Openness and Efficiency of India and China Relative to the World Economy: A Comparative Study

Guy S. Liu
Department of Economics and Finance
Brunel University, Uxbridge, UB8 3PH
Tel: 01895 816 206
E-mail: guy.liu@brunel.ac.uk

Xiaming Liu
Aston Business School
Aston University
Birmingham, B4, 7ET
Tel: 0121 359 3611
E-mail: x.liu@aston.ac.uk

Yingqi Wei
Department of Economics
Lancaster Management School
Lancaster University
LA1 4YX
Tel: 01524 593 178
E-mail: y.wei@lancaster.ac.uk

October 2001

Openness and Efficiency of India and China Relative to the World Economy: A Comparative Study

Abstract: This paper adopts a dynamic approach to investigate the impact of openness on efficiency improvement of the world economy and compares the linkages between openness and performance in India and China. Based on a panel of data set of 126 countries over the period 1970-98, the world production frontier is established using stochastic frontier techniques. The economic efficiency of an economy relative to the world production frontier is identified and its determinants are examined. The results indicate that international trade, foreign direct investment (FDI) and its interaction with labour quality improvement play a significant role in improving efficiency, respectively, although the trade growth in our test is not as robust as FDI. Contrary to the conventional perception, India performed better than China in raising productivity until the mid-1990s. However, China has experienced a higher degree of openness and therefore a faster rate of catching-up with the world's best practice.

Key Words: Openness; Productivity; Efficiency; The world production frontier; India; China; Comparative study

I. Introduction

The relationship between openness and economic growth has long been a subject of controversy. Liberal analysts suggest that free trade would lead to better economic performance, but some economists argue that protectionism may promote faster growth. Recently, while Romer (1986, 1992), Lucas (1988), Barro and Sala-I-Martin (1995) propose that openness can have a positive impact on growth, it is sometimes argued that openness may not automatically lead to growth. For instance, Grossman and Helpman (1991, Ch. 9) show that whether or not a country gains from openness to trade depends on a number of factors, including its comparative advantage vis-à-vis the rest of the world. Buffie (1992) contends that whether an export boom acts as an engine of growth depends on the structural characteristics of the economy.

Most empirical tests of the openness-growth relationship are based on the growth accounting approach. Total factor productivity (TFP), defined as a ratio of aggregate output to combined factors used, is estimated from the traditional production function, and then regressed on openness as well as other relevant explanatory variables. The growth accounting approach implicitly assumes economic efficiency, and therefore may be validly applied only to equilibrium states and marginal changes over short periods of time (Nelson and Pack, 1999). A few noticeable examples of openness-TFP research include cross-section analyses by Dollar (1992), Sachs and Warner (1995), Edwards (1998) and a panel data study by Miller and Upadhyay (2000). If TFP is regressed on openness under the assumption of economic efficiency, the contribution of openness to technological progress may be biased: the growth of TFP can be due to gains in efficiency, as well as to technical progress (Grosskopf, 1993; Maudos et al., 2000).

An alternative method is the production frontier approach. This line of analyses focuses on efficiency, which can be defined as an economic unit's production relative to some predicted level of maximum output given the level of inputs available at a given point in time. This method has been applied in the past mainly at a micro level, but has gradually gained popularity in the macro economic analysis in recent years. For example, Fare et al. (1994), Kruger et al. (2000) and Maudos et al. (2000) adopt a non-parametric production frontier function determined by the data envelopment analysis (DEA), to examine international productivity differences and track the productivity development over time using the Malmquist productivity index. Moroney and Lovell (1997) use a stochastic production frontier model to compare the relative efficiency of market and planned economies.

One common feature of the exisitng studies is static, ignoring adjustment costs in a dynamic process for labour and capital substitution. The impact of knowledge spillovers brought by opennness on re-organising prodcution for efficiency improvement could be played down by high adjustment costs in an economy. The rigidity of the adjustment in production for Chinese state-owned enterprises' productivity improvement was an example, since these entperrises were given unmobile labour forces. This suggests that without control of the adjustment process, it is hard to measure the true influcence of openness on an economy for its productivity improvement. Another common feature in the existing openness literature is that FDI, an important variable to reflect both the stock of advanced technological knowledge and intensity of market competition between domestic incumbents and new foreign entrants, is often excluded from the estimation of the openness effect on productivity improvement.

To take these arguments into account in estimating the relationship between openness and productive efficiency, the current research departs from many exisiting studies in two aspects: (1) dynamic panel data models are adopted to identify the world production frontier for analysing the efficiancy changes of individual countries and to estimate the impact of openness on the time-variant efficiency; and (2) foreign direct investment (FDI) and its interaction with human capital are explicitly included as one important measure of openness to explain efficiency improvement. The efficiency comparison of India and China relative to the world production frontier shows that India had outperformed China in the quality of growth until the mid-1990s. This is contrary to the conventional perception.

The paper is organised as follows. The next section reviews the literature on openness and efficiency. Section 3 describes the data, methodology and estimation procedures used. Section 4 presents the empirical results on the impact of openness on efficiency. Section 5 compares the linkages between openess and efficiency in India and China relative to the world production frontier. A final section offers the overall conclusions of the paper.

II. Openess and Efficnecy

The literature on the relationship between openness and economic performance mainly focuses on the impact of trade orientation on productivity. Neoclassical growth models assume that technical change is exogenous, and is not affected by a country's trade policy (see, e.g. Solow, 1957). Indeed, as Edwards (1993) notes, in the 1950s, 1960s, and 1970s free trade policy was not widely supported.

In the last two decades, there still have been hot debates on whether trade liberalisation packages have played an important role in the performance of the outward oriented economies. Taylor (1991) argues that the trade liberalisation strategy is intellectually moribund, and that there are no great benefits (plus some loss) in following open trade and capital market strategies. Therefore, 'development strategies oriented internally may be a wise choice towards the century's end' (Taylor, 1991).

Grossman and Helpman (1991) argue that protection could enhance the long-run growth if government intervention in trade encourages domestic investment along the lines of comparative advantage. Levine and Renelt (1992) note that increasing openness may raise long-run growth only when openness provides greater access to investment goods. Trade librealisation may stimulate FDI inflows. However, if domestic investment is discouraged because of increased international competition, the output effect of the two driving forces is ambiguous. Batra (1992), Batra and Slottje (1993) and Leamer (1995) have gone further by suggesting that free trade can be a primary source of economic downturn. Trade liberalsiation and openness reduce tariffs. This may make imports more attractive than domestic production. Thus, the domestic economy may suffer a loss.

On other hand, international trade was seen as the engine of growth by many economists such as Adam Smith and David Ricardo. Benefits from free trade have been widely documented since. For instance, Scitovsky (1954) suggests that exports produce positive externalities whose favourable impact is particularly significant in economic development. Keesing (1967), Bhagwati (1978), Krueger (1978) and Liu et al. (1997) argue that openness exposes countries to the most advanced new ideas and methods of production dictated by international competitive behaviour, and thus it enhances efficiency. Furthermore. Through openness countries manage to overcome the small size of their domestic market and reap in the process the cost advantage of increasing returns to scale. Chenery and Strout (1966) and Voivodas (1973) contend that exports contribute to a relaxation of foreign exchange constraints that normally impinge on development efforts.

The importance of international trade to economic performance has been strongly emphasised in new or endogenous growth theory. While neoclassical theory regards technical progress as an exogenous process, endogenous growth theory views commercially oriented innovation efforts that respond to economic incentives as a major engine of technological progress and productivity growth (Romer, 1990; Grossman and Helpman, 1991; Coe et al. 1997). As noted in Wei et al. (2001), endogenous growth theory aruges that international trade enables a country to use a large variety of technologically advanced physical capital, which may enhances the productivity of its own resources. International trade promotes across-the-board learning in product design, facilitates the diffusion and imitation of foreign technologies and helps the creation of innovations.

Although the term openness is widely used in the international economics and economic growth literature, there is no consensus on how to measure it. In the existing empirical studies, various measures have been tried. These include trade dependency ratios and the rate of export growth (Balassa, 1982), the trade orientation indexes which are defined as the distance between actual trade and the trade predicted by the "true" model in the absence of distortion (Leamer, 1988; Wolf, 1993), the World Bank's outward orientation index which classifies countries into four categories according to their perceived degree of openness (the World Bank, 1987), the "subjective index" of trade liberalisation (Michaely et al. 1991), the black market premium for foreign exchange (Levine and Renelt, 1992), the average import tariff on manufacturing and the average coverage of non tariff barriers reported by UNCTAD and used in Barro and Lee (1994), the composite openness index which is based on such trade-related indicators as tariffs, quotas coverage, black market premia, social organisation and the existence of export marketing boards (Sachs and Warner, 1995), and the Heritage Foundation index of trade policy which classifies countries into five categories according to the level of tariffs and other perceived distortions (Johnson and Sheehy, 1996).

Significant efforts have been made to construct a satisfactory comparative openness index, but the vast majority of the existing openness indexes continue to be subject to various limitations (Edwards, 1998). As international trade is influenced by various factors such as tariff and non-tariff barriers and exchange controls, it is very difficult, if not impossible, to develop an ideal indicator for openness. Therefore, instead of using just one or at most two of these indexes to study the relationship between openness and economic performance, which is the case in most empirical studies, Edwards (1998) uses nine measures of openness in order to determine whether econometric results are robust to alternative indexes.

One fundamental problem with the above indexes is their ignorance of FDI. FDI is a composite bundle of capital stocks, know-how and technology. What FDI transfers are not just capital and managerial skills, but also embodied and tacit technologies. The special role that FDI plays in tacit technology transfer and diffusion can not be replaced by any other forms of international integration (Balasubramanyam et al. (1996). MNEs are among the most technologically advanced firms, accounting for a substantial part of the world R&D investment. As a result, FDI is considered to be a major channel for the access to advanced technologies (Borensztein et al. 1998). Specifically, as Wei et al. (2001) note, multinational enterprises (MNEs) may develop new products and technologies earlier than indigenous firms, exert competitive pressure on them and force them to imitate or innovate. MNEs may generate spillover effect on the local economy by 'learning by doing' or 'learning by watching' by indigenous firms. Furthermore, advanced technologies or ideas may be diffused via the switch of labour from foreign subsidiaries to indigenous firms. All this indicates that FDI has an important effect on economic performance, and needs to be seen as a very important measure of openness.

Another problem with many existing openness indexes is that they are available for just one or a few years because of lack of comparative data. Consequently empirical tests of openness on economic performance are normally restricted to cross-section analysis (see Dollar, 1992; Sachs and Warner, 1995; Edwards, 1998), although Edwards (1993) suggests that a more precise answer to the general question of how openness affects output growth would require more detailed analysis replying at least in part on time series data. One exception is Miller and Upadhyay (2000) where the available time series of ratio of exports to GDP, the terms of trade and local price deviation from purchasing power parity are used to measure openness.

However, there is no explanation of how the terms of trade is related to a country's degree of openness and therefore economic growth.

When examining the impact of openness on economic performance, most extant empirical studies relate trade orientation to TFP obtained from growth accounting. Recent examples include Sachs and Warner (1995), Edwards (1998) and Miller and Upadhyay (2000). As mentioned earlier, this type of research is based on the conventional measure of technological change, i.e. equating the Solow residual to TFP, and may lead to biased estimates of technical progress in the presence of inefficiency (Grosskopf, 1993).

While there is a large literature on openness and productivity, how to define productivity is still a question worth noting. Fare et al (1994) decompose total factor productivity of an industry into two components: a shift in the production frontier that is the best possible output level obtained in the industry for the given inputs and technology, and a shift of firms towards the frontier. The first shift reflects technical progress in the industry, and the second measures a change in technical efficiency that is the ratio of the actual output to the best potential output. Based on this concept of productivity, we will measure the economic performance of each country relative to the world best possible achievement for the available resources and technology at a time period. This comparative measurement of economic performance is called economic efficiency, identical to Fare et al.'s concept of technical efficiency. In this sense, a change in efficiency of an economy is different from a change in the productivity. For instance, if innovations increase production potential by 5% for the same level of capital and labour input, and actual output rises by 3%, a productivity index would indicate an increase of 3%, while an efficiency measurement would show only 98% efficiency, a 2% reduction. So it is possible that the improvement of productivity and economic efficiency moves in different directions. This suggests that one advantage of using economic efficiency measurement to analyse the role of openness is to enable us to identify how openness can bring the catch-up effect on a host economy to reduce the efficiency gap between itself and the world's best possible practice.

III. **Data, Methodology and Estimation Procedures**

Most of the data used in this paper were taken from the World Bank's World Development Indicators (WDI) 2000 and 2001 CD-ROM. There are no capital stock data available straightaway. Capital stocks were estimated mainly from available gross domestic fixed investment (constant 1995 price) data from WDI CD-ROM by the standard perpetual inventory calculation method (See Appendix 2). When estimating the world production frontier, a panel data set covering 126 countries for the period 1970-98 was employed.

Either a non-parametric or a stochastic frontier approach can be used to relate openness to an economy's efficiency. A major advantage of the non-parametric frontier approach based on DEA is that there is no need to impose any functional form arbitrarily on the data set. However, the technical efficiency measures from this deterministic frontier production function computed from mathematical programming are susceptible to extreme observations and measurement errors (Forsund et al. 1980; Kalirajan and Shand, 1999); they ignore stochastic shocks and lack statistical properties (Martin-Marcos and Suarez-Galvez, 2000). On the other hand, modelling a production function following stochastic frontier approach is in conformity with production theory (Harold, et al. 1993), and offers flexibility in testing various hypotheses. A major criticism against the stochastic frontier approach is that it requires the imposition of a certain specific distribution assumption on country-specific efficiency related variable. However, this problem can be resolved by introducing country-specific dummy variables in the stochastic frontier estimation.

In this study, the world production frontier was estimated based on the following stochastic production frontier model:

$$y_{it} = a_i + b_t + \alpha(1-\theta)k_{it} + \beta(1-\theta)l_{it} + \theta y_{it-1} + v_{it} - u_{it} \qquad (1)$$

where i and t denote the cross-section and time series observations respectively. y_{it} is the natural log output level, i.e. GDP here, in the i^{th} country at the t^{th} period of observation. a_i is the country-specific time invariant efficiency, capturing the fixed effects on the differences of efficiency between the countries/regions in the long run, which could be a result of the quality of macroeconomic management system and natural resources available to the country. b_t is the time specific effect, picking up shifts in the world production frontier over time. k_{it} and l_{it} are capital and labour respectively. The null hypothesis implied in Equation (1) is that there are constant returns to scale in production in the long run (i.e. $\alpha+\beta = 1$), but the directly estimated capital or labour elasticity is short run. θ reflects a pace of dynamic adjustment process of input substitution for output changes. v_{it} and u_{it} are assumed to be independently distributed. v_{it} is a random disturbance term with N(0, σ_v^2), and is associated with the random factors which are beyond the country's control. u_{it} is a non-negative random variable. Economic efficiency is estimated as exp($-u_{it}$), where is short-run, arising from the improvement of management in employing the given natural resources and production factors for producing outputs.

The dynamic model of Equation (1) departs from the static production frontier equation where lagged adjustment of output is not included as an explanatory variable. This type of dynamic models has been applied in Nickell (1996) and Hay and Liu (1997) at the firm and industry level respectively. The introduction of dynamics is not just to capture the dynamic adjustment process, but also to alleviate any bias caused by the possible exclusion of explanatory variables other than capital and labour. With the presence of the serial autocorrelation in estimating Equation (1), the lagged dependent variable is instrumented using orthogonal pre-determined variables, such as y_{it-3} onwards.

Given that u_{it} is allowed to vary over time, there is a need to impose a specific distribution assumption. In this study, u_{it} being assumed to be exponentially, truncated normally, or half normally distributed was all carried out, respectively, and the estimated results from different assumptions of distribution are analysed econometrically. For example, the truncated normal model was compared with the half normal one, and given that $\frac{\mu}{\sigma_u}$ is statistically insignificant, the assumption that u_{it} follows a truncated distribution with N(μ, σ_u^2) is invalid. Having controlled for the country-specific fixed effects, the time effects and the dynamic adjustment process respectively, the frontier models based on the half-normal and the exponential distribution assumptions provided similar estimation results, and so they are reported in our study.

Our panel estimation is based on a two-way-fixed effects model since (1) Hausman statistic rejects the random effects model and (2) Likelihood Ratio test rejects the insignificant claim of both year and country fixed effects on estimation. Moreover, the estimation has taken into account the possible endogenous effect of explanatory variables, such as capital (k), labour (l), the trade ratio (tr) and foreign direct investment (fd), by applying Wu-Hausman approach to identify the effect. As it can be seen in Table 1 and 2, Wu-Hausman statistic strongly rejected the exogeneity claim for the variables in our large-sample estimation, and therefore, GMM techniques were applied to the estimation.

For the purposes of this paper, we are interested in examining the relationship between openness and the time-variant efficiency of countries. More specifically, we would like to estimate the following general equation:

$$m_{it} = \lambda_i + \Phi' Openness_{it} + \Gamma' HumanCapital_{it} + \Pi DomesticFixedInvestment_{it} + m_{it-1} + \varepsilon_{it}$$

(2)

where m_{it}=log[exp(-u)]$_{it}$ is the time-variant efficiency estimated from Equation (1). There can be several regressors/different measures in the vector of $\mathbf{Openness}_{it}$. Based on the availability of time series data, FDI, international trade, and the black marker premium for foreign exchange were used to measure openness in the current study. The other variables on the right hand side of Equation (2) are the control variables. The vector $\mathbf{HumanCapital}_{it}$ contains secondary and tertiary education enrolment. Human capital is seen to be very important in economic development in new growth theory and is expected to have positive impact on efficiency changes. The interaction between FDI and human capital was introduced in the regressions in this study to examine if there is a minimum threshold for FDI to have a positive impact. The introduction of a similar interaction term can be found in Borensztain et. al (1998). DomesticFixedInvestment relative to the GDP size of an economy is its own investment in fixed assets such as machinery and equipment. This upgrades embodied new technologies or improvement of the nation's infrastructure as whole, and is expected to have a positive impact on economic performance. Moreover, by placing domestic fixed investment and foreign direct investment in the estimation, it enables us to directly test Levine & Renelt (1992)'s argument on the ambiguity of this two rival investments that may provide the crowding-out effect on an economy. λ_i is the individual fixed effects, which is specific to the individual country i.

Equation (2) is estimated in a dynamic form in order to capture the costs of the adjustment process in changing efficiency. The higher the adjustment costs, the slower the process of efficiency change will be in response to more openness. With the presence of the 1st and 2nd order of autocorrelation, the lagged efficiency variable was instrumented using its 3rd order of lagged dependent variables as **Z** in order to ensure Cov(**Z**,ε)=0.

Having pursued a general investigation of the role of openness in promoting efficiency improvement, efficiency changes over time were plotted against the growth of FDI and trade for China in reference to India in order to learn some comparative experience. China and India share many similarities but the former has experienced higher growth rates of FDI and GDP. Would China's faster growth of FDI stock lead to quicker efficiency improvement? This is a question to be discussed shortly.

IV. Empirical Results

Table 1 represents our estimation of Equation 1 for efficiency measurement. Our estimation starts with a full estimation of Cobb-Douglas function with two extensions of (1) dynamic adjustment process and (2) the openness effect, measured by both trade growth and FDI. The estimation is made in comparing with the static estimation, and we found that the latter is mis-specified, evidenced by the strong presence of 2nd order autocorrelation and the negative constant coefficient as well as the unusual large size of the estimated capital elasticity in the estimation. In order to examine the effect of the openness on economic efficiency, we drop FDI and trade variables from our dynamic panel stochastic frontier estimation that will create a residual variable of the efficiency, exp(-u), for our 2nd stage of estimation. It is expected that the efficiency will be related to the openness if the output rise as a part of result of the openness is not captured in the production function.

Table 1. Estimation of the World Production Frontier

Dep. Variable q_{it}=log(GDP)$_{it}$	**Dynamic Panel Data Estimation (GMM)**		**Panel Stochastic Frontier Estimation**	
Indep. Variables:	*dynamic*	*Static*	*Half-Normal*	*Exponential*
Intercept	1.877 (1.1)	- 0.961 (0.3)	2.083 (2.6)	4.157 (4.8)
K_{it}	0.288 (4.4)	0.893 (11.6)	0.218 (6.6)	0.162 (4.8)
L_{it}	0.062 (2.4)	0.095 (2.9)	0.067 (2.5)	0.048 (2.1)
Tr_{it}	0.032 (3.0)	0.031 (2.7)		
Fd_{it}	0.023 (7.5)	0.028 (7.4)		
q_{it-1}	0.541 (35.1)	-----	0.593 (45.9)	0.577 (43.6)
Statistics of Estimations				
Country-fixed effect (χ^2) [countries: $\sum D_i=0$, df=125]	9668.24 [0.000]	8634.49 [0.000]	Included	Included
Year-time effect (χ^2) [year: $\sum T_t=0$, df=20]	357.20 [0.000]	149.96 [0.000]	Included	Included
$\hat{\sigma}$	0.102	0.491		
N	2247	2247	2241	2241
Hausman (F-Statastic) [H_0: Random Effect]	1219.2 [0.000]	773.68 [0.000]		
Wu-Hausman (χ^2) [H_0: Exogeneity, df=4]	42.52 [0.000]	36.65 [0.001]		
AR [1]	0.789 (34.6)	1.0478 (47.1)		
AR [2]	-0.001 (0.05)	-0.184 (8.1)		
$\lambda=\sigma_u/\sigma_v$			0.745(2.9)	
$\sigma=(\sigma_u^2+\sigma_v^2)^{0.5}$			0.114(5.7)	
θ				10.678 (26.2)
σ_v				0.053 (22.5)
U^2			0.0046	0.00277
V^2			0.0083	0.00275
Instrument Set	$k_{it-2} \sim k_{it-24}$ $\Delta l_{it-2} \sim \Delta l_{it-8}$ $l_{it-2} \sim l_{it-24}$ $\Delta tr_{it-2} \sim \Delta tr_{it-24}$ $tr_{it-2} \sim tr_{it-24}$ $fd_{it-2} \sim fd_{it-24}$ $q_{it-3} \sim q_{it-24}$	$k_{it-2} \sim k_{it-24}$ $\Delta l_{it-2} \sim \Delta l_{it-8}$ $l_{it-2} \sim l_{it-24}$ $\Delta tr_{it-2} \sim \Delta tr_{it-24}$ $tr_{it-2} \sim tr_{it-24}$ $fd_{it-2} \sim fd_{it-24}$	$k_{it-2} \sim k_{it-24}$ $\Delta l_{it-2} \sim \Delta l_{it-8}$ $l_{it-2} \sim l_{it-24}$ $q_{it-3} \sim q_{it-24}$	$k_{it-2} \sim k_{it-24}$ $\Delta l_{it-2} \sim \Delta l_{it-8}$ $l_{it-2} \sim l_{it-24}$ $q_{it-3} \sim q_{it-24}$

Note: *(1) The Likelihood Ratio Statistic was applied to test the country fixed effects and the year specific effects.*

(2) T ratios are in parentheses, and p values are in square branckets.

(3) The presence of higher-order autocorrelation was detected on the basis of

$$y_{it} = \sum a_i D_i + \sum a_t T_t + f(\hat{x}, \hat{\beta}) + \theta\, y_{it-1} + \rho_{t-1}\hat{e}_{it-1} + \rho_{t-2}\hat{e}_{it-2} + u_{it}$$

$$\text{where, } \hat{e}_{it} = \rho_{t-1}\hat{e}_{it-1} + \rho_{t-2}\hat{e}_{it-2} + u_{it} \qquad u_{it} \sim N(0, \sigma^2)\,.$$

(4) The basic instrument set used is of the form:

$$J_i = \left| \begin{array}{ccccc} J^E_{it-1} & 0 & \cdots & 0 & , \; J^X_{i1} \\ 0 & J^E_{it-1}, J^E_{it-2} & 0 & \vdots & , \; J^X_{i2} \\ \vdots & 0 & \ddots & 0 & , \; \vdots \\ 0 & \cdots & 0 & J^E_{it-1}, \cdots J^E_{it-4} & , \; J^X_{i4} \end{array} \right| \begin{array}{c} 1975 \\ 1976 \\ \vdots \\ 1998 \end{array}$$

where $\mathbf{J}^{\mathbf{E}}_{\mathbf{it}}$ *is the vector of pre-determined variables, and* $\mathbf{J}^{\mathbf{X}}_{\mathbf{it}}$ *is the vector of exogenous variables including dummies (Sargan (1988), Stewart(1992) and Arellano & Bond (1991)).*

*(5) Since the Wu-Hausman statistic rejects the exogeneity of k, l, tr and fd, instrumental variables (**z**) were applied, which include the corresponding pre-determined variables from lag 2 onwards in order to ensure* $Cov(\mathbf{z}, e_{it-2})=0$.

Having obtained economic inefficiency relative to the world best possible practice in reducing inefficiency in using the given resources available for production, u_{it}, it paved the way of assessing the impact of openness on efficiency. Table 2 shows our estimation in terms of two approaches: the full sample and the sub-sample. In the full sample estimation, the Wu-Hausman statistic rejected the exogeneity of the FDI variable. But this was reversed for the sub-samples of the different time periods. As a result, an instrumental-variable estimation was carried out for the full sample, while the original FDI variable was used for the sub-samples. To ensure the orthogonality in the estimation, the dynamic variable and the endogenous variables were instrumented by the pre-determined variables from lag 3 onwards in order to ensure the orthogonality between the instruments and the disturbance term that had first- and second-order autocorrelation. Another technical issue was the multicolinearity between trade and FDI. As a result, the trade ratio was differenced once to mitigate the problem.

Table 2. Openness and Efficiency of the World Economy: A Dynamic Panel Data GMM Estimation

Dep. Variable m_{it}=log[exp(-u)]$_{it}$	**Total Sample**		**Sample by time period**	
Indep. Variables:	*Endogenous*	*Exogenous*	*The 1980s*	*The 1990s*
Intercept	-0.108 (2.5)	- 0.149 (5.9)	-0.219 (5.7)	-0.242 (6.4)
Δtr_{it}	0.065 (3.2)	0.061 (3.1)	0.035 (2.0)	0.016 (0.5)
fd_{it}	0.022 (3.1)	0.036 (8.5)	0.028 (4.6)	0.057 (7.6)
m_{it-1}	0.605 (12.2)	0.554 (11.3)	0.107 (1.5)	-0.061 (0.8)
Statistics of Estimations				
Country-fixed effect (χ^2) [countries: $\sum D_i$=0, df=79]	235.36 [0.000]	263.18 [0.000]	402.54 [0.000]	421.63 [0.000]
Year-time effect (χ^2) [year: $\sum T_t$=0, df=20]	31.57 [0.004]	91.17 [0.001]	23.14 [0.002]	50.82 [0.000]
$\hat{\sigma}$	0.060	0.059	0.039	0.056
$\overline{R}^2$	0.26	0.29	0.55	0.48
N	1280	1280	592	687
Hausman (F-Statistic) [H_0: Random Effect]	3.13 [0.005]	2.83 [0.005]	5.56 [0.001]	7.26 [0.001]
Wu-Hausman (χ^2) [H_0: Exogeneity]	6.034 [0.025]	-----	2.10 [0.154]	0.328 [0.865]
AR [1]	0.671 (19.0)	0.663 (18.9)	0.608 (9.1)	0.246 (4.2)
AR [2]	-0.199 (4.6)	-0.182 (4.3)	-0.341 (4.5)	-0.239(3.8)
AR[3]	-0.039 (0.7)	0.011 (0.2)	0.056 (0.5)	0.108 (0.9)
Instrument Set	Δtr_{it-3}~ Δtr_{it-18} tr_{it-3} ~ tr_{it-18} fd_{it-3} ~ fd_{it-18} m_{it-3} ~ m_{it-18}	m_{it-3} ~ m_{it-18}	m_{it-3} ~ m_{it-18}	m_{it-3} ~ m_{it-18}

Note: *(1) The Likelihood Ratio Statistic is applied to test the country fixed effects and the time (year) specific effects.*
(2) T ratios are in parentheses, and p values are in square brackets.
(3) dtr is the first difference of the trade ratio.
(4) The presence of higher-order autocorrelation is detected on the basis of

$$m_{it} = \sum a_i D_i + \sum a_t T_t + f(\hat{x}, \hat{\beta}) + \theta\, m_{it-1} + \rho_{t-1}\hat{e}_{it-1} + \rho_{t-2}\hat{e}_{it-2} + \rho_{t-3}\hat{e}_{it-3} + v_{it}$$

where, $\hat{e}_{it} = \rho_{t-1}\hat{e}_{it-1} + \rho_{t-2}\hat{e}_{it-2} + \rho_{t-3}\hat{e}_{it-3} + v_{it} \sim N(0,\sigma^2)$.

(5) *The basic instrument set used is of the form:*

$$J_i = \left| \begin{array}{ccccc|c} J^E_{it-1} & 0 & \cdots & 0 & ,\ J^X_{i1} & 1979 \\ 0 & J^E_{it-1}, J^E_{it-2} & 0 & \vdots & ,\ J^X_{i2} & 1980 \\ \vdots & 0 & \ddots & 0 & ,\ \vdots & \vdots \\ 0 & \cdots & 0 & J^E_{it-1}, \cdots J^E_{it-4} & ,\ J^X_{i4} & 1998 \end{array} \right.$$

where, $\mathbf{J}^{\mathbf{E}}_{\mathbf{it}}$ *is the vector of pre-determined variables, and* $\mathbf{J}^{\mathbf{X}}_{\mathbf{it}}$ *is the sector of exogenous variables including dummies (See Sargan, 1988; Stewart, 1992; Arellano and Bond, 1991).*
(6) The lagged variable in each column was instrumented using lagged m_{it} *from lag 3 onwards since the third-order autocorrelation was not presented.*

Since the similar results obtained from the half-normal and the exponential distribution frontier models in the stage one of estimation, the information from the exponential model was used in the regressions of efficiency on openness. As indicated in Table 2, the results from the full sample suggest that both FDI stock and the growth in the trade-GDP ratio have the positive and significant impact on efficiency. This lends strong support to the hypothesis that openness promotes efficiency improvement. Openness introduces advanced technologies and managerial skills and promotes competition. All this helps move the production of an open economy towards the worlds' best possible practice.

To test the robustness of the openness-efficiency relationship the whole sample time period was divided into two: the 1980s and the 1990s. While the positive relationship between the growth in the trade-GDP ratio and efficiency was significant in the 1980s, it was no longer the case in the 1990s. On the other hand, the FDI variable was highly significant in both sub-time periods. The magnitude of the coefficient on FDI substantially increased from the 1980s to 1990s. This suggests that FDI is a more important means of promoting efficiency improvement than international trade, especially in the 1990s. The result may not be surprising: the special role that FDI plays in improving a country's performance cannot be replaced by any other forms of international integration. While international trade allows a country to obtain access to new ideas indirectly, inward FDI as a package of capital, technology and management skills directly affects the host economy. With science and technology advancing quickly over time, tacit knowledge transfer and diffusion and direct competition become more important in promoting efficiency improvement. FDI is a more effective channel for technical progress and efficiency improvement than international trade in this process.

As mentioned earlier, this study also introduced the black market premium for foreign exchange as an alternative measures of openness. In addition, human capital and domestic investment in fixed assets are also important in economic performance. These two types of variables should be controlled for when the relationship between efficiency changes and openness is examined. Because of missing values for these additional variables, the numbers of observations had to be reduced in order to incorporate these variables into the estimation. Therefore, the more compressive investigation had to be pursued on the basis of a smaller sample.

Table 3 presents the empirical results of the impacts of trade, FDI and black market premium individually as well as those of trade, black market premium alongside the product between FDI and human capital. When FDI-human capital interaction terms are excluded (see the partial estimation approach columns in the table), the dynamic model indicates that the coefficient on the trade ratio is still positive, but no longer significant as compared with Table 2. This may be because of the inclusion of all other variables of black market premium, domestic fixed investment and human capital in the estimation, which could result in weakening the significance of variables that have the less power to explain efficiency, such as the trade ratio.

In contrast, FDI has been highly significant over different estimations, and the same is true for secondary school enrolment. This confirms the importance of FDI and human capital in enhancing a country's performance. Tertiary education enrolment has the expected positive sign, but is not statistically significant. This may reflect one important feature of most foreign direct investments that are aimed to seek low-cost production rather than to strengthen R&D or relocate highly sophisticated production

Table 3. Impact of Openness and Interaction between FDI and Human Capital on Efficiency Improvement

Dep. Variable $m_{it}=\log[\exp(-u)]_{it}$	**Partial Est. Approach** **[$s=ss_{it}$, $t=st_{it}$]**		**Integrative Est. Approach** **[$s*fd=ss_{it}\times fd_{it}$, $t*fd=st_{it}\times fd_{it}$]**	
Indep. Variables:	*Static*	*Dynamic*	*Static*	*Dynamic*
Intercept	-1.103 (9.4)	- 1.054 (8.8)	-0.711 (11.0)	-0.678 (10.2)
tr_{it}	0.019 (0.5)	0.025 (0.6)	0.015 (0.4)	0.021 (0.5)
fd_{it}	0.022 (4.0)	0.021 (3.8)	-0.006 (0.4)	-0.005 (0.4)
S	0.101 (3.5)	0.096 (3.4)		
T	0.012 (0.7)	0.011 (0.7)		
s*fd			0.009 (2.7)	0.008 (2.6)
t*fd			-0.002 (0.8)	-0.002 (0.4)
bm_{it}	-0.004 (1.2)	-0.004 (1.1)	-0.005 (1.3)	-0.004 (1.2)
fx_{it}	0.179 (9.8)	0.176 (9.5)	0.179 (9.4)	0.176 (9.2)
m_{it-1}	-------	0.151 (1.8)	--------	0.167 (1.9)
Statistics of Estimations				
Country-fixed effect (χ^2) [H_0: $\Sigma D_i=0$, df=73]	328.11 [0.000]	302.73 [0.000]	320.73 [0.000]	206.65 [0.000]
Year-time effect (χ^2) [H_0: $\Sigma T_t=0$, df=9]	61.41 [0.001]	57.83 [0.001]	49.55 [0.001]	36.67 [0.001]
Lagged effect (χ^2) (H_0:$m_{it-1}=0$, df=1)	4.746 [0.030]	-----	4.000 [0.035]	----
$\hat{\sigma}$	0.0463	0.0460	0.0472	0.0470
$\overline{R}^2$	0.47	0.48	0.46	0.47
N	412	412	412	412
Wu-Hausman (χ^2) [H_0: Exogeneity]	3.02 [0.167]	-----	3.08 [0.182]	-----
AR [1]	0.143 (1.9)	-0.053 (0.5)	0.152 (2.1)	0.056 (0.5)
AR [2]	-0.194 (3.8)	-0.366 (3.5)	-0.176 (3.0)	-0.308 (2.9)
AR[3]	-0.079 (1.5)	-0.095 (1.3)	-0.092 (1.3)	0.05 (0.8)
Instrument Set		fx_{it-3} ~ fx_{it-18} m_{it-3} ~ m_{it-18}		fx_{it-3} ~ fx_{it-18} m_{it-3} ~ m_{it-18}

Note*:* *(1) The Likelihood Ratio Statistic is applied to test the country fixed effects, the year specific effects and the lagged dependent variable effect.*

(2) The presence of higher-order autocorrelation is detected on the basis of

$$y_{it} = \Sigma a_i D_i + \Sigma a_t T_t + f(\hat{x}, \hat{\beta}) + \theta\, y_{it-1} + \rho_{t-1}\hat{e}_{it-1} + \rho_{t-2}\hat{e}_{it-2} + \rho_{t-3}\hat{e}_{it-3} + v_{it}$$

$$\text{where, } \hat{e}_{it} = \rho_{t-1}\hat{e}_{it-1} + \rho_{t-2}\hat{e}_{it-2} + \rho_{t-3}\hat{e}_{it-3} + v_{it} \sim N(0,\sigma^2).$$

(3) *The lagged variable in dynamic estimation was instrumented using lagged m_{it-3} onwards and fx_{it-3} onwards since the third-order autocorrelations are not presented.*

(4) Wu-Hausman Statistic tests the exogeneity of both fd_{it} and fx_{it}, and the statistic does not reject H_0, so that the two variables are not instrumented.

(5) All variables in small letter means that they are in logarithm. For bm_{it} is log $(1+BM)_{it}$, where BM_{it}

is black market premium in an economy.

to remote regions for market development. Thus, sufficient supply of human capital with a reasonable quality level and lower costs seems to be more desirable by the current feature of FDI, in which the host country's ability to match this desirability is essential for FDI to be utilised more efficiently for a host economy.

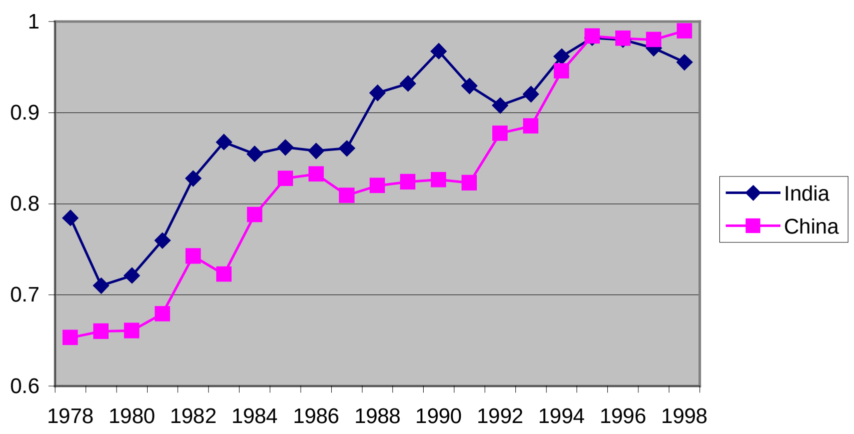
Moreover, for black market premium, it has the expected negative sign with reasonable significance. Domestic fixed investment has the expected positive sign and is highly significant. In terms of both the magnitude and the significance level, domestic fixed investment plays the most important role in efficiency improvement. But this is not made at expense of the significant role of foreign direct investment in stimulating the efficiency, as we can see in Table 3. This evidence clearly rejects Levine & Renelt (1992)'s argument of the crowding-out effect of the two investments for an economy.

Another interesting point in Table 3 for notice is that once the interaction terms are included, the coefficient on FDI becomes negative, but insignificant. Instead of it, the interaction term measured by the cross-product of FDI and secondary school enrolment becomes positive and significant. This suggests that FDI would have significant positive impact on efficiency only when the host country has a minimum threshold of human capital proxied by secondary school enrolment. The coefficient on the product of FDI and tertiary education enrolment has the wrong sign, but is statistically insignificant.

V. Openness and Efficiency of India and China

This section compares openness and performance, i.e. the relationships between the time-variant part of efficiency and openness, in India and China using a diagrammatic approach. The efficiency comparison is made relative to the common criteria - the world best possible practice. One advantage of this comparison is that the two countries have many similarities but the degree of their openness is so different, which will enables us to learn some policy experience on how to open an economy for higher growth.

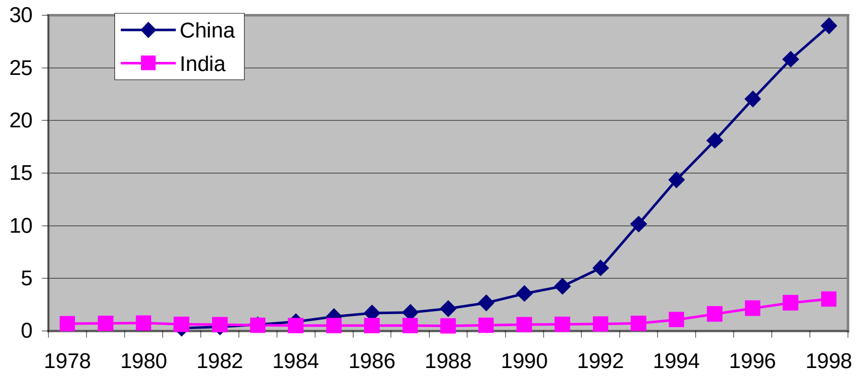
Figure 1. Efficiency of India and China Relative to the World Production Frontier



As shown in Figure 1, in 1978 when China started its economic reform and opening to the outside world, China's relative efficiency to the best possible practice was only about 0.66 and India's was about 0.79. However, in the following 20 years or so, while the economic efficiency of both countries demonstrated a general uprising trend, but China's efficiency index has risen faster than India since 1992 when China decided to develop a full market-oriented economy with more openness to the world. As a result, from 1995 China surpassed India. This result may not be a surprise as India had pursued a quite restricted open-economic policy until recent years. Inevitably, this could create unfavourable conditions in attracting FDI.

This is exactly shown in Figure 2, where it clearly illustrates that the inward FDI stock as the percentage of GDP was very small in both China and India up to the mid-1980s. The gap between the two countries began to rise in the second half of the 1980s, and became substantially large in the 1990s. In 1998, the FDI stock/GDP ratio in China was more than 6 times as high as that in India. Given that FDI is a very important means for efficiency improvement as indicated in Section IV, the higher FDI may explain the better economic performance in China.

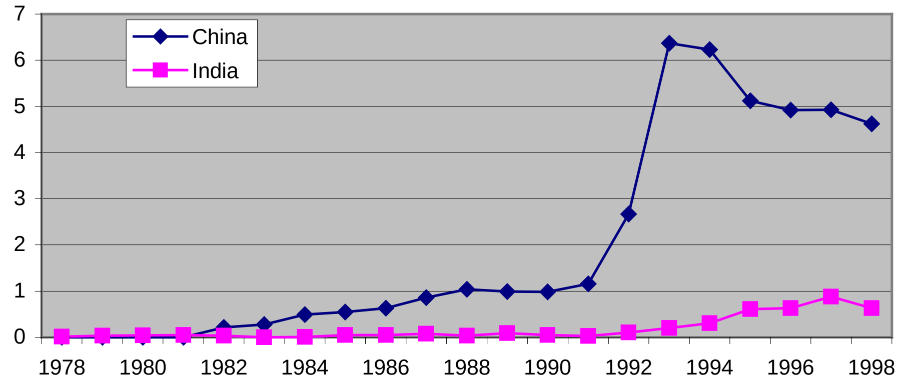
Figure 2. The Stock of Foreign Direct Investment as % of GDP



The larger FDI stock/GDP ratio in China resulted from larger inflows in FDI in China from the mid-1980s, and especially from 1992 onwards. As Figure 3 portraits, net FDI inflows in both countries were very small in the later 1970s and early 1980s. Between the mid-1980s and 1991 this ratio increased from about 0.5 to around 1.1 in China, while it remained marginal in India.

From 1991, India began its investment policy reform, and the New Industrial Policy of India demonstrated a close correspondence with the Chinese pattern of globalisation. India's switch towards globalisation in 1991 was a consequence of domestic resource deficits and balance of payments problems. It was suggested that if only India could attract enough foreign capital it could move on to a higher growth path. (Alamgir, 1999). It allowed up to 51 percent foreign equity in 34 "high-priority" sectors. Parallel to China's Special Economic Zones (SEZs), it emphasised export promotion through Export Processing Zones (EPZs), where 100 percent foreign ownership was allowed. Like China, India signed the Multilateral Investment Guaranty Agency's (MIGA) convention protecting foreign investors from political risk.

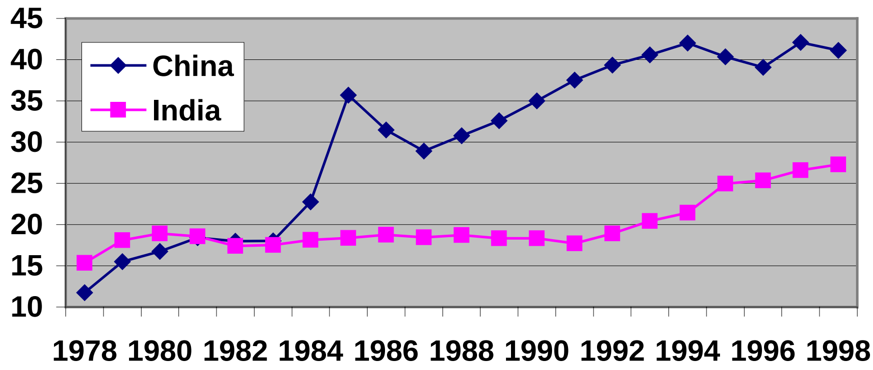
Figure 3. Foreign Direct Investment, Net Inflows
(% of GDP)



However, despite the encouragement, FDI flowed to India remained relatively small in relation to its economy even in the 1990s. The annual inflow of FDI in India was about two to three billion US dollars in the second half of the 1990s. This amount of inflows was much higher than that before 1991, but it was less than 5 percent of domestic capital formation (Athreye and Kapur, 2001), and less than 1 percent of GDP. During the same period, the annual net FDI inflow in to China was about 5 percent of GDP, and China became the largest host of FDI in the developing world.

India's trade liberalisation was started in 1991 when the government lowered peak tariff from 300 to 150 percent, to match China's. Then both countries experienced a number of incremental policy moves, and by the end of 1997, China and India had competitively lowered their average tariffs to 20.1 and 20.3 percent respectively (Alamgir, 1999). During the same period non-tariff barriers were also reduced in both countries. While a similar pattern in changes in trade policy was observed in both countries, Figure 4 shows that the trade/GDP ratio in China was much higher than that in India since 1984. From 1991, while India's trade/GDP ratio rose continuously, it never exceeded 30 percent. That ratio in China was around 40% for the same time period.

Figure 4. Growth of Trade (% of GDP)



A more open economy gains more access to new knowledge and is exposed to more competition from the outside world. In terms of the relative volumes of inward FDI and international trade, China is more open than India. This may explain why China experienced a more rapid improvement in efficiency changes.

VI. Conclusions

The main features of this study include (1) the application of stochastic production frontier techniques in establishing the world production frontier and (2) the adoption of dynamic models both in setting up the frontier and examining the impact of openness on efficiency changes. The world production frontier was constructed using the full sample covering 126 countries for the period 1978-98. By controlling the country-specific fixed effects and time-period effects, the economic efficiency of a country relative to the world's best possible practice was estimated.

The impact of openness on the time-variant efficiency was then examined based on two groups of samples. In the relatively larger sample, only FDI and trade were used to explain efficiency improvement and the results suggest that both variables had the significant impact over the sample period. However, if this sample was divided into the 1980s and 1990s, then the trade variable was only significant in the 1980s. On the other hand, the coefficient on FDI was always significant, and its level of significance substantially increased in the 1990s.

In the relatively small sample, black market premium was used as an additional measure of openness. To control for other possible influences on efficiency changes human capital and domestic fixed investment were included in the regressions. The results show that FDI as an individual variable was still a significant determinant of efficiency improvement. When the interaction between FDI and secondary school attainment was introduced, a minimum threshold stock of human capital was confirmed for FDI to have a significant impact. International trade still had a positive coefficient, but was no longer statistically significant when more explanatory variables were incorporated. Black market premium had the expected negative sign, but marginally insignificant. The control variable domestic fixed investment was always highly statistically significant and its magnitude was the largest among the variables on the right hand side of various equations.

The empirical evidence shows that among all three measures of openness FDI is the most important one for efficiency improvement. As a result, the econometric results are most robust to FDI. This may not be a surprise as firstly FDI enhances economic performance via more effective transfer and diffusion of knowledge and creation of direct competition with domestic firms. Secondly, black market premium just directly indicates the degree of distortion of the foreign exchange market and may not be as a good measure as FDI or trade for openness for the purpose of this study. Nevertheless, the results on trade and black market premium are consistent from different estimation models.

Unfortunately, most existing studies on openness and productivity or efficiency improvement ignore FDI as a measure for openness. This would probably result in model mis-specifications. However, the impact of openness, even if FDI, on efficiency changes should not be exaggerated as domestic investment has played a more important role in this process.

The effectiveness of openness on efficiency improvement in India and China was examined against the common criteria - the world production frontier. It reveals that China's efficiency index was lower than India's in the period from the late 1970s to the mid-1990s. This result is contrary to the conventional wisdom that China performed better than India in almost all macroeconomic fronts since China started economic reform and opening to the outside world. However, China experienced a higher degree of openness in terms of FDI inflows, FDI inward stock and international trade as a percentage of GDP. The higher degree of openness to the outside world facilitated China to fasten its pace to catching-up with the world best practice in reducing inefficiency in employing the available resources for the economy. As a result, China has overtaken India in raising productivity from 1995.

Policy implication derived from the study is clear: to promote openness, in particular, to create more favourable conditions for inward FDI growth. In turn, this will lead to improve efficiency in employing scare resources for output growth. In the 1990s, India has paid a price for its failure in opening more its economy, and China benefits from its policy for more openness. Now both countries have learnt the lesson that has led their policy to converge for more openness. Over next 10 year, which country will grow its economy more and faster will largely depend on which is able to implement the openness policy more effectively. Certainly, the imminent accession of China into the WTO will be much conducive to the economy for its racing with India in attracting FDI and so to improve the quality of the growth.

Appendix 1. Variable Measurement and Data Sources

Variable	Measurement
GDP	GDP at market prices (constant 1995 US$)
L	Total labour force
FD	FDI Stock
TR	Trade ratio, defined as the sum of exports and imports divided by GDP. IM: Imports of goods and services (constant 1995 US$); EX: Exports of goods and services (constant 1995 US$)
GDFII95	Gross domestic fixed investment (constant 1995 US$)
SES	School enrollment, secondary (% gross)
SEP	School enrollment, primary (% gross)
SET	School enrollment, tertiary (% gross)

Appendix 2. Estimations of Capital Stocks

Capital stocks were estimated mainly from available gross domestic fixed investment (constant 1995 price) data from WDI CD-ROM by the standard perpetual inventory calculation method. Data for some countries in some years were missing from WDI CD-ROM which were then calculated from gross domestic fixed investment (constant 1987 price) from Nehru and Dhareshwar (1993). As in Miller and Upadhyay (2000), the following procedure was taken to estimate the capital stock series:

Step 1: Initialise the capital stock by setting

$$K_0 = I_0/(\lambda g_d + (1-\lambda)g_w+\delta) \quad (1)$$

where the initial year is 1960;
g_d is the average growth rate of the GDP series for the country in question;
g_w is the world growth rate estimated at 4% per year;
$\lambda = 0.25$, is a measure of mean reversion in the growth rates, following Easterly et al. (1993) and $\delta = 0.5$, is the assumed rate of depreciation.

Step2: Estimate the capital stock using the standard perpetual inventory method

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

References

Alamgir, J. (1999), 'India's Trade and Investment Policy: the Influence of Strategic Rivalry with China', *Issues and Studies*, 35(3), 105-133.

Athreye, S. and Kapur, S. (2001), 'Private Investment in India: Pain or Panacea?', *World Economy*, 399-424.

Balassa, B. (1982), Development Strategies in Semi-Industrial Countries, Oxford: Oxford University Press.

Balasubramanyam, V. N., Salisu, M. and Sapsford, D. (1996), 'Foreign direct investment and growth in EP and IS countries', *Economic Journal*, 106, 92-105.

Barro, R. J. and Lee, J. W. (1994), 'Sources of economic growth', *Carnegie-Rochester Conference Series on Public Policy*.

Barro, R. J. and Sala-I-Martin, X. (1995), *Economic Growth*, New York: McGraw-Hill.

Batra, R. (1992), 'The fallacy of free trade', *Review of International Economics*, 1, 19-31.

Batra, R. and Slottje, D. J. (1993), 'Trade policy and poverty in the United States: theory and evidence, 1974-1990', Review of International Economics, 1, 189-208.

Bhagwati, J. (1978), *Foreign Trade Regimess and Economic Development: Anatomy and Consequences of Exchange Control Regimes*, Cambrige, MA: Ballinger.

Borensztein, E., De Gregorio, J. and Lee, J. W. (1998), 'How does foreign direct investment affect economic growth?', *Journal of International Economics*, 45, 115-35.

Chenery, H. and Strout, A. (1966), 'Foreign assitance and economic development', *American Economic Review*, 56, 679-733.

Dollar, D. (1992), 'Outward-oriented developing economies really do grow more rapidly: evidence from 95 LDCs, 1976-1985', *Economic Development and Cultural Change*, 40, 523-544.

Edwards, S. (1993), 'Openness, trade liberalisation, and growth in developing countries', *Journal of Economic Literature*, XXXI, 1358-93.

Edwards, S. (1998), 'Openness, productivity and growth: what do we really know?', *Economic Journal*, 108, 33-398.

Fare, R., Grosskopf, S. Norris, M. and Zhang, Z. (1994), 'Productivity growth, technical progress, and efficiency change in industrialied countries', *American Economic Review*, 84(1), 66-83.

Forsund, F. R., Lovell, C. A. K. and Schmidt, P. (1980), 'A survey of frontier production functions and their relationships to efficiency', *Journal of Econometrics*, 13, 5-25.

Grosskopf, S. (1993), 'Efficiency and productivity', in Fried, H. O., Lovell, C. A. K. and Schmidt, S. S. (eds) The Measurement of Productive Efficiency: Techniques and Applications, Oxford: Oxford University Press, 160-94.

Grossman, G. and Helpman, E. (1991), *Innovation and Growth in the Global Economy*, Cambridge: MIT Press.

Hay, D. A. and Liu, G. S. (1997), 'The efficiency of firms: what difference does competition make?', *Economic Journal*, 107, 597-617.

Johnson, B. and Sheehy, T. (eds) (1996), *1996 Index of Economic Freedom, Washington*: The Heritage Foundation.

Kalirajan, K. P. and Shand, R. T. (1999), 'Frontier production functions and technical efficiency measures', *Journal of Economic Surveys*, 13(2), 149-72.

Keesing, D. B. (1967), 'Outward-looking policies and economic development', *Economic Journal*, 77, 303-20.

Kormendi, R. C. and Meguire, P. G. (1985), 'Macroeconomic determinants of change: cross-country evidence', *Journal of Monetary Economics*, 16, 141-63.

Krueger, A. O. (1978), *Foreign Trade Regimes and Economic Development: Liberalisation Attempts and Consequences*, Cambrige, MA: Ballinger.

Kruger, J. J., Cantner, U. and Hanusch, H. (2000), 'Total factor productivity, the East Asian miracle, and the world production frontier', *Weltwirtschaftliches Archiv*, 136(1), 111-36.

Leamer, E. (1988), 'Measures of openness', in Baldwin, R. (ed.) *Trade Policy and Empirical Analysis*, Chicago: University of Chicago Press.
Leamer, E. (1995), 'A trade economicst's view of U.S. wages and globalisation', Brookings Conference Proceedings.
Levine, R. and Renelt, D. (1992), 'A sensitivity analysis of cross-country growth regression', *American Economic Review*, 82, 942-63.
Liu, X., Song H. and Romilly P. (1997), 'An empirical investigation of the causal relationship between openness and economic growth in China', *Applied Economics*, 29(12), 1679-1686.
Lucas, R. E. (1988), 'On the mechanics of economic development', *Journal of Monetary Economics*, 22(11), 3-42.
Martin-Marcos, A. and Suarez-Galvez, C. (2000), 'Technical efficiency of Spanish manufacturing firms: a panel data approach', *Applied Economics*, 32, 1249-1258.
Maudos, J., Pastor, J. M. and Serrano, L. (2000), 'Convergence in OECD countries: technical change, efficiency and productivity', *Applied Economics*, 32, 757-65.
Michaely, M., Papageorgiou, D. and Choksiu, A. (eds) (1991), *Liberalising Foreign Trade*, Oxford: Blackwell.
Miller, S. M. and Upadhyay, M. P. (2000), 'The effects of openness, trade orientation, and human capital on total factor productivity', *Journal of Development Economics*, 63, 399-423.
Moroney and Lovell (1997) 'The relative efficiency of market and planned economies', *Southern Economic Journal*, 63(4), 1084-93.
Nelson, R. R. and Pack, H. (1999), 'The Asian miracle and modern growth theory', *Economic Journal*, 109(3), 416-436.
Nickell, S. J. (1996), 'Competition and corporate performance', *Journal of Political Economy*, 104(4), 724-45.
Nowakowski, J. M. (1998), 'Openness and efficiency: the effect of trade on aggregate efficiency', paper presented at the 1998 Academy of Business and Administrative Sciences International Conference, Budapest, Hungary, 14 July.
Pilat, D. (1996), 'Competition, productivity and efficiency', *OECD Economic Studies*, 27(II), 107-46.
Romer, P. M. (1986), 'Increasing returns and long run growth', *Journal of Political Economy*, 94(5), 1002-37.
Romer, P. M. (1992), 'Two strategies for economic development: using ideas and producing ideas', World Bank Annual Conference on Economic Development, Washington, D.C. The World Bank.
Sachs, J. and Warner, A. (1995), 'Economic reform and the process of global integration', *Brookings Papers on Economic Activity*, 1, 1-118.
Scitovsky, T. (1954), 'Two concepts of external economies', *Journal of Political Economy*, 62, 143-51.
Solow, R. M. (1957), 'Technical change and the aggregate production function', *Review of Economics and Statistics*, 39, 312-20.
Taylor, L. (1991) 'Economic openness: problems to the century's end', in Banuri, T. (ed.), *Economic Liberalisation: No Panacea*, Oxford and New York: Oxford University Press, Clarendon Press, 99-147.
Voivodas, C. (1973), 'Exports, foreign capital inflow and economic growth', *Journal of Internaitional Economics*, 3, 337-49.
Wei, Y., Liu, X., Song, S. and Romilly, P. (2001) 'Endogenous innovation growth theory and regional income convergence in China', *Journal of International Development*, 13(2), 153-68.
Wolf, H. (1993), 'Trade orientation: measurement and consequences', *Estudios de economia*, 20(2), 52-72.
World Bank (1987), *World Development Report 1987*, Oxford: Oxford University Press.