



Disparity in factor contributions between coastal and inner provinces in post-reform China

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Abstract

The paper discusses China's post-reform regional economic growth imbalance relative to input disparity in technology, physical and human capital. Financial sources and types of ownership are used to construct physical capital. Technology is measured by innovation investment, and human capital is constructed from schooling years per capita. The results show that domestic bank loans and foreign-owned enterprises are important in coastal provinces, while state appropriation and state-owned enterprises are important in inner provinces. Technology and foreign investment have a larger impact on output growth in coastal provinces. Human capital is endogenous for coastal provinces, but is exogenous for inner provinces.

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1. Introduction

China since 1978 has adopted a market-oriented economic reform policy of liberalization, pragmatization, marketization and corporatization (Li, 1997; Perkins, 1988, 1994). Real annual economic growth has averaged at about 8% in China, and productivity has remained at about 3% (Borensztein & Ostry, 1996; Chow & Li, 2002). Various economic reforms have taken place, beginning with the agricultural reform embodied in the family responsibility system in 1979, the major reforms in the 1980s included industrial reform, revitalization of national banks, price reform and fiscal reform. Economic overheating in the form of supply bottlenecks and high inflation was common in the late 1980s (Li, 1994). Financial reform began with the 1993 Austerity Plan that redirected investment to western provinces. The 1995 banking reform

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restructured the banking sector, while the 1997 state-owned enterprises reform aimed to reduce state intervention in production. Between reforms in the 1980s and the 1990s, Li (2001) argued while the reinstatement of economics has been the key to the economic reforms in the 1980s, economic efficiency is the theme of various economic reforms in 1990s.

Recent studies (Cai, Wang, & Du, 2002; Chang, 2002; Chen & Fleisher, 1996; Fleisher & Chen, 1997; Yang, 2002) show that there is growing regional imbalance. For example, Bhalla, Yao, and Zhang (2003) found that inter-regional inequality is more serious than the rural–urban inequality. Yao and Zhang (2001) identified openness and transportation to be the two important factors in regional imbalance. Lin, Wang, and Zao (2004, p. 594) examined regional inequality in relation to labor migration across provinces, and showed that regional inequality has widened significantly between 1985 and 2000 from a coastal–inland income ratio of 1.31 to 1.65, while the urban–rural income ratio for the same period has risen from 1.82 to 2.42. Increase in inter-provincial migration from a total of 11.83 million in 1985–1990 to 27.53 million in 1995–2000 was responsible for the growing regional inequality. In the pre-reform years in China, school leavers and university graduates were assigned to a job in a particular region and affiliated to a particular institution. Job mobility has increased since economic reform, and inner regions face a “brain drain” problem (Xu, 2002). These changes in the labor market can cause imbalance in provincial growth. Other studies (Hauser & Xie, 2004; Wan, 2004; Yao, Zhang, & Feng, 2005) examined regional imbalances from the output end that contrasted differences in income and consumption.

Regional divisions in China can be made using different criteria. A broad geographical regional grouping is the division between coastal and non-coastal (inner) provinces. The 11 coastal provinces are Beijing, Tianjin, Hebei, Liaoning, Jiangsu, Zhejiang, Shandong, Guangdong, Hainan, Shanghai and Fujian, while the 19 non-coastal (inner) provinces are Shanxi, Mongolia, Jilin, Heilongjiang, Anhui, Jiangxi, Henan, Hubei, Hunan, Guizhou, Yunnan, Shaanxi, Gansu, Qinghai, Ningxia, Xinjiang, Guangxi, Sichuan and Tibet. The divergence ratio of real GDP in constant 1978 price between the 11 coastal and 19 inner provinces was 1.1296 in 1985, increased to 1.4139 in 1993 and to 1.4925 in 1997 before it level off to 1.3463 in 1998 (Statistical Yearbook of China (SYC), 1995).

Imbalance in regional income can be due to imbalance in factor inputs. Economic growth theories provide a framework to study the productivity and performance of factor inputs. The neoclassical economic growth theory proposes, in addition to capital and labor as the two basic factor inputs, that technology improvement, which has often been incorporated in total factor productivity, is necessary for economic growth (Solow, 1956; Swan, 1956). The neoclassical school has argued that factor inputs are exogenously determined. On the contrary, the “new growth theory” (Aghion & Howitt, 1998; Jones, 2002) argued that input factors are endogenously determined. For example, technology and human capital have been considered as endogenous inputs in Romer (1990) and Mankiw, Romer, and Weil (1992). Srinivasan (1999) argues that the endogenous factors in growth can be included by amending the Cobb Douglas production function. In China and in addition to the large migration of educated workers to the coastal regions after reform, both expenditure on technology and education are largely state-driven.

Growth divergence between coastal provinces and inner provinces in China can be associated with the type and performance of factor inputs, as seen from the disparity in different investment resources and human capital. All investment activities were state-owned before economic reform in 1978, but data on different types of financial sources and different forms of enterprises have emerged since 1978. Based on their originality, investments in fixed assets in China are divided into state appropriation, national bank loans, utilized foreign direct investment, self-raised funds

and others. Based on their usage destination, investments in fixed assets are classified under state ownership, non-state ownership and foreign ownership. Coastal provinces have the geographical advantage and will attract more productive financial resources than inner provinces. Individual-owned enterprises equally will prevail more in coastal provinces than in inner provinces.

This paper examines the impact of production inputs on coastal and inner provinces in post-reform China, and hypothesizes that difference in the use of financial resources, forms of enterprises and the level of provincial human capital cause imbalance in growth between coastal and inner provinces. The differences in economic outcomes between coastal and inner provinces reflect differences in the investment opportunities and the availability of physical capital, technology, and human capital inputs. Data on investment, together with labor and education, are used to construct three sets of factor inputs: physical capital, technology, and human capital. Data has been a problem in China (Holz, 2004a, 2004b; International Herald Tribune, 2003; Rawski & Xiao, 2001; Young, 2000, 2003).¹ Chow and Li (2002) argued that faults in macroeconomic data will cancel out each other and discrete data problem may not impose much distortion on trend analysis. Various data sources are used to derive the provincial information about output and capital inputs.²

Section 2 discusses the performance of three capital inputs and the national and provincial investment resources in the post-reform period. Section 3 outlines the methodology used for the empirical testing and Section 4 reports and discusses the estimates. The last section concludes the paper.

2. Physical capital, technology, and human capital

National income or industry sector output has previously been used to construct China's physical capital stock (Jefferson, Rawski, & Zheng, 1996; Wu, 1995; Yeh, 1984a, 1984b). China's capital stock in year i , K_i , is constructed using Eq. (1) that shows current capital stock is related to current real net investment, RNI_i , which is defined in Eq. (2) as a proportion of real gross investment, RGI_i , with the factor of proportionality being the ratio of net investment, NI_i , to nominal investment, GI_i (Statistical Yearbook of China, 1999, p. 67).

$$K_i = K_{i-1} + RNI_i. \quad (1)$$

$$RNI_i = RGI_i(NI_i/GI_i). \quad (2)$$

GI_i can then be estimated from the national income identity, $GDP_i - C_i - NX_i$, where C_i denotes year i consumption and NX_i is net export of goods and services.

Both Chow and Li (2002) and Li (2003) employed the initial capital stock in Chow (1993) of 2212.99 (100 million yuan, and hereafter) at the end of 1952, because the construction of that series was also based on net investment for the whole economy. The "accumulation" data in official statistics were assumed in real terms, and were used as real net investment for the period 1953–1978

¹ In addressing the data problem, for example, Young (2000, 2003) revised China's growth and productivity downwards by constructing a set of proxy data, which indirectly relied on official sources. While most reports showed that China's GDP has been over-estimated, recent report shows that China's GDP has been understated (*South China Morning Post*, December 13, 2005).

² Data used in this paper are available from the corresponding author's website at: <http://fbstaff.cityu.edu.hk/efkwli/ChinaData.html>.

(Statistical Yearbook of China, 1994, p. 41). By using these “accumulation” data, a capital-stock series up to 1978 can be constructed, with a value of capital stock of 14,111.99 at the end of 1978.

With reform in 1978, the prices of investment goods were assumed to have changed. Beginning from 1994, official Chinese national income statistics changed from the former “national income available” (consumption + accumulation) to the Gross Domestic Product (GDP = final consumption expenditure + gross capital formation + net export of goods and services). The GDP included some previously excluded service items. Real GDP is derived proportionally from the index of real GDP (Statistical Yearbook of China, 1999, p. 58) converted to 1978 prices using the 1978 nominal GDP (Statistical Yearbook of China, 1999, p. 55). The nominal-to-real GDP ratio gives the annual implicit price deflator, which is used to deflate the net exports of goods and services (Statistical Yearbook of China, 1999, p. 67) to obtain the real value of net exports. Real consumption is nominal consumption deflated by the consumption price index (Statistical Yearbook of China, 1999, pp. 67 and 72). Finally, real gross investment (RGI) is obtained by subtracting real consumption and real net exports of goods and services from the official real GDP figures in 1978 prices.

Depreciation figures of individual provinces are available for 1993 (Statistical Yearbook of China, 1995, p. 41), 1994 (Statistical Yearbook of China, 1996, p. 51), 1996, 1997 and 1998 (Statistical Yearbook of China, 1997, p. 51, 1998, p. 66 and 1999, p. 66). Summing up the depreciation figures from all provinces for 1993, 1994, 1996 to 1998 and estimating a figure for 1995 by averaging the 1994 and 1996 figures gives a national depreciation rate (Dep), which is then used to calculate the net investment by the following equation, where $i=1993, \dots, 1998$:

$$NI_i = GI_i - Dep_i. \quad (3)$$

With these NI_i values, the capital stock for the period from 1993 through 1998 can be derived from Eq. (1). One needs to find the depreciation rates for the period 1979 to 1992 because a capital stock for 1992 is needed for the 1993–1998 series. We apply a tentative rate of depreciation equal to 4% (0.96) to generate a temporary capital-stock series, say K_{i-1}^* for the period 1979–1992, and when $i=1979$, the K_{i-1}^* is 14,111.99.

$$K_i^* = 0.96 K_{i-1}^* + RGI_i. \quad (4)$$

The $K_{i=1992}^*$ is used as input to Eq. (1) to generate a temporary capital-stock series for the period 1993–1998. In turn, this temporary capital stock series is used to work out an implied depreciation rate, d , from the following equation, with $i=1993, \dots, 1998$:

$$1 - d_i = (K_i - RGI_i)/K_{i-1}. \quad (5)$$

This yields implied depreciation coefficients of 0.9549, 0.9520, 0.9492, 0.9450, 0.9394 and 0.9358, for the six successive years. The mean depreciation rate of 0.946 is used to construct the capital-stock series for the period 1979 to 1992 from the following equation:

$$K_i = 0.946 K_{i-1} + RGI_i. \quad (6)$$

The revised capital stock of 1992 generated from Eq. (6) is used to work out the final capital-stock series from Eq. (1) for the period 1993–1998. These steps helped to derive the capital stock for the 1952–1978, 1979–1992, and 1993–1998 periods. With a national capital stock value of 14,111.993 (Rmb 100 million) in 1978, China’s national capital stock has increased five-fold to 87,764.476 (Rmb 100 million) in the two decades of 1978 and 1998. In the contrast between

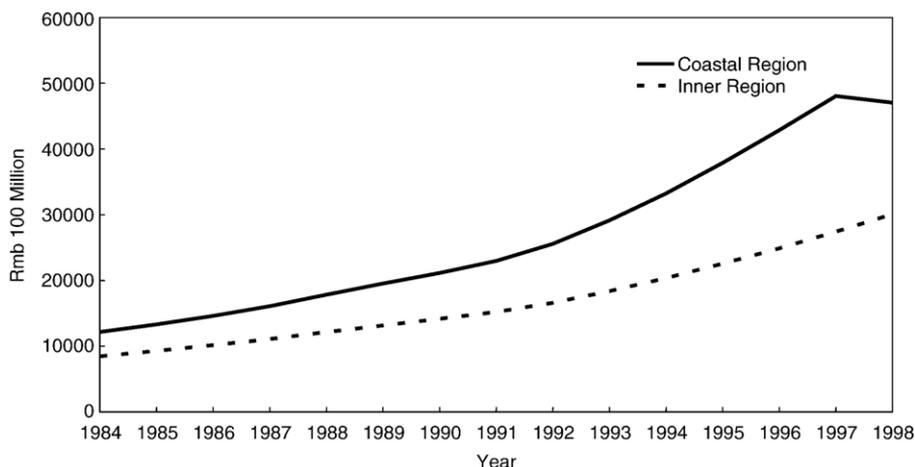


Fig. 1. Physical capital stock of coastal and inner provinces.

coastal and inner provinces as shown in Fig. 1, coastal provinces have a higher level of capital stock than inner provinces, and the gap has widened since the late 1980s.³

In the SYC, total investment in fixed assets (TIFA) is divided into different financial sources. Since 1981, the four sources of total investment in fixed assets (TIFA) are state appropriation (SA), domestic bank loans (DL), foreign direct investment (FI), and self-raised funds and others (SRF) (Statistical Yearbook of China, 1999 Table 6.3). By definition (Statistical Yearbook of China, 1995, p. 193), state appropriation are mainly state construction and infrastructure projects, though many state appropriations are given to industries. Domestic national bank loans are funds borrowed by enterprises and institutions from domestic bank and non-bank financial institutions, and include various types of loans issues by banks. Bank loans are given mainly to state-owned enterprises for production purposes, though the high level of non-performing loans resulted in a considerable amount of bad debt among national banks. Foreign direct investment refers to foreign funds in fixed assets, foreign funds borrowed and managed by government and by individual units, and foreign funds in joint ventures. Self-raised funds are institutional and local government funds given to enterprises for fixed-asset investment. These include bonds issued by individual enterprise and funds channeled through local governments. All other fixed-asset investments, such as funds supplied by overseas Chinese are included under self-raised funds.

Columns 1–5 in Table 1 show the percentage shares of TIFA to real GDP and the shares of four financial sources components in TIFA. State appropriation declined drastically, as its percentage share dropped by about 10-fold from 28.1% in 1981 to 2.8% in 1997. A considerable amount of state funding, however, was deployed via others channels of domestic bank loans and local government in the form of self-raised funds. The share of domestic bank loans, for example, increased from 12.7% of TIFA in 1981 to a peak of 27.4% in 1992. Self-raised funds and others remained the largest source of investment funds, and most of which came from local government sources. Despite much discussion on foreign investment in China, its share in total fixed asset investment was initially small (3.8% in 1981), but increased rapidly to 11.8% in 1996. This

³ The larger coastal provinces are Shandong, Guangdong and Shanghai, but over the years, Liaoning, Jiangsu and Zhejiang have caught up considerably. The capital stock of inner provinces is much lower, and the two inner provinces with higher capital stock are Henan and Hubei.

Table 1
Percentage shares of financial resources

Year	TIFA % of GDP	Sources of funds (% of TIFA)				Ownership of funds (% of TIFA)				Inno % of GDP
		SA	DL	SRF	FI	SO	CO	IO	FO	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
1981	22.9	28.1	12.7	55.5	3.8					
1982	27.6	22.7	14.3	58.1	4.9	68.7	14.2	17.1		12.1
1983	29.8	23.8	12.3	59.3	4.7	66.6	10.9	22.5		9.5
1984	32.1	23.0	14.1	59.1	3.9	64.7	13.0	22.3		12.4
1985	33.8	16.0	20.1	60.3	3.6	66.1	12.9	21.0		11.4
1986	37.5	14.6	21.1	59.9	4.4	66.6	12.6	20.8		10.2
1987	40.7	13.1	23.0	59.1	4.8	64.6	14.4	21.0		10.7
1988	41.8	9.3	21.0	63.8	5.9	63.5	15.0	21.5		11.3
1989	37.0	8.3	17.3	67.8	6.6	63.7	12.9	23.4		2.9
1990	33.7	8.7	19.6	65.4	6.3	66.1	11.7	22.2		5.3
1991	35.9	6.8	23.5	64.0	5.7	66.4	12.5	21.1		8.8
1992	41.9	4.3	27.4	62.5	5.8	68.1	16.8	15.1		12.7
1993	49.3	3.7	23.5	65.5	7.3	60.6	17.7	11.3	8.3	16.4
1994	52.4	3.0	22.4	64.7	9.9	56.4	16.2	11.6	14.1	12.9
1995	49.5	3.0	20.5	65.3	11.2	54.4	16.4	12.8	16.4	10.7
1996	50.0	2.7	19.6	66.0	11.8	52.5	15.9	14.0	17.7	10.2
1997	51.1	2.8	18.9	67.7	10.6	52.5	15.4	13.8	18.3	8.7
1998	55.1	4.2	19.3	67.4	9.1	54.1	14.8	13.2	18.0	7.8

TIFA=real total investment in fixed assets; SA=state appropriation; DL=domestic loans; SRF=self-raised funds and others; FI=foreign direct investment; SO=state-owned; CO=collective-owned; IO=individual owned; FO=foreign owned (composed of joint ownership, share holding, foreign fund and funds from Hong Kong, Macau, Taiwan and other economic units); and Inno=investment in innovation.

Source: *Statistical Yearbook of China (1999)*; *Comprehensive Statistical Data and Materials on 50 Years of New China*; *Statistics on Investment in Fixed Assets of China (1950–2000)*.

percentage share is expected to increase in China's post-WTO accession period.⁴ Overseas Chinese form a significant source of funding, particularly along the coastal regions.⁵

The alternative classification of investment since 1981 is the ownership of funds. Although there can be overlapping between the two classifications, their usage can provide additional information on how the institutional setup and ownership in China can influence the output elasticity of capital. State ownership (SO) consists of investment by state enterprises and is divided into capital construction, technical upgrading and transformation, other investment in fixed assets and development in real estate. Collective ownership (CO) includes investment in township and village enterprises by urban and rural collective units. Investment by individual units (IO) contains investment of residential building in cities, county towns and industrial and mining areas, and investment in rural residential building and in productive fixed assets. Since 1993, foreign ownership (FO) has a separate category that includes joint ownership, shareholding, foreign funds and funds from Hong Kong, Macau and Taiwan and other economic units.⁶

⁴ Expected rise in foreign investment in telecommunication, finance and insurance (Dees, 1998).

⁵ Overseas Chinese from Hong Kong, Macau and Taiwan funded economic units, for example, occupied about 2.6% of total investment in fixed assets, but it increased by 88.8% between 1993 and 1994 (*Statistical Yearbook of China, 1995*, p. 137).

⁶ The four items (JO, SH, FF and HMTO) produce a slightly larger percentage share than the foreign investment category under the sources of fund. This is due to the fact that the "Others" in the category of "Self-raised Funds and Others" include overseas Chinese investment that should belong to the foreign investment category.

Columns (6) to (9) in Table 1 give the percentage share of different ownership in TIFA. Over one half of total investment was still provided by state-owned enterprises in 1998, this produces a different picture from that of state appropriation in column (2), as the financial funds for state-owned enterprises are included either in national bank loans or in self-raised funds. Both the collective-owned and individual-owned enterprises remained steady over the two decades. The new classification of foreign ownership since 1993 reduced individual ownership considerably. By 1998, collective-owned and individual-owned enterprises together accounted for only 28% of total investment in fixed assets. The size of private investment is less than one third of total investment. Foreign ownership gradually increased since 1993, but the increase mainly came from shareholding and funds from Hong Kong, Macau, Taiwan and other economic units.

These figures can be utilized to construct the capital stock if a proper relation between the constructed net investment figures and “total investment in fixed assets” is established. Net investment occurs as a result of expenditures on “investment in fixed assets.” The connection between the two is imperfect for two reasons. First, capital stock includes both fixed assets and working capital, the latter being referred to as “circulation fund” in *SYC*. Thus data on investment in fixed assets are not inclusive enough, although they constitute a large fraction of the total that ranges between 60% and 85% (see Table 4 of Chow, 1993). Secondly, “investment in fixed assets” is always larger than the “newly increase in fixed assets” because of wastage or failure of some investment expenditures to result in an actual increase in the capital stock (see Chow, 1993, p 816, paragraph 3). Furthermore, “investment in fixed assets” refers to gross investment, but net investment is needed to construct a capital-stock series. As a result of these differences, “total investment in fixed assets” and aggregate net investment in China are different. In addition, land sales and second hand equipment transactions can lead to a reduction in the actual rate of usage of the capital stock.

To ensure comparability between national net investments and TIFA, real net investment (RNI_i) generated from Eq. (2) is regressed on real TIFA ($RTIFA_i$) for the period 1981–1998. The real TIFA is derived from deflating the gross TIFA by the investment index (nominal gross investment/real gross investment, with 1978=100). The estimated regressions are:

For sources of finance,

$$\ln \hat{RNI}_i = 0.2070 + 0.9481 \ln RTIFA_i, \quad (7)$$

(0.1981) (0.0238)

and for ownership,

$$\ln \hat{RNI}_i = -17.3985 + 0.9535 \ln RTIFA_i. \quad (8)$$

(0.6592) (0.0246)

The R^2 for Eqs. (7) and (8) are 0.9894 and 0.9901, respectively, confirming that net investment in constant prices can be estimated by using RTIFA. These regression estimates show that TIFA figures are reliable investment sources. Taking the anti-log of the predicted value of $\ln RNI$ gives a new series of net investment figures, say I_i^* , formed from the TIFA figures for the period $i=1981, \dots, 1998$. The new investment series, I_i^* , is then divided into four sources of finance ($n=1, 2, 3$ and 4) based on the real total investment in fixed assets ratio shown in Eq. (9).

$$RTIFA_{ni}/RTIFA_i. \quad (9)$$

A series of I_{ni}^* is then generated, with $n=SA, DL, FI, \text{ and } SRF$. Similarly, the initial capital stock for the four sources of finance is required. A constant ratio for the four individual sources is created from the following equation:⁷

$$\sum_{(1981-85)} RTIFA_n / \sum_{(1981-85)} RTIFA. \quad (10)$$

These ratios are used to divide the 1980 value of capital stock ($K_{1980}=15,735.359$) into four respective $K_n(1980)$. Thus, applying Eq. (11), which is similar to Eq. (1), a series of K_{ni} is derived from TIFA.

$$K_{ni} = K_{ni-1} + I_{ni}^*. \quad (11)$$

A similar procedure is applied to the ownership of funds, with I_{ni}^* being divided into three cases and seven cases of ownership for the period 1981–1992 and 1993–1998, respectively. Since 1993, foreign ownership is divided into joint ownership (JO), share holding (SH), foreign fund (FF) and funds from Hong Kong, Macau, Taiwan and other economic units (HMTO). The two 5 year period used for Eq. (10) are 1982–1986 and 1993–1997 for the two sub-periods 1982–1992 and 1993–1998, respectively. The attained ratios are used to divide the initial value of capital stock.⁸

Data are collected for 30 provinces. Gross provincial investment figures are not available until 1984.⁹ The steps in constructing provincial capital stocks are similar to the steps used in the construction of the national capital stock. The only exception is that the provincial GDP deflator is used throughout. Provincial real net investment (PRNI) is provincial real gross investment (PRGI) less provincial depreciation. Since an investment deflator for the provinces is unavailable, the provincial GDP deflator is used to deflate the provincial depreciation figures. Provincial depreciation values are used for the 1993–1998 period, and an implied depreciation value based on Eqs. (4)–(6) generated the depreciation value for the period 1984–1992. A deflated average depreciation rate for all provinces is 4.451%, while the rate for the coastal provinces and inner provinces are, respectively, 4.627% and 4.347%. Although there are variations, coastal provinces face a higher depreciation rate than inner provinces.

The provincial capital ratios derived from Eq. (12) are applied to the national capital in 1984 (which is 20,627.591).¹⁰ For each province, j :

$$\left(\frac{\sum_{(1985-88)} PRGI_j}{\sum_{(1985-88)} PRGI} \right). \quad (12)$$

⁷ This produces the following ratios which sum to unity: RTIFA (SA)=0.2178, RTIFA (DL)=0.1526, RTIFA (FI)=0.0411 and RTIFA (SRF)=0.5885.

⁸ The ratios for the period 1982–1992 are RTIFA(SO)=0.6637, RTIFA(CO)=0.1268 and RTIFA(IO)=0.2095, and for the ratios for period 1993–1998 are RTIFA(SO)=0.5491, RTIFA(CO)=0.1624, RTIFA(IO)=0.1281, RTIFA(JO)=0.0053, RTIFA(SH)=0.0407, RTIFA(FF)=0.0748 and RTIFA(HMTO)=0.0395.

⁹ With only three omissions: Xinjiang in 1984, and Shanghai and Tibet in 1998.

¹⁰ The five provinces with the largest ratios are Liaoning (14.15), Jiangsu (8.57), Shanghai (7.34), Shandong (6.41) and Guangdong (5.50). The smallest five provinces are Tibet (0.34), Hainan (0.56), Ningxia (0.58), Qinghai (0.65) and Guizhou (1.12).

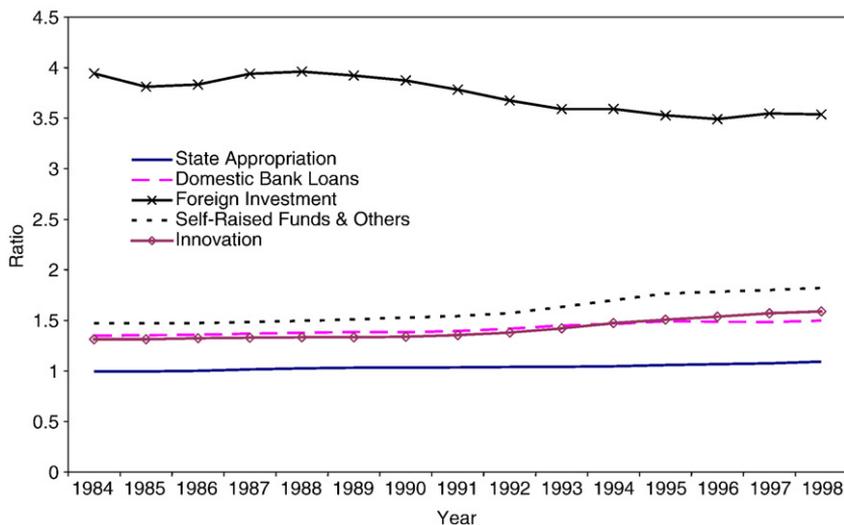


Fig. 2. Coastal to inner provinces physical capital ratios: five financial capitals.

Using provincial capital, Eq. (1) is applied to calculate the capital for 30 provinces. This exercise effectively disaggregated the national capital by provincial capital in the 1984–1998 sample periods. There is, however, a discrepancy in the total value of capital stock. In 1997, for example, the national capital stock reported in [Chow and Li \(2002\)](#) is 79,542.496. The capital stock from the four sources is 78,520.39 (a difference of 1.3%). The capital stock from the sum of the 30 provinces amounts to 75,466.62 (a difference of 5.1%). We attributed these differences to reporting error and inventory.

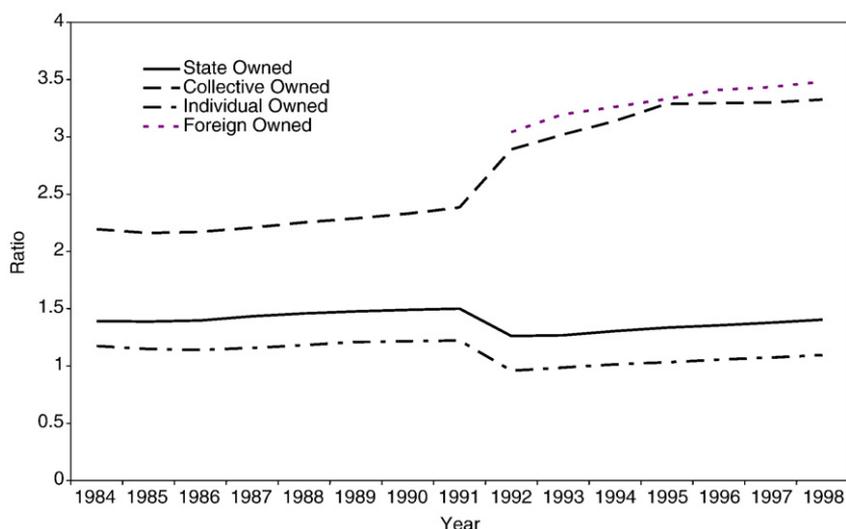


Fig. 3. Coastal to inner provinces physical capital ratios: ownership of funds.

Table 2
Education performance in China: 1980–1998

Year	Primary school graduates/age 15–64 population (%)	Secondary school graduates/age 15–64 population (%)	High education graduates/age 15–64 population (%)	Ratio of primary school to secondary school graduates	Ratio of high education to secondary school graduates
1980	3.50	2.78	0.03	1.2598	0.0090
1981	3.44	2.83	0.02	1.2137	0.0082
1982	3.33	2.25	0.07	1.4774	0.0326
1983	3.10	1.96	0.05	1.5789	0.0267
1984	3.03	1.83	0.04	1.6548	0.0238
1985	2.95	1.89	0.05	1.5635	0.0247
1986	2.91	2.00	0.06	1.4520	0.0283
1987	2.88	2.11	0.08	1.3648	0.0355
1988	2.66	2.14	0.08	1.2466	0.0357
1989	2.51	2.05	0.08	1.2211	0.0379
1990	2.46	1.98	0.08	1.2441	0.0410
1991	2.47	1.92	0.08	1.2842	0.0416
1992	2.40	1.92	0.08	1.2488	0.0403
1993	2.33	1.95	0.07	1.1943	0.0370
1994	2.37	1.92	0.08	1.2316	0.0413
1995	2.41	2.01	0.10	1.1983	0.0492
1996	2.35	2.10	0.10	1.1210	0.0486
1997	2.36	2.32	0.10	1.0157	0.0430
1998	2.51	2.52	0.10	0.9968	0.0391

Real government expenditure on culture, science, education and healthcare.

Sources: Statistical Yearbook of China (2000, p. 262); Comprehensive Statistical Data and Materials in 50 Years of New China (1999, pp. 85–86); World Development Indicators, various issues, World Bank.

Most provinces have their provincial total investment in fixed assets (TIFA) and the four sources of finance (SA, DL, FI and SRF) for the period 1985–1998, with some exceptions.¹¹ Previous procedures are repeated in order to obtain I_{nji}^* for the provinces, which is then used to add the provincial initial K_{nji} and to obtain a sequence of provincial capital stock for the four sources and the various ownership of funds.

Figs. 2 and 3 show the divergence ratio for the four sources of finance and the ownership of funds, respectively, between coastal and inner provinces.¹² Foreign direct investment had concentrated mostly in coastal provinces, while capital from state appropriation was more equally distributed, and other forms of capital showed an increasing trend of divergence.

¹¹ Mongolia's data covers 1985–1996, while Tibet, Shanghai and Guangxi have only 1995–1997 figures. Fujian has only 1996 data. Guangdong's provincial TIFA data began from 1990. Sichuan's missing data included 1993–1995 and 1997–1998. Lastly, Qinghai's data began from 1987.

¹² The divergence ratio for state appropriation is smallest, with 1.026 in 1984 increased to 1.127 in 1998. The ratios for domestic bank loans and self-raised funds and others are 1.412 and 1.579 in 1984, marginally increased to 1.574 and 1.947 in 1998, respectively. The ratio for foreign investment had dropped from 4.407 in 1984 to 3.914 in 1998. The ratio for collective ownership increased from 2.2 in 1984 to 3.36 in 1998; the ratios for state ownership and individual ownership are all below 1.5. The ratio of foreign ownership increased from 3.04 in 1992 to 4.48 in 1998.

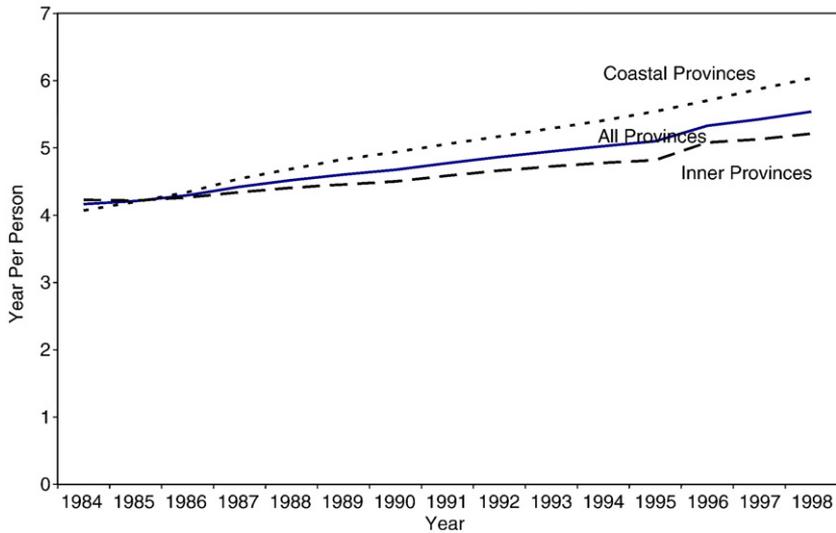


Fig. 4. Average years of schooling per capita.

A traditional measure of technology that contributed to growth is the total factor productivity (TFP).¹³ In this paper, we apply endogenous growth models and include a technology variable in the estimation. We construct a technology variable from the data on investment in innovation (*Comprehensive Statistical Data and Materials on 50 Years of New China, 1999*) since technological change and development has mainly been state-oriented. Classified under the channel of management and covering three investment categories, investment in innovation refers to expenditure on technological innovation of the original facilities by enterprises and institutions and supplementary projects (*Statistical Yearbook of China, 2003*, p. 258).¹⁴ The percentage of investment in innovation to real GDP exceeded 10% in most years, with 1993 exceeded 16% of real GDP, as shown in Column 10 in Table 1. Similar conceptual and practical steps previously used in disaggregating the national capital stock is employed to construct the time series of capital stock of innovation (see detailed construction in Appendix A).¹⁵ The divergence in innovation between coastal and inner provinces Innovation shows that the trend is increasing, as indicated in Fig. 2.

Data on the annual graduates of the six schooling levels are used to construct China's human capital stock.¹⁶ Table 2 shows the education performance ratios among the three major categories

¹³ Griliches (1973), for example, used TFP and total spending on R&D to estimate the return to social rate of return to R&D. Both Chow and Li (2002) and Li (2003) used the conventional Cobb–Douglas production function to determine China's post-reform national and provincial TFP.

¹⁴ One category concerns projects listed in the current year innovation plan of central and various levels of local governments. Projects carried forward from previous years can also be included. The second category includes projects of technological innovation or renewal of original facilities in the innovation and capital construction plans. Extension projects that either extend or revise existing production capacity and movement to new production sites are included. The third category covers projects of reconstruction or technological innovation or movement to new production sites that exceeds Rmb 500,000 by state-owned units.

¹⁵ The ratio between coastal and inner provinces for the capital stock of innovation was 1.314 in 1984 and 1.589 in 1998.

¹⁶ The six levels of schoolings are primary, junior secondary, senior secondary, vocational secondary, specialized secondary, and high education.

for the population aged between 15 and 64. The ratio of primary school graduates to total population has declined, while the same ratio for secondary school graduates has largely remained constant, but the ratio for high education has risen, though by the mid-1990s the ratio was still low at 0.1%. Using the number of graduates in different schooling levels, mortality rates, and migration data, human capital stock data is derived from a perpetual inventory approach. The human capital variable is measured by the average years of schooling per capita (see detailed construction in Appendix B). Fig. 4 shows the years of schooling per capita at national and regional levels. At the national level, China's average year of schooling per capita increased from 4.16 years in 1985 to 5.36 years in 1998.¹⁷ For coastal provinces, the average increased from 4.07 in 1984 to 6.04 in 1998; for inner provinces, the average increased from 4.23 in 1984 to 5.21 in 1998. The gap of the years of schooling per capita between coastal and inner provinces has widened since the late 1980s.

3. Methodology

We begin with a production function specifying the relationship between output (Y) and inputs of labor (L), physical capital (K), technology (T) and human capital (H) in a Cobb–Douglas function format. The output function at time i is

$$Y_i = aT_i^\delta L_i^\alpha K_i^\beta H_i^\gamma. \quad (13)$$

With the assumption of constant return to scale as in Chow and Li (2002) and Li (2003), we express each variable in per unit of labor with the use of lower case letters. Eq. (13) can be written as

$$y_i = a t_i^\delta k_i^\beta h_i^\gamma. \quad (14)$$

Using the logarithmic form to get a linear function and taking the first-difference, the estimating equation for the growth of output per unit of labor becomes

$$\dot{y}_i = b + \delta \dot{t}_i + \beta \dot{k}_i + \gamma \dot{h}_i + \varepsilon_i, \quad (15)$$

where \dot{y}_i , \dot{t}_i , \dot{k}_i , and \dot{h}_i are the growth of y_i , t_i , k_i , and h_i , respectively. When the panel data are used, the regression model becomes

$$\dot{y}_{ij} = \mu_i + \eta_j + b \dot{t}_{ij} + \beta \dot{k}_{ij} + \gamma \dot{h}_{ij} + \varepsilon_{ij}, \quad (16)$$

where the subscript j denotes provinces, μ_i measures the time fixed effects and η_j measures the provincial fixed effects and ε_{ij} is the random error. The time fixed effect measures the changes in output growth over time and the province fixed effect captures the uneven provincial growth caused by non-economic factors.

The aggregate physical capital stock, K , can be decomposed into four types of inputs based on the four financial sources of total investment in fixed assets: state appropriation, domestic bank loans, self-raising funds and others, and foreign investments, which are denoted as K_{SA} , K_{DL} , K_{SRF} , and K_{FI} , respectively. Suppose these four types of physical capital enter the production function with the same form as the other input factors, and the lower case letters are used to denote

¹⁷ As compared to Wang and Yao (2003, Appendix A), the overall human capital stock figures we calculated here are slightly higher. This is due to the fact that we include Vocational Secondary schooling in the estimation.

the four types of physical capital in terms of per unit of labor, the estimation equation for the growth of output per unit of labor becomes

$$\dot{y}_{ij} = \mu_i + \eta_j + b\dot{l}_{ij} + \beta_1\dot{k}_{SA,ij} + \beta_2\dot{k}_{DL,ij} + \beta_3\dot{k}_{SRF,ij} + \beta_4\dot{k}_{FI,ij} + \gamma\dot{h}_{ij} + \varepsilon_{ij}, \quad (17)$$

When the aggregate physical capital stock is divided into four types of inputs based on the sources of ownership, Eq. (17) can be rewritten as

$$\dot{y}_{ij} = \mu_i + \eta_j + b\dot{l}_{ij} + \beta_1\dot{k}_{SO,ij} + \beta_2\dot{k}_{CO,ij} + \beta_3\dot{k}_{IO,ij} + \beta_4\dot{k}_{FO,ij} + b_1d93_{ij} + \gamma\dot{h}_{ij} + \varepsilon_{ij}, \quad (18)$$

where \dot{k}_{SO} , \dot{k}_{CO} , \dot{k}_{IO} , \dot{k}_{FO} are the growth of physical capital per unit of labor owned by state, collective, individual and foreign enterprises, respectively. The dummy variable, $d93$, is used since the classification of foreign-owned enterprises was added in 1993.

Eqs. (16)–(18) are similar to the model by Benhabib and Spiegel (1994), where the endogenous human capital is included in a Cobb–Douglas function format. We extend Benhabib and Spiegel's (1994) model and follow Romer (1990) to include the technology change in the production function. However, there are two issues to consider when these two endogenous variables are included in the empirical estimation. Firstly, we need to find numerical measures for technology and human capital. The measure of technology is commonly solved by using a proxy (Jones, 2002). We use investment in innovation as a proxy for technology. For human capital, we use the years of schooling per capita as a proxy. Secondly, the inclusion of endogenous technology and human capital variables would suggest the estimation of a system of equations.¹⁸ In this paper, we use the Hausman test to empirically determine if technology and human capital are endogenous variables (Hausman, 1978). If these variables are endogenous, we use the two-stage least squares estimation to determine the impact of different factors of production on the output.

While most empirical neo-classical models estimate the production function with cross-country data, our estimation uses panel data. The cross-section estimation with provincial data in China assumes that the historical and institutional factors are the same across different provinces. Unless these factors can be controlled in the estimation, the cross-section estimation is invalid. The panel data regression in this paper allows the existence of heterogeneity in output growth for both cross-section and time domains (Islam, 1995; Lee, Pesaran, & Smith, 1997).

The provincial fixed effects estimate the means of the growth of output per unit of labor for different provinces. This simple approach does not cluster the provinces with similar characteristics. Therefore, we compare the estimations for coastal provinces data and for inner provinces data. These regressions can show the disparity in factor contributions to regional growths and the results can further help to explore the possible differences between the two regions if such differences exist.

4. Empirical results

We use panel data, including provincial annual data between 1986 and 1998, in China to estimate the fixed effects models in Eqs. (16)–(18). The dependent variable is the annual growth of provincial real GDP per unit of labor. Among the 30 provinces, Tibet does not have

¹⁸ See, for example, Li (2004) uses the GMM method to estimate technology in the output function with a system equation framework.

Table 3
Growth of output per unit of labor

	All (TSLS)	Coastal (TSLS)	Inner (OLS)	Inner (TSLS)
	(1)	(2)	(3)	(4)
Constant	0.0002 (0.004)	0.020 (0.98)	−0.009 (−0.77)	0.094 (0.49)
\dot{i}	0.276 [†] (1.55)	0.229* (1.93)	0.226* (2.71)	0.062 (0.15)
\dot{k}	0.777 (1.24)	0.612* (2.00)	0.582* (5.23)	−0.417 (−0.17)
\dot{h}	−0.098 (−0.12)	−0.023 (−0.08)	0.195* (2.33)	1.375 (0.48)
R^2	0.818	0.788	0.868	0.743
F -test	—	—	4.34* (0.00)	—

The dependent variable in each regression is the growth of provincial real GDP per unit of labor. OLS is ordinary least squares estimation; TSLS is two-stage least squares estimation with lags of the growth of human capital per capita as instrument variables. The numbers in the parentheses under the estimated coefficients are t statistics. The estimated coefficients of the fixed effects for each province and each time period are excluded from the table. The F -statistic is the statistic to test the joint significance of both provinces and time fixed effects. The F -statistic is not available for TSLS. The numbers in the parentheses under the F -statistics are p -values of the test. The asterisk represents the significance at 5% level. The dagger indicates the significance at 10% level.

complete physical capital data, giving 11 coastal and 18 inner provinces in the regression estimation. The independent variables include growth in the technology level, aggregate and disaggregate physical capital, and human capital, with all expressed in terms of per unit of labor.¹⁹

Based on the endogenous growth models, the included independent variables such as technology and human capital may be endogenous. To test for the possible endogeneity of technology and human capital, we apply the revised version of the Hausman test in Davidson and MacKinnon (1989). If the included independent variable is endogenous, we apply the two-stage least squares estimation. The instrument variables is the two periods lags of the included independent variables. If no endogenous variable is found, the ordinary least squares estimation is appropriate.

For Eq. (16), when the Hausman test is applied to all provinces data and coastal provinces data, technology is not endogenous, but human capital is. With human capital variable being endogenous, we apply the two-stage least squares estimation. For the inner province data, both technology and human capital are not endogenous. The ordinary least squares estimation is sufficient for inner provinces data.

The estimation results for Eq. (16) are summarized in Table 3. Since human capital is endogenous for all provinces data and coastal provinces data, columns (1) and (2) show the two-stage least squares estimation results for these two data sets. For the regression with all provinces data, column (1) shows that the coefficients for physical capital and technology are 0.777 and 0.276, respectively. The coefficient for physical capital is insignificant while the coefficient for technology is significant. The coefficient for human capital is very small and insignificant. For the coastal provinces in column (2), the coefficient for physical capital is 0.612 and the coefficient for

¹⁹ The model is based on the constant return to scale. To test for the constant return to scale, real GDP was regressed on labor, technology, physical capital, and human capital. The coefficients are: −0.002, 0.35, 0.62, and −0.085, respectively. The test of sum of coefficients being equal to one gives a F statistics of 0.77, which is not significant. Therefore, the constant return scale is a reasonable assumption.

Table 4
Growth of output per unit of labor: financial sources of funds

	All (TSLS)	Coastal (TSLS)	Inner (OLS)	Inner (TSLS)
	(1)	(2)	(3)	(6)
Constant	0.022 (0.54)	0.023 (0.75)	0.002 (0.11)	0.108 (0.81)
\dot{i}	0.184* (2.25)	0.364 [†] (1.48)	0.185* (2.09)	0.156 (1.05)
\dot{k}_{SA}	0.135 (0.56)	0.030 (0.29)	0.345* (2.09)	-0.327 (-0.33)
\dot{k}_{DL}	0.307* (1.88)	0.355* (2.35)	0.185* (1.92)	-0.206 (-0.35)
\dot{k}_{SRF}	0.087 (0.30)	0.055 (0.20)	0.145 (1.14)	-0.392 (-0.49)
\dot{k}_{FI}	0.020 (1.27)	0.071 (1.00)	0.028 [†] (1.43)	0.042 [†] (1.30)
\dot{h}	0.259 (0.35)	0.055 (0.10)	0.128 [†] (1.40)	0.174 (0.75)
R^2	0.831	0.800	0.870	0.667
F-test	–	–	3.56* (0.00)	–

Same as Table 3. SA = state appropriation; DL = domestic bank loans; SRF = self-raised funds and others; FI = foreign direct investment.

technology is 0.229; both coefficients are significant.²⁰ This indicates that physical capital is the most important to growth followed by technology. Although the coefficient of human capital is insignificant, human capital and output are simultaneous determined in the regression.

For the inner provinces, all independent variables are exogenous. The ordinary least squares estimation results in column (3) show that physical capital is the most important factor to growth, followed by technology and human capital. The estimated coefficients for these three factors are 0.582, 0.226, and 0.195, respectively.²¹ If the two-stage least squares estimation is used for inner provinces data, column (4) shows a very different result. The coefficients for all variables in the estimation for the inner provinces become all insignificant and the coefficient of human capital is 1.375. These abnormal results suggest that the two-stage least squares estimation is not appropriate for inner provinces data.

The empirical results from Eq. (16) show that the physical capital is the most important factor of production for coastal and inner provinces. Although technology is less important than physical capital, it has a significant impact on regional growth as well. The major difference between the growth in coastal and inner provinces is the impact of human capital. While human capital is endogenous determined in the coastal provinces, it is exogenous determined in the inner provinces. This implies that endogenous growth model is more appropriate to coastal provinces, where the growth is faster than inner provinces.

Table 4 shows the regression results for Eq. (17), where the aggregate physical capital is decomposed into four types of capital based on the financial sources of investment. When the Hausman test is applied to Eq. (17), human capital is endogenous for all provinces data and coastal provinces data. We check the two-stage least square estimation for these two data sets and the results are shown in columns (1) and (2). For all provinces, the impact of technology on output growth has the coefficient of 0.184 and the coefficient of human capital is 0.259. Although the coefficient of human capital is larger, it is not significant. Among the four financial sources, domestic bank loans are the most important and significant factor, and followed by state

²⁰ From the assumption of constant return to scale, the marginal productivity of labor (α) is 0.16. This low marginal productivity of labor may be caused by the inclusion of endogenous human capital.

²¹ The marginal productivity of labor being close to zero (0.027) may be caused by the significance of the exogenous human capital. The coefficient of human capital is 0.195. A part of the marginal contribution of labor is reflected on the human capital.

appropriation. The coefficients for these two factors are 0.307 and 0.135, respectively. The coefficients for self-raised funds and foreign investment are small (0.087, and 0.020) and are insignificant.

For coastal provinces, column (2) shows that the coefficient of technology (0.364) is the largest and significant, and the coefficient of human capital (0.055) is small and insignificant. For the four components of physical capital, domestic bank loans, with the significant coefficient of 0.355, are the most important factor for coastal provinces. The coefficients for the rest three factors are small (0.03, 0.055, and 0.071) and insignificant.

For inner provinces, both technology and human capital are exogenous based on the Hausman test. Column (3) shows the results for the ordinary least squares estimation. The coefficients of technology and human capital are 0.185 and 0.128, respectively. Both are significant. Among the four financial sources of physical capital, the state appropriation is the most important factor for inner provinces with the coefficient of 0.345 and followed by domestic bank loans with the coefficient of 0.185. Both coefficients are significant. The coefficients for self-raise funds and foreign investment are 0.145 and 0.028, respectively. Column (4) shows that the two-stage least squares estimation gives several large negative coefficients (-0.327 , -0.206 , and -0.392). This implies that the two-stage least squares estimation is inappropriate for inner provinces.

The above results show that both technology and domestic bank loans are important for the coastal and inner provinces. The technology has larger impact on output growth in coastal provinces than in inner provinces (0.364 vs. 0.185). Domestic bank loans are the most important factor for the coastal provinces while the state appropriation is the most important factor for the inner provinces. Domestic bank loans have increasingly been used to substitute state appropriation. Although the inefficiency of state-owned banks is a concern for the economic growth in China, the increased bank efficiency has contributed to the growth in coastal provinces. Since China was in her transition from a central planning to a market-oriented economy during the sample period, state appropriation would still be important to economic growth. Without alternative financial sources, inner provinces still rely on state appropriation for their development.

Although self-raised funds have remained the major financial source, the empirical results show that its importance is relatively small compared to state appropriation and domestic loans. This indicates that the funds have not functioned efficiently in the market mechanism, due probably to the fact that much self-raised funds are disguised state investments. Self-raised funds may have a larger impact in inner provinces than in coastal provinces (0.145 vs. 0.055), suggesting that they may have behaved similar to state appropriation.

Foreign direct investment is purely governed by profit maximization and should be the most efficient source of factors of production. The small percentage share of foreign investment in GDP explains its smallest contribution to the economic growth. The coefficient of foreign investment in coastal provinces is greater (0.071 vs. 0.028). This shows that foreign investment has a greater impact on the output growth in coastal provinces than in inner provinces. Its relatively high performance in coastal provinces indicates the economic and geographic advantage of coastal provinces.

In addition to the estimation with four financial sources of physical capital, we also consider the estimation of Eq. (18), where physical capital is classified into different forms of ownership. When the Hausman test is applied to Eq. (18), we found that both technology and human capital are not endogenous. The exogeneity of human capital for all provinces and coastal provinces data is different from the Hausman test results for Eqs. (16) and (17). This result may indicate that the classification of different forms of ownership for physical capital is not appropriate to explain the

Table 5
Growth of output per unit of labor: ownership of funds

	All (OLS)	Coastal (OLS)	Inner (OLS)	All (TSLs)	Coastal (TSLs)	Inner (TSLs)
	(1)	(2)	(3)	(4)	(5)	(6)
Constant	0.023 (1.15)	0.057* (2.64)	0.005 (0.36)	0.077 (0.58)	0.066 (0.75)	-0.013 (-0.07)
\dot{i}	0.603* (9.78)	0.587* (5.02)	0.321* (3.55)	0.227 (0.24)	0.567 (1.01)	0.378 (0.78)
\dot{k}_{SO}	-0.118* (-2.71)	-0.301* (-3.44)	0.263* (2.89)	-0.234 (-0.81)	-0.318* (-2.50)	0.358 (0.36)
\dot{k}_{CO}	0.026† (1.32)	0.069* (2.07)	0.053* (2.10)	-0.007 (-0.08)	0.065 (1.10)	0.069 (0.45)
\dot{k}_{IO}	0.014 (1.03)	0.033* (2.15)	0.015 (0.47)	-0.004 (-0.08)	0.032 (1.06)	0.038 (0.17)
\dot{k}_{FO}	0.005 (0.08)	0.276* (2.71)	-0.006 (-0.09)	-0.008 (-0.11)	0.265 (0.73)	0.002 (0.02)
$d93$	0.032* (1.76)	-0.026 (-0.71)	0.041* (1.93)	-0.002 (-0.02)	-0.031 (-0.53)	0.053 (0.41)
\dot{h}	0.385* (6.81)	0.210* (2.45)	0.327* (3.84)	1.007 (0.64)	0.269 (0.22)	0.130 (0.07)
R^2	0.815	0.795	0.860	0.753	0.790	0.860
F-test	5.10* (0.00)	6.58* (0.00)	2.26* (0.00)	-	-	-

Same as Table 3. SO=state-owned; CO=collective-owned; IO=individual owned; FO=foreign owned. $d93=1$ for 1993 and after.

growth. In case of the existence of endogeneity of human capital, Table 5 shows both regression results for the least squares estimation (columns (1)–(3)) and for the two-stage least squares estimations (columns (4)–(6)).

The least squares estimation for all provinces and coastal provinces in column (1) and (2) shows some abnormal results: the coefficient of technology is unusual high (0.603 for all provinces and 0.587 for coastal provinces); the sum of the coefficients of technology and human capital is close to one; the coefficient for state-owned capital is negative for all provinces and for coastal provinces (-0.117 and -0.301, respectively). These abnormal results indicate that the classification of physical capital based on different forms of ownership does not have explanatory power for the growth for all provinces and coastal provinces data. Note that these abnormal results stay even if the two-stage least squares estimation is used (columns (4) and (5)). The only possible meaningful conclusion from the least squares estimation in column (2) and (3) is that the individual and foreign owned enterprises are important to coastal provinces, while state and collective owned enterprises are important to inner provinces.

5. Conclusion

This paper uses different financial resources and human capital to examine their impacts on the imbalanced growth of the coastal and inner regions in China. Regression estimates show that the disparity in the use of technology, physical and human capital stock is responsible for the imbalance in regional output growth. In general, technology and human capital have different impacts to regional growth. Technology is more important in coastal provinces than in inner provinces; human capital is endogenous in coastal provinces and is exogenous in inner provinces. Among the four capital stock components from financial sources, domestic bank loans are important to coastal provinces, state appropriation and self-raised funds are important to inner provinces, while foreign investment is more important to coastal than to inner provinces. For the physical capital stock in the four types of ownership, foreign-owned enterprises are important for coastal provinces while state-owned enterprises are important for inner provinces. In summary, the high economic growth in coastal provinces is attributed to the use of more productive inputs, such as technology, domestic bank loans, and foreign investment; the low economic growth in

inner provinces is caused by the use of less productive inputs, such as state appropriations and self-raised funds.

The results lead to important policy recommendations and a tripartite investment strategy in addressing regional imbalances in China. First, domestic bank institutions can work closer with the non-state sector so as to provide a truly market based line of investment sources. Thus, banking reform and efficiency in banking institutions can promote a rapid development of self-raised funds to the benefit of both coastal and inner provinces. Second, although state funding is less efficient, state appropriation is still an important financial source for inner provinces. The state can address the input imbalance by spending more on infrastructure and economic capacity in inner provinces. A better provision of infrastructure in inner provinces activates the flow of income and economic activities from the coastal to inner provinces. Improvements in economic capacity in turn attract foreign investment to the inner provinces. Third, self-raised funds, as a largest share of physical capital, can be made similar to the retained earnings of private businesses. However, the business structures of state-owned enterprises in China are still different from the “normal” private business. The inefficient use of self-raised funds by state-owned enterprises could explain the low economic growth in inner provinces. The solutions may include: a better monitoring procedure in using the funds, redirecting the funds into banking system or stock and bond markets, and privatizing more state-owned banks and enterprises. Fourth, while foreign investment is the most efficient source of investment and will expand in China’s post-WTO era, focus should also be given to the deployment and the various microeconomic and non-economic conditions, such as the rules of law and property right issues.

It is not surprising to see that human capital is endogenous in coastal provinces. Efficient use of human capital is endogenously built into the development in the coastal provinces. For the inner provinces, human capital is still exogenously determined and a more efficient human resource policy is necessary. One solution is to solve the issue of the differences in education levels between coastal and inner regions. Urbanization should be speeded up in the inner regions, enhancing the quality of living for the skilled workforce. Improvement in the transportation and communication infrastructure would also lessen the remoteness of inner provinces and promote labor mobility. Since individual-owned enterprises could be the more efficient form of enterprises, there will be room for output growth with the further expansion of individual-owned enterprises. Government should encourage the transformation of state-owned and collective-owned enterprises into individual-owned enterprises. Comparing the results from two different types of classification of the total investments in fixed assets, one finds that the source of funds estimates in general can provide a better explanation of output growth than the ownership of funds results, indicating that a reform on the use of financial sources is important.

Regional output differences can be viewed positively as an incentive to allocate resources toward the lower cost areas. The rapid growth and economic prosperity in the coastal provinces could provide a road map for the economic development of inner provinces. At the same time, improved economic capacity in the inner provinces is important in attracting foreign investment and promoting both state and non-state investment. The question of regional imbalances should not be seen as a static situation, but an opportunity for the inner provinces to progress along the lines of a market economy.

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Appendix A. Construction of Level of Technology

We use the 1984 investment figure as the benchmark and a decomposition process is conducted by using the ratio of investment for innovation to gross investment during 1985–1989. We calculate the following ratio for province j , where $PRGI_{j,i}$ is the real gross investment of province j at time i obtained in previous exercise, and $PRINVI_{j,i}$ is real investment for innovation of province j at time i :

$$r_j = \frac{1}{5} \sum_{i=1985}^{1989} \frac{PRINVI_{j,i}}{PRGI_{j,i} + PRINVI_{j,i}} \quad (\text{A1})$$

The real investment for innovation of province j is obtained by deflating the nominal value of investment for innovation of province j by the corresponding provincial GDP deflator. For province j , the capital stock of innovation, T , is calculated by the following two formulas:

$$T_{j,i} = r_j k_{j,i}, \quad \text{for } i = 1984, \quad (\text{A2})$$

$$T_{j,i} = (1 - \ell_j) T_{j,i-1} + PRINVI_{j,i}, \quad \text{for } 1985 \leq i \leq 1998, \quad (\text{A3})$$

where $k_{j,i}$ is the provincial capital stock obtained in the previous exercise, and ℓ_j is the depreciation rate of province j .

Appendix B. Construction of Human Capital

A perpetual inventory approach is used to construct China's human capital. Instead of adopting an Indian initial value as in Wang and Yao (2003, p. 40), we derive the initial human capital from the data in the two Chinese censuses of 1990 and 2000. The 1985–2001 data on the annual graduates of the six schooling levels are collected from individual provincial statistical yearbooks. The total number of persons in various schooling levels in 1990 was used as the benchmark. The national aggregates are first divided into the number of graduates in the six schooling levels. National population numbers are further broken down into provincial figures. Both the mortality rate and inter-provincial migration are used to improve the estimate of human capital.

Provincial mortality rate reflects the difference between the entry and exit in each schooling level, while mobility allowed migration that changes the stock of human capital in each province. Mortality rates are provided in the two census in 1990 and 2000 and in the [Comprehensive Statistical Data and Materials in 50 Years of New China \(1999\)](#). The overall mortality rate of ages 15–64 in 1990 is calculated from the death population of age 15–64 and the total number of persons attained at each schooling level in 1990. The overall mortality rate of ages 15–64 other than 1990 equal to the national mortality rate of all ages at time i less the national mortality rate of all ages in 1990 plus the mortality rate of all ages in 1990, assuming that the overall mortality rate of the 15–64 age groups and the national mortality rate of all ages shared the same pattern over time. In calculating the mortality rate of different schooling levels, we assume that the mortality rate of each schooling level has the same contribution to the overall mortality rate at each time period and that the mortality rate of each schooling level is the same in all provinces.

The 1990 and 2000 Chinese censuses also provide inter-provincial migration data, and the same share of migrated population from one province to another in each schooling level is assumed. The 1990 census provides only the 1985 figure, and for schooling level in 1985, we multiple the migrated population into province j by the ratio of schooling level in 1990. An exponential interpolation is used to estimate the intermediate values of the adjusted total number of persons moving into and out of province j under each schooling level for the years from 1986 to 1999. We finally work out the accumulated number of graduates for each schooling level, ρ . The six human capital stock figures ($H_{\rho,j,i}$) are the number of accumulated graduates in different schooling levels for province j at the end of each period i . We assume the length of schooling cycles for primary and junior secondary are 5 and 8 years, respectively. Senior secondary, specialized secondary and vocational secondary have a similar schooling cycle of 11 years, while higher education requires 14.5 years (Ho, 2000). The following formula is applied to calculate the average years of schooling per capita as the human capital stock:

$$H_{j,i} = (5H_{1,j,i} + 8H_{2,j,i} + 11H_{3,j,i} + 11H_{4,j,i} + 11H_{5,j,i} + 14.5H_{6,j,i}) / \text{Pop}_{j,i}, \quad (\text{A4})$$

where $H_{j,i}$ is the level of human capital stock for province j at time i , and $\text{Pop}_{j,i}$ is the population aging 15–64 of province j at time i .

The provincial data on population aging 15–64 from the *China Population Statistical Yearbook* provide only the 1% or 10% sampling from the population, we improve these population figures by using the national figures in the *World Development Indicators* and decompose these national figures by the respective provincial employment figures.

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