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China's Economic Reform and Regional Productivity Differentials

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Reform of Chinese economy, especially the Urban Reform announced in 1984, has decentralized government control over the economy and encouraged freer trade, domestic as well as international. Consequently, strengths and weaknesses of geographic regions emerge and each region may specialize according to its comparative advantage. The abandonment of hitherto regional equality policy produces an anxiety over wo rsening regional disparity especially between the Coastal East and the Interior West. The reform policy is based on the Chinese leaders' belief that allowing some areas to get rich ahead of others produces a trickle-down of prosperity to less developed interior regions. Is the trickle-down consistent with the reality, especially with the phenomenon of the Coastal-led development triggered by the "Open Door" policy for foreign investment and trade? This paper examines the pattern of changes in total factor productivity differentials in industry across regions of China during 1986-1991, a period posterior to initiation of the industrial reform. The estimates of the panel data production function model, with regional and temporal variations in levels of productivity, confirm regional convergence of total factor productivity over the post reform period.

I. Introduction

Economic reform in China, especially the Urban Reform announced in 1984, is characterized by a reduction of central control over the economy and introduction of market forces.[1] The decentralization has encouraged inter-regional trade utilizing comparative advantage as opposed to regional self-sufficiency. New regional strengths and weaknesses have been emerging since the reform began. Especially, the decentralization combined with the *open door* policy for foreign investment and trade benefits the more advanced Coastal Region. This may worsen regional development disparity.

The reformers' apparent logic behind decentralization and freer inter-regional as well as international trade is that the prosperous coast would establish links to both foreign markets and interior provinces, and lead industrial concentration to generate technological

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1. The Twelfth Central Committee of the Communist Party of China announced in October 1984 that 'defects in the urban economic sector...seriously hinder the expansion of the forces of production'. The meeting set an outline for the Urban Reform. Its features include withdrawal of government control over management, independent enterprises responsible for profit and loss, and reformed price system reflecting the supply and demand conditions. See Chinese Communist Party (1984).

advances. Eventually the Coastal-led development would produce a *trickle-down* of prosperity to less developed interior regions.

However, this strategy has resulted in growing conflicts between the developed coast and other underdeveloped regions. The conflicts are most intensely felt by those in the Western Region. The issue is also political, because this region is heavily populated by non-Han minorities. This has led to the concept of the *east-west* divide in China, and the argument for a more equitable regional policy instead of the current regional specialization policy based on comparative advantage and inter-regional/international trade.

If there are some forces that can effectively *trickle-down* the benefits of the Coastal-led development, the regional inequality problem may not necessarily worsen. Although the *trickle-down* theory of economic development in China is largely discredited by many,[2] it may find support in the convergence hypothesis in economic growth literature: an economy's productivity level has a strong inverse correlation with its productivity growth rate.

The Neoclassical Growth Model predicts that if economies are similar with respect to preferences and technology, poor economies tend to grow faster than rich ones. Baumol (1986) regards convergence as a productivity-enhancing public good which takes place as the fruits of each industrialized economy's productivity-enhancement efforts are ultimately shared by others. Although some economic theories predict convergence among countries, the empirical evidence has been a subject of debate. Many studies show that convergence pattern is not a universal phenomenon and may exist only within certain groups. Abramovitz (1986) argues that an economy's potential for rapid growth is strong not when it is technologically backward, but when social capabilities are sufficiently developed to permit successful exploitation of technologies. *Social capabilities* include experience with organization and management, institutions and markets capable of mobilizing capital, openness to competition, and the state of education.

The phenomenon of convergence along with its accompanying theories has a very important policy implication for recent economic development in China, supporting the logic underlying the Coastal-led development as it relates to regional disparity. If there is a force leading convergence trend, the strategy that allows the more developed coastal provinces to *get rich first* would eventually benefit all other regions, and enhance the productivity level for the whole country in the long run. Development for the interior provinces would be only a question of time.

If the main source of convergence is innovation sharing, and if the rapidity of the innovation sharing process depends on the *social capabilities*, then changes in the economic system would have a great impact on the pattern of convergence. If the reform from a central planning system to the market mechanism facilitates inter-regional trade and communications in goods, resources, information, and technology, the institutional change can enhance *social capabilities* and rapid information sharing. Then, the reform would reinforce the trend of convergence rather than that of divergence.

Previous studies of Chinese economy have dealt with various aspects of convergence. Dollar (1990) and Jefferson and Xu (1991) presented evidence of productivity convergence

2. See Cannon and Jenkins (1990, p.50-54).

among industrial enterprises in terms of total factor productivity and factor returns, respectively. Jefferson, Rawski and Zheng (1992) and Jefferson and Xu (1994) reported convergence of factor returns between state and collective industry and among large- and medium-sized state enterprises, respectively. Jian, Sachs, and Warner (1996) found regional convergence in real per-capita income in 1978-1990. However, none of the past studies treat regional convergence of industrial productivity.

This study examines the pattern of changes in total factor productivity differentials in manufacturing across regions of China, and determines whether regional convergence of industrial productivity actually emerged in the period following the Urban Reform which was implemented with full strides by 1986. The study employs a panel data production function model to analyze province-level data from 1986 to 1991 for 28 provinces of China. The model allows for cross-sectional and temporal variation in levels of technical inefficiency to estimate time-varying productivity levels for regions, without invoking strong distributional assumptions on technical inefficiency. Different from the standard panel data model, our model includes a time function whose parameterization varies across regions.

The organization of the paper is as follows. Section II presents a summary of the economic reform of China. Section III describes the data and the econometric model. Section IV reports the estimated results of the model and their interpretations. Section V concludes the paper.

II. Economic Reform

Reforms of the collective economic system of China started with Rural Reforms in 1978, which raised the long-depressed state procurement prices for agricultural products, provided the land lease to individual farmers, and abolished eventually the mandatory state production plans in agriculture.[3] The highly successful Rural Reform gave impetus to reforms in industry. Industrial reforms began with the Urban Reform which was announced in late 1984 and has proceeded with full steam since 1986. Simultaneous with the industrial reforms was regional development reform which discarded regional self-sufficiency. It emphasized regional specialization according to comparative advantage, and encouraged inter-regional as well as international trade.

1. Urban Reform

The Urban Reform enhanced the role of market forces in the industrial sector. Specifically, the reform which continues into the 1990's includes price reform, management reform, and labor reform of the state-owned enterprises.

a. Price Reform

By the early 1980's several types of prices coexisted in China. They range from the

3. For review of China's economic reform, see Jackson (1992), Perkins (1988), and Lin (1992).

state-determined fixed prices for essential producer goods to the market determined free prices. In 1984, producer goods whose output was above-plan level and many daily-use commodities were freed from the state price fixing so that their prices could be determined by supply and demand. The reform is incomplete in that a two-tier system of state and free prices continues to date, especially for producer goods. But the gap between the state and free prices tends to diminish over the years.

b. Management Reform

The Urban Reform shifted management responsibility of state owned enterprises from the state to the enterprises and introduced profit incentive for them. First, the enterprises acquired decision-making power in production as well as in investment. The contractual responsibility system, begun in 1986 and widely implemented in 1987-88, imposes a contract between a state enterprise and the state. The enterprise is granted authority for management decisions, while it must guarantee to pay to the state an agreed amount of the after-tax profit. The state is obligated to supply the enterprise raw materials and energy at fixed prices. The enterprise could use retained earnings for plant expansion. The decentralized production-investment decisions allowed the managers to pursue their own enterprise interests.

Second, the enterprise under the contractual responsibility system maintains profit incentive since the enterprise can keep for itself some of the profit in excess of the set amount. This built-in profit incentive for enterprises is specified by the enterprise tax system, a system of profit sharing between the state and the enterprises, which replaces the old system of unified receipts and allocations by the state. Under the old system the state took the profits of state enterprises and covered their losses so that managers had little incentive for profit maximization. The enterprise taxation system imposes on profits of large- and medium-sized firms a flat tax rate of 55% on their net profit after the industrial-commercial tax. The remaining 45% of the profit was divided between the enterprise and the state. The specific profit shares of the state and the enterprise were determined by the rate schedule specified in the contract between them. Small firms were allowed to keep the profit left after payment of a progressive corporate income tax. As a result, firms could keep the more above-quota profit, the more profit they made.[4] For loss making enterprises, the Enterprise Bankruptcy Law was enacted later, in 1988, which gives bankruptcy warnings and then declares bankruptcy at the reorganization period to insolvent enterprises.

c. Labor Reform

Two types of reforms were made in labor. First, the wage reform of 1985 dismantled the egalitarian unified wage system to increase inter-grade wage differentials. It also introduced performance-based wages so that workers earn higher wages the more effort they put in and the more profit their firm makes. Thus, individual workers' performances as well as the firm's overall performance determine wages. Second, employment reform was made

4. The enterprise profit share amounts to around 1/3 in 1986 and increases since then. See Jackson (1992, p.106).

initially through the new labor contract system of 1986 which abolished lifetime employment of state workers among new hires. The labor reform culminates later in the job tenure reform of 1988 which authorized the state enterprises to dismiss surplus workers. This *smash the iron rice bowl* employment reform continues amidst the social problem of the jobless amounting to 2.3% unemployment rate in 1989, a clear indication of China's resolve to enhance economic efficiency.

2. Regional Development Reform

Prior to the reform era, the Chinese leadership promoted regional equality not only for the communist ideal of equality but also for military reasons. In the event of civil war or invasions, smaller units of equally developed, self-sufficient regions would have a higher survival probability than the integrated whole. The regional self-sufficiency is reflected in Table 1 which shows that the industrial sector accounts for one third or more of the national income in almost all provinces. This policy of regional uniformity/equality was costly in sacrificed efficiency (see Yang (1990)). Still it did not prevent big regional disparity in per capita industrial output which continued well into the 1980's as shown in Table 2.

In the 1970's after the Cultural Revolution, spatial decentralization began, as provincial and county governments assumed control over the economy, replacing the central government planning. Decentralized government authority allowed each province to keep more of its revenue. Due to profit sharing between the state and the enterprises introduced by industrial reforms, more profitable firms within a province meant more revenues for the province. The common profit-revenue motive of the provincial government and the firms fosters inter-provincial trade and hence interprovincial competition of state-owned enterprises, while inter-firm competition within a province is limited by the local government. The resulting development of each province according to its regional comparative advantage means that the regional uniformity forced by the central government planning is replaced by regional diversity.

Another factor conducive to regional diversity is the coastal development. Government policy favors the coast in terms of higher investment and the concessions granted for foreign capital. Chinese leadership opened up for foreign investment and trade a few Special Economic Zones on the south coast in 1980, granting them special development incentives and privileges, which were later extended to the fourteen port cities and then to the entire Coastal Region.[5] These policies, combined with the coast's historical advanced economic position, insured that the Coastal Region would prosper with reform. The apparent logic behind this *open door* policy was that the coast would establish links to both foreign markets and interior provinces. The benefits were to be many, such as the development of low-wage, labor-intensive exports to pay for needed imports; industrial concentration to generate

5. The four Special Economic Zones are Shenzhen, Zhuhai, Xiamen, and Shantou. Fourteen port cities are Qinhuangdao, Tianjin, Dalian, Yantai, Qingdao, Lianyungang, Nantong, Shanghai, Ningbo, Wenzhou, Fuz hou, Guangzhou, Zhanjiang, and Beihai. For development of the southeastern coastal provinces, see Lyons and Nee (1994).

technological advances; and, perhaps most important, the eventual *trickle-down* of prosperity to the less developed areas of the interior. Interior development, then, would be only a question of time.

3. Reforms and Regional Disparity in Industry Productivity

The reforms have resulted in shifting development priorities from regional self-sufficiency to regional specialization and trade based on regional comparative advantage. The reforms may or may not increase regional disparity in development. On the one hand, economically prosperous areas and their firms can invest the benefits from their traditional comparative advantages for further development, worsening the disparity. On the other hand, new strengths and weaknesses emerge among regions as the reforms continue. Areas which previously had the advantage of getting more support from the central planning system may lose their ground in the decentralized economy. Previously less developed areas may acquire new advantages to become winners in the competition. As the convergence hypothesis predicts, least developed regions may grow fastest to reduce regional disparity.

However, industrial and regional reforms and especially the concomitant Coastal-led development have added to the inter-regional tension in the country. People in the inland feel left behind, or deliberately neglected, under state policies which so clearly favor the coast. This issue raises a serious question about the relationship between the more-developed coast and the less-developed interior: Do the reforms and the accompanying Coastal-led development worsen productivity disparity in industry across regions in China? According to the second column of Table 2, although the output growth rate over 1987-1991 is highest in the southeast coast, that of the western region is also very high. The growth rate of the central region is lower than that of the western region, but higher than that of the northeast coast, which grew least among the four regions. The poor growth performance of the most developed northeast vis vis the good performance of the least developed west seems to point to convergence rather than divergence of industry growth across regions. To examine more thoroughly the pattern of the regional productivity disparity in the aftermath of the initiation of the economic reform, the next section provides an econometric model to estimate the regional total factor productivity differentials over the post reform era.

III. Data and the Model

1. Data Description

This study uses province level panel data which consists of annual data for 1986-1991, the era posterior to the Urban Reform, regarding twenty-eight of thirty provinces (including three municipalities) of the People's Republic of China. Tibet is excluded because some of the relevant data is not available. Hainan, the new province started in 1988, is also excluded. All data in this study are taken from the State Statistical Bureau of China. Specifically, the data for output and input variables are from the China Industrial Economy Statistical Yearbook. This yearbook contains more detailed and consistent data for industrial analysis than the China Statistical Yearbook which was used by most of the previous industrial

studies. All price indices are from the China Price Statistical Yearbook.

a. Region Dummies

The government designates the 28 provinces of China geographically into three macro-regions: the Coastal, Central, and Western Region. Instead of this official tripartite regionalization, we divide China into four regions for our analysis. We split the Coastal Region into two areas, and also make some other changes based on the economic characteristics of provinces. Region 1 is one part of the Coastal Region which encompasses four provinces (including three municipalities): Shanghai, Beijing, Tianjin municipalities, and Liaoning Province. This is the most developed and industrialized area with the highest industry shares in total national income (see Table 1) and with the highest ratios of national average of industrial output per capita (see Table 2) in 1986. State-owned, large- and middle-sized enterprises dominate in this region (see Table 3). Region two is the other part of the Coastal Region, comprising six provinces along the southeast coast: Jiangsu, Zhejiang, Guangdong, Shandong, Fujian, and Guangxi. All Special Economic Zones and most of the *Open Cities* and *priority development areas* are located in this region. For these provinces in the region except Guangxi, proportions of state-owned, large- and middle-sized enterprises are much lower than all other provinces (see Table 3). Region 3 is basically the Central Region, totaling ten provinces: Heilongjiang, Jilin, Hubei, Shanxi, Hunan, Anhui, Jiangxi, Henan, Hebei, and Sichuan. It includes Hebei from the Coastal Region and Sichuan from the Western Region, considering their economic characteristics are similar to Region 3. Inner Mongolia, though located in the Central Region, is included in Region 4, since its characteristics are similar to the Western Region. Region 4 is basically the Western Region (with the exception of Inner Mongolia), and includes eight provinces: Xinjiang, Qinghai, Ningxia, Gansu, Shaanxi, Yunnan, Quizhou, and Inner Mongolia, which is the least developed area and is inhabited heavily by non-Han minorities. Their ratios of national average of industrial output per capita and shares of national industrial output are quite low relative to all other provinces (see Table 2).

b. Adjustment for Output Variable

The output variable in this study refers to net output value (in ten million yuan). The difference between net output value and value added (which is a usual proxy of output for production function analysis) is that the former excludes depreciation. The reported net output value (*NOV*) in current prices needs adjustments. The reported *NOV* is gross output value (*GOV*) minus material cost (*MC*) and depreciation. Due to underdeveloped factor markets, more so than to the product markets, officially assessed *MC* (including raw materials and utilities) reflects government-controlled prices so that *NOV* may amplify the measurement error. To minimize the error, we deflate *MC* by the price index for material, $P_m(t)$. The deflator for *GOV*, the output price index $P(t)$, for each province is computed as the weighted average of the producer sale price indexes of 14 industrial sectors, weights being respective sectoral shares in the province. It is observed that prices of raw materials and utilities increased much faster than output sale prices. This is due partly to the demand and supply situations and partly to government price control policies.

Table 1 National Income by Province, 1986

Province		National Income per capita in 1986 yuan	Share in National Income		
			Agriculture	Industry	Other
Coastal Region:					
Shanghai	(R1)	3,471	4.4%	71.9%	23.7%
Beijing	(R1)	2,130	9.1	62.3	37.7
Tianjin	(R1)	2,040	10.2	62.7	27.1
Liaoning	(R1)	1,299	18.6	62.9	18.5
Jiangsu	(R2)	1,064	32.9	51.1	16.0
Zhejiang	(R2)	1,042	31.7	48.3	20.0
Guangdong	(R2)	897	37.1	36.0	26.9
Shandong	(R2)	770	41.3	42.2	16.5
Hebei	(R3)	673	32.0	49.5	18.5
Fujian	(R2)	672	38.9	38.1	23.0
Guangxi	(R2)	450	47.6	31.3	21.1
Central Region:					
Heilongjiang	(R3)	997	27.2	55.2	17.6
Jilin	(R3)	823	33.2	47.5	19.3
Hubei	(R3)	805	40.3	41.4	18.3
Shanxi	(R3)	682	21.1	53.9	25.0
Hunan	(R3)	603	47.8	34.4	17.8
Anhui	(R3)	599	48.7	34.7	16.6
Jiangxi	(R3)	543	47.2	35.2	17.6
Henan	(R3)	540	41.6	39.2	19.2
Inner Mongolia	(R4)	505	41.6	37.1	21.3
Western Region:					
Xinjiang	(R4)	740	44.9	31.8	23.3
Qinghai	(R4)	698	34.8	34.8	30.4
Ningxia	(R4)	616	38.4	36.0	25.6
Gansu	(R4)	570	29.8	42.8	27.4
Shaanxi	(R4)	531	34.9	43.7	21.4
Sichuan	(R3)	515	43.4	36.4	20.2
Yunnan	(R4)	453	45.4	35.9	18.7
Quizhou	(R4)	406	46.0	35.0	19.0
National Average		746	33.8	45.7	20.4

Source: State Statistical Bureau, *China Statistical Yearbook*, 1988, p.55 and 57.

Note: Here and in tables below, our quadri-partite regionalization is given in parentheses where Region 1 (R1) is the most developed northeast coastal region, Region 2 (R2) the southeast coast, Region 3 (R3) the central region, and Region 4 (R4) the western region. Tibet and Hainan are not included.

Table 2 Provincial Comparison (1)

Province		Industrial output[a] per capita 1986 (ratio of national average)	Average annual output growth rate[b] 1987-91 (%)
Coastal Region:			
Shanghai	(R1)	6.4	3.9
Beijing	(R1)	3.0	6.0
Tianjin	(R1)	3.3	2.9
Liaoning	(R1)	1.7	3.7
Jiangsu	(R2)	1.4	8.6
Zhejiang	(R2)	1.1	9.6
Guangdong	(R2)	0.7	19.6
Shandong	(R2)	0.7	11.4
Hebei	(R3)	0.6	8.0
Fujian	(R2)	0.5	13.2
Guangxi	(R2)	0.3	8.8
Central Region:			
Heilongjiang	(R3)	1.0	4.6
Jilin	(R3)	0.9	5.5
Hubei	(R3)	0.8	4.1
Shanxi	(R3)	0.7	6.1
Hunan	(R3)	0.5	4.9
Anhui	(R3)	0.4	6.5
Jiangxi	(R3)	0.4	5.7
Henan	(R3)	0.4	7.3
Inner Mongolia	(R4)	0.5	7.1
Western Region:			
Xinjiang	(R4)	0.5	11.1
Qinghai	(R4)	0.5	6.9
Ningxia	(R4)	0.5	8.3
Gansu	(R4)	0.5	5.1
Shaanxi	(R4)	0.5	6.4
Sichuan	(R3)	0.4	7.1
Yunnan	(R4)	0.3	10.0
Quizhou	(R4)	0.3	7.1

[a]Source: World Bank, *China: Macroeconomic Stability and Industrial Growth under Decentralized Socialism*, Washington: World Bank, 1990, p.132.

[b]Source: State Statistical Bureau, *China Industrial Economy Statistical Yearbook*, 1988-1992.

Table 3 Provincial Comparison (2)

Province		Industrial Output Share in % (1986)		
		State-owned Enterprises	Large-middle sized Enterprises	Rural Industry
Coastal Region:				
Shanghai	(R1)	80.1	56.4	7.2
Beijing	(R1)	76.7	67.9	6.2
Tianjin	(R1)	78.3	58.3	3.7
Liaoning	(R1)	71.9	62.0	4.8
Jiangsu	(R2)	46.4	32.0	27.0
Zhejiang	(R2)	41.3	20.2	27.0
Guangdong	(R2)	56.7	37.1	10.5
Shandong	(R2)	61.5	41.2	12.2
Hebei	(R3)	70.0	45.2	8.2
Fujian	(R2)	65.0	31.2	6.6
Guangxi	(R2)	78.9	41.1	3.8
Central Region:				
Heilongjiang	(R3)	81.0	60.2	2.7
Jilin	(R3)	75.2	48.8	3.2
Hubei	(R3)	71.5	45.2	8.2
Shanxi	(R3)	75.1	50.8	9.6
Hunan	(R3)	72.6	43.8	7.9
Anhui	(R3)	71.3	39.8	8.2
Jiangxi	(R3)	77.9	43.8	6.5
Henan	(R3)	74.9	45.1	6.1
Inner Mongolia	(R4)	80.6	47.7	2.4
Western Region:				
Xinjiang	(R4)	84.2	45.5	2.2
Qinghai	(R4)	82.6	43.1	1.6
Ningxia	(R4)	80.8	49.9	3.7
Gansu	(R4)	89.0	68.8	3.2
Shaanxi	(R4)	82.6	58.8	5.0
Sichuan	(R3)	74.1	45.9	9.0
Yunnan	(R4)	79.0	54.1	5.4
Quizhou	(R4)	84.1	59.7	4.6

Source: State Statistical Bureau, *China Statistical Yearbook*, 1988.

Now, our net output value in real terms can be written as

$$\text{Adjusted} \quad NOV(t) = GOV(t)/P(t) - MC(t)/P_m(t) - \text{depreciation.}^{6} \qquad (1)$$

c. Adjustments for Input Variables

The two input variables are labor and capital. Labor refers to the number of people employed (in ten thousand people). Since people are normally employed full time in China, working hours can be ignored. Capital refers to net fixed assets (in ten million yuan). A problem with the Chinese industrial data is that it overstates labor and capital data. Chinese industrial units employ substantial quantities of labor for non-industrial purposes such as education, medical care, etc., while capital data include residential construction and other investment for service facilities, such as schools, and health clinics.[7] Thus, our capital and labor variables are proxies for inputs used for industrial production.

For capital input, the Statistical Yearbook of Chinese Industrial Economy reports cross-province and time series data for the following: fixed asset (*FA*) as the sum of original book values in purchase year prices; net fixed asset (*NFA*) as the difference between *FA* and *DEP*.

To obtain real capital, we first compute investment (*I*) in current prices by

$$I(t) = FA(t) - FA(t-1) . \qquad (2)$$

Then, real capital is deflated *NFA* (*nfa*) given by the recursive formula:

$$nfa(t) = nfa(t-1) + I(t)/P_K(t) - \text{depreciation}, \qquad (3)$$

where P_K is the nationwide capital price index which we compute as a weighted average of the price indexes for both the machinery and building materials industries. The weights are set at 38:62, respectively, which are the average shares of investment in equipment and non-residential construction for 1978-1985 based on Chen *et al*. (1988, Table A1).[8] The output price index ($P(t)$), the material price index ($P_m(t)$), and the capital price index ($P_k(t)$) are as listed in Tables 4A, 4B, and 4C. Data for net real output (Q), labor (L), and real capital (K) are summarized in Table 5.

2. The Model

The estimation model is a variation of Cornwell, Schmidt and Sickles (1990), which deals with the problem of time-varying technical inefficiency measurement with panel data.

6. Depreciation is in book values.

7. For detailed Chinese input and output data problems, see Chen *et al*. (1988). For labor and capital data problems in developing countries, see Leamer (1984).

8. Chen *et al*. (1988) also shows that this ratio is close to a constant.

Table 4A Province-wide Output Price Index: 1986=100

Province	Year				
	1987	1988	1989	1990	1991
Beijing	108.53114	125.46258	150.07332	155.72229	163.50506
Tianjin	107.99333	124.86183	149.12481	155.39955	163.81841
Hebei	107.6478	123.96661	146.96987	153.54047	163.67277
Shanxi	106.53929	121.2443	142.30854	149.40551	161.71283
Inner Mongolia	109.76119	126.0304	148.42965	154.14722	164.38777
Liaoning	107.26212	122.6451	145.42922	152.29491	163.57
Jilin	109.58369	126.28103	149.59374	153.99989	161.88204
Heilongjiang	109.43915	123.88916	143.48784	148.68297	160.77158
Shanghai	107.94105	125.20471	150.37597	157.04683	165.20045
Jiangsu	107.99534	125.66042	150.71187	156.64095	163.86401
Zhejiang	108.38446	126.21415	151.04439	156.89081	163.99926
Anhui	108.15129	124.94427	147.87423	153.38427	162.44473
Fujian	110.34862	127.94071	151.55255	155.66065	162.29378
Jiangxi	108.83756	125.39063	148.97508	154.95186	164.59624
Shandong	107.80397	124.21437	146.77091	152.84486	162.33067
Henan	107.55694	123.86511	146.52116	152.46256	161.82024
Hubei	107.90813	124.70233	148.68489	155.35229	164.84639
Hunan	108.12636	124.61173	147.95757	153.48929	162.44307
Guangdong	108.34266	124.3966	147.56064	152.84983	160.73383
Guangxi	108.7889	125.8193	149.0187	153.79415	161.15734
Sichuan	108.15102	124.71249	148.11565	153.55037	162.03547
Guizhou	107.53986	122.99677	145.19246	150.67897	159.99119
Yunan	108.70782	125.36579	147.81973	153.37185	162.84468
Shaanxi	107.37165	123.5755	147.69789	153.4633	161.04448
Gansu	107.22737	121.49786	142.23235	149.46023	162.92399
Qinghai	107.68203	123.21613	145.75022	151.72455	161.59329
Ningxia	107.06747	121.85981	143.20405	149.21651	159.93077
Xinjiang	107.23757	122.3634	142.2143	148.95898	161.85659
Whole country	108.10025	124.65013	148.09796	154.07203	163.06846

Source: State Statistical Bureau, *China Price Statistical Yearbook*, 1990-92; State Statistical Bureau, *China Industrial Economy Statistical Yearbook*, 1988-92.

Note: The output price index for each province is the weighted average of the producer sale price indexes of 14 industrial sectors where weights are sectoral shares in the province.

Table 4B Material Price Index: 1986=100

Year	1987	1988	1989	1990	1991
Material Price Index	111	133.42	168.65	178.09	194.30

Source: State Statistical Bureau, *China Price Statistical Yearbook*, 1990-92.

Table 4C Capital Price Index[a]

Year	Machinery Price Index	Building Materials Price Index	Capital Cost Index
86	100.00	100.00	100.00
87	104.90	105.60	105.33
88	117.28	119.75	118.81
89	142.14	148.01	145.78
90	146.12	147.42	146.93
91	150.21	156.41	154.06

Source: State Statistical Bureau, *China Price Statistical Yearbook*, 1990-92.

[a]Capital Cost Index = (38*Machinery Price Index + 62*Building Materials Price Index)/100.

Table 5 Summary Statistics: Provincial Means of Variables[a]

	Net Real Output (Q)	Labor (L)	Real Capital (K)
1986	1063.62 (753.27)	2539.52 (1661.42)	1933.53 (1078.59)
1987	1205.31 (852.94)	2600.48 (1706.91)	2223.83 (1263.25)
1988	1384.39 (952.99)	2679.45 (1766.02)	2508.56 (1459.74)
1989	1490.34 (1025.11)	2689.09 (1738.46)	2778.22 (1646.34)
1990	1506.43 (1032.07)	2731.18 (1750.77)	3038.42 (1851.44)
1991	1751.45 (1297.50)	2830.96 (1846.25)	3440.94 (2220.89)

Source: State Statistical Bureau, *China Industrial Economy Statistical Yearbook*, 1988-92; State Statistical Bureau, *China Price Statistical Yearbook*, 1990-92.

[a] Numbers in parentheses are standard deviations. Means and standard deviations are across n=28 provinces. Labor is in ten thousand people. The price indexes with the base year of 1986 were used to have Net Real Output and Real Capital in ten million 1986 constant yuan.

We assume a fixed individual effect and a Cobb-Douglas production function to obtain the following fixed effect model of provincial output:[9]

$$Y_{jit} = \acute{a}_{jt} + X_{jit}\,ß + \mathring{a}_{jit} \quad (j=1,...J\,;\, i_j=1,...,N_j\,;\, t=1,...,T), \tag{4}$$

where j, i, and t are indices for regions, provinces, and time periods, respectively. Here, Y is log of the net output value (lnQ), and X denotes a vector of log labor (lnL) and log capital (lnK). $\acute{a}_{jt} = \acute{a} - U_{jt}$, and represents the individual effect for each j. Statistical noise $\mathring{a}$ is assumed independently and identically distributed with mean 0 and variance $ó^2$. $U \geq 0$

9. The random effect model estimates have produced essentially the same results which are available upon request from the authors.

represents technical inefficiency.

A special feature of the model is that the intercept terms $á_{jt}$ vary over time as well as over regions. We specify $á_{jt}$ by a flexibly parameterized function of time:

$$á_{jt} = á_{1j} + á_{2j}t + á_{3j}t^2 \qquad (5)$$

so that (4) can be written as

$$ln\ Q_{jit} = á_{1j} + á_{2j}t + á_{3j}t^2 + ß_1\ ln\ L_{jit} + ß_2\ ln\ K_{jit}\ .^{10} \qquad (6)$$

Regional productivity levels in terms of total factor productivity are given by $á_{jt}$. Comparison of $á_{jt}$ across regions, given t, provides regional differentials in productivity. The changing pattern of regional productivity differentials can then be measured by changing the time period. If a convergence in (total factor) productivity does happen, the differences in the $á_{jt}$ term across regions should decline over time. Thus, the estimates of $á_{jt}$ enable an empirical test of convergence of regional productivity differentials over the post reform era.[11]

Regarding the functional form of $á_{jt}$, we test two hypotheses. The first hypothesis is $á_{3j}=0$ for all j (referred to as H_L later) which means a linear form rather than a quadratic form. The second one is $á_{2j}=á_{3j}=0$ for all j (referred to as H_C later), which implies that productivity and relative efficiency levels do not change over time. Therefore, we need to estimate three fixed effect specifications.

IV. Estimated Results

The estimated results of the fixed effect models are in Table 6. The results of the hypothesis tests tell us first that we cannot reject H_L. Specifically, the observed value of the $F_{(4,154)}$ statistic testing H_L is 0.8492, while the critical value is 2.43 at a 5% significance level. H_C is rejected with the observed value of 2.0132 for $F_{(8,154)}$ statistic, while the critical value at a 5% significance level is 2.00. Maintaining H_L specifies

$$ln\ Q_{jit} = á_{1j} + á_{2j}t + ß_1\ ln\ L_{jit} + ß_2\ ln\ K_{jit} \quad (j=1,...J;\ i_j=1,...,N_j;\ t=1,...,T). \qquad (7)$$

Thus, the estimated model (7), as given by the Model 2 column of Table 6, is used to obtain the estimates of the productivity differentials $\exp(á_{jt})$ across region j and time t. According to

10. The Translog production function has also been estimated but most of its second order coefficient estimates turn out statistically insignificant.

11. An alternative Cobb-Douglas model to estimate convergence is using as a direct measure of total factor productivity a weighted average of capital and labor productivity, weights being the factor shares. See Bernard and Jones (1996). The direct total factor productivity approach, however, requires perfect competition and constant returns to scale. Perfect competition may not yet be a tenable description of Chinese economy even under market socialism reforms. The constant returns to scale assumption in our model is rejected as shown in Table 6.

the estimated $\exp(\acute{a}_{jt})$ in Table 7, Region 1 is the most productive region, and Region 2 is the second most productive. It is clear that these coastal regions continue to show higher productivity than the other two regions in the sample period. Region 4 starts with the lowest productivity level but it surpasses Region 3 in later years.

Table 6 Estimated Fixed Effect Model[a]

Parameter	Model 1	Model 2	Model 3
β_1	0.5254(8.480)	0.5170(8.393)	0.4152(8.274)
β_2	0.5332(7.879)	0.5430(8.074)	0.6661(12.933)
α_{11}	−0.8521(−3.850)	−0.8702(−4.564)	−1.0769(−5.897)
α_{12}	−1.1835(−5.810)	−1.1589(−6.392)	−1.1717(−6.459)
α_{13}	−1.4372(−7.392)	−1.3477(−7.435)	−1.4446(−7.995)
α_{14}	−1.4914(−8.359)	−1.4055(−8.707)	−1.4583(−9.316)
α_{21}	−0.0120(−0.138)	−0.0066(−0.350)	
α_{22}	0.0638(0.891)	0.0398(2.378)	
α_{23}	0.0926(1.671)	0.0184(1.492)	
α_{24}	0.1093(1.760)	0.0364(2.726)	
α_{31}	0.0009(0.075)		
α_{32}	−0.0033(−0.329)		
α_{33}	−0.0105(−1.364)		
α_{34}	−0.0103(−1.197)		
$\beta_1 + \beta_2$	1.0586(2.524)[b]	1.060(2.594)[b]	1.0813(3.691)[b]
Adjusted R^2	0.9995	0.9996	0.9995
Sample Size	168	168	168

[a]Parenthesized figures are *t*-values unadjusted for heteroscedasticity. White's heteroscedasticity consistent covariance estimates were used for adjusted *t*-values which turned out similar to the reported unadjusted *t*-values.

[b]Parenthesized figures for scale coefficients ($\hat{a}_1 + \hat{a}_2$) are estimated *t* statistics with the null hypothesis (H_0: $\hat{a}_1 + \hat{a}_2 = 1$) being constant returns to scale. The large positive *t*-values show that in all three models the constant returns to scale hypothesis (H_0) is rejected in favor of increasing returns to scale.

Table 7 Regional Productivity Levels over the Sample Period (measured by $\exp(\acute{a}_{jt}) = \exp(\acute{a}_{1j} + \acute{a}_{2j}t)$)

Year	Region 1	Region 2	Region 3	Region 4	St. Dev.[a]	Coef. of Var.[b]
1986	0.4161	0.3266	0.2647	0.2543	0.0743	0.2356
1987	0.4134	0.3398	0.2696	0.2638	0.0702	0.2184
1988	0.4107	0.3536	0.2746	0.2735	0.0666	0.2031
1989	0.4080	0.3680	0.2797	0.2837	0.0635	0.1897
1990	0.4053	0.3829	0.2849	0.2942	0.0612	0.1789
1991	0.4026	0.3985	0.2902	0.3051	0.0597	0.1711

[a]Four region standard deviation measured in %.

[b]Coefficient of variation is the standard deviation divided by the four region mean.

Although Region 1 is the most productive throughout the sample period, its productivity has declined slightly during the period, while all other regions show increasing productivity. The declining productivity is due to the negative estimate of $\acute{a}_{21}$ coefficient of -0.0066 (see Table 6). Although the estimate is statistically insignificant, non-increasing productivity of Region 1 seems unsettling and requires explanation. One factor behind the declining productivity estimate of Region 1 is that our sample period of 1986-1991 overlaps a downturn in Chinese macroeconomic cycles. According to a post-1950's business cycle study of China by Imai (1996), the eighth cycle of 1982-89 exhibits an upswing in 1982-88 and a downturn in 1989, before the upswing of the ninth cycle begins in 1990.[12] Thus, our estimates of absolute productivity levels among regions tend to be lower than with the trend. But comparisons of regional productivity differentials based on these estimates are still valid to the extent that the macroeconomic cycles affect regions more or less equally. Another factor resulting in the declining productivity of Region 1 relates to the particular nature of economic reform in China that the market mechanism is introduced but not completely. The reform may require many inefficient enterprises to be closed, but they survive under continuing government supports. Enterprises could not lay off employees as market forces dictate. This problem is especially serious in such areas as Region 1, where state-owned and large- and middle-sized enterprises dominate, and where old industrial bases are well established. Consequently, the slightly declining productivity estimate of Region 1 can be justified.

For relative differentials in the regional productivity levels, Table 8 and Figure 1 provide for each region and each year the estimated regional productivity level as a proportion of that of the most productive region. The table shows that productivity differentials have narrowed between the most developed and industrialized region (Region 1) and all other regions. Over the sampled six year period, Region 2 has moved the fastest to catch up with Region 1 in productivity, from 78.8% of Region 1 productivity in 1986 to 99.0%, virtual equality, in 1991. This spectacular growth performance of Region 2, which confirms the Coastal-led development, does not occur at the sacrifice of the growth of the interior regions. For both Region 3 and Region 4 narrow their productivity gaps with the most productive Region 1 over time. Region 4 has improved its productivity as a proportion of that of Region 1 significantly from 61.1% in 1986 to 75.8% in 1991, surpassing the level of Region 3 after 1988. The catch-up rate of Region 3 is slower; nevertheless, its relative productivity improves from 63.6% of that of Region 1 to 72.1% over the period.

The annual dispersion measures of regional productivity levels also indicate shrinking regional differentials. Table 7 shows that the standard deviation of regional productivity levels falls from 0.0743 in 1986 to 0.0597 in 1991. The coefficient of variation gives a similar result: a decrease from 0.2356 to 0.1711 over the period.

If we extrapolate our estimates of regional growth trends directly into the future, a concern arises that Region 2 would increase its productivity gap with all other regions, overshooting Region 1. This would worsen the regional disparity in productivity in the future. To a large extent, however, the growth of Region 2 is due to high investment and special

12. For Chinese business cycles, see also Naughton (1987; 1995).

incentives the government granted this region in order to encourage foreign capital in the initial stage of the coastal development. Hence, over time, this initial advantage of the region may subside, moderating regional disparity. Anyway, predicting the future disparity in regional productivity differentials is a risky task. What our empirical findings up to the end of the sample period demonstrate is an evidence of productivity convergence across regions. That is, total factor productivity differentials have narrowed across regions in China over the reform period.

Table 8 Relative Regional Productivity Levels over the Sample Period (measured by $\exp(\acute{a}_{jt}) / \exp(\max_j \acute{a}_{jt})$)

Year	Region 1	Region 2	Region 3	Region 4
1986	100%	78.5%	63.6%	61.1%
1987	100	82.2	65.2	63.8
1988	100	86.1	66.9	66.6
1989	100	90.2	68.6	69.5
1990	100	94.5	70.3	72.6
1991	100	99.0	72.1	75.8

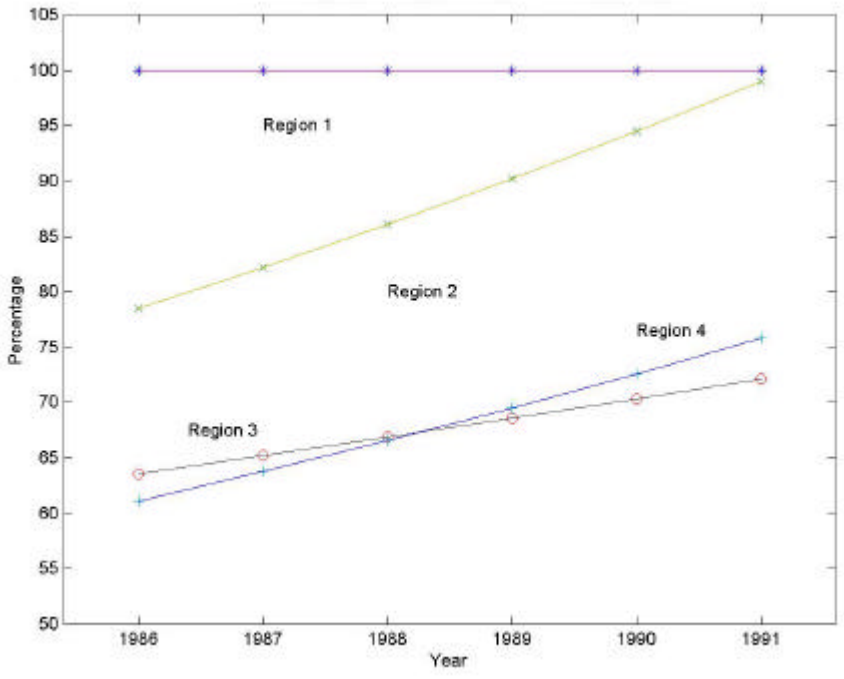

Figure 1 Relative Regional Productivity Levels over Time

V. Conclusion

This study examines the pattern of changes in regional differentials in total factor productivity in Chinese manufacturing and attempts to determine whether China's economic reform introducing market mechanism into the economy, via decentralization-regional specialization according to comparative advantage and freer regional-international trade amidst the Coastal-led development, has worsened the gap between developed and less developed regions. Comparing estimated total factor productivity levels among four regions for the years since the industrial reform began, we do not observe worsening of regional disparity. Rather, we find a convergence pattern. Over the post reform period, regional productivity differentials of Chinese industry have shrunk. That is, economic reform, by introducing the market mechanism, has reduced regional disparity in manufacturing productivity. This finding alleviates the concern that market reform in China worsens regional disparity, at least in manufacturing productivity over the sampled post reform period.

References

Abramovitz, M. (1986), "Catching up, Forging ahead, and Falling behind," *Journal of Economic History*, 46, June, 385-406.

Baumol, W.J. (1988), "Productivity Growth, Convergence, and Welfare: What the Long-run Data Show," *American Economic Review*, 78, 1155-59.

Bernard, A.B., and C.I. Jones (1996), "Productivity across Industries and Countries: Time Series Theory and Evidence," *Review of Economics and Statistics*, 78, 135-146.

Cannon, T., and A. Jenkins (1990)(ed.), *The Geography of Contemporary China: The Impact of Deng Xiaoping's Decade*, London: Routledge.

Chen, K., G.H. Jefferson, T.G. Rawski, H.C. Wang, and Y. Zheng (1988), "New Estimates of Fixed Capital Stock for Chinese State Industry," *China Quarterly*, 114, June, 243-266.

Chinese Communist Party, Central Committee (1984), "Decision of the Central Committee of the Communist Party of China on Reform of the Economic Structure," (October 20, 1984), *Beijing Review*, October 29, I-XVI.

Cornwell, C., P. Schimidt, and R. Sickle (1990), "Production Frontiers with Cross-sectional and Time-series Variation in Efficiency Levels," *Journal of Econometrics*, 46, 185-200.

Dollar, D. (1990), "Economic Reform and Allocative Efficiency in China's State-owned Industry," *Economic Development and Cultural Change*, 39, No. 1, 89-107.

Imai, H. (1996), "Explaining China's Business Cycles," *The Developing Economies*, XXXIV-2, 154-185

Jackson, S. (1992), *Chinese Enterprise Management Reforms in Economic Perspective*, New York: Walter de Gruyter.

Jefferson, G.H., T.G. Rawski, and Y. Zheng (1992), "Growth, Efficiency, and Convergence in China's State and Collective Industry," *Economic Development and Cultural Change*, 40, No. 2, 239-266.

Jefferson, G.H., and W. Xu (1991), "The Impact of Reform on Socialist Enterprises in Transition: Structure, Conduct and Performance in Chinese Industry," *Journal of Comparative Economics*, 15, 45-64.

_____ (1994), "Assessing Gains in Efficient Production among China's Industrial Enterprises," *Economic Development and Cultural Change*, 42, No. 3, 597-615.

Jian, T., J.D. Sachs, and A.M. Warner (1996), "Trends in Regional Inequality in China," *China Economic Review*, 7, No. 1, 1-21.

Leamer, E. (1984), *Sources of International Comparative Advantage*, MIT.

Liu, B. (1994), *Changes in Regional Differentials of Industrial Productivity in China: 1986-1991*, Doctoral Dissertation, State University of New York- Binghamton.

Lin, J.Y. (1992), "Rural Reforms and Agricultural Growth in China," *American Economic Review*, March, 34-51.

Lyons, T.P., and V. Nee (1994)(eds.), *The Economic Transformation of South China*, Ithaca, NY: Cornell East Asia Program.

Naughton, B. (1987), "Macroeconomic Policy and Response in the Chinese Economy: The Impact of the Reform Process," *Journal of Comparative Economics*, 11, 3, 334-353.

_____ (1995), "China's Macroeconomy in Transition," *The China Quarterly*, 1083-1104.

Perkins, D.H. (1988), "Reforming China's Economic System," *Journal of Economic Literature*, 78, June, 601-45.

State Statistical Bureau (1988-1992), *China Industrial Economy Statistical Yearbook* (in Chinese), Beijing: China Statistical Press.

_____ (1990-1992), *China Price Statistical Yearbook* (in Chinese), Beijing: China Statistical Press.

_____ (1987-1992), *China Statistical Yearbook* (in Chinese), Beijing: China Statistical Press.

World Bank (1990), *China: Macroeconomic Stability and Industrial Growth under Decentralized Socialism*, Washington: World Bank.

Yang, D. (1990), "Patterns of China's Regional Development Strategy," *China Quarterly*, 22, June, 230-257.