

Title:

Implication of China's regional convergence

Instructor: Professor Takatoshi ITO

教授 伊藤 隆敏

Author:: Xiao yang AN

安 曉 陽

Abstract

In this paper the author analyzed the cross-sectional standard deviation (σ convergence) across 26 provinces of China and found that σ convergence declined only between 1978–1990 but increased from 1990 to 2005. Estimating β -convergence confirms that three regions (coastal, central, and inland) each have an interregional convergence between 1978–2005 and 1978–1990. After 1991 there are neither absolute convergence nor conditional convergence among these regions. Panel data analysis also indicates the same divergence in per-capita GDP. FDI's analysis confirmed that each province's economic heterogeneity induced a divergence in per-capita GDP.

I will thank for the instruction of Professor Takatoshi ITO, Professor Hidehiko ICHIMURA and Roger Smith's help in English.

Implication of China's regional convergence

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Graduate School of Public Policy (GraSPP), Tokyo University, Japan

Xiaoyang, AN
Dec 19th, 2007

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Introduction

One important property of the neoclassical growth model is its prediction of convergence — poor nations or regions tend to catch up with the rich ones in terms of the level of per capita product or income. While empirical findings from cross-country studies remain controversial, there is ample evidence for convergence across regions within countries. Examples include convergence among US states, Japanese prefectures, and European regions (see Barro & Sala-i-Martin, 1999). The relative homogeneity in technology, preferences, and institutions facilitates regional convergence.

Contrary to international experience, however Chinese provinces display large differences in per capita GDP after market-oriented reforms of 1978. This is a somewhat puzzling phenomenon since market-oriented reforms should facilitate resource flows that tend to equalize factor returns across regions. Early research about China's regional convergence (such as Bao, Sachs (2002)) had found that geographic factors are statistically significant in explaining the regional disparity in China. Other literature has attempted to explain rising regional inequality by uneven development opportunities. Wei and Wu (2002) focus on the effect of globalization, especially foreign direct investment; Kanbur and Zhang (2001) examine openness and fiscal decentralization. Park (2002) proposes four hypotheses to explain regional inequality: industrialization, market integration (including the labor market), the decline of state-owned enterprises, and globalization.

In this paper I used the newest data to see whether there is convergence or divergence in per capita GDP from 1978 to 2006. In section one, I use cross-section data to estimate σ -convergence and β -convergence that are Barro & Sala-i-Martin's interpretation. In section two, I use panel data and FDI to see whether there is economic homogeneity among the provinces of China.

I find that there is a per-capita GDP divergence across provinces after 1978, but a weak interregional convergence is also present before 1990. This result is also confirmed by other research such as Yao and Zhang (2001), who use both the unit root test and the decomposition of an inequality index to prove the existence of geo-economic clubs among Chinese provinces. The contribution of my study is that I also use OLS to estimate the convergence speed of 1978–1990.

Panel data analysis using FDI also confirms divergence between the increasing rate per-capita GDP and GDP. Fixed effect model analysis confirms heterogeneity between provinces, which might be one of the reasons for divergence. Earlier research such as He, Zhang (2006) found conditional convergence, that used spatial panel data model. They also concluded that there is not an absolute convergence between the increasing rate per-capita GDP and GDP, which is the same result for this paper.

Section one: σ convergence and β -convergence using cross-sectional data

Two concepts of convergence appear in discussions of economic growth across countries or regions. The first one is β -convergence (according to Barro,

Martin's(1995) interpretation) that asks the question of whether poor economies tend to grow faster than rich ones. The second one, called σ -convergence, relates to the decline of the cross-sectional dispersion of per capita income or product. It is hard to say which convergence is the better one. If we are interested in how fast and to what extent the per capita income of a particular region is likely to catch up to the average across economies, then β convergence is the relevant concept. If we are interested in the distribution of per capita income across regions, then σ -convergence is more significant.

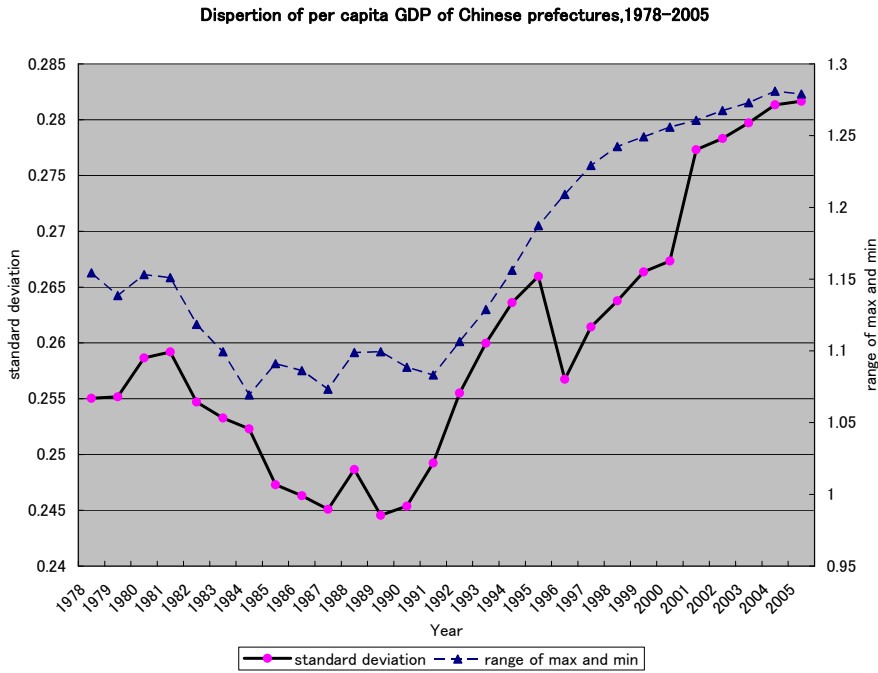
In this section I will use real per-capita GDP data, which was adjusted by 1978 constant price, to estimate σ convergence and β -convergence. Cross-sectional data is constructed for the 26 provinces of China, from 1978 to 2005. Regression is done for three period: 1978-2005,1978-1990,and1991-2005.¹

σ convergence:the standard deviation of the logarithm of per capita GDP across regions. I analyzed the cross-sectional standard deviation across 26 provinces of China and found that only in period of 1978-1990 was there has a decline. From 1990 to 2005 σ convergence is increasing. (Graph1)

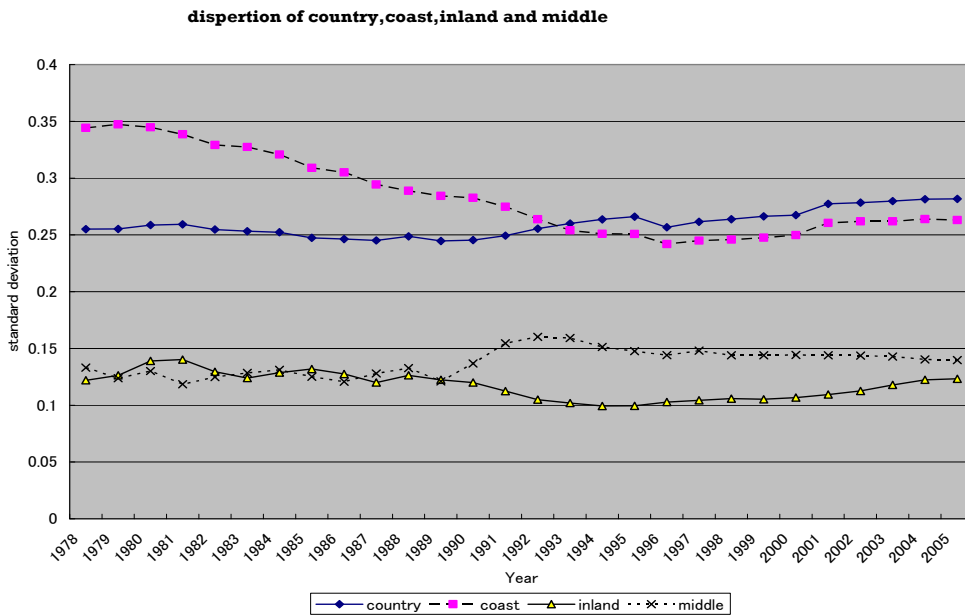
Graph 1: σ convergence of per capita GDP 1978-2005

The left pillar is standard deviation and the right is range of maximum and minimum.

¹ because after 1978's reform and openness, in 1990s the FDI policy was implemented, which will be explained concretely in section two.



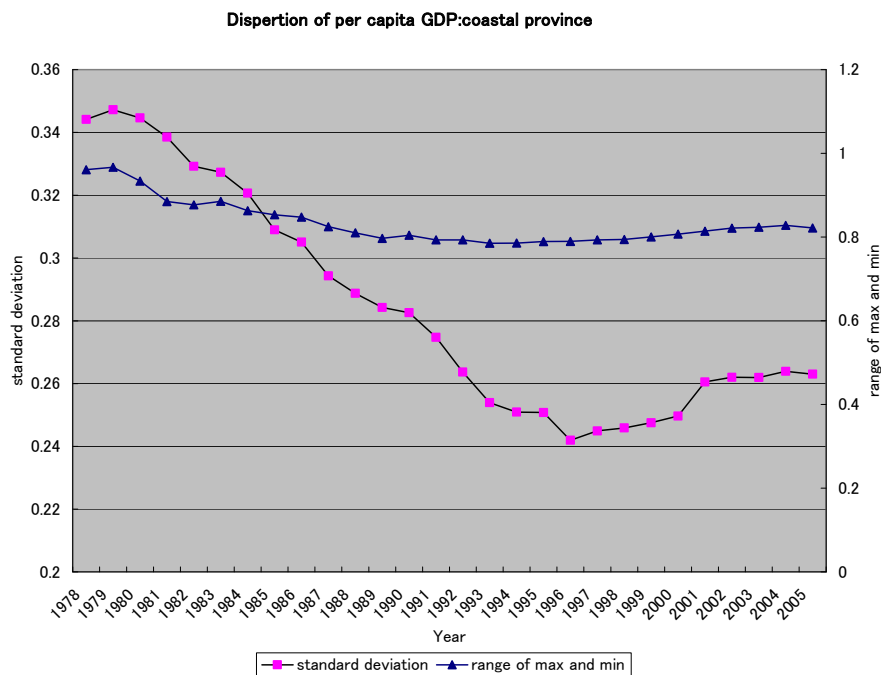
Graph 2 Interregional σ convergence; national, coast, central and inland



To see interregional σ convergence, the provinces are divided into three regions: coast, central and inland regions. (see APPENDIX A).

From graph 2 it can be seen that the coastal and inland regions declined before 1995, whereas the country and central regions increased. I examine the coastal region to see how its σ -convergence will be. Graph 3 is the coastal region's σ -convergence. The right is the range of maximum and minimum. We can see there was a obvious decline before 1997, and the distribution of per capita income across coastal region had become smaller after 1978, even though it became larger after 1997.

Graph3: Coastal region's σ -convergence



β convergence: is to test if an initially lower income group has a higher rate

of income growth. Scholars often use two types of equation to estimate β

convergence: absolute convergence and conditional convergence. First we will

consider absolute convergence.

(1)absolute convergence:

In absolute convergence, the initial income level is the only factor of concern and the catching up process will take place if the initially poorer economies have higher growth than the initially richer ones. The equation will be:

$$(1/T)\log(Y_{it}/Y_{0i}) = (1/T)\log A + \beta \log Y_{0i} + \varepsilon_i \quad (1)$$

Y_{it} - per capita GDP at time t in region i

Y_{0i} - initial per capita GDP in region i

A - regression constant

β - convergence rate per annum

t - time index.

T-years from initial to t

A large part of the literature on provincial inequality in China has found it necessary to include regional dummies in the provincial growth regressions. I tried the same.

(2)conditional convergence:

$$(1/T)\log(Y_{it}/Y_{0i}) = (1/T)\log A + \beta \log Y_{0i} + \alpha_1 X_1 + \alpha_2 X_2 + \varepsilon_i \quad (2)$$

Dummy independent variables are defined as:

$$X_1 = \begin{cases} 1 & \text{if, coast} \\ 0 & \text{if, notcoast} \end{cases}, \quad X_2 = \begin{cases} 1 & \text{if, inland} \\ 0 & \text{if, notinland} \end{cases}$$

Central region can be defined as: $(X_1, X_2) = (0,0)$

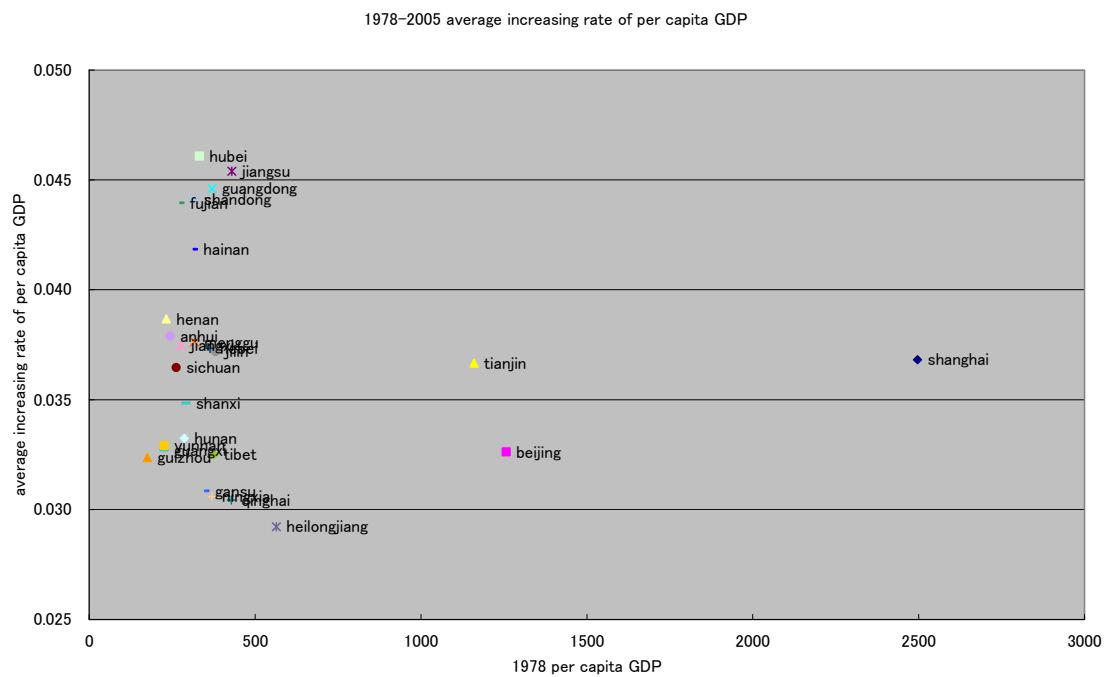
In order to calculate each region's convergent speed, I form equation (3) as below:

$$(1/T)\log(Y_{it}/Y_{0i}) = (1/T)\log A + \beta_1 \log Y_{0i} + \beta_2 X_1 \log Y_{0i} + \beta_3 X_2 \log Y_{0i} + \varepsilon_i \quad (3)$$

First let us consider the relationship of average increasing rate of per capita GDP and initial GDP. Graph4 shows the relationship of average increasing rate of per capita GDP and initial GDP: between 1978-2005. We can see that there is not an obvious

relation between them. The graph for the relationship of average increasing rate of per capita GDP and initial GDP:(1978–1990),(1991–2005),can be found in APPENDIX B.

Graph 4 : Average increasing rate of per capita GDP and initial GDP:(1978-2005)



The results of Equation(1),(2) are listed in Table 1–1.

The conditional convergence has significant t estimates. We can say there is a interregional convergence in period 1978–2005 and 1978–1990. After 1991, there is neither absolute convergence nor conditional convergence.

The regression result of Equation (3) also indicates the same tendency (see Table1–2) .

Table 1-1: Regression result using cross-section data 1978–2005

Model		absolute convergence (t-test)	conditional convergence (t-test)
1978–2005	β	-7.60e-07 (-0.36)	-4.38e-06 (-2.57)
	R^2	0.0054	0.5344
	p-value	0.722	0.018
1978–1990	β	-2.88e-06 (-1.16)	-6.27e-06 (-2.61)
	R^2	0.0534	0.3576
	p-value	0.256	0.016
1991–2005	β	1.01e-06 (1.05)	-4.08e-07 (-0.40)
	R^2	0.0436	0.3332
	p-value	0.306	0.691

$$(1/T)\log(Y_{it}/Y_{0i}) = (1/T)\log A + \beta_1 \log Y_{0i} + \beta_2 X_1 \log Y_{0i} + \beta_3 X_2 \log Y_{0i} + \varepsilon_i \quad (3)$$

β_1 : central

$\beta_1 + \beta_2$: coast

$\beta_1 + \beta_3$: inland

From Table 1-2 and 1-3 we can conclude that each of the three regions has a interregional convergence in period 1978–2005 and 1978–1990. T estimates are significant. Each of the convergent speeds, however, are weak: they are only about 0.0004% (coast), 0.0018% (central) and 0.0031%(inland). The country-wide per-capita

GDP increase is divergent, the result of which comes from the absolute convergence equation.

Table 1-2: Result of equation (3)

Year	β_1	β_2	β_3	R^2	F-test
1978-2005	-0.000179	.0000144	-0.0000129	0.5390	F(3, 22) = 8.57
t-test	(-3.06)	(2.75)	(-2.37)		
p-value	0.006	0.012	0.027		Prob > F = 0.0006
					F(3,22,5%)=3.05
1978-1990	-0.000195	.0000141	-0.0000104	0.3569	F(3, 22) = 4.07
t-test	(-2.35)	(1.91)	(-1.35)		
p-value	0.028	0.070	0.191		Prob > F = 0.0193
1991-2005	-2.39e-06	2.30e-06	-6.38e-06	0.3200	F(3, 22) = 3.45
t-test	-0.84	0.95	-2.33		
p-value	0.408	0.351	0.029		Prob > F = 0.0340

From table 1-3, we can also see: $\beta_1 + \beta_3$:inland > β_1 :central > $\beta_1 + \beta_2$:coast.

The inland had a faster convergent speed than central and coast regions. The above result tells us that the coast was initially rich and became richer over time, the central and inland were initially poor and became poorer. The divergence of regional incomes

became more apparent in the reform period than in the pre-reform period.

Table 1-3 : Speed of interregional convergence

year	$\beta_1 + \beta_2$:coast	β_1 :central	$\beta_1 + \beta_3$:inland
1978-2005	-0.0000035	-.0000179	-0.0000308
1978-1990	-0.0000054	-.0000195	-0.0000299
1991-2005	unreliable	unreliable	unreliable

To confirm if there is heterogeneity between provinces it will be useful for us to find the reasons that induce divergence. In section two, I will add FDI as another independent variable to see whether the effect FDI induced is the same across provinces.

Section two: Panel data analysis and FDI

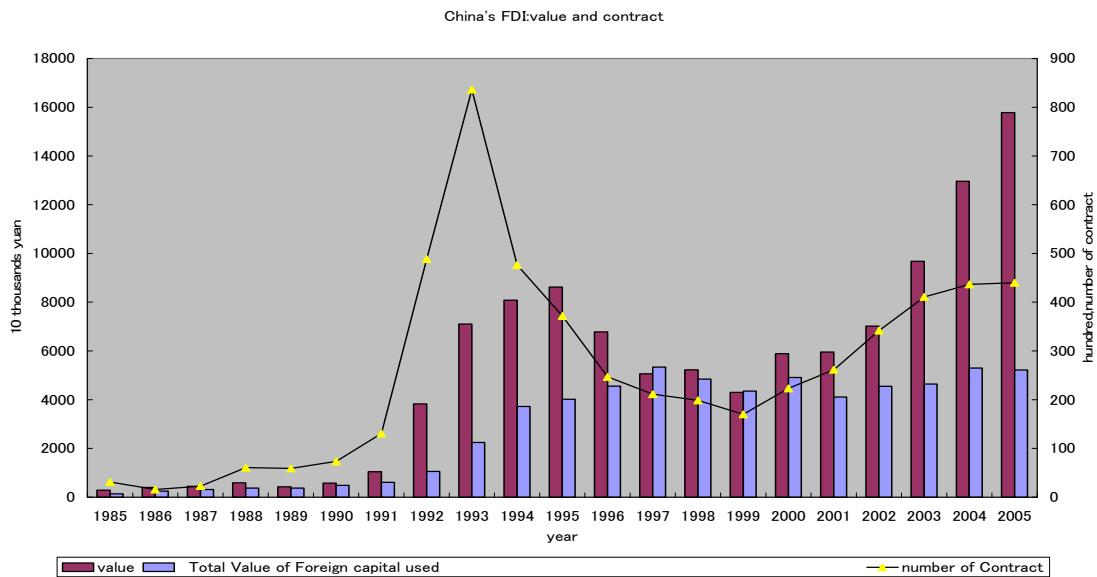
Why FDI ?

FDI has been a key driver of economic growth in China over the past three decades. After embarking upon economic reforms in 1978, the Chinese government has been opening up the economy gradually to foreign trade and investment. In 1988, the government introduced a development strategy for the coastal regions and the 'two-ends outside' policy, both of which encourage processing trade in order to exploit China's comparative advantage in abundant cheap labor. Export-oriented FDI was encouraged through fiscal and financial incentives, such as tax holidays and tax-rebates for exports. As a result, exports of foreign-invested enterprises (FIEs) and exports due to processing trade have increased rapidly in the coastal regions.

After Deng Xiaoping made his famous tour to South China in 1992, the total inflow of FDI rose enormously, In the following years, China quickly became the largest recipient of FDI among all the developing countries and the second largest recipient in the world by 1996. Graph 5 shows that there was an obvious increase after 1992.

Graph 5 : FDI contract number, value and total value of foreign capital

used



Through an examination of the FDI distribution effects I will test to see whether the provinces have economic homogeneity.

About FDI's data:

The examination of China's statistical data is problematic. The statistical methods used by the National Bureau of Statistics of China(NBS) have changed over time, and substantially different from the OECD's. Thus I will first explain the exact data used in this study.

Interpretation of FDI: the China statistical yearbook (2003)

Foreign Direct Investment : " the investments inside China by foreign enterprises and economic organizations or individuals (including overseas Chinese, compatriots from Hong Kong, Macao and Taiwan, and Chinese enterprise as registered abroad), following the relevant policies and laws of China, for the establishment of ventures exclusively with foreign own investment, Sino-foreign joint ventures and cooperative enterprises or for co-operative exploration of resources with enterprises or economic organizations in China. It includes the reinvestment of the foreign entrepreneurs with the profits gained from the investment and the funds that enterprises borrow from abroad in the total investment of projects which are approved by the relevant department of the government." (page 692)

From the China statistical year book we can see that the foreign capital actually utilized is divided into three parts: Foreign Loans, Direct Foreign Investment, and Other Foreign Investment. (see below)

C19-23 广东省实际利用外资和旅游外汇收入
FOREIGN CAPITAL ACTUALLY UTILIZED AND
FOREIGN EXCHANGE INCOME FROM TOURISM OF GUANGDONG

单位:万美元 (USD 10000)

年份 Year	实际利用 外资额 Foreign Capital Actually Utilized	对外借款 Foreign Loans	外商直接投资 Direct Foreign Investments	外商其他投资 Other Foreign Investments	旅游外汇 收入总额 Foreign Exchange Income from Tourism
1978					5000
1979	9143		3074		19000
1980	21419	590	12320	8509	28500
1981	28837	2580	17326	8931	77000

I use only this

Since foreign loan comes from World Bank or ODA has a tendency to be given to the poorer provinces. It can not indicate the economic character advantage of this province well.

Foreign Borrowings: " refer to funds borrowed from abroad through formal signing of borrowing agreements with foreign institutions, including loans of foreign governments, loans of international financial institutions,

commercial loans of foreign banks, export credit , and funds raised by Chinese bonds (and shares before 1996) is sued abroad. It is an import ant part of China's utilization of foreign capitals."

China Statistical Yearbook 2003 defined other foreign investment as:

Other Investment by Foreign Entrepreneurs:" refers to all forms of utilization of foreign capitals other than foreign borrowings and foreign direct investment. It includes the total value of stock shares in foreign currencies issued by enterprises at domestic or foreign stock exchanges (now mainly consisting of H shares issued at Hong Kong Security Market and B shares issued at domestic security market s), rent payable for the imported equipment through international leasing arrangement, cost of imported equipment, technology and materials provided by foreign counterparts in compensation trade and processing and assembly trade."

I will use only the term " Foreign Direct Investment" as it is defined in China statistical year book to do panel data regression. I think it is the best data which can represent the FDI's effect. I will also see these FDI's effect in fixed asset investment, since FDI is mainly invested in enterprises.

Data collection

FDI inflows into China started from a very low level in the 1980s but rose dramatically after Deng Xiaoping' s famous southern tour in 1992. I summarized the beginning year of each province in Table 2-1 in order to best collect the data.

I have chose 11 provinces which received FDI before 1985. They are Guizhou (west), Gansu (west), Shaanxi (west), Gansu (west) Xinjiang (west) Fujian (east), Guangdong (east), Shanghai (east), Shangdong (east) ,Jiangxi (central), Henan (central), and Heilongjiang (central).

Four western regions, four eastern regions and three central regions are chosen. Their location can found in APPENDIX A. (* Provinces with color indicate which data is used in panel estimation).

Table2-1: FDI beginning year: bold characters are coastal province

1979	1980-1983	1984	1985	1986-
Fujian*	Hainan	Gansu*	Anhui	Hubei
Guangdong*	Tianjin	Guangxi	Guizhou*	Beijing
	Shanghai*	Hebei	Jiangsu	Sichuang
	Liaoning	Heilongjiang*	Ningxia	Qinghai
	Hunan	Henan*	Shanxi	Chongqing
	Zhejiang	Jiangxi*	Xinjiang*	Mongolia
		Jilin	Yunnan	
		Shaanxi*		
		Shangdong *		

*: star marks indicates provinces whose data had been chosen for panel regression.

Graph 6 shows that there was a big difference within provinces.

The lower five provinces are Heilongjiang(central), Guizhou(west),

Gansu(west),Shaanxi(west), Gansu(west) and Xinjiang(west).

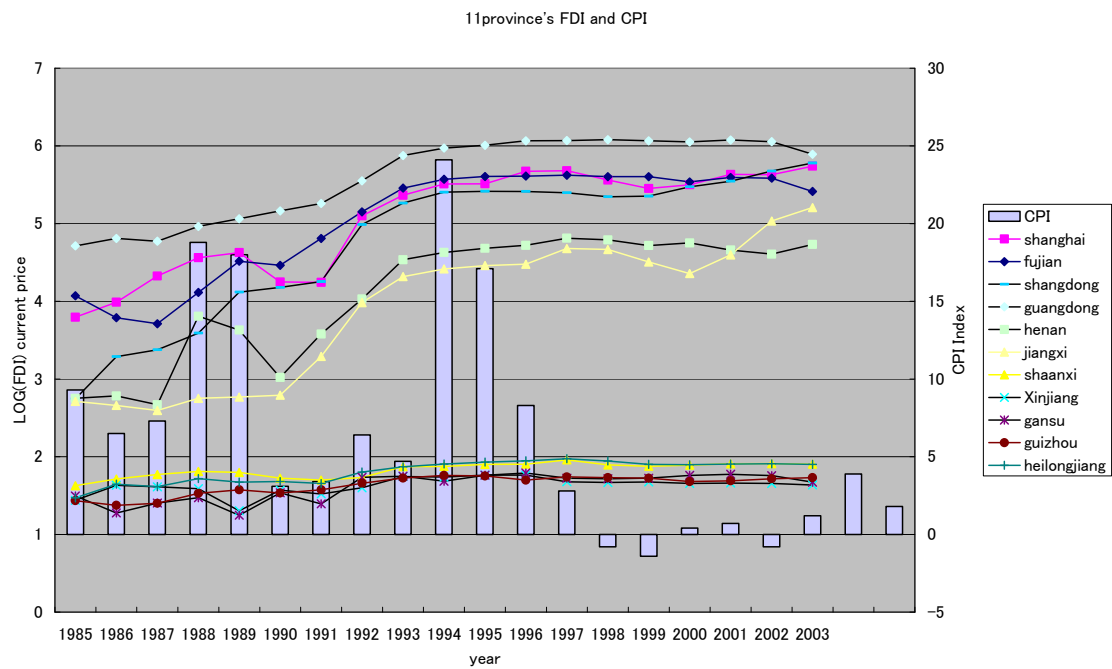
In contrast, the upper six provinces are Fujian(east), Guangdong(east), Shanghai(east),

Shangdong(east) ,Jiangxi(central), Henan(central).

FDI and CPI had same increase tendency in 1990-1995. An investment boom might

have induced inflation. The eastern provinces also had a larger increase in FDI after 1992.

Graph 6: FDI and CPI for eleven provinces



Panel fixed effect and random effect model regression

Equation used:

$$(1) \text{realrate}_{it} = A + \beta_1 \log \text{gdp}_{it} + \beta_2 \text{realFDI}_{it} + \mu_{it}$$

$$(2) \text{realrate}_{it} = A + \beta_2 \text{realFDI}_{it} + \mu_{it}$$

$$(3) \text{realrate}_{it} = A + \beta_1 \log \text{gdp}_{it} + \mu_{it}$$

t is time index , i is province index

realrate is increasing rate of per capita GDP annual from 1985 to 2003, for 11 provinces,

loggdp is 1985 constant-price gdp (1985–2003), for 11 provinces,

realFDI is 1985 constant-price FDI (1985–2003), for 11 provinces.

Table 2-2: Panel data fixed effect and random effect model estimation results:

Equation		(1)	(1)	(2)	(2)	(3) Fixed effect	(3) Random effect
		Fixed effect	Random effect	Fixed effect	Random effect		
Fixed effect	F-test (p-value)	2.56 (0.006)		2.31 (0.01)		2.81 (0.002)	
Random effect	CHI(2) (p-value)		2.79 (0.0951)		2.21 (0.13)		10.83 (0.001)
β_1	Coef	3.19	1.99			2.21	2.4
	T-test	2.24	1.84			1.96	2.58
	p-value	0.02	0.06			0.051	0.01
β_2	Coef	-7.79e-07	4.16e-07	1.74e-07	1.07e-06		
	T-test	-1.12	0.77	0.31	2.51		
	p-value	0.265	0.43	0.75	0.012		
Hausman Test	CHI(2)	1.66		6.18		0.10	
	p-value	0.19		0.012		0.755	

(Breusch and Pagan Lagrangian multiplier test of Random effect showed as CHI(2))

The first result is that there is a positive correlation between the increasing rate of per-capita GDP and loggdp, which suggests a divergence in per capita GDP.

Restraints on migration might have caused this divergence .

Some scholars, such as Lin, Wang and Zhao (2004) had suggested that there are differential rates of labor transfer from rural to urban sectors. The developed-countries' experience of industrialization (such as in the United States, Japan and EU) indicate that migration is needed after industrialization.

In China,however,migration from rural to urban areas and migration between provinces has been restrained for a long time. The coastal provinces' restraints are much stricter than inland provinces. Thus it is reasonable to suggest that migration restraints induce a divergence between the increasing rate of per capita GDP and loggdp. CAI (2002) also found that there is a labor market distortion that negatively impacts regional growth rates. He states that :“Distortions created by institutions related to *hukou* deter labor market development in two ways: rural-urban and inland-coastal migration. The migration has not reached a scale necessary to eliminate important misallocations of resources.”

The second result is that there is not an obvious correlation between increasing rates of per capita GDP and FDI. FDI is not the factor that effects per capita GDP. As seen in Table 2-2, there are significant fixed effect,which means there is not economic homogeneity between provinces of China. In other words, we can confirm that each

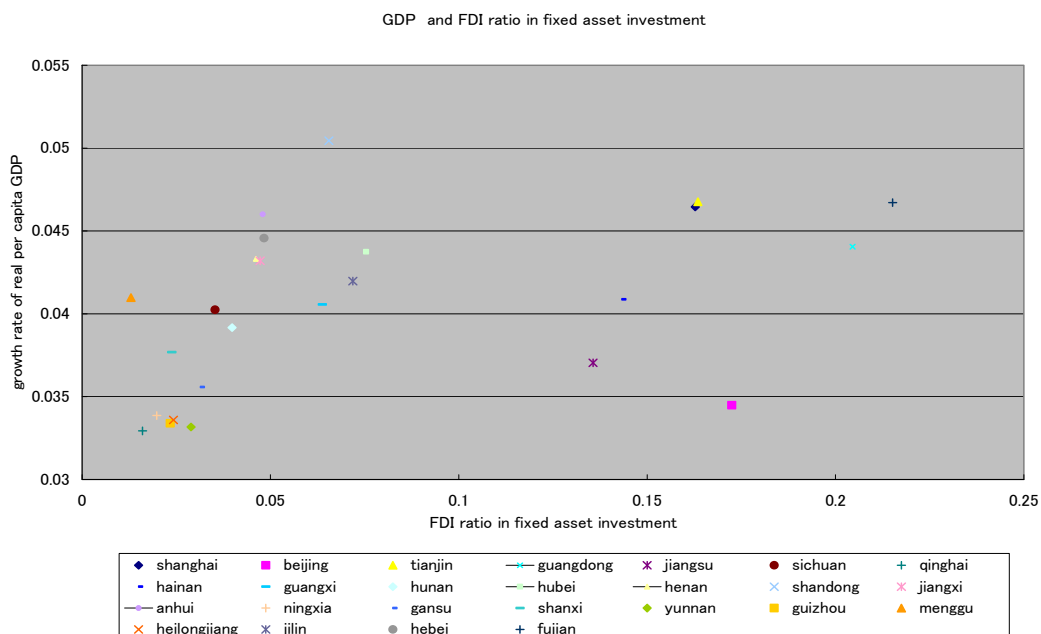
province's economic heterogeneity induced a divergence in per capita GDP.

Examining the FDI used in each province's fixed asset investment can also provide some evidence of economic heterogeneity.

Other evidence: FDI in fixed asset investment

I found an obvious uneven distribution of FDI used in fixed asset investment. Graph 8 shows that the coast region has a higher ratio of FDI in fixed asset investment, while the inland region has the lowest. Graph 7 shows the relation of growth rate of per capita GDP and ratio of FDI in fixed asset investment. Even though simple OLS regression showed they have a positive correlation (t-test:2.16,p-value:0.04),we can find that provinces are very clearly divided into two groups.

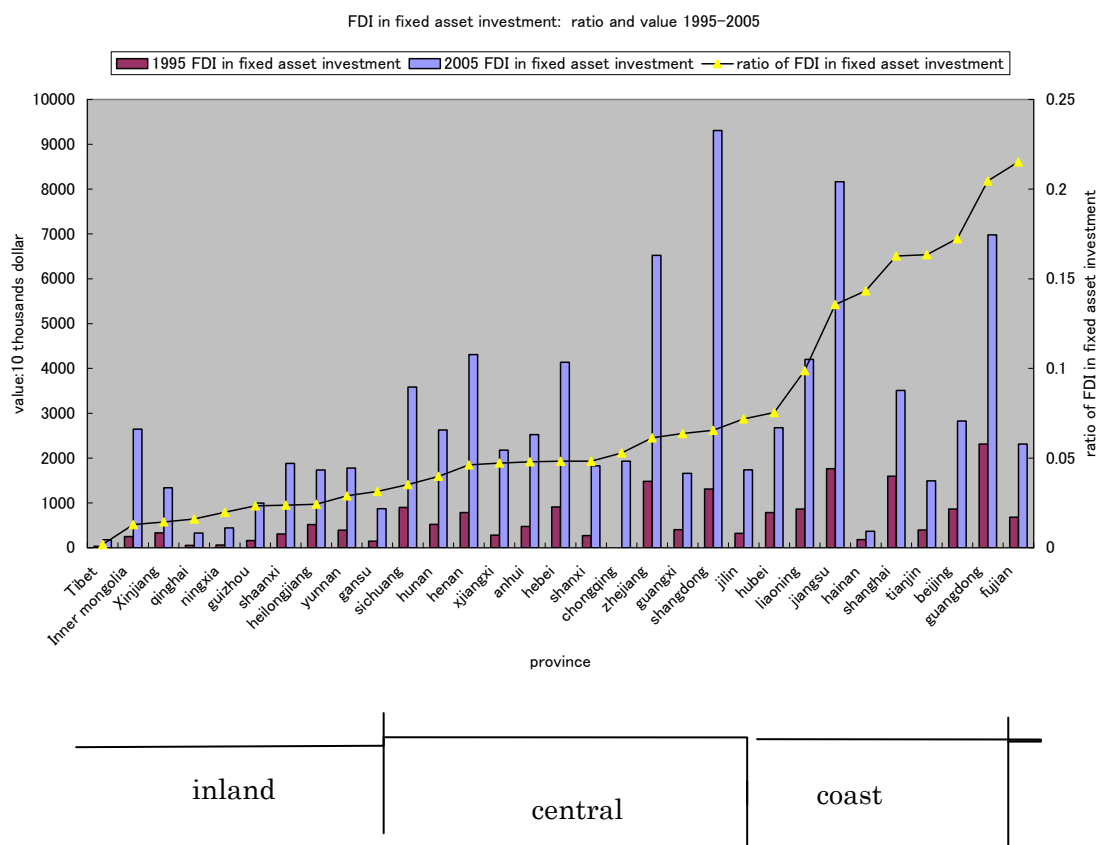
Graph 7 GDP and Ratio of FDI in fixed asset investment 1995–2005



This result can also indicate that FDI does not effect every region the same way. Factors that are responsible for these regional inequalities may include preferential government policies, favorable geographical location, and superior infrastructure facilities in the coastal regions.

Grah 8: Ratio of FDI in fixed asset investment 1995–2005

(ratio=fixed asset investment using FDI/total fixed asset investment)



Conclusion

In this paper I analyzed the cross-sectional standard deviation (σ convergence) across 26 provinces of China and found that σ convergence declined only between 1978–1990 but increased from 1990 to 2005 . Estimating β -convergence confirms

that three regions (coastal, central, and inland) each have an interregional convergence between 1978–2005 and 1978–1990. After 1991 there are neither absolute convergence nor conditional convergence among these regions. Panel data analysis also indicates the same divergence in per-capita GDP. FDI's analysis confirmed that each province's economic heterogeneity induced a divergence in per-capita GDP.

This result is different with the case of United States and Japan. It can tell us that economic heterogeneity among regions will lead to divergence, not convergence, which is contrary to normal expectations. Government policy in China may be one of the reasons behind this divergence trend.

Among many factors, the uneven distribution of resources and preferential policies applied to the eastern region, such as Special Economic Zones (SEZs) and Open Coastal Cities, are widely regarded as the dominant causes of regional inequality in China. GDP and FDI were highly concentrated in the eastern part of China during the reform period. Radical economic liberalisation enabled the eastern region to offer foreign investors preferential policies and access to large and rapidly expanding markets.

At the same time, the industrialization policies for the central and western regions were ineffective. All of these have allowed the coastal region to grow much faster than the other regions in the country.

Another important factor is migration restrictions, which deterred labor market development. Migration can not reached a scale necessary to eliminate important misallocations of resources. Consequently, the Chinese economy experienced increasing interregional disparities in the course of unprecedented rapid and steady

growth.

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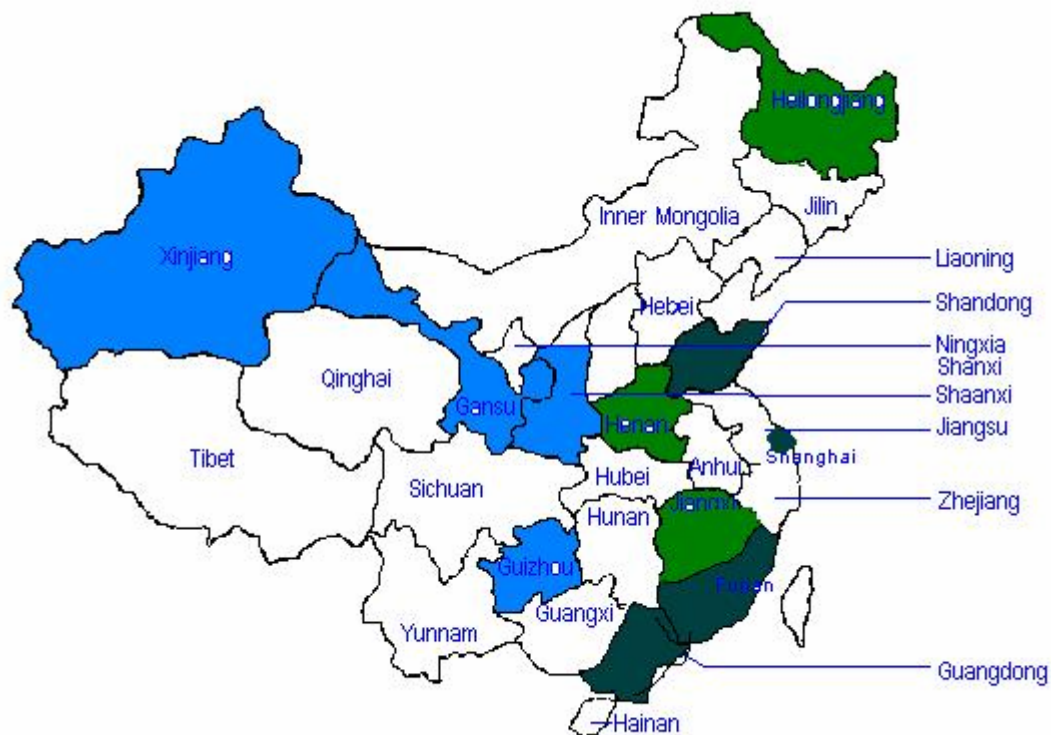
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APPENDIX A :Map of China



Census Regional Classification

Coast: fujian shanghai tianjin beijing guangdong jiangsu hainan shandong hebei

central: hunan hubei henan heilongjiang jilin jiangxi anhui

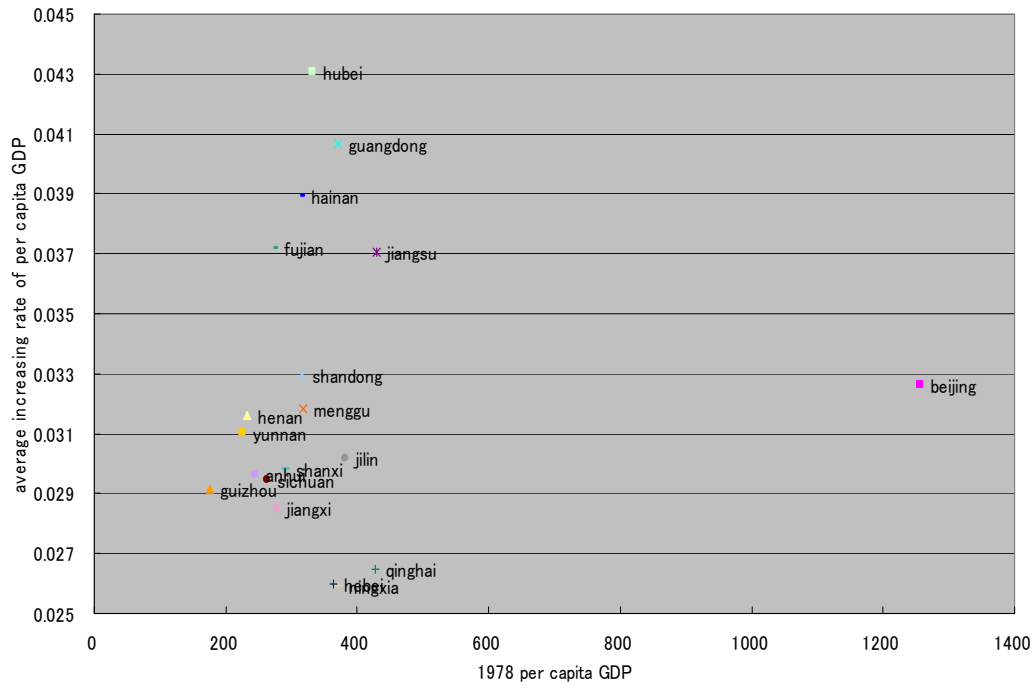
inland: shanxi ningxia sichuan gansu tibet yunnan guizhou qinghai guangxi menggu(inner

mongolia)

* Provinces with color indicate which data is used in panel estimation

APPENDIX B

1978-1990 average increasing rate of per capita GDP



1991-2005 average increasing rate of per capita GDP

