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# Geographic factors and China's regional development under market reforms, 1978–1998

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**Abstract**

This study investigates the geographic effects on regional economic growth in China under market reforms. We develop a model for the regional growth pattern of the Chinese economy during the period, characterized by foreign direct investment (FDI) and mobilization of rural surplus labor. The FDI and labor migration are directed by the differentials in the expected returns from the capital investment and in the wage rate. The differentials are, to a large extent, explained by geographic factors. In the context of market reforms and the open-door policy, the spatial and topographic advantages of the coastal provinces are realized. As a result, the returns to the capital investment in the coastal provinces are higher than in the rest of the country, thus attracting more FDIs and migrant labor into the region and causing the growth disparity. Our empirical test supports this hypothesis. It finds that geographic factors are statistically significant in explaining the regional disparity in China. This disparity is mainly a coast versus noncoast gap. 

*JEL classification:* O18; P2; R11

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## 1. Introduction

The Chinese reform has widely been regarded as a success. Since the reform started in 1978, the structure of the economy has experienced a fundamental change towards a market-oriented system. By the end of 1997, state-owned enterprises accounted for only 30% of output in industry, and the market determined the prices and output of more than 95% of goods. During the same period in 1978–1998, the economy has continuously grown at more than 9% average annual rate.[1]

While the nationwide growth rate was impressive, it has been noticed that the pace of reform and growth has been uneven across regions (Xu & Wang, 1997). In particular, coastal regions grew more rapidly than the mountain areas in the hinterland. During 1978–1997, the GDP per capita in the coastal provinces grew at 10% on average, while in the central provinces, it was at 8.4%. The provinces in the remote western region had an even slower growth rate at only 7.4%, which is 2.6 percentage points below that of the coastal provinces (Table 1). By 1997, the GDP per capita of coastal regions Shanghai and Zhejiang were 12 and 5 times, respectively, that of the hinterland Guizhou. The reasons given by scholars for the regional diversities in economic reform and growth in China include poor economic basis, lack of capital, low quality of education, closed culture, economic policy, and poor natural conditions of the interior provinces (Chang, 1995; Li, 1995). Numerous empirical studies have also been conducted to identify factors for the regional disparity (DeMurger, 2000; Fleisher & Chen, 1997; Lee, 2000; Song, Chu, & Chao, 2000).

Previous literature on the Chinese reform and regional performance suggests a long list of factors that may be responsible for regional differences. Although the geographic factor has not gone completely unnoticed, the role that it played in the reform period was overlooked, thus, it was not thoroughly discussed. In discussing the difference in the reform outcomes among the transitional economies in Europe, Sachs (1997) indicates that some effects of geographic factors might have been wrongly attributed to economic policies:

> Correlation between economic performance and economic policy that neglects geography will misconstrue the role of economic policy ... the effectiveness of a policy variable may depend on the physical geography of the country.

In addition, little econometric work has been done to quantitatively analyze the impact of geographic factors on the reform. An examination of the Chinese case on a theoretical and quantitative basis would likely be extremely fruitful in understanding the geographic factors in growth. In light of a series of recent literature on the geographic factors in economic performance in the European transitional economies (Sachs, 1997) and developing countries in general (Gallup & Sachs, 1998), this study intends to fill the gap between the

[1] CSY, 1998.

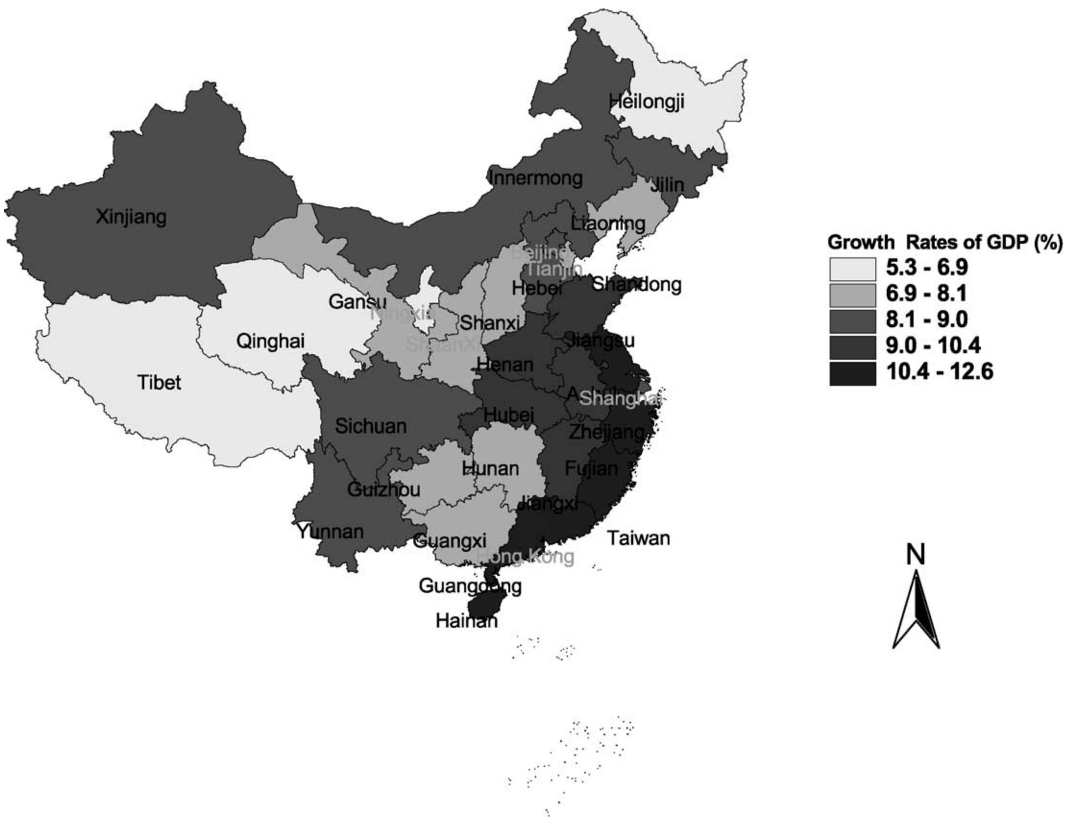


Fig. 1. The growth rates of GDP (1978–1997) in the provinces of Mainland China.

flourishing new geographic theory and the lesson from the Chinese reform. It is a first attempt in the literature to focus on the geographic factor during the Chinese reform period. Such a study could simply be dismissed as geographic determinism in the past. We are not geographic determinists; however, we do not wish to overlook the issue without examining the statistical evidence.

We organize our discussion as follows. In Section 2, we give a brief introduction to the geographic feature and regional economic performance in China. In Section 3, we develop a theoretical framework to analyze the regional disparity in income growth under reform. We capture two most obvious characteristics during the reform: the large volumes of capital and labor flows to the coastal regions, which serve as the major driving forces for the coastal economic growth. The model reveals that the direction of these flows is due to the geographic advantages and low transportation costs of the coastal regions. In Section 4, we test the hypothesis. The empirical test finds that the geographic factors alone can explain 60% of the variation in growth among provinces. From the statistical results, we draw inferences. Section 5 is the summary.

Table 1
GDP per capita growth indices in China (1978=100)

| | GDP per capita, China | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | Average |
| Zhejiang | 100.0 | 112.2 | 129.0 | 142.5 | 156.8 | 167.5 | 202.1 | 243.8 | 270.7 | 299.3 | 328.9 | 323.7 | 333.9 | 391.0 | 462.6 | 561.1 | 668.8 | 775.1 | 869.5 | 960.2 | 1.126 |
| Fujian | 100.0 | 104.3 | 122.1 | 139.4 | 149.1 | 156.0 | 182.0 | 208.9 | 218.3 | 243.9 | 274.7 | 291.3 | 307.5 | 344.9 | 409.6 | 508.3 | 614.6 | 699.4 | 792.0 | 896.5 | 1.122 |
| Guangdong | 100.0 | 106.2 | 121.2 | 129.0 | 141.1 | 148.3 | 167.8 | 198.6 | 217.9 | 250.9 | 287.3 | 302.6 | 328.1 | 375.1 | 449.8 | 540.4 | 632.2 | 715.5 | 779.9 | 842.3 | 1.119 |
| Jiangsu | 100.0 | 110.8 | 115.1 | 126.4 | 137.1 | 152.3 | 175.1 | 204.2 | 223.4 | 250.8 | 296.1 | 299.0 | 302.3 | 323.1 | 401.4 | 476.8 | 551.2 | 631.7 | 704.3 | 783.9 | 1.114 |
| Hainan | 100.0 | 100.6 | 103.4 | 124.7 | 154.3 | 168.6 | 198.0 | 223.5 | 239.8 | 263.3 | 285.2 | 296.0 | 321.2 | 362.6 | 500.8 | 595.9 | 656.7 | 674.4 | 695.3 | 730.8 | 1.110 |
| Shandong | 100.0 | 105.5 | 117.5 | 122.6 | 134.5 | 151.7 | 176.4 | 194.7 | 204.1 | 228.2 | 253.5 | 260.3 | 263.3 | 299.0 | 347.9 | 422.5 | 489.6 | 556.7 | 601.2 | 654.3 | 1.104 |
| Hebei | 100.0 | 105.1 | 107.3 | 106.8 | 117.1 | 128.5 | 145.2 | 161.6 | 167.7 | 184.5 | 206.5 | 215.8 | 217.7 | 238.2 | 272.7 | 319.1 | 363.4 | 410.6 | 462.7 | 517.2 | 1.090 |
| Beijing | 100.0 | 107.2 | 117.7 | 113.9 | 119.8 | 127.1 | 158.3 | 168.9 | 181.5 | 195.9 | 217.6 | 222.7 | 231.8 | 251.5 | 298.8 | 332.8 | 374.8 | 416.8 | 453.9 | 496.6 | 1.088 |
| Shanghai | 100.0 | 105.2 | 111.7 | 116.4 | 122.9 | 130.7 | 144.4 | 162.4 | 167.5 | 177.7 | 193.3 | 197.1 | 202.2 | 215.8 | 247.1 | 283.1 | 322.4 | 367.0 | 413.4 | 467.7 | 1.085 |
| Guangxi | 100.0 | 101.3 | 109.7 | 116.1 | 128.2 | 130.1 | 137.0 | 149.1 | 155.9 | 167.3 | 171.1 | 174.2 | 183.3 | 203.2 | 237.2 | 283.7 | 323.2 | 368.4 | 401.9 | 433.8 | 1.080 |
| Tianjin | 100.0 | 107.2 | 115.9 | 119.9 | 122.9 | 130.9 | 154.1 | 168.3 | 175.9 | 186.8 | 194.5 | 194.9 | 202.1 | 211.6 | 234.5 | 260.8 | 296.3 | 338.9 | 382.6 | 428.5 | 1.080 |
| Liaoning | 100.0 | 103.6 | 111.5 | 108.4 | 112.4 | 126.2 | 145.6 | 163.7 | 175.5 | 197.7 | 214.9 | 219.0 | 219.2 | 231.1 | 257.4 | 294.2 | 327.2 | 348.1 | 375.7 | 408.2 | 1.077 |
| Average, coast | 100.0 | 105.8 | 115.2 | 122.2 | 133.0 | 143.2 | 165.5 | 187.3 | 199.9 | 220.5 | 243.6 | 249.7 | 259.4 | 287.3 | 343.3 | 406.6 | 468.4 | 525.2 | 577.7 | 635.0 | 1.100 |
| Anhui | 100.0 | 107.8 | 108.2 | 125.5 | 135.6 | 146.1 | 173.9 | 198.8 | 218.5 | 226.1 | 234.8 | 242.8 | 243.2 | 235.2 | 271.0 | 323.5 | 386.2 | 438.0 | 496.3 | 554.4 | 1.094 |
| Henan | 100.0 | 106.9 | 121.5 | 129.2 | 132.7 | 161.8 | 175.5 | 196.4 | 202.3 | 228.4 | 245.7 | 251.4 | 257.7 | 271.1 | 304.4 | 348.8 | 393.1 | 447.3 | 505.5 | 553.6 | 1.094 |
| Hubei | 100.0 | 114.1 | 120.1 | 126.4 | 139.8 | 147.8 | 176.0 | 202.5 | 211.2 | 226.2 | 240.1 | 246.8 | 253.7 | 265.0 | 298.4 | 335.3 | 382.9 | 429.4 | 481.7 | 539.6 | 1.093 |
| Jiangxi | 100.0 | 113.8 | 116.9 | 122.0 | 131.8 | 138.9 | 157.7 | 178.0 | 186.8 | 198.8 | 218.2 | 225.9 | 233.0 | 247.5 | 281.8 | 326.6 | 380.5 | 429.4 | 480.7 | 529.3 | 1.092 |

| | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Jilin | 100.0 | 102.8 | 107.9 | 113.0 | 120.5 | 145.3 | 162.6 | 172.6 | 183.7 | 216.7 | 248.8 | 239.8 | 243.7 | 254.8 | 283.9 | 317.9 | 359.3 | 394.2 | 442.7 | 476.3 | 1.086 |
| Inner Mongolia | 100.0 | 107.4 | 107.6 | 117.7 | 137.6 | 148.4 | 172.4 | 197.6 | 207.0 | 223.0 | 241.7 | 245.1 | 259.3 | 274.9 | 302.1 | 330.5 | 359.6 | 387.6 | 432.0 | 469.0 | 1.085 |
| Shanxi | 100.0 | 108.8 | 109.7 | 109.3 | 124.6 | 140.1 | 168.6 | 178.5 | 188.2 | 195.6 | 207.9 | 215.4 | 221.5 | 220.4 | 247.7 | 276.4 | 299.1 | 328.9 | 361.3 | 395.1 | 1.075 |
| Hunan | 100.0 | 107.9 | 112.3 | 116.9 | 126.0 | 135.7 | 146.9 | 162.9 | 174.0 | 187.6 | 199.0 | 202.2 | 206.9 | 220.5 | 245.8 | 276.1 | 304.0 | 334.1 | 371.4 | 382.1 | 1.073 |
| Heilongjiang | 100.0 | 110.7 | 120.3 | 123.6 | 130.1 | 139.9 | 154.3 | 162.3 | 166.7 | 179.2 | 192.5 | 202.1 | 211.4 | 223.9 | 236.6 | 252.2 | 271.9 | 295.6 | 324.3 | 354.4 | 1.069 |
| Average, central | 100.0 | 108.9 | 113.8 | 120.4 | 131.0 | 144.9 | 165.3 | 183.3 | 193.2 | 209.1 | 225.4 | 230.2 | 236.7 | 245.9 | 274.6 | 309.7 | 348.5 | 387.2 | 432.9 | 472.7 | 1.084 |
| | | | | | | | | | | | | | | | | | | | | | |
| Xinjiang | 100.0 | 110.2 | 115.7 | 123.3 | 133.8 | 150.5 | 170.3 | 197.5 | 215.6 | 234.3 | 253.0 | 263.3 | 281.3 | 321.7 | 341.3 | 364.9 | 397.8 | 431.6 | 450.6 | 477.7 | 1.086 |
| Yunnan | 100.0 | 101.3 | 108.5 | 115.3 | 131.0 | 139.6 | 157.7 | 176.0 | 180.8 | 199.6 | 227.7 | 237.0 | 252.9 | 265.3 | 290.5 | 317.2 | 349.2 | 383.1 | 436.3 | 471.1 | 1.085 |
| Sichuan | 100.0 | 109.3 | 119.0 | 123.0 | 135.0 | 148.7 | 166.2 | 184.8 | 193.2 | 207.2 | 219.8 | 222.7 | 235.6 | 252.1 | 283.1 | 318.1 | 352.0 | 386.9 | 422.9 | 463.0 | 1.084 |
| ShaanXi | 100.0 | 110.0 | 107.8 | 111.6 | 120.1 | 127.7 | 149.3 | 171.8 | 185.0 | 199.5 | 237.8 | 241.1 | 244.2 | 257.4 | 278.0 | 311.9 | 340.6 | 367.5 | 401.6 | 438.1 | 1.081 |
| Guizhou | 100.0 | 109.1 | 112.1 | 117.4 | 133.6 | 148.5 | 176.2 | 188.0 | 196.0 | 214.2 | 227.5 | 234.5 | 239.4 | 254.3 | 281.8 | 307.2 | 329.1 | 349.2 | 374.9 | 402.8 | 1.076 |
| Gansu | 100.0 | 100.0 | 107.8 | 97.4 | 104.3 | 118.3 | 133.3 | 149.1 | 163.5 | 175.3 | 197.5 | 210.4 | 217.7 | 227.4 | 245.3 | 270.1 | 295.7 | 315.3 | 345.1 | 369.9 | 1.071 |
| Tibet | 100.0 | 105.6 | 126.9 | 151.6 | 150.5 | 140.0 | 172.1 | 189.0 | 169.0 | 165.6 | 168.2 | 179.0 | 193.0 | 191.5 | 201.8 | 214.9 | 244.8 | 284.2 | 316.6 | 347.4 | 1.068 |
| Ningxia | 100.0 | 103.8 | 109.3 | 108.6 | 115.4 | 130.5 | 145.8 | 168.5 | 178.8 | 188.5 | 206.6 | 217.7 | 218.1 | 224.0 | 238.8 | 259.1 | 275.7 | 293.9 | 319.2 | 340.1 | 1.067 |
| Qinghai | 100.0 | 89.2 | 103.3 | 100.7 | 110.4 | 120.4 | 135.1 | 146.4 | 154.0 | 160.3 | 168.7 | 168.5 | 172.2 | 177.7 | 188.1 | 203.7 | 217.6 | 231.4 | 247.3 | 265.7 | 1.053 |
| Average, west | 100.0 | 104.3 | 112.3 | 116.5 | 126.0 | 136.0 | 156.2 | 174.6 | 181.8 | 193.8 | 211.9 | 219.4 | 228.3 | 241.3 | 261.0 | 285.2 | 311.4 | 338.1 | 368.3 | 397.3 | 1.074 |
| | | | | | | | | | | | | | | | | | | | | | |
| *Ratios (west=1)* | | | | | | | | | | | | | | | | | | | | | |
| Coastal | 1.00 | 1.01 | 1.03 | 1.05 | 1.06 | 1.05 | 1.06 | 1.07 | 1.10 | 1.14 | 1.15 | 1.14 | 1.14 | 1.19 | 1.32 | 1.43 | 1.50 | 1.55 | 1.57 | 1.60 | 1.02 |
| Central | 1.00 | 1.04 | 1.01 | 1.03 | 1.04 | 1.07 | 1.06 | 1.05 | 1.06 | 1.08 | 1.06 | 1.05 | 1.04 | 1.02 | 1.05 | 1.09 | 1.12 | 1.15 | 1.18 | 1.19 | 1.01 |
| Western | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |

## 2. Geography and regional difference in China

Geography plays a role in regional difference in China, however, in order to understand why the coastal regions take their spatial and topographical advantages only after the reform in 1978, we need give a brief discussion of the economic and historical context.

China is a large country with a vast territory of 9.6 million $km^2$, stretching from the temperate to subtropical zones (Fig. 1). It is similar in size and climate to the United States, but its topography is quite different. China is mountainous and hilly. Plains at less than 500 m of elevation make up only 12% of the total land, while mountains and plateaus account for 60%.[2] This topographic feature implies an unfavorable natural condition for economic development because of the higher costs of transportation and infrastructure construction.

The topographical feature of China is a three-step staircase stepping down from west to east. It begins with the Qinghai–Tibet Plateau of 4000 m of elevation in the southwest. Then, in the central regions, the topography slopes down to highlands and basins mostly from 2000 to 1000 m above sea level. It further descends eastward to hilly regions and plains below 1000 m. The eastern regions have more favorable natural conditions for farming and trade. They are close to the coastline and seaports, and most of their land is flat plain. Thus, the transportation costs are lower, and contact with overseas countries is easier. They also have higher precipitation levels and a warmer climate. Thus, the nation's economy and population concentrate on the eastern region. The interior regions are mountainous and poor. The rich mineral resources that the regions endow with are very costly to extract and transport. The western region with the highest elevation, the Qinghai–Tibet Plateau, was traditionally the poorest.

The location of the economic center of China has not been fixed throughout history. It had a tendency of moving eastwards from the northwest region. The Chinese civilization started in the Loess Plateau and the Yellow River Valley in 2000 BC, which was considered to be the northwest part of China proper and is about 1000 km away from the coast. The reason for this location was common during the ancient period, when the civilization centered in the area with high agricultural productivity rather than a coast that was more convenient for overseas contact. For most of the history of China prior to the 9th century, the capitals of the country were Yuncheng, Anyang, Xi'an, Xianyang, and Luoyang, all located in the interior provinces of Shaanxi and Henan, about 800 km from the coastline.

The southeast coastal regions, where, contemporarily, the most economically dynamic provinces including Guangdong (Canton) and Fujian are located, largely remained uncultivated and sparsely populated in the early Chinese history. Although the natural conditions were favorable for agriculture, farming was undeveloped because the climate was not favorable for inhabitation and human activities. Malaria (which was called "Zhangqi" in Chinese) and other diseases in the subtropical areas checked population growth, and high temperature exhausted human energy, which thus lowered labor productivity. In ancient times, Guangdong was considered an uninhabitable place. A great Chinese poet of the 11th century, Su

[2] CSY, 1998, p. 6.

Shi, who was banished by the emperor to Canton, wrote a poem to amuse himself by saying that he did not mind living in Guangdong only because he could eat many litchis (Guangdong produced litchis).[3] His poem confirmed the fact that Guangdong was favorable for plants to grow, but the climate was too harsh for living during the ancient times.

Things gradually changed. Under the pressure of expanding population and the frequent wars in the northern region, much of the population moved to the southeast region. Humans also gradually adapted to the climate there. The Yangtze River Valley became very developed and densely populated in the 12th century. The development was driven mainly by the farming condition, as contact with the rest of the world by ocean navigation was unimportant and very limited. At that time, China's contact with the West was mainly through the Silk Road, which went through the northwest region.

The role of the southeast region in the national economy changed dramatically in the period after the Opium War in 1840. Western powers forced China to open coastal ports. They made footholds in Hong Kong, Shanghai, Ningbo, etc. Along with the military invasion, Western powers also brought capital and modern technology into the ports and neighboring areas. Trade with the rest of the world developed, and economy grew in these areas. The economic importance of the country shifted from the traditional area to the coastal regions. Meanwhile, local entrepreneurs emerged in the coastal regions.

The development of a modern capitalist economy in the coastal regions stopped when the Communists took power in 1949. During Mao's era, the country was under the doctrine of self-reliance. Mao was preparing a military confrontation with the US and its allies, thus, the coastal region would be the frontier in such a war. Hence, he restricted investment in the coastal region and further relocated many factories from coastal regions to the hinterland during the 1960s and 1970s. Although the coastal region was still the major source of the central government's revenue because of their high productivity from the better economic basis, these regions received very little funds from the state for reinvestment, which often could not cover the depreciation of their capital stock.[4]

The relocation of factories along with huge capital investment into the hinterland during Mao's period was economically ridiculous. Many companies in Shanghai and other coastal regions were relocated to the mountains in Guizhou, Sichuan, Hubei, where highways and railroads were deficient or nonexistent, water and electricity were in shortage, and the markets of raw material and products were distant. These factories often could not produce anything many years after the relocation, letting the equipment become rusty and unusable. Only a small fraction of relocated firms eventually managed to produce goods, but often limited to military products and at a huge economic cost. One example was the Second Automobile Company. It was built by Mao in the mountains in Hubei. The part and assembly plants were scattered among mountains, and transportation among the plants were very inconvenient and

[3] Su Shi, also named Su Dongpo, 1037–1101. He was banished to Huizhou, Guandong, and also Hainan. His original poem was: "Having three hundred litchis daily, I do not mind to be a person living in the south of Nanling Mountain (where Guangdong is located)."

[4] For instance, Shanghai provided more that 40% of the state revenue during the Cultural Revolution period, but it could not retain enough money to cover depreciation.

costly. The plants were distant from any major market and input supplier. The company eventually managed to produce trucks, but at an uncompetitive cost. Because of Mao's irrational policy, the coastal areas remained stagnant. During Mao's period, the nation's income inequality, measured by the Gini coefficient, was mainly explained by the urban–rural gap, rather than the provincial gap. Although coastal regions were still somewhat richer and more urbanized, it was simply because of their better economic foundations inherited from the prerevolution period, and the endowment of the more favorable natural conditions for farming. The income among the urban residents of various provinces was quite equal (The World Bank, 1983) during the prereform period.

On the eve of reform, China was basically an agricultural economy. Although some heavy industries developed during the early 1950s with assistance from the Russians and some others built by the Chinese themselves in the 1960s and 1970s. These newer heavy industries were mainly located in Manchuria and some central regions. The economic basis of the coastal regions remained basically unchanged from the prerevolution period. The gap between the interior and coastal regions was not substantial at that time (Jian, Sachs, & Warner, 1996). The economic bases and conditions of China on the eve of reform were quite different from that of the Soviet Union or Eastern Europe.

In 1978, two years after Mao's death, reform started. The first stage of the reform, from 1978 to 1984, succeeded mainly in the agricultural sector, as a result of the replacement of the Commune system with the household responsibility system. There was no obvious increase in regional inequality during this period (Jian et al., 1996). Table 1 shows that there was no substantial difference in the growth rate across regions during the period of reform prior to 1985. The cumulative average growth rates of GDP per capita from 1978 through 1984 were 165.5%, 165.3% and 156.2% for the coastal, central and western provinces. However, the gap, especially between coastal regions and the two interior regions, grew rapidly after 1991. By 1997, the same ratios were 1.60:1.19:1.00, and the coastal region's growth was 60% higher than the Western region (Table 1).

Some major changes started in 1992 (see Table 1) after Deng called for more opening of China to the outside and for economic acceleration. Many preferential policies, such as generous tax holidays and credit matching, were given to foreign investors. Foreign direct investments (FDIs) surged to US$11.3 billion in 1992 from US$4.6 billion the year before, representing a 140% jump. The coastal provinces, being spatially closer to overseas markets and topographically more convenient to transport to, immediately gained momentum and took off. The Guangdong province alone absorbed more than US$40 billion FDIs during the period of 1992–1996, accounting for about 30% of the national total. Most of the money came from Hong Kong, which is adjacent to Guangdong. Likewise, Fujian province, because it is close to Taiwan and its residents speak the same dialect as Taiwan, absorbed US$12 billion FDIs. Shanghai, Jiangsu, and Zhejiang also received higher than the national average investment from overseas Chinese and foreign companies from Taiwan, Hong Kong, Japan, and the US because their coastal location provided convenient access. FDIs played a critical role in growth since 1992. During the period of 1992 through 1997, China absorbed a total of US$205 billion FDIs, which was roughly 50% of all FDIs received by developing countries, and ranked the second in the world after the US.

There are several important features that we would like to emphasize. We notice that growth accelerated and the regional gap widened in 1992, after the radical opening policy was initiated to attract foreign investment and trade. Growth in this period was led by the coastal regions. Although all provinces would give more or less the same preferential policies to foreign investors, an overwhelming portion of the foreign capital chose to go to the coastal regions, because of the advantages in location and transportation convenience. At the same time, higher wage rate and more job opportunities in the coastal regions attracted tens of millions of migrant laborers from the hinterland. This flood of migrant workers, also termed ''floating population,'' is estimated to be more than 60 million. Guangdong alone received 15 million migrant workers and professionals from outside. Shanghai, which has 16 million local residents, has 3 million migrant workers.[5] Most FDIs in the coastal regions were engaged in the processing trade. They imported raw materials and parts, processed and assembled them, and exported the final products for sale in the world market. It is obvious that foreign investors choose the coastal regions for their geographic advantage and transportation and communication convenience.

One characteristic of the period is that the large amount of capital inflow did not depress the return of capital in the regions, thus attracting even more capital from overseas, as well as from domestic sources. This characteristic has been noticed in numerous studies (e.g., Fleisher & Chen, 1997). The wage rate in the coastal areas was higher than that in the interior regions, thus attracting migrants. Even years after the large influx of laborers, the differential in the real wage remained, largely because the rapid development of the modern firms in coastal areas kept the edge in productivity over the hinterland. The continuous capital and labor inflow sustained growth after the initial take-off in the coastal regions. The interior regions, especially the western regions, lagged further behind in growth. Their lower initial income levels did not bring a higher growth rate, thus resulting in divergent growth during the 1990s.

Studies on Chinese regional development in the reform period have extensively discussed the above noticeable features, such as the influx of foreign capital and floating population of the labor force. It is natural to ask a further question: Why do the capital and labor move in this direction? Is there a more fundamental reason for this move of capital and migrant workers? Some scholars argued that it was caused by the policy bias of the central government, which favored the coastal regions. That is not completely true, but at the least, it is controversial. Actually, the interior provinces received more direct transfer payment per capita, including capital and subsidy, from the central government during that period. Did the central government allow the coastal provinces to give more tax and other incentives to foreign investors? Just 2 years after the central government opened 14 coastal cities in 1992, all major cities in the entire interior regions were also opened. The preferential policies offered to foreign investors, in general, were the same over the country, especially after counting additional incentives

[5] For the estimated figures, see Analysis of the employment status and policy during the ninth five-year plan period. *Economic Analysis.* The CEI Net, Dec. 5, 1997. In addition, see estimates by Wang and Zuo (1999) and Zhang and Song (2001).

provided by the local governments.[6] The only common noticeable characteristic for the coastal regions is the geographic factor. The coastal regions have spatial and topographic advantages. These advantages lowered the costs of transportation and communication, thus raising the return of investment and attracting more capital. The investment served as the engine of growth, and was further sustained because of the agglomeration effect in the coastal region and the unlimited supply of labor from the Chinese rural areas at a constant wage rate. The geographic advantage of the coastal provinces was not realized during Mao's era, because the country was closed to the outside. The reform made the potential geographic advantage of the coastal regions realized. Yet, the interior regions, especially the western provinces, lacked the advantages, thus falling behind and resulting divergence.

Below, we provide a model that captures this nature of the issue to explain the process of growth during the reform and the divergence caused by the geography of the regions.

## 3. A theoretical framework

We first notice two important characteristics of the transitional China. First, the country is in transition from a closed planning system to a market economy. Second, it is a developing country with a very low income level at the time when reform started. Because of these characteristics, a model for China would be somewhat different from a canonical neoclassical growth model. First, as the reform opened the door for foreign investment, in the short run (i.e., in the transitional period), there was a virtually unlimited supply of capital from overseas, as long as foreign investors expect returns to be attractive. Hence, domestic investment is not restricted by domestic saving. This is different from the setup of a typical neoclassical model. Second, the labor market in China is characterized by the Lewis model, with an unlimited labor supply from the huge rural surplus labor (Lewis, 1954).

We describe how GDP grows as a result of the expansion of production.[7] We have the following production function for the GDP of each province, $Q$ (Eq. (1)):

$$Q = A(K,R)F(K,L) \tag{1}$$

where $F(K,L)$ is constant returns to scale with respect to the arguments of capital $K$ and labor $L$. It has the conventional properties for the signs of its derivatives, $F_i > 0$, $F_{ii} < 0$, and $F_{ij} > 0$. $A$

[6] One may compare coastal regions Zhejiang and Jiangsu to Xinjiang and Yunnan and notice no major differences in preferential policies actually provided to foreign investors. However, the former two absorbed much more FDI by 1997.

[7] For simplicity, as many other growth models do, we omit possible demand constraints. We think that it is justifiable for our case. Before 1994, China was basically an economy experiencing shortages, or structural shortages (with shortages in some bottleneck sectors, such as electricity and residential housing). In addition, as the reform liberalized an economy of shortage under the previous planning regime and opened the world market for processing trade for Chinese enterprises, a great opportunity had been created for the Chinese firms to sell goods in the domestic and overseas markets. Hence, the growth was mainly determined by the supply side. The economy experienced a fundamental change in 1997–1998, when a state of general surplus emerged. Since our model basically work on the period of 1978–1997, we omit the constraint of the demand side in our growth model for simplicity.

is the productivity factor, which represents the efficiency and productivity gain during the reform and development process. It is a function of $K$, as explained by the endogenous growth models, which implies the effect of learning-by-doing, etc., which are associated with capital investment. It is also a function of $R$, the reform factor including privatization and marketization. $\partial A/\partial K>0$, and $\partial A/\partial R>0$.

The major differences among provinces are their initial income levels and natural geographies. A province that is spatially closer to the world market and topographically more convenient for ground and ocean transportation has a lower transportation cost to access the world market. The transportation cost takes Samuelson's "iceberg" form, so only a fraction $\alpha$ of the produced goods will arrive to the world market. $\alpha_i$ is a function of $s_i$, the spatial distance to the world market from province $i$, and $\boldsymbol{T}_i$, a vector of topographic factors:

$$\alpha_i = \alpha_i\left(\frac{1}{1+s_i}, T_i\right) \tag{2}$$

$1/(1+s_i)$ is associated with the distance factor. Notice that the sign is a reciprocal: the longer the distance, the smaller its value is. $\boldsymbol{T}_i$ is a vector of topographic factors of the province, which could be the geographic condition for seaports, elevation from the sea level, roughness of the land, etc.

If a coastal province has a smaller $s$ and larger $T$, its $\alpha$ would be larger. Guangdong is very close to Hong Kong, and it is easy to ship goods to overseas market, hence, $\alpha$ should be much larger than in an interior province like Tibet. A long coastline may offer a better chance of good harbors. After incorporating the transportation cost, the GDP of the province $i$ is:

$$Q_i = \alpha_i A(K,R)F(K,L) \tag{3}$$

To avoid the cumbersome subscripts, below, we omit the subscript $i$ as we work on the equations for province $i$ when no ambiguity arises.

Investment including foreign investment is induced by the net return of the capital investment, i.e., the difference between the marginal product of capital minus depreciation and the interest cost.

$$I = K = \theta\left(\frac{\partial Q}{\partial K} - \delta - r\right) \tag{4}$$

where the cap of the dot over a variable denotes the time derivative of the variable. $\theta$ is a positive number that measures the responsiveness of investment to the net return. $\delta$ and $r$ are the depreciation and interest rates, respectively. Further,

$$\frac{\partial Q}{\partial K} = \alpha\left[\frac{\partial A}{\partial K}(K,R)F(K,L) + A(K,R)\frac{\partial F}{\partial K}(K,L)\right] \tag{5}$$

Although $F$ alone exhibits the property of diminishing marginal returns with respect to $K$, the overall output $Q$ may not. This is because productivity $A$ would increase as a result of learning-by-doing associated with capital investment. Hence, the sign of the second derivative $\partial^2 Q/\partial K_2$ is ambiguous. Thus, the sign of d$I$/d$K$ is also ambiguous (Eq. (6)):

$$\frac{\mathrm{d}I}{\mathrm{d}K} = \theta \frac{\partial^2 Q}{\partial K^2} \tag{6}$$

If it is positive, an increase in the initial investment could raise the return of capital and induce further investment.

Next, we examine the induced labor migration. We propose that wage differential will induce labor migration, in line with the Todaro theory. In particular, the change in labor force in the province $i$, $\dot{L}$ is

$$\dot{L} = \lambda\left(\frac{\partial Q}{\partial L} - \overline{W}\right) \tag{7}$$

The wage differential is indicated by the marginal return of labor $\partial Q/\partial L$ and $\overline{W}$, the subsistence wage rate in rural areas.[8] $\lambda$ is the responsiveness of migration to the wage rate differential. In line with the Lewis argument, we assume that the labor supply from rural areas described by the above function is unlimited.[9] An increase in the capital investment in a province will induce labor migration into the region (Eq. (8)):

$$\frac{\partial \dot{L}}{\partial K} = \lambda \frac{\partial^2 Q}{\partial L\, \partial K} = \lambda\alpha \left[\frac{\partial A}{\partial K}\frac{\partial F}{\partial L} + A\frac{\partial^2 F}{\partial L\, \partial K}\right] > 0 \tag{8}$$

To summarize, we have the following differential equation system (Eq. (9)):

$$\dot{K} = \theta\left(\frac{\partial Q}{\partial K} - \delta - r\right)$$

$$\dot{L}_i = \lambda\left(\frac{\partial Q}{\partial L} - \overline{W}\right) \tag{9}$$

Its phase diagram is depicted in Fig. 2. The slope of the locus $\dot{L}$=0 is unambiguously positive. The slope of the locus $\dot{K}$=0 can be positive, vertical, or negative. In any case, we

[8] The wage rate paid to the workers may not be exactly their marginal product. However, it should be directly related to the marginal product. Hence, the larger the gap between $\partial Q/\partial L$ and $\overline{W}$, the larger the gap between the paid wage rate and the rural subsistence wage rate is.

[9] In fact, in a developing country like China, with a large reservoir of rural surplus labor, which is estimated to be 150 million, the withdrawal of labor in rural areas would not reduce labor input and, thus, the production in rural areas, as Amartya Sen argued. Labor migration to the coastal regions did not adversely affect the unskilled labor (even skilled labor) input in the interior regions. Hence, when we explain why interior provinces also grew during the reform period, although many workers migrated out of the provinces, we can think of the migrant labor as coming out from the large reserve army of surplus labor, rather than as a reduction in labor input in these interior provinces.

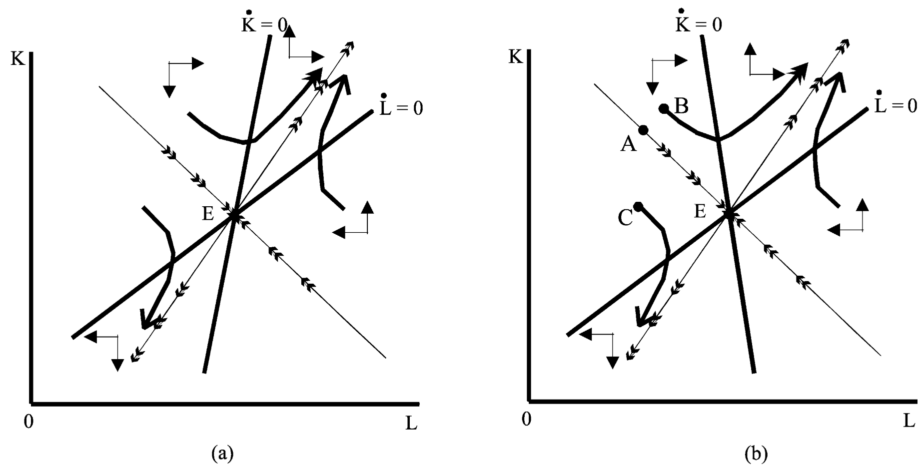


Fig. 2.

assume that it is steeper than $\dot{L}$=0, because the additional capital return represented by $\partial A/\partial K$ makes it likely to be steeper. Panel (a) illustrates the case when $\dot{K}$=0 has a positive slope, when the effect of $\partial A/\partial K$ is not dominant, and Panel (b) illustrates a case when $\dot{K}$=0 has a negative slope, when the effect of $\partial A/\partial K$ is dominant. Either of the two cases will lead to the same conclusion advanced later in this paper, as long as the $\dot{K}$=0 locus is steeper than $\dot{L}$=0. The equilibrium point $E$ is the intersection of the two loci. The arrowheads indicate the directions of motions in the four different fields. From the direction fields, we know that it is a saddle-path case. The stable and unstable arms are depicted in the diagram.

If the initial point is at $A$ in Panel (b), the economy would move to the equilibrium point $E$. If instead starting at $B$, the economy would eventually cross $\dot{K}$=0, move to the northeast indefinitely, and approach the unstable arm. As both capital and labor inputs increase during the process, the economy expands. In fact, GDP per capita would also continuously grow. This can be seen as follows. Let $P$ be the population size of the province, so GDP per capita of the province is $Q/P$ (Eq. (10)):

$$\begin{aligned}\frac{Q}{P} &= \frac{\alpha A(K,R)F(K,L)}{P}\\ &= \alpha A(K,R)F\left(\frac{K}{L},1\right)\frac{L}{P}\end{aligned} \tag{10}$$

where $L$ is factored out due to the constant returns to scale property of function $F$. In the long run, as the motion approaches the unstable arm, the ratio of $K/L$ is bounded within a range of some upper and lower limits.[10] The ratio $L/P$ in the short run could increase

[10] $K/L$ is steeper than the locus of $\dot{L}$=0.

because of migrant workers, but in the long run, it is also bounded by an upper limit, say, the total labor force of the nation. So neither of the two terms, $F(K/L,1)$ and $L/P$ may increase indefinitely in the long run. However, the term $A$, representing the factor productivity growth, would increase indefinitely in the long run, as $K$ continues to increase as the economy moves to the northeast. Thus, GDP per capita would continue to grow as the result of the motion.

In general, although it is not always true, the higher the initial point, the faster the speed of the motion is, and the more rapid the growth is. On the other hand, the economy would implode if the initial point is at some lower initial point, say, $C$. From the direction fields, we see that the stable arm serves as the threshold for growth. If the initial capital endowment is above the stable arm, the economy would eventually take off and grow. Since all provinces in China achieved sustained growth since reform, we can infer their initial points in 1978 shall be to the east of the locus $\dot{K}=0$ and to the north of the locus $\dot{L}=0$ (Fig. 2).[11] Yet, more general than the convergence neoclassical growth theory, our model permits, although not necessarily, a province to achieve more rapid growth if it had more capital endowment at the initial stage.

Now, let us consider how the geographic factor plays a fundamental role in affecting the motion. To better illustrate, let us consider a province that is initially at the equilibrium state $E$, so the economy is stagnant. Then, for some reason, the transportation cost of the economy lowers, thus, it raises the value of $\alpha$. What happens then? The increase in $\alpha$ would shift the locus $\dot{K}=0$ to the left and shift the locus $\dot{L}=0$ downward. The original point $E$ is now in the field for take off. This is illustrated by Panels (a) and (b) in Fig. 3, which correspond to the case in Panels (a) and (b) in Fig. 2. The greater the value of $\alpha$, the greater extent the loci would shift, the faster the speed of the motion would be, and the more rapidly the economy would grow.

Now we can extend the above argument to explain the divergence of growth between coastal and interior regions in reform, especially, in the 1990s after a radical open-door policy was implemented to attract foreign investment. As the Chinese government removed restrictions on foreign trade and offered incentives for foreign investment, the factor of transportation cost with the rest of the world started to play a significant role. The coastal provinces had their spatial and topographical advantages, but these advantages played little role during the prereform period when there was little foreign trade and investment. These advantages were realized after the reform removed the barriers on foreign trade and investment. In our model, the differential values of $\alpha$ were realized after this reform. In addition, the coastal provinces in general had more initial endowment of capital; that is, in the phase diagrams in Fig. 2, their initial position would be higher than

[11] The motion in this area implies both capital and labor increase. Capital stock increases in all provinces in China. What about the labor supply in the hinterland in the context that many laborers migrated out? Interestingly, the actual labor supply even in the interior provinces also increase as the development of the local industries also draw surplus labor from rural area, where the surplus labor was unlimited and the marginal product of the surplus labor was zero in rural areas.

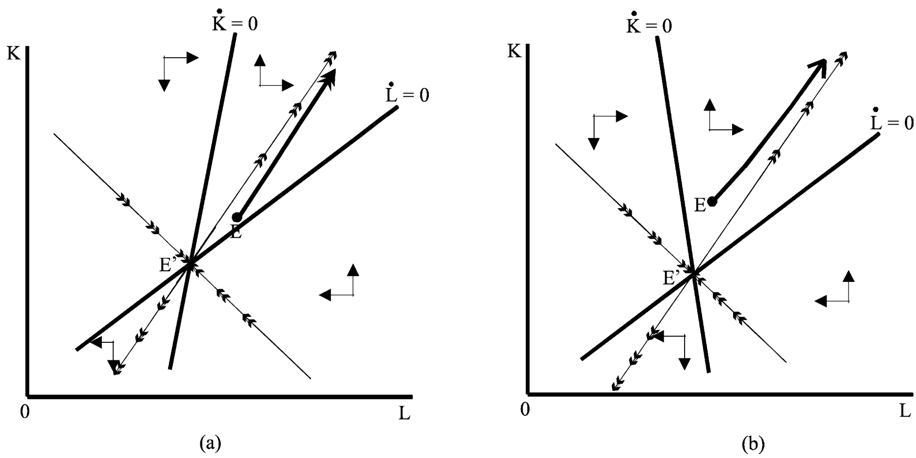


Fig. 3.

the hinterland. Thus, they gained more initial growth momentum and further sustained the growth in the following period. The divergence among provinces thus became substantial during the 1990s.

The model demonstrates that the growth rate of province $i$ is a function of its geographic factor $\alpha_i$. The difference in the values of $\alpha$ among provinces results in different GDP growth rates. The geographic factor $\alpha_i$ is the natural condition and is assumed to be time invariable (during the transitional period under our investigation). After it is realized, it does not change over time, so $\alpha_i$=0. Taking the logarithm of both sides of the production function, Eq. (3), and taking the derivatives with respect to time, we have:

$$\frac{\dot{Q}_i}{Q_i} = \left(\frac{\partial A/\partial K}{A(K,R)} + \frac{\partial F/\partial K}{F(K,L)}\right)\dot{K} + \frac{\partial F/\partial K}{F(K,L)}\dot{L} = \left(\frac{\partial A/\partial K}{A(K,R)} + \frac{\partial F/\partial K}{F(K,L)}\right) \times\left\{\theta\left[\alpha_i\left(\frac{\partial A}{\partial K}(K,R)F(K,L) + \alpha_i A(K,R)\frac{\partial F}{\partial K}(K,L) - \delta - r\right]\right\} + \frac{\partial F/\partial L}{F(K,L)}\left[\lambda\left(\alpha_i A(K,R)\frac{\partial F}{\partial L} - \overline{W}\right)\right] \tag{11}$$

$\dot{Q}_i/Q_i$ is the growth rate of GDP. From Eq. (11), we see the GDP growth rate is affected by the parameter of $\alpha_i$. Let "∴" denote the growth rate and $\Phi(\ )$ denote the above function. Notice in the equation that only $\alpha_i$ and the initial values of $K$ and $L$ are province variant. Hence, we can write Eq. (12) as

$$\hat{Q}_i \equiv \frac{\dot{Q}_i}{Q_i} = \Phi(\dot{K}(\alpha_i),\dot{L}(\alpha_i);K_{i0},L_{i0}) = \Phi(\alpha_i;K_{i0},L_{i0}) \tag{12}$$

It is also affected by the initial levels of $K_{i0}$ and $L_{i0}$.[12] Notice that $\alpha_i$ is a function of the spatial variable $s_i$ and the topographic vector $\boldsymbol{T}_i$, as defined in Eq. (2) and its follow-up paragraph. Hence, we can rewrite $\Phi(\ )$ as follows:

$$\hat{Q}_i = \Phi\left(\frac{1}{1+s_i}, T_i; K_{i0}, L_{i0}\right) \tag{13}$$

We may also be interested in the differences in the growth rate of GDP per capita. Let the population of province $i$ be $P_i$. The growth rate of GDP per capita therefore is (Eq. (14))

$$\hat{Q}_i - \hat{P}_i = \Phi\left(\frac{1}{1+s_i}, T_i; K_{i0}, L_{i0}\right) - \hat{P}_i \tag{14}$$

$\hat{P}_i$ refers to the natural growth rate of the population of the permanent residents in the province. Notice that the population growth rate can be different from the growth rate of labor force, $\hat{L}=\dot{L}/L$. In the Chinese statistics, migrant workers from outside of a coastal region are considered as a "floating population," which implies that they are not permanent residents of the province.[13] The GDP per capita figures reported by each province do not include migrant workers in general. The natural population growth rate of the province thus is exogenously determined outside the model. The population growth rates in official statistics for the interior regions are higher than those of coastal regions, although the difference is very small. Yet, this difference may be offset by many migrants to coastal regions who are unrecorded by the official statistics. Hence, the difference in the population growth rate among provinces may be negligible; and a regression by replacing GDP with GDP per capita shall yield no fundamental changes.

In the phase diagram, we can trace the trajectory of a representative province and find how the capital and labor inputs change along the trajectory in the growth process. A geographic advantage, i.e., a greater value of $\alpha$, would position the province in a faster-moving trajectory. A greater value of $\alpha$ would also lead to a higher capital return, as we can see from the combination of Eqs. (4) and (5). The higher return induces more capital flow into the province. A higher $\alpha$ value would also lead to a higher return to labor input, which can be

[12] $R$, which denotes privatization and marketization, is not explicitly expressed in the $\Phi$ equation since $R$ is implicitly assumed to be province invariant. One may argue that $R$ can be province variant, or he could further add many other causal factors that may be province variant including education or urban reform, in this equation. We agree that there are other causal factors independent of the geographic variance, however, here, we have reasonable reasons to drop them for the sake of simplicity and our focus. First, some policy or institutional variables of the $R$ nature including establishment of the special economic zones or hometown connection of overseas investors are endogenously determined by the geographic factor. Second, all remaining independent causal factors including the province-variant $R$ would be examined in the late empirical test, which is represented by the unexplained variation in the growth rate among provinces in the regression. If our model specification were wrong, then the unexplained variation in the empirical testing would be very large. If this were the case, we would come back to refine the theoretical model.

[13] The census conducted in 2001 will attempt to redefine who the urban residents are. However, the practice will only provide the demographic statistics for urban residents including migrants after the year of 2000.

seen by expanding the expression of Eq. (7). The higher return encourages immigrant workers to the region. Thus, our model characterizes exactly what happened in China—a huge influx of FDIs and a flood of migrant workers to the coastal regions. The economy thus explodes in the coastal regions, and the trend continues and rapid growth is sustained. This causes a divergence in growth between coastal and hinterland provinces. A fundamental reason that explains this divergence in the expansion of inputs and production across provinces, as we have shown, is the geographic difference.

## 4. Test and empirical evidence

From the above established framework, we examine the empirical evidence and test the Chinese case. The initial regression equation is derived from Eq. (13) by using the Taylor expansion (Eq. (15)):

$$\hat{Q}_i = \Phi\left(\frac{1}{1+s_i}, \boldsymbol{T}_i; K_{i0}, L_{i0}\right) \approx \Phi\left(\frac{1}{1+s_0}, \boldsymbol{T}_0; K_{00}, L_{00}\right) + \Phi_s\left(\frac{1}{1+s_i} - \frac{1}{1+s_0}\right)$$
$$+ \Phi_T(\boldsymbol{T}_i - \boldsymbol{T}_0) + \Phi_K(K_{i0} - K_{00}) + \Phi_L(L_{i0} - L_{00}) \tag{15}$$

where $\Phi_s$ denotes $\partial\Phi/\partial(1/(1+s))$. $s_0$, $\boldsymbol{T}_0$, $K_{00}$, and $L_{00}$ are some benchmark levels for the variables for each province to measure against. Collecting the terms, we have Eq. (16)

$$\hat{Q}_i = \beta_0 + \beta_1 \frac{1}{1+s_i} + \beta_2 T_i + \beta_3 K_{i0} + \beta_4 L_{i0} \tag{16}$$

where β's are constants, corresponding to the terms collected.[14] They are parameters to be estimated in the test. In particular, we can test the null hypothesis for each of the variable.

The above model is straightforward, and we can use the OLS method to test it. However, in applying it to the Chinese case, we encountered some theoretical and practical problems. First, the initial amount of labor input of province $i$, $L_{i0}$, is not truly exogenous in an economy that is characterized by unlimited labor supply and zero marginal product of labor. In such a case, the labor input in the production is solely determined by the demand for labor from firms, which, in turn, is determined by the capital endowment and growth speed. Mathematically, the last two terms can be written as $K_{i0}$ and $L_{i0}=L(K_{i0})$. That is, for the Chinese case, $L_{i0}$ is endogenously determined by $K_{i0}$. Thus, we should concentrate on $K_{i0}$, which determines both $L_{i0}$ and itself. However, there comes the second problem. The data of the initial capital stock $K_{i0}$ are not available for most provinces; and for the remaining ones, there are no reliable figures for serious testing either.

[14] In particular, $\beta_0=\Phi(s_0,\boldsymbol{T}_0;K_{00},L_{00})+\Phi_s(s_i-s_0)-\Phi_{\boldsymbol{T}}\boldsymbol{T}_0-\Phi_K K_{00}-\Phi_L L_{00}$, $\beta_1=\Phi_s$, $\beta_2=\Phi_{\boldsymbol{T}}$, $\beta_3=\Phi_K$, and $\beta_4=\Phi_L$.

We use the initial GDP per capita level as the proxy for $K_{i0}$. Notice that the GDP per labor input can be written as (Eq. (17)):

$$\frac{Q_{i0}}{L_{i0}} = \frac{A(R,K_{i0})F(K_{i0},L(K_{i0}))}{L(K_{i0})} \tag{17}$$

Hence, $Q_{i0}/L_{i0}$ is determined by $K_{i0}$. Assuming that the relationship is monotonically increasing, thus, $Q_{i0}/L_{i0}$ also determines $K_{i0}$. Initially, at Time 0, which corresponds to 1978, large amounts of labor migration had not taken place, and the labor-to-population ratio was similar among provinces. Thus, we can use GDP per capita instead of GDP per labor input as the proxy. Hence, the regression equation is revised as follows (Eq. (18)):

$$\hat{Q}_i = \gamma_0 + \gamma_1 g_{i0} + \gamma_2 \frac{1}{1+s_i} + \gamma_3 T_i \tag{18}$$

where $g$ is $Q/P$, the GDP per capita.

We use the cumulative real growth index of aggregate GDP of province $i$ during the period of 1978–1997 for the dependent variable $\hat{Q}_i$ in our regression model. The initial period is 1978, when the reform started. Hence, $g_{i0}$ refers to the GDP per capita of province $i$ in 1978. $s_i$ is the distance from the geographic center of the province to the nearest coastline in kilometers.[15] We use the transformed distance factor, $1/(1+s_i)$, in our regression model, which is closer to the nonlinear relationship between the transportation cost and the distance. We test three topographic variables for their impacts. One is the length of the continent coastline of the province. It serves as the proxy for ocean navigability and seaport condition, which, in turn, implies the convenience and efficiency of overseas transportation FDIs. Likewise, the elevation from the sea level may also be associated with the transportation cost with overseas. The distance that we measured is between the geographic center of the province to the coastline. This measure can be misleading, because the geographic center may be different from the economic center of the province. The economic center normally has a higher population density. Radelet and Sachs (1998) indicates that almost all countries with macroeconomic success in labor-intensive manufacturing exports have populations almost totally within 100 km of the coast. Hence, our test also includes the variable used in Gallup and Sachs (1998), Pop100c, which is defined as the proportion of the population within 100 km of the coastline or ocean-navigable waterway. The regression results are presented in Table 2.

The results are generally good, with $R^2$ ranged from .55 to .75, and confirm what we expected. The sign of GDP per capita is negative. It seems to agree with the convergence hypothesis. The insight is that the abundant labor supply yields high capital return, thus attracting a large flow of foreign investment and fostering growth. The signs of all geographic variables agree with what we expect in our model. The sign of the transformed distance factor is correct, although in three cases (Models 1, 3, and 5), it is not statistically significant. The

[15] We have tried to use other units for $s_i$, including 1000 km. The results yield no fundamental difference.

Table 2
GDP growth by province in China during reform (1978–1997)

| | Model 1 | Model 2 | Model 3 | Model 4 | Model 5 |
|---|---|---|---|---|---|
| Constant | 587.56 | 623.86 | 566.6 | 653.62 | 592.95 |
| | (15.21) | (13.84) | (15.21) | (9.58) | (10.88) |
| GDP per capita 1978 | −0.064 | −0.2706 | −0.0988 | −0.2710 | −0.0998 |
| | (−0.866) | (−3.580) | (−1.40) | (−3.540) | (−1.396) |
| Distance factor (1/(1+distance)) | 77.66 | 632.78 | 33.54 | 621.83 | 26.00 |
| | (0.297) | (2.427) | (0.137) | (2.349) | (0.105) |
| Coastline length | 0.1594 | | 0.1310 | | 0.1306 |
| | (5.400) | | (4.311) | | (4.247) |
| Pop100cr | | 265.04 | 145.17 | 236.15 | 120.24 |
| | | (3.44) | (2.209) | (2.559) | (1.578) |
| Elevation | | | | −0.182 | −0.016 |
| | | | | (−0.587) | (−0.668) |
| $R^2$ | .695 | .555 | .745 | .562 | .750 |

Dependent variable: GDP growth index in 1997 (1978=100) by provinces; observations: 30 (provinces).
*t* Ratios are inside parentheses.
Distance factor: the "Iceberg" transformation of the distance of the geocenter of the province to the nearest coastal line. It is equal to (1/(1+distance)).
Elevation: the average elevation of the land.
Coastline length is defined as the length of the continental coastline, excluding coastline above the winter extent of sea ice. The data is from *Zhongxue Jiaoshi Ditu Ji* (Maps for High School Teacher) Beijing, Dec. 1990. Beijing, China: Chinese Map Press, p. 51. The data for Guangxi province, 1500 km, was obviously an error. It is corrected by a new calculation based on the GIS data source.
Pop100cr is the proportion of the population distribution of a province in 1994 within 100 km of the coastline or ocean-navigable river, excluding coastline above the winter extent of sea ice and the rivers that flow to this coastline.

coastline length is the most powerful geographic variable. Its *t* ratios in all cases are so large that the associated *P* values are less than .001. Pop100cr is also statistically significant at the 5% level in three out of four cases. Although the sign of the estimated parameters for elevation is correct, the estimates are statistically insignificant. Conceivably, the coastline length and Pop100cr are highly correlated, thus, multicollinearity may exist in Models 3 and 5. This may adversely affect the precision of the estimates, although it looks less serious in this case, given the fact the *t* ratios of two concerned estimates are quite large. It seems that Pop100cr can be dropped once the coastline length is included, as one can see that the $R^2$ between Models 1 and 3 are not of big difference.

We further test the effects on GDP per capita. Table 3 presents the regression results. The dependent variable is the cumulative growth of the GDP per capita by province during 1978–1997, the same period. The explanatory variables are the same as Table 2. The results are not fundamentally different from Table 2 and are consistent with what we expected (as discussed in Section 3). The coastline length and Pop100cr are the most significant determinants for disparity in growth. In the Chinese official statistics, the disparity in the GDP per capita among the Chinese provinces is somewhat larger than that in aggregate GDP, because the population growth rate in the interior regions is slightly higher. However, as discussed before,

Table 3
GDP per capita growth by province in China during reform (1978–1997)

| | Model 1 | Model 2 | Model 3 | Model 4 | Model 5 | Model 6 |
|---|---|---|---|---|---|---|
| Constant | 466.92 | 441.26 | 503.69 | 420.04 | 460.70 | 426.41 |
| | (12.70) | (13.46) | (9.139) | (13.86) | (10.93) | (15.30) |
| GDP per capita 1978 | −0.178 | −0.0017 | −0.178 | −0.0370 | −0.0632 | −0.600 |
| | (−2.88) | (−0.027) | (−2.88) | (−0.644) | (−1.533) | (−1.456) |
| Distance factor (1/(1+distance)) | 375.02 | −71.253 | 361.50 | −116.03 | | |
| | (1.764) | (−0.321) | (1.690) | (−0.584) | | |
| Coastline length | | 0.1362 | | 0.1074 | 0.0979 | 0.0992 |
| | | (5.435) | | (4.348) | (4.886) | (4.943) |
| Pop100cr | 245.57 | | 209.87 | 147.339 | 113.19 | 144.80 |
| | (3.907) | | (2.815) | (2.760) | (1.88) | (2.756) |
| Elevation | | | −0.0225 | | −0.0201 | |
| | | | (−0.898) | | (−1.065) | |
| $R^2$ | .541 | .659 | .556 | .739 | .747 | .735 |

Dependent variable: GDP per capita growth index in 1997 (1978=100) by provinces; observations: 30 (provinces).

the official figures for the GDP per capita of coastal regions are exaggerated because of the unrecorded migrants from interior to coastal regions. If this bias had been corrected, the difference between the two tables would have been even smaller.

Further, we wish to know how much variation in provincial growth can be explained by a particular geographic factor. We thus regress GDP and GDP per capita on each geographic variable. The resulting $R^2$ provides the information we need. We report the results in Table 4. All variables have the expected signs and the $t$ ratios are significant at the 10% statistical level. Distance and elevation can only explain 12–17% of the variation in GDP growth among provinces. Pop100cr can explain 33%. However, coastline length alone can explain 68% of all variations. An investigation of the GDP per capita results in similar conclusions (Table 4).

Several important conclusions can be drawn from these results. First, although diversity in growth among the provinces exists, the economies of all provinces grew very rapidly by the international standard during the reform period. This is evident from the fact that the intercept (constant) is by far the most significant factor.

Second, the initial income level was not the reason for the divergence among the provinces, as revealed by the negative sign for initial GDP per capita level (in 1978). Previous studies often cited that the interior regions grew slower because they were poor and

Table 4
Significance of each geographic factor on growth

| | Coastline | Pop100cr | Elevation | Distance (transformed) |
|---|---|---|---|---|
| On cumulative GDP growth | $P$ value: .0000<br>$R^2$: .68 | $P$ value: .0009<br>$R^2$: .33 | $P$ value: .023<br>$R^2$: .17 | $P$ value: .055<br>$R^2$: .13 |
| On cumulative GDP per capita growth | $P$ value: .0000<br>$R^2$: .66 | $P$ value: .0002<br>$R^2$: .39 | $P$ value: .008<br>$R^2$: .23 | $P$ value: .065<br>$R^2$: .12 |

had less capital endowment. Theoretically, the low income level could also work in the other direction, as we indicated in our theoretical model in Section 3. The insight is as follows: A high labor-to-capital endowment ratio may make the return to capital higher, thus attracting more capital, and achieving more rapid growth. In other words, the poor provinces would grow faster if they had no geographic disadvantage. This is a very interesting point—the convergence theory prevails only if we could control the geographic factors.

Third, geographic factors are more important than previously thought in determining growth in provinces. The geographic factors can explain more than 60% of the variation in growth, as evident in Table 4. Notice that our model does not use exogenous economic variables such as investment and labor input. Instead, these economic variables are endogenously determined by the geographic factors in our model. We do not intend to be geography determinists, but the empirical results do expose the importance of the geographic impact on the reform and development. Such an importance has been overlooked in the past.

Finally, among the geographic factors, the effect of coastline length is the most significant, followed by Pop100cr. The effects from distance and elevation, however, are relatively weak. This implies that divergence in growth is more of a case of the coastal regions versus noncoastal regions. The spatial distance between a province in the central region and a province in the western region is not very critical. The reason behind this is as follows: The rapid growth in the 1990s was largely driven by FDIs. The overwhelming portion of FDIs was in the processing trade industry, which centers in the special economic zones and other processing industry zones. These zones were almost exclusively located along the coastlines.[16] That is why the coastline length and POP100cr are so significant.

## 5. Summary

Our study investigates the effect of geography on regional economic growth in China under market reforms. We agree with most studies that note that the influx of large amounts of FDIs and migrant labor (unskilled, as well as skilled) are mainly responsible for rapid growth in the coastal provinces in China. Hence, our model characterizes the growth pattern of the Chinese economy during this period, featured by a huge amount of FDIs and the mobilization of huge surplus rural labor.

However, we asked a further question and investigated the reasons behind the capital and labor flow during the reform period in China. The FDI and labor migration are induced by higher returns from capital investment and higher wage rates in the coastal regions. This differential, to a large extent, is explained by geographic factors. Coastal regions have spatial and topographic advantages; their transportation and communication costs are low. These factors raise the return to the capital and therefore attract more FDIs and migrant labor.

Results from our empirical test on the geographic effects strongly support the hypothesis. Indeed, the results were stronger than what we originally expected. In particular, the coastline

[16] See Zhang, K.H. (2001) for more evidence.

variable alone can explain more than 60% of the variation in growth rates among the Chinese provinces. The disparity can thus be viewed largely as a coast versus noncoast gap. The coastline variable serves as a proxy for FDIs and other capital flows, as well as the labor and human capital inputs. Statistically, the coastline explains the growth variations even better than the economic variables in many previous empirical tests. This can be interpreted as the following causality chain: The geographic factors influence and determine conventional economic or policy explanatory variables, such as FDI, labor, human capital, marketization, privatization, openness, etc. These variables, in turn, determine growth among the provinces. The conclusion in this paper may seem to be unconventional in a field where most scholars tend to concentrate on policy determinants. We do not wish to overemphasize the importance of geography, yet, we hope that our study will raise the academic interest and spur further discussion in the subject.

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