

Estimating the Growth Attributes of Mainland China and Hong Kong SAR

Kui-Wai Li, Tung Liu, Hoi Kuan Lam and Liang Wang

ABSTRACT

Since Hong Kong's reversion of political sovereignty to Mainland China in 1997, the pace of economic integration between the two economies has increased. This paper first examines the economic benefits and institutional differences between Mainland China and Hong Kong. The empirical section of the paper used a stochastic frontier model with the incorporation of a human capital variable to decompose the economic and productivity growth of Mainland China and Hong Kong into the four attributes of input growth, adjusted scale effect, technical progress, and efficiency growth.

Keywords: technical progress, technical efficiency, returns to scale, human capital, China economy, Hong Kong economy

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I. Introduction

The sovereignty of Hong Kong was returned to the People's Republic of China on July 1997 after 155 years of British colonial rule, turning Hong Kong into a Special Administrative Region (SAR) of China. The Hong Kong SAR retains its own constitution as stated in the Basic Law and the preservation of the capitalist market economic structure for fifty years. However, there are great systemic differences between Mainland China and Hong Kong. Mainland China since 1949 has adopted the Soviet Union's style of socialist economic principles with central planning. Throughout the three decades of the 1950s to 1970s, Mainland China experienced state ownership that has resulted in resource misallocation and economic inefficiency (Perkins, 1986, 1988). For decades, Hong Kong has practiced a laissez-faire economic system with strong adherence to private property rights and freedom in economic activities. Through a process of industrialization that began in the 1960s, Hong Kong by the 1980s has become a matured economy with GDP per capita similar to Japan, and has changed from a net receiver to a net supplier of foreign investment (Li, 2002, 2006).

Since China's economic reform in 1978 and prior to 1997, Hong Kong has fostered an important role as the financier, facilitator, mediator and investor to China's economic reform and development, especially in the adjacent Guangdong Province (Sung, 1991). One source disclosed that 70 percent of Guangdong's utilized foreign direct investment in 2001 was originated from Hong Kong (Li, 2006 p. 370). At the time of sovereignty reversion in 1997, there were still vast differences in the level of economic development between Mainland China and Hong Kong. For example, Hong Kong ranked first while Mainland China ranked 132th in the 2009 *Index of Economic Freedom*, and the per capita GDP of Hong Kong was 7.4 times higher than Mainland China in 2006 (Heritage Foundation, 2009). Businesses in Hong Kong are governed by the presence of a strong legal system, while *guanxi* (relationship) is a common form of business behavior in Mainland China (Dixit, 2004). With sovereignty reversion, "economic welding" in the form of economic cooperation and integration between China and Hong Kong is expected to increase.

This paper aims to examine the difference in the growth attributes between Mainland China and Hong Kong in order to understand the economic dimensions for

further integration between the two economies. Studies that examined the growth of total factor productivity (TFP) in the two economies have employed the neo-classical Solow (1957) growth accounting approach (Borenzstein and Ostry, 1996; Kalirajan *et al.*, 1996; Li, 2003, 2006, 2009; Lin, 2000; Liu and Li, 2006). The few studies on the analysis of economic efficiency in China are either sector or enterprise oriented (Tong, 1999; Wu, 1995; Fu, 2005; Kalirajan and Zhao, 1997; Huang and Kalirajan, 1998). Regional economic imbalance has been another concern in China. Input differences in economic growth in China has also been studied (Wan, 2004; Chang, 2002; Cai *et al.*, 2002; Zhang and Zhang, 2003; Yao *et al.*, 2005; Liu and Li, 2006).

However, the neo-classical assumptions of a constant returns to scale and an optimal production capacity in the Solow (1957) model has been challenged by the output-oriented stochastic frontier production approach, which argues that deviations between actual and optimal output due to technical inefficiency are possible (Aigner *et al.*, 1977). The stochastic frontier approach assumes a non-constant returns to scale and decomposes TFP growth into three components of technical progress, technical efficiency change, and scale effect (Kumbharkar and Lovell, 2000).

This paper uses the stochastic frontier production model to analyze the growth attributes of the two economies and compare them with the aim to draw lessons for further integration. In addition to the two physical capital and labor variables, a human capital variable is included in the stochastic frontier production function. The sample periods for Mainland China and Hong Kong are 1986-2006 and 1983-2005, respectively. To determine changes and improvement of efficiency and technical progress for the two economies, the estimates for the period before 1997 are used to compare to the whole sample period. The break point of 1997 is chosen to reflect both the sovereignty reversion and the Asian financial crisis in 1997-1998.

Panel data from Mainland China and Hong Kong are used in the regression exercise. The data sources and construction of the different variables for the thirty provinces in Mainland China are similar to those used in Li (2003, 2009), Liu and Li (2006) and Li *et al.* (2009), but the data are updated to 2006. Similarly, the data for Hong Kong used in Li (2006) are updated to 2005, and the construction of the human capital, together with the explanation of other data, is discussed in Appendix A. One should note

that the construction of the variables used in Mainland China and Hong Kong is different because of their differences in the basis of data compilation.

Section II provides a summary on the different aspects of economic integration between Mainland China and Hong Kong. Section III discusses the decomposition of the TFP and outlines the methodology for the stochastic frontier estimation. Section IV discusses the empirical findings. The last section concludes the paper.

II Different Economic Performance in Integration

Since 1949 and until 1978, Mainland China has pursued a closed door economic policy of self-sufficiency with socialist ideology characterized by state-ownership and communes. During the same time period, Hong Kong has practiced an open market capitalist economic system and has earned the status of an international center in finance, trade and investment. In 2005, for example, the total trade flows and the foreign direct investment as a percentage of GDP for Mainland China are 69.5% and 4.1%, respectively. The same percentages for Hong Kong are 385.2% and 34.2%, respectively.¹

There are vast differences in institutional performance between Mainland China and Hong Kong. For example, Table 1 shows that Mainland China's performances in key institutional indicators are not only weaker than Hong Kong, but the gap is large in a number of cases. In the 2009 rankings produced by the Chinese Academy of Social Sciences on the overall urban competitiveness of 294 cities in the greater China region that comprises of Mainland China, Chinese Taipei, Hong Kong and Macau, Hong Kong is ranked as the most competitive city, followed by Shenzhen, Shanghai, Beijing, Taipei, Guangzhou, Qingdao, Tianjin, Suzhou and Kaohsiung as the top ten most competitive cities. One should note that the location of both Shenzhen and Guangzhou are adjacent to Hong Kong.²

Although the Hong Kong economy since 1997 has suffered a series of economic shocks and crisis, including the Asian financial crisis in 1997-1998, the chicken flu that occurred in various years, the severe acute respiratory syndrome (SARS) in 2003 and the financial tsunami in US in 2008, cooperative agreements have been made between the

¹ *International Financial Statistics*, IMF (2007).

² *Annual Report on Urban Competitiveness*, No. 7 (2009), Blue Book of City Competitiveness, Chinese Academy of Social Sciences, Beijing.

central government in Beijing and the Hong Kong SAR Government since the turn of the century. Beginning in 2003, a series of Closer Economic Partnership Agreements (CEPA) have been made to lower the import tariff rates of Mainland China for Hong Kong's export in goods and services, and a number of facilitation agreements have also been included. Since 2005, the Beijing government has announced a visa-free travel policy for Mainland residents from major cities and provinces to travel to Hong Kong as tourist visitors. In 2006, led mainly by Guangdong, a regional Pan-Pearl River Delta (Pan-PRD) body has been established that consisted of nine southern provinces and Hong Kong SAR and Macau SAR with the intention to promote regional development and growth. To promote Hong Kong's financial center status, the policy on Qualified Domestic Institutional Investor (QDII) was announced in 2006 permitting Mainland capital to come to Hong Kong, but due to the drastic jump and shocks in the financial market in Hong Kong, the policy was shelved in 2007. In spring 2009, Beijing declared that Hong Kong will become one of the Renminbi trading centers.³

A closer examination on key economic variables shows that provinces closer to Hong Kong have benefitted most from Hong Kong's return to Mainland China through the spillover of investment, trade, cross-border consumption and human capital. For example, at least 49.4% of Hong Kong's total direct investment to Mainland China in 2007 has flowed into the nine provinces in the Pearl River Delta (PRD) region. Table 2 shows the inflow of FDI from Hong Kong and from the World to each of the nine provinces. The FDI from Hong Kong has been the largest share in each province, though Hong Kong's investment funds to Mainland China could have come from elsewhere (Sung, 1991). For the total exports from Mainland China to Hong Kong, the share from the nine provinces amounted to at least 74.7% in 2007. Table 3 shows the exports from the nine provinces to Hong Kong and the World.

Mainland China has become the key destination for Hong Kong resident departures for outbound travel, as its percentage share in Hong Kong's total resident departures amounted to 85% or higher between 1999 and 2007.⁴ As Table 4 shows, the

³ Information on various agreements and announcements can be found in the Hong Kong SAR Government official web page at www.info.gov.hk.

⁴ *Consumption Expenditure of Hong Kong residents Travelling to Mainland China 2007*, Hong Kong Monthly Digest of Statistics, Census and Statistics Department, Hong Kong SAR, July 2008.

majority of Hong Kong's residents' personal travel trips to Mainland China are destined to the Guangdong province, which accounted for 94.7% in 2007, with Shenzhen city having the largest share in Guangdong (a share of about 58%) in 2007. This reflects the geographical proximity and close socio-economic ties between Hong Kong and the Guangdong province.

Other than leisure travel trips, knowledge spill over from Hong Kong to Mainland China has also been important. Table 5 shows that a total of 218,200 Hong Kong residents are working in China in the third quarter of 2008, equivalent to 6.2% of total employed population in Hong Kong. Table 6 shows the number of Hong Kong residents working in several cities in Mainland China in the July-September 2008 period. Of the total Hong Kong residents working in Mainland China, 87.8% are working in the Guangdong province. The two Guangdong cities of Shenzhen and Dongguan occupy a total of 62.9% already. Outside the Guangdong province, Shanghai is the more popular city, occupying 4.9% of total.

Table 7 summarizes the number of Hong Kong residents working in China in different categories. In the age group category, for example, the middle age group of 40-49 years forms the largest group of 36.7%, which is larger than the percentage of middle age group in Hong Kong (28.2%). For the education attainment, the group with secondary and sixth-form education is the largest group, comprising 48.4%, though it is lower than the percentage of secondary and sixth-form education in Hong Kong (55.8%). The groups with post-secondary, both non-degree and degree, education attainment in Mainland have higher percentage than the percentages in the respective groups in Hong Kong. This implies that labor mobility from Hong Kong to Mainland China is more significant at the high education level than other levels. By industry groups, manufacturing and wholesale/retail services have attracted most persons. Comparing the percentages in the respective groups in Hong Kong, the major gap is in manufacturing. Although only 5.4% of people in Hong Kong are in manufacturing, 41% of Hong Kong residents working in Mainland China are in manufacturing. In terms of occupation, most Hong Kong residents working in Mainland China are managers, administrators, and professionals. The total percentage in these groups is 86.5%, which is much higher than the total percentage of these groups employed in Hong Kong (36.4%). Table 7 also shows

that 17.1% of Hong Kong residents working in China are employers, while in comparison there are only 3.6% of employers in Hong Kong.

Hong Kong residents working in Mainland China supplements the shortage of human capital in Mainland China. A large proportion of the Hong Kong residents working in China are engaged at the upper end of the occupation hierarchy. For example, the median monthly earning of Hong Kong residents working in Mainland China has reached HK\$20,000 (US\$2,564), but the median earning in Hong Kong in the same period is HK\$10,500 (US\$1,346). Knowledge spillover from Hong Kong to Mainland China is an important factor in the economic integration process in the period after sovereignty reversion.

Despite the systemic and institutional differences and given the rapid economic changes in Mainland China, economic integration and/or cooperation can also be seen dynamically. From the resource availability point of view, Li (2006) has pointed out that with its abundance of land, labor and probably capital, Mainland China is said to have an absolute advantage over Hong Kong. In contrast, the position that Hong Kong can take is to create and maintain its comparative advantages. Li (2006, Chapter 8, Figure 8.6, p. 383) discusses the “complement-competitive” framework in looking at economic integration between the two economies. On the one hand, since Hong Kong is economically more developed than Mainland China, Mainland China will need Hong Kong as a reference point in numerous development aspects. The “complement” element is that so long as performance in various economic activities lack standards, the experience of Hong Kong will become a “showcase”. On the contrary, armed with three decades of economic reform, the Mainland China economy has excelled in numerous areas, and therefore can become “competitive” to Hong Kong.

III Stochastic Frontier Model and Output Growth Decomposition

This paper considers the four sources of output growth: input growth, adjusted scale effect, technical progress, and technical efficiency change. The adjusted scale effect shows the combined effect from various input elasticity of physical capital, labor and human capital. Technical progress shows the rate of technological change and is indicated by an outward shift in the economy’s production possibility frontier. Technical efficiency

change refers to a movement from a position within the production possibility frontier towards the production frontier.

A conventional production function shows how a producer maximizes output from inputs. The estimation on the output, cost, and profit functions are based on the assumption that producers are operating optimally and efficiently. However, Kumbhakar and Lovell (2000) have pointed out that such an estimation technique fails to deal with variation in production efficiency since not all producers are successful in solving their optimization problems. The stochastic frontier analysis assumes that deviations from the efficient frontier can either be a realization of inefficiency or a random shock (Farrell, 1957; Coelli *et al.*, 1998; Stevenson, 1980).

The estimation model with a production frontier function without the random component as suggested in Aigner *et al.* (1977) can be stated as:

$$y_i = f(x_i; \beta) \cdot TE_i, \quad (1)$$

where y_i is the observed scalar output and x_i is a vector of inputs for i^{th} firm, β is a $k \times 1$ vector of parameters to be estimated and TE_i denotes the technical efficiency defined as the ratio of observed output to maximum feasible output (Aigner and Chu, 1968). Let $y_i = f(x_i; \beta) \exp(-u_i)$. Then

$$TE_i = \frac{y_i}{f_i} = \exp(-u_i), \quad (2)$$

where u_i is supposed to measure technical inefficiency and when $u_i \geq 0$, then $TE \leq 1$ (Battese *et al.*, 2005). Such an output-oriented measure of technical efficiency takes a value between zero and one. It measures the output of the i -th firm relative to the stochastic frontier output that could be produced by a fully-efficient firm utilizing the same vector of inputs. Technical efficiency TE_i can be derived using the estimates from the stochastic frontier production model. If $TE_i = 1$, then the firm is technically efficient.

The specification of technical inefficiency in Equation (1) might also capture

other random shocks that are either beyond the control of the firm or not directly attributable to the underlying technology. The random shocks affecting the production process can be included to the production frontier function by adding a two-sided error term (Aigner and Chu, 1968). The stochastic frontier production now becomes:

$$y_i = f(x_i; \beta) \exp(-u_i) \exp(v_i), \quad (3)$$

where $\exp(v_i)$ denotes the stochastic component that describes the random shocks. When expressed in a Cobb-Douglas format of the production function, $f(x_i; \beta)$ takes a log-linear form, and the stochastic frontier production model can be written as:

$$\ln y_i = \beta_0 + \sum_{j=1}^k \beta_j \ln(x_{ji}) + v_i - u_i. \quad (4)$$

The logarithmic production function can further be augmented by incorporating a human capital variable. The panel data production function for our empirical estimation is expressed as:

$$\ln Y_{it} = \alpha + \beta_K \ln K_{it} + \beta_L \ln L_{it} + \phi_H H_{it} + \sum_t \delta_t D_t + v_{it} - u_{it}, \quad (5)$$

where $i=1, \dots, N$ (provinces in China or economic sectors in Hong Kong) and $t=1, \dots, T$; $\ln Y_{it}$ is the log of real GDP for i^{th} province/economic sectors in China/Hong Kong at time t . $\ln K_{it}$ is the log of physical capital stock, $\ln L_{it}$ is the log of total number of employed workers in China or the log of total number of labor working hours in Hong Kong, H_{it} is the human capital variable, and D_t is the time dummy variable that captures technology progress and the parameter δ_t can be used to measure technical level over time.

The random error, v_{it} , is symmetric and normally distributed with $v_{it} \sim N(0, \sigma_v^2)$ and the technical inefficiency term, u_{it} , is assumed to be a non-negative truncated

normal random error with the $u_{it} \sim N(\mu, \sigma_u^2)$, where μ is the mode of the normal distribution (Kumbhakar and Lovell, 2000). Technical inefficiency can either be time variant (u_{it}) or time invariant (u_i). In the case of time variant technical inefficiency, u_{it} can be expressed as a monotonic ‘decay’ function as $u_{it} = \eta_t u_i$, where $\eta_t = \exp(-\eta(t-T))$, and η is an unknown scalar parameter for technical inefficiency. u_{it} can either be increasing (if $\eta < 0$), decreasing (if $\eta > 0$) or remained constant (if $\eta = 0$) (Battese and Coelli, 1992).

The maximum likelihood method is used to estimate the parameters in a stochastic frontier production. The minimum-mean-square-error predictor of the technical efficiency of the i^{th} province/economic sector at time t is shown as (Battese and Coelli, 1988, 1992, 1995; Kumbhakar and Lovell, 2000; Coelli 1996; Battese and Corra 1977):

$$TE_{it} = E(\exp(-u_{it}) | \varepsilon_{it}), \quad (6)$$

where

$$\varepsilon_{it} = v_{it} - u_{it}. \quad (7)$$

Equation (5) is applied to the provincial panel data of Mainland China and the economic sectors panel data of Hong Kong to derive the measures of output growth, total factor productivity (TFP) growth, and their sources. The output elasticities for physical capital, labor, and human capital for Mainland China and Hong Kong are denoted, respectively, as $e_{K_{it}} = \beta_K$, $e_{L_{it}} = \beta_L$ and $e_{H_{it}} = \beta_H H_{it}$. The returns to scale are measured as:

$$e_{it} = e_{K_{it}} + e_{L_{it}} + e_{H_{it}}. \quad (8)$$

Using Equation (A18) in Appendix B, the decomposition of output growth is shown as follows:

$$\dot{Y}_{it} = \frac{e_{K_{it}}}{e_{it}} \dot{K}_{it} + \frac{e_{L_{it}}}{e_{it}} \dot{L}_{it} + \frac{e_{H_{it}}}{e_{it}} \dot{H}_{it} + Scale_{it} + \Delta \delta_t + TE_{it}, \quad (9)$$

where

$$Scale_{it} = (e_{it} - 1) \left(\frac{e_{K_{it}}}{e_{it}} \dot{K}_{it} + \frac{e_{L_{it}}}{e_{it}} \dot{L}_{it} + \frac{e_{H_{it}}}{e_{it}} \dot{H}_{it} \right). \quad (10)$$

Equation (10) measures the adjusted scale effect, while $\Delta\delta_t = \delta_t - \delta_{t-1}$ is a measure of technical progress and δ_t can be estimated from Equation (5). $T\dot{E}_{it}$ refers to the change in technical efficiency and can be estimated from Equation (6). Note that the ratio of output elasticity for each input to returns to scale is equivalent to the cost share of each input (Equation (A14) in Appendix B). We define the growth of aggregate input as:

$$\dot{\Phi}_{it} = \frac{e_{K_{it}}}{e_{it}} \dot{K}_{it} + \frac{e_{L_{it}}}{e_{it}} \dot{L}_{it} + \frac{e_{H_{it}}}{e_{it}} \dot{H}_{it}, \quad (11)$$

Then

$$\dot{Y}_{it} = \dot{\Phi}_{it} + Scale_{it} + \Delta\delta_t + T\dot{E}_{it}. \quad (12)$$

We define the TFP for a production function with multiple inputs at time t as

$$TFP_{it} = \frac{Y_{it}}{\Phi_{it}}. \quad (13)$$

Then the growth of TFP is

$$T\dot{F}P_{it} = Scale_{it} + \Delta\delta_t + T\dot{E}_{it}. \quad (14)$$

The decomposition of output growth and productivity growth, shown in Equations (12) and (14), will be applied to the empirical data in Mainland China and Hong Kong. In particular, the components of decomposition, shown in Equations (8), (10), and (11), can be used to explain the change of growth over time.

IV Empirical Results

Table 8 presents the maximum likelihood estimates of the stochastic frontier production with the panel data from Mainland China's thirty provinces and Hong Kong's four sectors for the two periods. The first period covers the first sub-sample through 1996 due to the reversion of Hong Kong's sovereignty in 1997 and the Asian financial crisis in 1997-1998, while the second period is the whole sample period. For Mainland China, the first sub-sample period covers 1985-1996 with 360 observations and the whole sample period covers 1985-2006 with 660 observations. For Hong Kong, the first sub-sample period covers 1983-1996 with 56 observations and the whole sample period covers 1983-2005 with 92 observations. The purpose of the selection of these two sample periods is to examine if the two economies have encountered changes in their production efficiencies and frontier functions over time. Because of limited data in the second sub-sample period from 1997 onwards, the estimation cannot be applied to the second sub-sample period alone. However, the properties of the estimates for this period can be inferred by comparing the estimations from the first sub-sample period and the whole sample period.

The dependent variables of the models for both periods are the log real GDP. The independent variables, in addition to physical capital, labor, and human capital, include 11 and 21 time dummy variables for the two periods for Mainland China, and 13 and 22 time dummy variables for the two periods in Hong Kong. The last row in Table 8 presents the four sets of model specification tests that contain the likelihood-ratio tests for the joint effects of the time dummy variables for the two sample periods. The significance level of the likelihood-ratio tests is set at five percent. The statistics for the two periods in Mainland China and Hong Kong show that the significant time dummy variables suggest that technology change over time is significant.⁵

For the pre-1997 period in Mainland China, the effect of physical capital is clearly predominant in the production function. Nevertheless, the effect of labor has kept close to physical capital over time, as indicated by a larger estimate of labor for the whole sample

⁵ The maximum likelihood estimates of the coefficients of time dummies are not shown in the table but can be available from the corresponding author.

period of Mainland China.⁶ The estimated technical inefficiency parameters, η , are negative, meaning that the overall technical inefficiency is increasing over time for both periods. The measure of the variation in inefficiency is indicated by γ , $\gamma = \frac{\sigma_u^2}{\sigma_s^2}$, where σ_s^2 refers to the sum of the variances of the combined error terms (i.e., the variance of the normal random error term, σ_v^2 , and the variance of the technical inefficiency term, σ_u^2). The estimates for the two periods suggest that the inefficiency component has shown a greater variation in the composite error term in the pre-1997 period (0.988) than in the whole sample period (0.9743).

In the case of Hong Kong, the effect of physical capital is mildly predominant in the production function in the pre-1997 period, but the effect of labor surpasses that of physical capital in the whole sample period. This implies that the effect of labor has increased in the post-1997 period. The estimated technical inefficiency parameters, η , are positive, suggesting that the overall technical inefficiency is decreasing over time. The estimates of the variation in inefficiency, γ , show that the inefficiency component has a higher variation in the pre-1997 period (0.9713) than in the whole sample period (0.9324). This implies a mild decrease in the variation since 1997.

The estimates from Equation (5) are also used to derive the estimates for the sources of output growth (\dot{Y}) and total factor productivity growth (\dot{TFP}). These estimated are: the output elasticity with respect to factor input of capital (e_K), labor (e_L) and human capital (e_H); the returns to scale (e); the adjusted scale effect ($Scale$); the rate of technical progress ($\Delta\delta_t$); and the growth of technical efficiency (\dot{TE}).

Table 9 shows the overall means of output elasticity with respect to each input and the cost shares of inputs in Mainland China and Hong Kong for the two periods. We first consider the results for the period before 1997. For Mainland China, physical capital has the largest output elasticity with an average value of 0.7750 and followed by labor (0.1890) and human capital (0.0650). For Hong Kong, human capital has the largest

⁶ Since the human capital variable is not in logarithm form, its estimates are not comparable with the estimates of the other two inputs. The importance of human capital can be seen with its elasticity and cost share in the later table.

output elasticity (0.8259) and followed by physical capital (0.5393) and labor (0.4245). The differences in the output elasticities between Mainland China and Hong Kong result in the differences in returns to scale and cost shares of inputs. The returns to scale in Hong Kong (1.7896) are much higher than that in Mainland China (1.0291), suggesting that the returns to scale are an important factor for the economic growth in Hong Kong. For the cost shares in Mainland China, the share for physical capital (75.31%) is highest, followed by labor (18.37%) and human capital (6.32%). For Hong Kong, the range of the three cost shares is smaller, with human capital the largest (46.11%), followed by physical capital (30.15%) and labor (23.74%). In terms of both output elasticity and cost share, physical capital is important for Mainland China and human capital is important in Hong Kong before 1997.

For the whole sample period, Table 9 shows that the output elasticities for physical capital and labor in Mainland China (0.4424 and 0.4320, respectively) are similar and larger than the elasticity for human capital (0.2072). For Hong Kong, the output elasticities for labor and human capital (0.7087 and 0.7801, respectively) are similar and larger than the elasticity for physical capital (0.4047). In summary, the output elasticities for labor and human capital in Hong Kong are larger than those in Mainland China; while the elasticity for physical capital for Mainland China and Hong Kong are similar.

By comparing the results from the pre-1997 period and the whole sample period, we can infer the change in the output elasticities for the period since 1997. For Mainland China, the output elasticity for physical capital in the whole sample period (0.4424) is much smaller than that in the pre-1997 period (0.7750). This implies that the output elasticity of physical capital since 1997 has decreased and should be smaller than 0.4424. As for labor and human capital, their output elasticities have increased since 1997 because these two elasticities are larger in the whole sample period than in the pre-1997 period. Therefore, the physical capital has become less important, while labor and human capital have become more important for the period since 1997 in Mainland China. This can indicate that diminishing return appeared after the intensive use of physical capital in the pre-1997 period. For Hong Kong, the output elasticity for labor in the whole sample period (0.7089) is much higher than that in the pre-1997 period (0.4245). This implies

that the output elasticity of labor has become higher and labor has become important since 1997 in Hong Kong. However, the elasticities for both physical capital and human capital have shown a mild decrease since 1997. Overall, we can conclude that the output elasticities for all three inputs are higher in Hong Kong than in Mainland China since 1997. The returns to scale value in Hong Kong (1.8934) are still much larger than the value in Mainland China (1.0817). Hong Kong consistently has larger returns to scale than Mainland China in the second sub-sample period.

In the whole sample period, Table 9 shows that the pattern of the cost share is similar to that of the output elasticity. The cost shares for physical capital and labor in Mainland China (40.29% and 39.97%, respectively) are close and larger than the share of human capital (19.11%). For Hong Kong, the cost shares of labor and human capital (37.46% and 41.15%) are larger than the cost share of physical capital (21.39%). Among the three inputs, Mainland China has a larger share of physical capital than Hong Kong, while Hong Kong has a larger share of human capital than Mainland China.

We can consider the difference in the cost shares between the pre-1997 period and the whole sample period. The cost share for physical capital in Mainland China has declined and the shares for labor and human capital have increased during the second sub-sample period. For Hong Kong, the cost share for labor has increased and the shares for both physical capital and human capital have decreased in the second sub-sample period. We can conclude that both cost shares for physical capital and labor are higher in Mainland China than in Hong Kong and the cost share for human capital is higher in Hong Kong than in Mainland China in the second sub-sample period.

Table 10 shows the input growth for each input and the adjusted scale effect. In the pre-1997 period, the weighted aggregate input growth in Mainland China is 7.79%, with physical capital accounting for 93.20% (7.26% out of 7.79%), while labor and human capital accounted for 4.88% and 1.93%, respectively. This implies that physical capital is dominant in Mainland China. The growth of aggregate weighted inputs in Hong Kong shows an average of 2.38%, with physical capital accounted for 63% (1.5% out of 2.38%), while labor and human capital accounted for 9% and 27%, respectively. The lower input growth in Hong Kong when compared to Mainland China is mainly caused by the low growth in physical capital, although physical capital is still the main

contributor to the input growth in Hong Kong.

For the whole sample period, Table 10 shows that the growth of aggregate input in Mainland China has an average of 5.10% and Hong Kong has an average of 1.15%. Both input growth rates are lower than their values in the pre-1997 period. The lower input growth in Mainland China is mainly caused by a lower cost share of physical capital in the whole sample period than in the pre-1997 period. The low input growth in Hong Kong is caused by a low weighted physical capital growth and the negative labor growth (due probably to emigration, see Li, (2006)) in the post-1997 period. However, physical capital is still dominating in the weighted input growth for both Mainland China and Hong Kong in the whole sample period. Physical capital accounted for around 80% of Mainland China's input growth (4.06% out of 5.1%) and 70% of Hong Kong's input growth (0.83% out of 1.14%).

Since all the returns to scales shown in Table 9 are greater than one, the adjusted scale effect is positive. In the pre-1997 period, Table 10 shows that the scale effect is lower in Mainland China (0.24%) than in Hong Kong (1.89%). This difference is mainly caused by the higher returns to scale in Hong Kong than in Mainland China (1.7897 and 1.0291, respectively, shown in Table 9). In the whole sample period, the scale effects in Mainland China and Hong Kong are 0.42% and 0.97%, respectively. This gap between the two scale effects is smaller than the gap in the pre-1997 period. The higher scale effect in Mainland China in the whole sample period is caused by the higher returns to scale in the whole sample period; the lower scale effect in Hong Kong is caused by the lower input growth in the whole sample period.

Finally, the decomposition of output growth and the TFP growth for both Mainland China and Hong Kong for the two periods are shown in Table 11. The four sources of the output growth are: growth in inputs ($\dot{\Phi}$), scale effect (*Scale*), rate of technical progress ($\Delta\delta_t$) and growth in technical efficiency (\dot{TE}). In the pre-1997 period, the average economic growth in Mainland China is 9.6%. The major contributor to this high economic growth is input growth (7.79%) and followed by technical progress (3.18%). The adjusted scale effect (0.24%) has only contributed a small fraction to the economic growth. The contribution from technical efficiency is negative in all years with an average of -1.54%. When the sources of TFP growth are considered, the factor of input

growth is removed. The average TFP growth in Mainland China is 1.88%. Technical progress (3.18%) is the main factor for the TFP growth. The negative contribution from technical efficiency change (-1.51%) significantly reduces the potential growth of TFP in Mainland China.

In the case of Hong Kong, the mean of output growth in the pre-1997 period is 4.17%. The major contributors to Hong Kong's economic growth are input growth (2.38%) and scale effect (1.89%). The small positive value in technical efficiency (0.41%) is offset by the negative value in technology progress (-0.5%). Since the 1980s, the political uncertainty generated by sovereignty reversion, coupled with de-industrialization as manufacturing plants moved to Southern China could explain the fall in Hong Kong's technical progress in the pre-1997 years. The average TFP growth in Hong Kong is 1.79%, which is close to the TFP growth in Mainland China. However, the major factor for Hong Kong's TFP growth is scale effect (1.89%). A closer examination on the different performances of various TFP components in the pre-1997 period can be seen from the yearly figures (not included in Table 11). For example, technical progress has contributed as much as 8.87% and 3.01% to TFP growth in 1987 and 1988, respectively, when the Sino-British Joint Declaration on the political future of Hong Kong was concluded and economic stability was revived. However, it did not improve but instead slackened to negative rates in later periods when the economy overheated in the years before 1997. It can be seen that TFP has reached a peak of 4.96% in 1991 before it fell, largely due to a poor performance in technical progress.

In the whole sample period, Table 11 shows that the average economic growth in Mainland China is 9.99%, which is close its value in the pre-1997 period. However, technical progress (5.89%) has taken up the role of input growth (5.1%) as the major contributor to the economic growth in the whole sample period. The scale effect (0.42%) is still a small positive and the average contribution from technical efficiency remains negative (-1.51%). The TFP growth in the whole sample period is 4.8%, which is much higher than the value in the pre-1997 period (1.88%). This high TFP growth is largely responsible by technical progress. The economic growth in Hong Kong has an average of 2.39% in the whole sample period. The major contributors to its economic growth are still input growth (1.14%) and scale effect (0.97%). However, these values have fallen to

about one-half of those values in the pre-1997 period, and this has led to a lower growth rate in the whole sample period than in the pre-1997 period. The only improvement is the rate of technical progress, with a smaller negative average value of -0.08%. The overall mean of the TFP growth in the whole period is 1.26%. This value is lower than the value in the pre-1997 period and is mainly caused by the lower scale effect. As in the pre-1997 period, the most important factor for Hong Kong's TFP growth in the whole sample period is scale effect.

Comparing the economic growth between Mainland China and Hong Kong in the whole sample period, Table 11 shows that the economic growth in Mainland China is higher than that in Hong Kong since the input growth and technology progress are higher in Mainland China. Technical progress also explained the higher TFP growth in Mainland China than in Hong Kong. To infer the differences between Mainland China and Hong Kong during the second sub-sample period since 1997, we conclude that the input growth and technical progress in the second sub-sample period contribute higher economic growth and TFP growth in Mainland China than in Hong Kong.

V Conclusion

By applying the stochastic frontier models to the thirty provinces in Mainland China's post-reform economy and the four economic sectors in Hong Kong, this paper examines the economic performances of the two economies in two periods. Mainland China has experienced increases in output and productivity growth. The empirical results show that input growth is the main engine to economic growth in Mainland China before 1997. Technical progress is the major contributor to the TFP growth in the whole sample period and significantly contributed to TFP growth after 1997. Technical inefficiency remains and represents a significant drag in Mainland China's productivity growth.

The growth pattern in Hong Kong is different from Mainland China in several ways. The growth in input is the main engine of Hong Kong's economic growth both before and since 1997. The returns to scale in Hong Kong outperformed those in Mainland China for all years in the sample period. Hence, the adjusted scale effect induced by high returns to scale is the major contributor to the productivity growth in Hong Kong. Hong Kong has experienced decreases in output and productivity growth

after 1997. The decreases are mainly caused by the low input growth. Unlike Mainland China, Hong Kong has experienced a negative technical progress. Hong Kong should adopt new technology and increase R&D expenditures to improve its technical progress. However, Hong Kong's positive technical efficiency change does contrast sharply with the negative efficiency change in Mainland China. The production methods in Mainland China should be improved in order to improve technical efficiency, while more investment in technology innovation should be made in Hong Kong.

Factor accumulation is important in both Mainland China and Hong Kong as input growth is an important factor for their economic growth. The empirical results show that human capital is a major constraint in Mainland China. Continuous investment on education and training is needed. For example, Figure 1 shows that human capital in Mainland China is measured by the number of schooling years. The human capital with only primary school education has increased at an average rate of 0.05% (with negative growth rates in recent years), the same average growth rates for the junior middle school education, the senior middle school education (including vocational secondary school and specialized secondary school) and higher education are 1.54%, 2.08% and 4.64%, respectively, for the whole sample period. While tertiary education has received much attention since economic reform in Mainland China, the weaker section of human capital is the middle range, as seen from the low average growth rates in the human capital with junior middle school and senior middle school education.

In the case of Hong Kong, the sample period has reflected a changing situation in the era before and after the sovereignty reversion and Asian financial crisis in 1997. During the period since 1997, the decrease in the physical capital growth and negative labor growth has reduced input growth, and subsequently economic growth and productivity growth in Hong Kong. Political uncertainty before 1997 has resulted in a lack of long term investment, especially investments related to R&D or large-scale industrial plants. Investment that contributed to technical progress has not been forthcoming after 1997. The Hong Kong economy needs to revert back to a more stable environment that can nurture investment and promote technical progress in the long term (Li, 2006). However, technical efficiency in Hong Kong has been high, which would give an added advantage when technical progress improves.

The empirical findings can provide implications on the economic integration between Mainland China and Hong Kong. The production capacity in Mainland China has expanded greatly, and the improvement in technical progress is the driving force in productivity growth. Typically, the lack of technical progress in Hong Kong can be complemented by the strong performance in technical progress in Mainland China. Similarly, the poor performance in Mainland China's technical efficiency can be improved by learning from the experience of Hong Kong

Appendix A: Data description

Due to the differences in the way data are corrected, compiled and reported in Mainland China and Hong Kong, constructed economic variables may not be the same in the two economies, but they can provide a trend analysis for the two economies.

Hong Kong

The sources of data and the compilation of economic variables for the Hong Kong economy used in Li (2006, Chapter 3) have been updated to 2005. The capital stock figures in Li (2006) are constructed from the accumulation of gross investment and the initial capital stock followed the assumption used in Kim and Lau (1994). The aggregate data for the Hong Kong economy comes from the fourteen comprehensive industries that are grouped into four economic sectors of the tradable goods sector (agriculture and fishing, mining and quarrying, and manufacturing), the tradable services sector (import and export trade, restaurant and hotels, air and water transport, other transport services, storage and communications, and financing, insurance, real estate and business services), the non-tradable goods sector (construction, and electricity, gas and water), and the non-tradable services sector (wholesale and retail, land transport, and community, social and personal services).

The human capital variable used in this paper is constructed by using the mean years of schooling. The mean years of schooling of the aggregate economy and different industries are estimated from the *Hong Kong Population Census* reports for the sample period from 1981 to 2006.⁷ Estimation of mean years of schooling begins from assigning years of schooling to different levels of education attainment: levels 1 to 6 with 1-3, 4-9, 10-12, 13-14, 15-17 and 18-24 years of schooling for primary, lower secondary, upper secondary, polytechnic or technical institute or non-degree courses at post-secondary institutions and university or degree courses in universities, respectively. The mean years of schooling is estimated from the formula: $\sum_{i=1}^6 x_i y_i / \sum_{i=1}^6 x_i$, where x = no of people in the working population, y = mid-point interval of the years of schooling and i = level of educational attainment. The mean years of schooling for each industry are estimated for 6 years (1981, 1986, 1991, 1996, 2001 and 2006).⁸ The exponential growth rates of human capital for the remaining years are calculated.

Mainland China

The methods for calculating the key macroeconomic variables used in the regression follow those in Li (2003), Liu and Li (2006) and Li *et al.* (2009). A similar method in constructing the physical capital stock is used in these studies, but the initial capital stock followed the estimation in Chow and Li (2002). On the human capital variable, there was a change of classification between 2003 and 2004 in the China data. The data series used in Liu and Li (2006) and Li *et al.* (2009), which was adjusted by the number of migration and death, was up to 2003. Due to the lack of data on employment from primary education, the difference in the number of students entering junior

⁷ Reports of *Hong Kong Population Census* are updated and published every 5 years.

⁸ Estimation of mean years of schooling for years 1991 and 1996 cannot be done to agriculture and fishing industry, mining and quarrying industry and electricity, gas and water industry. This is because there is no data available in the *Hong Kong Population Census* reports in the years concerned.

secondary education and the graduates from primary education was the number of primary education graduates that entered the work force. The additional three years needed for the junior secondary education explained why the human capital series in Liu and Li (2006) and Li *et al.* (2009) stopped in 2000. The new classification since 2004 only showed four levels of education, and the transformation is shown in Appendix Table A1. The data series for the human capital variable used in this paper has been revised and updated. In order to remove the 3-year constraint, the human capital variable has been forecasted to 2010 by using the two average growth rates from 2004 to 2006 and assumed the same growth rates till 2010. Similar to Liu and Li (2006) and Li *et al.* (2009), the revised human capital variable is adjusted by the number of migration and death.

Table A1: Classification of Education Levels in Mainland China

Up to 2003	Since 2004
5 years of primary education.	5 years of primary education.
8 years of junior secondary education.	8 years of junior middle secondary education (a new junior vocational secondary education added, but data are incomplete in various provinces).
11 years of regular senior secondary, vocational secondary and specialized secondary.	11 years of senior middle secondary education (incorporating adult specialized secondary education).
14.5 years of higher education.	14.5 years of higher education.

Appendix B: Mathematical presentation of output and TFP growth.

The stochastic frontier production function at time t is:

$$Y_t = F(X_{1t}, X_{2t}, \dots, X_{nt}, t) e^{-u_t}, \quad (\text{A1})$$

where Y_t is output and X_{jt} is the inputs, $j=1,2,\dots,n$. The inclusion of t in F allows for the production function to shift over time, due to technical progress. The last term in Equation (A1) measures technical inefficiency. Taking logarithm transformation:

$$\log Y_t = \log F(X_{1t}, X_{2t}, \dots, X_{nt}, t) - u_t. \quad (\text{A2})$$

Technical inefficiency occurs when $u_t > 0$ and the level of $\log Y_t$ is less than the level of $\log F$. Differentiating with respect to time, the output growth equation becomes:

$$\dot{Y}_t = \sum_j \frac{\partial F}{\partial X_{jt}} \frac{X_{jt}}{F} \dot{X}_{jt} + \frac{\partial F / \partial t}{F} - \frac{\partial u_t}{\partial t}, \quad (\text{A3})$$

where \dot{X}_{jt} is the growth of input X_{jt} . Define the technical efficiency as the ratio of the actual output (Y_t) to the corresponding stochastic frontier output (F_t):

$$TE_t = \frac{Y_t}{F_t} = e^{-u_t}. \quad (\text{A4})$$

The growth of the technical efficiency TE_t is:

$$TE \dot{E}_t = -\frac{\partial u_t}{\partial t}. \quad (\text{A5})$$

The technical progress \dot{A}_t is:

$$\dot{A}_t = \frac{\partial F / \partial t}{F}. \quad (\text{A6})$$

Denote the output elasticity with respect to input X_{jt} as:

$$e_{X_{jt}} = \frac{\partial F}{\partial X_{jt}} \frac{X_{jt}}{F}. \quad (\text{A7})$$

Then

$$\dot{Y}_t = \sum_j e_{X_{jt}} \dot{X}_{jt} + \dot{A}_t + TE \dot{E}_t \quad \text{or} \quad \dot{Y}_t = e_t \sum_j \frac{e_{X_{jt}}}{e_t} \dot{X}_{jt} + \dot{A}_t + TE \dot{E}_t, \quad (\text{A8})$$

where $e_t = \sum_j e_{X_{jt}} = \sum_j \frac{\partial F}{\partial X_{jt}} \frac{X_{jt}}{F}$ is the sum of the output elasticity for all inputs and is a measure of returns to scale. When $e_t > 1$ ($= 1$, < 1), the production is increasing (constant, decreasing) returns to scale.

Suppose the input price for X_{jt} is w_{jt} , $j=1,2,\dots,n$. Using Divisia aggregation, the growth of input factors can be defined as (Jorgenson and Griliches, 1967):

$$\dot{\Phi}_t = \sum_j \frac{w_{jt} X_{jt}}{C_t} \dot{X}_{jt}, \quad (\text{A9})$$

where $C_t = \sum_j w_{jt} X_{jt}$ is the total cost. The weight for each input growth, $s_{jt} = \frac{w_{jt} X_{jt}}{C_t}$,

is the cost share of X_{jt} to the total cost. The measure of output growth does not involve price information. However, the definition of input growth $\dot{\Phi}_t$ includes the price of inputs. To integrating input growth into output growth equation, it is necessary to eliminate the price information. Consider the cost minimization problem of the objective function: $\min_{X_{jt}} C_t = \sum_j w_{jt} X_{jt}$, subject to the constraint of Equation (A1). In the

Lagrangian form, the objective function and the constraint are written as:

$$L(X_{jt}, \lambda) = \sum_j w_{jt} X_{jt} + \lambda(Y_t - F e^{-u_t}), \quad (\text{A10})$$

where λ is the Lagrange multiplier. The first-order condition for minimization is

$$w_{jt} = \lambda \frac{\partial F}{\partial X_{jt}} e^{-u_t}. \quad (\text{A11})$$

Multiplying the above equation by X_{jt} , it gives

$$w_{jt} X_{jt} = \lambda \frac{\partial F}{\partial X_{jt}} \frac{X_{jt}}{F_t} F_t e^{-u_t} = \lambda e_{X_{jt}} Y_t. \quad (\text{A12})$$

Taking sum of all inputs, it gives the total cost

$$C_t = \sum_j w_{jt} X_{jt} = \lambda \sum_j e_{X_{jt}} Y_t = \lambda e_t Y_t. \quad (\text{A13})$$

Dividing Equation (A12) by (A13), it gives the input share of X_{jt} :

$$s_{jt} = \frac{w_{jt} X_{jt}}{C_t} = \frac{e_{X_{jt}}}{e_t}. \quad (\text{A14})$$

Substituting Equation (A14) into Equation (A9), the input growth without price information is:

$$\dot{\Phi}_t = \sum_j \frac{e_{X_{jt}}}{e_t} \dot{X}_{jt}. \quad (\text{A15})$$

Substituting Equations (A15) into (A8), the output growth is:

$$\dot{Y}_t = e_t \dot{\Phi}_t + \dot{A}_t + T \dot{E}_t. \quad (\text{A16})$$

By subtracting and adding $\dot{\Phi}_t$ and rearranging terms to consider non-constant returns to scale, Equation (A16) becomes:

$$\dot{Y}_t = \dot{\Phi}_t + (e_t - 1) \dot{\Phi}_t + \dot{A}_t + T \dot{E}_t, \quad (\text{A17})$$

Or $\dot{Y}_t = \sum_j \frac{e_{X_{jt}}}{e_t} \dot{X}_{jt} + (e_t - 1) \sum_j \frac{e_{X_{jt}}}{e_t} \dot{X}_{jt} + \dot{A}_t + T \dot{E}_t. \quad (\text{A18})$

This shows that output growth is decomposed into four components: weighted sum of input growth, adjusted scale effect, technical progress, and growth of technical efficiency.

It should be noted that the weight $\frac{e_{X_{jt}}}{e_t}$ for each input growth is equal to the cost share of each input. The scale effect $(e_t - 1)$ is adjusted by the growth of aggregate input $\dot{\Phi}_t$.

For a production function with a single input and a single output, the productivity of the input factor at time t can be simply be defined as $\frac{Y_t}{X_t}$. Similarly, the TFP for a production function with multiple inputs at time t can be defined as:

$$TFP_t = \frac{Y_t}{\Phi_t}. \quad (A19)$$

Taking logarithm and differentiating with respect to time, the growth of TFP is:

$$TFP_t = \dot{Y}_t - \dot{\Phi}_t. \quad (A20)$$

From Equations (A17) and (A18),

$$TFP_t = (e_t - 1)\dot{\Phi}_t + \dot{A}_t + TE\dot{E}_t, \text{ or } TFP_t = (e_t - 1)\sum_j \frac{e_{x_j}}{e_t} \dot{X}_{jt} + \dot{A}_t + TE\dot{E}_t. \quad (A21)$$

The decomposition of TFP in Equation (A21) is the same as Equation (8.2.6) in Kumbhakar and Lovell (2000, pp. 284). The TFP growth is decomposed into three components: adjusted scale effect, technical progress, and growth of technical efficiency.

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Table 1 Institutional Performances: Mainland China and Hong Kong

Institutional Establishment (2005)	China	HK
Corruption perception index	3.2	8.3
Voice and accountability	16.8	55.1
Political stability	46.4	73.7
Government effectiveness	47.8	82.5
Regulatory quality	44.5	87.7
Rule of law	40.5	80.0
Control of corruption	36.2	83.7
Property rights protection	30.0	90.0
Regulatory scores	30.0	90.0
Economic Freedom (2009)		
Economic Freedom Index	53.2	90.0
Business freedom	51.6	92.7
Trade freedom	71.4	95.0
Fiscal freedom	70.6	93.4
Government size	88.9	93.1
Monetary freedom	72.9	86.2
Investment freedom	30.0	90.0
Financial freedom	30.0	90.0
Property rights	20.0	90.0
Freedom from corruption	35.0	83.0
Labor freedom	61.8	86.3

Sources: *Corruption Index*, Transparency House (2005), *Aggregating Governance Indicators*, World Bank (2005); *Index of Economic Freedom*, Heritage Foundation (2009).

Table 2 FDI from Hong Kong and the World to the Nine PRD Provinces
(Actually Utilized FDI, US\$ 1,000,000)

	1985			1995			2007		
	HK	World	HK/ World (%)	HK	World	HK/ World (%)	HK	World	HK/ World (%)
Fujian	9.6	11.8	81.6	25.0	403.9	6.2	170.2	406.1	41.9
Guangdong	45.0	51.5	87.4	797.3	1018.0	78.3	830.3	1712.6	48.5
Guangxi	1.3	1.3	100.0	37.2	67.0	55.6	16.0	68.4	23.4
Hainan	2.1	2.1 ²	97.9	56.4	105.5	53.5	n/a	112.0	n/a
Jiangxi	n/a	0.5	n/a	n/a	28.8	n/a	178.9	310.4	57.7
Hunan	n/a	n/a	n/a	32.3	48.8	66.2	157.3	327.1	48.1
Sichuan	n/a	n/a	n/a	n/a	n/a	n/a	n/a	149.3	n/a
Guizhou	n/a	n/a	n/a	n/a	5.7	n/a	n/a	12.7	n/a
Yunnan	n/a	0.2	n/a	n/a	22.5	n/a	15.8	39.5	40.1
9 Provinces ¹	57.9+	67.3+	86.1+	948.2+	1700.2+	55.8+	1368.7+	3137.9	43.6+
National	95.6	195.6	48.9	2018.5	3752.1	53.8	2770.3	7476.8	37.1

Notes: ¹The aggregate figures are based on the available data.

Sources: *China Statistical Yearbook*, and *Statistical Yearbooks* of the nine provinces, various years.

Table 3 Exports from the Nine PRD Provinces to Hong Kong and World
(US\$ 1,000,000,000)

	1985			1995			2007		
	HK	World	HK/World (%)	HK	World	HK/World (%)	HK	World	HK/World (%)
Fujian ³	0.2	0.5	40.3	4.1	9.3	43.9	3.6	49.9	7.2
Guangdong ¹	2.1	3.0	72.1	48.4	55.7	87.0	129.9	369.2	35.2
Guangxi ³	0.2	0.4	43.6	1.2	2.2	53.3	0.4	5.1	8.2
Hainan ¹	n/a	n/a	n/a	0.4	0.8	53.5	0.4	1.8	23.0
Jiangxi ²	0.1	0.3	33.2	0.8	1.4	52.5	0.6	5.5	11.3
Hunan ¹	n/a	n/a	n/a	0.3	1.1	31.8	0.8	6.5	12.5
Sichuan ¹	n/a	0.2	n/a	n/a	1.9	n/a	1.5	8.6	17.8
Guizhou	n/a	0.0	n/a	n/a	0.4	n/a	n/a	1.5	n/a
Yunnan ³	n/a	0.1	n/a	n/a	1.2	n/a	0.4	4.7	9.2
9 Provinces ⁴	2.6+	4.5+	57.4+	55.3+	74.1	74.6+	137.8+	452.9	30.4+
National	7.2	27.4	26.3	36.0	148.8	24.2	184.4	1217.8	15.1

Notes: ¹ HK is largest export destination in 2007. ² HK is the second largest export destination in 2007. ³ HK is the third largest export destination in 2007. ⁴ The aggregate figures are based on the available data.

Sources: Same as Table 2. All national data are based on customs statistics, while data for the provinces up till 1998 are from the Ministry of Foreign Trade, Beijing.

Table 4 Hong Kong Residents' Personal Travel to Mainland China (2003-2007)
(1,000,000)

	Mainland China	Guangdong Province		Shenzhen City	
	Person Trips (1)	Person Trips (2)	Share in China (2)/(1) (%)	Person Trips (3)	Share in Guangdong (3)/(2) (%)
2003	34.0	32.0	94.1	16.4	48.2
2004	38.6	36.3	94.0	18.6	48.2
2005	40.1	37.8	94.3	20.8	51.9
2006	43.4	41.2	94.9	23.7	54.6
2007	46.8	44.3	94.7	25.5	57.6

Source: *Consumption Expenditure of Hong Kong Residents Travelling to the Mainland of China (2007)*, Feature Article, Hong Kong Monthly Digest of Statistics, Census and Statistics Department, Hong Kong SAR, July 2008.

Table 5 Hong Kong Residents Working in Mainland China

	No. of Persons (1,000)	Percent to the Total Employed Persons in HK (%)
Sept to Oct 1995	122.3	4.2
May to June 1998	157.3	5.0
April to June 2001	190.8	5.9
Jan to Mar 2003	238.2	7.4
Jan to Mar 2005	237.5	7.2
July to Sept 2008	218.2	6.2

Source: *Hong Kong Residents Working in the Mainland of China*, Special Topics Report (7-9, 2008), No. 49, February 2009, Census and Statistics Department, Hong Kong SAR.

Table 6 Hong Kong Residents Working in Mainland China by Usual Place of Work
(July-September, 2008)

	No. of persons (1,000)	Percent to the Total HK Residents Working in China (%)
Guangdong	191.6	87.8
Shenzhen	75.8	34.7
Dongguan	61.5	28.2
Guangzhou	27.6	12.7
Others	26.7	12.2
Cities outside Guangdong	26.6	12.2
Shanghai	10.7	4.9
Beijing	4.6	2.1
Fujian	4.4	2.0
Others	6.9	3.2

Source: *Hong Kong Residents Working in the Mainland of China*, Special Topics Report (7-9, 2008), No. 49, February 2009, Census and Statistics Department, Hong Kong SAR.

Table 7 Hong Kong Residents Working in Mainland China

		No. of Persons (1,000)	Share to Total ¹ (%)	Percent of Respective Group in HK ² (%)
Age	15-19	NA ³	NA ³	1.5
	20-29	24.2	11.1	21.2
	30-39	57.9	26.5	26.3
	40-49	80.0	36.7	28.2
	≥ 50	55.9	25.6	22.8
Educational Attainment	Pre-primary & Primary	11.3	5.2	12.4
	Secondary & Sixth-form	105.6	48.4	55.8
	Post-secondary: Non-Degree	25.3	11.6	9.7
	Post-secondary: Degree	76.0	34.8	22.1
Industry ⁴	Sales & Trade	82.5	37.8	32.6
	Finance & Business Services	24.9	11.4	16.9
	Transportation	8.7	4.0	10.5
	Construction	5.9	2.7	7.8
	Other Services	4.6	2.1	26.2
	Manufacturing	91.0	41.7	5.4
Occupation	Managers and administrators	96.4	44.2	10.1
	Professional and associates	92.4	42.3	26.3
	Clerks	10.4	4.8	15.8
	Service & sales workers	2.9	1.3	15.6
	Craft & machine operators	14.9	6.9	13.4
	Elementary jobs & others	1.2	0.7	18.8
Employment Status	Employees	168.7	77.3	89.2
	Employers	37.4	17.1	3.6
	Self-employed persons	12.1	5.5	6.6
Monthly Earning (HK\$)	< 5,000	1.1	0.5	13.5
	5,000 - 9,999	17.1	8.1	31.9
	10,000 - 14,999	39.7	18.7	19.7
	15,000 - 19,999	33.0	15.5	10.7
	20,000 - 29,999	50.0	23.5	11.6
	≥ 30,000	71.6	33.7	12.6

Notes: ¹ Share of Hong Kong residents working in China in each group to the total Hong Kong residents working in China. ² Percent of the employed persons in the respective group in Hong Kong to the total employed persons in Hong Kong. ³ The estimates less than 1000 and statistics are not released due to very large sampling errors. ⁴ Sales & Trade includes wholesale, retail, import/export trade, restaurants and hotels; Finance & Business Service includes finance, insurance, real estate, business services; Transportation includes transportation, storage, and communications; Other Services includes Community, social and personal services.

Source: *Hong Kong Residents Working in the Mainland of China*, Special Topics Report (7-9, 2008), No. 49, February 2009, Census and Statistics Department, Hong Kong SAR.

Table 8 Maximum Likelihood Estimates of the Stochastic Frontier Production Function

	China		Hong Kong	
	Before 1997 1985-1996	Whole Period 1985-2006	Before 1997 1983-1996	Whole Period 1983-2005
	(1)	(2)	(3)	(4)
lnK	0.7750 (0.0381)	0.4424 (0.0208)	0.5393 (0.1139)	0.4047 (0.0300)
lnL	0.1890 (0.0388)	0.4320 (0.0239)	0.4245 (0.0484)	0.7087 (0.0313)
H	0.0133 (0.0109)	0.0386 (0.0064)	0.0712 (0.1811)	0.0641 (0.0427)
μ	0.3825 (0.1838)	0.8546 (0.1162)	0.2750 (1.2704)	0.4514 (0.2802)
η	-0.0361 (0.0039)	-0.0223 (0.0017)	0.0117 (0.0120)	0.0073 (0.0049)
$\sigma_s^2 = \sigma_v^2 + \sigma_u^2$	0.2031	0.1557	0.0775	0.0546
$\gamma = \sigma_u^2 / \sigma_s^2$	0.9880	0.9743	0.9713	0.9324
Log Likelihood	474.4785	771.6274	79.0864	105.6346
Log Likelihood Ratio Test:				
$\delta_t = 0$ for all t	160.76	454.45	37.93	64.92

Notes: Figures in parentheses stand for the standard errors of the estimates.

Table 9 Output Elasticities and Cost Shares of Inputs

	Output Elasticities				Cost Shares (%)		
	e_K	e_L	e_H	e	$\frac{e_K}{e}$	$\frac{e_L}{e}$	$\frac{e_H}{e}$
Before 1997							
China	0.7750	0.1890	0.0650	1.0291	75.31	18.37	6.32
Hong Kong	0.5393	0.4245	0.8259	1.7897	30.15	23.74	46.11
Whole period							
China	0.4424	0.4320	0.2072	1.0817	40.29	39.97	19.11
Hong Kong	0.4047	0.7087	0.7801	1.8934	21.39	37.46	41.15

Table 10 Input Growth and Adjusted Scale Effect

	Input Growth (%)				Scale Effect (%)			<i>Scale</i>
	$\frac{e_K}{e} \dot{K}$	$\frac{e_L}{e} \dot{L}$	$\frac{e_H}{e} \dot{H}$	$\dot{\Phi}$	$(e-1)(\frac{e_K}{e} \dot{K})$	$(e-1)(\frac{e_L}{e} \dot{L})$	$(e-1)(\frac{e_H}{e} \dot{H})$	
Before 1997								
China	7.26	0.38	0.15	7.79	0.22	0.01	0.004	0.24
Hong Kong	1.50	0.22	0.65	2.38	1.20	0.16	0.52	1.88
Whole period								
China	4.06	0.67	0.36	5.10	0.34	0.05	0.03	0.42
Hong Kong	0.83	-0.17	0.47	1.14	0.74	-0.18	0.42	0.97

Table 11 Decomposition of Output Growth and the TFP Growth (%)

	\dot{Y}	$\dot{\Phi}$	<i>Scale</i>	$\Delta \delta_{Tt}$	$T\dot{E}$	$T\dot{F}P$
Before 1997						
China	9.60	7.79	0.24	3.18	-1.54	1.88
Hong Kong	4.17	2.38	1.89	-0.50	0.41	1.79
Whole period						
China	9.90	5.10	0.42	5.89	-1.51	4.80
Hong Kong	2.39	1.14	0.97	-0.08	0.36	1.26

Figure 1 Growth Rates of Different Educational Levels in Mainland China

