The Coast-Noncoast Income Gap, Productivity, and Regional Economic Policy in China

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Abstract

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We postulate that inferior factor productivity in China’s noncoastal provinces is a principal reason for their lower economic growth despite high investment rates relative to provincial GDP. We find that TFP is roughly twice as high in the coastal provinces and estimate that investment in higher education and foreign direct investment help explain the productivity gap. We speculate that despite its relatively modest estimated return, investment in infrastructure may be necessary to attract foreign direct investment and to retain university graduates in the interior.
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1 Introduction

This paper is an attempt to understand the persistent and widening income gap between coastal and interior China and to suggest appropriate policies to help the lagging interior provinces catch up to their more prosperous counterparts.

Aware of the political danger and perhaps also sensitive to the inequity of favoring coastal development, the central government has taken steps to promote the growth of enterprises in the interior, focusing particular attention on steps to encourage investment in rural enterprises. (Yang and Wei, 1996) Evidently this strategy has yet to produce the desired results.2 We hypothesize that a major cause of the persistent and widening income gap between the coast and interior is lower factor productivity in the noncoastal provinces. We report tests of hypotheses that TFP and TFP growth vary across provinces, identify factors contributing to the productivity gap, and derive implications for policies that may help the interior provinces approach parity with their coastal counterparts.

The rest of the paper proceeds as follows. In section 2 we deal with methodological issues and outline the basic theoretical and econometric procedure. Section 3 contains our econometric results. The last section summarizes and draws policy implications.

2 MODELING TFP AND TFP GROWTH

2.1 Methodological Issues

The first methodological issue addressed is frontier- versus standard production-function estimation. Lau and Brada (1995) point out that an advantage of using the frontier approach
is knowing the relative contributions of technological growth and improvements in technical efficiency to TFP growth, which is important in forecasting how long current growth trends will continue. We have chosen not to use a frontier estimation approach for two reasons: (1) Accuracy in allocating the “residual” of the production relationship between technical efficiency and technological progress depends critically on the accuracy with which inputs have been measured. Because we focus on all sectors of the Chinese economy at the provincial level we do not have access to accurate capital-stock data.³

(2) Our second reason is, in a sense, philosophical, and rests on the belief that there is an inherent arbitrariness in distinguishing between the levels of technology technical efficiency. One source of this arbitrariness is the need to specify the mathematical form of the time paths of technical progress and technical efficiency. The allocation of TFP change between technical progress and changes in technical efficiency depends on the time paths assumed. Arbitrariness also arises in attempting to allocate the causes of failure to adopt “best” available technology, which may arise from: (i) failure to invest in physical capital in which the technology is embodied; (ii) lack of human capital, or knowledge of the best available technology; and (iii) adverse incentives due to market institutions, government controls, etc. Economic reforms since 1979 are designed to take care of item (iii) and are evidently reflected in the increased efficiency identified by Lau and Brada in the early years of the reform era. If TFP is below its maximum due cause (i) or (ii) is this necessarily “inefficient?” The answer depends in part on one’s view of capital markets, available resources, capital constraints, and so on. The current study focuses on (i) and (ii) as possible explanations of provincial differences in TFP.

The second methodological issue is specification of the form of the production function. In our empirical work, we assume a Cobb-Douglas production function with Hicks-neutral technology. G. S. Maddala (1979) points out that “. . . within the class of functions . . . Cobb-Douglas, generalized Leontief, homogeneous translog, and homogeneous quadratic, differences in the functional form produce negligible differences in measures of multi-factor productivity.” Imposing the Cobb-Douglas specification in the context of the Solow growth model (see below) is analogous to the standard growth-accounting technique of using hypothetical factor elasticities to compute TFP or TFP change as a residual. We, however, estimate our (constant) factor elasticities simultaneously with our estimates of TFP and TFP growth.⁴
2.2 An Empirical Model

The Cobb-Douglas production function with Hicks-neutral technology is

\[ Y_{i,t} = A_{i,t} K_{i,t}^{1-\beta} L_{i,t}^{\beta} e^{\epsilon_{i,t}} \]  

(1)

where \( i \) and \( t \) index the provinces and time, respectively. In the spirit of what is now graduate-textbook economic growth modeling, we specify \( A_{i,t} = A_{i,0} e^{\gamma_1 t + \gamma_2 t^2} \) as the systematic component of TFP at time \( t \), which includes all factors contributing to output other than labor \( L \) and physical capital \( K \) at time \( t \); \( g_i \) as the rate of technological change, and \( \epsilon_{i,t} \) as an error term with the usual properties, which may also be viewed as random productivity shocks.\(^5\)

The labor force evolves as \( L_{i,0} = e^{\eta_i t} \), where \( \eta_i \) is the rate of labor-force growth. Output per worker, a close correlate of income per capita, is \( y_{i,t} = A_{i,t} k_{i,t}^{1-\beta} \) where \( y \equiv Y/L \) and \( k \equiv K/L \).

From equation (1), we specify a Solow growth model,

\[ \ln y_{i,t} = \frac{1}{1-\beta} \left( \ln A_{i,0} + g_i + g_2 t^2 \right) + \frac{\beta}{1-\beta} \ln s_{i,t-1} - \frac{\beta}{1-\beta} \ln n_{i,t} + w_{i,t}, \]  

(2)

which, on the basis of the assumption that convergence to the steady state occurs at the rate \( \lambda (0 < \lambda < 1) \), leads to

\[ \ln y_{i,t} - \ln y_{i,t-1} = (1 - e^{-\lambda t}) \left[ \frac{1}{1-\beta} \left( \ln A_{i,0} + g_i + g_2 t^2 \right) + \frac{\beta}{1-\beta} \ln s_{i,t-1} ight. \\
- \left. \frac{\beta}{1-\beta} \ln n_{i,t} \right] - (1 - e^{-\lambda t}) \ln y_{i,t-1} + u_{i,t}. \]  

(3)

Our TFP estimates are based on equation (3), which allows us to obtain all production-function parameters directly and simultaneously and does not require data on the capital stock.

2.3 Explaining Technological Change

Making the standard growth accounting assumption that the error term in the above equations, \( u_{i,t} \), represents provincial productivity shocks, we define TFP in year \( t \) as \( \tau_{i,t} = A_{i,0} + g_1 t + g_2 t^2 + u_{i,t} \), and specify the following regression equation to explain provincial TFP differentials.

\[ \ln \tau_{i,t} = \alpha_0 + \sum_{m=1}^{5} \alpha_{m} x_{m,i,t-1} + \\
+ \alpha_6 C + \alpha_7 t + \alpha_8 t^2 + \alpha_9 C t + \alpha_{10} \ln \tau_{i,t-1} + v_{i,t}, \]  

(4)
where the right-hand variables and hypothesized qualitative relationship with TFP are

\[ x_1 = \text{a measure of investment in housing (to correct for the inclusion of expenditure on new housing in total investment)}, < 0^6; \]
\[ x_2 = \text{a measure of the vintage of the physical capital stock}, < 0; \]
\[ x_3 = \text{a measure of investment in human capital}, > 0; \]
\[ x_4 = \text{a measure infrastructure (highways, railways, and waterways)}, > 0; \]
\[ x_5 = \text{foreign direct investment (FDI) as a share of total investment}, > 0; \]

\[ C \equiv \text{a dummy variable = 1 for coastal provinces and Beijing}; \]
\[ t = \text{the year of observation (1979 = 1 \cdots 1993 = 15)}; \] and
\[ v_{i,t} \equiv \text{an iid error term.} \]

We follow Wolff (1991) in including lagged TFP, \( \tau_{t-1} \), in equation (4). Full definitions and sources of the variables are included in the Appendix.\(^7\)

The rationale for the role of vintage as contributing to TFP and TFP growth is neatly summarized by Wolff (1991). Although Wolff uses rate of change of the capital stock as a proxy for vintage, we have chosen to define variable \( x_2 \) as a weighted average of the age of existing capital, specifically,

\[ V_{i,t} = \sum_{j=1}^{t} \left[ \frac{I_{i,j}}{\sum_{j=1}^{t} I_{i,j}} (t-j+1) \right], \]

where \( I_j \) is real accumulation of fixed assets.\(^8\)

The contribution of human capital to production is by now part of received knowledge. It would be appropriate to include investment in human capital parallel to physical-capital investment in equation (3). We do not do this because data on the actual magnitude of human-capital investment are very difficult to construct. Doing so for China would be an extremely time- and resource-expensive project. (See Jorgenson and Fraumeni, 1992.)\(^9\) We therefore have elected to estimate the impact of human capital as reflected in the flow of graduates in the second stage of our research.\(^10\) We measure infrastructure by the aggregate length of water, paved highway, and trunk railway per square kilometer of area.\(^11\) Foreign direct investment (FDI), presumably embodies the latest in production and management technology.\(^12\)
3 ECONOMETRIC RESULTS

The estimates of the coefficients of investment share, employment growth, and lagged per-capita GDP for equation (3) are shown in table 1, and the estimates of TFP and TFP growth (for the year 1988) are depicted in figure 1, where coastal provinces are indicated with the (C) notation.\textsuperscript{13} \textsuperscript{14}

[Insert table 1 and figure 1 about here.]

Our estimates of the determinants of TFP and TFP growth are contained in table 2. As can be seen by comparing the second and fourth columns with the first and third columns, respectively, the variables other than trend and the coast-noncoast dummy can account for virtually all of the coast-noncoast productivity gap. The coefficient of capital vintage, while of the hypothesized sign, is insignificant in both the level and change regressions.\textsuperscript{15} The coefficient of the housing variable is indistinguishable from zero in the level regression, but negative and significant as hypothesized in the change regression.\textsuperscript{16} The regression coefficients of the variables representing human capital, transportation infrastructure, and foreign direct investment are all of the predicted sign, with \( t \)-statistics in the level regression of 3.20, 1.27, and 0.83, respectively. The coefficient of the natural log of university graduates/population is significant and slightly smaller in the change than in the level regression.\textsuperscript{17} The regression coefficient of the infrastructure variable is not significant by conventional standards in the level regression, and insignificant by any reasonable standard in the change regression, although the point estimate of its magnitude is much larger in the change regression. Despite this rather weak result in terms of statistical significance, it is probably worth while taking the estimated coefficients at face value and exploring their implications for economic policy.

[Place table 2 about here.]

The estimated regression coefficient of FDI in the level regression is statistically insignificant, but it is marginally significant in the change regression and implies that raising the FDI:I ratio from the bottom of the distribution to the sample mean would increase TFP growth by about 5 percentage points per year. This seems implausibly large, but it nonetheless suggests that FDI may be an important source of TFP growth through the embodiment of new technology, managerial skills, and so on.
The regression coefficient of lagged TFP is highly significant and implies an elasticity of TFP growth with respect to TFP level of just over 0.9. In the ∆TFP regression, lagged TFP remains highly significant, and it is almost exactly 1 minus the coefficient of lagged TFP in the TFP regression. As discussed in Wolff (1991), this evidence of TFP convergence may be due to disembodied technology transfer from across provinces.

4 EVALUATION AND POLICY IMPLICATIONS

The three variables we have examined that are amenable to policy control of both the central and provincial governments are investment in human capital, investment in transportation infrastructure, and foreign direct investment. It is instructive to view the net social pecuniary return to additional higher education in terms of a standard human-capital formulation in which the flow return of increasing the number of university graduates per year by the proportion $\Delta E/E_j$ in province $j$ is $\alpha \Delta E Y_j$,\(^{18}\) where $\alpha_3$ is the estimated elasticity of TFP with respect to university graduates, $E_j$ is the annual number of college graduates in province $j$, and $Y_j$ is a measure of aggregate provincial output. The one-year cost of such an investment would be $\frac{\Delta E}{E_j} (\beta \frac{Y_j}{N_j} + D)$ where $\beta$ is the elasticity of output with respect to labor, $N_j$ is a measure of the labor force in province $j$, and $D$ is the direct cost in terms of physical capital, instructional staff, support staff, etc. of one year of university education for one person. The expression $\beta \frac{Y_j}{N_j}$ is the indirect cost, or foregone output for one typical individual who leaves the labor force for one year to attend college. By setting the return and cost expressions equal to each other and assuming that the direct cost of one year of college is equal to the foregone-production cost\(^{19}\) we can solve for the implicit rate of return to higher education, $\rho^s$, obtaining

$$\frac{\alpha_3}{2 \beta \frac{Y_j}{N_j}} + 1 = (1 + \rho^s)^N, \quad (5)$$

where $N$ is the number of years required to graduate from college. Equation (5) illustrates that the payoff to investment in human capital is greater, the greater the elasticity of TFP with respect to adding new university graduates, the smaller is the elasticity of production with respect to labor and the ratio of the current flow of new college graduates relative to the labor force, and the fewer is the number of years needed to achieve a university diploma.\(^{20}\) It
is also smaller, the shorter is the time required to graduate from university.

We can calculate the rate of return to investment in infrastructure in a manner similar to that used to calculate the return to investing in human capital. A measure of the flow return to increasing transportation-route infrastructure by a proportion \( \frac{\Delta K}{K_j} \) (where \( K \) represents transportation routes in kilometers per square kilometer of provincial area) is \( \alpha_4 \bar{K} \frac{\Delta K}{K_j} Y_j \). \( \bar{K} \) is the provincial mean of \( K \) and \( \alpha_4 \bar{K} \) is the estimated elasticity (at mean \( K \)) of TFP with respect to \( K \). The commensurate cost of investing in infrastructure is \( \frac{\Delta K}{K_j} K_j k_j^2 C \) where \( k_j^2 \) is the area of province \( j \) and \( C \) is the per-unit (kilometer) cost of infrastructure construction. The rate of return to infrastructure investment is then \( \rho^j \) as follows.

\[
\frac{\alpha_4 \bar{K} Y_j}{K_j k_j^2 C} = \rho^j
\]

Equation (6) illustrates that the payoff to investment in infrastructure is greater, the greater is the elasticity of TFP with respect to adding additional infrastructure, and the greater is provincial GDP relative to the product of the existing quantity of transportation routes/provincial area, provincial surface area, and to the unit construction cost of transportation routes.\(^{21}\)

Our estimates of the rate of return to investment in human capital and infrastructure are shown in table 3.

| Insert table 3 about here. |

There are striking contrasts in table 3: (1) Rates of return to investment in human capital far exceed those for investment in infrastructure on average and in almost all provinces, Beijing, Tianjin, and Shanghai being the exceptions.\(^{22}\)

(2) Rates of return to infrastructure investment tend to be lower on average in the interior than in coastal provinces, whereas investment in human capital yields a return a fifth higher in the noncoastal than in the coastal provinces. \(^{23}\)

4.1 Policy Recommendations

The effectiveness of policies fostering higher investment rates in the interior as a means of reducing the coast-noncoast income gap will be reduced to the extent that the noncoastal provinces’ higher labor:capital ratios are offset by lower TFP. \(^{24}\) Assuming the Cobb-Douglas
production function of equation (1), we calculate the noncoast:coast ratio of marginal product of capital as approximately one-half. The policy implications, we think, are quite clear. Efforts to reduce coast-noncoast income inequality that focus solely on encouraging traditional investment will to be frustrated by low returns unless they are supplemented with policies designed to increase TFP, and through it the productivity of new capital. We interpret our results to suggest a massive increase in the stock of human capital—particularly college-trained managers and technical personnel in the interior. However, when we consider what policies might effectively induce new graduates to remain in the interior and also possibly encourage relocation from the coast, infrastructure not only in the form of transportation routes, but also public amenities that contribute to comfortable living, may well have a much higher rate of return than indicated by simple inference from our estimated production-function parameters. We also find evidence that policies to promote foreign direct investment in the interior, possibly through creation of special economic zones, may have a high payoff, although it is more difficult to quantify the payoff in terms commensurate with our calculations for investments in human capital and infrastructure. As in the case of infrastructure, interaction and reinforcement between investment in policies to encourage increased FDI and increasing the stock of college-trained managers, engineers, and scientific personnel in the interior should not be ignored.
Notes

1This paper has benefited from the help of Dongwei Su and comments of Mario Crucini, Pok-Sang Lam, Guang H. Wan, Shaowen Wu, Yong Yin, and two anonymous referees. We also thank Gary Jefferson and Barry Naughton, who offered extensive and valuable suggestions as discussants in the AEA session, “Empirical Analysis of the Chinese Economy,” New Orleans, 1997; and participants in a seminar at the Center for Chinese Studies, University of Michigan, including Robert Dernberger, Junling Hu, David Li, Kenneth Lieberthal, and Albert Park. Xiaojun Wang provided excellent research assistance. Please send communications to Fleisher. email fleisher.1@osu.edu

2See, for example, Chen and Fleisher, 1996 and Yang and Wei, 1996. Chen and Fleisher contains references to earlier studies on the provincial distribution of income and production. In particular, rising per-capita income in 10 coastal provinces (which we define to include Beijing because of its location and to exclude Guangxi and Hainan because of inadequate data) has outstripped growth in the interior, so that between 1978 and 1993 the coast/noncoast ratio of mean GDP per capita grew from 2.53 to 2.82, or 11 percent.

3As described below, we are able to estimate the desired production-function parameters without data on the capital stock, because we estimate a growth model, which requires data on investment. Discussion of difficulties in using capital stock data in China to estimate aggregate production functions can be found in Chen, et al. (1988) and Chow (1984), especially pp. 202-205. We also attempt to correct for inclusion of “nonproductive” investment in the data as described below.

4Another potentially serious problem, however, is pointed out by Guang H. Wan (1995), who argues that alternative specifications (e.g., Hicks-neutral, Harrod-neutral) can influence estimates of the degree of technical change.

5The quadratic trend term was suggested by an anonymous referee to capture a possible slowdown in TFP growth that may have occurred around 1985. (This may be inferred by
comparing the empirical results of Lau and Brada, 1990, with those of Wu, 1995).

6Chen, et al. (1988) report estimates of production functions for state industry in which capital-stock data have been purged of housing and other “nonproductive” capital. Jefferson, Rawski, and Zheng (1992) use corrected data for state and collective industry. It would be ideal for us to use such net capital stock data for each province, but constructing such data is a task that is far beyond our current resources. In order to solve the problem that annual data for this variable are not available 1978-93 we use an instrument for housing in estimating equation (4). The instrument is obtained by regressing a measure of housing area (square meters) per capita on per-capita real income. The “predicted” level of per-capita housing is then used as the measure of variable $x_1$.

7Unfortunately, variables $x_4$ (infrastructure) and $x_5$ (FDI) are not available annually 1978-93. Therefore in our empirical work we have treated them as “environmental” variables. Details are contained in the notes to table 2.

8Data for accumulation of fixed assets is available after 1952 for all provinces in our sample. We deflate using a price index obtained from series on construction in nominal prices and construction in fixed prices. Chen, et al. (June, 1988) assert that the data on construction in fixed prices are unreliable. However, our alternative is to use the provincial National Income deflator that can be obtained by comparing National Income and National Income at Fixed Prices. We chose to use the construction deflator on the assumption that using it would provide an index closer to that which is correct for accumulation than would using the alternative. We also used the same data to construct a variable ($\frac{\Delta K}{K}$)$_{i,t} = \frac{I_{i,t}}{\sum_{j=0}^{t} I_{i,j}}$, which is conceptually similar to the variable used by Wolff. The empirical results are not very sensitive to which of these variables is used to estimate equation (4).

9Despite lack of data on human-capital investment as such, Mankiw, Romer, and Weil (1992) do include a proxy in their well-known study.

10A referee and others who have commented on earlier drafts of this paper correctly point out that the flow of graduates from universities in a province is only a proxy for the change
in the province’s *population* or *labor force* with university degrees, as there is a significant migration of university graduates toward the “bright lights” in coastal provinces, especially the major cities. We would, of course, have used information on the population of educated workers had annual data been available. Commentators have also noted that any correlation between university education and TFP may reflect the impact of lower levels of educational attainment or even the attainment of literacy. Our attempts to deal with these comments are indicated below.

11 It has also been pointed out to us that our measure of transportation infrastructure is only a crude approximation and may well be poorly correlated with an interior province’s *access to the coast*, which is critical for export-oriented industries.

12 See Shang-Jin Wei (1993) for a similar view.

13 The empirical formulation of equation (3) uses the arithmetic form, rather than the log, of the employment-change variable, $n$, because annual employment growth in some provinces is occasionally negative. (This is approximately equivalent to using the log of $n + 1$.) Thus, it is impossible to impose the constraint on the estimated factor elasticities implied by the constant-returns-to-scale assumption implicit in equations (1)-(3).

It is apparent in figure 1 that the three “city provinces,” Beijing, Tianjin, and Shanghai appear as “outliers” in the sense that they exhibit much higher than average TFP. One of our referees suggested that inclusion of these “urban outliers” may have had a substantial effect on our econometric results. However, when equation (3) is estimated without Beijing, Tianjin, and Shanghai, the estimated coefficients and their significance are changed very little. Moreover, when the estimates of TFP obtained from the sample excluding these three provinces are used to estimate equation (4) results are very close to those reported for the full sample in table 2.

14 Based on the estimated coefficient of $ln(I/Y)$, the elasticity of capital is approximately 0.2, implying a labor elasticity of approximately 0.8. This is at the low end of estimates of the elasticity of production with respect to physical capital reported in the literature. (See, for example, Chen and Fleisher, 1996, Chow, 1994, and Chen, *et al.*, 1988). We suspect that one
reason for this relatively high estimate is omission of a human-capital variable from equation (3).

15 One of our referees suggests that this lack of significance is because, in the pre-reform period, and continuing into the early 1980’s, investment, (presumably especially that undertaken by SOE’s) did not always embody the best available technology.

16 One possible explanation of the increase in significance is that there is more collinearity in the TFP equation between lagged TFP and the housing variable than in the ΔTFP equation, where they are expressed in difference form.

17 In order to test for the sensitivity of our estimates to possible lack of correlation between the annual flow of university graduates and the presence of university graduates in provincial labor forces, we have done the following. (1) Using data available in various issues of *Statistical Yearbook of China* from the population censuses of 1982 and 1990 to regress the log of the proportion of university graduates in provincial populations on the log of new graduates from provincial universities. The regression coefficients (elasticities), which are highly significant, are 0.97 and 1.13 for 1982 and 1990, respectively. While it is apparently true that the flow of university-educated workers toward the “bright lights” has strengthened in recent years, it is also apparent that in the years covered by our sample, there is a strong relationship between the annual flow of university graduates in a province and the proportion of university graduates in its population. (2) We regress the change in the proportion of university graduates in provincial populations between 1982 and 1990 on the mean flow proportion of newly graduated university students in the population in 1982 and 1990 (multiplied by 7), obtaining an estimated regression coefficient of 0.75. This suggests that interprovincial differences in the flow proportion of graduates underestimate interprovincial differences in the proportion of university-educated workers in the labor force. In the estimates of provincial rates of return to further education presented below we use our most “pessimistic” estimates of the relationship between the population proportion and the flow proportion to obtain our final result.

To test for the possibility that data on university graduates reflects the impact of literacy and/or lower levels of education on productivity, we have (in regressions not reported here)
added the 1982 proportion of illiterate and semiliterate persons in the provincial populations and the 1982 proportions of persons whose highest year of schooling is lower middle-school to the variables included in table 2. The results are as follows: (a) The coefficient and significance of the variables reported in table 2 are virtually unaffected; and (b) the magnitudes and levels of significance of the middle-school and literacy variables are both extremely low.

18 We assume no depreciation and infinite lifetimes.

19 This is only a simplification. The nature of the solution is basically unaffected by this assumption.

20 In calculating the values of $\rho^8$ shown in table 3, we have used the mean value of the coefficient of university graduates in table 2, adjusted downward by the 1982-1990 mean of the cross-provincial elasticity of the flow of university graduates to university-graduate population (0.87), and set $N = 7$, which is the number of years required for a typical lower middle-school graduate to complete upper middle school and four years of university. This obviously leads to a lower value of $\rho^8$ than a calculation based on the same estimates that assumes only four additional years of schooling.

21 We use the mean of the coefficients from the level and change regressions in calculating the value of $\rho^i_j$. We interpret both coefficients as estimates of the effect of an additional unit of infrastructure on the level of TFP, because the $\Delta$ TFP regression includes as a right-hand variable an approximation of the first-difference of infrastructure. The same interpretation is applied to the $\Delta$ TFP regression coefficient of the education variable.

When the change in the natural logarithm of the infrastructure variable is used in the $\Delta$TFP regression, the estimated (constant) elasticity of TFP with respect to infrastructure is very close to the elasticity at the provincial means calculated on the basis of the regression coefficient reported in table 2.

22 While our estimates of the rates of return to higher education are high compared to estimates based on earnings data for many other economies, both advanced and emerging (e.g. George Psacharopoulos, 1992), extraordinarily high returns to university education have
also been estimated using micro production data for the Chinese paper industry. (See Fleisher, Dong, and Liu, 1996.) The estimated rate of return to investment in human capital in China is also quite high relative to the return to investment in physical capital. For example, Chow (1994, p. 207) estimates the marginal product of physical capital to be about 0.16 yuan per yuan of physical capital, which is equivalent to the rate of return if we ignore depreciation.

23 One of our anonymous referees points out that our estimated low rate of return to infrastructure investment in the interior “... should not be surprising. A typical interregional pattern in developing countries is that the more backward, remote regions have better infrastructure in relation to their economic activity than the more developed and dynamic regions.”

24 The mean labor:capital ratio measured as indicated in the text in the noncoastal provinces is 1.31 times that in the coastal provinces.

25 That is, \[ \frac{\frac{1}{10} \sum_{j=1}^{10} A_j \left( \frac{L_j}{K_j} \right)^{1-\alpha}}{\frac{1}{11} \sum_{j=11}^{25} A_n \left( \frac{L_j}{K_j} \right)^{1-\alpha}} = 2.10, \] based on our estimate of \( \alpha \) from the equation (3) regression and estimates of TFP in 1992.

As mentioned earlier, we do not have capital stock data at the provincial level. However, we can approximate the relative capital-stock ratios across provinces with the data on cumulative real fixed investment from which we derived the index of capital-stock vintage used to estimate equation (4). (See appendix table A3.) With these data and our estimates of TFP reported in table 3, we can derive our calculation.

Our estimate of the coast:noncoast ratio of the marginal product of capital is based on a value of \( \alpha \) that is higher than estimated in a number of other studies, as mentioned above. For \( \alpha = 0.4 \), a not unreasonable value, the coast:noncoast ratio of marginal product of capital is 1.91, assuming the same coast:noncoast TFP ratio.
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