Growth, Unemployment, and Business Cycle Integration

—Empirical Evidence from China

A thesis submitted for the degree of Doctor of Philosophy

by

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Abstract

This thesis aims to study the macroeconomic performance of China. China has been experiencing rapid economic growth and it has been changing gradually from a planned to a market economy since it initiated the well known "open door policy" combined with a "coastal development strategy" in 1978. However, rapid growth has occurred on the background of increasing regional disparity. Meanwhile, unemployment has increased significantly during last two decades, and has become one of the most pressing problems of the Chinese economy today. Moreover, another major challenge facing the Chinese economy is how to deal with various shocks, and to ensure the sustainability and balance of economic growth in the face of the increasing economic uncertainties associated with its deep reform and integration into the world trade and financial system.

Based on the above concerns and literature review, this study, firstly, uses an augmented Solow-Swan model of Mankiw, Romer and Weil (1992) to assess the role FDI plays in underlying regional differences in economic growth across Chinese provinces over the reform period 1978-2008. My analysis indicates that the augmented Solow growth model appears to provide a good description of regional growth patterns in China over the period 1978-2008 and the data display conditional convergence. After controlling for FDI and other determinants of growth, provinces that were initially poor tend to grow faster and the evidence in favour of conditional convergence becomes even stronger after splitting the data into subsamples.

I then focus on the study of the relationship between unemployment and growth at both national level and regional level in order to find out how unemployment affects China's economic growth and economic reform progress overall. I find that Okun's relationship does not hold in China universally and, furthermore, the nature

of the observed relationship has changed during the transition progress. I argue that there are hump shaped relationships both between growth and unemployment and between the speed of transition and unemployment in China. The results are consistent with several theoretical and empirical studies in the literature.

Finally, structural VAR methodology pioneered by Bayoumi and Eichengreen (1993) is used to identify and decompose supply and demand shocks to two variables, (the log of) output (annual real GDP) and (the log of) prices (annual GDP deflator). I then compute and discuss the correlation of such shocks across provinces and show how it has evolved over the four main sub-periods of China's history. Moreover, I investigate which factors contribute to economic integration or divergence in the Chinese economy.

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[1] The formal derivation of the Solow model in this subsection follows MRW(1992)

[2] The derivation of the model with FDI follows Li et al. (1998)

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Chapter 1
Introduction

1.1 Goals and Scope

The overriding goal of my thesis is to study how the macroeconomic performance of China, a country which holds one fifth of the global population, is changing during the transition from central planning to market oriented economic system. During this transition, China has been experiencing rapid economic growth, recently becoming the second largest economy globally. However, large chasms have opened up between regions. Urban areas in Eastern and South-Eastern China are increasingly shaping up as relatively rich industrialized and middle-class economies. Most Central and Western China, in contract remain relatively poor and underdeveloped. The regional disparities are further reinforced by the continued enforcement of the *hukou* system of household registration which restricts the ability of residents of poor and depressed areas to move. Whether or not China's economic growth and social development can be sustained in the long run is hotly debated. My focus in this thesis therefore is on the regional disparity on the background of rapid growth.

More concretely, the analysis focuses on the following questions: Why have some provinces become so much richer than others in the wake of economic reform and what accounts for the huge increases in real incomes over time? How can regional development be improved? Will unemployment keep increasing? Unemployment has increased significantly despite high economic growth during last two decades, and has become one of the most pressing problems of the Chinese economy today. Will increasing unemployment undermine China's economic development? Another major challenge facing China is how to prepare to deal with various shocks and to ensure sustainable and balanced economic growth. China is undergoing deep reform and integration into the world trade and financial systems. This

process it is likely to bring about more economic uncertainties. What drives business cycle fluctuations in China?

Although a comprehensive literature review is beyond the scope of this Chapter, it will be instructive to explain the main theme of my thesis in the context of the growth and transition literature.

1.2 Chinese Economic Reform Background

My thesis is most closely related with the following major reforms during economic transition.

1.2.1 Opening up the economy

Since 1949 the Chinese economy had been not only closed to the Western countries, but also to the Eastern block. Until 1978, it has remained one of the most closed economies in the world. Started from the late 1970s, China has implemented the well known "open door policy" combined with a "coastal development strategy". The government decided to expand foreign trade and welcome foreign investment. Meanwhile, the central government decided to allow selected Eastern and South-Eastern coastal provinces to pursue reform "one step ahead" of the other regions in the country. The vast majority of industrial equipment imported from Western countries was allocated to the major coastal urban areas which were thought to have better industrial foundation and favourable geographical position to absorb and make use of the investment. In addition, the central government also allowed them to adopt "special policies" (*teshu zhengce*) and to implement "flexible measures" (*linhuo cuoshi*) (Zhou, 1984, as cited in Qian, 1999). This helped boost the economic development and growth in the coastal provinces relative to inland provinces. Thus,

the coastal regions began to outgrow the rest of country and interregional gaps in terms of industrial output have been gradually widening (Tzeng, 1991).

1.2.2 Fiscal decentralization

Although some economic decentralization was implemented even before the economic reform, the Chinese economy remained highly centralized and tightly regulated whereby production and resource allocation were carried out according to a plan designed by the central government. In the late 1970s, after almost three decades of intense social movements, the central government decided to decentralise administrative power and allow local authorities and enterprises to retain part of their revenues. The purpose of this move was to reinvigorate the stagnant economy by encouraging local enthusiasm in production (Tang, 1998). From 1979 to 1993, the central fiscal power gradually weakened: the central government's share of expenditures (after revenue-sharing) declined from 51 percent to 28 percent (Ma and Norregaard, 1998, as cited in cited in Poncet and Barthélemy, 2008, p.899). The fiscal decentralization gave local governments the authority and incentives to develop their local economies and promoted fast growth of the Chinese economy in the last three decades. However, some locals have implemented protectionist policies, supposedly to develop local industry (Bai, 1981).

1.2.3 Privatization and Restructuring State-owned Enterprises

The process of economic transition has had a significant impact on the urban labor market in China. Privatization and restructuring of large state-owned enterprises has been taking place since 1995. China, like other former communist countries, started its transition from a situation of "permanent full- employment". After the reform of urban employment system was accomplished and the "iron-rice-bowl" was broken, labor allocation became mostly market-based. Unemployment in urban areas emerged during the period of privatization and restructuring of state-owned enterprises in the late 1990s (Cai and Wang, 2010).

Meanwhile, privatization of small state-owned enterprises mushroomed, encouraged under the policy of "grasping the large and letting go of the small" (*Zhua da fang xiao*). Until the end of 1996, up to 70 percent of small state-owned enterprises had been privatized in pioneering provinces[3] and around half were privatized in many other provinces (Qian, 1999).

1.3 Overview and Structure

This thesis is organized as follows. Chapter 2 explores the impact of FDI on Chinese economic growth in order to study the factors underlying China's regional disparities and lack of convergence. In Chapter 3, the main consideration is how unemployment will affect China's economic growth and economic reform progress overall. Chapter 4 assesses the business cycle' synchronization and analyzes the factors that drive this synchronization- Next, I discuss each chapter in more detail.

In Chapter 2, I explore the impact of foreign direct investment on growth, using a panel of Chinese provincial data spanning 1978-2008. I estimate an augmented Solow growth model inspired by Mankiw et al. (1992, MRW henceforth) which relates output growth to investment in human and physical capital and population growth. My motivation is that only a few empirical studies did attempt to analyze China's recent growth experience (see, for example, Chen and Fleisher, 1996; Li et al., 1998). My research extends Chen and Fleisher's (1996) and Li et al.'s (1998) analyses. I examine whether the gap in economic development between regions has narrowed or widened following the liberalization and what what role regional distribution of FDI inflows has played. In addition, the sample is split into three geographic sub groups (East, Central and West) to further examine if convergence within broader regions is faster given the similar economic background and similar macroeconomic policies.

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[3] "Privatization of state-owned enterprises started initially by local governments as experiments in a few provinces, such as Shangdong, Guangdong, and Sichuan" (Qian, 1999, p.21).

My finding indicates that the augmented Solow-Swan model fits the Chinese data very well. I find that FDI has a positive and statistically significant impact on economic growth, as theory predicts. The investment and labor-force growth rate and human capital are also significant and have the expected signs.

Chapter 3 adopts panel-data approach to test whether Okun's type relation holds in China. The sample is further divided into two sub-periods, to investigate the interaction between the unemployment and growth. There are only a few previous studies on this issue and those restricted their attention to the relationship between growth and unemployment in China at the aggregate level and they ignore the regional aspects of this relationship. However, the progress of reform has been uneven and the benefits of economic reform differ across regions. Therefore, an examination at the regional level is as important and interesting as the aggregate level analysis.

My key findings are: Firstly, Okun's law does not hold in China universally, and the nature of the relationship has changed during the transition progress. The differences in the nature of the relationship between growth and unemployment may be driven by the uneven pattern of Chinese economic development. The coastal areas of the Eastern region were exposed to reform measures and the market economy much earlier than the interior areas of the Central and especially Western region. This would explain also why Okun's relationship can be found in the later sub-period but not during the earlier one and it is in line with the results of Izyumov and Vahaly (2002). Secondly, there is a hump shaped relationship between growth and unemployment in China and the empirical evidence is consistent with the theory put forward by Aghion and Howitt (1994) who analyze two competing effects of growth on unemployment, one is the capitalisation effect and another is the creative destruction effect. Moreover, the results indicate that the creative destruction effect should dominate in China. Thirdly, the link between the speed of transition and unemployment in China also displays an inverted U shaped relationship which provides strong empirical evidence to the theory of Aghion and Blanchard (1994). To the best of my knowledge, this is the first time that this theory has been tested empirically. Meanwhile, Aghion and Blanchard

(1994) theory, together with my empirical results, tell us that the current unemployment rate is necessary and unavoidable. It should help facilitate China's transition and economic reform. Short-term hardship thus will be outweighed by long- term economic gain (Valev, 2004).

Chapter 4 investigates the changing nature of business-cycle synchronization in China or, in other words, economic integration among Chinese provinces based on provincial level data divided into four uneven sub-periods reflecting the different phases of China's economic reform. The analytical approach is based on identifying shocks affecting the various regions and then computing the correlations of such shocks, using the structural VAR methodology pioneered by Bayoumi and Eichengreen (1993). This analytical framework is motivated by the Theory of Optimum Currency Areas (Mundell, 1961) and its emphasis on the importance of asymmetric shocks for the viability of integration. Importantly, the structural VAR methodology allows us to distinguish between shocks that affect both output and the price level permanently (usually denoted as supply shocks in this literature) and those affecting output only temporarily while having a permanent price-level effect (demand shocks). The analysis does not stop at merely documenting the correlation of permanent and temporary shocks among Chinese regions. I also seek to explain the correlations of permanent/temporary shocks by relating them to the factors that proxy for the vulnerability of regions to idiosyncratic shocks as well as those that reflect the channels allowing the effects of such shocks to spill over regions' boundaries: the distance between the regions, dummy variables for adjacency, interior provinces adjacent with coastal provinces and belonging to the same broader region, economic size of regions, endowments of physical and human capital, infrastructure, structure of economic activity in each region, openness to (foreign) trade, foreign direct investment and economic policy. This allows me to assess which factors contribute to economic convergence or divergence in the Chinese economy. Few previous studies explored the determinants of Chinese economic business cycles at provincial level.

My key findings are: First, the degree of bilateral cross correlation of supply shocks has declined recently, which suggests a fall in the cohesion between Chinese regions. However, the bilateral cross correlation of demand shocks has increased, which in turn suggests a greater degree of cohesion. Second, under the central planning economic system, the variables I consider in my study do not explain the correlation of supply shocks across provinces in China. Third, distance between two provinces is robustly correlated with a higher cross provinces correlation of demand shock in the early period (1966-1977). With the development of electric railways which started from 1958, the effect of distance fades away. Fourth, two variables were found to be robust factors explaining the correlation of supply shocks across provinces during the recent two period of 1978-1991 and 1992-2007: coastal provinces and those with higher fixed asset investment are characterized by higher correlation of supply shocks. Fifth, greater similarity in production structure is not robustly correlated with correlation of supply or demand shocks. Although it is significant in the univariate regression and has positive relationship with the correlation of demand shocks during the period 1992-2007, the significance disappears when other explanatory variables are added. This is in line with the finding of Baxter and Kouparitas (2005) who also cannot find robust effect of industrial structure based on over 100 countries. Sixth, I do not find any link between fiscal policy coordination and the correlation of supply and demand shocks. This finding is in line with the empirical findings of Clark and van Wincoop (2001) who conjecture that it could be an indirect link through the effect of common policies on trade.

1.4 Concluding Remarks

In summary, my study supports the hypotheses that China's regional growth can be characterized as a process of conditional convergence. It suggests that the gap can be reduced by polices to help lagging provinces catch up with more developed provinces. Also very important, our finding indicates that government does not need worry about unemployment

too much as this unemployment is necessary to achieve the optimal speed of transition and it leads future prosperity. However, government should pay more attention to regional development and reduce regional disparity as disparity can undermine the sustainability of economic growth. Moreover, some studies argue that fiscal and administrative decentralization lead to economic market divergence in China, but it is not confirmed by my study. However, the study shows that coastal provinces are characterized by higher correlation of supply shocks and higher cross provinces' correlation of supply shocks with similar capital/fixed-asset investment. From the initial stages of reform till now, coastal provinces benefited a lot by public investment and policy priority.

Chapter 2
Foreign Direct Investment and Regional Growth in China

2.1 Introduction

China has experienced rapid economic growth since the economic reforms of the late 1970s and early 1980s. During this period it has, among other things, liberalized domestic agricultural markets, international trade and finance and switched the emphasis of industrial policy from heavy to light manufacturing (Anderson et al., 1985, p.65). Moreover, despite signs that growth has been abating somewhat recently, China is still widely expected to continue growing at around 10%. However, rapid growth has occurred on the background of increasing regional disparities. For example, Demurger et al. (2002) find that the growth is fastest and slowest growing provinces differ by 6.2 percentage points during the period 1979-1998.

Started from the late 1970s, China has implemented the well known "open door policy" combined with a "coastal development strategy"; the latter gave the coastal areas a special role and economic autonomy. The vast majority of industrial equipment imported from Western countries was allocated to the major costal urban areas which were thought to have better industrial foundation and favorable geographical position to absorb and make use of the investment (Tzeng, 1991). This helped boost the economic development and growth in the coastal provinces relative to inland provinces (Tzeng, 1991). As a result, the coastal region began to outgrow the rest of the country and interregional gaps in terms of industrial output have been gradually widening.

Regional disparities and convergence have received considerable attention in the context of European countries and the US. Barro and Sala-i-Martin (1992), and Rodwin and Sazanami (1988, 1991) examined the regional economic disparities as well as convergence in the United States and compared it with other groups of countries and regions. From the within-country point of view, the issue was addressed by Lee, Pesaran, and Smith (1998) who advocated heterogeneity in the growth rate of convergence; they point out that because countries differ in their rates of population growth, technological progress and depreciation, they may also display different convergence rates. However, in most of previous literature on economic growth and convergence, the experience of China is rarely mentioned.

A few empirical studies did attempt to analyze China's recent growth experience based on Solow model (see, for example, Chen & Fleshier, 1996; Li et al., 1998).Chen & Fleshier (1996) and Li et al. (1998) use cross-section and panel data on Chinese provinces over the reform period 1978-1993, 1978-1995, respectively, Chen & Fleshier argue that results are quite close based on the original Solow model. Li et al. (1998) find that an augmented Solow-Swan model of Mankiw, Romer and Weil (1992) provides a fairly good description of cross-section data but works poorly in the panel-data framework. They also find that foreign direct investment inflows seem to boost economic growth at the provincial level. Wei (2002) similarly find that industrial growth is positively associated with export and foreign direct investment. Indeed, in the three decades since economic reform began in China, the foreign-owned sector experienced rapid growth and amazing success. China has become a major recipient of foreign direct investment. In 1993, China was the destination of more foreign direct investment than any other developing country (The World Bank, 1994). In 1999 China ranked third in attracting FDI among all the countries and regions in the world (Chow, 2002). A further surge in FDI preceded and accompanied China's accession to the World Trade Organization (WTO) in December 2001, promoting China to top position as an FDI destination in 2003. China appears to have benefited from a pattern of capital inflows heavily tilted toward FDI[4].

[4] Table in Appendix shows the unusually high share of FDI in the composition of China's capital inflows.

FDI is widely believed to be beneficial to the recipient countries as it not only serves as a capital injection to the domestic market but also plays as a central role for technological spillover and advancement of managerial skills. However, its effect remains controversial due to the use of different samples and various methodologies. Aitken and Harrison (1999) use panel data on Venezuela. However, they found little evidence supporting the existence of technology 'spillovers' from foreign firms to domestic firms which might be the level of foreign investment in Venezuela is too low and the economy not sufficiently diversified to receive large benefits from foreign presence. They also mention that the scope for spillovers might be greater in the export-oriented economies in East Asia. Comparing the economic experience of China and Russia, Sachs and Woo (1994) emphasize that 40% of FDI[5] in China are from Hong Kong, Macao and Taiwan during the sample period. They argue that this tends to facilitate FDI spillovers as the investors from these regions have additional advantages of geographical proximity, same culture, same language and even family ties, which played a critical role in China's economic development.

The objective of this chapter therefore is to explore the impact of foreign direct investment on growth, using a panel of Chinese provincial data spanning 1978-2008. We estimate the augmented Solow-Swan growth model of Mankiw et al. (1992, MRW henceforth) which relates output growth to investment in human and physical capital and population growth. It extends Chen & Fleshier (1996)'s and Li et al (1998)'s study since Human capital and FDI are not included in Chen & Fleshier (1996)'s panel approach study and Physical capital, and population growth are insignificant and human capital gets opposite sign in Li et al (1998). In this study, to examine whether the gap is narrowed or widened with a major step forward occurring following Deng Xiaoping's "South Trip" in 1992[6] (Fleisher et al,

[5] In Appendix shows the share of utilized FDI by source based on available data. Much of this is believed to be round-tripping through Hong Kong in order to evade taxes

[6] From January 8 to February 21, 1992, Deng Xiaoping paid an inspection tour to south China such as Wuchang, Shenzhen, Zhuhai and Shanghai, in that order. During his trip, the former Chinese leader made important speeches and offered answers to a series of important theoretical and conceptual questions and he stressed that planning and market forces are not essential difference between socialism and capitalism, among others. It played a crucial role in guiding and accelerating China's reform and opening-up as well as the socialist modernization process.

2009). In addition, the sample will be split into three sub groups (East, Central and West) to examine if convergence within the same region is faster, given the similar economic background and similar macroeconomic policies.

The rest of the chapter is organized as follows. Section 2 provides a brief survey of literature. Section 3 introduces the augmented Solow-Swan model with foreign direct investment that we estimate. Section 4 introduces the data and empirical methodology. In Section 5, we first show how leaving out foreign direct investment affects the coefficients on physical capital investment, population growth and human capital, and then split the samples into three sub-groups to investigate club convergence. Section 6 concludes.

2.2 Literature Review

The empirical approach is based on the theoretical contributions of Solow (1956) and Swan (1956). They assume a standard neoclassical production function with decreasing returns to capital. Their model predicts that output per worker is increasing in the savings rate and decreasing in the growth rate of the labor force. When the economy is away from its steady state, the convergence rate depends positively on the savings rate and negatively on the labor-force growth rate. Because of decreasing returns, economies tend to converge eventually to a steady state (however, because countries may have different savings rates and labor-force growth rates, they may converge to different steady states).

The Solow-Swan model has been criticized as arbitrary and too simplistic and eventually was challenged by the advent of endogenous growth theory (Romer 1986, Lucas 1988). Endogenous growth theory relaxes the restriction posed by diminishing returns or at least allows that the limit of the marginal product of capital does not tend towards zero. Because of their research advantage, it is possible for richer nations to maintain long-run rates of income growth that exceed those of poorer nations, implying cross-national divergence rather than convergence.

Since the mid-1980s, research on economic growth has experienced a new boom. The literature on growth and convergence has proceeded through several stages. First, Baumol (1986) and others report finding convergence among groups of countries included in Maddison's (1982) sample (Maddison, 1982 cited in Islam, 1995) and put forward the term "convergence club" to express this phenomenon. These countries tend to converge both to similar steady state levels of per capita income and to similar rates of growth. This notion of convergence later came to be known as absolute convergence. A popular criterion for judging whether countries are in their steady states is to study the correlation between initial levels of income and subsequent growth rates. The negative correlation is considered as evidence of convergence in terms of both income levels and growth rates (Islam, 1995).

Next, Barro and Sala-i-Martin (1992) and MRW put forward the concept of conditional convergence and argue that the evidence on the failure of per capita income to converge does not contradict the Solow-Swan model. They emphasize that the growth theory need not imply that all countries reach identical steady state levels of income. In equilibrium, differences in countries' per capita incomes are likely to remain, because of differences in labor markets, industrial structure and natural-resource endowments.

In addition, MRW show that the Solow-Swan model augmented to include human capital in addition to physical capital and population growth provides a good fit for cross-country data. They stress the importance of human capital for growth. Including human capital can potentially alter the theoretical modeling or the empirical analysis of economic growth (1992, MRW, p.415). The augmented Solow model predicts that differences in savings, education and labor-force growth should have a long way to go in explaining the cross-country differences in income per capita. Their examination of the data indicates that these three variables indeed explain most of the cross-country variation.

Third, Knight et al. (1993) and Islam (1995) extend MRW's analysis to panel-data framework. An important advantage of analyzing growth in a panel setting is that one can account

for country-specific effects such as allowing for differences in the aggregate production function across economies.

Islam (1995) finds that adoption of the panel-data approach leads to a twofold change in the results compared with the cross-section approach. First, he obtains much higher rates of convergence. Second, he obtains lower values of the elasticity of output with respect to capital. To this extent, the conventional cross-section estimates presented by MRW may be biased.

However, as Barro (1996) points out, the panel-data approach is not perfect. It may introduce unwanted business cycle effects and exacerbate the effects of measurement errors. Griliches and Mairesse (1995) suggest that it can be resolved by proxying for the unobserved fixed effects, which leaves more identifying variance in the regressor.

A natural fourth stage in the literature, Lee, Pesaran, and Smith (1995, 1998) extend the use of the panel data approach to allow for heterogeneity of growth rates across countries in consistent estimation of the speed of convergence coefficient. The question whether countries have the same steady state growth rate remains controversial (see Romer's comment on Mankiw's paper in Mankiw, 1995).

However, the linear models cannot explain the convergence performance in different income regimes well. The best way is the nonlinear mechanism whereby the speed of convergence depends on initial per-capita income. Durlauf and Johnston (1995) split the MRW sample using 1960 income and literacy rates and present a regression tree model to test the multiple regimes in cross-country nonlinear growth behavior. They allow heterogeneity in the speed of convergence for different groups of countries, with the grouping determined endogenously and find that technology parameters vary across the samples, suggesting that the assumption of a common technology is a poor one. Temple (1998) also questions the MRW's findings. He finds largely disparate coefficient estimates across the sub samples,

some of which imply the absence of convergence. In particular, he shows that estimated technology parameters and convergence rates are highly sensitive to measurement error.

A number of studies focused on the subject of convergence within countries. Rodwin (1988) and Sazanami (1991) did an empirical study of the United States and some European countries. Barro and Sala-i-Martin (1995) reported evidence for convergence in the U.S. and compared it with other groups of countries and regions.

So far there have been only a few empirical studies that have attempted to explain China's recent growth experience by Solow-Swan model. Wei (1992, cited in Li et al., 1998) found that industrial growth was positively associated with export and foreign direct investment by using two samples of city-level data. Chen and Fleisher (1996) found that convergence in per capita production across China's provinces from 1978-1993 is conditional on physical investment, employment growth, human capital investment and foreign direct investment based on cross section methodology. Li et al.'s (1998) extended Chen and Fleisher's study. Their results, nevertheless, are broadly similar. In addition, they found that regional economies show convergence both conditionally and unconditionally over the reform period. However, the goodness of fit is considerably poorer in the panel data framework. There is strong evidence of conditional convergence in the fixed-effect model, but when random effects are assumed, there is no evidence of conditional convergence.

2.3 The Model

We begin by briefly reviewing the Solow growth model. The growth model has been widely used as a theoretical framework for understanding cross-country growth patterns. Then we introduce the augmented Solow growth model with human capital and foreign direct investment. The augmented Solow growth model with human capital is developed by Mankiw, Romer and Weil (1992), hereafter MRW. The version of Solow augmented to include human capital and inflows of foreign direct investments are suggested by Li et al. (1998).

2.3.1 The textbook Solow model[7]

The Solow growth model assumes diminishing returns to capital and takes the rates of saving, population growth and technological progress as exogenous. The Cobb-Douglas production function with constant returns to scale can be written as:

$$Y = K^{\alpha} A L^{1-\alpha},\ 0 < \alpha < 1 \tag{2.1}$$

where, Y is output, K is capital, L is labor, A is "knowledge" or the "effectiveness of labor" and α is the share of capital. L and A are assumed to grow exogenously at rates n and g, respectively, so that

$$L_t = L_0 e^{nt} \tag{2.2}$$

$$A_t = A_0 e^{gt} \tag{2.3}$$

The model assumes that a constant fraction of output is invested or saved. Defining output and the stock of capital per effective unit of labor as $y = Y/AL$, and $k = K/AL$, respectively, the evolution of k is obtained by

$$\dot{k} = sy - (n + g + \delta)k = sk^{\alpha} - (n + g + \delta)k \tag{2.4}$$

where δ is the rate of depreciation. Equation (2.4) implies that k converges to its steady state value k^*

[7] The formal derivation of the Solow model in this subsection follows MRW(1992)

$$k^* = (\frac{s}{n+g+\delta})^{\frac{1}{1-\alpha}} \tag{2.5}$$

substituting Equation (2.5) into the production function and taking logs, we find the steady-state income per capita is

$$ln(\frac{Y^*}{L}) = lnA_0 + gt + \frac{\alpha}{1-\alpha}ln(s) - \frac{\alpha}{1-\alpha}ln(n+g+\delta) \tag{2.6}$$

This equation shows how differing labor force growth rate, accumulation of physical capital and technological progress can explain the differences in per capita incomes across countries.

MRW assume the rate of technological progress, g, and the rate of depreciation is constant for all across countries. However, the A_0 term captures not just technology but resource endowments, climate, institutions and so on, It may therefore differ across provinces (MRW, 1992). They, therefore, postulat that

$$lnA_0 = a + \varepsilon \tag{2.7}$$

Where a is a constant and ε is the country-specific shift or shock term (MRW, 1992).

Then the empirical specification of steady-state income per capita is

$$ln(\frac{Y^*}{L}) = \alpha + \frac{\alpha}{1-\alpha}ln(s) - \frac{\alpha}{1-\alpha}ln(n+g+\delta) + \varepsilon \tag{2.8}$$

Equation (2.8) assumes that all countries are currently in their steady states or that departures from steady states are random across countries. However, regional economies of China are out of their steady states. It is therefore also necessary to examine the dynamic

evolution of regional economies along transition to their steady states, namely a phenomenon that is called "conditional convergence". Without special point out, the convergence discussed in this chapter henceforth is conditional σ-convergence.

Discussing regional economic growth, there are two concepts of convergence in the classical literature (Sala-i-Martin, 1996). They are β-convergence and σ-convergence. We say that there is absolute β-convergence if poor economies tend to grow faster than rich ones. The concept of σ-convergence can be defined as follows: a group of economies are σ-converging if the dispersion of their real per capita GDP levels tends to decrease over time (Sala-i-Martin, 1996, p.1020). σ-convergence relates to whether or not the cross-country distribution of world income shrinks over time. In the Solow-Swan version of the neoclassical model, countries would reach their respective steady states. Hence, in looking for convergence in a cross-country study, it is necessary to control for the differences in steady states of different countries. This is the concept known in the classical literature (Sala-I-Martin, 1992) as conditional σ-convergence.

Let y^* be the steady-state level of income per effective labour given by Equation (2.8), and let y_t be the actual value at time t. Approximating around the steady state, the speed of convergence is given by

$$\frac{dln\,(y_t)}{dt} = \lambda\,[ln(y^*) - ln\,(y_t)] \tag{2.9}$$

Where, λ is the rate of convergence, given by $\lambda = (n + g + \delta)(1 - \alpha)$ and it implies that

$$ln\,(y_t) = (1 - e^{-\lambda t})ln(y^*) + e^{-\lambda t} ln\,(y_0) \tag{2.10}$$

Where y_0 is income per effective worker at some initial date. Subtracting lny_0 from both sides,

$$\begin{aligned} ln\,(y_t) - ln\,(y_0) = -(1-e^{-\lambda t})ln\,(y_0) + (1-e^{-\lambda t})\tfrac{\alpha}{1-\alpha}ln(s) \\ -(1-e^{-\lambda t})\tfrac{\alpha}{1-\alpha}ln(n+g+\delta) \end{aligned} \tag{2.11}$$

Equation (2.11) is formulated in terms of income per effective labour; it has to be reformulated in terms of income per worker. Substituting the following expression for income per effective labour

$$ln\,(y_t) = ln\left(\frac{Y_t}{L_t}\right) - ln\,(A_0) - gt \tag{2.12}$$

yields

$$\begin{aligned} ln\left(\tfrac{Y_t}{L_t}\right) - ln\left(\tfrac{Y_0}{L_0}\right) = -\theta ln\left(\tfrac{Y_0}{L_0}\right) + \theta\tfrac{\alpha}{1-\alpha}ln(s) \\ -\theta\tfrac{\alpha}{1-\alpha}ln(n+g+\delta) + \theta ln\,(A_0) + gt \end{aligned} \tag{2.13}$$

Where $\theta = 1 - e^{-\lambda t}$, λ is the speed of convergence[8]. Equation (2.13) represents the dynamics of a country's growth rate towards the steady state.

2.3.2 The augmented Solow model with human capital and foreign direct investment[9]

In order to capture the explicit role of human capital in determining economic growth, MRW augmented the Solow model by including accumulation of human capital in addition to physical capital.

Li et al. (1998) pointed out that FDI can foster technological progress at least in two ways. On the one hand, it enables inflow of foreign techniques and management expertise and reduces the costs of domestic innovation. On the other hand, it benefits not only the

[8] More detailed derivation is in the Appendix.

[9] The derivation of the model with FDI follows Li et al. (1998)

company concerned, but also other firms, as the importation of foreign techniques has spill-over effects.

The Cobb-Douglas production function is specified as

$$Y = K^{\alpha} H^{\beta} A L^{1-\alpha-\beta},\ 0 < \alpha + \beta < 1 \tag{2.14}$$

Where H is the stock of human capital, β is the share of human capital in total output, and all other variables are defined as before. It assumed $\alpha + \beta < 1$ so that there are constant returns to scale and diminishing returns to each factor of input.

Labour and technology are assumed to grow according to the following functions:

$$L_t = L_0 e^{nt} \tag{2.15}$$

$$A_t = A_0 e^{gt} F^{\phi} \tag{2.16}$$

F is the degree of openness of the regional economy to foreign countries, and ϕ is the elasticity of technical progress with respect to openness. MRW assumed that the fractions of income invested in physical capital and human capital are constant at the rates of s_k and s_h respectively, and that both types of capital depreciate at a common rate δ. The evolution of the economy is derived by

$$\dot{k} = s_k y - (n + g + \delta)k = s_k k^{\alpha} h^{\beta} - (n + g + \delta)k \tag{2.17}$$

$$\dot{h} = s_h y - (n + g + \delta)h = s_h k^{\alpha} h^{\beta} - (n + g + \delta)h \tag{2.18}$$

Steady state is given by

$$k^* = \left(\frac{s_k^{1-\beta} s_h^{\beta}}{n+g+\delta}\right)^{\frac{1}{1-\alpha-\beta}} \tag{2.19}$$

$$h^* = \left(\frac{s_k^{\alpha} s_h^{1-\alpha}}{n+g+\delta}\right)^{\frac{1}{1-\alpha-\beta}} \tag{2.20}$$

Substituting Equations (2.19) and (2.20) into the production function and taking logs, we obtain the steady-state income per capita:

$$\begin{aligned} ln\left(\frac{Y_t}{L_t}\right) = ln\left(A_0\right) + gt + \frac{\alpha+\beta}{1-\alpha-\beta} ln(n+g+\delta) + \frac{\alpha}{1-\alpha-\beta} ln(s_k) \\ + \frac{\beta}{1-\alpha-\beta} ln(s_h) + \phi ln\left(F\right) \end{aligned} \tag{2.21}$$

Approximating around the steady state, MRW and Li et al. (1998) show that the growth rate of output per worker in this model is given by

$$\begin{aligned} ln\left(\frac{Y_t}{L_t}\right) - ln\left(\frac{Y_0}{L_0}\right) = -\theta ln\left(\frac{Y_0}{L_0}\right) + \theta \frac{\alpha}{1-\alpha-\beta} ln(s_k) + \theta \frac{\beta}{1-\alpha-\beta} ln(s_h) \\ -\theta \frac{\alpha+\beta}{1-\alpha-\beta} ln(n+g+\delta) + \theta ln\left(A_0\right) + gt + \theta\phi ln\left(F\right) \end{aligned} \tag{2.22}$$

where λ is the rate of convergence $\lambda = (n+g+\delta)(1-\alpha-\beta)$

MRW also present an alternative way to express the role of human capital in determining economic growth.

$$\begin{aligned} ln(\frac{Y_t}{L_t}) - ln(\frac{Y_0}{L_0}) = -\theta ln(\frac{Y_0}{L_0}) + \theta \frac{\alpha}{1-\alpha-\beta} ln(s_k) - \theta \frac{\alpha}{1-\alpha-\beta} ln(n+g+\delta) \\ +\theta \frac{\beta}{1-\alpha-\beta} ln(h^*) + \theta ln\left(A_0\right) + gt + \theta\phi lnF \end{aligned} \tag{2.23}$$

Equation (2.22) is the reduced form of the augmented model. Equation (2.23) adds the level of human capital $ln(h^*)$ to the right-hand side. They predict different coefficients for the saving rate and population growth terms.

2.4 Data and empirical methodology

2.4.1 Data and sample

In this chapter, the units of analysis are the individual provinces of China and the period of analysis is from 1978 to 2008. This period was chosen because the Chinese economic reforms were initiated in 1978. The data are available in annual frequency. Annual frequency, however, may be too short to be appropriate for studying growth convergence because of short-term disturbances (Islam, 1995). Following Islam (1995), we therefore split the sample into five-year intervals. Hence, considering the period 1978-2008, we have five data points for each province: 2008, 2003, 1998, 1993, 1988, and 1983. When $t = 1983$, for example, $t - 1$ is 1978. Regional data set is classified by geography into EAST, CENTRAL and WEST shows in Table 2.1. However, data are not available for some provinces; thus, we exclude Chongqing and Tibet. One important question when testing the Solow growth model is whether to use per capita or per worker variables. In line with the Solow growth model it seems more appropriate to use per worker GDP and the growth of the labor force, because the model is based on a production function and not every person contributes to production.

Y stands for the real gross provincial product in a particular year. L is the working-age population in that year. Y/L is the real GDP per worker. Following MRW and Islam (1995) we proxy the saving rate, s_k, by the ratio of aggregate investment to GDP, and h^*[10] by secondary and higher education enrolment rates (i.e. the ratio of the total secondary and higher education enrolment to the employment). The growth rate of employment n is derived from the formula: $L_{t+5}/L_t = (1 + n)^5$. To measure the provincial openness to foreign investment, we use take the ratio of the foreign direct investment to GDP ($F_i =$

[10] Gemmell (1996) and Temple (1999) argued that school enrolment rates may conflate human capital stock and accumulation effects. MRW(1992) point out that which augmented Solow model be used is based on the available data corresponds more closely to the rate of accumulation or the level of human capital. Our data is more close to the level of human capital by restricted regression.

$\frac{\sum_{t}^{t+5} FDI_{i,t}}{\sum_{t}^{t+5} GDP_{i,t}}$). We follow Islam (1995) and MRW in assuming that technological progress and the depreciation rate are constant and that they sum to 0.05. We use the laborforce to compute $ln(n+g+\delta)$. All the data come from 'Comprehensive Statistical Data and Materials: 50 Years of New China' and Statistical Bureau of China.

2.4.2 Empirical methodology

We apply panel data approach rather than cross-section regressions since it is possible to control for the unobserved province-specific effects by treating initial efficiency as a time-invariant fixed effect and eliminating its influence through a time dimensional transformation. Though an important assumption of the Solow growth model and augmented Solow growth model is that all the explanatory variables are exogenous, Caselle et al. (1996) argue that the endogeneity of within-group estimator may also provide biased and inconsistent estimates in a dynamic panel data model. They advocate the use of panel data and generalized method of moments (GMM). However, Bond et al. (2001) claim that it can also make serious bias on the initial income term created by the first-difference GMM estimator when the weak instruments of lagged levels of the variables are adopted. Based on the available data, I apply LSDV (least square with dummy variables) and EGLS (Estimated Generalized Least Squares)[11].

The growth equation (2.23) can be generalized in the following panel data model

$$\begin{aligned} ln\left(\frac{Y_{i,t}}{L_{i,t}}\right) - ln\left(\frac{Y_{i,t-1}}{L_{i,t-1}}\right) = \lambda_0 + \beta_1 ln(n_{it}+g+\delta) + \beta_2 ln\left(s_{k_{it}}\right) + \beta_3 ln\left(h^*\right) \\ +\beta_4 ln\left(F_{it}\right) + \beta_5 ln\left(\frac{Y_{i,t-1}}{L_{i,t-1}}\right) + \eta_t + \mu_i + \upsilon_{it} \end{aligned} \tag{2.24}$$

[11] When I use LSDV and EGLS for the estimations, the results should not be biased by endogeity issue since there is no correlation be found between the error term and the independent variables.

$$\begin{aligned}\beta_5 &= e^{-\lambda t} - 1 \\ \mu_i &= (1 - e^{-\lambda t}) ln\,(A_0) \\ \eta_t &= g(t_2 - e^{-\lambda t} t_1)\end{aligned}$$

where, υ_{it} is the transitory error term. It captures province-specific and time invariant effect. In this chapter, h^* is level of human capital.

2.5 Estimation Results and Interpretation

The question we consider in our empirical analysis is twofold. Fist, we are interested in finding whether the data support the augmented Solow-Swan model's predictions about the determinants of economic growth. Second, we want to shed some light on the role played by foreign direct investment in fuelling Chinese growth since 1978 and in giving rise to the growing inter-regional disparities. All reported results in this section are based on the augmented Solow model as shown by Equation (2.24).

Columns (1) and (2) of Table 2.2 report the results of fixed- and random-effects models based on whole sample, respectively, without including foreign direct investment. The Hausman-test statistic of 26.18 suggests that we should reject the random-effects model in favor of the fixed-effects model. Therefore, our discussion below will focus on the results of the fixed-effects model.

All variables are significant at the 1% or 5% level and have the expected sign. The coefficient of human capital investment is positive, physical capital investment is positive and labor-force growth is negative as expected. Regional economic growth is positively related to investment in physical capital and human capital and negatively related to labor-force growth. The fact that the coefficient on initial logGDP per worker is -0.053 indicates

conditional convergence. Thus, controlling for the differences in the steady-state across provinces, poor provinces would tend to grow faster than rich ones. As far as the steady-states determinants are concerned, the augmented Solow growth model implies that the sum of coefficient of $ln(g+h+\delta)$ and s_k is equal to zero. In order to check if the coefficients are consistent with the economic theory, we further examine it by estimating a restricted regression (we use the Wald test for restriction, see Table 2.3 model 1). The F-statistic for the restriction of p value is 0.25. Hence, the validity of the restriction cannot be rejected at 5% significant level.

$$ln\left(\frac{Y_t}{L_t}\right) - ln\left(\frac{Y_{t-1}}{L_{t-1}}\right) = 0.6634 - 0.0439ln\left(\frac{Y_{t-1}}{L_{t-1}}\right) + 0.2014(ln(s_k) - ln(n+g+\delta)) \; + 0.1149ln(h^*) \tag{2.25}$$

The regression yields the adjusted R^2 is 0.58, significant at 1% level. In this model $e^{-\lambda t} - 1 = -0.0439$, so that we can again confirm conditional convergence.

We now turn to the question what happens when foreign direct investment per capita is brought into the analysis. At the empirical level, the introduction of foreign direct investment can alter the analysis of cross-province differences: in the first set of regressions, foreign direct investment is an omitted variable. The results with fixed- and random-effects are shown in column (3) and (4) of Table 2.2, respectively. In this model, the Hausman test yields a statistic of 25.56 and we again reject the random-effects specification. Our discussion below is still based on the results of the fixed-effect model.

Foreign direct investment measure enters significantly in the regression. It reduces the size of the coefficient on physical capital investment and increases the coefficient of human capital somewhat. Moreover, the inclusion of foreign direct investment improves the overall fit of the regression. The remaining variables in the regression strongly support the augmented Solow growth model. To check if the coefficient is consistent with the theory, we estimate the restricted regression again(see Table 2.3 model 2). The restriction that the co-

efficients on $ln(s_k)$ and $ln(n+g+\delta)$, and sum to zero is not rejected by the Wald test at 5% significant level.

$$ln\left(\frac{Y_t}{L_t}\right) - ln\left(\frac{Y_{t-1}}{L_{t-1}}\right) = 1.1856 - 0.0786ln\left(\frac{Y_{t-1}}{L_{t-1}}\right) + 0.1767(ln(s_k) - ln(n+g+\delta)) \\ +0.1846ln(h^*) + 0.0137ln(F) \tag{2.26}$$

The adjusted R^2 is increased to 0.64, significant at 1% level. In this model, $e^{-\lambda t} - 1 = -0.0786$ this again suggests conditional convergence at the provincial level in China. The implied speed of convergence, λ, is 0.01638, which means 1.638% of gap of income per capita between regional economies vanishes every year if their steady states are identical. The half-life of convergence, namely the time that it takes for half the initial gap to be eliminated, is about 42 years. Islam (1995) found convergence rates ranging between 0.038 and 0.091 (the latter obtained for a sample including only OECD countries). Although our estimate of the speed of convergence is lower than Islam's, we need to consider that for much of the analyzed period, China was a tightly regulated and centrally planned developing economy. With that in mind, the speed of convergence appears rather high. Finally, we estimate the elasticity of the physical investment to output, α,is approximately 0.69.

We can extend the analysis further by splitting the sample. In an important paper, Durlauf and Johnson (1995) split the MRW sample using 1960 income and literacy rates. They found evidence that technology parameters varied across the samples, suggesting that the assumption of a common technology is a poor one. Baumol (1986) coined the term "convergence clubs" to describe this phenomenon. We divided the sample into three sub-groups: Central, East and West (the provinces in each sub-sample are listed in Table 2.1). The Hausman test implies that the fixed-effect model is more appropriate: the test statistics values are 19, 0.98 and 14.66 for East, Central and West, respectively, while those of the augmented model are 37.44, 8.08 and 10.30). The regression results are presented in Table 2.4, Table 2.5 and Table 2.6.

Human capital is still negative and insignificant in Central region and in both regression models. The other coefficients have not only the predicted sign but also the expected magnitude. After adding foreign direct investment, the Central sub-sample switches from displaying divergence to convergence as shown in the restricted regression of Table 2.7 and the tendency toward convergence becomes even stronger in the West and East sub-samples. Moreover, the inclusion of foreign direct investment per capita improves the overall fit of the regressions. Foreign direct investment also appears to be an important determinant of income per capita: its coefficient estimate is positive and strongly significant. Again, focusing on the estimates of the structural parameters, we see that the implied rates of convergence, λ, for the Central, West, and East samples are 0.024, 0.026, and 0.036, respectively. The corresponding estimates of the output elasticity α with respect to capital are 0.40, 0.61, and 0.61, respectively. In all these cases, convergence was found to be much stronger within the groups. The restricted regressions (Table 2.7) again confirm these findings at 5% significant level. Hence, our analysis indicates that (1) there is slow conditional convergence among provinces in China as a whole; and (2) there is faster conditional convergence among "similar" sub-groups of provinces.

2.6 Conclusions

The objective of this chapter was to evaluate empirically the impact of FDI on economic growth of different provinces of China and, more generally, to examine if economic growth of China can be explained by the augmented Solow-Swan model. After the liberalization was initiated in 1978, China has become one of the main destinations for international capital flows. China has also defied the trend shared by virtually all post-communist countries in Eastern Europe whose liberalizations were followed by severe output contractions. Instead, China has experienced very high rates of growth for over a decade. China's experience is unique since its economy grew rapidly in the context of reforms that transformed it from a rigid central planning system to an increasingly open and market-based economy.

China's remarkable growth performance over the last three decades is widely attributed to foreign direct investment. Attracting foreign direct investment has been the main motivation of Chinese open-door policy (Chow, 2002). A good example of the success of this policy is the Shenzhen economic zone bordering Hong Kong created in 1982. Foreign investors could set up factories there to take advantage of the inexpensive and skilled labor and also of special tax breaks. In less than a decade Shenzhen developed from a piece of farmland to a modern city. As this example amply demonstrates, FDI inflows contributed not only to overall growth of the Chinese economy but also to increasing economic disparities across China's regions in line with the results of Fleisher et al (2009) which based on TFP growth model. Zhuhai and Shantou in Guangdong Province and Xiamen in Fujian Province also became special economic zones at that time, and all of them are among the most developed cities in China now. In contrast, other towns in the Guangdong province that are approximately as close to Hong Kong as Shenzhen have lagged far behind Shenzhen and the other special economic zones.

Our main finding is that the effect of FDI on economic growth in different provinces is positive and statistically significant[12]. More generally, our analysis indicates that the augmented Solow growth model appears to provide a good description of regional growth patterns in China over the period 1978-2008. Furthermore, the data display conditional convergence, after controlling for other determinants of growth, provinces that were initially poor tend to grow faster. After splitting the data into sub-samples, the evidence in favor of conditional convergence becomes even stronger, suggesting that regions within China may converge to different steady states.

The policy implications from our results should not be overlooked. China has experienced rapid economic growth over the last three decades, which has also resulted in increasing regional disparities. This was caused by the whims of central planning in the reform period and by the strategy of selective localized liberalization in the 1980s. For example, in

[12] We did robustness tests by adding more control variables, shown in the appendix and our finding about the FDI are not affected by the added variables.

terms of the geographical distribution, the Eastern areas accounted for about 85 percent of FDI in 1999 (Chow, 2002). Such regional disparities create social and political obstacles to the continuation of the strategy of selective localized liberalization and undermine the sustainability of such policies. To resolve it, the policy of Western and Central development should aim to help the laggards and to improve their productivity. The Western and Central areas of China should be granted the same privilege that the economic zones have, the government should invest much more capital in education as it did in Beijing and Shanghai. Finding evidence of ongoing convergence it does not imply that regions will achieve the same level of per capita income in the long run. Even in equilibrium, gaps in regional per capita income are likely to remain, reflecting differences in labor markets, industrial structure and natural-resource endowments.

2.7 Tables and Figures

Table 2.1. Sub-groups

Sample	Observations
East	Beijing, Tianjin, Shanghai, Liaoning, Shandong, Jiangsu, Zhejiang, Fujian, Guangdong, Hainan
Central	Hebei, Shanxi, Neimenggu, Jilin, Heilongjiang, Anhui, Jiangxi, Henan, Hunan, Hubei
West	Guangxi, Guizhou, Yunan, Sichuan, Shanxi, Gansu, Ningxia, Qinghai, Xinjiang

Table 2.2. Panel Regression of Five-Year Span Data: Test for Conditional Covergence Dependent Variable: Growth of GDP per Working-age Person

Variable	Model 1		Model 2	
	LSDV (fixed effect)	EGLS (random effects)	LSDV (fixed effects)	EGLS (random effects)
Constant	0.794674^{***} (0.260622)	0.294383^{*} (0.181991)	2.029187^{***} (0.365588)	1.127410^{***} (0.226508)
$ln(Y/L)_{t-1}$	-0.052676^{***} (0.020734)	-0.011377 (0.014042)	-0.134570^{***} (0.026342)	-0.064760^{***} (0.016190)
$ln(n+g+\delta)$	-0.186589^{***} (0.024918)	-0.187606^{***} (0.024077)	-0.130860^{***} (0.025937)	-0.148963^{***} (0.023226)
$ln(s_k)$	0.242925^{***} (0.260622)	0.164614^{***} (0.035252)	0.207590^{***} (0.039460)	0.150992^{***} (0.032970)
$ln(h^*)$	0.105744^{**} (0.050527)	0.058608 (0.037863)	0.251021^{***} (0.057681)	0.137620^{***} (0.038318)
$ln(F)$			0.039816^{***} (0.008885)	0.035743^{***} (0.006499)
Number of Observations	145	145	142	142
Adjusted R^2	0.58	0.44	0.65	0.53
F-statistic	7.12	29.01	8.86	33.13
Hausman Test	$\chi^2 = 26.18$		25.56	

Figures in parentheses are standard errors

$^{***}1\%$ signifant level, $^{**}5\%$ significant level, $^{*}10\%$significant level

Table 2.3. Test for Conditional Convergence by LSDV Estimation, Restricted Regression
Dependent Variable: Growth of GDP per working-age person

Variable	Model 1	Model 2
Constant	0.663415^{***}	1.185649^{***}
	(0.235155)	(0.284022)
$ln(Y/L)_{t-1}$	-0.043853^{**}	-0.078616^{***}
	(0.019319)	(0.021836)
$ln(s_k) - ln(n+g+\delta)$	0.201387^{***}	0.176682^{***}
	(0.021440)	(0.022211)
$ln(h^*)$	0.114929^{**}	0.184575^{***}
	(0.049979)	(0.053338)
$ln(F)$		0.013686^{***}
		(0.004476)
Number of Observations	145	142
Adjusted R^2	0.57	0.64
Wald Test of Restriction of P-Value	0.25	0.09
Implied λ	$8.968\,7 \times 10^{-3}$	1.6376×10^{-2}
Implied α	0.821 18	0.692 06

Figures in parentheses are standard errors

$^{***}1\%$ signifant level, $^{**}5\%$ significant level, $^{*}10\%$significant level

Table 2.4. Test for Conditional Convergence by LSDV Estimation, Unrestricted Regression
Dependent Variable: Growth of GDP per Working-age person, East

Variable	Model 1		Model 2	
	LSDV (fixed effects)	EGLS (random effects)	LSDV (fixed effects)	EGLS (random effects)
Constant	1.687464^{***} (0.551068)	1.112659^{***} (0.294175)	3.101302^{***} (0.582805)	1.189495^{***} (0.249347)
$ln(Y/L)_{t-1}$	-0.097487^{***} (0.035511)	-0.068673^{***} (0.018855)	-0.186700^{***} (0.037270)	-0.073938^{***} (0.015997)
$ln(n+g+\delta)$	-0.161982^{***} (0.038778)	-0.167706^{***} (0.033093)	-0.087929^{**} (0.037490)	-0.158143^{***} (0.028036)
$ln(s_k)$	0.269603^{***} (0.074564)	0.184202^{***} (0.064566)	0.189932^{***} (0.065760)	0.127352^{**} (0.057901)
$ln(s_h)$	0.269123^{***} (0.097115)	0.161056^{***} (0.061280)	0.438576^{***} (0.091975)	0.147291^{***} (0.051853)
$ln(F)$			0.057208^{***} (0.014316)	0.028116^{***} (0.009804)
Number of Observations	50	50	50	50
Adjusted R^2	0.54	0.38	0.67	0.43
F- Statistic	5.42	8.46	8.26	8.31
Hausman Test	$\chi^2 = 19.00$		$\chi^2 = 37.44$	

Figures in parentheses are standard errors

$^{***}1\%$ signifant level, $^{**}5\%$ significant level, $^{*}10\%$significant level

Table 2.5. Test for Conditional Convergence by LSDV Estimation, Unrestricted Regression
Dependent Variable: Growth of GDP per Working-age person, Central

Variable	Model 1		Model 2	
	LSDV (fixed effects)	EGLS (random effects)	LSDV (fixed effects)	EGLS (random effects)
Constant	0.287947 (0.488434)	0.262356 (0.460740)	2.641572*** (0.754331)	0.675044 (0.555138)
$ln(Y/L)_{t-1}$	−0.022539 (0.046697)	−0.0017795 (0.041016)	−0.207436*** (0.060181)	−0.044143 (0.043174)
$ln(n+g+\delta)$	−0.207084*** (0.054332)	−0.195360*** (0.055275)	−0.134659** (0.056063)	−0.172603*** (0.054788)
$ln(s_k)$	0.334793*** (0.090091)	0.303385*** (0.072866)	0.383026*** (0.072764)	0.306302*** (0.069808)
$ln(h^*)$	−0.053815 (0.054332)	−0.047299 (0.099971)	0.176002 (0.110289)	−0.024344 (0.105434)
$ln(F)$			0.052399*** (0.014405)	0.020879 (0.012913)
Number of Observations	50	50	48	48
Adjusted R^2	0.53	0.49	0.70	0.53
F- Statistic	5.28	12.64	9.00	11.61
Hausman Test	$\chi^2 = 0.98$		$\chi^2 = 8.08$	

Figures in parentheses are standard errors

***1% signifant level, **5% significant level, *10%significant level

Table 2.6. Test for Conditional Convergence by LSDV Estimation, Unrestricted Regression
Dependent Variable: Growth of GDP per Working-age person, West

Variable	Model 1		Model 2	
	LSDV (fixed effects)	EGLS (random effects)	LSDV (fixed effects)	EGLS (random e ffects)
Constant	1.341237^{***} (0.251705)	0.512157 (0.322876)	1.721576^{***} (0.227778)	1.046867^{***} (0.401439)
ln(Y/L)$_{t-1}$	-0.134987^{***} (0.024447)	-0.064347^{**} (0.032142)	-0.145969^{***} (0.017570)	-0.097368^{***} (0.035748)
$ln(n+g+\delta)$	-0.188137^{***} (0.034320)	-0.249601^{***} (0.039669)	-0.152802^{***} (0.030547)	-0.224778^{***} (0.041230)
$ln(s_k)$	0.340481^{***} (0.072461)	0.110390^{*} (0.057066)	0.320352^{***} (0.071398)	0.125468^{**} (0.057664)
$ln(h^*)$	0.080798^{*} (0.042455)	0.111889^{**} (0.048312)	0.121935^{***} (0.037565)	0.155243^{***} (0.052159)
$ln(F)$			0.024328^{**} (0.009559)	0.021584^{**} (0.009186)
Number of Observations	45	45	44	44
Adjusted R^2	0.76	0.54	0.81	0.58
F- Statistic	12.69	13.73	15.23	12.73
Hausman Test	$\chi^2 = 14.66$		$\chi^2 = 10.30$	

Figures in parentheses are standard errors

$^{***}1\%$ signifant level, $^{**}5\%$ significant level, $^{*}10\%$significant level

Table 2.7. Test for Conditional Convergence by LSDV Estimation, Restricted Regression Dependent Variable: Growth of GDP per working-age person

Sample	East		Central		West	
provinces number	10		10		9	
	Model 1	Model 2	Model 1	Model 2	Model 1	Model 2
Constant	1.281221^{***} (0.446698)	2.725972^{***} (0.524362)	-0.022740 (0.466285)	1.576784 (1.038667)	1.036070^{***} (0.191576)	1.414862^{***} (0.207100)
$ln(Y/L)_{t-1}$	-0.074044^{***} (0.030297)	-0.165093^{***} (0.034375)	0.008603^{***} (0.045098)	-0.113146 (0.086504)	-0.109827^{***} (0.021530)	-0.122443^{***} (0.015542)
$ln(s_k) - ln(n+g+\delta)$	0.186733^{***} (0.033507)	0.110879^{***} (0.034164)	0.218377^{***} (0.055205)	0.179120^{***} (0.058189)	0.225678^{***} (0.027901)	0.193849^{***} (0.026169)
$ln(h^*)$	0.240483^{**} (0.095025)	0.412586^{***} (0.091277)	-0.013378 (0.100284)	0.209071 (0.164091)	0.120611^{***} (0.038153)	0.163882^{***} (0.035907)
$ln(F)$		0.057594^{***} (0.014503)		0.035890^{*} (0.021099)		0.024833^{**} (0.010338)
Number of Observations	50	50	50	48	45	44
Adjusted R^2	0.53	0.67	0.51	0.51	0.74	0.78
Wald Test P-Value	0.22	0.17	0.15	0.09	0.10	0.09
Implied λ	1.5386×10^{-2}	3.6087×10^{-2}		$2.401\,5 \times 10^{-2}$	2.3268×10^{-2}	$2.612\,3 \times 10^{-2}$
Implied α	0.716 06	0.401 78		0.612 87	0.672 65	0.612 88

Figures in parentheses are standard errors. *** 1% significant level, **5% significant level, 10% significant level

2.A Appendix

Speed of Convergence (λ) in the Solow Model

Following the modern empirical growth literature, starting with the framework of Mankiw, Romer and Weil (1992), Solow model is expressed in terms of capital per effective worker k, with Cobb-Douglas producction function $y = k^{\alpha}$, saving rate s, depreciation rate δ, rate of population growth n, and rate of technological progress g. The fundamental equation of motion is

$$\dot{k} = sy - (n + g + \delta)k = sk^{\alpha} - (n + g + \delta)k \tag{2.27}$$

In the steady state, $\dot{k} = 0$,which implies

$$k^{*} = (\frac{s}{n + g + \delta})^{\frac{1}{1-\alpha}} \tag{2.28}$$

The growth rate of k can be expressed as follows:

$$g_k \equiv sk^{\alpha-1} - (n + g + \delta) \equiv G(k) \tag{2.29}$$

In the steady state, $g_k^{*} = G(k^{*}) = 0$

To compute the speed of convergence, take the first-order of $G(k)$ approximate around the steady satate k^{*}:

$$G(k) \approx G(k^{*}) + G^{'}(k^{*})(k - k^{*}) \tag{2.30}$$

Substituting the derivative $G'(k)$ of Equation 2.29, it obtains:

$$G(k) \approx (\alpha - 1)s(k^*)^{\alpha-1}(\frac{k - k^*}{k^*}) \tag{2.31}$$

Substituting Equation 2.28, yields:

$$g_k \approx -(1 - \alpha)(n + g + \delta)(\frac{k - k^*}{k^*}) \tag{2.32}$$

λ is the rate of convergence, $\lambda = (1 - \alpha)(n + g + \delta)$. It measures how quickly k increases when $k < k^*$

Taking the first-order Talor approximation of lnk around the steady state k^*

$$lnk \approx lnk^* + \frac{1}{k^*}(k - k^*) \tag{2.33}$$

and

$$(\frac{k - k^*}{k^*}) \approx (lnk - lnk^*) \tag{2.34}$$

Substituting Equation 2.34 into Equation 2.32

$$g_k \approx -(1 - \alpha)(n + g + \delta)(lnk - lnk^*) \tag{2.35}$$

$y = k^\alpha$, it implies $lny = \alpha lnk$,

$$g_y = \frac{\dot{y}}{y} = \frac{dlny}{dt} = \alpha\frac{dlnk}{dt} = \alpha\frac{\dot{k}}{k} = \alpha g_k \tag{2.36}$$

So,

$$g_y \approx -(1 - \alpha)(n + g + \delta)(lny - lny^*) \tag{2.37}$$

$\lambda = (1 - \alpha)(n + g + \delta)$ is the speed of convergence. It measures how quickly y increases when $y < y^*$.

Table 2.8. Panel Regression of Five-Year Span Data: Test for Conditional Covergence Dependent Variable: Growth of GDP per Working-age Person

Variable	Model 1	Model 2	Model 3	Model 4
	LSDV (fixed effect)	LSDV (fixed effect)	LSDV (fixed effects)	LSDV (fixed effect)
Constant	2.029187^{***} (0.365588)	1.844032^{***} (0.382173)	1.822943^{***} (0.381313)	2.029117^{***} (0.386492)
$ln(Y/L)_{t-1}$	-0.134570^{***} (0.026342)	-0.129789^{***} (0.027474)	-0.128385^{***} (0.027227)	-0.134565^{***} (0.028193)
$ln(n+g+\delta)$	-0.130860^{***} (0.025937)	-0.117904^{***} (0.025946)	-0.117793^{***} (0.025855)	-0.130862^{***} (0.026211)
$ln(s_k)$	0.207590^{***} (0.039460)	0.240252^{***} (0.260622)	0.240901^{***} (0.040507)	0.207592^{***} (0.039765)
$ln(h^*)$	0.251021^{***} (0.057681)	0.291456^{***} (0.050527)	0.251021^{***} (0.057681)	0.251014^{***} (0.059100)
$ln(F)$	0.039816^{***} (0.008885)	0.030171^{***} (0.050527)	0.029894^{***} (0.009459)	0.039816^{***} (0.008983)
$ln(T)$		-0.001414 (0.005366)		$-3.16E-06$ (0.005491)
$ln(E)$			-0.002319 (0.005246)	
$Ln(G)$		-0.126780^{***} (0.047427)	-0.127915^{***} (0.047471)	
Number of Observations		142	142	142
Adjusted R^2	0.65	0.66	0.66	0.64
F-statistic	8.86	8.95	8.97	8.52
Hausman Test	25.56	$\chi^2 = 23.82$	23.92	24.69

Figures in parentheses are standard errors

$^{***}1\%$ signifant level, $^{**}5\%$ significant level, $^{*}10\%$significant level

T is the "trade openness/ GDP"

E is the "export/ GDP"

G is the "government spending/ GDP"

Table 2.9. Panel Regression of Five-Year Span Data: Test for Conditional Covergence Dependent Variable: Growth of GDP per Working-age Person

Sample	East	Central	West
Provinces Number	10	10	9
variables	(fixed effects)	(fixed effects)	(fixed effects)
Constant	3.048816^{***} (0.617453)	2.582027^{**} (1.187220)	1.715380^{***} (0.232050)
$ln(Y/L)_{t-1}$	-0.182282^{***} (0.040700)	-0.134570^{***} (0.026342)	-0.064760^{***} (0.016190)
$ln(n+g+\delta)$	-0.090222^{**} (0.038797)	-0.154722^{***} (0.059735)	-0.151766^{***} (0.031381)
$ln(s_k)$	0.191698^{***} (0.066912)	0.302195^{***} (0.090230)	0.324076^{***} (0.074092)
$ln(h^*)$	0.436039^{***} (0.093608)	0.224298 (0.166523)	0.120721^{***} (0.038476)
$ln(F)$	0.056252^{***} (0.014873)	0.040955^{*} (0.021961)	0.024703^{**} (0.009870)
$ln(T)$	−0.002282 (0.007834)	0.052566 (0.073486)	−0.001848 (0.006479)
Number of Observations	50	48	44
Adjusted R^2	0.67	0.53	0.80
F-statistic	7.52	4.57	13.66

Figures in parentheses are standard errors

$^{***}1\%$ signifant level, $^{**}5\%$ significant level, $^{*}10\%$significant level

T is the "trade openness/ GDP"

Table 2.10. FDI inflows by source country (in 10000 US dollars)

	1994	1995	1996	1997	1998	1999	2000	2001
Hong Kong	1982268 (58.40%)	2018511 (53.39%)	2085160 (49.49%)	2155111 (41.14%)	1850836 (40.71%)	1636305 (40.58%)	1549998 (38.07%)	1671730 (35.66%)
Virgin Islands	12827 (0.38%)	30376 (0.80%)	53761 (1.28%)	171730 (3.28%)	403134 (8.87%)	265896 (6.59%)	383289 (9.41%)	504234 (10.76%)
Japan	208616 (6.15%)	321247 (8.50%)	369214 (8.76%)	439037 (8.38%)	340036 (7.48%)	297308 (7.37%)	291585 (7.16%)	434842 (9.28%)
Korea	72612 (2.14%)	104710 (2.77%)	150416 (3.57%)	222763 (4.25%)	180320 (3.97%)	127473 (3.16%)	148961 (3.66%)	215178 (4.59%)
US	249082 (7.34%)	308373 (8.16%)	344417 (8.17%)	346117 (6.61%)	389844 (8.58%)	421586 (10.46%)	438389 (10.77%)	443322 (9.46%)
UK	68884 (2.03%)	91520 (2.42%)	130193 (3.09%)	185956 (3.55%)	117486 (2.58%)	104449 (2.59%)	116405 (2.86%)	105166 (2.24%)
Germany	26412 (0.78%)	39053 (1.03%)	51887 (1.23%)	100858 (1.93%)	73673 (1.62%)	137326 (3.41%)	104149 (2.56%)	121292 (2.59%)
France	19340 (0.57%)	28702 (0.76%)	42465 (1.01%)	47586 (0.91%)	71489 (1.57%)	88429 (2.19%)	85316 (2.10%)	53246 (1.14%)
Taiwan	339134 (9.99%)	316516 (8.37%)	348202 (8.26%)	334234 (6.38%)	291521 (6.41%)	259870 (6.45%)	229658 (5.64%)	297994 (6.36%)
Singapore	117961 (3.47%)	186061 (4.92%)	224716 (5.33%)	260696 (4.98%)	340397 (7.49%)	264249 (6.55%)	217220 (5.34%)	214355 (4.57%)
Macao	50944 (1.50%)	43982 (1.16%)	60628 (1.44%)	40325 (0.77%)	42157 (0.93%)	30864 (0.77%)	34728 (0.85%)	32112 (0.69%)
Others	246504 (7.26%)	291518 (7.71%)	352457 (8.36%)	934321 (17.83%)	445382 (9.80%)	398116 (9.87%)	471783 (11.59%)	594288 (12.68%)
Total FDI inflow	3394584 (100%)	3780569 (100%)	4213516 (100%)	5238734 (100%)	4546275 (100%)	4031871 (100%)	4071481 (100%)	4687759 (100%)

Figures in parentheses are in percentage of Total FDI inflows

Sources: National Bureau of Statistic of China

This Table is based on data for utilized (not contracted) FDI

Table 2.11. FDI inflows by source country (in 10000 US dollars)

	2002	2003	2004	2005	2006	2007	2008
Hong Kong	1786093 (33.86%)	1770010 (33.08%)	1899830 (31.33%)	1794879 (29.75%)	2023292 (32.11%)	2770342 (37.05%)	4103640 (44.41%)
Virgin Islands	611739 (11.60%)	577696 (10.80%)	673030 (11.10%)	902167 (14.96%)	1124758 (17.85%)	1655244 (22.14%)	1595384 (17.27%)
Japan	419009 (7.94%)	505419 (9.45%)	545157 (8.99%)	652977 (10.82%)	459806 (7.30%)	358922 (4.80%)	365235 (3.95%)
Korea	272073 (5.16%)	448854 (8.39%)	624786 (10.30%)	516834 (8.57%)	389487 (6.18%)	367831 (4.92%)	313532 (3.39%)
US	542392 (10.28%)	419851 (7.85%)	394095 (6.50%)	306123 (5.07%)	286509 (4.55%)	261623 (3.50%)	294434 (3.19%)
UK	89576 (1.70%)	74247 (1.39%)	79282 (1.31%)	96475 (1.60%)	72610 (1.15%)	83094 (1.11%)	91401 (0.99%)
Germany	92796 (1.76%)	85697 (1.60%)	105848 (1.75%)	153004 (2.54%)	197871 (3.14%)	73397 (0.98%)	90049 (0.97%)
France	57560 (1.09%)	60431 (1.13%)	65674 (1.08%)	61506 (1.02%)	38269 (0.61%)	45601 (0.61%)	58775 (0.64%)
Taiwan	397064 (7.53%)	337724 (6.31%)	311749 (5.14%)	215171 (3.57%)	213583 (3.39%)	177437 (2.37%)	189868 (2.05%)
Singapore	233720 (4.43%)	205840 (3.85%)	200814 (3.31%)	220432 (3.65%)	226046 (3.59%)	318457 (4.26%)	443529 (4.80%)
Macao	46838 (0.89%)	41660 (0.78%)	54639 (0.90%)	60046 (1.00%)	60290 (0.96%)	63700 (0.85%)	58161 (0.63%)
Others	725426 (13.75%)	823038 (15.38%)	1108094 (18.28%)	1052845 (17.45%)	1209532 (19.19%)	1301141 (17.40%)	1635536 (17.70%)
Total FDI inflow	5274286 (100%)	5350467 (100%)	6062998 (100%)	6032459 (100%)	6302053 (100%)	7476789 (100%)	9239544 (100%)

Figures in parentheses are in percentage of Total FDI inflows

Sources: National Bureau of Statistic of China

This Table is based on data for utilized (not contracted) FDI

Table 2.12. Total Capital inflow and FDI inflow (in 10000 US dollars)

	FDI inflow	Total Capital inflow	the share of FDI in Total Capital inflow
1984	125800.00	412800.00	30.47%
1985	166100.00	953100.00	17.43%
1986	187400.00	1139300.00	16.45%
1987	231400.00	974000.00	23.76%
1988	319400.00	1111400.00	28.74%
1989	339200.00	1213300.00	27.96%
1990	348700.00	1161100.00	30.03%
1991	436600.00	1285900.00	33.95%
1992	1100700.00	2764200.00	39.82%
1993	2751500.00	5035300.00	54.64%
1994	3376700.00	6078900.00	55.55%
1995	3752100.00	6606700.00	56.79%
1996	4172500.00	6972100.00	59.85%
1997	4525700.00	11117998.00	40.71%
1998	4546300.00	8932679.00	50.90%
1999	4041200.00	9175393.90	44.04%
2000	4077200.00	9198639.20	44.32%
2001	4684600.00	9953113.50	47.07%
2002	5274300.00	12832130.60	41.10%
2003	5350500.00	21963061.20	24.36%
2004	6063000.00	34335015.10	17.66%
2005	8550641.00	41895620.00	20.41%
2006	8656741.00	65327625.00	13.25%
2007	14962371.00	92196070.00	16.23%
2008	16087818.00	76987609.00	20.90%

Sources: National Bureau of Statistic of China and "Comprehensive Statistical Data and Materials 50 Years of New China"

1984-2004 is based on data for utilized FDI, 2005-2008 is based on data for contracted FDI

Chapter 3
Unemployment, Growth and Transition in China

3.1 Introduction

China has been experiencing rapid economic growth since it initiated economic reform in 1978, changing gradually from a planned to a market economy. However, unemployment has increased significantly during the last two decades, and has become one of the most pressing problems of the Chinese economy today. Intuitively, we should expect the high output growth rate to reduce unemployment. This would be in line with Okun's Law, one of the basic rules of macroeconomics, which postulates an inverse relationship between output growth and changes in unemployment (Okun, 1962). Arthur Okun, using U.S. data, concluded that "in the post-war period, on the average, each extra percentage point in the unemployment rate above four percent has been associated with about a three percent decrement in real GNP." Previous studies have largely confirmed the existence of the trade-off between unemployment and output in mature market economies (Izyumov and Vahaly, 2002). This chapter asks the question whether the direction of the link between output and unemployment changes in China is the same as that found in mature market economies. The main consideration is how unemployment will affect China's economic growth and economic reform progress overall.

The process of economic transition has had a major impact on the urban labor market in China. China, like other former communist countries, started its transition from a situation of permanent full employment. Before the reform, the employment system consisted of three key components: First, when an urban worker was assigned to a post, he/she would enjoy a life-long employment without fear of dismissal and unemployment. Second, the

hukou system of household registration restricted the ability of residents to move between rural and urban areas and across regions. Third, there was a host of welfare policies including rationing of basic necessities, urban exclusive social security policy and other public service provision policies which effectively prevented labor mobility and equal treatment of residents in rural and urban areas (Cai and Wang, 2010). After the reform of urban employment system was accomplished and the "iron rice bowl"[13] was broken, labor allocation became mostly market-based. Privatization of state owned enterprises and unemployment in urban areas emerged during the period of economic transition and structural adjustment in the late 1990s (Cai and Wang, 2010). Around ten million workers were laid off from state owned enterprises and urban collectives in 1996, and again in 1997 (Qian, 1999)

There are only a few previous studies on this issue of China and those restricted their attention to the relationship between growth and unemployment at the aggregate level and they ignore the regional aspects of this relationship (see Wu, 2003, Cai and Wang, 2010). However, the progress of reform has been uneven and the benefits of economic reform differ across regions. As a result, there are large differences in the degree of economic development between the three broad regions of China: EAST, CENTRAL and WEST. During this transition, the coastal areas in the East have particularly benefited from the open-door policy, developing much more quickly than the interior areas in the Central and Western regions. Therefore, an examination of the growth-unemployment relationship at the regional level is as important and interesting as the aggregate level analysis.

This chapter is organized as follows: Section 2 tests the Okun's type relation in China at both national level and regional level, focusing on two sub-periods. We anticipate Okun's Law to be stronger in the Eastern region than in the interior regions. Section 3 focuses on the interaction between the unemployment and growth both at national level and regional level. We expect the relationship between unemployment and growth to be weak or non-existent during the early stage of market transition. Rather, the relationship should

[13] It is a Chinese term used to refer to an occupation with guaranteed job security, as well as steady income and benefits.

emerge only as market reforms progress. In section 4, we discuss the linkage between unemployment rate and the speed of transition as postulated by the Aghion- Blanchard model. Section 5, conclusions and policy implication.

3.2 Background of China's labor market

Before the initiation of reform in 1978, China's urban labor market was characterized by a system of centrally fixed wages and lifetime secured employment. Under central planning, particularly in SOEs, the State Ministry of Labor operated a centrally controlled employment plan with individual firms being allocated an annual employment quota. In addition, firms were not allowed to dismiss workers and employee's mobility were also strictly limited (White, 1988). Wages were set according to a wage grid, originally taken over from the Soviet model. It classified workers into eight levels based on an individual's personal endowments and work experience but in practice it was determined more by seniority or age (Coady and Wang, 2000).

In order to provide improved incentives for greater enterprise and individual productivity, labor market reforms were introduced in the mid-1980s (Coady and Wang, 2000). The major labor market reforms in the urban sector included the introduction of bonus wages and labor contract system. The new wage system separated total wages into two components: standard (including basic wage, position wage, tenure wage and work-related allowances) and bonus wages. Since labor contract was introduced from 1986 up until 1996, the new entrants into the labor force became to rely more on the market mechanism for allocations, but the employment mechanism of the labor stock was not marketized (Lu and Jiang, 2008).

Prior to the early 1990s, reforms were aimed at improving managerial and worker incentives of state enterprises, thus encouraging the entry of non-state firms as well as fostering competition. After 1996, the employment system of the labor stock was quickly marke-

tized. Privatization of state owned enterprises was initiated and unemployment in urban[14] areas emerged during the period of economic transition and structural adjustment in the late 1990s (Cai and Wang, 2010). Cai and Wang (2010) state that it was only after the reform of urban employment system was accomplished and the "iron rice bowel" was broken, by and large, that labor allocation became mostly maket-based. They also point out that during that period not only a lay-off subsidy program was implemented by the government, an unemployment insurance system, a basic pension regime, and a minimum living standard program were built up to protect urban workers but also set a liberalized labor market regulations to encourage labor mobility. As a result, the employment structure has diversified. Dong and Xu (2009) show that China has successfully moved toward a functioning labor market by examining the patterns and determinants of the labor restructuring process in China using two large firm-level datasets for the period between1998-2002. In the process of labor market reform, the market mechanism has taken an increasingly important role in the determination of a person's income. However, Lu and Jiang (2008) mention that given the institutional background of the labor market, in SOEs, employees' negotiating power was very weak because of the weakness of trade unions as in reality, trade unions are subordinate organizations established within enterprises by the Party and governments. Furthermore, although the household registration system became much more flexible, there still exists serious segmentation in China's labor market as local governments aim to protect local urban residents.

3.3 Does Okun's type relationship exist in China?

[14] In rural areas, the household responsibility system gurantees that everybody has his or her share of land, so it is a reasonable assumption that rural unemployment is negligible since laborers either work in non-argricultural sectors or in argriculture.

3.3.1 Literature review

Okun's law is a macroeconomic relation between output growth and unemployment change. Okun's law states that, on average, each extra percentage point in the unemployment rate above four percent has been associated with about a three percent decrease in real GNP over the post-war period (Okun, 1962; pp.99). It is one of the basic rules of macroeconomics. The aggregate supply curve is derived by combining Okun's relation with the Philips curve (Moosa, 1997). In addition, it is used as a benchmark for measuring the cost of unemployment (Moosa, 1997).

The negative sign of the Okun's coefficient has been confirmed in the literature, although its magnitude coefficient is sensitive to the model specification, choice of control variables, econometric methods and sample periods. Smith (1975), Gordon (1984), Weber (1995) and Prachowny (1993) re-estimate the Okun's relationship based on US data and the coefficient varies with the different methodology used, such as ordinary least square, autoregressive transformation instrumental variable procedure, cyclical data series, and other factors added in. Kaufman (1988), Lee (2000), and Moosa (1999) evaluate the Okun relationship in order to check the robustness based on a cross-country (6 industrial countries, 16 OECD countries, and G7 countries, respectively). They find significant differences among them. In addition, Lee (2000) points out that the results are sensitive to the choice of "first-difference" model or the "gap" model. Courtney (1991, see Harris and Silverstone, 1993) first presents the idea of asymmetry that Okun's coefficient may be different in expansions and contractions. Harris and Silverstone (2001) test the Okun's coefficient in an asymmetric model for seven OECD countries (Australia, Canada, Germany, Japan, New Zealand, the United Kingdom and the United States). They find that some results only can be obtained with the asymmetric model rather than standard estimation of Okun's law. Silvapulle et al (2004) show that their results support Okun's law being asymmetric based on US data over the post-war period.

Furthermore, Izyumov and Vahaly (2002) detect Okun's relationship in 25 transition countries. They divided the sample into two groups, leaders and laggards and show that transition countries establish a normal Okun's relationship as the market transition progressed.

Although the empirical study of Okun's law has indeed blossomed, especially, in studying developed countries, little attention has been paid to study whether Okun's type relationship exists in China. Nevertheless, a lot of Chinese economists and politicians studied Okun's type relation in China by using different methods and different time spans. Wu (2003) find Okun's law to be non-linear in China over the period 1988-1998. However, most of them found that Okun's Law does not work in China. This is explained by reasons such as structural unemployment, frictional unemployment and so on.

3.3.2 Model and Data

In Okun's original article (Okun, 1962), there are two standard model specifications: the "first-difference" model and the "gap" model. The "first-difference" model uses the real GDP (GNP) growth and the first difference of unemployment, as given by the following expression:

$$\Delta U = a - b(\Delta Y/Y) \tag{3.38}$$

From the point of view of the "gap" model, the difference between the observed and natural rate of unemployment represents the cyclical rate of unemployment and the difference between the observed and potential GDP captures the cyclical level of output. The specification is given by the expression.

$$\Delta U = a + b(gap) \tag{3.39}$$

For China, like other transition countries, there are no reliable estimates of potential GDP, NAIRU, or similar macroeconomic benchmarks (Izyumov and Vahaly, 2002). So, only the first-difference model seems feasible for our study. We follow Izyumov and Vahaly (2002) and use the equation.

$$\begin{gathered} y_{i,t} - y_{i,t-1} = \alpha + \beta(u_{i,t} - u_{i,t-1}) + \varepsilon_{i,t} \\ i = 1, 2, 3, ...m, provinces \\ t = 1, 2, 3, ...n, years \end{gathered} \tag{3.40}$$

Where $y_{i,t}$ is represents the log of observed real output (GDP) of province i, $u_{i,t}$ is the observed unemployment rate of province i, α is the intercept estimating the average real GDP growth rate; β is the Okun coefficient; and $\varepsilon_{i,t}$ is the usual disturbance term. The Okun's law suggests that the growth rate of output is negatively related to the changes of unemployment rate ($\beta < 0$).

Output is measured by the real provincial GDP. Unemployment is the provincial registered urban unemployment rate. Annual data were obtained from the Chinese National Statistical Bureau and China labour statistical yearbook. Chongqing and Tibet are excluded due to lack of data. The period is 1997-2006 as market mechanism become more prominent in the determination of employment and output and could be expected to operate more normally during the period (Izyumov, and Vahaly, 2002).

Unemployment measurement in China is also inadequate, as some other former communist countries. Rural residents tend to be under employed rather than unemployed because they often work at least some hours on the family farm (Giles et al., 2005). Furthermore, neither hidden unemployed people nor laid-off workers (xia gang) are counted as unemployed (Jackman, 1998; Clarke and Borisov, 1999). There are some plausible explanations: Gu (1999) explains that this is because they are still maintaining employment relations with their enterprise by living in company-owned houses and/or having National Insurance paid by their enterprises and therefore are not required to register as unemployed. Giles et al. (2005) think that substantial numbers of officially laid off (xia gang) workers may actually

be working part- or full-time or may no longer be looking for work. There are a number of alternative estimates calculated based on published government data on employment, registered unemployment, and officially laid off (xia gang[15]) workers. However, Giles et al. (2005) point out that estimates based on administrative data are subject to potentially serious shortcomings and none of them are calculated in a way that is consistent with the standard international practice. They present "true" unemployment rates calculated based on data from the 2002 follow-up survey to the China Urban Labor Survey which follows international practice in defining unemployment. Interestingly and surprisely, the correlation between the official urban registered unemployment rates and their "true" unemployment rate, which includes laid off, is very high (0.98). Therefore, the difference in the definition of the unemployment rate should not substantially affect the direction of the findings of this study. So, in this chapter we use the official urban registered unemployment as a proxy instead of the "true" unemployment rates, as the latter is only available limited years.

3.3.3 Empirical Results

The question we consider in our empirical analysis is whether Okun's type relationship exists at the national and the regional level. All reported results in this section are based on the Okun's "first difference" model (Equation (3.38)) with LSDV (Least Square Dummy Variables). The regional analysis is carried out in panel framework.

The Okun's type relationship is tested based on the whole data by Equation (3.40). Table 3.13 reports the results. The Okun's coefficient is insignificant and negative for the full period, 1997-2006. When we consider sub-periods, the coefficient is positive but insignificant for the early period (1997-2001). However, we find support for Okun's law during the later period, 2002-2006.

[15] For "laid off", China uses the term, "xia gang", it implies that those not working are still retained by their original units with partial pay.

Besides the analysis for sub periods, we further split the sample into three regional sub-groups (EAST, CENTRAL and WEST) shown in Table 3.14. The results for EAST, CENTRAL and WEST are reported in Table 3.15. Those for EAST and CENTRAL are quite similar: they both have significant and negative coefficients which are consistent with the pattern observed for developed countries. When considering sub-periods, the coefficients are again insignificant and negative for early sample period 1997-2001. For the later period, 2002-2006, the coefficients are significant and negative which implies Okun's type relationship present. However, the WEST appears quite different from EAST and CENTRAL. During the period 1997-2006, the estimated coefficient is highly significant and positive. The results for sub periods are insignificant.

3.3.4 Summary

This section has examined the Okun's type of relationship in China, both for the country as a whole and for broad regional groups that reflect the different progress that different parts of China have made towards liberalizing and opening the economy. When considering the full period, we find that Okun's Law does not hold for the whole sample, but it is found to be valid in the EAST and CENTRAL sub-samples. These results are in line with the results of Izyumov and Vahaly (2002) who examine the post-communist transition countries and find that Okun's Law only holds in those countries that have made enough progress in market-oriented reform. The pattern observed in the WEST sub-sample, however, goes against Okun's law: during the full period, 1997-2006, the relationship between the GDP growth rate and changes of unemployment rate is in fact positive and highly significant while it is not significant in either of the sub-periods. These differences in the nature of the relationship between growth and unemployment may be driven by the uneven progress in implementing economic reform in China. The coastal areas of the EAST region were exposed to reform measures and the market economy much earlier than the interior areas of CENTRAL and especially WEST. This would explain also why Okun's relation can be

detected in the later sub-period for EAST and CENTRAL but not during the earlier one and in neither sub-period for WEST. We address this issue in the following two sections.

3.4 The relationship between growth rate and unemployment rate

3.4.1 Theoretical results and empirical evidence

The bulk of the existing theoretical literature has focussed on the effects of growth on unemployment. A significant innovation occurred with Pissarides (1990) who derives a theoretical model that is the first to introduce the link between long run growth and unemployment, and argues that a higher rate of productivity growth reduces unemployment through a positive "capitalization effect" of investment on job creation. Building up on Pissarides (1990), Aghion and Howitt (1994) develop a model that combines "capitalization" and "creative destruction". The capitalisation effect reflects the fact that an increase in growth raises the capitalised returns by decreasing the discount rate which increases the present benefit of entry and hence increases the number of job openings. This, in turn, reduces the equilibrium rate of unemployment. This stands in contrast to the creative destruction effect, according to which an increase in growth may reduce the life time of production units[16] and thus raises the equilibrium level of unemployment by raising the job separation rate. In order to take advantage of innovation, the old machines need to be shut down by the firm. When this happens, workers become unemployed until matched with a new machine. Aghion and Howitt show that the 'creative destruction' effect dominates at low growth rates while the 'capitalisation' effect dominates at high ones, leading to a hump shaped relationship between unemployment and growth. The sign of the relationship between growth and unemployment therefore can be either positive or negative.

[16] Aghion and Howitt (1994) explain that each production unit consists of (1) a machine embodying a technology of some vintage t, (2) a worker, appropriately matched with the machine, (3) a (variable) amount of human capital.

Hoon and Phelps (1997) show that no relationship exists in the long run between the rate of growth and unemployment in their model. Acemoglu (1997) proposes a simple extension of the standard search model of Diamond, Mortensen and Pissarides (see Pissarides, 1990) and discusses the link between skills and technological change and the interaction of unemployment and technology. He also explains that technological progress is likely to be slower in labor markets where job tenure is low. Mortensen and Pissarides (1998) develop a model that analyzes both the capitalization and creative destruction effects. They suggest that it is not easy to find clear-cut associations between growth and unemployment in aggregate data since technological progress can lead to job destruction but can also create new jobs because of innovation.

There is similarly no concensus in the previous empirical literature regarding the sign of the correlation between growth and unemployment either across countries or across longer periods of time within the same country. A number of authors, such as Saint-Paul (1993), argue that there is a positive relationship between unemployment and productivity growth. Davis and Haltiwanger (1992) suggest the possibility of a positive long-run relationship between growth and unemployment, since they show that periods of high unemployment tend to be periods of high job-turnover at the establishment level. Caballero (1993), in a time-series framework with quarterly data, finds evidence of a weak positive relationship between growth and unemployment in the UK and US between 1966 and 1989. Hoon and Phelps (1997) confirm their theory-based hypothesis in their analysis of G7 countries: they find that increases in the unemployment rate tend to slow down productivity growth. Muscatelli and Tirelli (2001) find negative correlation for five G7 economies (Japan, Germany, Italy, France, Canada). Bean and Pissarides (1993) show that bivariate correlation between unemployment and growth can be either positive or negative depending on the differences in economic structures across OECD economies.

The above literature focuses on the effect of growth on unemployment. However, there are also likely to be forces running in the other direction, which is also of interest. High unemployment may have an adverse effect on growth in the presence of a learning-by-

doing, reduction of the pool of saving available for investment in physical or human capital or knowledge-creating activities (Bean and Pissarides, 1993).

3.4.2 Empirical methodology and data

In order to examine the interaction between the growth rate and unemployment rate, we adopt panel data approach with fixed effects. We investigate the impact of growth on unemployment and unemployment on growth, respectively.

This section uses the same data sets as section 2.2.2: unemployment rate is the registered urban unemployment rate, growth rate calculated as the annual difference in the log of the annual provincial real GDP with data ranging from 1997 to 2006. The whole data set includes 29 provinces based on availability of data and descriptive statistics are provided in Table 3.16. In this section, sub samples and are also applied (see Table 3.14).

3.4.3 Empirical results

The question which we consider in this section is twofold. First, it is interesting to see how growth affects the labor market (and unemployment in particular). Second, how the performance of labor market (unemployment) affects growth. This section carries out the analysis at national (whole sample) and regional level. We tried both linear and non-linear regressions. The R-squared of results based on the non-linear model is larger than that of the linear model. So, non-linear LSDV (Least Square Dummy Variables) specification is adopted.

Table 3.17 shows how growth affects unemployment. It is very clear that there is a hump shaped relationship between unemployment and growth based on Full sample, EAST, CENTRAL and WEST data set. The empirical results confirm the prediction of Aghion and Howitt (1994): the sign of the effect of growth on unemployment can be either positive

or negative depending on the magnitude of growth. High rates of growth are negatively correlated with unemployment, while low rates of growth are positively correlated with unemployment. The calculated turning points (peak points) for the Full sample, EAST, CENTRAL, and WEST data sets are 0.22, 0.13, 0.19 and 0.15, respectively.

Table 3.18 presents the effect of unemployment on growth. There is again a hump-shaped relationship between unemployment and growth based on full sample, WEST and EAST (1997-2001). However, it is not significant for CENTRAL neither for the period 1997-2006 nor 1997-2001. The calculated turning points (peak points) for the FULL, EAST and WEST data sets as 5.28%, 2.53% and 4.9%, respectively.

3.4.4 Summary

This section has investigated the link between the unemployment and growth. The main finding is that there is a hump-shaped relationship between unemployment and growth, which may go either from growth to unemployment or from unemployment to growth. The former is consistent with Aghion and Howitt's (1994) theory that stipulates two different kinds of effects of growth on unemployment. Figure 3.1 indicates that growth should affect unemployment positively as in the whole sample and in the three sub-samples, EAST, CENTRAL and WEST, most of the actual observations of growth are below their turning points. So, based on Aghion and Howitt's (1994) theory, the creative destruction effect should dominate in China.

Concerning the relationship going from unemployment to growth, Figure 3.2 shows that in EAST, unemployment has a negative effect on growth as most observation of unemployment are greater than the turning point 2.53%. So, increasing unemployment inhibits economic growth in this region. In WEST, unemployment has positive relationship with growth as the majority of observations in this area are lower than the turning point 4.9%. The relationship obtained for CENTRAL is, as stated above, insignificant.

This pattern, positive relationship between unemployment and growth in WEST, absence of any relationship in CENTRAL and negative relationship in EAST may appear peculiar at first. In essence, it implies that, given its low unemployment level, increasing unemployment should improve WEST economic growth. Why China and especially the West region should display a positive relationship between growth rate of output and unemployment rate? We believe this pattern is related to the fact that China continues to be a transition economy and, crucially, that the progress in implemented economic reform has differed substantially across the three broad regions. By the end of 1996, some 70 percent of small state owned enterprises[17] have been transformed and privatized. The reform has had a far-reaching impact on the Chinese economy and has come at a considerable cost in terms of employment losses.

Does unemployment affect the speed of transition in China? The Aghion-Blanchard model (1994) is particularly instructive with respect to this question. The purpose of next section therefore is to show how this theoretical model can shed light on this questions.

3.5 The trade off between the speed of transition and unemployment rate

3.5.1 Overview

China has been experiencing rapid economic growth on the background of increasing unemployment in the last decade. Total unemployment increased significantly during the last two decades, becoming today one of the most pressing problems of the Chinese economy[18].

[17] China's public sector is dominanted by small and medium sized enterprises which accounted for 95 percent of the number of entities, 57 percent of employment and 43 percent of output of the state industrial sector (Qian, 1999).

[18] Urban regitered unemployment rate increased to 4.3% in 2009 which reported by National Bureau of Statistics of China. This is the highest rate since 2002. The official reported unemployment rates are undoubtedly low. For example, official reported registered unemployment rate is 4% in 2008. The "true" unemployment

Meanwhile, China is facing the challenge of transforming its planned and less efficient labor allocation system into a well-functioning and more efficient labor market (Appleton et al, 2005). Unemployment is a political concern in all economies during the transition to a market economy since any government will want the level of unemployment to remain low because of the ultimate threat to its own survival (Katz and Owen, 1993). So, it is sensible to focus the attention on the relationship between the optimal speed of transition and unemployment rate.

There are few empirical studies on the speed of transition and unemployment rate in transition countries. Valev (2004) mentions that a reasonable number of Bulgarians think that high unemployment is necessary to maintain the economic reform to get succeed. Furthermore, he states that high unemployment is a necessary part of economic reforms and it can reduce the opposition to the reforms. However, Blanchard (1997) points out that the reform may be reversed if economic gains do not accrue soon enough. Aghion and Blanchard (1994) present a theoretical model which illustrates that the maximum speed of labor allocation depends on the optimal rate of unemployment during transition. Tichit (2006) develops a theoretical model based on the Aghion- Blanchard model which introduces job-to-job search and layoffs in the private sector, and argues: (1) job destruction is present in the new private sector even if this one is the key job creator and (2) most of the job reallocation from state to private employment is direct. However, the Aghion-Blanchard model assumes state workers must first be laid off before finding a job in the new sector.

Transition, simply described, is the process whereby state-owned enterprises are handed over to private agents (Behrens and Wunner, 1996). During the process of transformation, there will be a number of unemployed people who are laid off from state owned firms and who will be absorbed by the creation vacancies of new private firms.

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rate calculated with including laid off (xia gang) is 9.4% in 2008 by the institute of Economics of the Chinese Academy of Social Sciences. It implies it is a pressing problem of the Chinese economy.

Considering China's situation, the majority of labour flows from the state-owned sector to private sector is consistent with the assumptions of the Aghion-Blanchard model. First, in China, state-sectors workers are usually laid off first and seek private-sector jobs while being unemployed rather than moving to the private sector directly; this is because state-sector workers enjoy social benefits and greater job security compared with the private sector. Second, Huang et al (2010) find out that productive efficiency in the state sector is lower than in other sectors. Therefore, our empirical analysis is based on Aghion Blanchard model.

3.5.2 The Aghion Blanchard Model

Before proceeding with the empirical analysis, we first briefly describe the Aghion-Blanchard model. Aghion and Blanchard (1994) present a dynamic optimization model of the optimal speed of transition and optimal unemployment rate (see also the description in Roland, 2000).

Aghion and Blanchard (1994) derive the following relationship for the speed of job creation in the new private sector with unemployment level (for detailed derivation see Roland, 2000, P 113).

$$\dot{N_p}(t) = \frac{aU(t)}{U(t) + ca}\left[1 - \rho c - \frac{b}{1 - U(t)}\right] \tag{3.41}$$

$N_p(t)$ denotes the number of workers in the private sector at date t whose marginal productivity is y_p. $N_s(t)$ is the number of workers in the state sector at date t whose marginal productivity is y_s. $U(t)$ is the number of unemployed people at time t. Population is normalized to one, thus $N_p(t) + N_s(t) + U_t = 1$. The equation above is obtained by maximizing the net present value of output: $\int_0^\infty \left[N_p(t)y_p + N_s(t)y_s\right] e^{-\rho t} dt$, based on private sector marginal productivity (y_p) being higher than that in the state sector (y_s). $\dot{N_p}(t)$, hiring in the private sector is decided by market forces. $\dot{N_s}(t)$, lay-offs in the state sector, are

determined by the government. At the beginning of the economic transition, everybody is employed in the state sector. During the transition, employment in the state sector drops from 1 to less than 1. a, b, c and ρ are constants and stand for scale parameter, per capital level unemployment benefits, the difference between the value of being in the private sector and the value of being unemployed, and interest (discount) rate, respectively.

Figure 3.3 shows the relationship between $U(t)$ and $N_p(t)$: an inverted U-curve. Clearly, there is an optimal level of unemployment U^* that maximizes $\dot{N_p}(t)$, the speed of expansion of the private sector. In addition, if there is no unemployment, the private sector cannot develop, and when unemployment reaches level $1 - b/(1 - \rho c)$, the private sector cannot develop either. Hence as Aghion and Blanchard (1994) point out, at low unemployment, higher unemployment leads to more job creation in private sector whereas at high unemployment, higher unemployment leads to less job creation. Because they assume that taxes are levied equally on both state and private employment to finance unemployment benefits, when unemployment gets sufficiently large, the effect on taxes dominates the effect on wages[19] and private job creation decline. The model implicates that optimal unemployment leads to better development of the private sector and maximizes the net present value of the sum of output.

3.5.3 Empirical Results

To the best of our knowledge, empirical tests based on Aghion-Blanchard model have not been conducted yet. We make use of panel data approach with fixed effects. Aghion and Blanchard (1994) depict the relationship between the speed of reform and the unemployment as hump shaped, so a quadratic formula $y = c + ax^2 + bx + e$ is applied to examine if the model works in China.

[19] Aghion and Blanchard (1994) assume that high unemployment leads to low wage and low unemployment leads to high wage which is derived from supply and demand curve.

The data on unemployment are the same as the above. The speed of transition is measured as increases in the number of private employees which include the number of workers in firms that are private, individually owned, joint-venture owned, share holding, foreign fund, investment by Hong Kong/ Taiwan/ Macao, share cooperative or limited liability company[20].

Empirical test results based on the full sample are reported in Table 3.19. The results strongly support the model of Aghion and Blanchard (1994) at the 1 percent significance level: there is an inverted U-curve relationship between the speed of transition and unemployment rate in China. It is consistent with their theory, according to which at low unemployment level, higher unemployment leads to faster the speed of transition; at high unemployment level, higher unemployment leads to lower the speed of transition. The optimal speed of transition corresponds to the unemployment rate of 3.53%. We do not split data into sub-regions as the taxes are set by national level not provincial level. For example, province A has higher unemployment rate than province B but they will also have the same taxes rate.

3.5.4 Summary

In this section, the link between the speed of transition and unemployment in China has been investigated. The main finding is that there is an inverted U-shaped relationship which is consistent with the theory of Aghion and Blanchard (1994). We also can learn some implication from this theory and it can help us to better understand and balance the challenges of increasing unemployment with the reallocation of economic activities, reforms of the labor market and restructuring of existing firms.

[20] In any privatization plan there are three groups of firms. The first group consists of the firms that have been converted to private ownership, and the second group is newly created private firms by domestic entrepreneurs and foreign investors, and the third group is those restructured by investment or introduced advanced management (Katz and Owen, 1993). Aghion and Blanchard (1994) state that in their paper, no difference between privatization and restructure. However, restructuring requires outside finance, requires privatization.

Aghion and Blanchard (1994) theory tells us that there is an optimal rate of unemployment which maximizes the total output over the specific period. The optimal level of unemployment rate is 3.53%, which it will yield the optimal speed of transition, at least based on data covering the period 1997-2006 (see Table 3.19). In fact, China's average unemployment rate was 3.54%[21] over this period. We can draw the conclusion that the current unemployment rate is necessary and unavoidable: it should help facilitate China's transition and economic reform. Short-term hardship thus will be outweighed by long-term economic gain, as suggested by Valev (2004).

3.6 Conclusions

Based on the above analysis and investigation, we can give some plausible answers to the questions raised at first. Why Okun's law does not hold in China? Will transition be achieved with increasing unemployment? How to improve regional development and reduce regional disparities?

Okun's law does not hold in China universally. In particular, we found positive relationship between the growth rate and changes of unemployment rate during the period 1997-2006 in the WEST sub-sample. In contrast, the CENTRAL and EAST sub-samples both display negative relationship between the growth rate and the changes of unemployment rate which is consistent with Okun's relationship. Furthermore, we can find that this relationship has changed during the transition progress. Specifically, based on two sub periods, the underlying relationship changed from significant positive to insignificant negative based in WEST, from insignificant negative to significant negative in CENTRAL and from insignificant negative to significant negative in EAST. This is because China is different from developed countries. China is experiencing transition from a planned labor allocation system

[21] This appears very low, compared to developed economies as well as other transition economies as here we only use the registered unemployment rate to proxy the actual true unemployment rate. The latter corresponding to this optimal rate is likely to be higher.

into a market-drive labor market. At the beginning of opening up reform, the government let EAST (coastal provinces) pursue reform "one step ahead" of the other regions in the country. EAST obtained most of priority to introduce foreign funds and advanced technology which lead to the degree of economic development that is much higher than those in WEST and CENTRAL. CENTRAL in turn is more developed than WEST.

So far, government does not need worry about unemployment too much at the aggregate level. The empirical test based on Aghion and Blanchard (1994) theory implicates that this unemployment level is necessary to achieve the optimal speed of transition and it leads to maximize the total output. It is a price that China must pay for the future prosperity. However, China is a quite big country with more than 1.3 billion populations and disparities in economic development are high. Government should pay more attention to regional development and reduce regional disparities. The conjecture depend on this empirical analysis and China's current state. It implies that excess state firms closures in EAST may slow down job creation in the private sector since given that the states firms bore the task of maintaining employment and promote social stability (Huang et al., 2010). However, close some inefficient state firms in WEST which is necessary for the development of private sector to promote transition progress. Meanwhile, government should invest more in the some interior regions to help them attract more investments and job creation based on better infrastructure and transportation.

3.7 Tables and Figures

Table 3.13. Estimates of Okun's Coefficient by LSDV Panel approach, Whole sample (29 provinces)

Period	Okun's coefficient	t-Statistics
$1997-2006$	-0.000924	-0.519247
	(0.001780)	
$1997-2001$	0.000212	0.367136
	(0.000578)	
$2002-2006$	-0.015068^{***}	-5.237059
	(0.002877)	

Figures in parenthese are standard errors. *** 1% significant level

Table 3.14. Sub-groups

Sample	Observations
East	Beijing, Tianjin, Shanghai, Liaoning, Shandong, Jiangsu, Zhejiang, Fujian, Guangdong, Hainan
Central	Hebei, Shanxi, Neimenggu, Jilin, Heilongjiang, Anhui, Jiangxi, Henan, Hunan, Hubei
West	Guangxi, Guizhou, Yunan, Sichuan, Shanxi, Gansu, Ningxia, Qinghai, Xinjiang

Table 3.15. Estimates of Okun's Coefficient by LSDV Panel approach

Period	Okun's coefficient	t-Statistics
Panel A. EAST sample (10 provinces)		
$1997-2006$	-0.013416^{***}	-3.630902
	(0.003695)	
$1997-2001$	-0.001656	-0.490475
	(0.003376)	
$2002-2006$	-0.009531^{***}	-3.399882
	(0.002803)	
Panel B. Central sample (10 provinces)		
$1997-2006$	-0.011868^{**}	-2.166914
	(0.005477)	
$1997-2001$	-0.001420	-0.474572
	(0.002992)	
$2002-2006$	-0.034073^{***}	-4.472599
	(0.007618)	
Panel C. WEST sample (9 provinces)		
$1997-2006$	0.004012^{**}	2.021445
	(0.001985)	
$1997-2001$	0.000343	0.551241
	(0.000623)	
$2002-2006$	-0.011758	-1.924081
	(0.006111)	

Figures in parenthese are standard errors

*** 1% significant level,**5% significant level

Table 3.16. Descriptive Statistics on regional variables (1997-2006)

Varibles	Number of observations	Mean	Standard Deviation
	Panel A. EAST sample (10 provinces)		
g	100	0.109 (10.9%)	0.02
u	100	2.85%	0.92
	Panel B. Central sample (10 provinces)		
g	100	0.103 (10.3%)	0.03
u	100	3.50%	0.71
	Panel C. WEST sample (9 provinces)		
g	90	0.094. (9.4%)	0.02
u	90	3.85%	0.82

Source: computed by author
g is the "GDP growth rate"
u is the "urban registered unemployment rate"

Table 3.17. Estimate equation with dependent variable U during 1997-2006

Variables	Full sample	EAST	CENTRAL	WEST†
constant	1.703510^{***} (0.301767)	-2.561383 (2.143907)	0.974850^{**} (0.395113)	2.297389^{***} (0.206061)
g^2	-54.49003^{***} (21.56805)	-371.2240^{***} (161.2112)	-90.15515^{***} (25.72050)	-78.43072^{***} (23.78040)
g	23.75909^{***} (5.166393)	95.36929^{**} (37.65610)	34.41178^{***} (6.549670)	24.05964^{***} (4.459429)
$Adjusted\ R^2$	0.78	0.81	0.78	0.92

U is unemployment rate. g is growth rate. †WEST area used fixed effect with SUR

Figures in parenthese are standard errors. *** 1% significant level,**5% significant level

Table 3.18. Estimate equation with dependent variable g during 1997-2006

variables	Full sample	EAST†	CENTRAL	WEST
constant	0.019748^{**}	0.067158^{***}	0.050354	-0.045893^{***}
	(0.010074)	(0.015763)	(0.041436)	(0.011111)
U^2	-0.003442^{***}	-0.005454^{***}	0.001544	-0.006269^{***}
	(0.000570)	(0.001560)	(0.003659)	(0.000490)
U	0.036363^{***}	0.027556^{***}	0.009283	0.061769^{***}
	(0.004883)	(0.010182)	(0.024942)	(0.004794)
$Adjusted\ R^2$	0.40	0.81	0.30	0.71

U is unemployment rate. g is growth rate. †EAST area based on period 1997-2001

Figures in parenthese are standard errors *** 1% significant level, **5% significant level

Table 3.19. Interaction between the speed of transition and unemployment during 1997-2006

variables	Full sample
constant	-287.1233^{***}
	(52.11857)
U^2	-24.97831^{***}
	(3.890164)
U	176.3222^{***}
	(28.81680)
$Adjusted\ R^2$	0.3

U isunemployment rate

Figures in parenthese are standard errors. *** $1\%_0$ significant level

Fig. 3.1. Growth rate sample

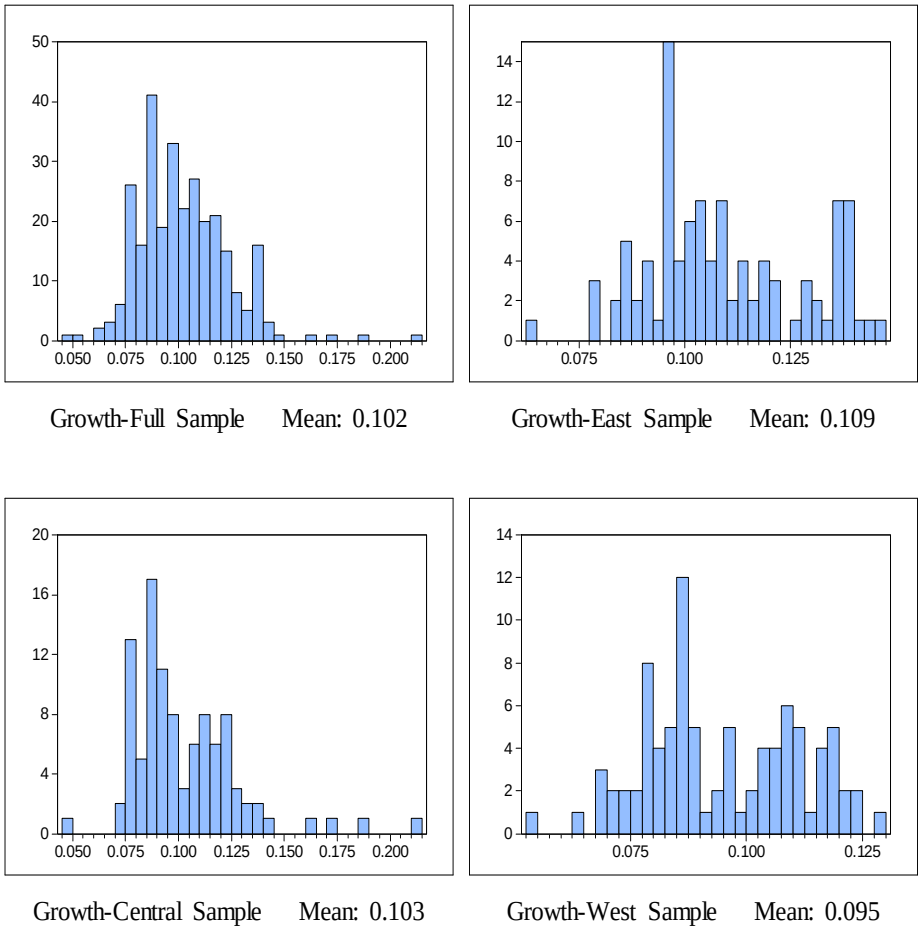
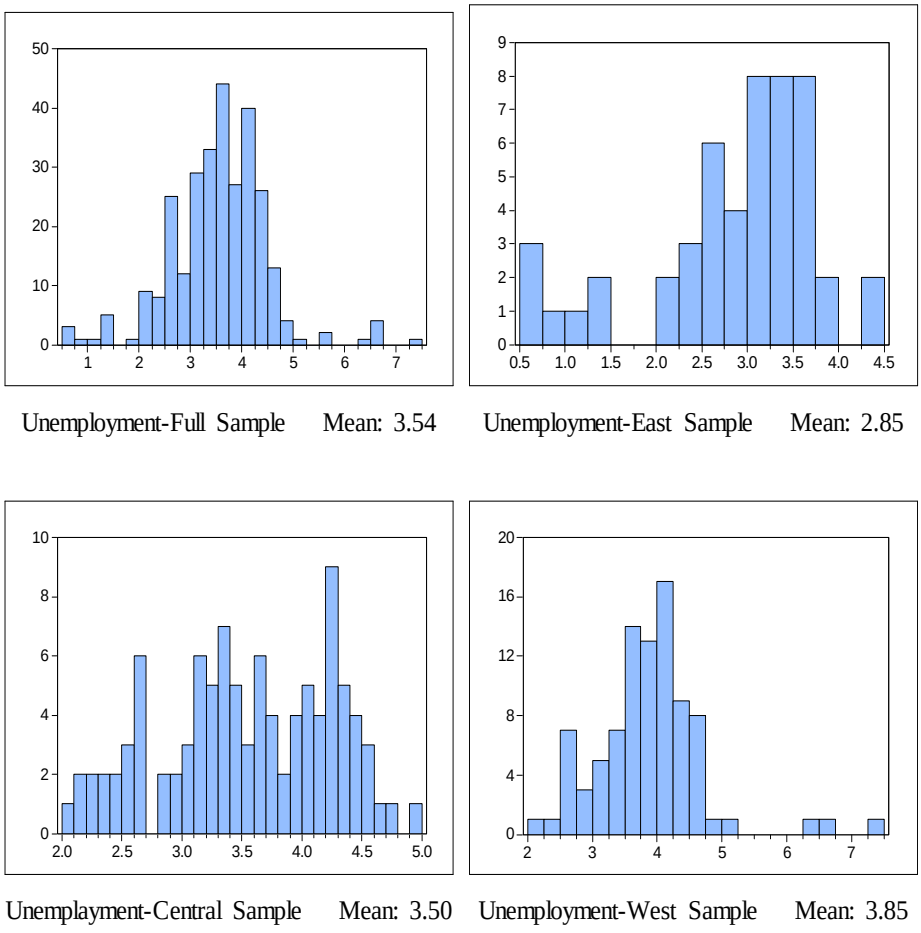


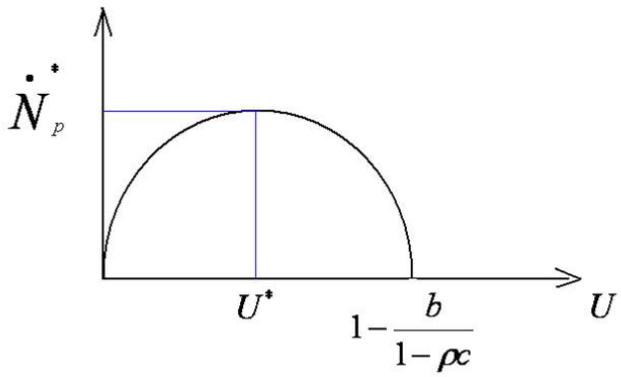
Fig. 3.2. Unemployment rate sample



Unemployment-Full Sample Mean: 3.54 Unemployment-East Sample Mean: 2.85

Unemplayment-Central Sample Mean: 3.50 Unemployment-West Sample Mean: 3.85

Fig. 3.3. The Optimal Level of Unemployment U^* And The Maximal Speed of Transition $\dot{N}_p^*$



Chapter 4
Liberalization and Economic Integration among Chinese Regions

4.1 Introduction

Since 1978, China has been undergoing a gradual yet steady liberalization. The changes were especially profound in the economic sphere but, lately, have been extending also to the political domain. The three decades of liberalization have had a far-reaching effect on the Chinese economy and society. Most of the changes have been for the better: China has been growing rapidly and recently became the second largest economy globally. Yet, the benefits of this expansion have not been universally shared. Large chasms have opened up between regions (and also within regions). Urban areas in Eastern and South-Eastern China are increasingly shaping up as relatively rich industrialized and middle-class economies. As such, they stand it sharp contrast with rural areas and also with urban regions of Central and Western China, most of which remain relatively poor and underdeveloped. The regional disparities are further reinforced by the continued enforcement of the hukou system of household registration which restricts the ability of residents of poor and depressed areas to move.

The Chinese economy is characterized not only by large inter-regional economic differentials but also by a high degree of economic decentralization. This is highlighted by Xu (2010) who describes China as a regionally decentralized authoritarian system. He points out that while the central government controls key political appointment at the regional level, it allows the regional governments to run their regional economies largely unimpeded. An even more dramatic example of economic decentralization and divergence was the creation of special economic zones in the early years of liberalization. This allowed

selected regions to move faster ahead in terms of economic transformation and laid the foundations of the subsequent economic gap between the coastal areas and the rest of the country.

In this chapter, we investigate the changing nature of economic integration among Chinese provinces. The analytical approach is based on identifying shocks affecting the various regions and then computing the correlations of such shocks, using the structural VAR methodology pioneered by Bayoumi and Eichengreen (1993). This analytical framework is motivated by the Theory of Optimum Currency Areas (Mundell, 1961) and its emphasis on the importance of asymmetric shocks for the viability of integration. Bayoumi and Eichengreen applied this methodology to assess the merits of adopting the common currency in the European Union. Since their seminal contribution, this method has become accepted as the workhorse for assessing the depth and nature of integration in other regions as well. Importantly, the structural VAR methodology allows us to distinguish between shocks that affect both output and the price level permanently (usually denoted as supply shocks in this literature) and those affecting output only temporarily while having a permanent price-level effect (demand shocks)[22].

Capturing the changing nature of business-cycle[23] synchronization in China is interesting in its own right; to this effect, first compute and present the correlations of permanent and temporary shocks for different periods before and after the onset of liberalization in 1978. We then compare these with values found elsewhere in the literature for the Eurozone and

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[22] Early studies on Optimum Currency Areas (OCA) focused on how the various observable macroeconomic variables, such as GDP growth rates, inflation rates, exchange rates, interest rates and stock prices, are correlated across the economies or the region. However, these approaches do not allow one to distinguish between the shocks themselves and the reactions to them. Ian Babetskii (2005, p.108) points out that both components are present in the actual series. Similar results in terms of correlation coefficients might be observed in the presence of various combinations of shocks and responses to shocks, for example, in the case of a symmetric reaction to asymmetric shocks or an asymmetric reaction to symmetric shocks.

[23] Babetskii (2005, P106) points out that "There is a tendency in the literature to use the terms 'shocks' and 'business cycles' as synonyms. However, the term 'business cycle' has a broader meaning than shock": business cycles usually refer to the de-trended components of macroeconomic aggregates such as GDP, industrial production, employment, eta. Hence, the business cycle represents a mixture of shocks (e.g., export, oil, etc.) and the responses to them."

other regional integration arrangements (see Fidrmuc and Korhonen, 2003 and 2006, and the references therein). In this context, the distinction between permanent and temporary shocks is important: Fidrmuc (2010) formulates a theoretical model of the political economy of fiscal federalism and shows that the correlation of permanent shocks is much more important for the stability of integration than the correlation of temporary shocks.

The analysis does not stop at merely documenting the correlation of permanent and temporary shocks among Chinese regions. We will also explore the determinants of such correlation using a stylized version of the gravity model (broadly in line with Artis and Okubo, 2008, although they use a different methodology for estimating business-cycle correlations). In this study, we seek to explain the correlations of permanent/temporary shocks by relating them to factors that proxy for the vulnerability of regions to idiosyncratic shocks as well as those that reflect channels allowing the effects of such shocks to spill over regions' boundaries: the distance between the regions, dummy variables for adjacency, interior provinces adjacent with coastal provinces and belonging to the same broader region, economic size of regions, endowments of physical and human capital, infrastructure, structure of economic activity in each region, openness to (foreign) trade, foreign direct investment, and economic policy. This allows us to assess which factors contribute to economic convergence or divergence in the Chinese economy.

In the reminder of this chapter, Section 2 presents a literature review of background about economic decentralization and fragmentation in China. Section 3 describes the data and empirical methodology. Section 4 reports the main empirical finding. Section 5 states the conclusions.

4.2 Literature review

4.2.1 Economic decentralization in China

Until 1978, Chinese economy remained highly centralized and tightly regulated in which production and resource allocation were carried out according to a plan designed by the central government. In the late 1970s, after almost three decades of intense social movement, the central government decided to decentralise administrative power and allowed local authorities and enterprises to retain part of their revenues. The purpose of this move was to reinvigorate the stagnant economy by encouraging local enthusiasm in production (Tang, 1998). From 1979 to 1993, the central fiscal power gradually weakened: the central government's share of expenditures (after revenue-sharing) declined from 51 percent to 28 percent (Ma and Norregaard, 1998, as cited in Poncet and Barthélemy, 2008, p.899). Fiscal and economic decentralization promoted fast growth of the Chinese economy in the last three decades. However, some locals have implemented protectionist policies, supposedly to develop the local economies (Bai, 1981).

The gradual liberalization policy initiated in the late 1970s entailed a clear bias in favour of the development of coastal regions. The central government gave costal (Eastern) regions priority in terms of directing foreign investment to them, allowing them to keep a greater part of their income in foreign currency and to create new financial instrument which stimulated the development and increased their competitiveness vis-a-vis interior regions (Poncet, 2004). Meanwhile, the inland provinces suffered from the price distortions imposed by the central government, whereby a part of the production of raw materials was to be sold at a fixed low price. This induced a net transfer of resources from the regions producing raw materials to the manufacturing provinces on the coast. The less developed regions became very sensitive to the industry-agriculture relative price since industrial products have a larger profit margin than agricultural products. So, they pursued a policy of industrialisation through import substitution, as decentralization combined with the fact that most of tax revenue accrued from industrial production made them keen to develop their own industrial bases (Lee, 1998 cited in Poncet, 2004).

In addition, the household registration system (*hukou* system) remains a major impediment to free movement of resources across provinces. Under this system, people cannot move freely without permission from the authorities. With the economic reform progressing, the planning system has been giving way to the market oriented system and labor mobility is higher, especially from inland rural to coastal urban areas (Tang, 1998). Young (2000) states that the reforms lead to the fragmentation of the domestic market.

In all, China is an economy which is using a single currency yet, capital and labor are not perfectly mobile. It consists of 22 provinces, 5 Minority Autonomic Area, and 4 Municipalities including Beijing, Shanghai, Tianjin and Chongqing[24].

4.2.2 Shocks asymmetry and economic integration in China

Is China an integrated national economy like the US?[25] Over the past decade, a growing number of analysts have attempted to study China's provincial economic integration. In general, the literature can be classified into four different approaches: production approach[26], trade approach[27], price approach[28], and business-cycle approach. Their conclusions differ, which in part reflects the differences in analytical methodologies as well as different time period. For example, the World Bank (1994) indicates that industrial structure across Chinese provinces has remained remarkably constant over time according to the production approach. Naughton (2003) argues that the production structure approach lacks a theoretical yardstick to evaluate changes. He examines data on inter-provincial trade[29] and finds that Chinese provinces are integrated based on the trade approach. Young (2000)

[24] Chongqing was separated from Sichuan province and became the fourth Municipality in 1997.

[25] Most economists accept that the US has been integrated national economy during the 19th and 20th centuries (Naughton, 2003).

[26] This approach attempts to measure the degree of economic integration by examining the similarity of production structure across different provinces (Xu, 2002).

[27] Direct examination of data on interprovincial trade flows (Xu, 2002).

[28] Price convergence is the most common indicator of the degree of market integration (Xu, 2002).

[29] He states that the provincial I-O data are not published and are considered sensitive for commercial and national security reasons. He got access to the final-demand columns of 27 provincial I- O for 1992.

shows that there is no clear cut conclusion based on four different data sets on regional prices.

Compared with the other approaches to assess economic integration mentioned above, business-cycle approach has proven to be especially popular. It not only provides a comprehensive measure of various factors that contribute to economic fragmentation but also reveals whether there are any regional groupings of the provincial economies (Tang, 1998). The focus on asymmetric nature of the business cycles has been widely adopted to gauge the degree of economic integration of the Chinese provinces in China. Accordingly, regions within the same country which tend to have high business-cycle correlations are considered highly integrated.

A number of approaches have been utilized to detect the degree of asymmetry of shocks across economies – whether these are countries or regions within countries. One method is based on cross-country correlation of GDP growth rates, inflation rates, exchange rates, interest rates and stock prices. The weakness of this method is that it does not allow one to distinguish between the shocks themselves and the reactions to them. For example, Poncet and Barthélemy (2008) investigate business cycles and their determinants by the cyclical component of monthly data of provincial gross output value of industry fluctuations over 1991-2004 which is isolated by filtering their data on regional activity through the Hodrick and Prescott (1997)'s filter. They emphasize that though a cleavage exists between the coastal and interior regions, business-cycle synchronization increased from a rather low level at the beginning of the 1990s to a level comparable to that of the US at the beginning of the 2000s. Furthermore, they argue that international trade and local economic policy foster synchronization. However, Carsten et al. (2010) argue that one cannot extrapolate these results to the new millennium as the observation period might be simply special with regard to the macroeconomic environment, whereas the business cycle research covers many more years.

Another method is to compute shocks using the structural VAR model formulated by Blachard and Quah (1989) in order to identify the origins of shocks from the responses to them (supply and demand). This method has became a popular tool for identifying asymmetric shocks since it was applied by Bayoumi and Eichengreen (1993) to assess the similarities of economic cycles in Europe in the run-up to the formation of the European Economic and Monetary Union (Babetskii, 2005). The structural VAR methodology allows us to distinguish between shocks that affect both output and the price level permanently (usually denoted as supply shocks in this literature) and those affecting output only temporarily while having a permanent price-level effect (demand shocks).[30]

The literature studying business-cycle synchronization of the Chinese economy using the VAR method remains very limited. Tang (1998) adopts a structural VAR model to gauge the degree of economic integration of China using data on industrial output and the retail price index. He argues that a high degree of integration is found in Eastern China only. This implies that treating China as a single closely-integrated entity could be misleading. However, his finding is based on a period spanning 1990Q2- 1995Q4 which is very short and his finding might also be specific to that period only.

4.2.3 Determinants of business cycle co-movements

There is no consensus on which determinants of business-cycle co–movement are particularly important. There are many potential candidate explanations of business-cycle synchronization or the lack thereof.

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[30] For example, "Many countries experienced severe negative supply shocks following disruptions to world oil supplies in 1973 and 1979"(Krugman, Wells and Graddy, 2008, p.685). Some Asian regions such as Japan, Korea and Singapore exhibited similar pattern of high inflation and low output during that period, this may be explained as they are in the same area and they have similar export oriented economic policy. 2008 Olympic game in Beijing is a good example for demand shock. "The Beijing Statistical Bureau estimates that spending on the Olympics has added 2.5 percent annually to Beijing's overall economic growth since 2002. The ripple effect on economic growth not simply in Beijing but in areas surrounding the capital" (Sands, 2009). Though the long term benefits of the Olympic game for Beijing is not clear yet, many scholars are believe that there will be no lasting effects on the city's economy as a result of the games.

One leading candidate is trade. Frankel and Rose (1998) present empirical evidence that higher bilateral trade between two countries is associated with more closely correlated business cycles. However, Krugman (1993) argues the opposite effect should prevail as international trade increases specialization, making shocks more asymmetric. Based on Krugman's view, Frankel and Rose (1998) explain that a discussion of the role of international trade should distinguish between inter-industry and intra-industry trade. The former reflects specialization and therefore may cause asymmetries. The latter implies that the country simultaneously exports and imports products of the same category. The total effect of trade intensity on cycle correlation is therefore theoretically ambiguous and poses a question that could only be solved empirically. Fidrmuc (2004) adopts the specification of Frankel and Rose (1998) and applies it to a cross section of OECD countries over the last ten years with quarterly data, controlling for intra-industry trade in his analysis and confirms higher bilateral trade between two countries is associated with more closely correlated business cycles. Baxter and Kouparitas (2005) stress that only trade integration has a robust effect among the various candidate determinants of business cycle synchronization.

Empirical evidence of the positive relationship between similarity in structure of output on business-cycle synchronization has been stressed in a series of papers by Jean Imbs (1998, 2003, 2004) and also is found in analyses using regional data by Kalemi-Ozcan et al.(2001), Clark and van Wincoop (2001). Kalemi- Ozcan et al. (2001) find that U.S. states that are more specialized have a lower correlation with aggregate U.S. growth.

Gravity variables such as distance between regions, common language, common border, and so on, have been studied, among others, by Clark and van Wincoop (2001), Calderon et al. (2002) and Fidrmuc (2002).

Fatás (1997) argues that coordination of monetary and fiscal policies is also a key determinant of business-cycle synchronization. He points out it has an ambiguous impact on business cycles since it depends on the type of shocks driving economic fluctuations and the ability of governments to stabilize output. If macroeconomic policies are the source of

business cycles, more coordinated policy could then lead to higher synchronization. Poncet and Barthélemy (2008), and Lan and Sylwester (2010) examine and confirm this based on Chinese regional data. Darvas et al. (2007) and Artis et al. (2008) also investigate and reconfirm it based on the European Union data.

Furthermore, factor endowments also drew attention of scholars and most theories, such as Heckscher-Ohlin theory, Ricardian theories and Hybrid models, predict a significant relationship among factor endowments and business-cycle co-movement.

4.3 Data and methodology

This section begins with a description of the datasets, followed by the empirical methodology, which contains three aspects: Firstly, we identify supply and demand shocks. Secondly, we compute the correlation of shocks for different sub-periods. Lastly, we investigate the determinants of business cycle co-movement.

The sample covers 29 provinces based on data availability[31]. Annual data are available for 1952-2007. Provincial real GDP growth data and the GDP deflator are obtained from nominal and real GDP indexes published by the Bureau of National Statistics of China[32]. The sample is divided into three geographical regions: EAST, CENTRAL and WEST; besides reflecting geography, this categorization also broadly captures differences in the degree of economic development. During the early transition period, the coastal areas in the East benefited from the open door policy, developing much more quickly than the interior areas in the Central and Western regions. Furthermore, we divide the 53 years[33] covered by the data into four uneven sub-periods: 1955-1965, 1966-1977, 1978-1991 and 1992-

[31] Tibet and Chongqing are dropped from our sample due to missing data. The data for Sichuan is available from 1978.

[32] We used the following publications: 'Comprehensive Statistical Data and Materials 50 years of New China', China Labour Statistical Yearbook and provincial statistical book.

[33] The sample that we actually analyze is slightly shorter than the period covered by the raw data period since we need to use lags.

2007. This break-down corresponds to different phases of China's history. We call the first two sub-periods early Maoist period and late Maoist period; during these, China remained ab highly centralized planned economy. The early Maoist period includes the Great Leap Forward (1958-1961) while the late Maoist period overlaps with the Cultural Revolution (1966-1976). Chinese economic reform was initiated in 1978 and China maintained a high real GDP growth averaging 8-10% during the last three decades (Xu, 2007). The post Maoist period is also split into two sub-periods for two reasons: First, market reforms underwent a major step forward occurring following Deng Xiaoping's "South Trip" in 1992. This year thus marked the start of a new phase of China's reform process (Fleisher et al. 2009). Second, Xu (2007) argues that it was highly possible that a structural break occurred in this year.

4.3.1 Identification of supply and demand shocks

In this subsection, we present the methodology used to identify the supply and demand shocks in different economies. We use a structural VAR model with two variables, (the log of) output (annual real GDP) and (the log of) prices (annual GDP deflator). It is assumed that fluctuations in these two variables result from two types of distribances: supply and demand shocks. Supply shocks, which are associated with a shift in the aggregate supply curve, have both short-term and long-term impacts on both output and prices. Demand shocks also have short-term effects on both variables. However, since the long-term aggregate supply curve is vertical, demand shocks do not have a long-term effect on the level of output.

Following Blanchard and Quah (1989), Bayoumi and Eichengreen (1993) and Babetskii (2005) we estimate a VAR with the differences of GDP y_t and the difference of price level p_t as variables.The following VAR representation can be estimated:

$$\begin{aligned} y_t &= b_{01} + \sum_{k=1}^{K} b_{11k} y_{t-k} + \sum_{k=1}^{K} b_{12k} p_{t-k} + e_t^y \\ p_t &= b_{02} + \sum_{k=1}^{K} b_{21k} y_{t-k} + \sum_{k=1}^{K} b_{22k} p_{t-k} + e_t^p \end{aligned} \tag{4.42}$$

Where $y_t = logGDP_t - logGDP_{t-1}$ and $p_t = logP_t - logP_{t-1}$. b_{ijk} are coefficients, and k is the lag length . e_t^y and e_t^p are serially uncorrelated disturbances. e_t^y and e_t^p are not structural and can be decomposed by Equation (4.43):

$$\begin{aligned} e_t^y &= c_{11}\varepsilon_t^D + c_{12}\varepsilon_t^S \\ e_t^p &= c_{21}\varepsilon_t^D + c_{22}\varepsilon_t^S \end{aligned} \tag{4.43}$$

where ε_t^D and ε_t^S are demand and supply disturbances, respectively. These equations state that the unexplainable components in the movements of output growth and inflation are linear combinations of supply and demand shocks. The vector of the structural disturbances ε_t can be obtained under restrictions:

1. $c_{11}^2 + c_{12}^2 = Var(e^y)$
2. $c_{21}^2 + c_{22}^2 = Var(e^p)$
3. $c_{11}c_{21} + c_{12}c_{22} = Cov(e^y, e^p)$
4. $\sum_{k=0}^{\infty} c_{11}\varepsilon_{t-k}^D = 0$

The first three restrictions on the coefficients of Equation (4.43) are directly derived from Equation (4.44) and Equation (4.45) using normalization conditions:

(i) the variance of demand and supply shocks is unity:

$$Var(\varepsilon^D) = Var(\varepsilon^S) = 1, \tag{4.44}$$

(ii) demand and supply shocks are orthogonal:

$$Cov(\varepsilon^D, \varepsilon^S) = 0, \tag{4.45}$$

The fourth restriction on coefficients c_{ij} states that demand shocks have no long term impact on the level of output.

4.3.2 Estimation of correlation of supply/demand shocks

We first calculate ρ_{ij} which is the correlation of supply/demand shocks between a pair of provinces i and j. If the correlation of shocks is positive, the shocks are considered to be symmetric and if it is negative, they are considered asymmetric. Table 4.20 and Table 4.21 gives the weighted average[34] correlation of supply shock and demand shocks for each province and for each sub-period, respectively. Figures 4.4-4.7 depict the distribution of bilateral cross correlation of supply shocks for sub-periods 1955-1965, 1966-1977, 1978-1991 and 1992-2007. Figures 4.8-4.11 provide the same information for demand shocks. It is clear that the nature of shocks changed over the periods considered. However, the change is not the same for the two kinds of shocks. The correlations of supply shocks computed for more recent periods suggest a lower degree of cohesion. However, more recent correlations of demand shocks suggest a greater degree of cohesion.

The focus on the symmetry of shocks is typically associated with the optimum currency area(OCA) literature (Mundell, 1961). Indeed, Bayoumi and Eichengreen's article pioneering the use of structural VARs to analyze business-cycle synchronization was motivated by Mundell.s theory. If shocks are symmetric, the argument goes, the regions/countries sharing the same currency will have little need for independent monetary policy. With asymmetric shocks, policy preferences can diverge: a region hit by a negative shock would prefer loose monetary policy while another affected by a positive shock would be instead in favor of a monetary tightening. The OCA theory, however, considers only the overall symmetry of shocks, without distinguishing between demand and supply shocks. Therefore, it gives us little guidance for the evaluation of cases such as China.s where falling correlation of supply shocks seems counter-balanced by increasing symmetry of demand shocks.

[34] Weighted by GDP.

Fidrmuc (2011), in contrast, formulates a model of fiscal integration that makes the distinction between permanent and temporary output shocks (recall that supply shocks affect output permanently while demand shocks only have a temporary effect). He shows that symmetry of permanent shocks is more important for the stability of integration than symmetry of temporary shocks: both kinds of shocks give rise to divergent policy preferences but the impact of temporary shocks is (by definition) short lived while permanent shocks can fundamentally undermine the stability of integration. In this context, the fact that China is experiencing falling correlation of supply (permanent) shocks may come across as worrying, despite the change in opposite direction taken by the correlation demand (temporary) shocks.

4.3.3 The determinants of business cycle co-movement

In this section, the objective is to investigate the determinants of business cycle co-movements. Co-movements of shocks across countries and regions are used for the assessment of OCA criteria. In China, it can be used to examine how the effect of reform on Chinese ecomomy. A high correlation between two regions shocks indicates that the economic structures of the countries or regions are quite similar and the cost of a common monetary policy is low. However, the degree of regional integration has important macroeconomic implications especially for monetary policy. For example, if two regions, i and j, are in different economic situations with region i experiencing high unemployment and region j high inflation, to adjust the unemployment in region i, the central bank has to increase the money supply. However, to solve the high inflation pressure for region j, the central bank has to reduce the money supply. In this example, conducting monetary policies by the central bank becomes more difficult since different regions are not be found in similar business cycle stages (Xu, 2002).

In order to investigate and find the determinants of the business cycle correlation, we take the following steps. Firstly, we use univariate OLS estimates to assess the nature

of the relationship between bilateral correlation coefficients and each individual variable: $\hat{\rho}_{ij} = \alpha + \beta X_{ij} + \gamma$. Secondly, we repeat the same procedure but apply the Fishier "z" transformation on the dependant variable, bilateral cross-correlation coefficients, to overcome the potential bias as the values are bound between -1 and $+1$. This implies that the estimation equation takes the following form: $\frac{1}{2}log(\frac{1+\rho_{ij\tau}}{1-\rho_{ij\tau}}) = \alpha + \beta X_{ij} + \varepsilon_{ij\tau}$. Thirdly, a further robustness check includes a set of dummy variables and all variables that proved significant during the earlier two steps.[35] The form is: $\rho_{ij\tau} = \alpha + \beta X_{ij\tau} + D_{ij} + \varepsilon_{ij\tau}$, $\frac{1}{2}log(\frac{1+\rho_{ij\tau}}{1-\rho_{ij\tau}}) = \alpha + \beta X_{ij}\tau + D_{ij} + \varepsilon_{ij\tau}$. Following Frankel and Rose (1998), Imbs(2004), Calderon et al.(2007), and Poncet and Barthélemy (2008), we estimate the variance-covariance matrix of β using White (1980) correction for heteroskedasticity.

Following the literature review on determinants of business-cycle co-movement in section 3.2.3, the following vaiables are studied: 4 dummy variables (common border, coast, provinces belonging to the same region, and interior province which have common border with coastal provinces). The other control variables are: size, distance, similarity of production structure, dissimilarity of local policy, international trade, FDI, capital investment/fixed asset investment and human capital. Now, we turn to a detailed consideration of each group of variables.

Gravity variables

There is abundant evidence in the existing literature that the gravity variables can explain bilateral trade (see Frankel and Rose, 1998). The commonly-used gravity variables are: common border, same–region dummy, coast-intra, interior- coast border, bilateral distance, and size. The first dummy variable (common border) equals 1 when province i and j are adjacent and 0 otherwise. The second dummy (the same region) equals 1 when province i and j are in the same geographic region[36] and 0 otherwise. The third dummy (coast-intra)

[35] Another alternative way is tried (general to specific) also which starts with a relatively broad regression and then gradually drops insignificant variables. However, the variable sign is not consistent before and after dropping some insignificant variables of. The way which is adopted here lets us draw robust results.

[36] The sample can be divided to three regions, EAST, CENTRAL and WEST.

equals 1 when provinces i and j are both located in the coastal region and 0 otherwise. The fourth dummy (interior-coast border) equals 1 when provinces i and j are located on either side of the border separating the interior and coastal regions and 0 otherwise[37]. Bilateral distance data are calculated as the shortest distance for cargo transportation by railway in kilometres. Size is the sum of GDPs[38] of two provinces. Gravity variables are especially important to our study since no data are available on bilateral trade flows between Chinese provinces. Hence, by controlling for a set of standard gravity variables, we are proxying for the bilateral-trade opportunities between the two provinces. Poncet and Barthélemy (2008) use the freight traffic volume through the railway system between and within provinces as a proxy, which is very unreliable, and they also stressed that railway freight volume is a truly imperfect proxy for domestic trade, especially in the preliminary stage of the reform. For example, coal, grain, iron and steel account for well over half of railroad freight volume, they make up at most 10% - 20% of the value of inter-provincial trade (pp.918).

Similarity of production structure

There are no standard measures of similarity in the production structure. Following Clark and van Wincoop (2001), Imb (2004) and Poncet and Barthélemy (2008), Krugman's (1991) absolute value index was adopted in this study. Let S_{ni} and S_{nj} denote the GDP shares for industry n in province i and j, respectively. Then, the dissimilarity of province i's and province j's production structure is measured as $\frac{1}{N}\sum_{n=1}^{N}|S_{ni}-S_{nj}|$. It is measured by covering 5 sectors for all Chinese provinces[39].

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[37] This dummy variable is investigated by Poncet and Barthélemy (2008)

[38] The same method adopted by Clark and van Wincoop (2001) and they state that measuring size with GDP or population yields similar results.

[39] Sectors are: 1. Agriculture, Hunting, Forestry, Fishing, Mining and Quarrying; 2. Construction; 3. Manufacturing; 4. Transportation Post and Telecommunications; 5. Wholesale Retail & Catering Trade. Data are taken from Chinese national statistic year book.

Dissimilarity of Local policy

Provincial dissimilarity of local policy is measured by means of two indicators. One is to capture provincial divergence by fiscal policy and another is to investigate provincial heterogeneity in terms of inflation to reveal local economic autonomy. Similar to Clark and van Wincoop (2001) and Poncet and Barthélemy (2008), we use the standard deviation of provincial budget deficit differentials to measure dissimilarity of fiscal policy. Annual budget deficit data are expressed as a percentage of GDP. To capture provincial divergence of economic autonomy, we use $\frac{1}{T}\sum_{t}|GPI_{i,t} - GPI_{j,t}|$ which was used by Boyreau-Debray (2000) and Poncet and Barthélemy (2008) as well[40]. $GPI_{i,t}$ is the general price index of the province i during the period t. T is the sub-period time span.

Dissimilarity of openness

To investigate the dissimilarity of provincial openness degree, we use two indicators of international trade and Foreign Direct Investment. International trade dissimilarity is computed as $\frac{1}{T}\sum_{t}|Trade_{i,t} - Trade_{j,t}|$. $Trade_{i,t}$ correspond to the percentage share of trade in GDP of province i during period t. T is the sub-period time span. Similar formula is used for dissimilarity of FDI.

Factor endowments

In this study, we consider two factors of production: human capital and public capital investment/fixed asset investment[41]. Human capital is measured as secondary and higher education enrolment rates (i.e. the ratio of the total secondary and higher education enrolment to the population) which follows Islam (1995). Public capital investment/fixed asset

[40] They used comsumer price index which is not available for our observation period 1955-2007.

[41] Fixed asset investment data is available from 1978.

investment is expressed as a percentage of GDP. The dissimilarity indexes are computed in line with the above variables.

4.4 Empirical results

Table 4.23, 4.24 4.25 and 4.26 present the coefficients of univariate regressions between each variable considered in our study and the correlation of supply shocks and demand shocks. Table 4.27 to 4.32 present the regression results for each sub-period which include the all significant variables based on previous individual regression tests. In addition, we also report further regressions with some variables dropped since they are multi-collinear. For comparison, regressions results are reported both for the original data and Fisher "z" transformations.

4.4.1 Maoist periods with central planning economic system (1955-1965, 1966-1977)

Table 4.23 shows univariate regression results, based on the two methods considered. It can be found that the variables considered in this study hardly explain the inter-provincial correlation of supply shocks in China. Table 4.25 shows that the variables also have little explanatory power with respect to the correlation of demand shocks during the period of 1955-1965. However, over the second sub-period 1966-1977, the common border dummy is positive and significant, distance is negative and significant, size is positive and significant and dissimilarity of capital investment appears with negative and significant sign. Adjacent provinces have higher correlation of demand shocks, large provinces tend to trade more with each other and thus have higher correlation of demand shocks, and two distant provinces have lower correlation of demand shocks. Moreover, higher correlation of demand shocks between provinces could be the result of the provinces with higher capital investment. Table 4.28 reports there is no significant effect for adjacent provinces which is

in line with the empirical evidence of Clark and van Wincoop (2001) and Barrios and de Lucio (2003) that the set of explanatory variables can explain part (not all) of the border effect.

4.4.2 Early period of economic reform with market oriented economic system (1978-1991)

Table 4.24 shows univariate regression results, based on the two methods considered. The correlation of supply shocks can be explained by coast_intra dummy with positive sign, size with positive sign, dissimilarity of fixed asset investment with negative sign, dissimilarity of international trade with positive sign which are all expected signs. This result indicates: Coastal provinces are characterized by higher correlation of supply shocks. Large provinces tend to have higher correlation of supply shocks. Provinces with similar fixed asset investment have higher correlation of supply shocks. Provinces with similar international trade have higher correlation of supply shocks. Poncet and Barthélemy (2008, p. 921) note that international trade acts as a stabilizing force and facilitates regional adjustment to idiosyncratic shocks, especially in a context of poor domestic integration. However, Table 4.29 reports that dissimilarity of international trade has no significant effect when included other explanation variables.

Table 4.26 shows univariate regression results, based on the two methods considered. The correlation of cross provinces demand shocks can be explained by dissimilarity of standard deviation with negative sign, dissimilarity of production structure with negative sign, size with negative sign, and dissimilarity of GPI with positive sign. The signs of the first two variables are expected which suggest that the greater local policy divergence, the lower correlation of demand shocks, and a higher similarity in production structures across provinces is likely to be associated with greater demand shocks correlations. These findings are in line with Clark and van Wincoop (2001), Barrios and de Lucio (2003), Imbs (2004), Poncet and Barthélemy (2008)'s findings. However, the rest of variables are significant with

opposite sign compared with theory and existing empirical evidence. Table 4.30 reports the robust results when all the significant variables are included based on univariate regressions (see Table 4.26) and the results are quite surprising. The dissimilarity of standard deviation of fiscal deficit and dissimilarity of production structure are insignificant. The rest of significant variables are of opposite sign which is not in line with previous literature.

4.4.3 Deep economic reform period with market oriented economic system (1992-2007)

Table 4.24 shows univariate regression based on the two methods to be considered. The correlation of supply shocks can be explained by common border dummy with positive sign, same_region dummy with negative sign, coast_region dummy with positive sign, dissimilarity of capital investment and dissimilarity of fixed asset investment with negative sign. Table 4.31 reports robust results after considering multi collinearity, it indicates that adjacent provinces have higher correlation of supply shocks, coastal provinces are characterized by higher correlation of supply shocks, and provinces with similar fixed asset investment/capital investment[42] have higher correlation of supply shocks.

Table 4.26 shows the univariate estimates based on the two methods considered, the correlation of cross provinces demand shocks can be explained by dissimilarity of fixed asset investment with positive sign, dissimilarity of human capital with negative sign and dissimilarity of international trade with negative sign. Table 4.32 reports the robust results when we add all significant variables. It indicates that higher correlation of demand shocks between provinces could be the result of the provinces with similar human capital investment; However, our results indicate higher correlation of demand shocks in provinces with lower similarity of fixed asset capital investment.

[42] Multi collinear is observed between capital investment and fixed asset investment.

4.5 Conclusion

In this chapter, the correlations of supply or demand shocks in China has been examined. Supply and demand shocks were recovered from structural vector autoregressive models. The sample period was divided into four uneven sub-periods: 1955-1965, 1966-1977, 1978-1991, and 1992-2007 which corresponds to different phases of China's economic reform. The key findings of this study are as follows.

(i) The degree of bilateral cross correlation of supply shocks suggests a fall in the cohesion between Chinese regions. However, the bilateral cross correlation of demand shocks has increased, which in turn suggest a greater degree of cohesion.

(ii) Under central planning economic system, the variables I considered in the study do not to explain the correlation of supply or demand shocks across provinces in China.

(iii) Distance between two provinces is robustly correlated with a higher cross provinces correlation of demand shock in the early period (1966-1977). With the development of electric railways which started from 1958, the effect of distance fades away.

(iii) Two variables were found to be robust explaining the correlation of supply shocks across provinces during the recent two period of 1978-1991 and 1992-2007. Coastal provinces and those with similar fixed asset investment are characterized by higher correlation of supply shocks.

(iv) Greater similarity in production structure is not robustly correlated with correlation of supply or demand shocks. Although it is significant in the univariate regression and has positive relationship with the correlation of demand shocks during the period 1992-2007, the significance disappears when other explanatory variables are added. Baxter and Kouparitas (2005) also cannot find robust results based on over 100 countries dataset and

doubt about the findings of Imbs (1998, 2003, and 2004) which stress the importance of industrial structure.

(v) We do not find any link between fiscal policy coordination and the correlation of supply and demand shocks. This finding is in line with the empirical findings of Clark and van Wincoop (2001) who conjecture that it could be an indirect link through the effect of common policies on trade. In the early period of economic reform, the coastal areas in the East have particularly benefited from the open door policy.

In conclusion, this chapter investigates to study the correlation of business cycle among Chinese provinces and seeks to explain the relationship between business cycle co-movement and other economic variables.

4.6 Tables and Figures

Table 4.20. Weighted average supply shocks's correlation by province

Region	Province name	1955-1965	1966-1977	1978-1991	1992-2007
EAST	Beijing	0.61	0.54	0.41	0.26
	Tianjin	0.77	0.37	0.48	0.34
	Shanghai	0.68	0.35	0.49	0.33
	Liaoning	0.78	0.27	0.38	-0.35
	Shandong	0.63	0.38	0.46	0.29
	Jiangsu	0.39	0.53	0.37	0.27
	Zhejiang	0.68	0.10	0.53	0.35
	Fujian	0.69	0.35	0.49	0.37
	Guangdong	0.65	0.35	0.38	0.41
CENTRAL	Hebei	0.71	0.42	0.50	0.25
	Shanxi	0.78	0.50	0.23	0.03
	Inner-Mongolia	0.65	0.46	0.18	0.10
	Jilin	0.73	0.49	0.35	0.33
	Heilongjian	0.78	0.40	0.37	0.09
	Anhui	0.48	-0.09	-0.21	0.09
	Jiangxi	0.43	0.45	0.39	0.36
	Henan	0.71	0.34	0.19	-0.12
	Hunan	0.78	0.52	0.36	0.38
	Hubei	0.72	0.48	0.37	0.16
WEST	Guangxi	0.76	0.24	0.42	0.43
	Sichuan	-	-	0.46	0.32
	Guizhou	0.82	0.35	0.29	0.08
	Yunnan	0.58	0.38	0.35	0.32
	Shaanxi	0.78	0.36	0.39	-0.04
	Gansu	0.61	0.19	0.33	0.20
	Ningxia	0.56	0.32	0.25	-0.26
	Qinghai	0.69	0.23	0.39	0.11
	Xinjiang	0.59	0.51	0.29	0.27

Table 4.21. Weighted average Demand shocks's correlation by province

Region	Province name	1955-1965	1966-1977	1978-1991	1992-2007
EAST	Beijing	0.01	0.05	0.43	0.60
	Tianjin	0.20	0.23	0.47	0.66
	Shanghai	0.18	0.16	0.34	0.73
	Liaoning	-0.18	0.17	0.17	0.50
	Shandong	0.21	0.07	0.19	0.51
	Jiangsu	-0.07	0.18	0.37	0.76
	Zhejiang	0.26	0.08	0.41	0.75
	Fujian	0.18	-0.13	0.48	0.74
	Guangdong	0.18	0.10	0.37	0.66
CENTRAL	Hebei	0.17	0.09	0.49	0.71
	Shanxi	0.05	0.20	0.38	0.66
	Inner-Mongolia	0.05	-0.02	0.44	0.79
	Jilin	0.19	0.03	0.10	0.60
	Heilongjian	0.11	0.30	0.20	0.75
	Anhui	-0.18	0.29	0.40	0.66
	Jiangxi	0.21	0.14	0.45	0.66
	Henan	-0.07	0.29	0.37	0.72
	Hunan	0.18	-0.17	0.38	0.78
	Hubei	0.08	0.10	0.39	0.75
WEST	Guangxi	0.14	0.02	0.53	0.70
	Sichuan	-	-	0.32	0.68
	Guizhou	0.23	0.16	0.53	0.77
	Yunnan	0.16	-0.18	0.28	0.58
	Shaanxi	0.14	0.22	0.26	0.67
	Gansu	0.14	-0.24	0.21	0.36
	Ningxia	0.16	-0.04	0.49	0.73
	Qinghai	0.12	-0.10	0.37	0.71
	Xinjiang	-0.08	-0.15	0.38	0.68

Table 4.22. Sub-groups

Sample	Observations
East	Beijing, Tianjin, Shanghai, Liaoning, Shandong, Jiangsu, Zhejiang, Fujian, Guangdong, Hainan
Central	Hebei, Shanxi, Inner-Mongolia, Jilin, Heilongjiang, Anhui, Jiangxi, Henan, Hunan, Hubei
West	Guangxi, Guizhou, Yunan, Sichuan, Shaanxi, Gansu, Ningxia, Qinghai, Xinjiang

Table 4.23. OLS univariate estimates regression of cross-province correlation of supply shocks, before reform

variables	$1955-1965$		$1966-1977$	
	o	z	o	z
common border	0.028157	0.048582	0.040173	0.047516
	(0.031775)	(0.062398)	(0.044468)	(0.055910)
	$[0.002425]$	$[0.001873]$	$[0.002520]$	$[0.002231]$
distance	$2.07E-06$	-0.000606	$-6.70E-06$	-0.014926
	$(1.10E{-}05)$	(0.034733)	$(1.53E{-}05)$	(0.031116)
	$[0.000110]$	$[0.000001]$	$[0.000590]$	$[0.000712]$
size	0.000568	0.060311	-0.000343	-0.027246
	(0.000361)	(0.049827)	(0.000254)	(0.041057)
	$[0.007588]$	$[0.004515]$	$[0.005650]$	$[0.001362]$
dissimilarity of capital investment	-0.336200^{**}	-0.037162	-0.268362	0.008314
	(0.169711)	(0.030349)	(0.241338)	(0.024251)
	$[0.012004]$	$[0.004621]$	$[0.003814]$	$[0.000364]$
dissimilarity of human capital	0.018180	0.032628^{*}	0.015472	-0.009189
	(0.017182)	(0.018441)	(0.047604)	(0.021297)
	$[0.003454]$	$[0.009599]$	$[0.000328]$	$[0.000578]$
dissimilarity of GPI	-0.000604	0.040185	-0.002502	-0.038544^{*}
	(0.001503)	(0.041364)	(0.002149)	(0.022564)
	$[0.000500]$	$[0.002913]$	$[0.004181]$	$[0.008953]$
dissimilarity of standard deviation of fisical deficit	0.221947	0.049456	-0.810108	-0.087079^{**}
	(0.187832)	(0.037616)	(0.535593)	(0.041178)
	$[0.004304]$	$[0.005323]$	$[0.007033]$	$[0.013656]$
number of observations:	325	325	325	325

Figures in ( ) are standard errors. Figures in [ ] are R^2

*** 1% significant level,**5% significant level, *10% significant level

o: results based on original data, z: results based on Fisher "z" tranformation and log(variables)

Table 4.24. OLS univariate estimates regression of cross-province correlation of supply shocks, after reform

variables	$1978-1991$		$1992-2007$	
	o	z	o	z
common border	0.023345	0.044330	0.130154^{***}	0.154216^{***}
	(0.037581)	(0.045354)	(0.051851)	(0.062148)
	$[0.001025]$	$[0.002534]$	$[0.016482]$	$[0.016112]$
same region	0.039198	0.056307	0.084523^{**}	0.100917^{**}
	(0.029714)	(0.035853)	(0.041183)	(0.049355)
	$[0.004607]$	$[0.006517]$	$[0.011079]$	$[0.010997]$
coast_intra	0.221088^{***}	0.276857^{***}	0.195236^{***}	0.257427^{***}
	(0.046338)	(0.055838)	(0.065587)	(0.078403)
	$[0.057088]$	$[0.061369]$	$[0.023024]$	$[0.027873]$
coast_interior border	0.054391	0.076551	-0.039507	-0.048638
	(0.070802)	(0.085488)	(0.098507)	(0.118047)
	$[0.001567]$	$[0.002128]$	$[0.000428]$	$[0.000451]$
distance	$-2.13E-05$	-0.055849^{**}	$1.10E-06$	-0.025725
	$(1.36E-05)$	(0.026435)	$(1.90E-05)$	(0.036664)
	$[0.006451]$	$[0.011732]$	$[0.000009]$	$[0.001308]$
size	0.000346^{***}	0.138312^{***}	$5.78E-06$	0.009697
	$(7.40E-05)$	(0.033675)	$(1.85E-05)$	(0.040324)
	$[0.054782]$	$[0.042939]$	$[0.000259]$	$[0.000154]$
dissimilarity of capital investment	-0.202189	-0.013527	-1.327728^{***}	-0.101748^{***}
	(0.242573)	(0.020732)	(0.384416)	(0.036837)
	$[0.001844]$	$[0.001131]$	$[0.030751]$	$[0.019888]$
dissimilarity of fixed asset investment	-1.831116^{***}	-0.148670^{***}	-0.897178	-0.080585^{**}
	(0.348473)	(0.029156)	(0.330894)	(0.040774)
	$[0.068412]$	$[0.064679]$	$[0.019177]$	$[0.010282]$
dissimilarity of human capital	0.503795	0.015454	-4.272693	-0.051782
	(1.877101)	(0.027268)	(3.910434)	(0.045384)
	$[0.000192]$	$[0.000853]$	$[0.003165]$	$[0.003450]$
dissimilarity of GPI	0.016084	0.042656	0.041759^{*}	0.086882
	(0.012270)	(0.033941)	(0.025354)	(0.055054)
	$[0.004549]$	$[0.004183]$	$[0.007163]$	$[0.006580]$
dissimilarity of standard deviation of fisical deficit	0.517423	0.021295	-0.731659	-0.054555
	(0.352769)	(0.022140)	(1.128675)	(0.037963)
	$[0.005689]$	$[0.002454]$	$[0.001116]$	$[0.005462]$
dissimilarity of production structure	0.101360	0.037248	0.211801	0.025112
	(0.076309)	(0.027723)	(0.207825)	(0.052348)
	$[0.004670]$	$[0.004778]$	$[0.002755]$	$[0.000612]$
dissimilarity of FDI	2.892671	0.026751	0.179763	0.005275
	(2.466734)	(0.011721)	(0.721279)	(0.024454)
	$[0.003644]$	$[0.013664]$	$[0.000165]$	$[0.000124]$
dissimilarity of international trade	0.205564^{*}	0.038594^{***}	0.046245	-0.005189
	(0.106799)	(0.012968)	(0.046314)	(0.015493)
	$[0.009757]$	$[0.023013]$	$[0.002645]$	$[0.000298]$
number of observations:	378	378	378	378

Figures in ( ) are standard errors. Figures in [ ] are R^2

*** 1% significant level,**5% significant level, *10% significant level

o: results based on original data, z: results based on Fisher "z" tranformation and log(variables)

Table 4.25. OLS univariate estimates regression of cross-province correlation of demand shocks, before reform

variables	$1955-1965$		$1966-1977$	
	o	z	o	z
common border	0.016038	0.012693	0.167365^{***}	0.179765^{***}
	(0.058028)	(0.067104)	(0.053691)	(0.060920)
	$[0.000236]$	$[0.000111]$	$[0.029205]$	$[0.026251]$
distance	$4.98E-08$	0.022808	-0.000105^{***}	-0.175933^{***}
	$(2.00E{-}05)$	(0.037298)	$(1.78E{-}05)$	(0.032907)
	$[0.000000]$	$[0.001156]$	$[0.096647]$	$[0.081301]$
size	-0.000997	-0.051080	0.000839^{***}	0.094533^{***}
	(0.000659)	(0.053583)	(0.000308)	(0.045008)
	$[0.007033]$	$[0.002806]$	$[0.022488]$	$[0.013474]$
dissimilarity of capital investment	-0.103934	-0.027562	-1.208475^{***}	-0.101415^{***}
	(0.311406)	(0.032648)	(0.288197)	(0.026151)
	$[0.000345]$	$[0.002202]$	$[0.051627]$	$[0.044490]$
dissimilarity of human capital	0.004045	0.003724	0.055264	-0.003252
	(0.031397)	(0.019909)	(0.058134)	(0.023473)
	$[0.000051]$	$[0.000108]$	$[0.002799]$	$[0.000060]$
dissimilarity of GPI	-0.003036	-0.068216	-0.002924	-0.041937^{*}
	(0.002737)	(0.044347)	(0.002630)	(0.024890)
	$[0.003793]$	$[0.007272]$	$[0.003810]$	$[0.008713]$
dissimilarity of standard deviation of fisical deficit	0.150066	-0.010881	-0.732635	-0.064897
	(0.343279)	(0.040521)	(0.656563)	(0.045588)
	$[0.000591]$	$[0.000223]$	$[0.003840]$	$[0.006235]$
number of observations:	325	325	325	325

Figures in ( ) are standard errors. Figures in [ ] are R^2

*** 1% significant level,** 5% significant level, * 10% significant level

o: results based on original data, z: results based on Fisher "z" tranformation and log(variables)

Table 4.26. OLS univariate estimates regression of cross-province correlation of demand shocks, after reform

variables	$1978-1991$		$1992-2007$	
	o	z	o	z
common border	0.023834	0.046782	0.020040	0.037709
	(0.037145)	(0.047124)	(0.023144)	(0.042607)
	[0.001094]	[0.002614]	[0.001990]	[0.002079]
same region	−0.023149	−0.031228	0.011592	0.031778
	(0.029414)	(0.037340)	(0.018341)	(0.033743)
	[0.001645]	[0.001857]	[0.001061]	[0.002353]
coast_intra	−0.012962	−0.017831	−0.039961	−0.057588
	(0.047163)	(0.059879)	(0.029331)	(0.054049)
	[]	[0.000236]	[0.004912]	[0.003010]
coast_interior border	0.041835	0.092028	−0.068357	−0.146728*
	(0.070004)	(0.088795)	(0.043516)	(0.080019)
	[0.000949]	[0.002849]	[0.006520]	[0.008863]
distance	$-2.39E-05^{*}$	−0.037748	$-1.13E-05$	−0.030809
	$(1.35E{-}05)$	(0.027561)	$(8.41E{-}06)$	(0.024924)
	[0.008339]	[0.004964]	[0.004779]	[0.004047]
size	−0.000299***	−0.135683***	$-1.25E-05$	−0.048086*
	$(7.37E{-}05)$	(0.035076)	$(8.18E{-}06)$	(0.027339)
	[0.041990]	[0.038274]	[0.006195]	[0.008160]
dissimilarity of capital investment	0.238076	0.008761	0.389290**	0.025987
	(0.239674)	(0.021549)	(0.171852)	(0.025293)
	[0.002617]	[0.000439]	[0.013464]	[0.002800]
dissimilarity of fixed asset investment	0.728007**	0.031695	0.327238**	0.050676*
	(0.354885)	(0.031282)	(0.147085)	(0.027777)
	[0.011068]	[0.002723]	[0.012993]	[0.008774]
dissimilarity of human capital	−1.064335	−0.010069	−2.411289	−0.057103*
	(1.854753)	(0.028341)	(1.731047)	(0.030807)
	[0.000875]	[0.000336]	[0.005134]	[0.009055]
dissimilarity of GPI	0.040543***	0.107509***	0.007895	0.000705
	(0.011975)	(0.034903)	(0.011268)	(0.037600)
	[0.029585]	[0.024612]	[0.001304]	[0.000001]
dissimilarity of standard deviation of fisical deficit	−0.786255**	−0.057348***	0.478487	0.021793
	(0.347326)	(0.022843)	(0.499800)	(0.025889)
	[0.013446]	[0.016487]	[0.002432]	[0.001881]
dissimilarity of production structure	−0.155250	−0.077501***	−0.115586	−0.057319*
	(0.075178)	(0.028596)	(0.092024)	(0.035523)
	[0.011215]	[0.019160]	[0.004178]	[0.006877]
dissimilarity of FDI	0.493072	0.001729	−0.446336	−0.024001
	(2.442522)	(0.012263)	(0.318804)	(0.016601)
	[0.000108]	[0.000053]	[0.005186]	[0.005528]
dissimilarity of international trade	−0.152044	−0.019970	−0.045081***	−0.030514***
	(0.105792)	(0.013594)	(0.020417)	(0.010430)
	[0.005463]	[0.005707]	[0.012800]	[0.022259]
number of observations:	378	378	378	378

Figures in ( ) are standard errors. Figures in [ ] are R^2

*** 1% significant level,** 5% significant level, * 10% significant level

o: results based on original data, z: results based on Fisher "z" tranformation and log(variables)

Table 4.27. Estimates of of cross-province correlation of supply shocks (1955-1966, 1966-1977)

variables	1955-1965		1966-1977	
	o	z	o	z
constant	0.688744^{***} (0.020120)	1.044120^{***} (0.093624)	–	0.175746 (0.119948)
dissimilarity of capital investment	-0.336200^{**} (0.169711)	–	–	–
dissimilarity of human capital	–	0.032628^{*} (0.018441)	–	–
dissimilarity of GPI	–	–	–	-0.033231 (0.022639)
dissimilarity of standard deviation of fisical deficit	–	–	–	-0.079661^{*} (0.041414)
number of obsevations	325	325		325
R^2	0.012	0.010	–	0.020

Figures in ( ) are standard errors.

*** 1% significant level,** 5% significant level, * 10% significant level

o: results based on original data, z: results based on Fisher "z" tranformation and log(variables)

Table 4.28. Estimates of of cross-province correlation of demand shocks (1966-1977)

variables	(1)		(2)	
	o	z	o	z
constant	0.227013^{***}	0.981223^{**}	0.288083^{***}	0.985346^{***}
	(0.085484)	(0.485426)	(0.039987)	(0.287326)
common border	0.024822	-0.017246	$-$	$-$
	(0.055137)	(0.075053)		
distance	$-8.42E-05^{***}$	-0.152108^{***}	$-9.05E-05^{***}$	-0.147575^{***}
	$(2.08E-05)$	(0.045464)	$(1.74E-05)$	(0.033431)
size	0.000283	0.010009	$-$	$-$
	(0.000319)	(0.053158)		
dissimilarity of capital investment	-0.720103^{**}	-0.050750^{*}	-0.807868^{***}	-0.056192^{**}
	(0.311185)	(0.031753)	(0.283940)	(0.027645)
dissimilarity of GPI	$-$	-0.012691	$-$	$-$
		(0.025573)		
number of obsevations	325	325	325	325
$adjusted\ R^2$	0.109	0.080	0.112	0.087

Figures in ( ) are standard errors.

*** 1% significant level,** 5% significant level, * 10% significant level

o: results based on original data, z: results based on Fisher "z" tranformation and log(variables)

Table 4.29. Estimates of of cross-province correlation of supply shocks (1978-1991)

variables	(1)		(2)	
	o	z	o	z
constant	0.359874^{***}	-0.015009	0.359855^{***}	-0.030714
	(0.046818)	(0.374642)	(0.046790)	(0.074962)
coast_intra	0.155760^{***}	0.207104^{***}	0.156212^{***}	0.249393^{***}
	(0.039629)	(0.053773)	(0.039495)	(0.047613)
distance	–	-0.015937	–	–
		(0.030031)		
size	0.000136^{*}	0.029901	0.000139^{*}	–
	$(7.85E-05)$	(0.037547)	$(7.84E-05)$	
dissimilarity of fixed asset investment	-1.460731^{***}	-0.125348^{***}	-1.459721^{***}	-0.134764^{***}
	(0.342703)	(0.027043)	(0.342472)	(0.026486)
dissimilarity of FDI	–	-0.002599	–	–
		(0.013332)		
dissimilarity of international trade	0.011444	0.019981	–	–
	(0.096135)	(0.015714)		
number of obsevations	378	378	378	378
$adjusted\ R^2$	0.107	0.109	0.109	0.109

Figures in ( ) are standard errors.

*** 1% significant level,**5% significant level, *10% significant level

o: results based on original data, z: results based on Fisher "z" tranformation and log(variables)

Table 4.30. Estimates of of cross-province correlation of demand shocks (1978-1991)

variables	(1)		(2)	
	o	z	o	z
constant	0.485790^{***}	0.990617^{***}	0.485978^{***}	1.035088^{***}
	(0.057223)	(0.218081)	(0.056768)	(0.214072)
distance	$-5.57E-05^{***}$	–	$-5.59E-05^{***}$	–
	$(1.53E-05)$		$(1.50E-05)$	
size	-0.000291^{***}	-0.128419^{***}	-0.000292^{***}	-0.127943^{***}
	$(8.61E-05)$	(0.034374)	$(8.36E-05)$	(0.034254)
dissimilarity of fixed asset investment	0.711013^{*}	–	0.706959^{*}	–
	(0.371342)		(0.368353)	
dissimilarity of GPI	0.056075^{***}	0.130941^{***}	0.056241^{***}	0.133734^{***}
	(0.010106)	(0.036135)	(0.009938)	(0.036256)
dissimilarity of standard deviation of fisical deficit	-0.048417	-0.023475	–	–
	(0.543226)	(0.028519)		
dissimilarity of production structure	-0.106374	-0.052021	–	-0.070239^{***}
	(0.109215)	(0.036217)		(0.026650)
number of obsevations	378	378	378	378
$adjusted\ R^2$	0.106	0.076	0.109	0.077

Figures in ( ) are standard errors.

*** 1% significant level,** 5% significant level, * 10% significant level

o: results based on original data, z: results based on Fisher "z" tranformation and log(variables)

Table 4.31. OLS estimates of cross-province correlation of supply shocks (1992-2007)

variables	(1)		(2)	
	o	z	o	z
constant	0.150881^{***} (0.059293)	-0.045445 (0.107708)	0.132814^{**} (0.055184)	0.001078 (0.105391)
common border	0.124094^{**} (0.051910)	0.128492^{**} (0.065003)	0.128157^{***} (0.049160)	0.130177^{**} (0.060859)
same region	-0.003619 (0.044620)	-0.015869 (0.052936)	–	–
coast_intra	0.194820^{**} (0.086171)	0.253545^{**} (0.108196)	0.205914^{***} (0.079754)	0.257652^{***} (0.101402)
dissimilarity of capital investment	-0.585795 (0.556194)	-0.065553 (0.051288)	–	–
dissimilarity of fixed asset investment	-0.474180 (0.536941)	-0.020523 (0.063594)	-0.846228^{**} (0.360634)	-0.072825^{*} (0.042179)
dissimilarity of GPI	0.060553^{**} (0.024758)	–	0.065424^{***} (0.024660)	–
number of obsevations	378	378	378	378
$adjusted\ R^2$	0.057	0.041	0.060	0.043

Figures in ( ) are standard errors.

*** 1% significant level,**5% significant level, *10% significant level

o: results based on original data, z: results based on Fisher "z" tranformation and log(variables)

Table 4.32. OLS estimates of cross-province correlation of demand shocks (1992-2007)

variables	(1)		(2)	
	o	z	o	z
constant	0.684091^{***} (0.020706)	0.540562^{*} (0.290016)	0.684091^{***} (0.020706)	0.672258^{***} (0.143204)
coast_interior border	–	-0.141539^{**} (0.067345)	–	-0.141503^{**} (0.065497)
size	–	0.017173 (0.036778)	–	–
dissimilarity of fixed asset investment	0.418093^{***} (0.141738)	0.087472^{***} (0.030794)	0.418093^{***} (0.141738)	0.077972^{***} (0.028202)
dissimilarity of human capital	-2.781927^{*} (1.434807)	-0.068842^{**} (0.029771)	-2.781927^{*} (1.434807)	-0.072713^{***} (0.028987)
dissimilarity of production structure	–	−0.027369 (0.039062)	–	–
dissimilarity of international trade	-0.055733^{***} (0.019805)	-0.035294^{***} (0.012805)	-0.055733^{***} (0.019805)	-0.034669^{***} (0.009995)
number of obsevations	378	378	378	378
$adjusted\ R^2$	0.030	0.046	0.030	0.060

Figures in ( ) are standard errors.

*** 1% significant level,**5% significant level, *10% significant level

o: results based on original data, z: results based on Fisher "z" tranformation and log(variables)

Fig. 4.4. Cross provinces' correlation of supply shocks 1955-1965

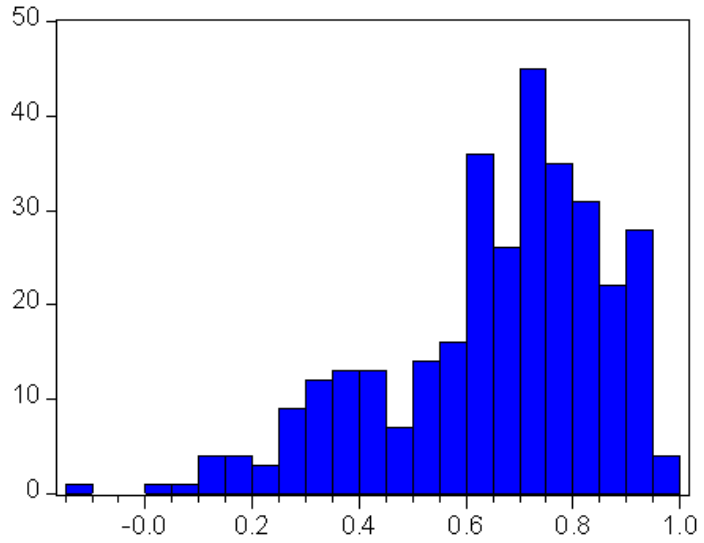


Fig. 4.5. Cross provinces' correlation of supply shocks 1966-1977

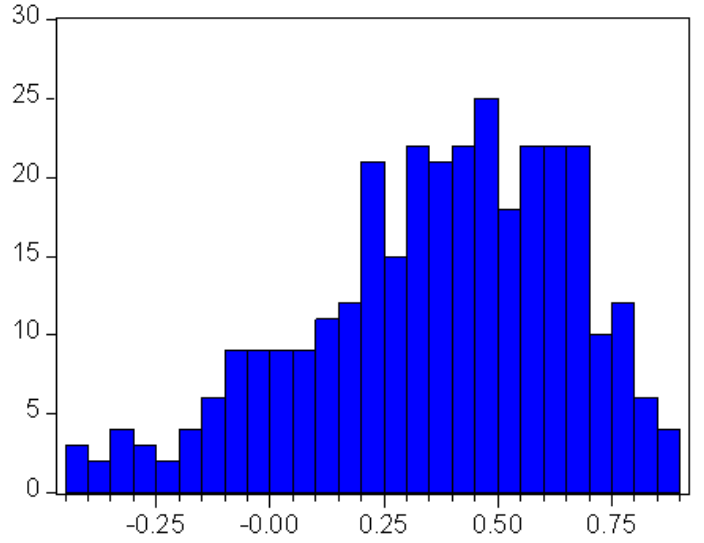


Fig. 4.6. Cross provinces' correlation of supply shocks 1978-1991

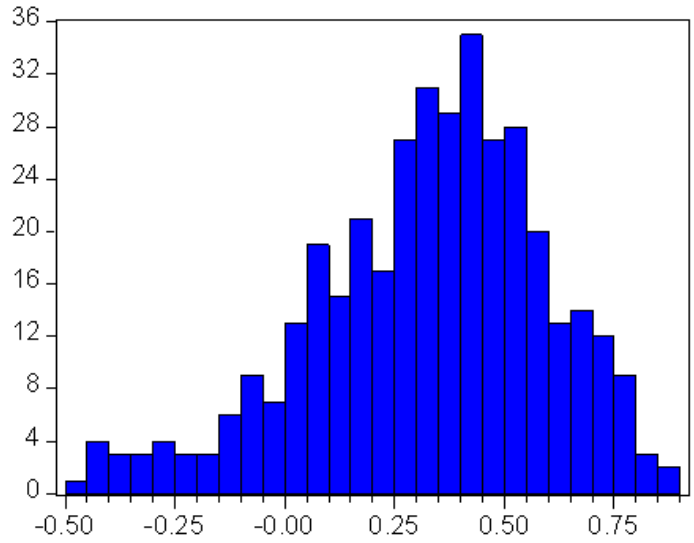


Fig. 4.7. Cross provinces' correlation of supply shocks 1992-2007

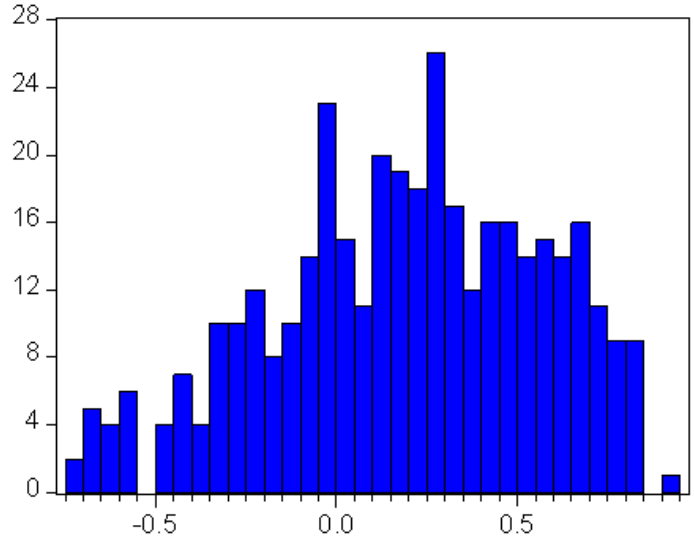


Fig. 4.8. Cross provinces' correlation of demand shocks 1955-1965

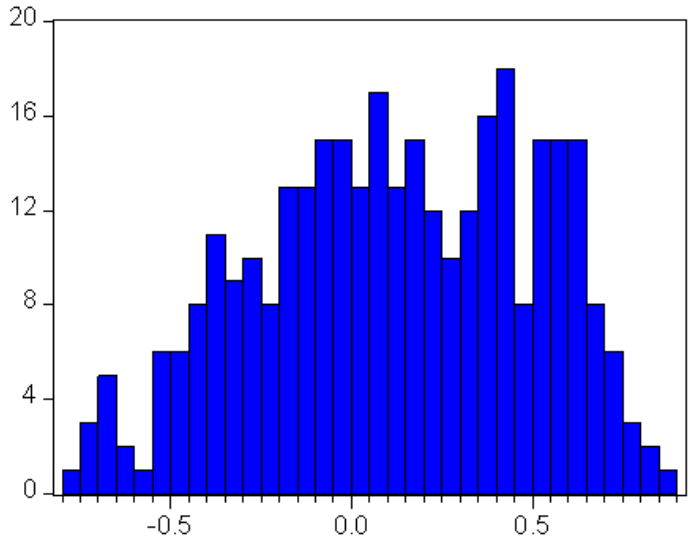


Fig. 4.9. Cross provinces' correlation of demand shocks 1966-1977

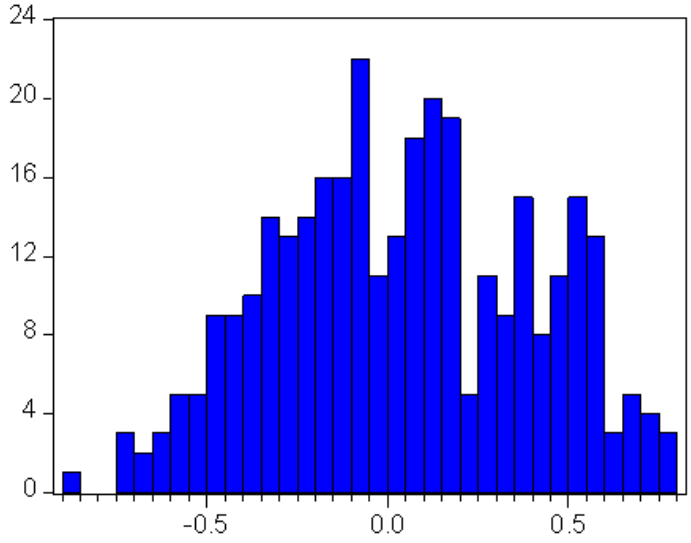


Fig. 4.10. Cross provinces' correlation of demand shocks 1978-1991

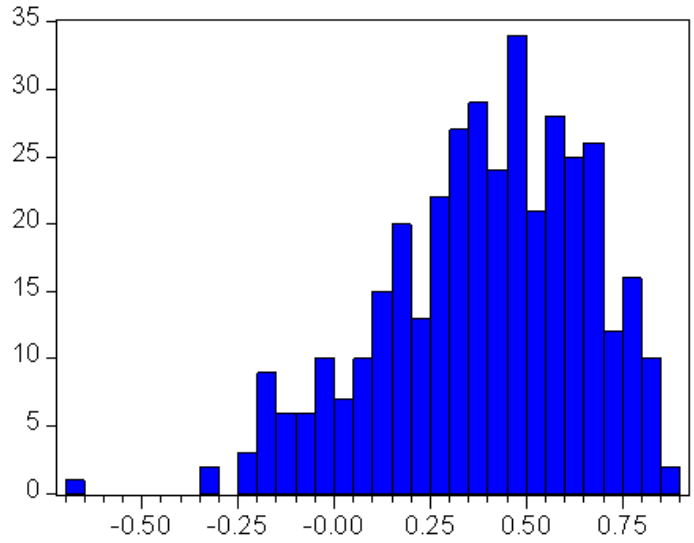
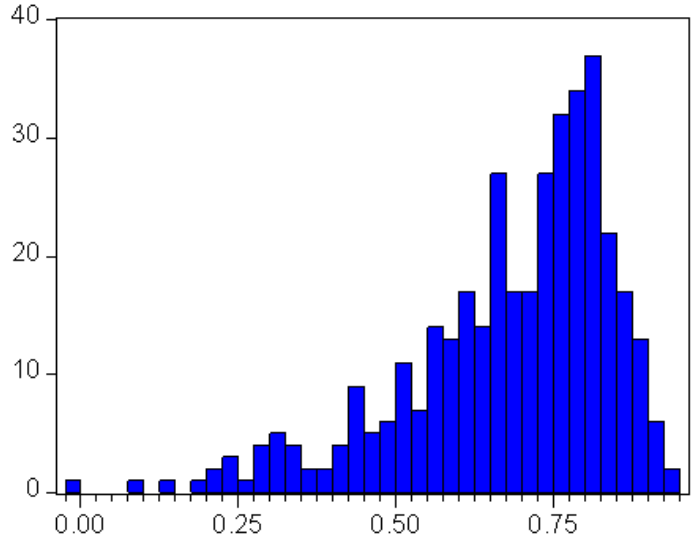


Fig. 4.11. Cross provinces' correlation of demand shocks 1992-2007



Chapter 5
Conclusions

The objective of this thesis is to study the macroeconomic performance of China and China's growth experience during the transition period from central planning to market oriented economic system. The economic reform was initiated in 1978. China has been experiencing rapid economic growth, since then, recently becoming the second largest economy globally. However, the progress of reform has been uneven and the fruits of reform differ across regions. As a result, large differences emerged with the degree of economic development among the regions of China. Urban areas in Eastern and South-Eastern China are increasingly shaping up as they benefited a lot from the "open-door" policy. As a result, they are developing much more quickly than the interior areas of Central and Western China. In order to improve local enthusiasm in production and promote fast growth of their local economies, the government implemented economic decentralization. The Chinese economy is thus characterized by large inter-regional economic differentials and a high degree of economic decentralization. In addition, urban employment system changed from a system of centrally fixed wages and lifetime secure employment to a mostly market-based system. Privatization of state owned enterprises was initiated and unemployment in urban areas emerged during the period of economic transition and structural adjustment in the late 1990s. Unemployment has increased significantly during last two decades, and has become one of the most pressing problems of the Chinese economy today. Based on the regional disparity on the background of rapid growth, we focused my study on the following aspects.

In Chapter 2 we explore the impact of foreign direct investment on growth by using a panel of Chinese provincial data spanning 1978-2008 China's remarkable growth performance over the last three decades is widely attributed to foreign direct investment. Attracting foreign direct investment has been the main motivation of Chinese open door policy. We

estimate an augmented Solow growth model which relates output growth to investment in human and physical capital and population growth. We then introduce FDI into the model to compare if convergence within broader regions is faster. Our main finding is that the effect of FDI on economic growth in different provinces is positive and statistically significant. More generally, my analysis indicates that the augmented Solow growth model appears to provide a good description of regional growth patterns in China over the period 1978-2008. Conditional convergence becomes even stronger after splitting the data into sub samples which indicates that China may converge to different steady states. The policy implication is that regional disparity is created by the strategy of allowing selected areas to develop "one step ahead". So, it's time to help the laggards to improve their productivity to balance the regional economic development and maintain the social stability. The West and Central areas of China should be granted the same privilege that the economic zones have to attract more foreign investment and domestic investment, and invest much more capital in education as they did in well developed area.

In Chapter 3 we adopt a regional panel data approach to investigate the relationship between unemployment and growth in China during the period 1997-2006. First, we test whether the Okun's law holds in China. With the market-oriented reform progressed, the law is found to hold only in Eastern and Central China. More generally, we find the unemployment level in China remains moderate. The Aghion and Blanchard (1994) model suggests an intermediate level of unemployment is necessary to achieve the optimal speed of transition that would maximize the total output. Our empirical estimates suggest that the current unemployment rate in China is indeed close to the optimal unemployment rate. Unemployment is thus the price that China needs to pay for the future prosperity. However, China is a large country with more than 1.3 billion populations and with a growing regional disparity in economic development. Base on the empirical study of the relationship between growth rate and unemployment rate at regional level, it indicates that excessive state firm closures in Eastern China may slow down job creation in the private sector and undermine social stability. In contrast, the process of winding down and transforming in-

efficient state firms in Western China should be accelerated, and this would facilitate the development of the private sector and promote the transition progress.

In Chapter 4 we attempt to investigate the changing nature of economic integration among Chinese provinces and explain the interprovincial correlations of supply and demand shocks with a host of economic variables. The observation period covers five decades: from the communist take-over, through the upheavals of the Great Leap Forward and Cultural Revolution, to the economic liberalization and opening up to the outside world and the rapid growth that this has generated. The results show that Chinese provinces encounter increasingly symmetric demand shocks whereas supply shocks are becoming more asymmetric over time. This is potentially worrying: supply shocks leave behind permanent effects while demand shocks are only temporary in nature. If Chinese provinces are subject to increasingly divergent permanent shocks, this may translate into growing economic and political tensions in the future. We are unable to explain the comovement of business cycles during the Maoist period, especially during its early part, 1955-1965. This is perhaps not surprising, given that this period was dominated by politically-induced shocks. For the reform period, coastal provinces and those with higher fixed asset investment are characterized by higher correlation of supply shocks. Rather surprisingly, little evidence can be found that inward FDI (the factor associated with fuelling Chinese growth) and fiscal/administrative decentralization affect the synchronisation of demand or supply shocks.

In my study, one of the important and obvious causes of the increasing regional disparity is the “Coastal Development Strategy”. Central government neglected the interior regions while focusing on supporting investment in the coastal regions. The initial priority given to coastal development was motivated by the coastal region’s natural advantages for global transport and communication. This made it much more convenient and easier to attract foreign direct investment. In turn, the inflows of foreign direct helped the coastal provinces get ahead of the rest of China: there is strong evidence that foreign direct investment is a crucial factor leading to higher economic growth rates. It was expected that by supporting the coastal region and “letting some people and some regions get rich first”, the spill-over

effect from growth centers would gradually help the rest of economy to expand as well. However, this strategy has eventually resulted in the interior region lagging far behind the coastal region. Regional disparity is not only an economic challenge but also a political one. China is composed of 56 ethnic groups and most of ethnic minority people live in the far west region which is among the least developed areas. The widening of regional disparity may therefore also undermine social stability. The central government has realized the urgency and importance and has made enormous effort to control regional disparities. Zhu Rongji government launched the "Western Development Strategy" in 1998. "North-East Revival Strategy" was implemented in 2003. In 2006, Wen Jiabao government initiated the "Rise of Central China" program to speed up the development of central areas and to attain well balanced regional development. The interior regions of China will certainly benefit from these development policies by the development of infrastructure (government-led investment), creating a more stable environment to bring in foreign investment and promotion of education. Nevertheless, with the economy being gradually liberalized, the market economy mechanism has become firmly established in China. The effectiveness of the development policies initiated by both Zhu and Wen falls short of Deng's "open door" policy and "special economic zone" policy. "Harmonious society" is the goal of current Chinese leadership and Hu and Wen's governments have paid substantial attention to regional disparity. They issued many preferential policies to encourage excellent teachers/graduates to go to the countryside especially in the West since human capital is another important factor leading to higher economic growth rates. They stressed the importance of teachers' quality for closing the gap between rural and urban areas. It is not clear whether the less developed regions can finally catch up with the rapidly-growing coastal region. However, my empirical study based on augmented Solow model found that convergence in per capita production across China's provinces from 1978-2008 is conditional on physical investment, employment growth, human capital investment and foreign direct investment. This suggests that factor accumulation in the interior regions will eventually lead to convergence in incomes. Continued extensive reform will further help the process of convergence.

In future research, several lines can be suggested. Firstly, the rural-urban disparity is another form of disparity in China: there is often large income differential between urban and rural regions even within the same province. This issue should receive more attention in the future. Secondly, an important question is whether reducing regional inequality and maintaining high economic growth can be achieved at the same time. Will it undermine economic efficiency? Inequality is bad for social stability but there is another saying that in some way also positive to economic growth (Gravier-Rymaszewskaet et al., 2010). Therefore, studying the growth-inequality nexus in China will be very useful and important.

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