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HOW EFFICIENT HAS BEEN CHINA'S INVESTMENT? EMPIRICAL EVIDENCE FROM NATIONAL AND PROVINCIAL DATA

Key points:

- *China's investment has been growing very strongly. The share of gross capital formation in GDP in China has also been higher than in other East Asian economies during their high growth period in the 1970s-80s. Many commentators have argued that such high rates of investment growth have been driven by irrational incentives and have been largely inefficient, will cause a build up of non-performing loans in the banking system, and will also lead to over-capacity and deflation. Others, however, have argued that China is still capital scarce, returns to capital are high, and therefore high rates of investment are both desirable and sustainable. This paper attempts to shed new light on the debate.*

- *We analyse both the allocative efficiency and the dynamic efficiency of China's spending on capital. The allocative efficiency measures the extent to which resources have been invested in places where potential rates of return on capital are high. The potential rates of return can be calculated as the marginal products of capital derived from an aggregate production function. The dynamic efficiency measures the extent to which the capital-output ratio exceeds the optimal level. The optimal level of the capital stock is determined by a rate of investment, at which level the Chinese residents at the present enjoy the highest level of consumption without sacrificing the level of consumption in the future.*

- *We first construct China's total capital stock at national and provincial levels, estimate the Cobb-Douglas and CES production functions, and compute the marginal products of capital. Assuming that the Chinese economy was operating on the production frontier, the marginal products of capital at the aggregate level have been relatively high in the past two decades, and have not shown clear signs of decline in recent years. We find that China's marginal product of capital compares favourably with those observed in the major industrialised economies and in the Asia region. We also find that the marginal products of capital have been higher in the coastal areas than in the less developed areas of western and central China, but the marginal products of infrastructure capital have been higher in the inland areas than in the coastal areas. These results are robust to different assumptions made in constructing the data of capital stock.*

- *We then analyse the correlation patterns between the growth of investment and the marginal product of capital. We find that, in recent years, the correlation between the growth of investment and the marginal product of capital has been increasing, implying that the allocative efficiency of investment has improved. We also find that the positive relationship between the growth of investment and the marginal product of capital was stronger the coastal areas than the inland areas, implying that the former had higher allocative efficiency than the latter. Among the various types of investment, FDI had the highest allocative efficiency. Infrastructure investment in the inland areas appeared to have had low allocative efficiency, possibly reflecting the observation that infrastructure investments in those areas were typically made by the public sector without much consideration for current period rates of returns.*

- *We analyse the question whether the current rate of investment is too high by applying the methodology developed by Abel et al (1989) to judge the dynamic efficiency of an economy. According to that methodology, an economy that invests more than its total profit in steady state is dynamically inefficient. By comparing the share of capital income in GDP and the rate of investment in China, we find that the latter has consistently exceeded the former since the early 1990s. This implies that the rate of investment in China has been too high, and the Chinese economy is probably on a dynamically inefficient growth path. This provides analytical support for the government's intention to reduce the rate of investment and raise the rate of consumption.*

- *The message of the paper is that, while we can take some comfort that the current high rate of investment is not necessarily a sign of allocative inefficiency or going to cause a hard landing of the Chinese economy, the welfare of the current and future generations of Chinese citizens can be improved by changing the pattern of expenditures into one that involves less investment and more consumption.*

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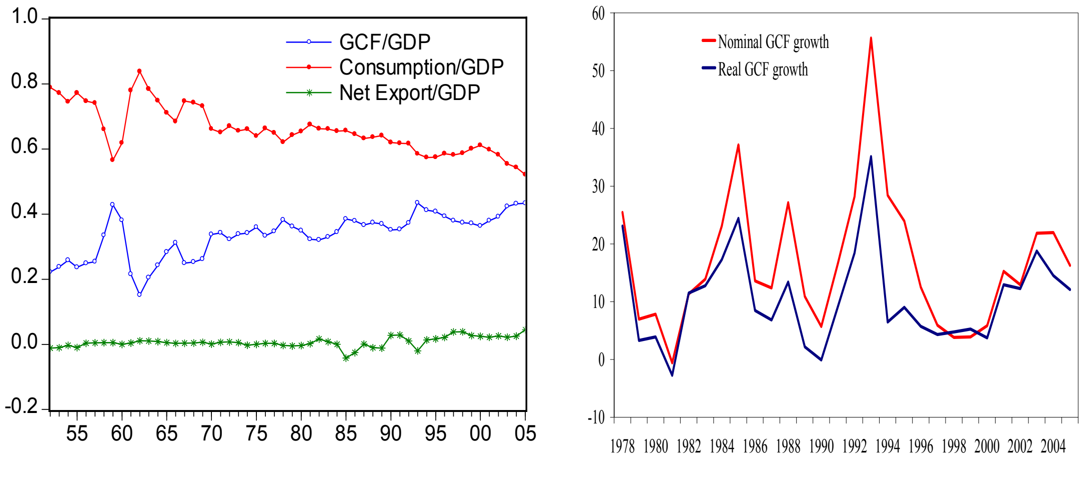
I. INTRODUCTION

Spending on capital goods has been the main driver of economic growth in China in recent years. The ratio of gross capital formation (GCF) to GDP has been trending up, and the ratio of consumption to GDP has been declining (Figure 1). Compared with Japan in the 1970s and Korea in the 1980s, which saw consumption-to-GDP ratios averaging 64% and 70% respectively, China has seen much lower consumption-to- GDP ratios.

The elevated investment-to-GDP ratio has raised concerns about the possibility of boom-bust investment cycles and the sustainability of China's economic growth. Wolf (2005), for example, claims that China's investment efficiency has deteriorated in view of an increasing incremental capital-output ratio (ICOR) in the past two decades.[1] To the proponents of this argument, China's high investment rates have been driven by irrational incentives (particularly on the part of local governments), will lead to large amount of non-performing loans in the banking system and sow the seeds of financial instability, and will also lead to over-capacity and deflation. In contrast, a few economists, such as Song (2006), claim that China's investment rate is too low. They have argued that China is still capital scarce, returns to capital are high (see for example Bai *et al*, 2006), and therefore high rates of investment are both desirable and sustainable (Liang, 2006).

Figure 1: GDP components, 1952-05 and investment growth rate 1978-05



Sources: CEIC and self estimates.

[1] Wolf (2005) uses the capital stock data of Angus Maddison (1998), who derived gross fixed capital stock by 'cumulating the increments in investment' and assuming that capital had a life span of 25 years.

By attempting to measure the allocative and dynamic efficiency of China's investment, this paper hopes to shed new light on the following questions: Have China's higher growth rates in investment been justified by higher potential rate of return to capital? Can we make a judgment whether China's investment rates have been too high or too low?

The remainder of this paper is organised as follows: the second section describes how we construct data of capital stock, both at the national and provincial levels. The third section estimates China's production function and the marginal product of capital (MPC), also at the national and provincial levels. Section four calculates the MPC of infrastructure investment across regions. Section five examines the allocative efficiency of investment, and Section six provides some preliminary results relating the dynamic efficiency of investment. The last section concludes the paper. Appendix 1 describes in more detail the methodology used to construct the capital stock data, and Appendix 2 examines how sensitive our results are to different assumptions made in constructing these data.

II. DATA CONSTRUCTION

We follow the methodology of Li (2003) to construct the capital stock at the national and provincial levels.

(1) National capital stock

The capital stock formula reads:

$$K_t = K_{t-1} + RNI_t$$

where K_t denotes real capital stock and RNI_t the real net investment (real gross investment minus real depreciation), with t standing for time. Real net investment is computed with the formula:

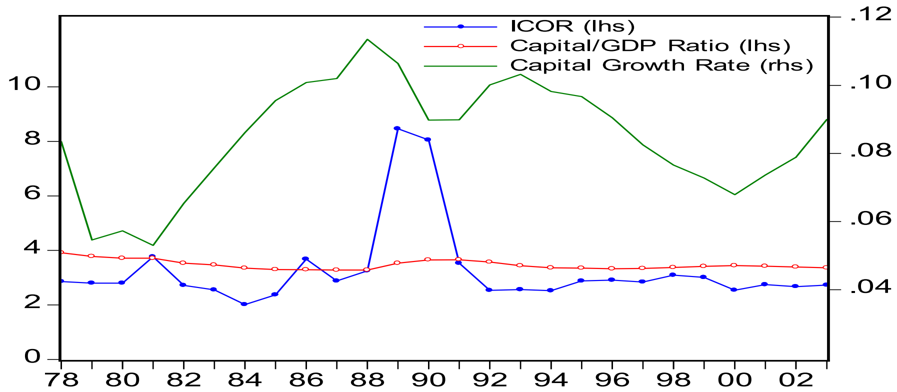
$RNI_t = \dfrac{GCF_t - D_t}{P_t}$, where GCF denotes the (nominal) gross capital formation (gross investment), D the nominal depreciation of capital stock and P the deflator.[2] Following Qiu *et al* (2006), we compute the national depreciation of capital D_t as follows:

[2] Note that Li (2003) computes real gross capital formation by real production-based GDP minus real consumption and real net exports. Here we just take the data of gross capital formation directly from official statistical sources.

$D_t = D_t^{'}\frac{Y_{et}}{Y_{pt}^{'}}$, with $D^{'}$ being the sum of provincial depreciation of fixed assets. Y_{et} is the national expenditure-based gross domestic product (GDP), and $Y_{pt}^{'}$ the sum of provincial production-based GDP.[3] We adjust the national depreciation in this way because the sum of provincial depreciation may not equal the national depreciation of capital stock owing to statistical discrepancy.[4] P is measured by the GDP deflator with 1978=1. Taking the 1992 capital stock in Li (2003) as the starting value, we construct the national capital stock up to 2003, since depreciation of fixed assets thereafter is not yet available.[5]

The growth rate of the capital stock, ICOR ($\frac{\Delta K}{\Delta Y}$), and the capital stock to GDP ratio at the national level are shown in Figure 2.[6]

Figure 2: China's capital stock and ICOR



The ICORs (5-year moving averages) of Korea, Japan and Taiwan are shown together with that of China in Figure 3. China's ICOR fluctuated significantly before 1980 and hovered around 3 thereafter (average 3.36), with some ups and downs around 1990 for political reasons. In recent years there has been no clear sign of the ICOR increasing in China, and the ratio is comparable to the levels observed in Japan and Korea in the late 1980s and early 1990s.

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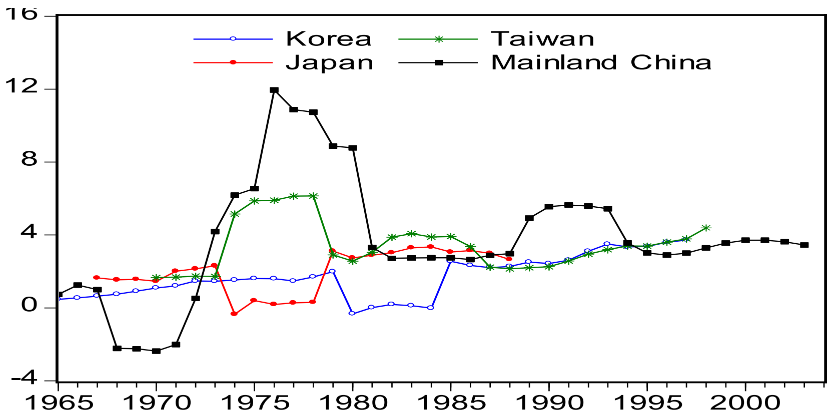
3 The reason why we use the production-based rather than expenditure-based GDP at provincial levels is because for some provinces the latter is not available for some years of the sample studied.

4 Note that depreciation data are available at the provincial level but not at the national level. Qiu *et al* (2006) derives the national data of depreciation by summing up the depreciation of different provinces and scaling the sum by the ratio of national GDP to the aggregate of provincial GDP (As is well known, the sum of provincial GDP exceeds the national GDP). However, Li (2003) takes the sum of provincial depreciation as the national depreciation.

5 A brief description of Li's (2003) construction of national capital stock is presented in Appendix 1. The national capital stock constructed with the above methodology is presented in Table A1 in the appendix. The capital stock before 1993 is taken from Li (2003).

6 The ICOR presented here is computed with production-based GDP. The ICOR computed with expenditure-based GDP has more fluctuations.

Figure 3: Five-year moving average ICOR



Sources: OECD Analytical Data Base, Timmer and van Ark (2002), and self estimates.

(2) Provincial capital stock

Capital stock at the provincial level is constructed in the similar way as at the national level. Li (2003) constructs the provincial capital stock from 1984. The initial capital stock in 1984 of province j is constructed with the following formulae:

$$K_{j,1984} = \frac{\sum_{t=1985}^{1988} RGCF_{j,t}}{\sum_{t=1985}^{1988} RGCF_t} K_{1984}, \quad RNI_{jt} = \frac{GCF_{jt} - D_{jt}}{P_{jt}},$$

$$K_{j,t} = K_{j,t-1} + RNI_t \ (t \geq 1984),$$

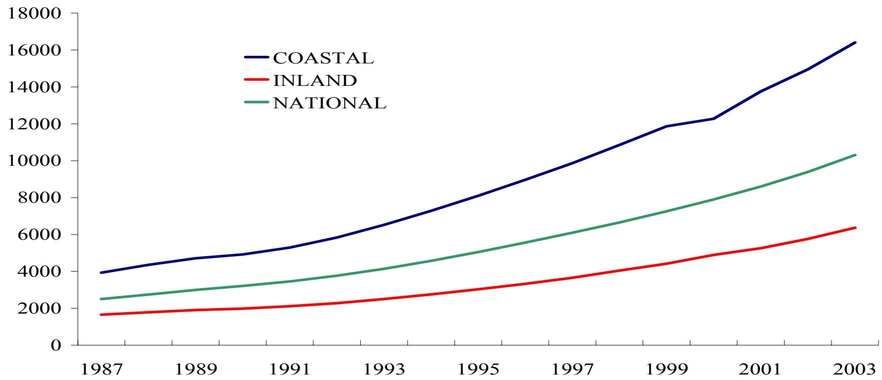
with j denoting individual provinces. The K and $RGCF$ without indicator j denote national capital stock and real gross capital formation. P_{jt} denotes the provincial GDP deflator in year t with 1978=1. Taking the 1992 provincial capital stock of Li (2003) as starting value, we construct the provincial capital stock up to 2003.[7]

The national per capita capital stock and the arithmetic averages of the per capita capital stock in inland and coastal provinces are shown in Figure 4. It is clear that per capita capital stock in coastal provinces was higher than in inland areas. Take 2003 as example, the per capita capital stock of all provinces in the coastal area except Hebei was over 10,000 Yuan, while in the inner area only four remote provinces, Qinghai, Ningxia, Xinjiang and Tibet have per capita capital stock exceeding that number.

[7] The provincial capital stock (in billion, 1978 RMB) and the capital stock to output ratio in coastal and inner provinces are shown in Tables A2-A3 in the Appendix. In these calculations, Chongqing is counted as a part of Sichuan province.

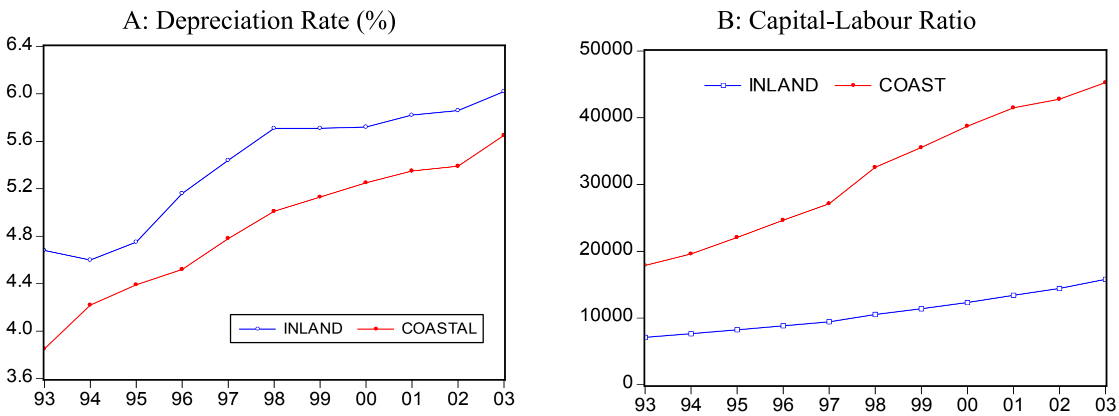
Shanghai and Beijing had the highest per capita capital stock, while Guizhou and Guangxi had the lowest. The per capita capital stock of Guizhou was just 6.4% of that of Shanghai in 2003.

Figure 4: Per capita capital stock (Yuan, 1978 price)



We present the weighted averages of the depreciation rates in the coastal and inner areas in Figure 5A, with the weights being the ratios of individual provincial capital stock to the coastal or inner area total capital stock. We see that the depreciation rates in both inland and coastal areas have been on the rise, and moreover, the coastal area had lower depreciation rates than the inner area in the 1990s. The arithmetic averages of the factor intensity K_t/L_t (with L denoting employment) in coastal and inland provinces are shown in Figure 5B. Obviously, coastal provinces have higher capital-labour ratios (CLR). In 2003, for example, the CLR of Guizhou was just 5.24% of that in Shanghai.

Figure 5: Capital depreciation rate and factor intensity



(3) Infrastructure capital stock at national level

In this subsection we describe the construction of national infrastructure capital stock, for which we need both the yearly real net investment in infrastructure and the initial value of the infrastructure capital stock. The initial value of capital stock in infrastructure (with 1993 being the starting year) is computed with the following formula:

$K_{i,1993} = \dfrac{\sum_{t=1994}^{1997} FAI_{i,t}}{\sum_{t=1994}^{1997} FAI_t} K_{1993}$, with $K_{i,1993}$ denoting the infrastructure capital stock in 1993, K_{1993} the aggregate national capital stock in 1993, $FAI_{i,t}$ fixed asset investment (*FAI*) in infrastructure in year *t*, and FAI_t total FAI in year *t* (in real terms). Li (2003) uses such a formula to compute the starting value of capital stock of different sources of funding.

Here we consider both social infrastructure, physical infrastructure and total infrastructure (sum of physical and social infrastructure).[8] Social infrastructure consists of social services, health care, sport and social welfare and education, culture and broadcasting. The physical infrastructure consists of electricity, gas and water, transport, storage and telecom. Similarly, real net investment in infrastructure is calculated with the following formula: $RNI_{i,t} = \dfrac{FAI_{i,t}}{FAI_t} RNI_t$, with $RNI_{i,t}$ being the real net investment in infrastructure and RNI_t total real net investment in year *t*, respectively.

Ratios of physical, social and total infrastructure FAI to total FAI are shown in Figure 6A. It is clear that the ratio of physical infrastructure FAI to total FAI rose from about 16% in 1993 to 25% in 1998 and edged down thereafter, while that of social infrastructure FAI to total FAI edged up over time, from 5% in 1993 to 10% in 2002. Ratios of physical, social and total infrastructure capital stocks to GDP are shown in Figure 6B. The ratio of total infrastructure capital stock to GDP was around 0.85 while that of the social infrastructure to GDP was just about 0.20.

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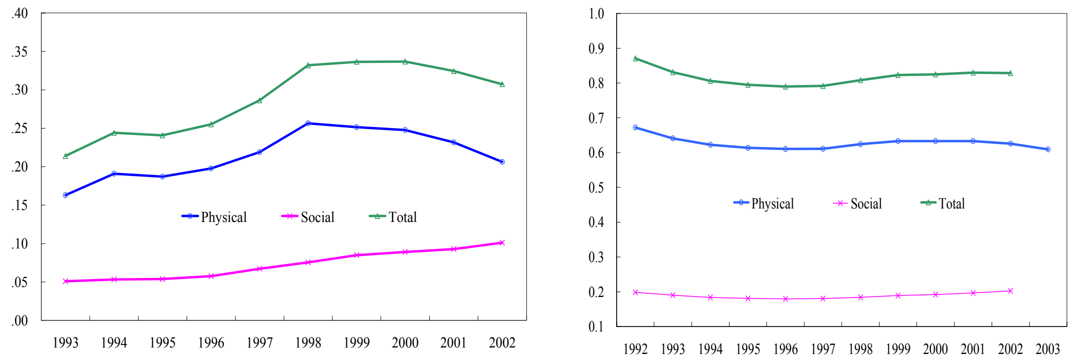
[8] Social infrastructure is also referred to as superstructure in the literature. There can be various definitions of social infrastructure. Social infrastructure in this paper includes social services, health care, sport and social welfare and education, culture and broadcasting, similar to the definition used by Asian Development Bank.

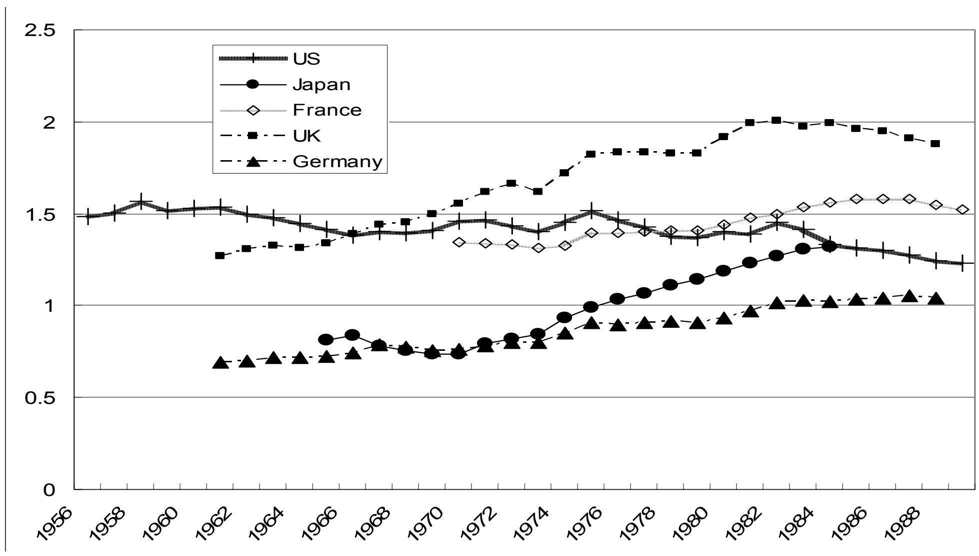
Figure 6: Infrastructure FAI and capital stock, ratios

A: Ratio of Infrastructure FAI to Total FAI B: Ratio of Infrastructure Capital Stock to GDP



In Figure 7 we present the ratios of infrastructure capital stock to GDP of the US, Japan, France, the UK and Germany in the decades before the 1990s. It is clear that the ratios trended up in all countries except in the US, which had trended down since mid-1970s.[9] Among these countries, Germany had the lowest ratio which increased to above 1.0 in the 1980s, while the UK had the highest. Japan's infrastructure capital stock accounted for 81.2% of total capital stock in 1965 and trended up thereafter. Compared with these countries, China's infrastructure capital stock has been relatively scarce.[10]

Figure 7: Ratio of infrastructure capital stock to GDP in several developed countries



Sources: Ford and Poret (1991), OECD Analytical Data Base, and self estimates.

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9 Against this background, Aschauer (1989) ascribes the growth slowdown in the 1980s to insufficient investment in infrastructure.

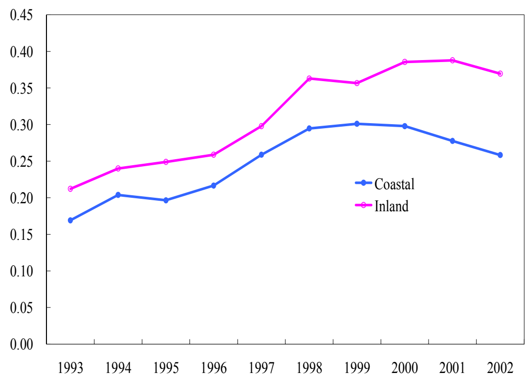
10 Note that the infrastructure capital shown in Figure 7 is defined similarly as the physical infrastructure stock of China. Infrastructure capital of these countries includes capital of "producers of government services", structures in transport and communication, and equipment and structures in electricity, gas and water (except for France for which series for the energy-sector capital stock are used). Military capital is not included.

(4) Infrastructure capital stock at provincial levels

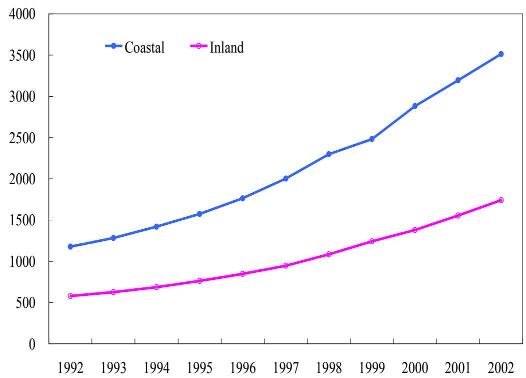
The infrastructure capital stock at provincial levels is constructed with the same methodology as for that at the national level. The arithmetic averages of the ratios of infrastructure FAI to total FAI at provincial levels are shown in Figure 8A. It is clear that in the 1990s most inland provinces had a higher ratio than in coastal provinces. The arithmetic averages of the per capita infrastructure capital stock are shown in Figure 8B.[11] Obviously, coastal provinces usually have higher per capita infrastructure capital stock than inland areas. In 2003, for example, the per capita infrastructure capital stock in Anhui was only 7.8% of that of Shanghai.

Figure 8: Provincial infrastructure

A: Ratio of Infrastructure FAI to Total FAI (%)



B: Per Capita Infrastructure Capital Stock (Yuan, 1978 Price)



III. PRODUCTION FUNCTION AND MPC

In this section we estimate the production function with the data constructed above at national as well as provincial levels. We estimate both the Cobb-Douglas (CD) production function and the constant elasticity of substitution (CES) production function. We then use the estimated coefficients to calculate the marginal product of capital. Note that the calculated marginal product of capital may not be equal to the actual rates of return on capital, since the production function methodology assumes that the economy operates on the production frontier, whereas in reality the economy may be operating below the production frontier.

[11] We have constructed social and physical infrastructure capital stock separately at provincial levels, but for the sake of simplicity we just present the sum of the physical and social infrastructure capital stock here. The coastal area had a higher ratio of social infrastructure capital to GDP than the inner area during 1992-2002, with the former being around 30% and the latter 22% on the whole.

The CD production function to estimate reads:[12]

$$Y_t = Ae^{\alpha t} K_t^{\beta} L_t^{\gamma},$$

where the parameter α measures the rate of growth in output through time, on account of institutional or technological changes. The production function is said to satisfy constant returns to scale if $\beta + \gamma = 1$. Taking logarithms of both sides, one then has the following equation:

$$\ln Y_t = \ln A + \alpha t + \beta \ln K_t + \gamma \ln L_t + \varepsilon_t,$$

with the last term added as a white noise.

(1) National production function

One problem in estimating the above equation is that capital stock usually has strong multi-collinearity with employment, which may make the estimates of parameters unreliable. Indeed, in our data we find that the two time series have a significant correlation coefficient of 0.92 for the sample of 1952-2003. To overcome the problem of multi-collinearity between employment and capital stock, we estimate the following modified equation:[13]

$$\ln y_t = \ln A + \alpha t + \beta \ln k_t + \varepsilon_t \qquad (*)$$

with $y_t = \dfrac{Y_t}{L_t}$ and $k_t = \dfrac{K_t}{L_t}$.

This modified production function implies $\beta + \gamma = 1$, that is, constant return to scale holds. In fact, estimating such an equation hypothesizes co-integration between the time series, otherwise it is a spurious regression since y_t and k_t are usually non-stationary. The augmented Dickey-Fuller (ADF) tests show that both $ln\, y_t$ and $ln\, k_t$ are I(1). Moreover, the residual of the above equation turns out to be I(0), suggesting that $ln\, y_t$ and $ln\, k_t$ are co-integrated. The estimation with national data of 1952-2003 reads (t-statistics in parentheses):

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[12] This production has also been estimated by Chow (2002) for China.

[13] Li (2003) does not consider the problem of multi-collinearity in estimating the production function. In fact, we find that the correlation coefficients between the capital stock series of four funding sources are relatively high, with the lowest being 0.86 (FDI and state appropriation) and the highest being 0.99 (FDI and domestic bank loans).

$$\ln y_t = \underset{(3.735)}{1.985} + \underset{(5.761)}{0.029}\,t + \underset{(8.817)}{0.592}\ln k_t, \quad R^2 = 0.998,$$

with the first-order residual serial correlation coefficient ρ being 0.728. To compare our regression with that of Chow (2002), we present his estimation result as below:

$$\ln y_t = -\underset{(0.866)}{0.110} + \underset{(6.233)}{0.027}\,t + \underset{(15.697)}{0.647}\ln k_t, \quad R^2 = 0.996, \quad \rho = 0.680$$

The capital share in our estimation is slightly lower, while the TFP growth is marginally higher.[14]

Assuming $\ln K_t = c + \kappa t$, with c and κ being constants, one obtains $\frac{\dot{K}_t}{K_t} = \kappa$, with the "•" over a variable denoting the derivative with respect to time. The parameter κ is referred to as the exponential growth rate of capital which can be estimated with the capital stock constructed before. Similarly, one can also estimate the exponential growth rates of output and employment. The exponential growth rates of output, capital stock and employment for the sample of 1979-2003 turn out to be 0.089, 0.087 and 0.025.

We can then decompose the sources of growth as follows:

$\frac{\dot{Y}_t}{Y_t} = \alpha + \beta\frac{\dot{K}_t}{K_t} + (1-\beta)\frac{\dot{L}_t}{L_t}$. Therefore, the sources of growth are 0.052 (0.592×0.087) and 0.010 (0.025×0.408) with respect to capital and to employment, respectively. Their contributions to GDP growth are then 58.43% (0.052/0.089) and 11.46% (0.010/0.089), respectively. The source of growth with respect to total factor productivity (TFP) is 0.027 (0.089 – 0.052 – 0.010), close to the estimate of α (0.029), with the contribution to growth being 30.34% (0.027/0.089).[15]

Our estimate of the TFP growth is comparable to the findings of other studies on China's growth, as shown in the Table 1. It is also clear that China's TFP growth rates compare favourably with other economies, as shown in Table 2.

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[14] Following Chow (2002), we assume that $\alpha = 0$ before 1978. Note that Chow (2002) excluded the observations of 1958-1969 in the regression, and the same is true of our estimation above. We use the expenditure-based GDP to measure output because our capital stock was constructed with expenditure-based GDP. The estimates with production-based GDP (α=0.032, β=0.619, and ρ =0.626) are not substantially different from those shown above. The reasons why our estimates are not completely the same as those of Chow (2002) are (a) we construct the capital stock following the methodology of Li (2003) who made slight modifications to that of Chow (2002), as mentioned in the appendix, and (b) we have a longer sample period.

[15] The sources of growth with respect to capital, employment and TFP during 1978-1998 in Chow (2002) are 0.058, 0.010 and 0.027, with their contributions to growth being 62.9%, 10.6% and 28.9%, respectively.

Table 1: China's TFP growth estimates

Source	Period	%
Jefferson and Rawski (1994)	1980-1992	2.43
Hu and Khan (1997)	1979-1994	3.90
Wang and Hu (1999)	1978-1995	2.90
Chow (2002)	1978-1998	2.70
Heytens and Zebregs (2003)	1990-1998	2.70
CSLS (2003)	1980-2000	1.66*
Wu (2004)	1982-1997	1.41
Kuijs and Wang (2005)	1993-2004	2.70
Our Estimate	1978-2003	2.90

* This is the TFP growth of state owned enterprises. Note that the sample of 1958-1969 was excluded in the regression of Chow (2002) and our research.

Table 2: TFP growth rates of other economies

Economy	Period	Growth (%)	Economy	Period	Growth (%)
Japan	1960-89	2.00	US	1960-89	0.40
Hong Kong	1966-91	2.30	Singapore	1966-90	1.70
S. Korea	1966-90	1.70	Taiwan	1966-90	2.10
UK	1960-89	1.30	Germany	1960-89	1.60
France	1960-89	1.50			

Sources: Young (1995), Dougherty (1991).

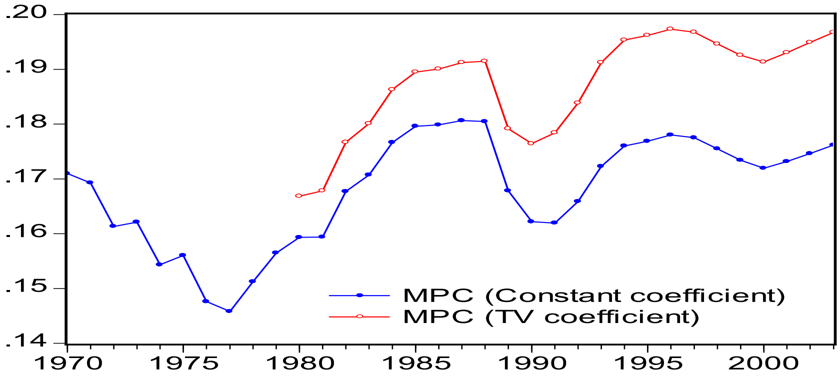
With the estimate of β one can then compute the marginal product of capital stock (MPC) as follows:

$$MPC_t = \frac{\partial Y_t}{\partial K_t} = \beta A e^{\alpha t} K_t^{\beta-1} L_t^{\gamma} = \beta \frac{Y_t}{K_t}$$

We have also estimated the equation with time-varying (TV) coefficients by recursive least squares (RLS). The MPC with constant as well as TV coefficients is shown in Figure 9.[16] It is clear that the MPC reached a minimum in 1976, trended up thereafter until 1988, experienced some fluctuations around 1990 and stabilized at around 0.175 in the past ten years.

[16] The MPC with constant coefficients is shown for the period of 1970-2003 because the sample of 1958-1969 was excluded in the estimation. It hovered around 0.22 during 1953-1957. The TFP growth is assumed to be zero before 1979, as mentioned before, and as a result, the RLS estimates are only available for the period of 1980-2003.

Figure 9: MPC estimated from CD production function



As is well known, a major weakness of the CD function is that the elasticity of substitution is restricted to unity, and as a result, the capital share rises exactly the same as the labour share.[17] In view of this problem, we also estimate the CES production function:

$$Y_t = \lambda[\beta K_t^{-\rho} + (1-\beta)L_t^{-\rho}]^{-\frac{1}{\rho}}.$$

with λ (>0) being the efficiency parameter, 0< β <1 the share of capital and -1< ρ <∞ the substitution parameter. The elasticity of substitution between capital and labour is then $\sigma = \dfrac{1}{1+\rho}$. It can be shown that

$$\lim_{\rho \to 0} \lambda[\beta K_t^{-\rho} + (1-\beta)L_t^{-\rho}]^{-\frac{1}{\rho}} = \lambda K_t^{\beta} L_t^{1-\beta},$$

suggesting that the CD production function is a special case of the CES function. Taking logarithms of both sides of the CES function, one has

$$\ln Y_t = \ln \lambda - \frac{1}{\rho} \ln[\beta K_t^{-\rho} + (1-\beta)L_t^{-\rho}].$$

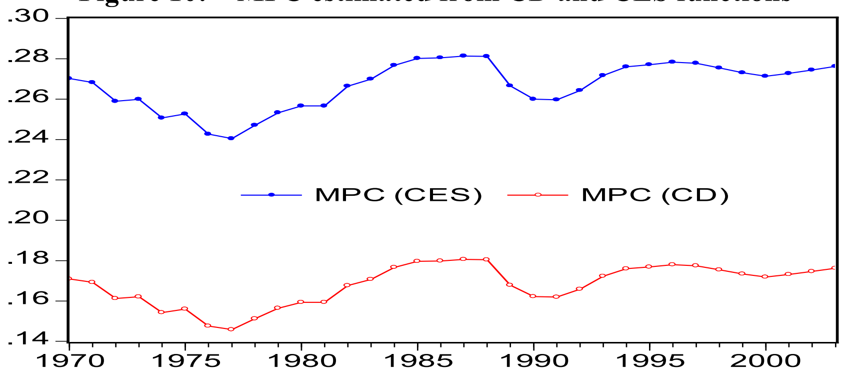
Taking the estimate of β from the Cobb-Douglas production function, 0.592, we obtain the following estimates of parameters for the CES function, with t-statistics in parentheses: λ=1.604 (5.973), ρ= − 0.267 (6.699), $R^2 = 0.992$, and therefore, the elasticity of substitution σ=1.364.[18] The marginal product of capital from the CES

[17] That is, α / β stays constant.

[18] We have estimated the CES function without constraints on the parameters and found that there appear to be multiple solutions due to high nonlinearity. We thus take the estimate of β from the Cobb-Douglas production function as a restriction in solving for the solution of the CES function. Nevertheless, we have tried to estimate the CES function with various values of β ranging from 0.45 to 0.95 and found that the MPCs calculated with these estimates are relatively close to each other.

function is $MPC_t = \frac{\beta}{\lambda^{\rho}}\left(\frac{Y_t}{K_t}\right)^{1+\rho}$. The MPCs from the CES function and CD function are shown in Figure 10.[19] The CES MPC is higher than that of the CD function, but the time pattern of the two series looks similar.

Figure 10: MPC estimated from CD and CES functions



One cannot separate the sources of growth with respect to production factors in the CES function because

$$\frac{\dot{Y}_t}{Y_t} = \frac{1}{\beta L_t^{\rho} + (1-\beta)K_t^{\rho}}\left(\beta L_t^{\rho}\frac{\dot{K}_t}{K_t} + (1-\beta)K_t^{\rho}\frac{\dot{L}_t}{L_t}\right),$$

which is non-separable with respect to $\frac{\dot{K}_t}{K_t}$ and $\frac{\dot{L}_t}{L_t}$.

Since the CD function is a special case of the CES function, one may further assume the efficiency parameter to take the form of $Ae^{\alpha t}$, as in the CD function. Such a function form has been estimated by Duffy and Papageorgiou (2000). In this way, the CES function may read

$$\ln Y_t = \ln A + \alpha t - \frac{1}{\rho}\ln[\beta K_t^{-\rho} + (1-\beta)L_t^{-\rho}]$$

Setting β at 0.592, we have the following estimates (t-statistics in parentheses):

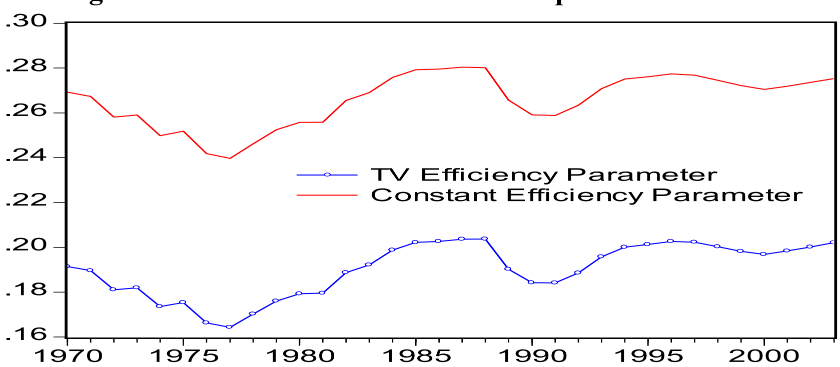
A = 5.331 (9.757), α = 0.025 (10.734) and ρ = – 0.040 (2.680), R^2 = 0.998,

and as a result σ =1.042. Obviously t has a significant statistic, implying that the total factor productivity has been growing over time. The fact that ρ is close to zero

[19] The MPC is computed assuming a constant share of capital stock, β=0.592.

indicates that the CD function may capture China's production well. Thus, we will focus on the CD function in the analysis below. The MPC calculated with time-varying efficiency parameter is shown in Figure 11, together with that calculated with a constant efficiency parameter. The MPC with a time-varying efficiency parameter is lower than that with a constant efficiency parameter.

Figure 11: MPC estimated from CES production function



China's MPC compares favourably with those observed in the major industrialised economies and in the Asia region. The capital share, output-capital ratio and MPC of the ASEAN countries and the US from Sarel (1997) are shown in Figures A3-1 and A3-2 in the appendix.[20] The MPC was lower than 0.2 in the ASEAN countries most of the time during 1978-1996. The MPC of the US was just around 0.1 in the same period. We have also computed the MPC of Japan, Korea and Taiwan with the formula $MPC_t = \beta_t \frac{Y_t}{K_t}$, as shown in Figure 12.[21] Korea's MPC was above 0.20 in the 1970s and declined to around 0.14 in 1990. The MPC of Japan and Taiwan remained below 0.16 throughout the period.

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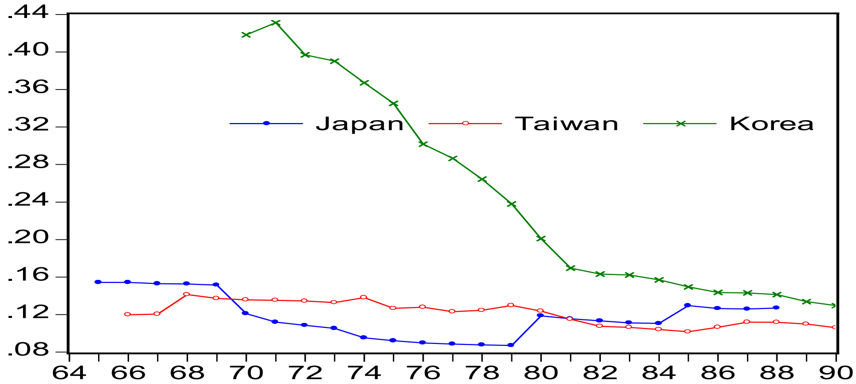
[20] Sarel (1997) computed the factor shares in the production function with a methodology different from the regression and the national accounts approaches. Interested readers are referred to Appendix IV of Sarel (1997) for details of his methodology.

[21] The capital stock and GDP of Japan are taken from Ford and Poret (1991) who take the data from OECD's Analytical Data Base. The capital stock of Korea and Taiwan are taken from Timmer and van Ark (2002) in Groningen Growth and Development Centre (GGDC). The GDP of Taiwan and Korea are taken from CEIC. There are alternative methods to construct capital stock, as surveyed by Beffy, Ollivaud, Richardson and Sedillot (2006) who find that the GGDC results are very close to those of the OECD. The capital share of Japan is taken from Singh and Trieu (1996) and that of Korea is taken from Young (1995). As for Taiwan, we have computed the MPC of 1966-91 with the capital share being the arithmetic average of Young (1995) and Singh and Trieu (1996). As discussed below, the capital share of Japan, Korea and Taiwan taken from the literature changes over time.

Figure 12: MPC of Japan, Korea and Taiwan



(2) Provincial production function

In this subsection we use pooled provincial data of 1993-2003 to estimate the CD production function. In order to see the difference between coastal and inland areas, we estimate the equation with the panel data of eleven coastal provinces (including Beijing and Shanghai) and 19 inland provinces separately. The regression of the eleven coastal provinces with t-statistics in parentheses reads:[22]

$$\ln y_t = \underset{(8.864)}{2.396} + \underset{(5.242)}{0.037}\,t + \underset{(21.849)}{0.619}\ln k_t, \quad R^2 = 0.862$$

The panel regression with data of the 19 inland provinces of 1993-2003 reads:[23]

$$\ln y_t = \underset{(11.684)}{3.206} + \underset{(8.198)}{0.045}\,t + \underset{(15.530)}{0.491}\ln k_t, \quad R^2 = 0.738\,.$$

Comparing the estimation results of coastal and inland provinces, one finds that capital has a lower share in the inland area than in the coastal area. It is about 60% in the coastal provinces and less than 50% in the inland area. The sources of growth with respect to capital, employment and TFP during 1993-2003 in the coastal area are 0.067, 0.0005 and 0.037, with their contributions to growth being 64.4%, 0.48%

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[22] We also estimated the equation with cross- section weights, that is, generalized least squares (GLS) using estimated cross-section residual variances, and seemingly unrelated regression (SUR) weights, that is, GLS using estimated cross-section residual covariance matrix. The regression with cross-section weights reads:

$$\ln y_t = \underset{(19.532)}{2.493} + \underset{(12.913)}{0.034}\,t + \underset{(43.531)}{0.611}\ln k_t, \quad R^2 = 0.975$$

while that with the cross-section SUR weights reads:

$$\ln y_t = \underset{(298.425)}{2.394} + \underset{(386.392)}{0.037}\,t + \underset{(702.337)}{0.620}\ln k_t, \quad R^2 = 0.999$$

It is obvious that the estimation results are similar.

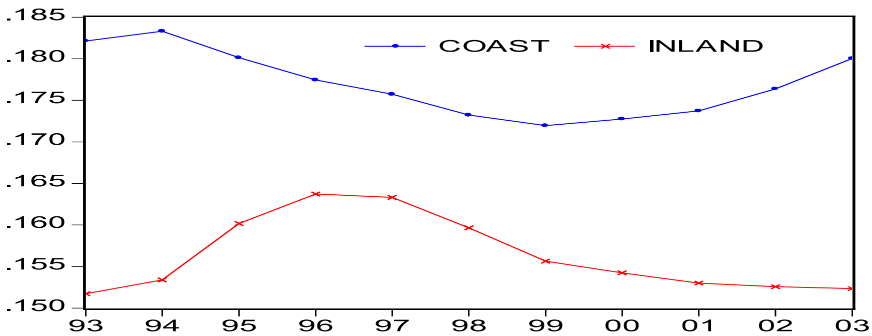
[23] The estimation with cross-section weights reads:

$$\ln y_t = \underset{(26.623)}{3.171} + \underset{(24.195)}{0.042}\,t + \underset{(36.555)}{0.498}\ln k_t, \quad R^2 = 0.965$$

and 35.6%, respectively. The sources of growth with respect to capital, employment and TFP in the inland area are 0.047, 0.0033 and 0.044, with the contributions to growth being 50%, 3.5% and 46.8%, respectively.[24] The contribution of capital to growth in the coastal area has been larger than in the inland area, while the opposite is true of TFP. This appears reasonable, given that the institutional reforms started earlier in coastal areas (the early 1980s) than in inland provinces (mostly the 1990s). Thus, TFP may have made larger contributions to output growth in the 1980s and smaller contributions in the 1990s in coastal provinces.[25]

Figure 13 shows that the coastal area has a higher MPC than the inland area. This reflects the fact that the coastal area has a higher β than the inland area, despite a lower average product of capital stock, *Y/K,* in the coastal area.[26] The results are not substantially different if we use a time-varying β, as has been done at the national level.

Figure 13: Marginal product of capital of coastal and inland areas



[24] Note that we assume different intercepts across provinces in estimating the exponential growth rates of GDP, capital and employment, so that the regression fits the data better.

[25] We also find that the source of growth with respect to capital in Wang and Hu (1999) was higher in the coastal area than in the inner area, and the opposite is true of labour. We compute the arithmetic average of the values shown in Table 5.3 of Wang and Hu (1999, p.150) in coastal and inner provinces separately. Their data cover 1978-95.

[26] Note that the aggregate *Y/K* in the coastal and inland areas is the weighted sum of provincial *Y/K* in coastal and inland provinces, respectively. Let v_j denote the standard deviation (SD) of the provincial average product of capital stock, and $s_j = 1/v_j$, then the weights are computed with the formula: $\omega_j = s_j \big/ \sum s_j$. Therefore, a more volatile series is usually assigned a smaller weight, so that the weighted sum can reflect the most common trend of individual series. We will call this method the SD weighting, which is the main weighting approach employed by the US Conference Board in constructing various economic indexes and will be employed in our research below, together with other weighting methods.

In order to check whether this finding changes with the form of the production function, we estimate the CES function (t-statistics in parentheses):

For the coastal area

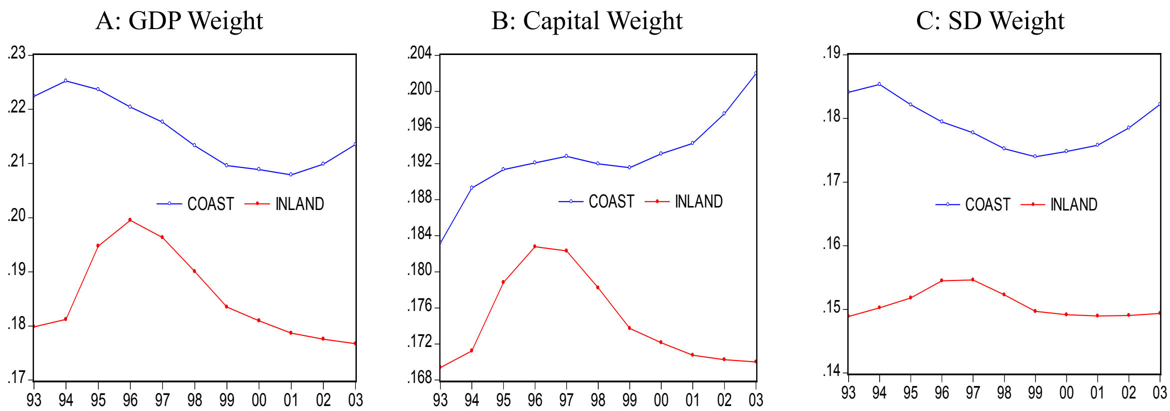
A = 10.620 (7.604), α = 0.036 (5.164) and ρ = – 0.003 (0.226), R^2 = 0.935,

For the inland area

A = 25.066 (7.485), α = 0.045 (8.247) and ρ = 0.001 (0.078), R^2 = 0.957.

In both cases we find that ρ is insignificant, suggesting that the elasticity of substitution is not different from 1, consistent with the result at the national level. Therefore, the CD function seems to be an appropriate production function for China. In Figure 14 we show the MPC of inland and coastal areas with alternative weighting methods to compute the average product of capital stock, *Y/K*. The inland MPC has been lower than that in the coastal area no matter which weighting method (GDP weight, capital stock weight or SD weight) is used to compute the aggregate *Y/K*. The results are similar to those derived from the CD production function as shown in Figure 13.

Figure 14: MPC in coastal and inland areas from CES function



To summarize, based on estimated production functions at the national and provincial levels, we find that: (a) assuming that the Chinese economy was operating on the production frontier, China's MPC has stayed at an elevated level and has not shown any clear signs of declining; (b) the coastal area has had higher MPC than the inland area during 1993-2003, and (c) China's TFP growth rate has been relatively high, when compared with other economies.

IV. MPC OF INFRASTRUCTURE CAPITAL

In this section we study the marginal product of infrastructure capital stock. Following Aschauer (1989), we write the production function with infrastructure capital stock as follows:

$$Y_t = A_t f(NIK_t, IK_t, L_t) = Ae^{\alpha t} f(NIK_t, IK_t, L_t)$$

where *NIK* denotes non-infrastructure capital stock, *IK* the infrastructure capital stock and *L* employment. We employ the same Cobb-Douglas production function as Aschauer (1989): $Y_t = Ae^{\alpha t} NIK_t^{\beta} L_t^{1-\beta} IK_t^{\theta}$. This production function assumes constant returns to scale with respect to non-infrastructure capital stock (or private capital in Aschauer, 1989) and labour, but increasing returns to scale with respect to all inputs.[27] Taking logarithms of both sides of the above function, we have the following equation:

$$\ln y_t = \ln A + \alpha t + \beta \ln nik_t + \theta \ln IK_t$$

with $y_t = \dfrac{Y_t}{L_t}$ and $nik_t = \dfrac{NIK_t}{L_t}$.

We do not estimate the above equation with the national time series data since we have constructed the infrastructure capital stock only for the period of 1992-2002, which is too short to generate reliable estimates for five parameters. Instead, we estimate the above equation with cross-section data from 1992-2002, obtaining eleven regressions, each with 30 observations.[28] We then calculate the marginal product of infrastructure capital stock, $\theta_t \dfrac{Y_t}{IK_t}$, with *Y/IK* being the ratio of national product to infrastructure capital stock. The estimate of θ and the MPC of infrastructure are shown in Figure 15.

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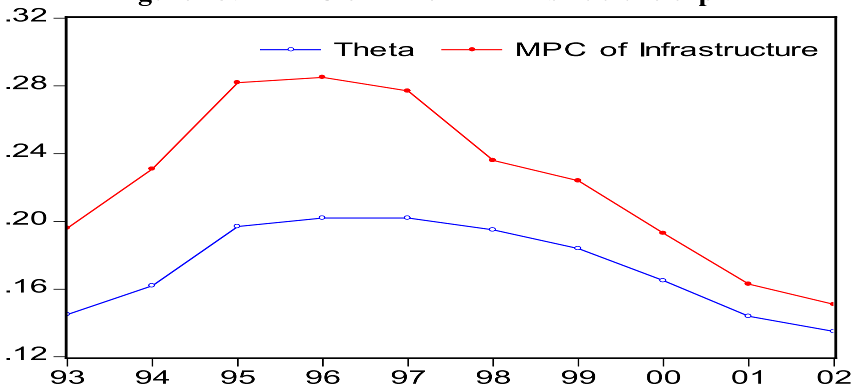
[27] This assumption is based on the possibility of spill-over effects in public capital stock, and appears reasonable in the case of China, considering that China's economy has been affected by the "bottleneck" sectors. In addition, this assumption helps us to overcome multi-collinearity between infrastructure and non-infrastructure capital stock.

[28] Time *t* is not included as an explanatory variable in the cross-section regression.

Figure 15: MPC of national infrastructure capital



We also estimate the above equation with panel data, as has been done for the total capital stock in coastal and inland provinces. The regression with the panel data of total (social plus physical) infrastructure capital of 1993-2002 for the eleven coastal provinces reads:

$$\ln y_t = \underset{(20.832)}{2.699} + \underset{(11.862)}{0.043}\, t + \underset{(42.653)}{0.593} \ln nik_t + \underset{(1.156)}{0.018} \ln IK_t, \quad R^2 = 0.976$$

It is clear that non-infrastructure capital has a larger coefficient than the infrastructure capital. The regression result with the panel data of nineteen inner provinces (1993-2002) reads:

$$\ln y_t = \underset{(8.612)}{3.910} + \underset{(5.206)}{0.071}\, t + \underset{(11.996)}{0.467} \ln nik_t + \underset{(1.800)}{0.082} \ln IK_t, \quad R^2 = 0.999$$

Infrastructure capital also has a lower coefficient than non-infrastructure capital. However, infrastructure capital seems to have played a more important role in the production in inland provinces than in coastal areas during 1993-2002, as evidenced by the following two points: (a) θ has a more significant t-statistic in the inland regression, and (b) the ratio of β to θ is higher in the coastal regression (32.944) than in the inland regression (5.695).[29]

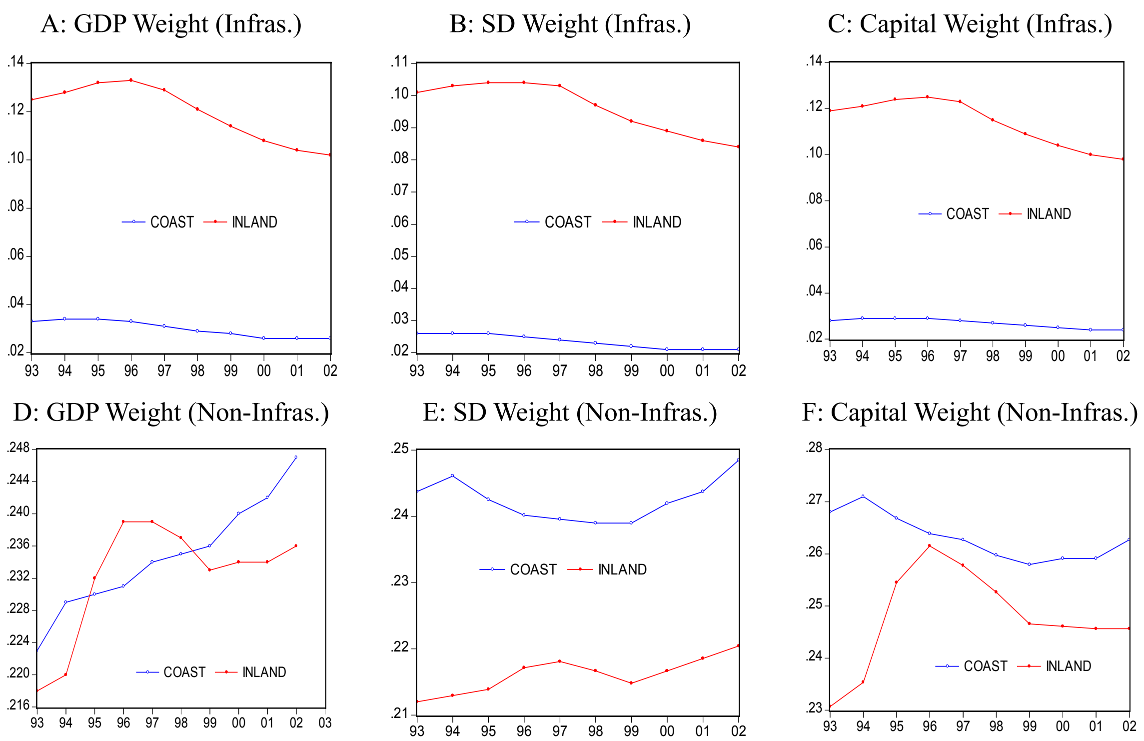
With the estimate of θ we then compute the marginal product of infrastructure capital, namely, $\theta \frac{Y_t}{IK_t}$, as shown in Figures 16A-C with alternative weighting approaches. We see that the marginal product of infrastructure capital in the inland area has been higher than in the coastal area. In fact, $\frac{Y_t}{IK_t}$ is higher in the coastal area than in the

[29] The above regressions are undertaken with cross-section weights (i.e. generalized least squares with panel data).

inland area during 1992-2002, but the fact that the θ in inland provinces exceeds that in the coastal area dominates and, as a result, leads to higher marginal product in the inland area, which suggests that infrastructure capital stock was potentially more productive in the inland provinces than in the coastal counterparts. In the coastal area, the sources of growth with respect to non-infrastructure and infrastructure capital during 1993-2002 were 0.063 and 0.002, with their contributions to output growth being 57.80% and 1.83%, respectively. In the inland area, however, the sources of growth with respect to non-infrastructure and infrastructure capital were 0.041 and 0.010, with the contributions to growth being 42.70% and 10.40%, respectively. Thus, infrastructure capital seems to have made larger contributions to output growth in inland areas than in the coastal area during 1993-2002.

The marginal product of non-infrastructure capital stock is shown in Figures 16 D-F which indicate that the coastal area had higher marginal product of non-infrastructure capital if SD weighting or capital weighting is used. If GDP weighting is used, the coastal area had higher MPC of non-infrastructure capital in most years during 1993-2002.

Figure 16: Marginal product of infrastructure and non-infrastructure capital



V. MPC AND THE ALLOCATIVE EFFICIENCY OF INVESTMENT

The theory of marginal productivity suggests that, at the optimum, the return to capital should equal the MPC. In other words, the MPC measures the return to capital if the economy is efficient and operates on the production frontier. Thus one way to measure the allocative efficiency of investment is to examine how investment growth is correlated with MPC. If allocative efficiency is high, then more investment should be spent in areas that have a higher MPC. As discussed earlier, China's MPC has been found to be higher than that in other East Asian economies when they were growing fast. This observation may provide the rationale for the fact that China's investment growth has been higher than in those economies. To analyse the correlation patterns more formally, we estimate the following equation:

$$\Delta RGCF_t = \phi_1 + \phi_2 MPC_t$$

with $\Delta RGCF$ denoting real gross capital formation growth and MPC is the marginal product of capital from the CD production function. The panel data of 1994-2003 generate the following results:[30]

Table 3: Estimates of ϕ_2

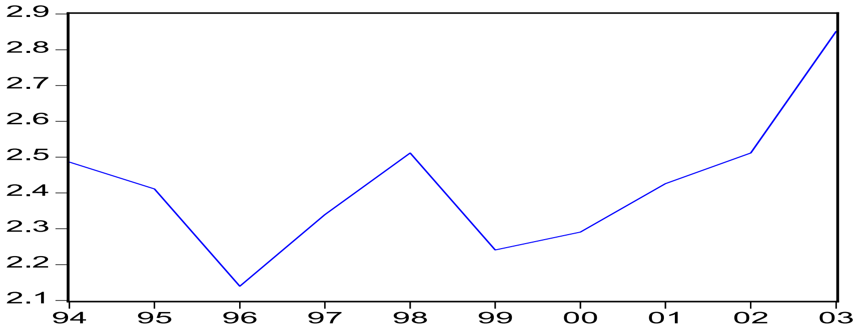
Area	ϕ_2 (t-st.)	R^2
National	1.803 (6.461)	0.294
Costal	1.814 (4.440)	0.396
Inland	1.186 (3.301)	0.120

As can be seen in the table, all estimates of ϕ_2 have positive signs and significant t-statistics. Figure 17 shows the estimate of time-varying ϕ_2 with national panel data of 1994-2003.[31] It experienced significant fluctuations during 1996-1999 but has showed an upward trend in recent years, implying that the positive relationship between the growth of investment and MPC has become stronger. Table 3 also shows that the positive relationship between investment growth and the MPC was stronger within the coastal areas than within the inland areas, implying that the allocative efficiency of investment was higher in the coastal areas.

[30] The equation is estimated with fixed effects and the AR(1) process to deal with first-order residual serial correlation. The estimates of ϕ_2 would be smaller, though still have significant t-statistics, if no fixed effects are assumed. R^2 would also be lower than shown in Table 3.

[31] The estimation with panel data here is similar to the cross-section regression. The estimates with common intercept are lower in magnitude.

Figure 17: Time-varying ϕ_2



We also examine the allocative efficiency of infrastructure investment by estimating the following equation:

$$\Delta FAI_{it} = \varphi_1 + \varphi_2 MPC_{it}$$

where ΔFAI_i denotes the real growth in infrastructure investment, and MPC_{it} is the MPC of infrastructure capital. The estimation results with panel data of 1994-2002 read as[32]

Table 4: Estimates of φ_2

Area	φ_2 (t-st.)	R^2
National	3.526 (2.709)	0.242
Costal	16.074 (4.163)	0.376
Inland	2.935 (1.528)	0.074

Table 4 shows that the MPC has significant correlation with the growth of infrastructure investment at both national level and in the coastal area, but the correlation was statistically insignificant in the inland areas, possibly implying that the allocative efficiency of infrastructure investment was lower in the inland provinces than in the coastal area. This probably reflected the fact that infrastructure was considered public goods. Investment in infrastructure has mainly been undertaken by the public sector, which does not necessarily act in line with profit-maximizing principles. Nevertheless, the above empirical results appeared to indicate that infrastructure investment in the coastal area has been more market-driven than in the inland provinces.

[32] Fixed effects and first-order serial residual correlation have been considered. The estimates are less significant otherwise.

The allocative efficiency of investment funded by different sources (i.e., state budget, domestic loans, foreign direct investment and self-raised funds) may also differ since the investor faces different incentives, as analysed by Boyreau-Debray and Wei (2005). To further examine the issue, we regress the real growth of investment decomposed into the four funding sources on the total MPC,[33]

$$\Delta FAI_{ft} = C_1 + C_2 MPC_t$$

where ΔFAI_f denotes the real growth of FAI with different funding sources. The regression results with national time series data of 1982-2003 are shown in Table 5:[34]

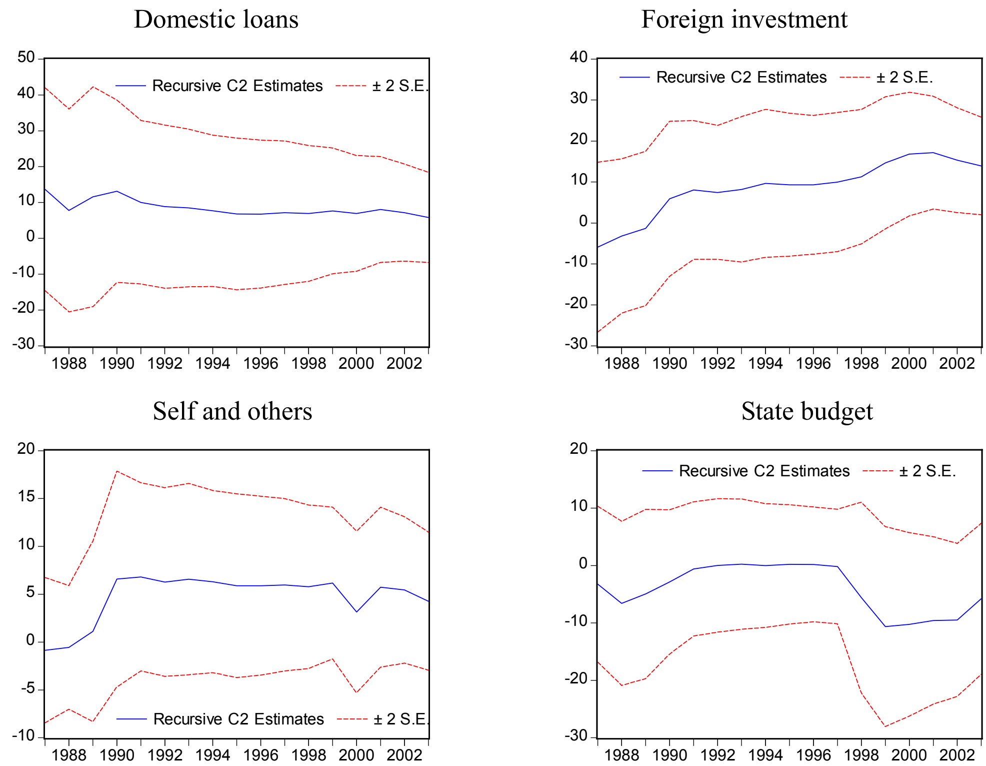
Table 5: Estimates of C_2

Source	C_2 (t-st.)	R^2
Self raised funds	5.401 (2.041)	0.100
Domestic loans	8.756 (0.843)	0.129
Foreign investment	18.226 (2.776)	0.516
State budget	− 5.355 (0.791)	0.239

These results indicate that foreign investment had the highest allocative efficiency, followed by self–raised funds, while investment funded by bank loans and state budget had low allocative efficiency. The RLS estimates of C_2 are shown in Figure 18.

[33] FAI growth is deflated with an investment index calculated the same way as in Li (2003).
[34] The equation is estimated as an AR(1) model to deal with first-order residual serial correlation.

Figure 18: RLS estimate of C_2



VI. The Dynamic Efficiency of Investment

Although the allocative efficiency of China's investment may have been improving, is the rate of investment, at around 45% of GDP, too high? It has been argued that the high investment growth rates are sustainable because the investments have been profitable (Liang 2006). It is possible that the rate of profit has been kept high because input prices such as energy cost and the cost of environmental protection have been kept artificially low. Thus high investment growth rates could be undesirable even if the return on capital has been high. Therefore, being profitable and efficient does not necessarily imply sustainability.

An alternative way to answer the question whether the current rate of investment is too high is by examining the dynamic efficiency of investment. The dynamic efficiency measures the extent to which the capital stock of an economy exceeds its optimal level. A Pareto improvement can be achieved in a dynamically inefficient economy by allowing the current generation to lower its rate of investment and raise its rate of consumption and then holding constant the consumption of all future generations.

Traditionally, the dynamic efficiency of an economy is typically judged by comparing the real interest rate with the real rate of economic growth. If the former is equal to or larger than the latter, then the economy would be considered as dynamically efficient. However, Abel *et al* (1989) show that, in a world of uncertainty, the correct way of judging whether there is dynamic efficiency is to compare the cash flow generated by production after the payment of wages with the level of investment: an economy is dynamically efficient if it invests less than the return to capital and is inefficient if it invests more than the return to capital. Intuitively, a capital sector that is on net making resources available by producing more output that it is using for investment is contributing to consumption, whereas one that is using more in resources than it is producing is not contributing to consumption. The former is a dynamically efficient outcome but the latter is not.

Following Abel *et al* (1989), we measure capital income as GDP minus employees' compensation, or as the sum of operating surplus and depreciation allowance. Taxes on production are apportioned between capital income and labour income according to their relative shares in GDP at factor cost.[35] Since GDP by income is available in China only at the provincial level, and not available at the national level, we derive the national aggregates from the sum of the provincial aggregates. Figure 19 compares the capital income with the level of gross capital formation, both expressed as a ratio to GDP. It is clear that the level of investment was consistently larger than capital income during 1992-2003, indicating that the Chinese economy was dynamically inefficient.

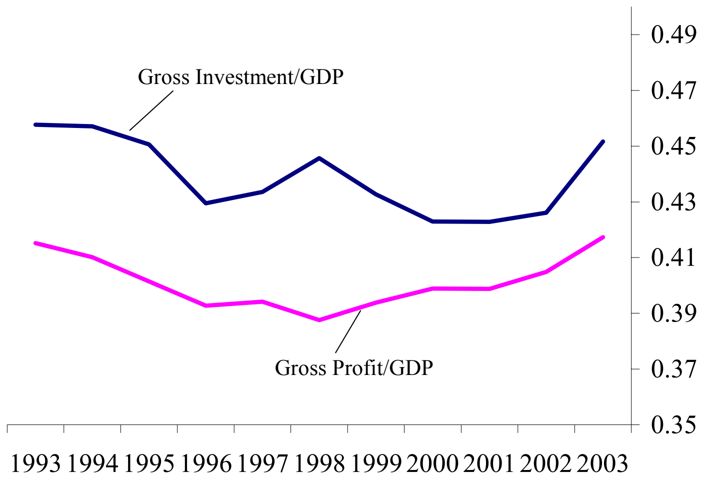
One important caveat is in order, as pointed out by Abel *et al* (1989): "a path cannot be judged as dynamically efficient or dynamically inefficient prior to eternity. That is, dynamic efficiency cannot in principle be judged by observing only a particular segment of time. These calculations do allow us to conclude, however, that if the economy behaves in the future as it has in the past, it will be realizing a dynamically efficient equilibrium." Thus for the Chinese economy, our conclusion is that, if the rate of investment continues to exceed the rate of profit indefinitely into the future, then the economy is dynamically inefficient.

A further caveat is that the methodology used in Abel *et al* (1989) assumes perfect competition and constant returns. If profits are overstated as indicators of the return to capital because they include monopoly rents, then the test is biased

[35] Since taxes on production include taxes on the labour employed, or compensation of employees paid during the production process, it would be problematic to assign all taxes on production as capital income. For example, if we assign all taxes on production (about 14% of GDP) as capital income, profits' share in GDP would amount to 51% of GDP in 2003. Instead, we apportion 6% of the 14% taxes to capital income, and apportion 8% of the 14% taxes to labour income, since capital income's share in GDP at factor cost is about 42%, and labour income's share is 58%.

towards accepting the hypothesis that the economy is dynamically efficient. However, in our case, this bias would strengthen our argument. Since many of the profitable state-owned enterprises in China derive their profits from being in monopolistic positions, particularly in the upstream energy, telecommunications and other government-regulated sectors, their profits therefore contain monopoly rents. In other words, if monopoly rents are removed from the measurement of profits, then the rate of profit in China would be lower, which would strengthen our argument that the investment rate is too high, and the economy is dynamically inefficient.

Figure 19: Comparing investment and capital income



VII. CONCLUSIONS

In this paper we have first constructed China's total (and infrastructure) capital stock at national and provincial levels. Employing these data we have then estimated the Cobb-Douglas and CES production functions and computed the marginal product of capital stock (MPC). We have analysed the correlation patterns between the growth of investment and the marginal product of capital. We have also examined the question whether the current rate of investment is too high by applying the methodology developed by Abel *et al* (1989) to judge the dynamic efficiency of an economy. The main findings are summarized as follows:

(1) Assuming that the Chinese economy was operating on the production frontier, the marginal products of capital at the aggregate level have been relatively high in the past two decades, and have not shown clear signs of decline in recent years. China's marginal product of capital compares favourably with those observed in the major industrialised economies and in the Asia region. The marginal products of capital have been higher in the more developed coastal areas than in the less

developed areas of western and central China, but the marginal products of infrastructure capital have been higher in the inland areas than in the coastal areas. These results are robust to different assumptions made in constructing the data of capital stock.

(2) In recent years, the correlation between the growth of investment and the marginal product of capital has been increasing, implying that the allocative efficiency of investment has improved. The positive relationship between the growth of investment and the marginal product of capital was stronger within the coastal areas than within the inland areas, implying that the former had higher allocative efficiency than the latter. Among the various types of investment, FDI had the highest allocative efficiency. Infrastructure investment in the inland areas appeared to have had low allocative efficiency, possibly reflecting the observation that infrastructure investments in those areas were typically made by the public sector without much consideration for current period rates of returns.

(3) The rate of investment in China consistently exceeded the share of capital income in GDP during 1992-2003. This implies that the rate of investment in China has been too high, and the Chinese economy is probably on a dynamically inefficient growth path. This provides analytical support to the government's intention to reduce the rate of investment and raise the rate of consumption.

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Appendix 1: Li's (2003) methodology of national capital stock construction

Chow (1993, 2002) constructs a capital stock series for China at national level. Li (2003), based on slight improvements to Chow's methodology, constructs a new capital stock series for China. The capital stock of 1952, the starting year, was 221.199 billion RMB in 1978 price. This starting value was taken from Chow (1993) which was the sum of the constructed capital stock in five sectors of agriculture, construction, commerce, industry and transportation.[36] The data of *accumulation* in official statistics were used as real net investment for the period of 1953-1978 because the price of investment goods was almost constant during this period. Net investment (NI) for 1993-1998 was computed with the following formula:

$$NI_t = GI_t - D_t,$$

with *GI* denoting gross investment and *D* the depreciation of capital stock. Li (2003) summed up the provincial depreciation of fixed assets as the national capital stock depreciation.[37] Gross investment was computed with the formula:

$$GI_t = GDP_t - C_t - NX_t,$$

where *GDP* denotes the production-based gross domestic product,[38] *C* denotes consumption and *NX* the net exports. Consumption and net exports were deflated with consumption price index and GDP deflator, respectively. Based on the capital stock of 1992, Li (2003) computed the capital stock for 1993-1998 with the following formulae:

$$K_t = K_{t-1} + RNI_t$$

$$RNI_t = RGI_t \times \frac{NI_t}{GI_t}$$

where *RGI* denotes the real gross investment (real GDP minus real consumption and net exports). The main problem here is how to get a reasonable capital stock for 1992. Assuming the depreciation rate to be 0.04 during 1979-1992, Li constructed the capital stock series for 1979-1992 as follows:

$$K_t = 0.96K_{t-1} + RGI_t$$

Next, with the capital stock series constructed for 1993-1998, Li (2003) computed the depreciation rate for 1993-1998. Taking the average depreciation rate of 1993-1998 (0.054) as the depreciation rate of 1979-1992, he re-computed the capital stock series for 1979-1992 with the following formula:

$$K_t = 0.946K_{t-1} + RGI_t$$

Finally, he used the newly constructed capital stock of 1992 to re-construct the capital stock series for 1993-1998 with the following equation:

$$K_t = K_{t-1} + RNI_t.$$

Chow (1993, 2002) just assumes the depreciation rate to be 0.04 during 1981-1998.

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[36] The reader is referred to Chow (1993) for the details of the construction of the initial capital stock.

[37] He did not adjust the depreciation as Qiu (2006).

[38] Li (2003) always takes production-based GDP from China's Statistical Yearbook to measure China's GDP in capital stock construction and estimation.

Appendix 2: Data sensitivity analysis

In the paper we estimated the marginal product of capital at the national and provincial levels using data constructed with Li's methodology, which is, of course, not the only way to do so, and not necessarily the best.[39] In this appendix we use alternative sets of data of provincial capital stock to check how sensitive our results are to different methods of data construction.

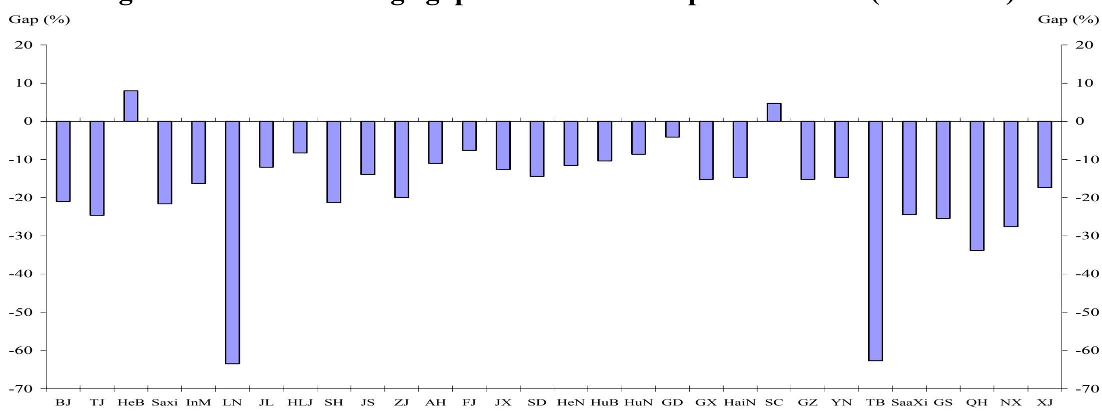
(1) Wu's (2004) data set

Wu (2004) constructs provincial capital stock with the so-called *backcasting approach*, through which the incremental capital stock was first backcasted to 1900:

$$K_t = \sum_{i=0}^{t-1901} (1-\delta)^i \Delta K_{t-i} + (1-\delta)^{t-1900} K_{1900}$$

where 1900 is taken as the starting year and K_{1900} assumed to be zero, with the depreciation rate δ set at 7%. We compute the percentage gaps between Wu's provincial data and those used in our estimation and find that Wu's provincial capital stocks are smaller than ours for most of the provinces. The average percentage gaps of 1993-2003, namely the differences between Wu's data and ours divided by our capital stock, are shown in the following figure.

Figure A2-1: Percentage gap between Wu's capital and ours (1993-2003)



As can be seen from Figure A2-1, Liaoning and Tibet are the two provinces with the largest gaps, -63.5% and -62.7%, respectively, while Guangdong and Sichuan have the lowest gaps, -4.1% and 4.7%, respectively. The average gap of the thirty provinces is -17.5%. The fact that Wu's data are lower than ours for most of the provinces is probably attributed to the assumed depreciation rate of 7%, which might be too high. As will be shown below, the national depreciation rate derived from Li's capital stock ranges between 1.75% and 5.77% for the sample period of 1953-2003, averaging 3.6%. A smaller depreciation rate would lower the gaps shown in the above chart.

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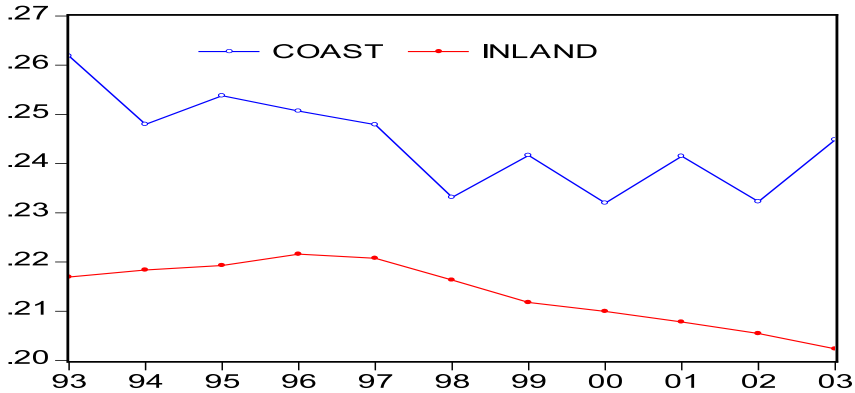
[39] Wang and Hu (1999), for example, assume that the ratios of provincial capital stock to national capital were the same as those of provincial GDP to national GDP in 1978, and construct provincial capital stock for 1978-1995.

We calculate the MPC with Wu's provincial data of 1992-2003 by estimating the CD production function.[40] As shown in Figure A2-2, the inland area had lower MPC than the coastal area, similar to our results in Figure 14.[41]

Figure A2-2: MPC from Wu's data



(2) Perpetual inventory approach

We also use the perpetual inventory approach (PIA) to construct provincial capital stock data. Assuming a constant depreciation rate of capital stock and the growth rate of investment to be δ and g, respectively, the capital stock formula reads:

$$K_t = (1-\delta)K_{t-1} + I_t = (1-\delta)^2 K_{t-2} + \frac{1-\delta}{1+g} I_t + I_t$$

$$= (1-\delta)^3 K_{t-3} + \left(\frac{1-\delta}{1+g}\right)^2 I_t + \frac{1-\delta}{1+g} I_t + I_t$$

$$= (1-\delta)^T K_{t-T} + \left(\frac{1-\delta}{1+g}\right)^{T-1} I_t + \ldots + \frac{1-\delta}{1+g} I_t + I_t$$

It is clear that $K_t \to \frac{1+g}{\delta+g} I_t$ as $T \to \infty$, implying that as long as I_t, δ and g are known, K_t is then available.

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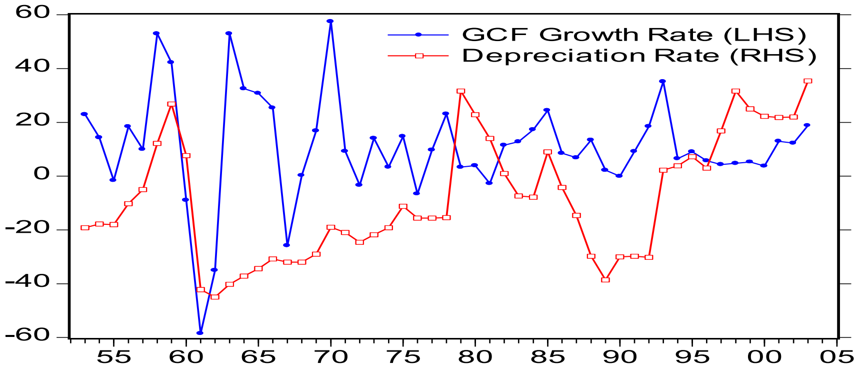
[40] The share of capital estimated from the CD production function is 0.711 and 0.570 in coastal and inland areas, respectively. We updated Wu's data from 2001 to 2003.

[41] The SD weighting is used in computing the average product of capital, as in Figure 14C. Note that we have also computed the MPC in both areas with GDP and capital-stock weighting and found similar results.

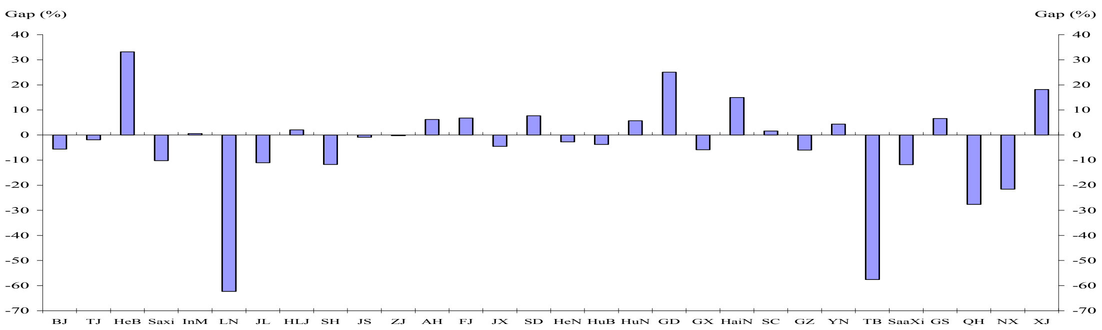
We use the above formula to calculate the provincial capital stock for 1993, the initial year of the sample period, with the estimated values of the depreciation rate and growth rate of investment for each province.[42] We then construct the provincial capital stock up to 2003 with the formula $K_t = K_{t-1} + RNI_t$, with the RNI constructed in section 2. The average percentage gaps (1993-2003) between the capital stock constructed with PIA and that constructed in section 2 are shown in Figure A2-4.

Figure A2-3: National GCF growth and depreciation rate (%)



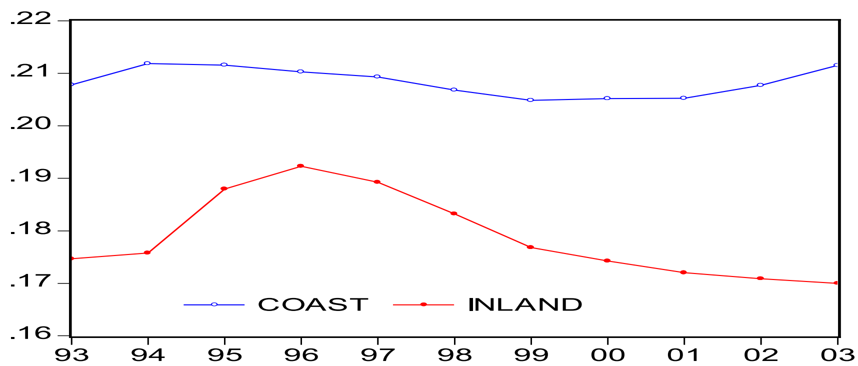
[42] The issue is how to get reasonable estimates of δ and g, since I_t in 1993 is known (real gross capital formation). For most provinces the data of gross capital formation is available only for the period after 1993, which is too short to generate a reasonable estimate of g. The same difficulty exists in computing the depreciation rate δ. The provincial depreciation rate δ_{it} (i=1…30) in year t is computed with the formula: $\delta_{it} = \frac{\mu_{it}}{\mu_t}\delta_t$, with μ_{it} and μ_t denoting the provincial and national GDP growth rates in year t and δ_t the national depreciation rate. This formula hypothesizes that a higher GDP growth leads to higher depreciation rate of assets. The national depreciation rate shown in Figure A2-3 is derived from the national capital stock data constructed in section 2, averaging 3.6% during 1953-2003. The constant provincial depreciation rate δ_i is just approximated by the average value of δ_{it}. The provincial GCF growth is approximated by the FAI growth rate, because FAI growth rate is available since 1982 in all provinces while the GCF growth is available only after 1990 in most cases. In order to get the provincial FAI growth rate before 1982, we first regress the provincial FAI growth on the national GCF growth for the period of 1982-2004, then assuming structural stability, we construct the provincial FAI growth before 1982 from national GCF growth of the same period using the parameters obtained in the regression. The constant provincial GCF growth rate g_i is then approximated by the average provincial FAI growth rate of the period 1953-2004. In principle, we should use the data up to 1993 in calculating δ_i and g_i to construct the capital stock of 1993. But $K_t \rightarrow \frac{1+g}{\delta + g} I_t$ holds only if $T \rightarrow \infty$. Therefore, we have used the data up to 2004 in calculating δ_i and g_i so that the estimates may be closer to their long-term values as a result of the longer sample.

Figure A2-4: Percentage gaps between PIA capital and ours (1993-2003)



As can be seen in Figure A2-4, Liaoning and Tibet are the two provinces with the highest gaps, -62.3% and -57.6%, while Inner Mongolia has the lowest, 0.6%. The average gap during 1993-2003 of thirty provinces is -3.7%. The MPC derived from the CD production function is shown in Figure A2-5 and also looks similar to the result from Wu's data and those in section 3.[43]

Figure A2-5: MPC with the PIA data



[43] The capital share in the CD production function is 0.614 and 0.466 for coastal and inland areas, respectively. Here GDP weighting is used. Similar results are found with SD and capital-stock weighting.

Appendix 3: Figures and tables

Figure A3-1: Capital share (β), output-capital ratio and MPC of Indonesia, Malaysia and Philippines, Sarel (1997)

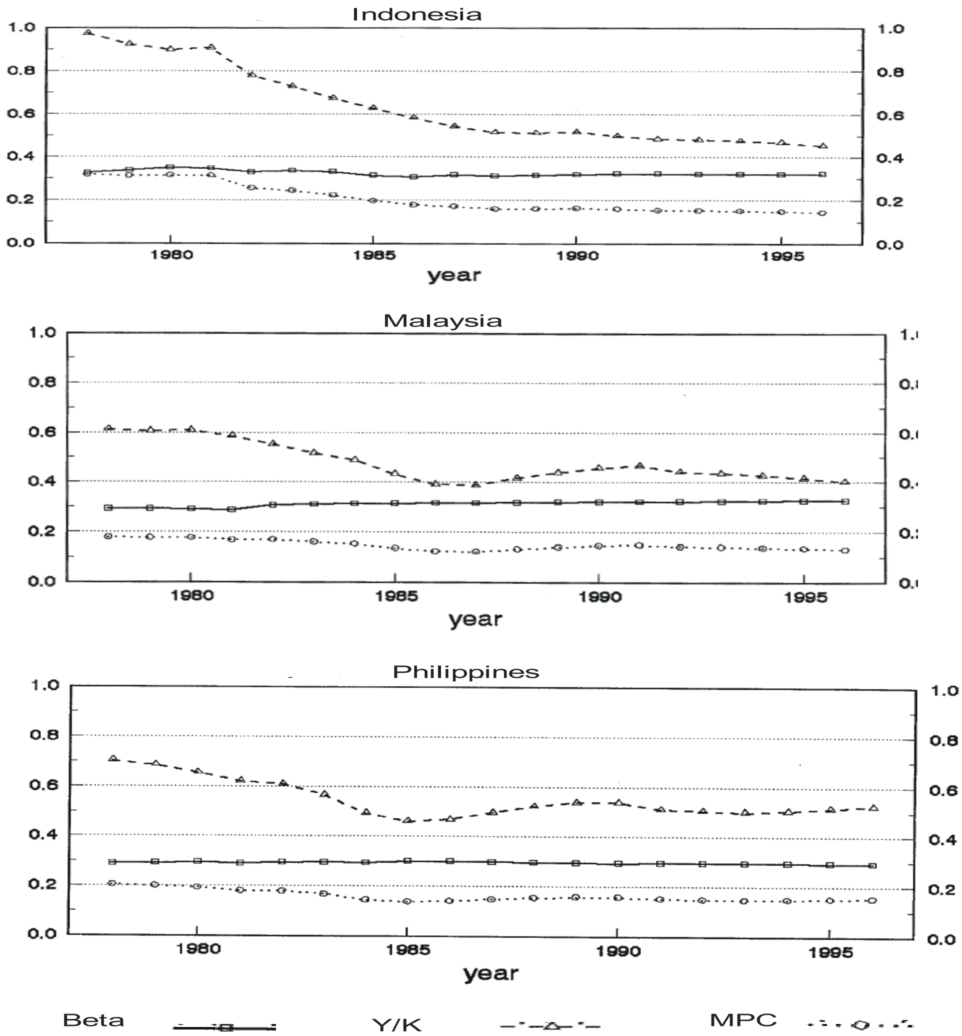


Figure A3-2: Capital share (β), output-capital ratio and MPC of Singapore, Thailand and the US, Sarel (1997)

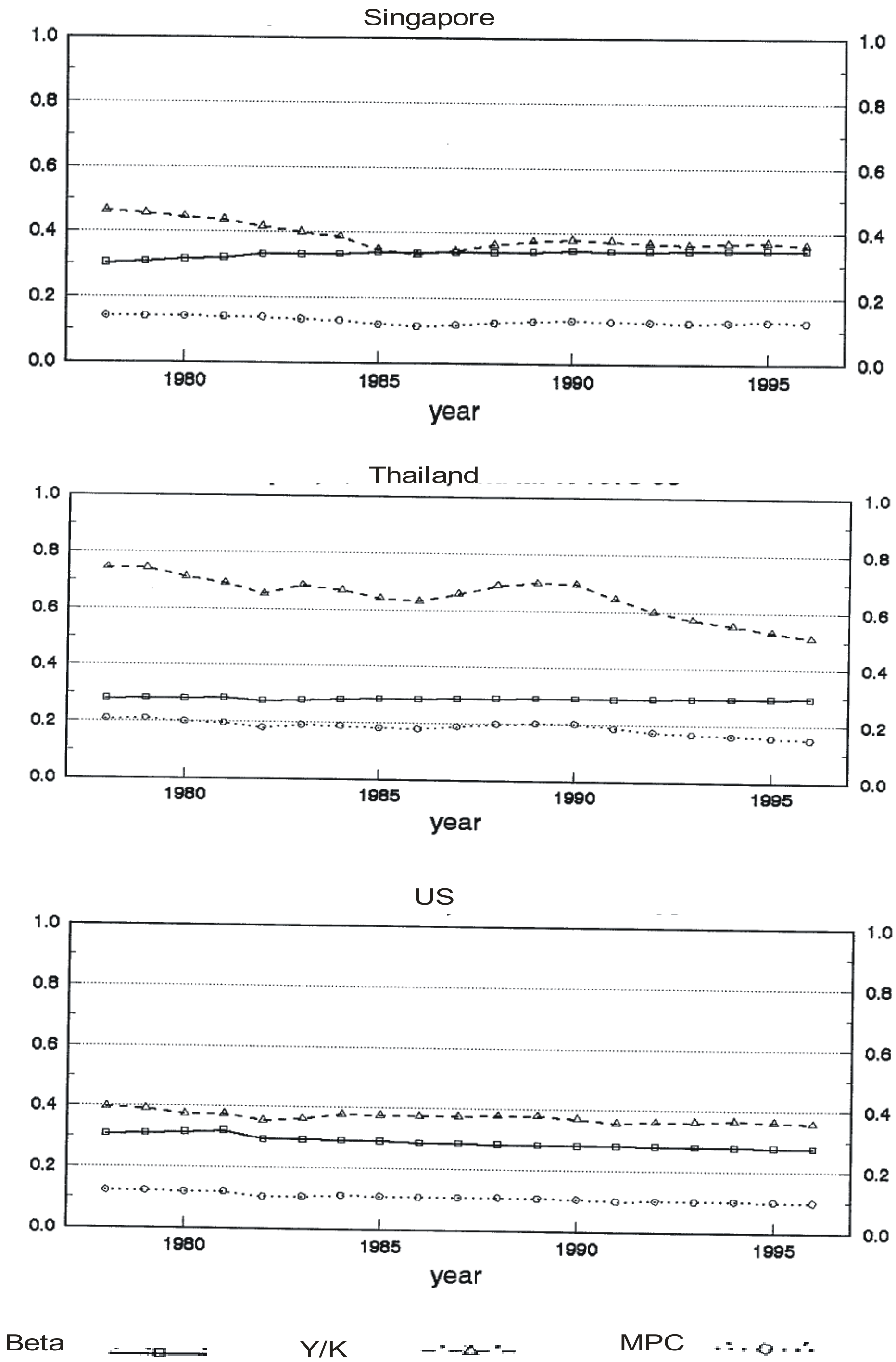


Table A1: National capital stock (billion RMB, 1978 price)

Year	Capital	% of GDP	% Growth	ICOR	Per capita
1978	1411.20	391.39	8.35	2.86	na
1979	1488.21	378.29	5.46	2.80	na
1980	1573.54	371.54	5.73	2.80	na
1981	1656.93	371.47	5.30	3.77	na
1982	1765.35	353.01	6.54	2.72	na
1983	1899.18	346.76	7.58	2.55	na
1984	2062.76	335.12	8.61	2.01	na
1985	2259.80	329.58	9.55	2.37	na
1986	2487.69	329.11	10.08	3.68	2313.98
1987	2741.36	327.72	10.20	2.88	2508.11
1988	3052.47	328.01	11.35	3.25	2749.33
1989	3377.33	352.74	10.64	8.46	2996.64
1990	3680.55	365.01	8.98	8.05	3219.15
1991	4011.50	365.55	8.99	3.53	3463.48
1992	4413.19	356.92	10.01	2.53	3766.45
1993	4868.60	343.62	10.32	2.56	4107.93
1994	5346.58	336.33	9.82	2.52	4461.06
1995	5863.40	334.67	9.67	2.88	4840.95
1996	6393.77	332.56	9.05	2.91	5224.14
1997	6921.45	333.47	8.25	2.84	5598.70
1998	7451.75	337.33	7.66	3.09	5972.82
1999	7994.46	341.39	7.28	3.01	6355.60
2000	8537.67	344.28	6.79	2.54	6736.20
2001	9166.81	341.82	7.37	2.75	7182.50
2002	9889.88	338.99	7.89	2.67	7699.22
2003	10780.03	335.99	9.00	2.73	8341.93

Sources: Li (2003) and authors' estimates.

Table A2: Provincial capital, bn RMB 1978 price (% of GDP and per capita Yuan in parentheses): coastal provinces

	Beijing	Tianjin	Hebei	Liaoning	Jiangsu	Zhejiang
1984	86.2 (448.6%, na)	56.4 (399.3%, na)	63.4 (219.4%, na)	291.9 (810.8%, na)	176.7 (381.8%, na)	96.2 (361.2%, na)
1985	94.4 (452.3%, na)	62.2 (398.1%, na)	68.5 (210.7%, na)	327.6 (803.4%, na)	191.1 (352%, na)	105.4 (325%, na)
1986	103.7 (456.4%, na)	68.7 (415.8%, 8391)	73.7 (215.6%, na)	366.2 (829%, 9827)	209.7 (349.8%, na)	115.9 (319%, na)
1987	116.1 (466.2%, 10885)	74.1 (416.9%, 8921)	78.6 (206%, 1376)	410.2 (814%, 10860)	230.2 (338.7%, 3626)	128.8 (317%, 3129)
1988	129.4 (460.5%, 11970)	83 (441%, 9844)	85.1 (196.6%, 1468)	459.4 (816.1%, 12026)	255 (313.7%, 3961)	142.5 (315.3%, 3416)
1989	144.2 (491.6%, 13904)	90.5 (473.6%, 10575)	89.2 (194.2%, 1517)	509.5 (877.8%, 13144)	276.4 (331.7%, 4229)	153.8 (342.3%, 3655)
1990	158.3 (512.2%, 14580)	97 (481.3%, 10969)	94 (193.4%, 1526)	559.3 (955.1%, 14099)	299.8 (342.7%, 4431)	161.1 (345.2%, 3865)
1991	171.3 (504.1%, 15658)	105.2 (492.7%, 11577)	100.2 (185.7%, 1610)	611.8 (984.6%, 15333)	327 (345.1%, 4777)	172.1 (313%, 4095)
1992	188.2 (497.5%, 17074)	117.1 (490.7%, 12725)	112.1 (179.9%, 1787)	670.9 (963.3%, 16705)	371.3 (311.9%, 5372)	191.2 (292.2%, 4513)
1993	214.1 (504%, 19249)	129.2 (483.3%, 13926)	133.5 (181.9%, 2107)	697.3 (871.3%, 17251)	431.1 (302.4%, 6188)	221.8 (277.8%, 5198)
1994	244.6 (506.5%, 21741)	143.3 (468.8%, 15325)	157.6 (186.9%, 2467)	724.1 (813.7%, 17804)	495.2 (298.1%, 7054)	255.1 (266.3%, 5940)
1995	282 (521.5%, 22545)	158.1 (450.3%, 16787)	187.8 (195.6%, 2918)	747 (783.8%, 18256)	564.7 (294.6%, 7991)	302.2 (270.3%, 6996)
1996	310.4 (526.6%, 24657)	174 (433.4%, 18352)	223.6 (205.2%, 3449)	767.8 (741.7%, 18653)	633.8 (294.7%, 8914)	352.6 (280%, 8120)
1997	339.3 (522.9%, 27366)	192.4 (427.6%, 20192)	264.7 (215.9%, 4057)	787.9 (699%, 19040)	706.4 (293.3%, 9882)	406.7 (290.6%, 9170)
1998	369.6 (520.1%, 29663)	211.6 (430.2%, 22110)	312.3 (230.1%, 4754)	807 (661.1%, 19414)	791.3 (296%, 11018)	468.3 (303.9%, 10510)
1999	402.7 (511%, 32039)	230.4 (425.9%, 24029)	361.9 (244.4%, 5472)	825.3 (624.8%, 19785)	883.3 (300.1%, 12246)	529.8 (312.6%, 11840)
2000	433 (491.4%, 31332)	250.5 (417.8%, 25021)	414.4 (255.6%, 6145)	846.7 (588.6%, 19978)	983.5 (302.1%, 13223)	589.2 (313.2%, 12599)
2001	467.6 (475.1%, 33814)	273.1 (406.8%, 27205)	468.6 (265.8%, 6995)	871.2 (555.6%, 20772)	1087.3 (303%, 14783)	651.3 (313.3%, 14119)
2002	505.3 (460.4%, 35505)	298.5 (395.2%, 29640)	524.8 (271.7%, 7793)	902.1 (522.1%, 21464)	1205.7 (301.1%, 16335)	726.5 (310.6%, 15633)
2003	547 (449.1%, 37560)	329.7 (380.2%, 32612)	589.1 (273.2%, 8703)	942.1 (489%, 22377)	1361.8 (299.4%, 18387)	825.7 (308.6%, 17644)

	Shandong	Guangdong	Hainan	Shanghai	Fujian	Simple Average Per Capita
1984	132.2 (311.4%, na)	113.5 (320.7%, na)	11.5 (385.9%, na)	151.4 (350%, na)	37 (282.4%, na)	n.a.
1985	141.9 (300%, na)	120.9 (289.6%, na)	12.8 (383.6%, na)	165.8 (338%, na)	39.9 (258.8%, na)	n.a.
1986	152.3 (302.9%, na)	128.8 (273.6%, na)	14.3 (393.8%, 2356)	183.6 (358.5%, na)	43.6 (267.7%, 1586)	n.a.
1987	166.9 (291.8%, 2098)	138.7 (246.4%, 2151)	15.6 (386.4%, 2531)	201.3 (365.7%, 16104)	47.6 (257.3%, 1697)	5761.7
1988	183.3 (284.9%, 2274)	151.7 (232.7%, 2559)	16.9 (380.6%, 2693)	225.4 (371.9%, 17860)	51.8 (244.9%, 1821)	6353.8
1989	200.1 (299%, 2452)	165 (236.1%, 2738)	18.5 (393.3%, 2891)	248.8 (398.5%, 19496)	55.8 (244.6%, 1926)	6956.9
1990	217.9 (309.1%, 2565)	178.7 (229.2%, 2816)	20.8 (401.1%, 3143)	267.3 (413.6%, 19991)	59.7 (243.6%, 1967)	7268.2
1991	241.1 (298.5%, 2813)	195.1 (212.5%, 3030)	23.3 (391.2%, 3464)	283.9 (410.4%, 21190)	64.9 (232%, 2109)	7786.9
1992	271.5 (287.5%, 3153)	224.6 (200.4%, 3442)	28.2 (336.9%, 4109)	308.4 (388.3%, 22933)	72.5 (215.2%, 2326)	8558.2
1993	312.5 (271.5%, 3616)	273.5 (199.5%, 4139)	33.8 (333.9%, 4818)	343.6 (376.4%, 25470)	84.7 (202.6%, 2688)	9513.8
1994	354.7 (265%, 4091)	328.5 (201.4%, 4911)	40.5 (345.2%, 5697)	391.8 (375.5%, 28890)	102.8 (202%, 3228)	10649.9
1995	402.2 (263.1%, 4620)	384.1 (205%, 5592)	46.4 (378.9%, 6406)	452.1 (379.8%, 31951)	123.7 (211.1%, 3822)	11625.9
1996	456.8 (266.3%, 5228)	433.1 (208.8%, 6221)	51.3 (399.8%, 6987)	517.8 (384.9%, 36492)	147.1 (217.6%, 4512)	12871.4
1997	516.6 (270.8%, 5880)	483.6 (210.8%, 6858)	55.4 (404.8%, 7456)	590.2 (389.4%, 40510)	173.5 (224.1%, 5286)	14154.4
1998	579.9 (274.4%, 6561)	541 (214%, 7574)	59.9 (404.4%, 7961)	657.5 (393.9%, 44910)	204.5 (237.1%, 6198)	15515.7
1999	649.1 (279%, 7307)	600.4 (216.9%, 8259)	65.1 (404.3%, 8540)	719 (390.9%, 48776)	237.6 (250.5%, 7166)	16860.0
2000	726.8 (282.7%, 8006)	659 (214.8%, 7626)	70.4 (401.9%, 8943)	785.3 (385.3%, 46914)	272.1 (262%, 7840)	17057.1
2001	805.1 (284.4%, 8905)	726.3 (216%, 9331)	76.2 (399.5%, 9571)	856.6 (381.4%, 53075)	308.8 (272.8%, 8978)	18868.0
2002	887.6 (281%, 9773)	799.9 (213.6%, 10179)	82.4 (395.4%, 10263)	931.1 (373.8%, 57296)	348.4 (278.5%, 10053)	20357.6
2003	976.7 (271.9%, 10704)	900 (210.2%, 11315)	89.5 (388.7%, 11041)	1020.9 (366.6%, 59665)	392.5 (281.1%, 11253)	21933.0

Table A3: Provincial capital, bn RMB 1978 price (% of GDP and per capita Yuan in parentheses): inner provinces

	Shanxi	Mongolia	Jilin	Heilongjiang	Anhui	Jiangxi	Henan
1984	55.2 (346.9%, na)	31.2 (287.6%, na)	42.9 (298.2%, na)	73.5 (277.9%, na)	58.1 (269.2%, na)	42.8 (286.3%, na)	94.8 (302.7%, na)
1985	61.6 (361.5%, na)	34.7 (272.9%, na)	46.9 (305.6%, na)	80.9 (288.6%, na)	63.5 (254.6%, na)	46.4 (270.9%, na)	103.6 (291.4%, na)
1986	67.9 (374.2%, 2557)	37.7 (280.3%, 1858)	50.9 (308.7%, 2198)	89.1 (307.1%, 2674)	69.7 (251.7%, na)	50.7 (277.1%, 1444)	111.9 (300.8%, na)
1987	75 (392.8%, 2759)	40.8 (279.2%, 1976)	55.7 (284.3%, 2373)	97.6 (310%, 2852)	75.7 (260.8%, 1429)	55.5 (280.3%, 1560)	121.8 (284.8%, 1528)
1988	81.6 (396.4%, 2960)	45.7 (283.9%, 2183)	61.2 (269.5%, 2577)	106.2 (310.5%, 3064)	81.8 (267.2%, 1521)	61.7 (279.4%, 1709)	134.8 (287.2%, 1666)
1989	88 (406.6%, 3151)	50.4 (304.5%, 2373)	66.5 (300.3%, 2766)	114.9 (316.1%, 3275)	86.9 (270%, 1590)	67.1 (286.5%, 1816)	147.8 (301.5%, 1795)
1990	94.6 (416.1%, 3262)	55.2 (310.7%, 2553)	72.9 (318.8%, 2938)	124.4 (323.3%, 3511)	92.5 (279.2%, 1630)	71.2 (290.9%, 1868)	160.2 (312.7%, 1852)
1991	99.9 (421.9%, 3396)	60.2 (315.3%, 2758)	79.4 (327.6%, 3163)	132.7 (322.7%, 3712)	97.8 (297.7%, 1697)	75.9 (284.9%, 1964)	174 (317.7%, 1986)
1992	107.2 (397.9%, 3600)	67.6 (318.8%, 3064)	85.8 (315.5%, 3387)	142.1 (323.5%, 3938)	105.4 (274.9%, 1807)	84 (274.6%, 2146)	192.9 (309.8%, 2177)
1993	116.2 (384.3%, 3859)	77.4 (329.8%, 3466)	94.1 (307%, 3684)	153.5 (324.9%, 4218)	116.9 (251.8%, 1982)	95.4 (274.4%, 2406)	212.3 (294.5%, 2373)
1994	127 (383.8%, 4170)	86.7 (335.6%, 3835)	104.3 (297.5%, 4050)	165.2 (321.6%, 4499)	132.6 (236.8%, 2226)	107.1 (263.1%, 2667)	233.8 (284.9%, 2590)
1995	136.3 (370.9%, 4430)	95.9 (340.5%, 4200)	115.2 (299.7%, 4445)	177.9 (315.9%, 4807)	151.5 (236.8%, 2520)	119.4 (256.3%, 2938)	260.5 (276.6%, 2863)
1996	146.6 (359.4%, 4716)	105.9 (333.6%, 4591)	125.9 (288.1%, 4825)	190.3 (305.8%, 5104)	172.3 (235.4%, 2838)	133 (251.6%, 3239)	289.6 (269.9%, 3157)
1997	158.6 (351.9%, 5050)	116.8 (335.2%, 5021)	136.3 (285.6%, 5187)	203.7 (297.6%, 5431)	196.1 (237.8%, 3201)	147.9 (251%, 3563)	322.9 (272.7%, 3494)
1998	177.5 (361.2%, 5595)	128.3 (336%, 5470)	148.4 (285.3%, 5614)	221.9 (299.3%, 5880)	220 (245.9%, 3558)	163.4 (256.3%, 3899)	360.6 (280.1%, 3871)
1999	194.2 (376.1%, 6061)	140.5 (341.4%, 5948)	161.6 (287.3%, 6080)	236.3 (296.6%, 6232)	241.7 (249.8%, 3875)	179.9 (261.9%, 4253)	401.4 (288.7%, 4276)
2000	212.2 (381.3%, 6437)	154.7 (342.7%, 6511)	173.8 (282.9%, 6371)	251.4 (291.6%, 6816)	264.5 (252.5%, 4419)	193.5 (260.8%, 4675)	444.7 (292.3%, 4804)
2001	231.3 (383.3%, 7069)	168.2 (339.8%, 7074)	188.6 (280.9%, 7008)	266.8 (283.1%, 7000)	289.3 (255%, 4572)	207.7 (257.3%, 4962)	489.9 (295.2%, 5127)
2002	252.7 (375%, 7674)	187.7 (338.3%, 7890)	206 (280.3%, 7633)	285.6 (274.8%, 7489)	317.2 (256.7%, 5004)	225.9 (253.2%, 5351)	539.5 (296.9%, 5613)
2003	279.5 (364.1%, 8435)	218.5 (337.3%, 9182)	228 (281.4%, 8431)	301.1 (262.6%, 7891)	347.7 (257.7%, 5425)	253.9 (251.8%, 5969)	593.5 (294.8%, 6140)

	Hubei	Hunan	Guizhou	Yunnan	Shaanxi	Gansu	Qinghai
1984	76.5 (269.9%, na)	52.9 (227.3%, na)	23.1 (257.3%, na)	30.4 (255%, na)	57.9 (430%, na)	30.3 (324.5%, na)	13.4 (580.9%, na)
1985	83.7 (254.1%, na)	56.7 (217.8%, na)	25.6 (263.7%, na)	33.6 (249.1%, na)	64.5 (411.1%, na)	33 (312.3%, na)	15.1 (591.8%, na)
1986	90.8 (261.3%, na)	61.7 (219%, na)	28.1 (274.6%, 935)	36.8 (261.9%, 1066)	71.2 (417.2%, 2340)	36.5 (311.6%, 1764)	16.4 (595.8%, 3992)
1987	98.2 (260.7%, 1918)	67.3 (218.8%, 1162)	30.9 (271.9%, 1016)	39.8 (251.9%, 1126)	78.3 (417.2%, 2535)	39.9 (312.4%, 1886)	18.3 (626.9%, 4274)
1988	108.1 (266.3%, 2085)	74.1 (222.3%, 1257)	33.8 (274.4%, 1081)	43.6 (237.7%, 1212)	86 (378.8%, 2744)	44 (303.3%, 2061)	20.4 (649.5%, 4702)
1989	114.3 (269.4%, 2174)	79 (228.9%, 1314)	36.9 (286.3%, 1164)	47.6 (245.3%, 1304)	96.8 (412.5%, 3033)	48.7 (308.2%, 2240)	21.2 (665.2%, 4808)
1990	122.4 (274.8%, 2251)	83.4 (232.3%, 1361)	39.5 (294%, 1209)	51.4 (244%, 1378)	104.2 (429.6%, 3143)	53.7 (322.2%, 2382)	21.9 (664.5%, 4892)
1991	130.6 (275%, 2369)	89.1 (230.1%, 1435)	42.3 (288.1%, 1275)	57 (253.7%, 1507)	112.3 (432.5%, 3338)	58.8 (330.8%, 2572)	22.8 (661.4%, 5030)
1992	141.4 (260.9%, 2534)	97.2 (223.3%, 1551)	45.6 (287.3%, 1356)	64.5 (258.7%, 1682)	119.6 (419.8%, 3513)	64.2 (329%, 2776)	23.8 (642.1%, 5165)
1993	157.8 (254.7%, 2791)	108.1 (219.5%, 1712)	49.7 (285.1%, 1457)	74.5 (270.4%, 1918)	130.8 (409.6%, 3798)	70.4 (323.2%, 3003)	25.2 (619.5%, 5392)
1994	179.7 (251.8%, 3141)	121.1 (221.6%, 1905)	53.3 (282%, 1542)	84.6 (275%, 2147)	143.1 (414.7%, 4111)	76.8 (319.2%, 3229)	26.5 (602%, 5586)
1995	204.2 (249.7%, 3537)	136 (224.4%, 2128)	58.8 (289.1%, 1675)	94.1 (275.1%, 2358)	156.2 (415.4%, 4446)	83.8 (317.1%, 3438)	28.1 (590.8%, 5834)
1996	231.4 (250%, 3972)	150.6 (221.5%, 2343)	64.8 (292.8%, 1823)	104.2 (275.9%, 2515)	168.8 (407.4%, 4766)	91.3 (309.8%, 3700)	30 (582.3%, 6154)
1997	261 (249.5%, 4443)	166.1 (220.5%, 2569)	71.7 (297%, 1987)	116.4 (281.8%, 2843)	181.3 (397.6%, 5077)	100.4 (314.1%, 4028)	32.3 (574.7%, 6515)
1998	293.5 (254.4%, 4969)	185 (225%, 2845)	80.1 (305.9%, 2189)	130.2 (291.8%, 3141)	197.3 (396.6%, 5486)	110.9 (317.7%, 4404)	34.9 (570.2%, 6947)
1999	330 (264.1%, 5557)	203.6 (228.7%, 3117)	89.9 (317.3%, 2424)	142 (297%, 3388)	213.1 (395.2%, 5890)	122.8 (324.8%, 4831)	37.8 (569.6%, 7406)
2000	370.9 (271.6%, 6154)	221.9 (228.7%, 3446)	101.3 (328.8%, 2875)	153.5 (299.7%, 3580)	233.8 (397.8%, 6485)	133.4 (324.6%, 5208)	40.5 (560.7%, 7823)
2001	411.3 (276.1%, 6883)	243.8 (230.6%, 3697)	114.9 (342.8%, 3025)	169.5 (310.8%, 3955)	256 (399.3%, 6997)	144 (320.2%, 5593)	44.6 (551.5%, 8536)
2002	451.8 (278%, 7546)	267.8 (232.3%, 4040)	129.5 (354.1%, 3375)	183.6 (311%, 4236)	282.5 (401.6%, 7690)	158.2 (321.6%, 6104)	49.7 (545.7%, 9393)
2003	493 (277.3%, 8214)	295.6 (233.9%, 4436)	147 (364.9%, 3797)	203.4 (317.3%, 4647)	315.3 (404.2%, 8546)	172.2 (318%, 6617)	55.6 (544.7%, 10404)

Table A3 (Cont'd): Provincial capital, bn RMB 1978 price (% of GDP and per capita Yuan in parentheses): inner provinces

	Ningxia	Xinjiang	Guangxi	Sichuan	Tibet	Simple Average Per Capita
1984	12 (552%, na)	29.6 (409.2%, na)	29.5 (254%, na)	85.2 (200.3%, na)	7.1 (562.5%, na)	n.a.
1985	13.2 (515.5%, na)	32.9 (388.6%, na)	32.7 (254.2%, na)	91.4 (192.3%, na)	8.9 (612.1%, na)	n.a.
1986	14.7 (530.3%, 3468)	36.1 (381.9%, 2606)	36.3 (264.8%, na)	98.2 (195.9%, na)	9.6 (724.5%, 4711)	n.a.
1987	16.3 (543.9%, 3740)	39.6 (381.9%, 2778)	39.8 (266.1%, 989)	106.2 (194.8%, 1016)	10.5 (794.1%, 5044)	2208.6
1988	18.2 (541.9%, 4084)	43.8 (386%, 3073)	43.5 (278.1%, 1063)	114.7 (195.8%, 1085)	11.2 (816.3%, 5302)	2391.1
1989	20 (552.4%, 4385)	48.7 (404.7%, 3347)	46.5 (287.5%, 1120)	122.2 (203.3%, 1142)	12.7 (850.8%, 5879)	2561.7
1990	21.7 (578.3%, 4609)	53.7 (399.9%, 3513)	48.9 (282.3%, 1147)	129.3 (201%, 1197)	13.7 (842.2%, 6166)	2676.8
1991	23.3 (594.7%, 4864)	59.4 (386.5%, 3819)	52.1 (267.3%, 1206)	137.2 (197.5%, 1259)	15.7 (963.2%, 6954)	2858.1
1992	25.1 (588.5%, 5152)	67.9 (390.6%, 4293)	58.3 (252.4%, 1330)	148.3 (189%, 1349)	17.8 (1018.1%, 7804)	3085.4
1993	27.2 (579.2%, 5492)	78.9 (411.7%, 4917)	67 (245.4%, 1510)	171 (192.9%, 1540)	18.4 (973.8%, 7938)	3339.7
1994	29.1 (572.8%, 5772)	91.8 (431.7%, 5622)	77 (243%, 1713)	196.3 (199.3%, 1751)	19.3 (884.3%, 8192)	3618.3
1995	31 (560.2%, 6045)	101.8 (439.2%, 6126)	89 (252.2%, 1959)	224.7 (159.6%, 1984)	20.6 (799.1%, 8581)	3911.3
1996	33.2 (507.8%, 6371)	111.6 (452.8%, 6608)	99.3 (260%, 2164)	257 (154.5%, 2249)	21.7 (745.4%, 8913)	4213.1
1997	35.5 (505.3%, 6707)	121.8 (445.2%, 7091)	108.8 (263.6%, 2348)	304.7 (164.8%, 2656)	22.6 (694.6%, 9110)	4543.2
1998	38.6 (505.3%, 7169)	134.9 (459.3%, 7720)	119.7 (265.9%, 2561)	354.5 (176.7%, 3068)	22.9 (638.9%, 9089)	4919.7
1999	42 (505.9%, 7729)	145.3 (462%, 8189)	130.9 (270%, 2778)	404.3 (190.9%, 3478)	23.6 (601.5%, 9232)	5302.4
2000	46 (505.1%, 8187)	154.4 (453.8%, 8020)	142.6 (274.1%, 3177)	456.6 (198.2%, 3999)	24.2 (564%, 9253)	5696.8
2001	51 (509%, 9066)	166.8 (453.5%, 8890)	155.5 (276.2%, 3248)	519.5 (206.5%, 4426)	24.9 (512.8%, 9453)	6135.9
2002	57 (515.9%, 9976)	180.8 (454.7%, 9490)	170.1 (273.5%, 3528)	597.6 (213.5%, 5073)	26.1 (476.3%, 9766)	6677.4
2003	64.8 (522.2%, 11166)	199.6 (453.1%, 10321)	187.4 (273.4%, 3859)	696 (221.1%, 5884)	28.3 (461.9%, 10498)	7361.1

Sources: China's statistical yearbook, Li (2003) and authors' estimates.

Table A4: Provincial depreciation rate (in %): coastal provinces

	Beijing	Tianjin	Hebei	Liaoning	Jiangsu	Zhejiang
1993	2.16	3.06	7.26	1.41	4.24	3.73
1994	3.52	3.18	7.48	1.47	4.30	4.17
1995	3.11	3.62	7.02	1.76	4.60	3.76
1996	2.87	4.01	6.68	2.04	4.89	3.49
1997	3.06	3.86	7.13	2.20	5.19	3.76
1998	3.39	4.00	6.84	2.46	5.44	3.70
1999	3.19	3.84	6.76	2.78	5.55	3.86
2000	2.98	4.28	6.32	2.90	5.60	4.52
2001	2.88	4.56	6.08	3.09	5.71	4.58
2002	2.84	4.93	5.91	3.12	5.76	4.44
2003	2.75	5.22	5.86	3.87	5.77	4.52
	Shandong	**Guangdong**	**Hainan**	**Shanghai**	**Fujian**	**Weighted average**
1993	5.89	7.53	4.05	3.10	5.88	3.85
1994	6.21	7.74	3.60	3.72	5.61	4.22
1995	5.98	8.32	3.69	3.74	5.91	4.39
1996	5.92	8.45	3.89	3.73	6.14	4.52
1997	7.02	8.16	4.21	3.55	6.18	4.78
1998	7.53	8.26	4.15	3.76	6.01	5.01
1999	7.20	8.69	4.20	4.03	5.66	5.13
2000	7.50	8.68	4.33	3.96	5.53	5.25
2001	7.86	8.30	4.40	4.17	5.49	5.35
2002	8.13	8.07	4.31	4.27	5.52	5.39
2003	8.79	8.14	4.51	4.50	5.71	5.65

Sources: authors' estimates.

Table A5: Provincial depreciation rate (in %): inner provinces

	Shanxi	Mongolia	Jilin	Heilongjiang	Anhui	Jiangxi	Henan
1993	4.17	4.38	4.53	3.87	6.17	3.48	5.31
1994	3.61	4.17	4.75	4.11	5.84	4.36	5.24
1995	3.57	3.88	4.98	4.58	5.57	4.55	5.26
1996	3.68	3.81	5.26	4.99	5.80	4.52	5.43
1997	3.66	3.97	6.23	5.14	5.22	5.42	5.56
1998	4.17	4.57	6.16	5.36	6.00	5.86	5.47
1999	3.81	4.49	6.15	5.40	6.03	6.82	5.22
2000	3.72	3.97	6.80	4.74	6.18	7.24	5.22
2001	3.80	4.01	6.52	5.80	6.09	8.03	5.24
2002	4.01	4.52	6.34	6.22	6.04	8.74	5.18
2003	4.62	4.41	6.55	6.42	5.95	8.98	5.21
	Hubei	Hunan	Guizhou	Yunnan	Shaanxi	Gansu	Qinghai
1993	4.24	5.27	4.17	4.78	3.66	4.25	2.27
1994	4.11	5.30	3.95	4.85	3.45	4.40	2.45
1995	5.14	5.92	4.09	5.27	3.45	4.68	2.44
1996	5.65	6.45	4.27	5.37	3.51	4.54	2.57
1997	6.88	6.81	4.25	5.24	3.77	4.54	2.99
1998	7.32	6.60	4.28	4.60	3.92	4.32	3.01
1999	7.57	6.28	4.41	5.62	4.44	4.32	3.08
2000	6.48	7.47	4.44	5.29	4.44	6.33	4.35
2001	6.04	7.19	4.88	5.47	4.95	6.05	3.61
2002	5.98	7.32	4.74	5.57	4.61	5.96	3.46
2003	6.49	7.30	3.96	5.46	5.05	7.19	3.60
	Ningxia	Xinjiang	Guangxi	Sichuan	Tibet	Weighted average	
1993	2.75	3.62	3.53	7.46	1.10	4.68	
1994	2.62	3.22	3.31	7.25	1.00	4.60	
1995	2.65	3.60	3.75	6.56	1.22	4.75	
1996	3.10	4.11	4.00	8.71	1.40	5.16	
1997	3.36	4.04	4.28	9.02	2.21	5.44	
1998	3.54	4.10	4.09	10.27	4.85	5.71	
1999	3.86	3.89	4.04	9.65	3.92	5.71	
2000	4.06	3.97	4.17	9.20	4.47	5.72	
2001	4.24	4.34	4.57	8.96	4.62	5.82	
2002	4.42	4.49	4.91	8.31	4.97	5.86	
2003	4.51	4.12	5.00	8.20	4.63	6.02	

Source: authors' estimates.

Table A6: Factor intensity of coastal provinces

	Beijing	Tianjin	Hebei	Liaoning	Jiangsu	Zhejiang
1993	32471.4	27065.0	4118.6	35729.5	11517.1	8338.5
1994	35878.2	29212.7	4769.7	36039.1	13183.6	9468.6
1995	42127.5	32292.6	5578.1	36727.8	14995.8	11188.2
1996	46971.8	35879.8	6594.9	37803.6	16912.2	13051.9
1997	51353.0	39143.8	7751.9	38185.6	18860.0	15060.6
1998	59201.5	49553.4	9231.1	44386.8	21769.0	17665.5
1999	64757.7	54723.7	10645.6	45939.2	24565.0	19912.4
2000	69605.1	61584.7	12042.4	46710.9	27635.9	21820.0
2001	74288.4	66538.7	13864.7	47516.2	30494.6	23496.7
2002	63249.9	74057.3	15502.2	48974.6	34394.2	25627.4
2003	63711.9	78562.0	17380.4	50614.1	37719.5	27878.9
	Shandong	Guangdong	Hainan	Shanghai	Fujian	simple average
1993	6986.2	7860.0	10548.6	46412.7	5568.5	17874.2
1994	7802.8	9204.3	12074.1	51330.4	6622.7	19598.7
1995	8695.4	10503.3	13832.3	58867.5	7894.2	22063.9
1996	9824.0	11733.6	15307.8	67750.6	9232.8	24642.1
1997	10974.4	12777.8	16741.1	76633.4	10753.4	27112.3
1998	12451.2	14476.0	18686.2	98132.1	12606.7	32560.0
1999	13814.3	15966.1	19949.6	106150.9	14570.3	35545.0
2000	15591.5	17068.9	21092.2	116674.1	16391.9	38747.1
2001	17233.8	18326.6	22428.3	123720.1	18407.5	41483.2
2002	18678.5	20166.2	24122.7	125344.0	20360.3	42770.7
2003	20136.3	21847.9	25310.3	132318.3	22343.7	45256.7

Table A7: Factor intensity of inner provinces

	Shanxi	Mongolia	Jilin	Heilongjiang	Anhui	Jiangxi	Henan
1993	8220.3	7747.3	7652.2	10288.8	3833.3	5039.8	4737.7
1994	8768.8	8564.1	8339.2	10838.8	4249.6	5330.7	5072.3
1995	9333.6	9364.2	9184.4	11459.3	4724.6	5797.9	5546.7
1996	9919.7	10157.6	10015.3	12139.8	5307.0	6440.4	5996.1
1997	10693.6	11119.3	11017.8	12281.8	5905.0	7117.2	6436.9
1998	12419.3	12740.2	13165.9	12876.2	6645.8	8288.5	7211.9
1999	13539.4	13814.8	14655.3	14066.5	7296.7	9174.5	7712.3
2000	14955.7	15217.3	16108.0	15377.7	7842.7	10000.1	7981.0
2001	16371.0	16595.2	17837.7	16355.7	8534.6	10745.2	8880.9
2002	17832.9	18579.4	18811.2	17557.0	9318.4	11556.0	9770.8
2003	19022.4	21740.9	21823.4	18555.9	10179.9	12873.7	10722.1

	Hubei	Hunan	Guizhou	Yunnan	Shaanxi	Gansu	Qinghai
1993	6052.9	3214.8	2807.0	3538.3	7613.6	6225.0	11587.6
1994	6721.6	3519.7	2920.9	3938.6	8192.3	6671.1	11877.8
1995	7541.9	3879.3	3163.9	4303.3	8804.9	7229.8	12415.9
1996	8594.6	4246.4	3424.8	4705.3	9391.9	7770.1	12951.2
1997	9633.8	4625.4	3718.2	5177.7	10003.8	8470.2	13726.9
1998	11218.9	5287.0	4113.7	5733.5	10947.2	9436.8	15166.5
1999	12827.7	5823.9	4552.1	6247.8	11966.7	10361.5	15658.4
2000	14791.2	6409.8	4953.0	6687.3	12896.9	11287.8	16984.6
2001	16768.7	7090.8	5556.9	7300.2	14347.0	12130.4	18577.4
2002	18311.3	7719.6	6222.9	7841.0	15082.4	12610.5	20078.1
2003	19431.7	8406.4	6937.3	8654.8	16498.4	13207.5	21850.7

	Ningxia	Xinjiang	Guangxi	Sichuan	Tibet	Simple average
1993	11824.2	12207.9	2942.1	2748.3	16268.5	7081.6
1994	12353.1	14122.8	3294.2	3137.4	17154.0	7635.1
1995	12729.8	15366.6	3734.7	3546.7	18113.8	8223.2
1996	13272.7	16619.2	4109.9	4083.1	18477.0	8822.2
1997	13650.3	17638.8	4435.9	4830.8	18781.3	9435.0
1998	14862.0	19883.9	4845.6	5736.4	19345.0	10522.3
1999	15498.1	21695.1	5275.8	6604.1	19340.8	11374.3
2000	16768.0	22956.9	5636.0	7519.9	19646.7	12316.9
2001	18360.7	24333.9	6114.1	8602.6	19953.2	13392.4
2002	20254.9	25773.0	6617.8	9879.6	20243.7	14424.2
2003	22282.9	27672.4	7205.1	11393.2	21689.2	15797.3

Table A8: National infrastructure capital (1978 price)

Year	Physical		Social		Total		
	Value in bn	% of GDP	Value in bn	% of GDP	Value in bn	% of GDP	Per Capita (Yuan)
1992	861.02	67.22	254.35	19.86	1115.37	87.08	951.92
1993	935.53	64.1	277.6	19.02	1213.13	83.12	1023.59
1994	1027.06	62.23	303.14	18.37	1330.2	80.59	1109.89
1995	1124.07	61.39	331.05	18.08	1455.13	79.47	1201.39
1996	1229.26	61.03	361.7	17.96	1590.95	78.98	1299.91
1997	1345.15	61.11	397.31	18.05	1742.46	79.15	1409.46
1998	1481.47	62.41	437.46	18.43	1918.94	80.84	1538.09
1999	1618.25	63.34	483.67	18.93	2101.92	82.27	1671.03
2000	1753.12	63.29	532.15	19.21	2285.27	82.5	1803.07
2001	1899.19	63.31	590.59	19.69	2489.78	82.99	1950.83
2002	2048.58	62.6	663.87	20.29	2712.44	82.88	2111.62
2003	2193.28	60.91	#N/A	#N/A	#N/A	#N/A	#N/A

Sources: CEIC and authors' estimates.

Table A9: Ratio of infrastructure FAI to total FAI in coastal provinces (%)

	Beijing	Tianjin	Hebei	Liaoning	Jiangsu	Zhejiang
1993	21.18	18.1	14.82	15.55	9.29	11.78
1994	21.34	18.43	17.06	16.75	10.86	15.18
1995	20.23	15.54	16.57	17.5	13.35	16.16
1996	21.18	19.64	18.48	21.52	18.22	23.61
1997	23.86	22.74	25.5	31.22	19.44	26.66
1998	26.57	31.58	28.5	32.48	22.23	32.56
1999	29.4	30.61	26.63	29.51	23.64	33.29
2000	28.99	25.65	29.85	27.24	26.05	37.28
2001	20.5	27.4	24.47	28.38	27.24	35.79
2002	17.17	32.85	19.08	22.59	29.61	31.85

	Shandong	Guangdong	Hainan	Shanghai	Fujian	simple average
1993	14.17	22.32	31.4	19.02	20.35	18.00
1994	16.25	28.99	44.18	20.66	25.61	21.39
1995	16.23	28.91	47.91	16.94	30.57	21.81
1996	18.02	27.25	51.08	18.57	29.66	24.29
1997	17.96	34.03	58.36	25.95	28.42	28.56
1998	24.06	34.03	62.44	31.28	31.39	32.47
1999	25.08	33.57	53.93	36.55	27.95	31.83
2000	24.89	31.33	54.04	31.58	27.66	31.32
2001	21.11	28.09	55.31	28.79	29.15	29.66
2002	19.14	26.16	59.02	25.82	27.42	28.25

Table A10: Ratio of infrastructure FAI to total FAI in inner provinces (%)

	Shanxi	Mongolia	Jilin	Heilongjiang	Anhui	Jiangxi	Henan
1993	22.22	26.88	18.66	19.96	13.33	20.77	15.33
1994	26.63	28.49	18.42	23.74	15.96	26.16	21.73
1995	33.02	25.53	15.47	17.35	17.72	25.13	23.48
1996	29.84	32.57	21.02	23.38	14.97	27.31	21.41
1997	32.72	33.32	24.72	29.57	18.68	35.59	21.16
1998	50.21	37.37	31.52	29.37	24.6	40.72	24.88
1999	49.49	39.71	31.54	29.56	30.36	31.25	26.19
2000	45.77	41.93	34	35.53	29.18	33.45	34.09
2001	48.07	45.57	30.35	34.77	27.13	35.71	36.13
2002	38.38	46.7	31.08	30.23	25.98	33	33.27

	Hubei	Hunan	Guizhou	Yunnan	Shaanxi	Gansu	Qinghai
1993	28.62	26.52	22.68	28.59	21.03	16.17	28.2
1994	29.49	25.88	24.76	26.75	21.41	16.74	44.58
1995	29.46	30.51	26.81	24.92	21.76	19.78	52.68
1996	26.11	29.2	29.24	27.36	26.58	26.65	49.78
1997	29.94	29.77	30.17	35.99	33.83	24.47	46.06
1998	37.52	31.66	40.52	42.63	42.86	33.33	49.32
1999	37.94	31.5	39.81	43.89	36.98	40.86	44.26
2000	39.56	36.4	38.21	49.34	37.7	41.67	57.14
2001	39.86	38.48	50.16	46.28	38.87	40.41	60.69
2002	37.88	32.48	52.85	46.8	35.82	36.45	54.19

	Ningxia	Xinjiang	Guangxi	Sichuan	Tibet	Simple average
1993	22.62	13.34	23.84	20.43	55.56	23.41
1994	27.24	13.16	27.02	24.89	76.19	27.33
1995	32.67	16.39	28.45	26.32	74.51	28.52
1996	41.9	17.96	31.98	27.49	77.47	30.64
1997	47.35	25.56	33.55	34.56	62.88	33.15
1998	43.33	36.27	41.8	40.95	44.25	38.06
1999	39.84	30.62	41.05	37.75	29.78	36.44
2000	47.63	33.98	45.95	39.21	77.37	42.01
2001	49.93	28.34	46.79	37.78	65.64	42.16
2002	51.21	35.09	45.69	36.97	66.05	40.53

Table A11: Provincial infrastructure capital, bn RMB in 1978 price (% of GDP and per capita Yuan in parentheses): coastal provinces

	Beijing	Tianjin	Hebei	Liaoning	Jiangsu	Zhejiang
1992	40.6 (107%, 3687)	22.4 (94%, 2431)	21.7 (35%, 346)	138.2 (198%, 3441)	54.8 (46%, 794)	36.9 (56%, 872)
1993	44.8 (105%, 4025)	24.6 (92%, 2647)	24.9 (34%, 393)	142.3 (178%, 3521)	60.4 (42%, 867)	40.5 (51%, 950)
1994	49.7 (103%, 4419)	27.2 (89%, 2905)	29.3 (35%, 458)	146.8 (165%, 3610)	67.6 (41%, 963)	45.6 (48%, 1062)
1995	55.9 (103%, 4471)	29.5 (84%, 3128)	34.3 (36%, 532)	150.8 (158%, 3686)	77.1 (40%, 1091)	53 (47%, 1226)
1996	62.7 (106%, 4982)	32.7 (82%, 3453)	41.2 (38%, 635)	155.4 (150%, 3775)	90.6 (42%, 1274)	65.3 (52%, 1503)
1997	71.1 (110%, 5738)	36.9 (82%, 3875)	51.7 (42%, 792)	161.7 (143%, 3907)	105.2 (44%, 1472)	79.8 (57%, 1800)
1998	81.8 (115%, 6565)	43 (87%, 4491)	65.2 (48%, 993)	167.9 (138%, 4039)	124.3 (46%, 1731)	100 (65%, 2244)
1999	95.9 (122%, 7629)	48.8 (90%, 5083)	78.4 (53%, 1186)	173.3 (131%, 4154)	146.7 (50%, 2035)	120.4 (71%, 2691)
2000	110.2 (125%, 7974)	53.9 (90%, 5383)	94.1 (58%, 1395)	179.1 (125%, 4226)	173.8 (53%, 2337)	142.5 (76%, 3048)
2001	122 (124%, 8821)	60.1 (90%, 5986)	107.3 (61%, 1602)	186 (119%, 4436)	203.2 (57%, 2763)	164.7 (79%, 3571)
2002	133.3 (121%, 9368)	68.4 (91%, 6795)	118.1 (61%, 1753)	193 (112%, 4593)	239.4 (60%, 3243)	188.7 (81%, 4060)
	Shangdong	Guangdong	Hainan	Shanghai	Fujian	Per capita (simple average)
1992	45.2 (48%, 524)	63.4 (57%, 972)	12.8 (153%, 1864)	63.1 (79%, 4689)	19.8 (59%, 636)	1841.50
1993	51.2 (44%, 593)	74.4 (54%, 1126)	14.5 (144%, 2074)	69.8 (76%, 5171)	22.5 (54%, 713)	2007.27
1994	58.4 (44%, 674)	90.4 (55%, 1351)	17.5 (149%, 2463)	79.7 (76%, 5878)	27.1 (53%, 851)	2239.35
1995	66.7 (44%, 766)	102.9 (55%, 1498)	20.3 (166%, 2807)	89.9 (76%, 6355)	33.5 (57%, 1035)	2417.75
1996	77.5 (45%, 887)	116.2 (56%, 1669)	22.9 (178%, 3118)	102.1 (76%, 7192)	40.4 (60%, 1240)	2702.62
1997	88.4 (46%, 1006)	133.4 (58%, 1892)	25.3 (185%, 3409)	120.8 (80%, 8294)	47.9 (62%, 1460)	3058.51
1998	103.6 (49%, 1173)	152.9 (60%, 2141)	28.2 (190%, 3747)	141.9 (85%, 9691)	57.3 (66%, 1736)	3504.64
1999	121 (52%, 1362)	172.9 (62%, 2378)	31 (193%, 4068)	164.4 (89%, 11150)	66.6 (70%, 2009)	3976.79
2000	140.4 (55%, 1546)	191.2 (62%, 2213)	33.9 (193%, 4305)	185.3 (91%, 11070)	76.3 (73%, 2200)	4154.14
2001	156.9 (55%, 1735)	210.1 (63%, 2700)	37.1 (194%, 4658)	205.8 (92%, 12753)	87.3 (77%, 2538)	4687.64
2002	172.7 (55%, 1901)	229.4 (61%, 2919)	40.8 (196%, 5075)	225.1 (90%, 13849)	98.6 (79%, 2845)	5127.56

Sources: CEIC and authors' estimates.

Table A12: Provincial infrastructure capital, bn RMB in 1978 price (% of GDP and per capita Yuan in parentheses): inner provinces

	Shanxi	Inner Mongolia	Jilin	Heilongjiang	Anhui	Jiangxi	Henan
1992	31 (115%, 1040)	19.8 (94%, 899)	16.9 (62%, 669)	32.8 (75%, 908)	17.2 (45%, 295)	22.8 (75%, 584)	40.2 (65%, 454)
1993	32.9 (109%, 1092)	22.5 (96%, 1006)	18.5 (60%, 724)	35.1 (74%, 963)	18.8 (40%, 318)	25.2 (73%, 636)	43.2 (60%, 483)
1994	35.7 (108%, 1173)	25.1 (97%, 1111)	20.3 (58%, 789)	37.8 (74%, 1030)	21.3 (38%, 357)	28.3 (70%, 705)	47.8 (58%, 530)
1995	38.8 (106%, 1262)	27.6 (98%, 1210)	22 (57%, 847)	40.1 (71%, 1083)	24.6 (38%, 409)	31.3 (67%, 770)	54.1 (57%, 595)
1996	42.2 (103%, 1356)	31.3 (98%, 1355)	24.4 (56%, 936)	43.4 (70%, 1165)	27.7 (38%, 457)	35.7 (68%, 870)	61.1 (57%, 666)
1997	46.1 (102%, 1469)	35 (100%, 1504)	26.8 (56%, 1021)	47.9 (70%, 1278)	32.2 (39%, 525)	41.6 (71%, 1004)	68.2 (58%, 737)
1998	53.8 (109%, 1696)	39.6 (104%, 1687)	30.5 (59%, 1154)	53 (71%, 1404)	38.1 (43%, 616)	48.7 (76%, 1163)	77.5 (60%, 832)
1999	62.2 (120%, 1940)	44.6 (108%, 1888)	34.5 (61%, 1297)	57.4 (72%, 1515)	44.7 (46%, 716)	53.2 (77%, 1258)	88.2 (63%, 940)
2000	70.5 (127%, 2138)	50.7 (112%, 2132)	38.2 (62%, 1401)	63.2 (73%, 1714)	51.3 (49%, 857)	58 (78%, 1402)	103 (68%, 1112)
2001	79.5 (132%, 2431)	56.8 (115%, 2390)	42.2 (63%, 1566)	69 (73%, 1810)	58 (51%, 917)	63.3 (78%, 1512)	119.3 (72%, 1249)
2002	87.5 (130%, 2655)	65.5 (118%, 2753)	46.8 (64%, 1735)	75.1 (72%, 1969)	65.2 (53%, 1029)	69.2 (78%, 1638)	135.8 (75%, 1413)
	Hubei	**Hunan**	**Guizhou**	**Yunnan**	**Shaanxi**	**Gansu**	**Qinghai**
1992	40.6 (75%, 727)	27.7 (64%, 442)	12.4 (78%, 368)	18.7 (75%, 489)	30.3 (106%, 891)	13.7 (70%, 594)	10.6 (286%, 2299)
1993	45.1 (73%, 798)	30.2 (61%, 478)	13.3 (76%, 390)	21.6 (78%, 556)	32.7 (102%, 949)	14.7 (68%, 628)	11 (270%, 2352)
1994	51.4 (72%, 898)	33.6 (61%, 528)	14.2 (75%, 412)	24.3 (79%, 617)	35.3 (102%, 1015)	15.8 (66%, 665)	11.6 (263%, 2439)
1995	58.1 (71%, 1007)	38.1 (63%, 596)	15.7 (77%, 448)	26.7 (78%, 669)	38.2 (102%, 1086)	17.2 (65%, 705)	12.4 (261%, 2575)
1996	65.8 (71%, 1130)	42.8 (63%, 666)	17.4 (79%, 490)	29.9 (79%, 722)	41.6 (100%, 1175)	19.7 (67%, 798)	13.3 (258%, 2730)
1997	75.4 (72%, 1283)	47.4 (63%, 733)	19.4 (80%, 537)	34.3 (83%, 837)	45.8 (101%, 1284)	21.9 (69%, 880)	14.3 (254%, 2882)
1998	88.5 (77%, 1499)	52.6 (64%, 809)	22.3 (85%, 611)	40.2 (90%, 969)	52.7 (106%, 1466)	25.4 (73%, 1010)	15.5 (254%, 3088)
1999	103 (82%, 1735)	58.5 (66%, 895)	26.3 (93%, 708)	45.4 (95%, 1082)	58.6 (109%, 1619)	30.3 (80%, 1192)	16.7 (253%, 3284)
2000	120.8 (88%, 2003)	65.1 (67%, 1011)	30.6 (99%, 869)	51 (100%, 1190)	66.4 (113%, 1841)	34.7 (84%, 1354)	18.5 (256%, 3569)
2001	138.2 (93%, 2313)	73.6 (70%, 1115)	37.4 (112%, 986)	58.5 (107%, 1364)	75 (117%, 2050)	38.8 (86%, 1507)	21.1 (260%, 4032)
2002	155 (95%, 2588)	81.3 (71%, 1227)	45.2 (123%, 1177)	65 (110%, 1500)	84.5 (120%, 2300)	43.9 (89%, 1694)	23.8 (262%, 4512)
	Ningxia	Xinjiang	Guangxi	Sichuan	Tibet	Per capita (simple average)	
1992	8.9 (209%, 1831)	12 (69%, 757)	17 (74%, 389)	41.5 (53%, 377)	12.4 (712%, 5458)	1024.754	
1993	9.4 (200%, 1896)	13.4 (70%, 838)	19.1 (70%, 431)	46.2 (52%, 416)	12.8 (677%, 5517)	1077.489	
1994	9.9 (195%, 1965)	15.1 (71%, 927)	21.8 (69%, 486)	52.5 (53%, 468)	13.5 (616%, 5706)	1148.434	
1995	10.5 (190%, 2053)	16.8 (72%, 1010)	24.5 (69%, 539)	68.5 (49%, 605)	13.9 (541%, 5807)	1225.069	
1996	11.5 (176%, 2206)	18.4 (75%, 1090)	27 (71%, 588)	81 (49%, 709)	14.5 (497%, 5940)	1318.423	
1997	12.6 (179%, 2378)	21 (77%, 1224)	28.7 (69%, 619)	97.5 (53%, 850)	15 (460%, 6036)	1425.372	
1998	13.9 (182%, 2586)	25.8 (88%, 1475)	33.2 (74%, 711)	117.9 (59%, 1020)	15 (418%, 5947)	1565.381	
1999	15.3 (184%, 2812)	28.9 (92%, 1632)	37.8 (78%, 803)	136.7 (65%, 1176)	15.2 (388%, 5949)	1707.272	
2000	17.2 (189%, 3059)	32 (94%, 1662)	43.2 (83%, 963)	157.1 (68%, 1375)	15.8 (369%, 6046)	1878.881	
2001	19.7 (196%, 3500)	35.5 (97%, 1892)	49.2 (87%, 1028)	180.5 (72%, 1538)	16.3 (335%, 6181)	2072.612	
2002	22.8 (206%, 3983)	40.4 (102%, 2122)	55.9 (90%, 1160)	208.6 (75%, 1771)	16.8 (306%, 6277)	2289.688	

Sources: CEIC and authors' estimates.