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Foreign Direct Investment and Regional Growth in China

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Abstract

China has experienced rapid economic growth and the recent Global Economic Projections 2004 by the World Bank suggest that there is a continuation of Chinese growth of at lest 7 to 8 percent (World Bank, 2003). Nevertheless, on the background of rapid growth came increasing regional disparities. This paper uses the augmented Solow-Swan model of Mankiw, Romer and Weil (1992) to analyze data on provinces of China over the reform period 1978-2003. Our main finding is that FDI has a positive and statistically significant impact on economic growth as theory predicts and the augmented Solow-Swan model provides an excellent fit of the data. The other determinants are significant at one percent level and have the expected sign. However, the human capital is insignificant or the coefficient is negative.

Key words: economic growth, conditional convergence, regional disparities

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1. Introduction

China has experienced rapid economic growth since the major economic reforms of the late 1970s and early 1980s which, among other things, liberalized domestic agricultural markets and international trade and finance and switched the emphasis of industrial policy from heavy to light manufacturing (Anderson et al., 1985, P65). Moreover, there are currently no signs that the rapid growth is abating. However, rapid growth has occurred on the background of increasing regional disparities. For example, Demurger et al. (2002) find the evidence of annual growth rates among Chinese provinces during the period 1979-1998 that the fastest and slowest growing provinces differ by 6.2 percentage points.

Started from the late 1970s, China has implemented the well known “open door policy” and so-called “coastal development strategy” which gave the costal areas a special role and autonomy. Most capital-intensive and industrial equipments which imported from western countries were allocated to the major costal urban areas where we thought they 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), 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 the vast 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 (Li et al., 1998; Wei, 2002). Using cross-section and panel data on Chinese provinces over the reform period 1978-1995, Li et al. (1998) found 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) found that industrial growth was positively associated with export and foreign direct investment. Indeed, in the two decades since economic reform began in China the role of the foreign sector got 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 country (The World Bank, 1994). In 1994, gross foreign direct investment inflows into China were exceeded only by those into the United States. In 1999 China ranked third in attracting FDI among all the countries and regions in the world (Chow, 2002).

The objective of this paper therefore is to explore the impact of foreign direct investment on growth, using a panel of Chinese provincial data spanning 1978-2003. 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. We augment this model further by adding FDI inflows.

The rest of the paper 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. In Section 5 we first show how leaving out foreign direct investment affects the coefficients on physical capital investment, population growth and human capital. We then split the samples in to three sub-groups to investigate club convergence. Section 6 concludes.

2. Literature Review

Our 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 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 of the 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 (Islam, 1995) and put forward the term "convergence club" to express this phenomenon. These countries tended 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.

Next, the Barro and Sala-i-Martin (1992) and MRW put forward the concept of the conditional convergence and argued that the evidence on the failure of per capita income to converge does not contradict the Solow-Swan model. They emphasized that the growth theory did not imply that all the countries would reach the identical steady state levels of income. Even in equilibrium, differences in countries' per capita incomes are likely to remain, reflecting 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, P415). The augmented Solow model predicts that differences in savings, education and labor-force growth should go a long way 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) found that adoption of the panel-data approach leads to a twofold change in the results compared with cross-section approach. First, he obtained much higher rates of convergence. Second, he obtained lower values of the elasticity of output with respect to capital. To the extent, the conventional cross-section estimates used 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 the measure errors by time-series variation and transformations respectively. Griliches and Mairesse (1995) suggest that it can be resolved by proxy for the unobserved fixed effects, which leaves more identifying variance in the regressor.

A natural forth stage in the literature, Lee, Pesaran, and Smith (1995, 1998), they extend the use of the panel data approach to allow for heterogeneity of growth rates (g) 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 can not 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 presented 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 questioned the MRW's findings. He found largely disparate coefficient estimates across the sub samples, some of which imply the absence of convergence. In particular, it is shown 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 empirical study to the United States and some other European countries. Barro and Sala-i-Martin (1995) reported convergence exist in the U.S. and compared it with other groups of countries and regions. It is surprise that given the same economic background (same currency, similar macroeconomic policies) and high mobility of factors and goods (no trade barriers, same currency), the convergence of within a country do not faster than between countries.

So far there have been only a few serious 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 (1995, 1996) found the 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. Li et al.'s (1998) extended Chen and Fleisher's study. They got the same results which the above mentioned. 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 analysis. 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.

3. The Model

Following Islam (1995) and Li et al. (1998), we estimate the following version of the Solow model augmented to include human capital (as suggested by MRW) and inflows of foreign direct investment.[1]

$$\ln\frac{Y_{t+1}}{L_{t+1}} = (1-e^{-\lambda t})\frac{\alpha}{1-\alpha-\beta}\ln s_k + (1-e^{-\lambda t})\frac{\beta}{1-\alpha-\beta}\ln s_h - (1-e^{-\lambda t})\frac{\alpha+\beta}{1-\alpha-\beta}\ln(n+g+\delta)$$
$$+ e^{-\lambda t}\ln\frac{Y_t}{L_t} + \theta(1-e^{-\lambda t})\ln F + (1-e^{-\lambda t})\ln A_0 + g(t+1-e^{-\lambda t}t) \qquad (1)$$

where Y_t/L_t refers to output per worker at time t, s_k and s_h are the savings rates (assumed to be constant and exogenous) that apply for investment in physical and human capital, respectively, δ is the constant rate of depreciation, n and g are the rate of growth of the labor force and the rate of technological progress, respectively, F is the degree of openness of the regional economy to foreign countries, A_0 is the initial

[1] The detailed derivation of the model can be found in Islam (1995) and Li et al. (1998) who in turn build on MRW.

level of technology, α, β and θ are parameters (assuming $\alpha>0$, $\beta>0$ and $\alpha+\beta<1$, and $\lambda = (n + g + \delta)(1 - \alpha - \beta)$ is the speed of convergence that the model yields. The above represents a dynamic panel data model with $(1-e^{-\lambda t})\ln A(0)$ as the time-invariant province-specific fixed effect (Islam, 1995).

The equation suggests that the rate of growth of output per worker is negatively related to population growth and positively related to investment in physical and human capital. The impact of FDI depends on the sign of θ; it is intuitive to assume that θ is positive so that FDI inflows foster growth. The notion of conditional convergence implies that regional economies grow faster if they are initially below their steady-state growth path which implies $e^{-\lambda t} < 1$. Finally, the model implies also that the sum of the coefficients associated with $\ln s_k$ and $\ln s_h$ plus that of $\ln(n + g + \delta)$ is equal to zero (Li et al., 1998).

4. Data

In this paper, the units of analysis are the individual provinces of China and the period of analysis is from 1978 to 2003. This period was chosen because the major economic reform was initiated in 1978. In equation (1), t can be thought of as time in years or also in longer intervals. The data are available in annual frequency. Annual frequency, however, may be are 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

1978-2003, we have five data points for each province: 2003, 1998, 1993, 1988, and 1983. When t = 1983, for example, t-1 is 1978. However, data are not available for some provinces; thus, our data exclude Chongqing and Tibet. One important question when testing the Solow-Swan model is whether to use per capita or per worker variables. According to the Solow-Swan 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 s_h by secondary and higher education enrolment rates (i.e. the ratio of the total secondary and high education enrolment to the population). 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 ($INV_i = \sum_{t=1978}^{2003} I_{i,t} \Big/ \sum_{t=1978}^{2003} GDP_{i,t}$). 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 resulting figure to compute $\ln(n+g+\delta)$. All the data come from 'Comprehensive Statistical Data and Materials 50 Years of New China' published by the Statistical Bureau of China.

5. Estimation Results and Interpretation

The question we consider in our empirical analysis is two fold. Fist, we are interested in finding out 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 (1).

Columns (1) and (2) of table 1 report the results of fixed- and random-effects models, respectively, without including foreign direct investment. The Hausman-test statistic of 19.98 suggests that we should reject the random-effect model in favor of the fixed-effect model. Therefore, our discussion below will focus on the results of the fixed-effect model.

All variables except s_h are significant at the one percent level and have the expected sign. The coefficient of human capital investment is significantly negative, which is opposite to what is predicted by the augmented Solow-Swan model. Investment is positive and population growth is negative as expected. Regional economies' growth is positively related to investment in physical capital and negatively related to population growth. The fact that the coefficient on initial GDP is negative indicates conditional convergence. Thus, controlling the differences in the steady-state across provinces, poor provinces would tend to grow faster than rich ones. As far as the steady-state determinants are concerned, the augmented Solow-Swan model implies that the sum of coefficient of $\ln(n+g+\delta)$ and $\ln s_k$ is equal to zero. To check this, we use the Wald test for restriction. We do not consider the variable of human capital as it is negative and insignificant. The F-statistic for the restriction of the sum is 0.037 with p value is 0.55. Hence, the validity of the restriction can not be rejected. In order to check if the coefficient is consistent with the economic theory, we further examine it by estimating a restricted regression:

$$\ln\frac{Y_{t2}}{L_{t2}} = 0.0098 + 0.93\ln\frac{Y_{t1}}{L_{t1}} + 0.13(\ln s_k - \ln(n+g+\delta))$$

The regression yields R^2 of 0.97, the adjusted R^2 is 0.96, F-statistic is 111.19, significant at one percent level. In this model, $e^{-\lambda t} = 0.93$ 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 existence 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 1, respectively. In this model, the Hausman test yields a statistic of 22.04 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 also reduces the size of the coefficient on physical capital investment somewhat. Moreover, the inclusion of foreign direct investment improves the overall fit of the regression. However, the effect of human capital accumulation is still negative and insignificant. The remaining variables in the regression strongly support the augmented Solow-Swan model. The restriction that the coefficients on $\ln(I/Y)$, and $\ln(school)$ sum to zero is not rejected by the Wald test. To check if the coefficient is consistent with the theory, we estimate the restricted regression again:

$$\ln\frac{Y_{t2}}{L_{t2}} = 0.0037 + 0.847\ln\frac{Y_{t1}}{L_{t1}} + 0.0857(\ln s_k - \ln(n+g+\delta)) + 0.03383\ln F$$

R^2 is 0.98, the adjusted R^2 is 0.976, F-statistic is 174.88, significant at one percent level. In this model, $e^{-\lambda t} = 0.847$ which again suggests conditional convergence at the provincial level in China. The implied speed of convergence, λ, is 0.0332, which means 3.32% 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 21 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, to be approximately 0.36 which is very close to the estimates of the text book Solow-Swan model.

MRW argue that their model performs better when human capital is included but in our regressions it seems to make little difference. However, as Islam (1995) points out, attempts to incorporate the temporal dimension of human capital into growth regressions frequently yield statistically insignificant or even negative results. This somewhat surprising result may be due to the poor data quality. In particular, high reported increases in enrollment rates may often overestimate the true improvement in the level and quality of human capital, especially in less developed countries. This then results in finding negative temporal relationship between human capital and growth which may even outweigh the positive cross-sectional relationship (Islam, 1995).

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 4). The Hausman test implies that the fixed-effect model is more appropriate (the test statistics of the first model are 1.96, 24.69 and 4.1, respectively, while those of the second model are 14.12, 18.09 and 12.71). The regression results are presented in Table 3.

Human capital is still negative and insignificant in all three regions and in both regression models. The other coefficients of variables have not only the predicted sign but also the expected magnitude. After adding the foreign direct investment, the Central sub-sample switches from displaying divergence to convergence and the tendency toward convergence becomes even stronger in the West sample and East sub-samples. Moreover, the inclusion of foreign direct investment per capita improves the overall fit of the regressions. Foreign direct investment thus 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 for the Central, West, and East samples are 0.049, 0.039, and 0.052, respectively. The corresponding estimates of the output elasticity with respect to capital are 0.363, 0.264, and 0.292, respectively. In all these cases, convergence was found to be much stronger within the groups. The restricted regressions (Table 5) again confirm these findings. Hence, our analysis indicates that (1) there is slow conditional convergence among provinces in China as a whole; (2) there is faster conditional convergence among “similar” sub-groups of provinces.

6. Conclusions

The objective of this paper 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 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 the foreign direct investment. Attracting foreign direct investment has 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.

Our main finding is that the effect of FDI on economic growth in different provinces is positive and statistically significant. More generally, our analysis indicates that the augmented Solow-Swan model appears to provide a good description of regional growth patterns in China over the period 1978-2003. Furthermore, the data display conditional convergence: after controlling for other determinants of growth, provinces that were initially poor tend to grow faster. Furthermore, 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 since the major economic reforms over the last three decades, which has also resulted in an increasing regional disparity. 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 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 solve it, the policy of Western and Central development should aim to help the laggar and to improve their productivity. The West and Central areas of China, on the one hand they should be granted the same privilege that the economic zones have. On the other hand the government needs to invest much more capital in education as they did in Beijing and Shanghai. However, finding evidence of ongoing convergence itself 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.

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Table 1

Panel Regression of Five-Year Span Data: Test for Conditional Convergence

Dependent variable: log GDP per Working-age person

Variable	Model 1		Model 2	
	Fixed-effect	Random-effect	Fixed-effect	Random-effect
Constant	-0.6527	0.0752	0.0117	0.2041
	(0.3352)	(0.2133)	(0.2861)	(0.1776)
$\ln(Y/L)_0$	0.9871	0.9662	0.85	0.8657
	(0.0334)	(0.0235)	(0.0328)	(0.0231)
$\ln(n+g+\delta)$	-0.1168	-0.1018	-0.0788	-0.0841
	(0.0277)	(0.0237)	(0.0230)	(0.0195)
$\ln(s_k)$	0.1536	0.0299	0.1141	0.02
	(0.0547)	(0.0359)	(0.0447)	(0.0299)
$\ln(s_h)$	-0.3439	-0.0317	-0.0130	0.0757
	(0.1476)	(0.0815)	(0.1277)	(0.0694)
$\ln(F)$			0.0335	0.0296
			(0.0045)	(0.0037)
Adjusted R^2	0.96	0.96	0.975	0.973
F-statistic	108.65	804.3036	162.007	926.09
Hausman Test	$\chi^2 = 19.98$		$\chi^2 = 22.04$	

Figures in parentheses are standard errors.

Table 2

Test for Conditional Convergence by OLS Estimation, Restricted Regression

Dependent Variable: log GDP per Working-age person

Variable	Model 1	Model 2
constant	0.0098	0.0037
	(0.1229)	(0.097)
$\ln(Y/L)_0$	0.9308	0.847
	(0.0236)	(0.0213)
$\ln(s_k) - \ln(n+g+\delta)$	0.1284	0.0856
	(0.0254)	(0.0208)
Adjusted R^2	0.96	0.976
Implied λ	0.014	0.0332
Implied α	0.65	0.36

Figures in parentheses are standard errors

Table 3

Test for Conditional Convergence by OLS Estimation, Unrestricted Regression

Dependent Variable: log GDP per Working-age person

Sample	East		Central		West	
Observation:	10		10		9	
	Model 1	Model 2	Model 1	Model 2	Model 1	Model 2
Constant	0.5258	0.8089	-1.0272	-0.2840	-0.3832	0.006
	(0.7878)	(0.7149)	(0.7287)	(0.6469)	(0.5288)	(0.3766)
$\ln(Y/L)_0$	0.835	0.78	1.0316	0.7947	0.9591	0.8123
	(0.0780)	(0.0727)	(0.0829)	(0.0942)	(0.053)	(0.0451)
$\ln(n+g+\delta)$	-0.1118	-0.08	-0.1073	-0.1218	-0.1183	-0.075
	(0.0360)	(0.0343)	(0.0647)	(0.0549)	(0.0614)	(0.0437)
$\ln(s_k)$	0.696	0.5385	0.1682	0.1343	0.0858	0.0523
	(0.1617)	(0.1552)	(0.1940)	(0.1643)	(0.0627)	(0.0443)
$\ln(s_h)$	0.1564	0.3108	-0.5882	-0.0496	-0.1662	0.0293
	(0.3604)	(0.3284)	(0.2983)	(0.2899)	(0.203)	(0.1462)
$\ln(F)$		0.0283		0.0356		0.0352
		(0.00098)		(0.0094)		(0.0061)
Adjusted R^2	0.975	0.98	0.95	0.96	0.95	0.98

Figures in parentheses are standard errors

Table 4

Sub-groups

Sample	Observations
East	Beijing, Tianjin, Shanghai, Liaoning, Shandong, Suzhou, 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 5

Test for Conditional Convergence by OLS Estimation, Restricted Regression

Dependent Variable: log GDP per Working-age person

Sample	East	Central	West
Observations	10	10	9
Constant	-0.00620	-0.2061	-0.005
	(0.1468)	(0.2608)	(0.1604)
$\ln(Y/L)_0$	0.7703	0.7825	0.8219
	(0.0303)	(0.0628)	(0.0346)
$\ln(s_k) - \ln(n+g+\delta)$	0.0953	0.1239	0.0638
	(0.0372)	(0.0478)	(0.0329)
$\ln F$	0.0374	0.0366	0.035
	(0.0098)	(0.0078)	(0.0057)
Adjusted R^2	0.975	0.97	0.98
Implied λ	0.052	0.049	0.039
Implied α	0.292	0.363	0.264

Figures in parentheses are standard errors

Appendix: Computation of Parameter Estimates

In section 5, we referred to three important parameters estimates: the elasticity parameter α, the speed of convergence λ and the half-life convergence time. We calculated them by the following equation:

$\lambda = (1/\tau)\ln(\gamma)$

Where λ denotes the speed of the convergence.

$\tau = t_2 - t_1$, in this paper, it means five-year time interval

γ, the estimated coefficient of the initial GDP

This equation shows that a higher value of γ leads to a lower value of λ (Islam,1995).

$\alpha = \beta/(1-\gamma+\beta)$

Where α denotes the elasticity of the physical investment to output

γ is the same as the above

β is the coefficient of $\ln(s) - \ln(n+g+\delta)$

The equation shows a lower value of γ leads to a lower value of α (Islam, 1995)

The half-life formula is $T = \ln(2)/\lambda$ (Li et al., 1998).