Structural Change, Capital's Contribution, and Economic Efficiency: Sources of China's Economic Growth Between 1952-1998

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April 2004

ABSTRACT

This paper examines the effects of structural change, long-term TFP trend and marginal return to capital on China's economic growth, comparing such effects with those in the other East Asian economies. Our empirical results show that China's TFP converges to a higher level, and that the marginal return to capital declines dramatically in the late 1990s. Capital contributes much less, while labor contributes more to China's post-reform growth. China is catching up via technology adoption from the developed economies, and this in turn results in higher TFP growth. Future growth hinges on improving efficiency in the capital allocation system, whose distortions cause the declining marginal return to capital.

Key Words economic growth; total factor productivity; capital contribution; GARCH model

JEL Classification: C890, C220, O530, O470, O380

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We would like to thank Prof. Jintao Xu, Prof. Arne Bigsten, Dr. Ran Tao, Dr. Yazhen Gong and Prof. Weiling Mao, for their advice on model construction and data process in this paper. Swedish Institute (SI.) and Swedish International Development Authority (SIDA) financial support for our respective work is appreciated.

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This paper examines the effects of structural change, long-term TFP trend and marginal return to capital on China's economic growth, comparing such effects with those in the other East Asian economies. Our empirical results show that China's TFP converges to a higher level, and that the marginal return to capital declines dramatically in the late 1990s. Capital contributes much less, while labor contributes more to China's post-reform growth. China is catching up via technology adoption from the developed economies, and this in turn results in higher TFP growth. Future growth hinges on improving efficiency in the capital allocation system, whose distortions cause the declining marginal return to capital.

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[1] In this paper, China refers to People's Republic of China, not including Taiwan (China Taipei) Hong Kong and Macao. When necessary, we also use Mainland China instead of "China" to clarify the facts.

1. Introduction

Between 1952 and 1998, China's economic growth experienced great changes: the whole economy gradually transfers from a centrally planned to a market one. Economic performance improved significantly between 1978 and 1998, as the effect of progressively opening and reform policy measures. China's annual economic growth rate averaged 9 percent within this 20-year reform period, a remarkable record indeed, particularly in comparison with the low performance of the other transition economies. Although China's growth record is acknowledged by most economists, they differ as to the sustainability of China' economic growth. Some scholars paint an optimistic picture of China's future economic growth (such as Justin Yifu Lin, 1997), while others stress that China's economic growth rate declines obviously in their empirical studies (such as Zhang Jun, 2002).

Economic growth depends on technical progress and input factor condition change. The dynamics of marginal return to factors (mainly capital and labor) and total factor productivity (TFP) is the key to understand the sustainability of long-run economic growth. Zhang Jun attributes China's declining economic growth rate in the 1990s to TFP deterioration. The worsening TFP is closely related to depressed capital returns and inefficiency in the capital allocation system. He explains China's TFP deterioration from the firms responses to distorted price signals, as well as the technology adoption process (Zhang Jun, 2002).

His research partially discloses the inner mechanism in China's economic growth, but it doesn't identify the trends in marginal return to factors, and the contribution of factors to China's economic growth. This evident gap constitutes the primary motivation of our research. In this paper, we attempt to provide an updated empirical analysis of China's TFP trends, and the marginal returns to factors during 1952-1998, in the context of historical and cross country perspectives.

East Asian growth experience has been an empirical research focus of economists since the early 1990s. Alywn Young (1995) employs a trans-log production function to calculate the TFP of the East Asian "Four tigers" during their high growth periods, and finds insignificant TFP progress, despite their acknowledged high growth rates. Kim and Lau (1994) and Lau (2000) arrive at similar conclusions. Paul Krugman (1994) holds pessimistic views towards such input-driven growth in East Asian economies, and foretells its unsustainable future through the comparison of the East Asian growth with that of the Soviet Union. What happed during 1997-1998 certifies the Krugman assertion. China's growth records during the reform period is comparable to East Asian "Four tigers", and China's TFP deteriorates during the 1990s. A comparison on the contributions of TFP and the factors to economic growth in China and the other East Asian economies is needed, in order to tell whether China's economic growth is more sustainable than that of the other East Asian economies. Such work is not found in current literature. This constitutes the secondary motivation of our research.

The reminder of this paper is organized as follows. Section Ⅱ reviews the literature on growth accounting results about China and the other East Asian economies. Section Ⅲ explains the methodology we use, and set up the empirical models. Section Ⅳ describes the data used in our research. Section Ⅴ reports the econometric results of the OLS, AR(2) and GARCH (1, 1) models, and the implications of the GARCH(1, 1) model. Section Ⅵ presents the results of TFP accounting and the marginal return to factors. A cross -country comparison of the results is presented. Section Ⅶ concludes.

2. Literature Review

TFP is the index to measure output efficiency of factors, whose growth is estimated as a residual, thus it is a measure of our ignorance, and there is a large scope for measurement error. The TFP magnitude is jointly determined by technology changes and institutional conditions. Neoclassical economists recognize TFP as an important factor in economic growth, because technology change compensates for the diminishing return to factors. Productivity analysis is the instrument to solve the TFP puzzle.

TFP provides a simple and internally consistent intellectual framework for organizing data on economic growth (Hulten, 2000). The standard neoclassical growth accounting approach suggests that the fast growth of the East Asian “Four tigers” is input driven. Alwyn Young (1993) uses simple back of the envelope calculations to show that, as regards productivity growth in the aggregate economy and in manufacturing in particular, the East Asian NICs are not, in general, substantial outliers. The principal conclusion is that ‘static’ neoclassical gains have fueled the dynamic growth of the “Four tigers” for more than 20 years.

Felipe (1999) survey the empirical literature TFP growth in East Asia, and the debate about the sources of growth in East Asian NIEs. He argues that the theoretical problems underlying the notion of TFP are so significant that the whole concept should be seriously questioned. TFP growth estimates for East Asian Economies vary significantly, even for the same country and time period. Felipe (2001) again finds TFP growth rates of the East Asian NIEs increase with the adoption of the modified growth accounting methodology, so do the TFP growth rates of developed countries. In light of such results, the standard conclusion about the role of technical progress in East Asian NIEs still holds.

Within the literature concerning productivity analysis in China’s economic growth[2], Jingwen Li (1992) found dramatic fluctuations in China’s TFP as the result of political instability and high inflation before the 1990s. Gregory Chow (1993) proposed a detailed method to calculate China’s capital stock and measure its formation process. He also analyzed the TFP difference between the prior and post-reform periods with the Solow approach. With the estimation of a stochastic frontier translog production function using post-reform panel data of 27 Chinese provinces, Yanrui Wu (2000) found that China’s regional TFP converged to the same level during his survey period. Zhang Jun (2002) also found that China’s TFP declined dramatically in the 1990s using the Solow approach. Felipe (2002) also applies his empirical framework to China’s TFP growth, and discusses the evidence regarding whether or not China’s TFP increased after the reform in 1978. He finds that technical progress in China was biased in a laborsaving direction and that the elasticity of substitution was substantially less than unity. He also argues that the

[2] Sector analysis is not in the scope of our paper.

notion of TFP growth used in most analyses is problematic and misleading, since it is based on the concept of an aggregate production function, which is subject to insurmountable problems that limit its usefulness for empirical exercises.

Zhang Jun (2003) analyzes the aggregate level investment-growth nexus during the 1978-2000 reform period with the calculation of investment/GDP ratio and incremental capital-output ratio in real terms, and compares the results to the East Asian NIEs. He finds that China achieved high growth without increases in these two ratios. China's investment efficiency was largely gained through rural industrialization, which means transfer the surplus labor to the TVEs, and proliferation of small firms in non-state sector. This conclusion is consistent in with that of Alywn Young (2003), who regards rising participation rates, improvements in educational attainment, and the transfer of labor out of agriculture as the cause of productivity growth in China's non-agricultural sector during the reform period of 1978-1998.

3. Empirical Model

Production function estimation is a prerequisite for TFP calculation. Solow and Tinbergen estimated the Cobb-Douglass production (abbreviated as the C-D function) function with time trend in their path-breaking work, explaining the time trend as the result of technology change. However, the C-D function assumes that output elasticity is constant no matter what the factors stock is. Christensen, Jorgensen and Lau proposed the translog production function (Christensen, Jorgensen and Lau, 1971), which not only preserves the conveniences of the C-D function (C-D function is one special case of translog production function), but also can be expressed with the second derivative expansion. The translog production function stipulates that output elasticity is exponential to per capita capital. With the introduction of the translog production function, TFP growth accounting entered a new phase[3]. Felipe (2003) shows that it is possible to approximate the value-added accounting identity (i.e., value added equals labor's compensation plus total profits) by a mathematical expression that has all the

[3]The method to calculate the TFP with translog function can be found in the work of D.W. Jorgenson (1995). Here the authors review the method in brief.

properties of a well-behaved neoclassical aggregate production function[4].

Previous literature contributes to China's TFP analysis from diverse perspectives, despite of their common limitations in paradigm deficiency, excluding structural changes in the economy, as well as marginal return to factors and the output elasticity. Considering such paradigm deficiency and structural changes in China's economy, our translog production function is set up as follows:

$$\begin{aligned} Ln(Q) &= \alpha_0 + (\alpha_{k1} + \alpha_{k2} * D + \alpha_{k3} t) \ln k + (\alpha_{l1} + \alpha_{l2} * D + \alpha_{l3} t) \ln l + \\ &\alpha_{kk} \ln^2 k + \alpha_{ll} \ln^2 l + \alpha_{kl} \ln k \ln l + \mu_t \end{aligned} \tag{1}$$

where the dummy variable D reflects the structural change within China's economic growth between 1952-1998, whose value is 0 before 1978, and 1 after 1978, the division of China's prior and post-reform periods.[5] μ_t is the error term, which might involve serial correlation and heteroscedasticity. According to the aggregation and symmetry restrictions[6], parameters in this model must satisfy the following conditions：

$$\alpha_{k1} + \alpha_{k2} + \alpha_{l1} + \alpha_{l2} = 1 \;;\; \alpha_{k3} + \alpha_{l3} = 0 \;;\; \alpha_{kk} = \alpha_{ll} \;;\; \alpha_{kl} = -2\alpha_{kk} = -2\alpha_{ll}$$

Differentiating this translog production function with respect to $\ln k$ and $\ln l$, we derive the output elasticity or the factor-share equations[7]：

$$shareK = \alpha_{k1} + \alpha_{k2} + \alpha_{k3} t + \alpha_{kl} \ln l + 2\alpha_{kk} \ln k \tag{2}$$

$$shareL = \alpha_{l1} + \alpha_{l2} + \alpha_{l3} t + \alpha_{kl} \ln k + 2\alpha_{ll} \ln l \tag{3}$$

[4] However, according to Felipe (2003), this implies that statistical estimations of putative aggregate production functions can provide no independent evidence as to whether they accurately describe the production technology of the economy or whether the aggregate production function actually exists. A corollary is that the conventional measures of the growth of TFP cannot be unambiguously interpreted as an estimate of the rate of technical progress. Felipe reviews the works of Kim and Lau and Young and, in the light of this, explains why both analyses and interpretations of the notion of TFP growth as the rate of technical progress are problematical. This argument provides chances for a more strict measurement of TFP.

[5] 1978 is the starting point of China's transition from plan to market. The Chow test is 2.38, the respective significance level of which is 3.96%, so the hypothesis that there is no structural change is rejected at the significance level of 5%. The t value of the dummy variable using GARCH (1,1) model is larger than the t value of 10% significance level, which rationalizes the choice of 1978 as the breakpoint in another aspect.

[6] The aggregation restriction implies constant returns to scale of the factors, this facilitates the calculation of TFP; Symmetry is not as intuitive. It implies the marginal response of capital output elasticity to proportional change in labor is equal to the marginal response of labor output elasticity to proportional change in capital.

[7]The assumption, on which the equation after differencing production function with respect to factors is the shares of the factors, is that firms act as producers in a competitive market, thus from the first order condition, we can derive the postulates. Some economists estimate the parameters in equation (2) and (3) using the SUR (Seemingly Uncorrelated Regression) method. However, is the assumption reasonable in China, especially during the centrally planning period? Factor returns derived under non-market or imperfect market conditions are not the same to true marginal factor returns. We face the same problem, when we argue that equation (2) and (3) are the factor-shares.

The parameters can be estimated with proper econometric methods and long-enough time series data sets of GDP, capital and labor. Again we can calculate the yearly output elasticity and factor-shares with equation (2) and (3). As shown by equation (2) and (3), the factor-shares calculated with translog production function is variable over time, this is different from the constant output elasticity result with the C-D function. TFP growth rate is found from equation (4) with the factor-share results from (2) and (3), applying Tornquist-Theil Divisia index theory:[8]

$$\ln(TFP_t) - \ln(TFP_{t-1}) = \ln(Q_t) - \ln(Q_{t-1}) - (shareK_t + shareK_{t-1}) \cdot (\ln(K_t) - \ln(K_{t-1}))/2$$
$$-(shareL_t + shareL_{t-1}) \cdot (\ln(L_t) - \ln(L_{t-1}))/2 \quad (4)$$

The TFP index of the t th year over the base year t_0 is calculated as follows with the results form equation (4):

$$TFP_t = 100 * \exp(\sum_{i=t_0}^{t} \Delta \ln(TFP_i)) \quad (5)$$

4. Data Process

In order to estimate our translog production function and analyze China's TFP evolution trend, we adopt data from *China Statistical Yearbook* (abbreviated as CSY) and *China Labor Statistical Yearbook* for various years, which provides official data of the nominal GDP of 1952-1998, the real GDP of 1978-1998, the nominal gross capital formation and labor force of 1978-1998.

There exists a long-lasting dispute about the accuracy of China's economic data. However, as R. F. Denberg claimed, China's official data is after all the best data available for research purpose, because such data reflect the fundamentals behind China's economic change, despite of the discrepancies when it comes to the marginal

[8] In fact it's a discrete approximation. (See E, Sadoulet &A, Janvry 1995, Quantitative Development Policy Analysis, Page 251.)

measurement terms (Justin Yifulin 1999). Gregory Chow (1993) held similar views on China's economic data. Due to the fact that there is no alternative to Chinese official economic data, we use the CSY statistics.

An essential problem is that capital stock data is not directly found in CSY columns. Such data are to be calculated from the related statistics found in CSY, and this indirect measurement has been the object of a long-lasting dispute. There exist two different methods to measure China's capital stock indirectly in the literature. Yanrui Wu (2000) assumed a 5% capital depreciation rate in his aggregation, while he analyzed TFP convergence of different Chinese regions during 1981-1995; Gregory Chow (1993) assumed a 4% capital depreciation rate in his aggregation while he analyzed China's capital stock during 1952-1988 to identify TFP change after reform. We adopt Chow's assumption and method to preserve time consistency and results comparability, since our survey period is also after 1952, the same as that covered in Chow's paper. During 1952-1978, China's price system had been distorted by the centrally planning, and the relative scarcity of the factors was not reflected in their prices. Since no meaningful price data are available for this 1952-1978 period, we assume the yearly price level as constant to the 1978 price for each year from 1952-1978[9].

Capital stock for 1952-1978 is calculated as the sum of fixed assets investment and inventory change. It should be noted that China's capital investment after 1980 is not calculated the same way as that before 1980, due to statistical method changes. For the after 1980 period, we calculate investment as the difference between real expenditure and real consumption. We derive the yearly GDP deflator (defined as nominal GDP to real GDP), deflate the nominal consumption and gross capital formation values and then add them up, to obtain China's real domestic final expenditure. Here, nominal consumption is converted into real terms with the general consumer price index in CSY (CSY1999, p.294), and this general consumer price index is classified as the general retail price index for 1981-1985. Real investment time series is obtained by subtracting real final consumption from real final domestic expenditure.

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[9]The method we adopted here is found in Gregory Chow (1993), p 813. We use his calculation method and the initial value process into our research.

We construct China's capital stock series with Chow's equation and real investment time series based on the 1978 constant price: K(t)=(1-d)[K(t)-720]+I(t)+720, where K(t=1952)=221.3 billion Yuan. Here land value equals 72 billion RMB Yuan[10] in 1978 constant price[11]. The occupational, educational and rural-urban differences are not included in our labor data process. We choose the yearly social labor statistics in CSY as the labor stock measurement, which is measured with the unit of 100,000 persons. The values of capital stock and labor input are measured with the unit of 10 billion RMB Yuan.

5. Empirical Results

If the error term in equation (1) follows classical assumptions, then the OLS estimators are BLUE (Best Linear Unbiased Estimate). This assumption is violated and the estimate is not efficient with error term heteroscedasticity, or with serial correlation of the error term. Such troubles arise due to the time sequence correlation in capital formation process. The estimation is not consistent, when the explanatory variable is correlated with the error term. China's economic structure has experienced drastic changes since 1978, and these changes brought cyclical fluctuations to the economy. Its consequence for econometrics work is that the error term distribution no longer observes homoscedasticity. When the problem of heteroscedasticity is ignored, one cannot expect an efficient estimation. Because of these undesirable effects of conditional heteroscedasticity, we give both OLS and serial correlated autoregression estimation results in Table 4.1.

We compute an augmented Durbin-Watson test[12] statistics as 0.7 (far less than 2) with the serial residuals from the OLS estimation result listed in the first column of Table 4.1, and this definitely means serial correlation. It is rational to choose the autoregression model as an alternative and skip the OLS. The first task is to determine

[10] CSY uses Yi, a traditional Chinese statistical unit which means 0.1 billion or 100 million, instead of billion. 720 Yi equals 72 billion Yuan.

[11] Chow discussed the formulation of this equation in his 1993 work. China's 1952 capital stock, which includes land value, is 221.3 billion RMB Yuan in 1978 constant price. Based on the 1978 constant price assumption, capital stock calculated with 1978 constant price is the same as the result with the 1952 price.

[12] The Augmented D-W test is devised for higher-order autocorrelation.

the order of autoregression. Using AIC and gradual regression, the order is set as 2. The result of this AR (2) employing Yule-Walk method is listed in the second column of Table 4.1.[13]

On observing the Q statistics testing heteroscedasticity in the AR model and the LM (Lagrange Multiplier) statistics, it is found that heteroscedasticity is significant despite 12 lagged periods. Then the GARCH model is an appropriate choice to deal with heteroscedasticity with a long memory error term. In view of AIC and the sample length, we specify a GARCH (1,1) model and estimate the parameters with the Maximum Likelihood (ML) estimation method. The ML estimation method depends heavily on the assumption of normal distribution, so we proceed with the normality test, which shows the Jarque-Bera test value whose asymptotic distribution is x^2 distribution, is 0.9791. Then the hypothesis in normality of error term distribution is not rejected (see the third column of Table 4.1 for results). GARCH model is proved to be the best configuration, in view of its level of fitness and the significance level of its parameters. In what follows, we will explain the economic intuition of the GARCH result.

Dlnk corresponds to the dummy variable that describing structural change in the economy. A significance level at 10% of Dlnk proves the existence of structural break in 1978. A 0.324 increase in the output elasticity of capital implies that the share of capital experienced dramatic change because of the reform period. The variable “t*lnk” reflects the time trend of the output elasticity of capital. As shown by the positive sign of this variable, output elasticity of capital increases in the long run. In contrast, a 0.363 decrease in output elasticity of labor is witnessed because of the reform. As shown by the signs of “t*lnL”, the output elasticity of labor decreases in the long run.

This disproportional change in the output elasticity of capital and labor has further implications. With the 1978 and onward structural changes, capital and labor stock as well as technology causes a time trend. This time trend in turn causes further changes in factor-shares. This time trend shows that share of capital increases while share of labor decreases. The reason for this is that the relative scarcity of capital to labor in the post

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[13] The order of autoregression model is the key step in the specification, according to AIC, we find that the AR model with an order of 2 has the minimum value of AI, and we specify it as AR (2).

-reform period determines its expensiveness. During the pre-reform period, China's resource allocation system had long been distorted with the overall industrialization strategy, capital couldn't be allocated to the higher return sectors, and capital utilization was generally inefficient. During the post-reform period, distortions in the capital allocation system was gradually rectified, firms got more and more autonomy concerning investment decision-making, with the 1986 administrative reform of "loan instead of allocate". More capital flows to high marginal return sectors. These high marginal return sectors had previously been repressed and could not display their comparative advantages in the resource competition during the pre-reform era.

The negative signs of "Lnk*Lnk" and "LnL*LnL" parameters imply the decreasing trends in out elasticity of the factors when there are more factor inputs. From equation (2), this result also shows that output elasticity of capital decreases as capital stock increases, when the time trend is eliminated (and this can be attributed to technology change). In other words, the capital-output ratio decreased, and the magnitude is calibrated as $2\alpha_{kk}\ln k = 0.65\ln k$. The positive sign of "Lnk*LnL" parameter implies that when capital input is held constant, an increase in labor input causes an increase in the share of capital, and the magnitude is shown as 0.649*Ln(L). When labor input is held constant, an increase in capital has similar effects. As we enter the parameters into equation (2) and (3), it can be seen that one percentage point increase in per capita capital leads to 0.649 percentage point decrease in share of capital, and 0.649 percentage point increase in share of labor.

6. Cross-Country Comparison

The factor-shares can be calculated from equations (2) and (3) with parameters estimated in our GARCH (1,1) model. TFP is obtained from equation (4) with the factor-share results. TFP index on the 1952 base is calculated from equation (5) with the TFP result. Results from equation (2) and (3) are elasticity values, and marginal return to factors can be derived with these known elasticity values. Figure 5.1 and 5.2 describe the TFP index and its growth trend, as well as the marginal return to factors over time.

It can be inferred from Figure 5.1 that China's TFP growth decreases dramatically and fluctuates drastically in the short run, wherever any policy shock (or social instability) happens. However, in the long run, TFP experiences a steady growth[14]. China's TFP grew by 1% per year during 1952-1978, while it grew at 3.8% during 1978-1998. Such a growth pattern difference strengthens the inference that China's TFP growth is liable to policy shocks. Our finding is that between 1992-1998, after the 1992 fluctuation, China's TFP growth rate converges to a steady state, and this conclusion is different from that of Zhang Jun's (Zhang Jun, 2002).

TFP is the joint result of technology adoption and technical efficiency. Technical efficiency measures the deviation of the production point from the PPF (Production Possibility Frontier). Technology and endowments conditions being equal, as institutional arrangements of production improve, production point moves further towards the PPF, hence technical efficiency is raised, which results in TFP growth. In contrast, when institutional arrangements of production are distorted, production point deviates away from the PPF, hence technical efficiency is depressed, which results in TFP slump.

The marginal return to capital trend between 1952-1998 can be regarded as a proxy reflecting technical efficiency evolution during this period. Chinese government advocated heavy industry priority by distorting resource allocation, thus marginal returns to capital decreased to a low level during the pre-reform era. After the 1978 reform, marginal return to capital increased significantly due to more market-oriented investments. As to the drastic decrease in marginal return to capital in the 1990s, it is attributable to less technical efficiency improvement, in addition to fewer breakthroughs in institutional arrangements. China's TFP growth in the 1990s depends more on technology adoption (borrowing existing technology from other countries) than technical efficiency improvements or institutional arrangement changes.

China's TFP growth comes through the learning-by-doing effect originated from the enormous technology gap between China and the industrialized economies. Technology change is realized with technology adoption. Most new technology comes

[14] This result is also consistent with those of Jinwen Li's (1992) and Zhang Jun (2002).

from R&D activities in the industrialized economies, which is too expensive and risky for the LDCs (less developed countries) as China to adopt. LDCs have few advantages of forging technical innovations and leading technology change compared to the industrialized economies. LDCs' alternative is to duplicate and transplant existing technology from the industrialized economies. In this technology transfer sense, the technology gap between the LDCs and the industrialized economies provides the LDCs as China the possibility of copying and learning technology without excessive R&D costs. On one hand, China's TFP growth slowdown in the 1990s reflects the large gap between China and the industrialized economies. On the other hand, it also reflects the technology convergence process due to the existence of such an enormous technology gap. With the deepening reform and opening, China accesses to more and more broad and cheap technology choices in the 1990s, this prospective technology adoption process in turn implies a "late development advantage" for a technology scarce country like China.

In the work of some development economists, the technology gap leads to possible technology change in the LDCs. For this reason technology convergence is an advantage for the LDCs[15]. Capital is scarce in the LDCs. Hence some development economists conclude that capital could have higher returns in the LDCs than in the industrialized economies. Under the assumption of the factor price equalization theorem, the LDCs could experience "natural growth" through liberalizing the economies to market systems.

However, we show that technology change and high TFP growth are not helpful enough as to reverse the drastically diminishing marginal returns to capital in the 1990s' China, although this country is capital-scarce. Depressed return to capital in the 1990s' China is not explainable by the existing orthodox, but is more explainable by China's country-specific capital allocation distortions. China's credit allocation has been administratively controlled from 1952-1998 (since 1998 the traditional credit quota

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[15] Bernard and Jones （1994）point out how growth theorists misunderstand the economic development process without attention to the importance of technology transfer. They proposed a simple model to analyze the importance of technical and economic convergence caused by technology difference across countries. Baumol（1986）empirically analyzed the technology convergence in industrialized countries, and pointed out that such a convergence also happened in the centrally planned economies. Justin Yifu Lin (2001) analyzed the relationship between development strategy and economic convergence.

allocation gradually dissolves). The interest rate is officially managed and being distorted in most part of 1952-1998. The official interest rates could not reflect the relative scarcity of capital. Interest rate liberalization is part of the future agenda (albeit some recent trails in interest rate liberalization). Most part of China's capital went into low return or negative return investment areas as the result of "blind investment" or repeated investment out of low cost bank loans, and the consequence is decreasing marginal returns to capital between 1986-1998.

In table 5.1 and 5.2, we present the TFP growth rate and the respective contribution of factors to economic growth in East Asian "Four tigers" and China in different historical periods[16]. TFP contribute more to Mainland China's economic growth than to the East Asian "Four tigers". This result provides a fundamental answer to the TFP debates (such as Krugman, 1994). It can also be seen that although China's TFP growth rate during 1966-1970 is far less than that of "Four tigers", China's TFP growth rate is higher than those of South Korea, Singapore and Hong Kong in the 1980s-90s' transition to market.

On average, capital contributes more than TFP to the East Asian "Four tigers" under discussion during the 1966-1990 economic growth. Capital contributes thirty folds more than TFP to Singapore's economic growth in our survey period. Capital contributes only 1.6% to Mainland China's economic growth during 1966-1990(1.8%, 1.2% and 1.7% in 1966-1970, 1970-1980 and 1980-1990, respectively), which is much lower than those of the East Asian "Four tigers" (6.2%, 4.8% and 3.4% and 3.4% for Singapore, South Korea, Taiwan and Hong Kong, respectively). This result is attributed to Mainland China's capital allocation inefficiency. Mainland China's capital allocation efficiency is low in both absolute and relative senses compared to the East Asian "Four tigers", due to the traditional distortions and underdevelopment state in the financial system. However, seen from the long run, due to the fact that share of capital is relatively depressed to that of labor out of institutional distortions and artificially lowered interested rate, capital's potential contribution to Mainland China's economic growth is significant whenever the

[16] In the work of Alwyn Young (1994), it is not possible to compare the variables between regions, because the differences in survey period classifications. We choose the time interval as shown in table 5.1 and 5.2 to avoid such inconvenience.

distortions are addressed with marketlization.

Labor contributed significantly to economic growth in South Korea and Taiwan during their take-off stages. The degree of labor's contribution decreased in South Korea, Singapore and Hong Kong during the 1980-90s, and the degrees of labor's contribution of South Korea, Taiwan and Mainland China are much higher than those of Singapore and Hong Kong. Labor is without doubt the dominant source of economic growth in Mainland China. Labor's contribution to economic growth increases 50% during 1966-1990. This results from at least two reasons: the human capital stock in Mainland China increases over time; Mainland China's labor market integration proceeds quickly during the periods.[17]

7. Concluding Remarks

This paper discusses the trend in TFP and the marginal return to factors in Chinese economy during 1952-1998 using translog production function with the assumption of variable elasticity, and comparing the empirical results with those from the East Asian NIEs. As our empirical results show, China's TFP experienced great fluctuations during 1952-1998. The pattern is that TFP declines dramatically whenever there is political instability, and recovers significantly to a higher level then due to adjustment measures. Since 1978, China's TFP growth rate varies each year but continues to grow. This trend differs significantly from the TFP growth pattern in 1958-1978, where TFP always remained at low levels.

Our findings differ from the previous results in two aspects:

i) As our empirical result shows, China's TFP converges to a steady and higher level after the shock in 1992. This results from the technical gap between China and the advanced economies, and quickened technology adoptions and technology convergence as consequence, but not the result of efficiency in capital utilization.

ii) Labor contributes more as the primary source of China's economic growth in the 1990s, as the result of human capital accumulation and labor market development. In

[17] Figure5.2b reflects the increasing trend in marginal return to labor.

contrast, capital contributes much less to China's economic growth than it did in the East Asian NIEs. During the 1990s, quickened technology adoptions do not bring corresponding increase in the return to capital. Instead we observe a dramatic decline in the return to capital. Such a trend contradicts with the capital-scarce fact of China. This paradox is problem due to the institutional distortions, especially the credit allocation process, and the underdevelopment state of the capital market.

It should be noted that the applicability of our empirical framework is bounded by existing technical restraints. This paper does not include sectorial difference, and also excludes the rural-urban difference. Human capital is measured without any adjustment for changes in educational levels. When calculating China's capital stock, we just adopt one method from the literature, thus excluding tests of the robustness of the results. Our explanation is based partly on extrapolation, which still needs rigorous proof. These limitations provide the scope for further work on this subject.

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TABLE 4.1

A COMPARISON OF THE ESTIMATION METHODS

	OLS			Autoregression			ML of GARCH (1,1)		
Variable	Estimates	St-Error	t-value	Estimate	St-Error	t-value	Estimate	St-Error	t-value
Constant	-1.036**	0.477	-2.173	-1.194*	0.615	-1.941	-1.354***	0.253	-5.351
Ln_k	0.191	0.186	1.027	0.322	0.228	1.415	0.604***	0.186	3.246
Ln_l	0.837***	0.145	5.758	0.719***	0.176	4.078	0.436**	0.172	2.540
LnK*LnK	-0.382**	0.160	-2.391	-0.318	0.204	-1.560	-0.325***	0.039	-8.363
LnL*LnL	-0.382**	0.160	-2.391	-0.318	0.204	-1.560	-0.325***	0.039	-8.342
LnK*LnL	0.764**	0.319	2.391	0.637	0.408	1.560	0.649***	0.078	8.374
D*LnL	-0.245	0.456	-0.539	-0.357	0.585	-0.611	-0.363*	0.213	-1.706
D*LnK	0.218	0.399	0.547	0.316	0.510	0.620	0.323*	0.187	1.731
t*LnK	0.031***	0.009	3.514	0.024**	0.010	2.497	0.020***	0.006	3.316
t*LnL	-0.031***	0.009	-3.514	-0.024**	0.010	-2.497	-0.020***	0.006	-3.316

Note: "***", "**", and "*" represents the significance level 1%, 5%, and 10%, respectively.

OLS Estimate：R-Square 0.9904， A-D-W : 0.7139；

Autoregression model with 2 orders: AIC -111.50892 R-Square 0.9960；

GARCH(1,1) Model Estimate: Log Likelihood 76.620017， R-Square 0.9945，

Normality Test: x^2 statistics 0.0423, the corresponding probability value 0.9791.

FIGURE5.1A
TFP INDEX TREND

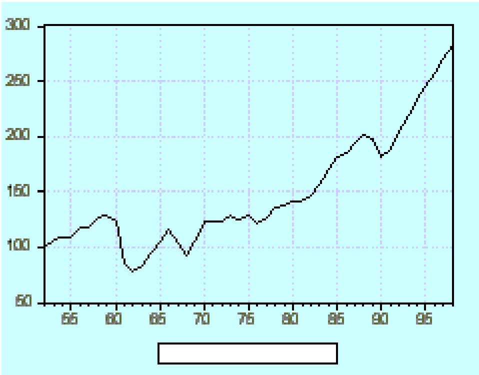

FIGURE5.1B
TFP GROWTH TREND

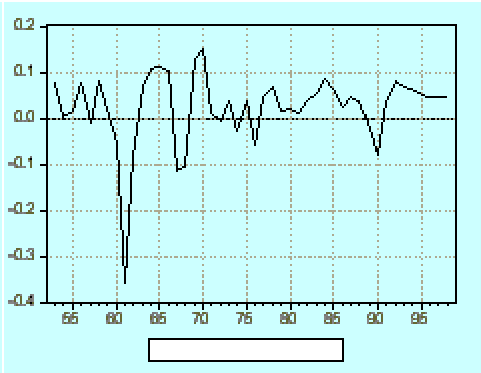

FIGURE5.2A
MARGINAL RETURN TO CAPITAL

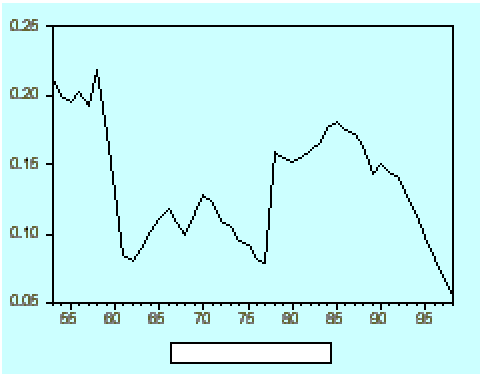

FIGURE5.2B
MARGINAL RETURN TO LABOR

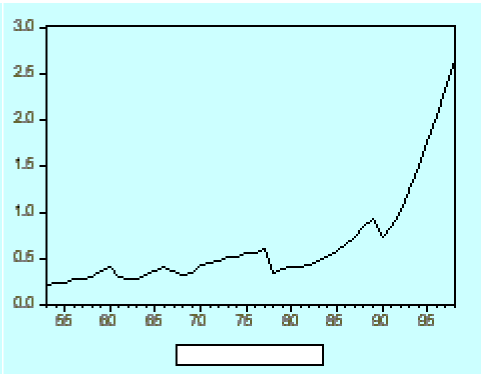

TABLE5.1

GROWTH RATE Of TFP IN EAST ASIAN ECONOMIIES

Year	South Korea	Singapore	Taiwan	Year	Hong Kong	China
66-70	0.013	0.046	0.034	61-71	0.029	0.001
70-80	0.011	-0.009	0.015	71-81	0.031	0.013
80-90	0.025	-0.005	0.033	81-91	0.017	0.027
66-90	0.017	0.002	0.026	66-91	0.023	0.023[18]

Note: Data about East Asian "Four tigers" is the weighted average value from Alywn Young (1994). The calculation is proved to be a satisfactory approximation after Taylor expansion of the logarithm. China's data are calculated by the authors.

TABLE5.2

FACTORS' CONTRBUTION IN EAST ASIAN ECONOMIES

Year	South Korea		Singapore		Taiwan		Year	Hong Kong		China	
	Capital	Labor	Capital	Labor	Capital	Labor		Capital	Labor	Capital	Labor
66-70	0.065	0.066	0.057	0.027	0.045	0.032	61-71	0.039	0.019	0.018	0.022
70-80	0.052	0.031	0.071	0.026	0.038	0.050	71-81	0.033	0.027	0.012	0.032
80-90	0.037	0.034	0.056	0.018	0.027	0.018	81-91	0.037	0.007	0.017	0.045
66-90	0.048	0.038	0.062	0.023	0.034	0.034	66-91	0.034	0.016	0.016	0.033

Note: same to the note in table5.1[19]

18 The results show TFP experienced a great recession in 1960s, so the period 61-65 not considered, the TFP was still high in comparison to TFP in four tigers.

19 The contribution to economic growth in East Asian countries is calculated from multiplying the labor share by growth rate of labor, the contribution is calculated from GDP growth rate minus the contribution of labor and TFP.