.07	5483.38	19405.80
1999	12838.40	5724.30	21263.00

Therefore the objective of this chapter is to investigate the persistence and the widening of the gap between coastal region and inland region by disentangling policy effects from geographical factors, which are captured by capital investment distribution and railway distance, respectively. In particular, we hope to uncover their roles in shaping the patterns of the coastal-inland gap in the 1990s. While policy

liberalization started in the previous decade, the relaxation was greatly increased in the 1990's, as were its effects: hence the choice of the period. The structure of this chapter is as follows. First, the coastal-inland gap in the 1990s is described in section-II. Secondly, the geographical distribution of disaggregated capital investments is illustrated in section-III, to give a better understanding of the different performances by different capital investment across provinces. Thirdly, in section-IV, we introduce our model and present an empirical analysis of disaggregated capital investments by taking account of geographical factors. The results show that firstly, different ownership exhibit different influences on economic development; the roles of public, foreign and domestic private investment will be discussed in detail. Secondly, distance displays negative effects on economic income level, but at a decreasing rate as distance increases. And finally, the conclusions are given in section-V.

5.2 THE COASTAL-INLAND INCOME GAP DURING THE 1990S

There are 12 provinces along the East Coast of China, including three metropolitan cities: Shanghai, Beijing and Tianjin; and nine provinces: Hebei, Liaoning, Jiangsu, Zhejiang, Fujian, Shandong, Guangdong, Guangxi and Hainan. Among the other 19, inland, provinces, 9 are located in the middle part of China, which covers Shanxi, Inner Mongolia, Jilin, Heilongjiang, Anhui, Jiangxi, Henan, Hubei and Hunan; while the other 10 provinces belong to the western part; these are Chongqing (the fourth metropolitan city), Sichuan, Guizhou, Yunnan, Shaanxi, Gansu, Qinghai, Ningxia, Xinjiang and Tibet. As in Chapter Four, it is noted that Tibet is excluded from our analysis for lack of data; while Chongqing is included in Sichuan Province, since its identity has been changed from an ordinary city to a metropolitan city only after 1997.

In sum, we are going to deal with 29 provinces, for which 12 belong to the coastal region and 17 belong to the inland region; the latter comprises 9 from the middle and 8 from the western part.

Figure 5.1

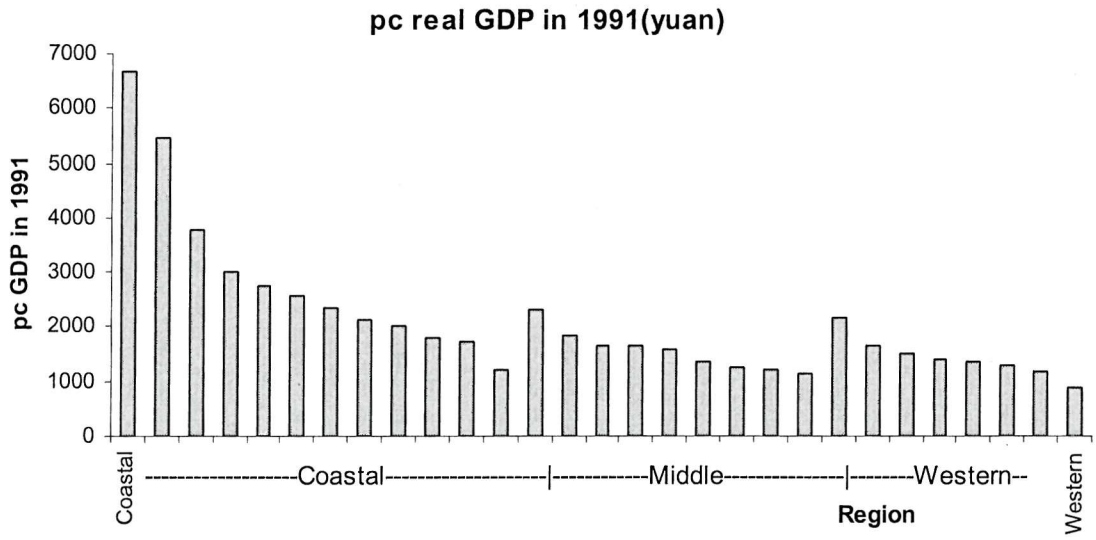
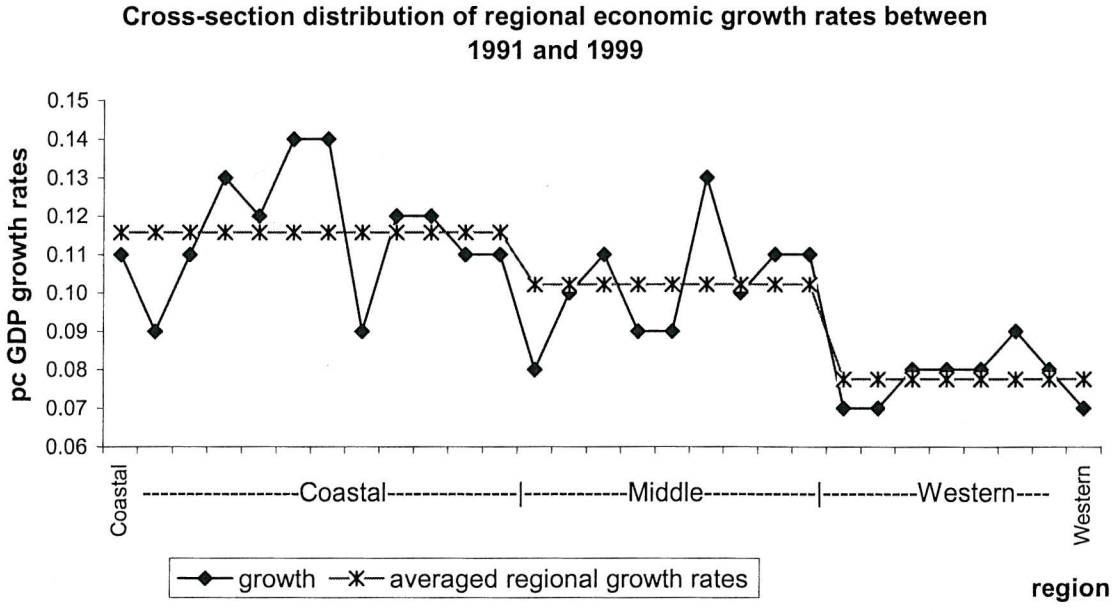


Figure 5.2



The coast-inland income gap today may be divided into two components: the initial income gap and the growth rates of different regions. Therefore, to show the initial income gap, the per capita real GDP of each province in 1991 is depicted in figure 5.1 by the provinces' geographical locations. The data used are from the China Statistical Yearbooks for various years and cover the period 1991 – 1999. Obvious regional disparities can then be observed from the figure as per capita GDP level decreases from east coast to west inland

On the other hand, when looking at the growth rates, which are calculated as the averages of the differences in (natural) logarithm of per capita GDP between the initial and final years, figure 5.2 shows that most provinces in coastal region grow faster than provinces in inland region. For example, three coastal provinces: Fujian, Jiangsu and Zhejiang, whose per capita GDP grows at 14.44%, 13.64% and 13.28% per year respectively, exhibit the fastest growth rates in the 1990s. All eight western provinces grow at the slowest rate. The only inland province that grows as quickly as the top five fastest provinces in China is Anhui province, which is located in the middle part of China. It is also noted that Liaoning province displays the slowest growth rate within coastal region. As the northeast industrial center and the base for state owned enterprises (SOEs), such a disappointing performance indicates the plight of SOEs, and this will be further explained below.

These two figures well exhibit the coast-inland income gap in the 1990s. In summary, coastal provinces grow at faster rates, which further enlarge the coastal-inland income gap when combined with higher initial income levels.

Furthermore, the above inter-regional inequality can be examined more accurately by employing the concept of sigma convergence. Jian *et al* (1996) apply this concept to

investigate the tendency towards convergence among China's provinces from 1952 to 1993. Their results show that evidence for sigma *convergence* is weak during the period 1952-1965 and strong between 1978-1990, while strong evidence of sigma *divergence* can be seen during both 1965-1977 and 1990-1993. The divergence from 1990-1993, as they claimed, is entirely caused by the enlarged variance *between* coastal region and inland region, not *within* each region. Therefore, they concluded that provinces within coastal region display sigma convergence, while the coastal-inland gap keeps increasing. Following this method, sigma convergence is also analyzed in this chapter by using provincial data in China from 1991 to 1999, which is illustrated in figure 5.3. The standard deviations of provincial logarithm of per capita real GDP from 1991 to 1999 within coastal region, within inland region, between coastal region and inland region and the aggregated are represented by *sigma-coast*, *sigma-inland*, *sigma-between* and *sigma-aggregated*, respectively. They are related as follows. The total sum of squared deviations (of log per capita GDP) can be decomposed into the sum of squares within each region (coastal and inland) plus the sum of squares between them. Each sum of squares (coastal, inland, between) yields a standard deviation (details see Appendix 5.A). Firstly, it can be observed that the largest component of *sigma-aggregated* is *sigma-coast*, while all four sigmas have a similar slight upward trend from 1995 onwards. Secondly, before 1995 the patterns are different: there was an obvious convergence within coastal region when sigma-inland displayed a flat line. Thirdly, the sigma-between possesses a similar upward trend as the sigma-aggregate. In general, the enlarged gap between coastal region and inland region leads to the aggregated divergence during the 1990s. The within-inland gap increases slightly while the within-coast gap reduces during the whole 1990s.

A variance decomposition table for this figure is displayed in table 5.2, which provides the exact values for the four curves.

Figure 5.3

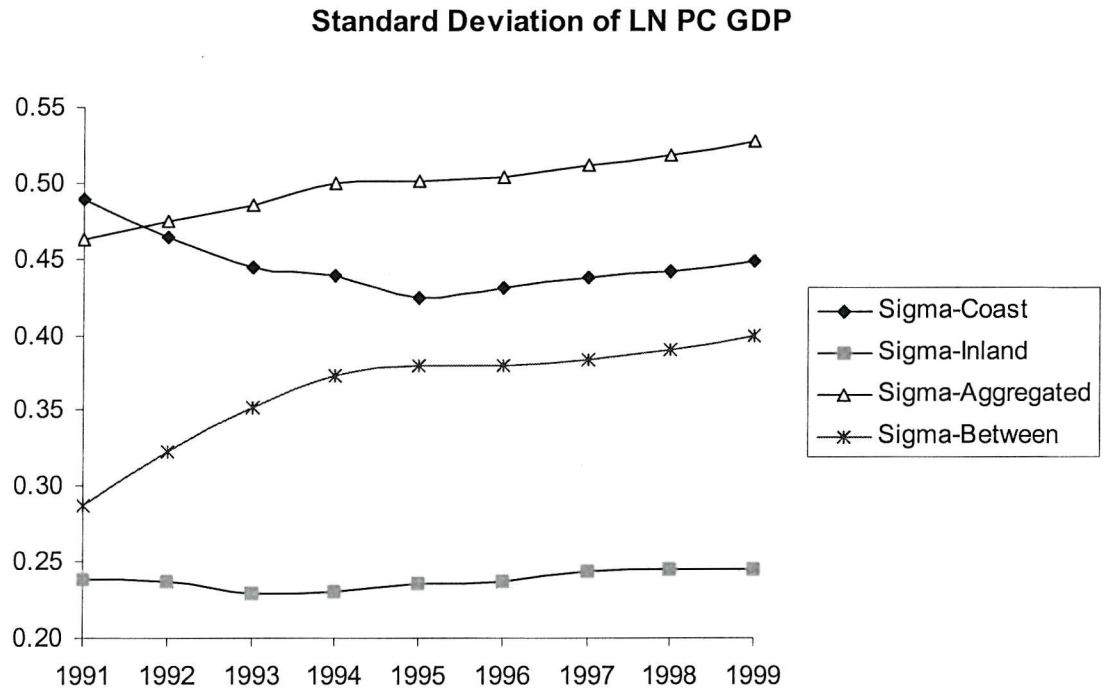


Table 5.2 Variance Decomposition for Figure 5.3

Year	σ-Coast	σ-Inland	σ-Between	σ-Aggregate
1991	0.489	0.239	0.287	0.463
1992	0.464	0.236	0.322	0.475
1993	0.444	0.229	0.351	0.486
1994	0.439	0.231	0.373	0.500
1995	0.424	0.235	0.380	0.501
1996	0.431	0.237	0.379	0.504
1997	0.438	0.243	0.384	0.511
1998	0.442	0.245	0.391	0.518
1999	0.448	0.245	0.399	0.527
Change rate	-8.4%	2.4%	13.8%	39.3%

5.3 GEOGRAPHICAL DISTRIBUTION OF DISAGGREGATED CAPITAL INVESTMENTS

The issue of ownership indeed attracts special attention in the literature addressing economic growth in China. Berthelemy and Demurger (2000) regard the transfer of foreign technology as the key factor determining economic growth. Yet they also suggest that economic growth might simultaneously influence the inflows of foreign capital. Chen, Chang and Zhang (1995) find that FDI, lagged one year, has a positive effect on economic growth. Dees (1998) supports the view that FDI affects China's economic growth through the diffusion of ideas; while Wei (1996) concludes that FDI has a weak positive effect on economic growth. On the other hand, in a project supported by the Asian Development Bank, Mao and Zhang (2001) look into the relationship between the employment share of private enterprises and per capita GDP using 30 provinces' data in 1999 for China. They conclude that private sector development is very much associated with provincial income level and promotes provincial economic growth. The latter conclusion has also been drawn by both Chen and Feng (2000) and Qian, Weingast and Cao (1999). However, it is pointed out that public investment has not been efficiently allocated or allocated to produce at a profitable scale, by some researchers such as Chen and Feng (2000); they find the presence of SOEs reduces the provincial economic growth rate.

The decomposition of capital investment is shown in table 5.3. Total investment in fixed assets is disaggregated into public, foreign and domestic private investment. Public investment includes investments in fixed assets by SOEs and Collective-Owned Enterprises (COEs). Foreign investment refers to investments in fixed assets by Foreign-

Owned Enterprises (FOEs) and Overseas Chinese-Funded Enterprises (OCEs). Domestic private investment refers to all private investments without foreign ownership.

Table 5.3 Ratios of Disaggregated Capital Investments to GDP

s : ratio of capital investment to total GDP.	
Lnssc = ln((total investment in fixed assets by SOEs + COEs) / total GDP)	(Log) Ratio of **Public** investment to GDP
lnsf = ln((total investment in fixed assets by FOEs + OCEs) / total GDP)	(Log) Ratio of **Foreign** investment to GDP
lnsr = ln(The rest of total investment in fixed assets / total GDP)	(Log) Ratio of **Domestic private** investment to GDP

When examining the distribution of disaggregated capital investments in China, it has been pointed out that the most noticeable feature is the concentration of foreign investment in coastal region: thus OECD (2000), "*From 1983 to 1998, FDI in the eastern region took up 87.8 percent while the central region attracted 8.9 percent and the western region recorded only 3.3 percent.*" (p. 8). However, the distribution of public and domestic private investment is not given explicitly. In order to investigate this problem, table 5.4 lists simple averages of the ratios of the capital investment in fixed assets to GDP across the 1990s, for coastal region and inland region. From this table, firstly we see that all kinds of investments have higher ratios in coastal region except investment made by SOEs. In fact, the exception can be ascribed to a political reason: SOEs are allocated by the central and local governments. Before economic reform, inland region was more favored for the establishment of SOEs since it is further away from the outside world, thus reducing the risks induced by any possible conflicts between China and other countries. However, locating SOEs in inland region turned out

to be a disadvantage when trying to attract private investments (both foreign and domestic) after China adopted the open door policy. There is such a slow development of private investment in the inland region that public investment, especially investment from SOEs, continues to be the major contributor of capital investment.

While public investment is mainly undertaken by SOEs, the ratio of public investment to GDP in inland region is slightly lower than in coastal region. This is because investment by COEs in coastal region has a ratio to GDP more than double that in inland region. Investment made by collective-owned enterprises is defined as part of public investment. Nonetheless, COEs' development contains the development process of towns-and-village-owned enterprises, a large percentage of which are essentially private owned enterprises. These private owned enterprises wore a protection color of collective ownership to avoid any political risk and to obtain any economic convenience in the early stages of economic reform. So investment made by COEs is relatively higher in coastal region, which is very different from the SOEs' investment pattern. Therefore, COEs exhibit more clearly the characteristic of "non-state" ownership, rather than "public ownership".

Table 5.4 Capital Investments in Fixed Assets to GDP Ratio (1991-1999)

	Coastal (Ratio)	Inland (Ratio)	Ratio (Coastal/inland)
Total investment in fixed assets to GDP	0.370	0.298	1.243
Public investment to GDP	0.261	0.231	1.128
SOEs investment to GDP	0.202	0.207	0.976
COEs investment to GDP	0.059	0.025	2.397
Foreign investment to GDP	0.056	0.012	4.542
Foreign-funded enterprises to GDP	0.039	0.009	4.465
Overseas Chinese-funded enterprises to GDP	0.017	0.004	4.743
Domestic private investment to GDP	0.071	0.062	1.160

Secondly, besides influencing SOEs' investment distribution patterns, government policy has also affected the foreign investment distribution pattern to a large extent. As shown in table 5.4, coastal region receives relative to GDP almost 4 times the foreign investment that inland region receives. The argument that the open door policy plays an important role in determining the geographical distribution of foreign investment is based on official statements with respect to the open door policy and the economic reform process: there was almost no foreign capital investment in China before economic reform. During the economic reform period, the establishment of Special Economic Zones (SEZs), economic and technology development zones (ETDZs) and the Pudong New Development Area has boosted foreign capital investment inflows. All the provinces that benefit greatly by the open door policy are located along the coast.

For example, two coastal cities, Guangzhou and Shanghai, take the lead in both economic development and attracting foreign investments. The reasons that they are favored by foreign investors are not only their easier access to the international market, but also their leading roles in China's open door process to the outside world. Their easier access to the international market is because both of them are major port cities and have close relationships with Hong Kong, Macao and Taiwan. Further their leading roles are clear from the fact that Guangdong Province has three out of four SEZs while Shanghai has the biggest open area in China – Pudong. Hence the high share in foreign investment of these two provinces may be attributed to their favored conditions granted by the open door policy.

On the other hand, compared with the concentration of foreign investment in coastal region, SOEs' investment and domestic private investment distribute rather evenly at national level. This different geographical distribution pattern should be attributed to the less favored policy that inland region receives. In general, coastal region receives a considerably higher share of capital investment than inland region, which would account for higher economic growth.

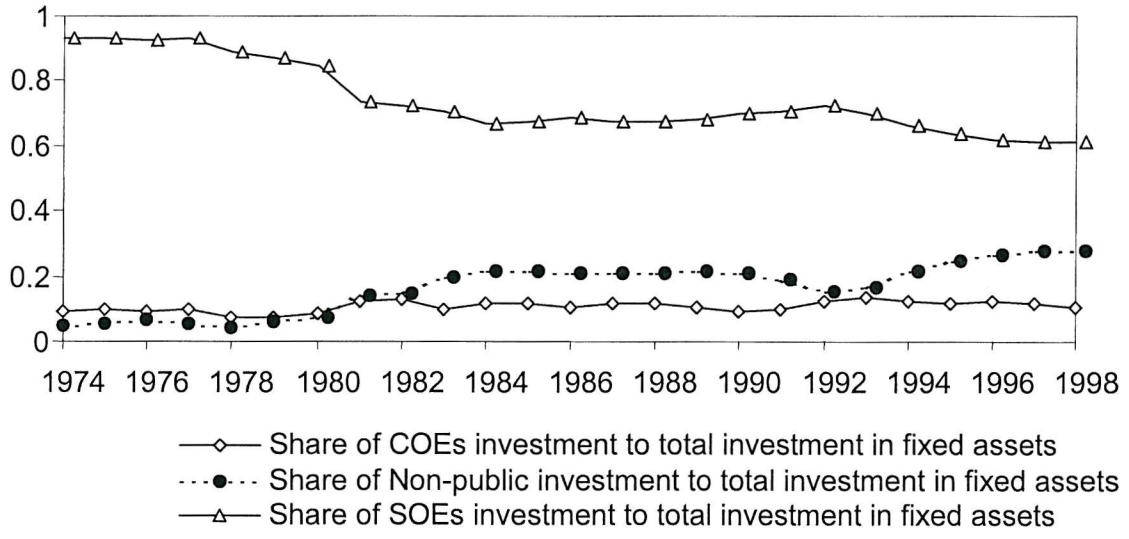
Table 5.5 shows the Spearman rank correlations between the ratios of total investment to GDP and other forms of capital investment. The ratio of total investment to GDP has its highest rank correlation with ratio of public investment to GDP. This is not surprising bearing in mind that public investment composes the biggest share of total investment in fixed assets. To support such an argument, the shares of investment by different ownership structures in different years is illustrated in figure 5.4, from which it can be seen that the share of public investment is still more than 2/3 of the total

investment even though it decreases across the whole of the 1990s. The detailed argument for this rank correlation test is in Appendix 5.B.

Table 5.5 Spearman Test

	Total investment to GDP ratio	
	Spearman's rho N = 29	**Test of Ho: two variables are independent Prob > |t| =**
Public investment to GDP ratio	**0.9089**	**0.0000**
SOEs investment to GDP ratio	**0.6394**	**0.0002**
COEs investment to GDP ratio	0.3360	0.0748
Foreign investment to GDP ratio	**0.4163**	**0.0247**
Investments made by FOE	**0.4567**	**0.0128**
Investment made by Overseas-Chinese	**0.4793**	**0.0085**
Domestic Private investment to GDP ratio	0.0443	0.8194

Figure 5.4 Share of investment by different ownership structure



Data Source: "Comprehensive Data and Materials on 50 Years of New China", State Statistical Bureau, 1999.

From the above analysis, we may conclude that policy is a determining factor in the distribution patterns of the disaggregated capital investments. In particular, an egalitarian policy shaped the distribution pattern of public investment before the economic reform. The open door policy leads to the highly concentrated distribution of foreign investment after the reform. Thus it is appropriate to use the geographical distribution of the disaggregated capital investments as a proxy for policy influence.

5.4 EMPIRICAL MODELING AND APPLICATION

To trace factors leading to the enlarging coastal-inland income gap, first we consider the sources leading to the provincial economic growth patterns. Since coastal region and inland region receives a different distribution of capital investment in different ownership, the disaggregation allows us to investigate the different roles displayed by the various ownership structures in shaping income inequality. Moreover, the geographical distribution of capital investment is very much influenced by policies. Thus, the different geographical distribution of ownership is capable of capturing different policies that government applies to different provinces.

On the other hand, we use distance by railway, from each province's capital city to its nearest port city, as a measure for provinces' geographical locations; more specifically, to see whether a province is far from coastline or not. From table 5.6 of the railway distances between major Chinese cities, four coastal cities have been picked out as the major port cities – Tianjin, Shanghai, Guangzhou and Haikou, for the analysis. The first three are the large port cities with great freight handling capabilities; the selection is straightforward. The fourth one – Haikou is chosen as it is the capital city of an island province – Hainan. Since Hainan has no railway connections with other parts

of China, Haikou is in fact the only choice as the port city for the international trade of Hainan province, especially when railway distance is chosen as the major transportation means. The further away a province is located from these port cities, the higher transportation costs will be, and thus the harder it will be for such a province to gain foreign investment. Table 5.7 gives railway distance of the capital cities to their nearest port city.

Table 5.6 Railway Distance Between Capital Cities.

Unit (km)

		1	2	6	7	8	15	12	10	9	11	14	13	3	16	17	18	19	20	26	27	28	30	22	23	24	4	5	29
1	Beijing	0	137	741	1046	1288	497	1074	1160	1463	1589	1449	2334	277	689	1225	1583	2289	2561	1159	1811	2092	3768	2042	2539	3178	514	667	1343
2	Tianjin	137	0	707	1012	1354	360	973	1023	1326	1452	1444	2197	419	831	1367	1725	2431	2703	1301	1948	2235	3911	2185	2681	3320	650	804	1480
6	Shenyang	741	707	0	305	547	1067	1680	1730	2033	2159	2151	2904	1126	1538	1972	2330	3036	3411	1906	2552	2839	4515	2789	3286	3925	1255	1408	2084
7	Changchu	1046	1012	305	0	242	1372	1985	2035	2355	2464	2456	3209	1431	1843	2277	2635	3341	6313	2211	2962	3144	4820	3094	3591	4230	1560	1713	2389
8	Harbin	1288	1354	547	242	0	1614	2227	2277	2577	2706	2689	3451	1673	2085	2519	2877	2928	3855	2453	3099	3386	5062	3336	3833	4472	1802	1955	2631
15	Jinan	497	360	1067	1372	1614	0	613	663	966	1092	1137	1837	301	666	1202	1560	2151	2538	1177	1853	2069	3745	2019	2516	3119	532	1164	1840
12	Hefei	1074	973	1680	1985	2227	613	0	312	615	451	478	1196	914	645	1181	1222	1826	2098	1156	1832	2048	3724	1998	2076	3098	1145	1777	2002
10	Nanjing	1160	1023	1730	2035	2277	663	312	0	303	429	838	1174	964	695	1231	1200	1804	2076	1206	1182	2098	3774	2048	2054	2693	1195	1827	2052
9	Shanghai	1463	1326	2033	2335	2577	966	615	303	0	201	837	1173	1267	998	1230	1199	1803	2075	1509	2185	2401	4077	2351	2053	3069	1498	2130	2355
11	Hangzhou	1589	1452	2159	2464	2706	1092	451	429	201	0	636	972	1393	1124	1029	998	1602	1874	1635	2311	2527	4065	2552	1852	2868	1624	2256	2481
14	Nanchang	1449	1444	2151	2456	2689	1137	478	838	837	636	0	622	1293	927	391	418	1022	1294	1412	2088	2304	4391	2239	1272	1911	1944	2674	2258
13	Fuzhou	2334	2197	2904	3209	3451	1837	1196	1174	1173	972	622	0	1915	1549	1013	984	1588	1860	2389	3065	3281	4957	2805	1838	2477	2521	3303	3235
3	Shijiazhua	277	419	1126	1431	1673	301	914	964	1267	1393	1293	1915	0	412	948	1306	2012	2282	923	1599	1815	3491	1765	2262	2901	231	871	1547
16	Zhengzho	689	831	1538	1843	2085	666	645	695	998	1124	927	1549	412	0	536	894	1600	1870	511	1187	1403	3079	1353	1850	2489	577	1362	1357
17	Wuchang	1225	1367	1972	2277	2519	1202	1181	1231	1230	1029	391	1013	948	536	0	358	1064	1336	1047	1723	1939	3615	1737	1314	1953	1179	1898	1893
18	Changsha	1583	1725	2330	2635	2877	1560	1222	1200	1199	998	418	984	1306	894	358	0	706	978	1405	2081	2297	3973	1923	956	1595	1537	2256	2251
19	Guangzho	2289	2431	3036	3341	2928	2151	1826	1804	1803	1602	1022	1588	2012	1600	1064	706	0	1334	2111	2787	3003	4679	2527	1560	2199	2243	2962	2957
20	Nanning	2561	2703	3411	6313	3855	2538	2098	2076	2075	1874	1294	1860	2282	1870	1336	978	1334	0	2383	3059	3275	4951	1832	865	1504	2515	3234	3229
26	Xian	1159	1301	1906	2211	2453	1177	1156	1206	1509	1635	1412	2389	923	511	1047	1405	2111	2383	0	676	892	2568	842	1809	1942	651	1291	846
27	Lanzhou	1811	1948	2552	2962	3099	1853	1832	1182	2185	2311	2088	3065	1599	1187	1723	2081	2787	3059	676	0	216	1892	1172	2139	2272	1327	1144	468
28	Xining	2092	2235	2839	3144	3386	2069	2048	2098	2401	2527	2304	3281	1815	1403	1939	2297	3003	3275	892	216	0	2108	1388	2355	2488	1543	1360	684
30	Urumqi	3768	3911	4515	4820	5062	3745	3724	3774	4077	4065	4391	4957	3491	3079	3615	3973	4679	4951	2568	1892	2108	0	3026	3993	4126	3219	3036	2008
22	Chengdu	2042	2185	2789	3094	3336	2019	1998	2048	2351	2552	2239	2805	1765	1353	1737	1923	2527	1832	842	1172	1388	3026	0	967	1100	1493	2133	1342
23	Guiyang	2539	2681	3286	3591	3833	2516	2076	2054	2053	1852	1272	1838	2262	1850	1314	956	1560	865	1809	2139	2355	3993	967	0	639	2460	3100	2309
24	Kunming	3178	3320	3925	4230	4472	3119	3098	2693	3069	2868	1911	2477	2901	2489	1953	1595	2199	1504	1942	2272	2488	4126	1100	639	0	2593	3233	2442
4	Taiyuan	514	650	1255	1560	1802	532	1145	1195	1498	1624	1944	2521	231	577	1179	1537	2243	2515	651	1327	1543	3219	1493	2460	2593	0	640	1316
5	Hohhot	667	804	1408	1713	1955	1164	1777	1827	2130	2256	2674	3303	871	1362	1898	2256	2962	3234	1291	1144	1360	3036	2133	3100	3233	640	0	676
29	Yinchuan	1343	1480	2084	2389	2631	1840	2002	2052	2355	2481	2258	3235	1547	1357	1893	2251	2957	3229	846	468	684	2008	1342	2309	2442	1316	676	0

Table 5.7 Railway Distance Between Capital Cities and The Nearest Port City

(000 km)

Capital city	Province	Nearest Port City	Distance
Beijing	Beijing	Tianjin	0.137
Tianjin	Tianjin	Tianjin	**0.001**
Shijiazhuang	Hebei	Tianjin	0.419
Taiyuan	Shanxi	Tianjin	0.65
Hohhot	Inner Mongolia	Tianjin	0.804
Shenyang	Liaoning	Tianjin	0.707
Changchun	Jilin	Tianjin	1.012
Harbin	Heilongjiang	Tianjin	1.354
Shanghai	Shanghai	Shanghai	**0.001**
Nanjing	Jiangsu	Shanghai	0.303
Hangzhou	Zhejiang	Shanghai	0.201
Hefei	Anhui	Shanghai	0.615
Fuzhou	Fujian	Shanghai	1.173
Nanchang	Jiangxi	Shanghai	0.837
Jinan	Shandong	Tianjin	0.36
Zhengzhou	Henan	Tianjin	0.831
Wuchang	Hubei	Guangzhou	1.064
Changsha	Hunan	Guangzhou	0.706
Guangzhou	Guangdong	Guangzhou	**0.001**
Nanning	Guangxi	Guangzhou	1.334
Haikou	Hainan	Haikou	**0.001**
Chengdu	Sichuan	Tianjin	2.185
Guiyang	Guizhou	Guangzhou	1.56
Kunming	Yunnan	Guangzhou	2.199
Xian	Shaanxi	Tianjin	1.301
Lanzhou	Gansu	Tianjin	1.948
Xining	Qinghai	Tianjin	2.235
Yinchuan	Ningxia	Tianjin	1.48
Urumqi	Xinjiang	Tianjin	3.911

This chapter resorts to the Solow growth model to study the influences of policy factors and geographical factors on provincial economic growth patterns. First we look at the Solow growth model based on a Cobb-Douglas production function:

$$Y_t = K_t^{\alpha}(A_t L_t)^{1-\alpha} \qquad 0 < \alpha < 1 \tag{5.1}$$

where Y_t is the output level, K_t is the capital stock, L_t stands for labor, and A_t represents the technological development level. L_t and A_t are assumed to grow at rates n and g respectively. As derived in Chapter Four, but omitting time effects, the dynamic model of the level of per capita GDP is:

$$\ln(Y/L)_{it} = \alpha_i + \beta_0 \ln(Y/L)_{i,t-1} + \beta_1 \ln p_{it} + \beta_2 \ln s_{it} + \varepsilon_{it} \tag{5.2}$$

Suppose s is the share of savings to GDP and p stands for population growth rate, we also assume that investment in each province consists of a fixed part of investment due to fixed costs and an additional part of investment due to transportation costs, then distance plays its role through the influence on transportation costs in our model:

$$I(t) = sY(t) = FC + DC \tag{5.3}$$

in which FC stands for the fixed costs and DC stands for the transportation costs.

From the above equation, we can derive

$$s = \frac{FC + DC}{Y} = \frac{FC}{Y} + \frac{DC}{Y} = s_1 + s_2 . \tag{5.4}$$

Thus taking logs of the above gives

$$\ln s = \ln(s_1 + s_2) = \ln[s_1 \times (1 + \frac{s_2}{s_1})] = \ln s_1 + \ln(1 + \frac{s_2}{s_1}) \approx \ln s_1 + (\frac{s_2}{s_1}) - \frac{1}{2}(\frac{s_2}{s_1})^2$$

$$\text{for all } \frac{s_2}{s_1} < 1 . \tag{5.5}$$

It is reasonable to suppose $s_2/s_1 < 1$ considering that the transportation costs normally will not surpass the fixed costs for a specific investment project. Now substituting the investment equation (5.5) into equation (5.2) gives

$$\ln(Y/L)_{it} = \alpha_i + \beta_0 \ln(Y/L)_{i,t-1} + \beta_1 \ln p_{it} + \beta_2[\ln s_{1i,t} + \frac{s_2}{s_1} - \frac{1}{2}(\frac{s_2}{s_1})^2] + \varepsilon_{it} \quad (5.6)$$

In the above model, α_i represent the unobserved provincial characteristics such as cultural features, economic development levels, *et al*; *Y/L* stands for per capita real GDP at 1990's prices, which is used to measure provincial income. GDP indices are used to deflate GDP in current price to 1990 constant prices. Total investment in fixed assets is the proxy for capital investment. Its ratio to GDP, represented by s_1, is further disaggregated by its ownership structure. s_2/s_1, which is the ratio of transportation costs to fixed costs, is proxied by the railway distance from each province's capital city to its nearest port city. This railway distance variable is measured in 1000 km. For example, Urumqi, the capital city of Xinjiang Autonomous Region that has the longest distance from its nearest port city, is measured to be 3.911 (×1000 km) roughly. On the other hand, it is noted that the distance of all the four port cities on their own are specified as 0.001 (×1000 km), since being a port city does not mean zero transportation cost, though this cost might be rather less.

Our time dummy is set to be 1 if years are between 1994 and 1996 and 0 otherwise, that is

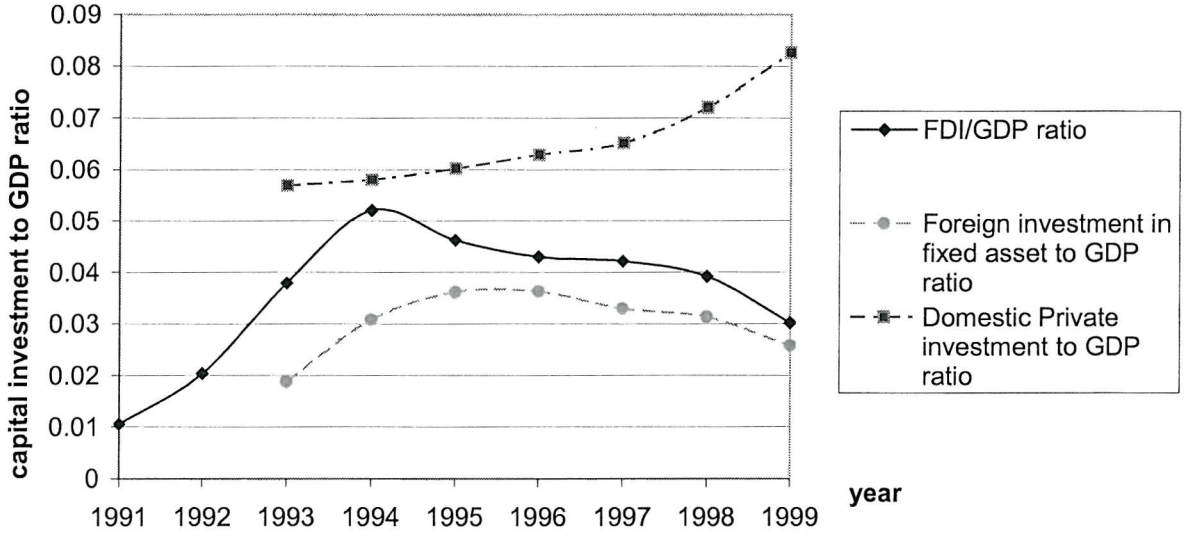
$$\gamma_0 = 1 \text{ if years} \in [1994, 1996] \quad \& \ \gamma_0 = 0 \text{ otherwise} \quad (5.7)$$

Allowing for one-year lag, our estimation starts from 1994 since data for foreign investment starts from year 1993. We choose 1996 as the transition year as the Asian Financial Crisis happened in 1997, which had affected the inflow of foreign investment

into China significantly. As demonstrated in figure 5.5, both the FDI to GDP ratio and the foreign investment to GDP ratio decrease faster after 1997, while only the domestic private investment ratio shows an upward trend and increases even faster afterwards.

Figure 5.5

Time series distribution of capital investment ratio by Foreign and Domestic Private sectors



Based on these observations, those changes are then captured by modifying our regression equation (5.6) to be

$$\ln(Y/L)_{it} = \alpha_i + \beta_0 \ln(Y/L)_{i,t-1} + \beta_1 \ln p_{it} + (\beta_{2sc} + \beta^*_{2sc}\gamma_0)\ln ssc_{it} + (\beta_{2f} + \beta^*_{2f}\gamma_0)\ln sf_{it} + (\beta_{2r} + \beta^*_{2r}\gamma_0)\ln sr_{it} + \beta_3 \frac{s_2}{s_1} - \beta_4 \frac{1}{2}(\frac{s_2}{s_1})^2 + \varepsilon_{it} \quad (5.8)$$

GMM estimation has been carried out using PcGive 10. This estimator follows Arellano and Bond (1991), which was then modified by Windmeijer (2000) to correct the standard errors generated by the two-step GMM estimator. Lags of more than two years of the dependent variable are employed to construct the GMM IV matrix, which reduces endogeneity bias. The analysis uses both the first-difference transformed data set, which reduces omitted variable bias, and the levels data. We assume that the error

terms are serially un-correlated. The empirical analysis results are given in table 5.8, together with the test results. Before starting to interpret the analysis results, we first check the validity of our assumptions using the test results. The Sargan and AR(1) and (2) tests are all based on two-step GMM estimation results. Firstly, the Sargan test shows that we cannot reject our hypothesis that the instrumental variable matrix is valid. Secondly, from the AR test, apparently AR(1) has negative and significant results while AR(2) has insignificant results. The idea of AR tests is that, if error term is not serially correlated, the differenced error term will be first order negatively correlated and second order serially un-correlated. Therefore it can be concluded that the hypothesis of serial un-correlation in the error term cannot be rejected.

Table 5.8 GMM Estimation of Disaggregated Capital Investments Ratios and Railway Distances

Ln per capita real GDP_{it}		I	
		GMM-1	GMM-2
Ln per capita real GDP_{it-1}		**0.8505** **(41.5)*** **	**0.8552** **(40.7)*** **
Ln Population growth		**-0.0333** **(-1.95)***	**-0.0286** **(-1.66)****
Ln public investment to GDP ratio		0.0212 (1.26)	0.0154 (0.748)
	γ_0	-0.0164 (-0.771)	-0.0199 (-0.953)
Ln Foreign investment in fixed asset to GDP ratio		**0.0293** **(2.0)****	**0.0281** **(2.21)****
	γ_0	-0.0160 (-1.39)	-0.0143 (-1.06)
Ln Domestic Private investment to GDP ratio		**0.036** **(1.92)***	**0.0328** **(1.76)***
	γ_0	**0.0329** **(1.87)***	**0.0320** **(1.79)***
Distance		**-0.1287** **(-5.70)*****	**-0.1315** **(-4.48)*****
Sq distance		**0.0302** **(5.61)*****	**0.0304** **(4.10)*****
Constant		**1.4627** **(7.24)*****	**1.4276** **(6.56)*****
RSS		0.4998	0.4812
Sargan test		Chi^2 (35) = 17.36 [0.995]	
AR(1)		-2.040 [0.041]**	
AR(2)		0.4714 [0.637]	
No. of Observation		196	196
λ-calculated		0.162	0.156
t-calculated		4.278	4.443

Note:

***Significant at the 0.01 error level.

** Significant at the 0.05 error level.

* Significant at the 0.10 error level.

Both one-step and two-step GMM estimation results are listed.

t-value in ( ). P-values in [ ].

Sargan and AR(1) and AR(2) tests are based on the two-step results.

Now we start to interpret the empirical analysis results. As in table 5.8, both one-step and two-step GMM estimation results are listed, though two-step results are normally regarded as more efficient than one-step. Firstly we look at the convergence speed. The convergence speed calculated from the two-step GMM estimation results is about 15.6% annually, which indicates that those provinces need 4.44 years to halve the deviation from their own balanced growth paths. Since this is the result obtained from System GMM estimation, we draw the conclusion that fast convergence speed is a robust result. Population growth displays negative effects on economic growth.

The second point, which is also the most important part to be interpreted in table 5.8, is the role of different ownership structures on economic growth. From the elasticities of per capita GDP to the ratios of disaggregated capital investment/GDP, the results clearly suggest that the components of disaggregated capital investments exhibit quantitatively different influences on the national economy. In particular, domestic private investment has the highest elasticity in the estimation, which is 3.3 + 3.2 = 6.5% with time dummy and 3.3% without, both significant at the 10% level. On the other hand, public investment proves to be insignificant, with and without time dummy. Thus during the whole data period, domestic private investment has a positive influence on economic growth, while public investment shows an insignificant effect. Further, the estimated elasticity of foreign investment changes from insignificance with time dummy to 2.8% without. Therefore, foreign investment has a similar positive effect throughout data period.

Thirdly, we start to analyse the influence of transportation costs on economic growth. The results from table 5.7 show that distance (**Distance**) has a negative sign, while the

squared distance (**Sq distance**) has a positive sign. If we write the distance components in equation (5.8) as $\beta_3 d - \frac{1}{2}\beta_4 d^2$, there is a minimum at a positive value:

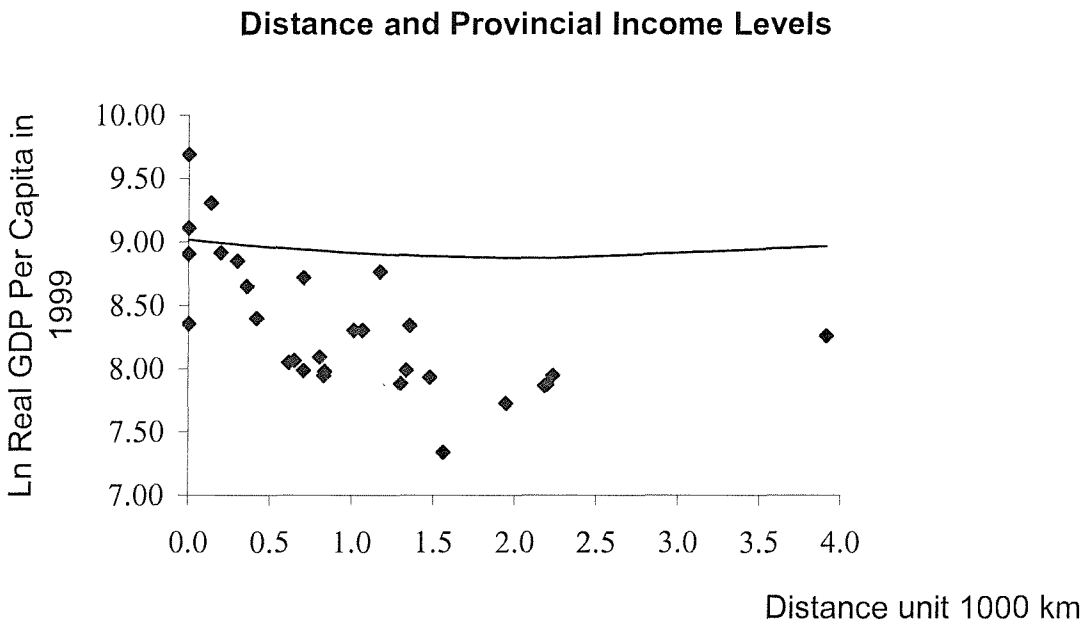
$$d = \frac{\beta_3}{\beta_4} \tag{5.9}$$

as $\beta_3 \leq 0$ and $-\frac{1}{2}\beta_4 > 0$

Applying equation (5.9) to the two-step estimation results in table 5.7, which gives that $\beta_3 = -0.1315$ and $-1/2\beta_4 = 0.0304$, both significant at 1% level, the minimum can then be found at a distance of 2.16 (×1000 km) to the nearest port city.

To calculate the 95% asymptotic confidence interval, the delta method is used, to produce (1.87, 2.45) (see the Appendix 5.C). According to this distance, from our data set, it can be seen that there are four provinces located on the right hand side of the minimum point, which are Sichuan, Yunnan, Qinghai and Xinjiang; while all the others are located on its left hand side. Indeed, only one province, Xinjiang, lies to the right of the confidence interval. In figure 5.6, the relationship between the distance and the economic development level is illustrated. The data exhibit income reducing with distance, except for Xinjiang. Our estimation obtains similar results when Xinjiang is considered as an outlier, so that it is dropped from the data set. The results are omitted here for the sake of space. Therefore, the model predicts, *ceteribus paribus*, a reduction of income levels as distance increases, with a diminishing marginal effect, until the minimum is reached. However, the distance effect is limited.

Figure 5.6



5.5 CONCLUSIONS

This chapter examines the role of disaggregated capital investments and the function of geography in provincial economic growth. When coastal-inland inequality becomes the major source of income inequality in China, the geographical factors are found to be important in influencing the provincial economic growth patterns. To single out the role played by geography in determining economic growth, a coastal dummy has been employed by a number of economists. However, we would argue that this dummy is not able fully to represent the influence of geography on economic growth, and it is also correlated with other provincial effects, such as policy influences.

To separate policy factors and geographical factors influencing provincial economic growth, two terms are employed in this chapter; the geographical distribution of disaggregated capital investments and railway distances.

Being influenced by the policies, different distribution patterns of the public, foreign and domestic private investments are observed in different provinces of China. Since all the SEZs and ETDZs are located in the coastal region, there is no doubt that they are more favored than inland region by foreign investors, and this leads to the concentration of foreign investment in the coast. At the same time, public investment is more evenly distributed geographically due to the strict government control of the SOEs; this reflects the political consideration that inland region is far from the coast and thus away from any possible international conflict.

On the other hand, the economic reform process in China is also accompanied by the rapid development of the domestic private sector. While the influence of public investment on the economic growth is becoming less and less, as is implied by our non-significant estimation results, the influence of the domestic private sector is significant but declines during the 1990s, which is also clearly shown from the positive estimated elasticity of per capita income to the ratio of the domestic private investment/GDP.

Geographical factors have been taken into consideration by introducing the transportation costs, which are proxied by the railway distance from the capital city of each province to its nearest port city. Since longer distances lead to higher transportation costs and thence more obstacles to investors, it is reasonable to assume that provinces located further from coast tend to have lower GDP per capita when other conditions remain the same, and this matches fairly well with the fact that a typical inland province is growing less rapidly than a typical coastal province. Therefore, distance plays a

negative role in economic growth. However, such a negative effect would increase more slowly as distance increases. The most distant province, Xinjiang, appears to be an outlier, but rail may not be so dominant a means of transport in this case.

However, there might exist a shortcoming to this approach. Since provincial distribution of different investment in various ownerships, the policy approximation may be correlated with the geographical approximation measure. This needs further justification. Other approximation methods can be applied as well, such as the preferential policy index and the degrees of openness, which we construct in Chapter Two. An effort in analyzing these substitutes will be included in my future work.

The analysis of this chapter identifies two major reasons for inland region to lag far behind coastal region in terms of economic development: (a) lack of foreign and domestic private investments, (b) the greater distance from the coast. Therefore, to attract more private investment, and to provide a better transport infrastructure, may be the means for the inland region to develop faster and reduce the coast-inland income gap.

APPENDIX 5.A

VARIANCE DECOMPOSITION

Divide China's provinces into coastal region and inland region:

i = 1, 2 (1 if provinces in coastal region and 2 in inland region.)

j = 1, 2, ….., 12 for i = Coastal

j = 13, 14, …., 29 for i = Inland

n = 29

$$\sigma_{agg}^2 = \frac{\sum_i \sum_j (x_{ij} - \bar{x})^2}{n} = \frac{1}{n}\sum_{ij} x_{ij}^2 - \frac{1}{n^2}(\sum_{ij} x_{ij})^2 \quad (5.A.1)$$

Similarly, we have variance for coastal region and variance for inland region:

$$\sigma_c^2 = \sum_j (x_{1j} - \bar{x}_1)^2 = \frac{1}{12}\sum_j x_{1j}^2 - \frac{1}{12^2}(\sum_j x_{1j})^2 \quad (5.A.2)$$

$$\sigma_I^2 = \sum_j (x_{2j} - \bar{x}_2)^2 = \frac{1}{17}\sum_j x_{2j}^2 - \frac{1}{17^2}(\sum_j x_{2j})^2 \quad (5.A.3)$$

Variances for the aggregated, coastal and inland can be written as:

$$29\sigma_{agg}^2 = \sum_{ij} x_{ij}^2 - \frac{1}{29}(\sum_{ij} x_{ij})^2 \quad (5.A.4)$$

$$12\sigma_c^2 = \sum_j x_{1j}^2 - \frac{1}{12}(\sum_j x_{1j})^2 \quad (5.A.5)$$

$$17\sigma_I^2 = \sum_j x_{2j}^2 - \frac{1}{17}(\sum_j x_{2j})^2 \quad (5.A.6)$$

(5.A.4) – (5.A.5)- (5.A.6) will be:

$$
\begin{aligned}
&29\sigma_{agg}^2 - 12\sigma_c^2 - 17\sigma_I^2 = \frac{1}{12}(\sum_j x_{1j})^2 + \frac{1}{17}(\sum_j x_{2j})^2 - \frac{1}{29}(\sum_{ij} x_{ij})^2 \\
&\Rightarrow \sigma_{agg}^2 = \frac{12}{29}\sigma_c^2 + \frac{17}{29}\sigma_I^2 + \frac{\sum x_{1j}}{12}\cdot\frac{\sum x_{1j}}{12}\cdot\frac{12}{29} + \frac{\sum x_{2j}}{17}\cdot\frac{\sum x_{2j}}{17}\cdot\frac{17}{29} - \frac{\sum x_{ij}}{29}\cdot\frac{\sum x_{ij}}{29} \\
&\Rightarrow \sigma_{agg}^2 = \frac{12}{29}\sigma_c^2 + \frac{17}{29}\sigma_I^2 + \bar{x}_1^2\cdot\frac{12}{29} + \bar{x}_2^2\cdot\frac{17}{29} - (\frac{12}{29}\bar{x}^2 + \frac{17}{29}\bar{x}^2) \\
&\Rightarrow \sigma_{agg}^2 = \frac{12}{29}\sigma_c^2 + \frac{17}{29}\sigma_I^2 + \frac{12}{29}(\bar{x}_1^2 - \bar{x}^2) + \frac{17}{29}(\bar{x}_2^2 - \bar{x}^2)
\end{aligned}
\qquad (5.A.7)
$$

Therefore, the aggregated variance is a weighted sum of the coastal variance, the inland variance and the between variance. The between standard deviation will be computed as:

$$\sigma_{between} = \sqrt{\sigma_{agg}^2 - \frac{12}{29}\sigma_c^2 - \frac{17}{29}\sigma_I^2} \qquad (5.A.8)$$

APPENDIX 5.B

SPEARMAN RANK-ORDER CORRELATION COEFFICIENT

Spearman's rank correlation is calculated as Pearson's correlation computed using ranks of paired observations on two variables.

$$\rho_{Spearman} = 1 - \frac{6\sum D^2}{N(N^2 - 1)} \tag{5.B.1}$$

N is the number of observations while D is the difference in ranks between each pair of observations. ρ will be equal to +1.00 if the two variables have perfect positive correlation, i.e., with same ranking order; to –1.00 if the two have perfect negative correlation, i.e., opposite ranking order; and to 0 if there is no correlation.

APPENDIX 5.C

COMPUTE CONFIDENCE INTERVAL

To calculate the confidence interval, first we need a Wald test to calculate covariance between β_3 and β_4, and this is carried out by batch command in PcGive 10.

H_0: $\beta_3 + k\beta_4 = 0$.

$$w(k) = \left[\frac{\hat{\beta}_3 + k\hat{\beta}_4}{\sqrt{\left(\hat{\text{var}}(\hat{\beta}_3) + 2k\,\hat{\text{cov}}(\hat{\beta}_3\hat{\beta}_4) + k^2\,\hat{\text{var}}(\hat{\beta}_4)\right)}} \right]^2 \xrightarrow{D} \chi^2(1) \tag{5.C.1}$$

$$\begin{aligned} &\frac{w(k)}{(\hat{\beta}_3 + k\hat{\beta}_4)^2} = \frac{1}{\left(\hat{\text{var}}(\hat{\beta}_3) + 2k\,\hat{\text{cov}}(\hat{\beta}_3\hat{\beta}_4) + k^2\,\hat{\text{var}}(\hat{\beta}_4)\right)} \\ &\Rightarrow 2k\,\hat{\text{cov}}(\hat{\beta}_3\hat{\beta}_4) = \frac{(\hat{\beta}_3 + k\hat{\beta}_4)^2}{w(k)} - \hat{\text{var}}(\hat{\beta}_3) - k^2\,\hat{\text{var}}(\hat{\beta}_4) \end{aligned} \tag{5.C.2}$$

k = -4 suggests:

$$\hat{\text{cov}}(\hat{\beta}_3\hat{\beta}_4) = \frac{1}{2k}\left[\frac{(\hat{\beta}_3 + k\hat{\beta}_4)^2}{w(k)} - \hat{\text{var}}(\hat{\beta}_3) - k^2\,\hat{\text{var}}(\hat{\beta}_4)\right] \tag{5.C.3}$$

Substituting with our estimation results, we can calculate the covariance:

$$\begin{aligned} \hat{\text{cov}}(\hat{\beta}_3\hat{\beta}_4) &= \frac{1}{-8}\left[\frac{(-0.131549 - 4\times 0.0304404)^2}{18.7804} - 0.02934^2 - 16\times 0.007423^2\right] \\ &= -0.0002093 \end{aligned} \tag{5.C.4}$$

Therefore:

$$\rho = \frac{\hat{\text{cov}}(\hat{\beta}_3\hat{\beta}_4)}{se(\hat{\beta}_3)\times se(\hat{\beta}_4)} = \frac{-0.0002093}{(0.02934\times 0.007423)} = -0.96086308 \tag{5.C.5}$$

then from the delta method:

$$\left(-\frac{\hat{\beta}_3}{2\hat{\beta}_4}\right) \approx -\frac{\beta_3}{2\beta_4} + \left(\hat{\beta}_3 - \beta_3\right)\left(\frac{-1}{2\beta_4}\right) + \left(\hat{\beta}_4 - \beta_4\right)\left(\frac{\beta_3}{2\beta_4^2}\right) \tag{5.C.6}$$

$$E\left(\left(-\frac{\hat{\beta}_3}{2\hat{\beta}_4}+\frac{\beta_3}{2\beta_4}\right)^2\right)\approx \text{var}(\hat{\beta}_3)\frac{1}{4\beta_4^2}-2\,\text{cov}\left(\hat{\beta}_3,\hat{\beta}_4\right)\left(\frac{\beta_3}{4\beta_4^3}\right)+\text{var}\left(\hat{\beta}_4\right)\left(\frac{\beta_3^{\,2}}{4\beta_4^4}\right)$$

$$\Rightarrow SE(\frac{\hat{\beta}_3}{2\hat{\beta}_4})\approx\frac{1}{2}\sqrt{\text{var}(\hat{\beta}_3)\frac{1}{\beta_4^2}-2\,\text{cov}\left(\hat{\beta}_3,\hat{\beta}_4\right)\left(\frac{\beta_3}{\beta_4^3}\right)+\text{var}\left(\hat{\beta}_4\right)\left(\frac{\beta_3^{\,2}}{\beta_4^4}\right)}$$

$$\Rightarrow SE(\frac{\hat{\beta}_3}{2\hat{\beta}_4})=\frac{1}{2}\sqrt{\frac{0.02934^2}{0.0304404^2}-2(-0.000209)(\frac{-0.131549}{0.0304404^3})+0.007423^2(\frac{-0.131549^2}{0.0304404^4})}$$

$$\Rightarrow SE(\frac{\hat{\beta}_3}{2\hat{\beta}_4})=0.14792953 \qquad (5.C.7)$$

The last step is to calculate the confidence interval:

$$\text{Confidence interval} = \hat{\theta}\pm c_{1-(1/2)\alpha}[se(\hat{\theta})]$$

If $\alpha = 0.05$ and $n\rightarrow\infty$, the $c_{1-(1/2)\alpha} = 1.96$.

Therefore,

$$2.1607633\text{-}1.96(.14792953) = 1.8708214 \qquad (5.C.8)$$

$$2.1607633\text{+}1.96(.14792953) = 2.4507052 \qquad (5.C.9)$$

CHAPTER SIX

PROVINCIAL ECONOMIC GROWTH PATTERNS, INTER-PROVINCIAL AND COASTAL-INLAND INCOME INEQUALITY IN CHINA FROM 1991 TO 1999: CONCLUSIONS

China's economic development during the period of economic reform and the "open to the outside world" policy provides one of the most heated topics of debate in the world. However, when the country as a whole grows fast, provinces achieve different development levels, because they face different initial conditions and have different growth patterns. The observation that China has 31 regions at provincial level makes regional study an important issue. Given the vast size of the territory, there exist large differences in geographical environment, natural resource endowment, and initial level of economic and social development. In addition to these differences, provinces are subject to different policies from the central government. As the result, different provinces have achieved different development levels after 20 years reform.

Therefore, this thesis aims at making an objective investigation of provincial economic growth patterns in China, focusing on the 1990s. The 1990s sees a significant development in the reform process, from the modifications of the centrally planned system to the establishment of a market system. Accompanying this movement is the enlarging scope of the "opening process", from the opening of a few coastal cities to the overall opening of the whole country. Consequently, non-state-owned sectors developed fast when foreign investment flowed in and domestic private owned enterprises blossomed. Different policies carried out in different provinces at different period exerted huge influence on the distribution pattern of firms with different ownership,

which ultimately led to different development levels in different provinces. The most distinctive characteristic of the different provincial development levels is inter-provincial and inter-regional income inequality, which increases dramatically during the 1990s. Kanbur and Zhang (2001) suggest that "*the Gini coefficient for regional inequality in China in 1999 exceeds the peak of inequality reached at the end of cultural revolution in 1976, and is more than 95% of the all time high at the peak of the Great Famine in 1960*". (p. 1). Therefore, we put great emphasis on investigation of the income gap between provinces and between regions.

6.1 STRUCTURE OF THE THESIS AND CONCLUSIONS

To investigate provincial economic growth patterns in China, we started from a comparison between the gradualism of China's reform and the "big-bang" of the other transitional economies' reform. Chapter One also introduced some specific problems associated with China's reform process. Unlike other transitional economies' experience, the piecemeal reform process in China has been commended for the fast economic growth achieved by the country. However, some problems involved in China's reform have become so significant that doubts have arisen whether such fast growth is sustainable. Therefore, our investigation intended to uncover the sources of some of these problems, which will help to suggest their possible solutions. The problems addressed in this thesis include the income distribution, the coastal-inland development gap, and the development of ownership structure; all three are linked with each other.

It has been noted that the linked problems affecting China's economic development are induced by many entangled factors; in particular, economic policy. The reform

policy which has led to huge institutional change, exerts great influence on provinces' development. Hence, Chapter Two describes the institutional changes during the 1990s. An overview of institutional change and its impact on the provincial economic growth pattern in China is provided here. Even though China's economic reform started in 1978, the country's transformation from a planned economy to a market system did not really start until 1993. After the initial gains from relaxing central controls over the economy, especially gains from reform in agriculture and the development of towns-and-village-owned enterprises (TVEs) during the 1980s, the country needed to look for other engines of economic growth during the 1990s. Both the reform measures and the degree of openness have been extended in the 1990s, with their effects still under observation today. In particular, fiscal policy reform and monetary policy reform have changed the vertical, central-local, relationship; the open door policies led to the current horizontal, inter-provincial, relationship. Being significantly affected by macro level reform, reforms on ownership structure, which are at a more micro level, bring developments to the public, foreign and domestic private sectors. We have observed that the financial burdens of SOEs preclude them from being profit maximizers and the problem of uncertain ownership impedes the development pace of TVEs. On the other hand, while domestic private enterprises developed rapidly, foreign owned enterprises, due to the various sources and objectives of their investment, display different effects across China's provinces. After given a quantification of preferential policies and degrees of openness at provincial level, the roles of restricted factor mobility and institution rigidity have been illustrated as well.

Before proceeding to theoretical and empirical investigation of provincial economic growth patterns in China, we described our data set and the empirical method in Chapter

Three. The data is from the China Statistical Yearbook for various years, covering 9 years (1991 – 1999) data for 29 provinces. After explaining how to deflate the GDP data using GDP indices, we showed several merits and demerits of the panel data set. The GMM estimator has been explained in detail, since it is employed as the most consistent and efficient estimator in a dynamic panel data model.

Hence, using provincial data in China during the 1990s, Chapter Four investigates provincial economic growth patterns and the inter-provincial income inequalities. According to our study, a province takes around 8 years to halve the deviation from its balanced growth path. The institutional rigidity and the inter-provincial trade barriers determine that different provinces have different steady states, which are moving away from each other. Based on the Solow growth model, GMM estimation results imply that physical capital investment, which is approximated by the fixed investment to GDP ratio, contributes positively to economic growth. However, the existence of *conditional* convergence could not be used to predict whether poor provinces can catch up with rich provinces or not. We applied sigma and beta *absolute* convergence analysis to our panel data set. We found no evidence that the initially poor provinces could catch up with the initially rich provinces.

In Chapter Five, we focus our study of inter-regional income inequality on the enlarging gap between coastal region and inland region. It is noted that the open door policies have been closely related to provinces' geographic positions. Reviewing the history of China's open door policy, it is easy to notice that all the provinces that benefit greatly from the preferential policies are located in coastal region. Therefore in this chapter we tried to distinguish the role of geography and the role of policy in provinces' development. This chapter concludes that, on the one hand, by using the distance by

railway of each province's capital city to its nearest port city as a proxy for transportation costs, there are significant differences across provinces. Distance has negative effects on economic development but its marginal effects become less as distance increases. On the other hand, since the geographical distribution of capital investment, disaggregated by ownership, is influenced by government policy, differences in ownership pattern across provinces are used to disentangle policy factors from geographical factors. Public investment proves to have an insignificant impact on growth in our panel data for 29 provinces; foreign investment plays positive role while domestic private investment is the most influential. The coastal-inland gap will grow in the foreseeable future, if inland region cannot benefit from an increase in non-state investment.

In sum, from our investigations of provincial economic growth patterns in China during the 1990s, we find that while provinces conditionally converge to their steady state, the inter-provincial income gap enlarges since the initially poor provinces cannot catch up with the initially rich provinces. Among all kinds of income inequalities in China, the income gap between the coastal region and the inland region is the most distinguishable one. The disparity has been caused by many entangled factors, among which geography plays a limited role. Open door policies, on the other hand, lead to different distribution patterns of firms with various ownership structures. Therefore, while public investment has an insignificant impact on a provinces' economic growth, foreign and domestic private investments are influential. Hence, we could tell that the inter-regional income gap, referring to the income gap between coastal region and inland region, will hardly be reduced. The hope for inland region to catch up, therefore,

may lie in some special policy applications, which could facilitate the development of non-state owned sectors.

6.2 FUTURE WORK

From the above analysis we can see that this thesis only dealt with some of the economic problems associated with China's economic reform process. There are many topics which deserve economists' attention that have not been touched. 20 years of reform and the open door process have brought significant improvements to people's living standards; while deep-rooted problems which existed in the economy also came to the surface. In particular, the reform during the 1980s was propelled by development in agriculture and in the development of TVEs; and the reform during the 1990s witnessed the much faster economic growth in the coastal part of the country while inland region lagged far behind. Then what can be done to reduce this enlarging inter-regional disparity, and what will be the challenges for the 21st century? With China joining the WTO, the economy will become more liberalized and more open, which will probably result in more dramatic shifts in provincial comparative advantages. What other effects will there be of WTO membership? Therefore, in the near future, my research topics could include the following.

6.2.1 DEVELOPMENT OF INLAND REGION

According to the statistical data in 2000, the 19 provinces in inland region of China contain 58.3% of the country's total population and 86.1% of the total land area. In addition to being poor, the inland region, especially the western provinces, is also vulnerable in terms of the ecological environment. Furthermore, Cai (2001) points out that most ethnic minorities in China live in the inland part of the country. In particular,

the top eight minority groups in terms of population concentrate to a large extent in the western provinces while the rest of the minority population mainly live in the central provinces. "*The fact that people living in these areas have been trapped in a cycle of poverty could cause serious political chaos and thus jeopardize national security and unification if the poor are not able to be relieved from the poverty.*" (p. 158). Therefore, the development of inland region is of great importance. For this reason, the following topics are interesting to work on.

6.2.1.1 Model local government's objective function to achieve sustained economic development in inland region

Sustained economic development is important for inland region's development since the ecological environment is vulnerable, and there have been severe ecological disasters. In the 1990s, the unprecedented flooding of the Yangtze River caused death or property losses to millions of people along the river. On the other hand the Yellow River, once the mother river in China, saw serious water exhaustion. Its exploitation inland has caused water irrigation problems for the downstream coastal provinces.

However, rich in natural resource endowments such as minerals and poor in infrastructure construction and education, inland region may appear to have a comparative advantage which is dangerous to the ecological environment. From the beginning of the 21st century, the central government has initiated the Western Development Strategy to speed up economic growth in the west while four major areas are given priority. These are, firstly, the construction of infrastructure; secondly, the protection of the ecological environment; thirdly, the readjustment of the industrial structure and fourthly, the development of technology and education. Therefore, a model of the local governments' objective function, which promotes economic growth

subject to environmental protection, could be formulated. Through infrastructure construction, investment in education and technology development, the comparative advantage of the inland region could be exploited.

6.2.1.2 Model better integration of China's provinces – via the distribution of non-state owned enterprises

While the "M-Form" administrative structure has helped the gradual economic reform in China's provinces by reducing resistance to reform, and mitigating negative influences from failure to reform, it has fostered increasing inter-provincial trade barriers. China's auto market is one of the best examples. It has been reported[1] that, to boost local economic growth, provincial and city officials naturally favor local car manufacturers. In 1999 Shanghai announced it would levy an 80,000 yuan license fee for each Fukang auto in Shanghai to stop an increasing market share being gained by this model, produced by the Citroen joint venture in Hubei province. The license fee for Santana made by the Shanghai Volkswagen Company is 20,000 yuan only. Hubei province immediately issued a rule that all institutes and departments that receive national financial appropriations either had to opt to buy the local-made Fukang auto or pay an additional 70,000 yuan license fee for other brands.

In addition to constructing obstacles to economic growth, lack of integration also contributes to the enlargement of inter-provincial and inter-regional inequalities. At the beginning of economic reform it was expected that the coastal provinces could help the development of inland provinces, once they became rich. Nonetheless, in reality the firms from coastal provinces often find obstacles in trade with and investment into inland provinces, which partly explain the increasing inter-regional disparity. In fact,

[1] http://www.china.org.cn/english/2001/Mar/9673.htm

China's domestic market is fragmented because of provincial protectionism. The fragmentation has affected the development of the non-state sectors. For domestic private owned enterprises, their development is impeded by the fragmented market since it is hard for them to achieve economies of scale. Therefore the removal of trade barriers is very necessary for their development. However, for foreign direct investment (FDI), the influence may be more ambiguous. Huang (2001) argues that the demand for FDI has been increased by the fragmentation of China's domestic market since FDI turns out to be much more mobile than investment by indigenous enterprises. However, multinational corporations may be held back if they want to invest to sell in the potentially large domestic market.

This issue is very important since we have just identified in the thesis that the hope of the inland region may lie in the development of private and other forms of non-state owned enterprises. Therefore, to model the relationship between better integration and the economic growth of inland region, through influencing the distribution of non-state owned enterprises, will be an interesting topic.

6.2.1.3 Model better integration of China's provinces – development of urban areas

Better integration among China's provinces has other implications. Without greater integration, the huge number of migrating workers from poor inland region to coastal cities will aggravate the big cities' problems. The pressure on urban land, the environment, and other resources could lead to sharply diminishing returns from agglomeration. Hence, another model can be built to analyse the relationship between provincial integration and urban area development; in particular, the development of the urban areas in the coastal part of the country.

6.2.1.4 Application of other policy measures to the study of coastal-inland development gap

As mentioned in Chapter Five, there are limitations to the policy approximations. Table 2.4 have given several other potential substitutions. Beside these measures, we can think about other approximation methods as well, for example, investment efficiency, marketization index and urbanization indicator, and among others. It can be done in the near future to prolong the starting point of the available data in our analysis from 1991, to 1952. With longer series of data available, many other tests could be carried out and interesting analysis is expected.

6.2.2 PROGRESSIVE OPENING OF THE COUNTRY

China's accession to the World Trade Organization in 2001 indicates further opening of the country. The average tariff rate has fallen from above 40 percent in the early 1990s to 15 percent in 2001. The overall opening has increased the competitiveness of domestic enterprises and affected the development of multinational corporations (MNCs).

6.2.2.1 Model the accession to the WTO and the change in MNCs' objective function

As mentioned before, MNCs can be grouped into two types: one group invests in China to sell their products in the domestic market, thus circumventing import barriers; this group is "domestic market-oriented". The other group invests in China to take advantage of lower production costs and aim to export their products to the international market; this group is "export-oriented". China's accession to the WTO and the fragmentation of its domestic market have contributed to the change of objective

functions in many "domestic-oriented" MNCs; they now aim at the export market instead.

This change is shown in the change of the country's export structures: from exporting the low-end products, China is moving into exporting more sophisticated products. Businesses all over the world have seen the country dominates the export markets for toys and textiles; now they observe China's increasing share of exports of computers, air-conditioners and microwave ovens. Many fear the country is becoming the production factory of the world. At the same time, FDI keeps flowing into the country; in 2002 China becomes the world's biggest net recipient of FDI (Economist: 13-02-2003). Hence, a model which explains the relationship between the change of objective functions of MNCs and China's accession to the WTO will be desirable.

6.2.2.2 Model the influence of market opening on China's technological development

Another change in MNCs' investment in China lies in the redirection from the processing and manufacturing industries to R&D activities. In 1998, Intel established a research institute in Shanghai and Microsoft set up its own research institute in Beijing. More and more, MNCs invest in research and development institutions, to take full advantage of local human resources and to participate more in the local market. However, the competition between MNCs and local corporations will become fiercer. Hence, a study of market opening and technology development will be thought provoking.

6.2.2.3 Model the influence of WTO accession on China's industrial development by sector

WTO accession has different influences on different industries in China. The development in textile industry, raw material industry, manufacturing industry will be affected to different directions and degrees. An analysis of the difference by industrial sectors will be interesting, as its impact on China's technology upgrade process.

There are many other interesting topics, such as the identification of the consequences, of China's intention to create a free trade area with ASEAN countries, for East Asian economic development; the quantifying of the impact of China's WTO accession on its neighbours; the results of the competitiveness and complementarity of MNCs with domestic firms; and the search for the future engines for economic growth. The thesis will be the start of my research career. I expect to see serious research work in these directions.

REFERENCES

Arellano M. and S.Bond (1991), "Some tests of specification for Panel Data: Monte Carlo evidence and an application to employment equations", *Review of Economic Studies* 58: 277-297.

Arellano M. and O.Bover (1995), "Another Look at the Instrumental Variable Estimation of Error-Components Models", *Journal of Econometrics* 68: 29-51.

Baltagi B. H. (1999), *Economic Analysis of Panel Data*, John Wiley & Sons Ltd., England.

Barro R. (1991), "Economic Growth in a Cross Section of Countries", *Quarterly Journal of Economics* 106: 407-443.

Barro R. and X. X. Sala-i-Martin (1990), "Economic Growth and Convergence Across the United States", *http://www.nber.org/papers/w3419* .

Barro R. and X. X. Sala-I-Martin (1995), *Economic Growth*. McGraw-Hill Ltd., New York.

Bernard A.B. and S.N. Durlauf (1994), "Interpreting tests of the convergence hypothesis", http://papers.nber.org/papers/T0159.

Berthelemy J. and S. Demurger (2000), "Foreign Direct Investment and Economic Growth: Theory and Application to China". *Review of Development Economics* 4, Issue 2: 140-155.

Boldrin M. and F. Canova (2001), "Inequality and Convergence in Europe's Regions: Reconsidering European Regional Policies." *Economic Policy* 16, 207 – 253.

Cai F. (2001), "Regional disparity and regional development policy", In *China's Integration with the World Economy: Repercussions of China's Accession to the WTO*, K.T.Lee, J.Y.Lin and Kim S.J. (ed): 144 – 165. Korea Institute for International Economic Policy, Korea.

Caselli F., Esquivel G. and F. Lefort (1996), "Reopening the Convergence Debate: A New Look at Cross-country Empirics". *Journal of Economic Growth* 1: 363-389.

Chen B. and Y. Feng (2000), "Determinants of Economic Growth in China: Private Enterprises, education and Openness", *China Economic Review* 11: 1-15.

Chen C., Chang L. and Y. Zhang (1995), "The Role of Foreign Direct Investment in China's Post-1978 Economic Development", *World Development* 23, issue 4: 691-703.

Chen J., B. M. Fleisher (1996), "Regional Income Inequality and Economic Growth in China", *Journal of Comparative Economics* 22: 141-164.

Dees S. (1998), "Foreign Direct Investment in China: Determinants and Effects". *Economics of Planning* 31: 175-194.

Demurger S (2001), "Infrastructure Development and Economic Growth: An Explanation for Regional Disparity in China?" *Journal of Comparative Economics* 29: 95-117

Demurger S., Sachs J.D., Woo W.T., Bao S., Chang G. and A. Mellinger (2001), "Geography, Economic Policy, and Regional Development in China", http://papers.nber.org/papers/W8897 .

Doornik J. A., Arellano M. and S.Bond (1999), "Panel Data estimation using DPD for OX", http://www.nuff.ox.ac.uk/users/doornik/

Durlauf S. N. and D. T. Quah (1998), "The new Empirics of Economic Growth". http://econ.lse.ac.uk/~dquah

Economists: "Eating your lunch?" 13-02-2003.

Economists: "In praise of rules", 05-04-2001.

Economists: "Income Distribution in China, to each according to his abilities", 31-05-2001.

Fleisher B.M., J. Chen (1997), "The Coast-Noncoast Income Gap, Productivity, and Regional Economic Policy in China", *Journal of Comparative Economics* 25: 220-236.

Gallup J.L., Sachs J.D. and A.D.Mellinger (1998), "Geography and economic development", http://www.nber.org/papers/w6849

Hausman J.A. (1978), "Specification tests in Econometrics", *Econometric,* 46: 1251-1271.

Hsiao C. (1985), "Benefits and limitations of Panel Data", *Econometric Reviews* 4: 121-174.

Hsiao C. (1986), "*Analysis of Panel Data*", Cambridge University Press, Cambridge.

Hu A. (2000), "About Economic Growth Model Transformation in the Ninth Five-Year Plan Period", http://forum50.cei.gov.cn/.

Huang Y. (2001), "Economic fragmentation and FDI in China", http://eres.bus.umich.edu/docs/workpap-dav/wp374.pdf

IFC (2000), "China's emerging private enterprises, Prospects for the new century".

Jian T., J. D. Sachs and A. M. Warner (1996), "Trends in Regional Inequality in China", *http://www.nber.org/papers/w5412* .

Kanbur R. and X.Zhang (1999), "Which regional inequality? The evolution of Rural-Urban and Inland-Coastal inequality in China from 1983-1995", *Journal of Comparative Economics* 27: 686-701.

Kanbur R. and X.Zhang (2001), "Fifty years of regional inequality in China: A journey through evolution, reform and openness", http://www.cepr.org/pubs/DP2887.asp

Klevmarken N.A. (1989), "Panel Studies: what can we learn from them? Introduction", *European Economic Review* 33: 523-529.

Krugman P. (1998), "The role of geography in development", *paper prepared for the Annual World Bank Conference on Development Economics held in 1998, U.S.* http://www.worldbank.org/html/rad/abcde/krugman.pdf .

Lardy N. (1998), "*Chin''s Unfinished Economic Revolution*". The Brookings Institution, Washington D.C.

Lee K., M. H. Pesaran, and R. Smith (1997), "Growth and Convergence in A Multi-Country Empirical Stochastic Solow Model", *Journal of Applied Econometrics* 12: 357 – 392.

Ma J. (1997), "China's economic reform in the 1990s", *World Bank.*

Mankiw N. G., D. Romer, and D. N Weil (1992), "A Contribution to the Empirics of Economic Growth". *Quarterly Journal of Economics* 107, Issue 2: 407-437.

Mao Y. and Y. Zhang (2001), "Private sector development process and future expectation in China", http://forum50.cei.gov.cn/

Naughton B. (1994 a), "Chinese Institutional Innovation and Privatization from Below", *The American Economic Review* 84: 266-270.

Naughton B. (1994 b), "What is distinctive about China's economic transition? State enterprises reform and overall system transformation", *Journal of Comparative Economics* 18: 470-490.

OECD (2000), "Main Determinants and Impacts of Foreign Direct Investment on China's Economy", *OECD working paper.*

OECD (2002), "China in the World Economy – The domestic policy challenges", *OECD Synthesis Report.*

Qian Y. (1996), "Enterprise reform in China: Agency problem and political control", *Economics of Transition* 4 (2): 427-447.

Qian Y., B. R.Weingast and Y.Cao (1999), "From Federalism, Chinese Style, to Privatization, Chinese Style", *Economics of Transition* 7(1): 103-131.

Qian Y., C. Xu (1993), "Why China's economic reform differ: The M-form hierarchy and entry/expansion of the non-state sector", *Economics of Transition* 1(2): 135-170.

Qian Y., L. Lau and G. Roland (2000), "Reform without losers: An interpretation of China's dual-track approach to transition", *Journal of Political Economy* 108 (1): 120-143.

Rawski T. G. (2001), "What is happening to China's GDP statistics?", *China Economic Review* 12: 347 – 354.

Sachs J.D. and W.T.Woo (1997), "Understanding China's Economic Performance", www.nber.org/w5935

Sala-i-Martin X. X. (1996), "Regional Cohesion: Evidence and Theories of Regional Growth and Convergence", *European Economic Review* 40: 1325-1352.

Solon G.S. (1989), "The value of panel data in economic research", in *Panel Surveys*, D.Kasprzyk, G.J.Duncan, G.Kalton and M.P.Singh (ed): 486 – 496. John Wiley, New York.

State Statistical Bureau (SSB) (various years), "*China Statistical Yearbook*", China Statistical Publishing House, Beijing.

State Statistical Bureau (SSB) (1999), "Comprehensive Data and Materials on 50 years of New China", China Statistical Publishing House, Beijing.

Verbeek M. (2000), "*A Guide to Modern Econometrics*", John Weley & Sons Ltd., England.

Wang S. and A. Hu (1999), "*The Political Economy of Uneven Development: The case of China*", An East Gate Book, M.E. Sharpe, Inc., USA.

Wang Z. (2003), "Regional Divergence of per capita GDP in China: 1991-1999", *Journal of Chinese Economic and Business Studies*, accepted and forthcoming.

Wei S. (1996), "Foreign Direct Investment in China: Sources and Consequences", in *Financial Deregulation and Integration in East Asia*: 77 – 101. University of Chicago Press.

Windmeijer F. (2000), "A finite sample correction for the variance of linear two-step GMM estimators", *The Institute for Fiscal Studies WP 00/19.*

Woo W. T., W. Hai, Y. Jin and G.Fan (1994), "How successful has Chinese Enterprise Reform Been? Pitfalls in Opposite Biases and Focus", *Journal of Comparative Economics* 18: 410-437.

Xie P. (1999), "Challenges Faced by China Banking System Reform", in *Prospects of China*, Hu A. (ed): 218 – 236. Zhejiang Peoples' Publish Press, 2000. China. (In Chinese).

Yao S. and Z. Zhang (2001), "On Regional Inequality and Diverging Clubs: A Case Study of Contemporary China", *Journal of Comparative Economics* 29: 466-484.

Yao Y. (1998), "Non-state Factors and the Technical Efficiency in China's Industrial Sector", *Jingji Yanjiu (Economic Research)* 12. (In Chinese).

Young A. (2000), "The razor's edge: distortions and incremental reform in the P. R. China". *http://papers.nber.org/papers/W7828* .