Effects of Trade Openness on the Steady State Growth Rates of Selected Asian Countries with an Extended Exogenous Growth Model

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Abstract

The Solow growth model is extended with an endogenous growth framework to estimate the effects of trade openness on the steady state growth rate (*SSGR*). Estimates of the augmented production functions are used to compute the *SSGR*s for Singapore, Malaysia, Hong Kong, India and Thailand. That good policies increase the growth effects of openness is also tested with an interactive term. Our results show that Singapore has the highest *SSGR* of 2.75%, followed by Hong Kong and Thailand with 2.5%. India and Malaysia have lower *SSGR*s of 1.7% and 0.5% respectively.

Keywords: Exogenous and Endogenous Growth, Trade Openness, Steady State Growth Rate, Country Specific Estimates with Time Series Data, Asian Countries.

JEL: N1, O1, O4, O11

1. Introduction

In the Solow (1956) growth model the steady state rate of growth of output per worker *(SSGR)* equals to the exogenously determined rate of growth of total factor productivity (*TFP*). Therefore, this model is known as the exogenous growth model. It is hard to use it to develop policies for growth because the determinants of *TFP* are not known. In contrast endogenous growth literature identifies more than 80 variables as potential determinants of *TFP*; see Hoover and Partez (2004) for a survey.

Empirical studies on growth models, based on the endogenous growth theories to analyze the determinants of *TFP,* have used three types of data. First, many studies have used cross section data of 80 or more countries, where the average growth rate of output over 20 years or more is regressed on a set of potential *TFP* determinants. Some popular determinants of *TFP* are human capital, expenditure on R & D, trade openness, good governance and institutions, responsible economic polices, foreign direct investment and aid etc. Second, some empirical studies have used panel data methods and they are popular especially in studies which evaluate controversies on the effectiveness of a small number of determinants of growth. In these studies, generally, the average growth rate of output between 3 to 5 year periods is used as the dependent variable. Third, several studies have also estimated growth equations with country specific time series data in which the dependent variable is the annual growth rate of output and with the time series methods of unit roots and cointegration. They may also be called case studies although not comparable in scope to the more comprehensive case studies reviewed by Desai (1997) and Srinivasan and Bhagwati (1999). It may be said that case studies are useful for identifying the significance of a set of crucial variables for the growth process. In contrast cross-section and panel data studies are useful to examine if the conclusions from the case studies can be generalized. For this purpose cross these studies use a number of control variables and large samples.

While the econometric techniques of these three approaches are satisfactory, they seem to have specification weaknesses because it is hard to accept that annual growth rates of output or even average growth rates over 3 to 5 years adequately measure the dependent variable viz., *SSGR*. This is so because simulations with the closed form solutions show that an economy takes several periods to converge to anywhere close to its steady state. This transition period may be as long as 25 to 30 years even for small perturbations. Baldwin (2004), Dollar and Kraay (2004), Edwards (1998) and Winters (2004), are among a few who explicitly note that the transition period from one to another steady state may span over two or three decades. Therefore, while the dependent variable in the cross section studies viz., average growth rates of 20 or more years is a good approximation to the steady state growth of output, it is hard to accept that the dependent variable is a good measure of the *SSGR* in the panel and annual time series studies.

In this paper we show how to estimate the growth effects of a growth enhancing variable with country specific annual data with an extended Solow model. We have selected trade openness (*TRA*) as our growth enhancing variable because its growth effects have attracted considerable attention in the post war period. Since the early 1970s the GATT/WTO, the IMF and the World Bank have initiated trade liberalization policies under their Conditionality and Structural Adjustment Programmes. These programmes have been more vigorously implemented since the late 1980s by some countries like India and other developing countries after noting the spectacular success in the ast Asian countries; see Baldwin (2004) for a history and survey of the literature on the relationship between growth and trade. Commenting on the significance of trade liberalisation policies, Santos-Paulino and Thirlwall (2004) noted that since the 1970s world trade has grown five times faster than world output. Dollar (1992), Ben-David (1993), Sachs and Warner (1995), Edwards (1993, 1998), Frankel and Romer (1999) and Dollar and Kraay (2004) are some of the strong proponents for trade liberalisation. However, Rodriguez and Rodrick (2001), in a critical review, have warned that trade liberalisation alone is unlikely to improve growth without complementary measures like institutional reforms and good economic policies etc. Subsequently Jones (2001), while partly accepting Rodriguez and Rodrick's criticisms, stated that he was not convinced that the relationship between openness and growth is unimportant and insignificant.

The outline of this paper is as follows. Section 2 shows that the claims made by many studies, based on country specific time series data, that there is a long run relation between the rate of growth of output and some growth enhancing variable(s) is difficult to accept because of misspecification errors. The same holds also for studies based on panel data methods. Section 3 argues that it is meaningful to estimate a production function or its extended variants, not steady state growth equations, with the country specific annual time series data and panel data methods. We show a few alternative methods of extending the production function to make *TFP* endogenous. We then derive the implications from the estimated parameters of the production function for the relationship between the *SSGR* and trade openness. A similar procedure can also be applied to estimate the growth effects of other variables like aid and foreign direct investment etc. Our empirical results are in Section 4. For this purpose we have selected a few Asian countries viz., Singapore, Malaysia, Hon Kong, India, and Thailand which have vigorously implemented trade liberalization policies and also have grown rapidly.[1] Trade openness, as measured by the ratio of exports plus imports to output, in the first 3 countries has more than doubled from 1970 to 2004 and by 65% and 85% respectively in India and Thailand. During 1970-2004 average per capita incomes in these countries grew by about 4.5%, except in India where this was slightly below 3%. Finally, in Section 5 our conclusions and limitations are summarized.

2. Specifications in Time Series Models

A typical *ad hoc* specification of the ARDL equation in many country specific time series growth models is as follows[2]:

[1] We have also tried with data of Korea and the Philippines. However, the results were disappointing and somewhat puzzling because trade openness in Korea seems to have increased between 1970 and 2004 by 180% and by 75% in the Philippines. This may partly be due to the dominance of factors like high levels of human capital formation and learning by doing or that both countries may be implementing restriction policies in a disguised form.

[2] We have desisted from citing references that suffer with the limitations discussed in this section because these are too many and selecting a few gives the misleading impression that we have handpicked them for pillorying.

$$\Delta lnY_t = -\lambda[lnY_{t-1} - (lnA_0 + gT + \alpha \ln Z_{t-1})] + \sum_{i=0}^{n1} \gamma_{1i} \Delta \ln Z_{t-i} + \sum_{i=1}^{n2} \gamma_{2i} \Delta \ln Y_{t-i} \quad (1)$$

where Y = output, A_0 = initial stock of technology, T = time and Z = some growth improving variable(s) like openness, aid, foreign direct investment and exports etc. Note that the error correction (*ECM)* term is given in the square brackets. It is not known whether the above specification in the *ECM* is based on the exogenous growth model of Solow or some endogenous growth model. Irrespective of which model is used, cointegration methods can only find if there is a long run relationship between the levels of the variables viz., lnY and lnZ, and *not* between ΔlnY and lnZ. Yet many studies, after finding cointegrating vectors and perhaps after conducting the Granger causality tests, mistakenly conclude that there is a long run relationship between *ln Z* and ? *ln Y.* Needless to say ? *ln Y* is not in the *ECM* and this conclusion does not make any sense.

There are a few other weaknesses in these *ad hoc* specifications. First, as stated earlier if the growth rate of output is measured as annual growth rate, or in the panel data studies as the average growth rate over 3 to 5 year periods, these are unsatisfactory measures of the steady state growth rates. Therefore, this specification cannot be justified as based on endogenous growth models because the economy cannot reach its steady state in such short periods. On the other hand, if the Solow (1956) model is used, the *ECM* term should be a production function or its extended and modified variants. One has yet to come across a production function in which output depends on some *Z* variables and independent of the basic factor inputs viz., labour and capital. Consequently, the findings of these studies with such *ad hoc* specifications are unacceptable.

A somewhat *ad hoc* but a more acceptable specification, say based on the Solow (1956) growth model, in which *Z* is introduced as an arbitrary shift variable into the production function is as follows.

$$\Delta lnY_t = -\lambda[lnY_{t-1} - (lnA_0 + gT + \beta \ln Z_{t-1} + \alpha lnK_{t-1} + (1-\alpha)lnL_{t-1})]$$
$$+\sum_{i=0}^{n1}\gamma_{1i}\Delta lnL_{t-i} + \sum_{i=0}^{n2}\gamma_{2i}\Delta lnK_{t-i} + \sum_{i=0}^{n3}\gamma_{3i}\Delta \ln Z_{t-i}$$
$$+\sum_{i=1}^{n4}\gamma_{4i}\Delta lnY_{t-i} \qquad (2)$$

However, in the steady state, growth of output $(\Delta \ln Y^*)$ will be given by $\Delta \ln Y^* = g + n + \beta\Delta \ln Z$, where n is the rate of growth of labour. Therefore, as long as it is plausible to assume that $\Delta \ln Z > 0$ in the steady state, Z can enhance growth.

3. Extending the Solow Model

We shall discuss now a few alternative methods of extending the Solow (1956) for estimation with the country specific time series data. Country specific time series studies are important because it is hard to justify the basic assumptions of the cross-section and panel data studies that the forces of economic growth and the underlying structural parameters are the same for all countries and at all times. Furthermore, while cross-section and panel data studies may give some insights into growth enhancing policies, they are not useful to estimate country specific *SSGR*s and identify the effects of policies to improve the *SSGR*. These estimates seem to be as important as country specific estimates of the natural rate of unemployment. To the best of our knowledge there are no country specific estimates of *SSGR*s and their determinants.

Our extension is limited to analysing the growth effects of the manna from the heaven type spillovers. Some examples of variables with such effects are learning by doing, aid and openness of trade etc. On the other hand variables like expenditure on R & D, human capital formation need additional resources. Country specific time series models with such growth enhancing variables, based on the endogenous growth models, are complicated to estimate and need non-liner dynamic econometric methods. Greiner, Semler and Gong (2004) discuss in some detail how such models can be estimated.

In our example we shall use openness of trade (*TRA*) as the growth enhancing variable. Extensions to capture the effects of other growth improving variables can follow a similar procedure.[3] Let the Cobb-Douglas production function with the constant returns and Hicks-neutral technical progress be

$$y_t = A_t k_t^{\alpha} \qquad 0<\alpha<1 \tag{3}$$

where y = per worker output, A = stock of technology and k = capital per worker. It is well known that *SSGR* in the Solow model equals the rate of growth of A. It is common in the Solow model to assume that the evolution of technology is given by

$$A_t = A_0 e^{gT} \tag{4}$$

where A_0 is the initial stock of knowledge. Therefore, the steady state growth of output per worker (*SSGR*) equals g.

It is also plausible to assume that $A_t = f(T, TRA_t)$. For example Winters (2004) takes the view that a more convincing and robust evidence between openness and growth should be derived from the effects of openness on productivity.[4] The effect of *TRA* on *TFP* can be captured with a few alternative empirical specifications of the above relationship. In the first 2 formulations we assume that in equation (4), $g = \psi(TRA)$. Simple linear and non-linear specifications of the production function in equation (3) are as follows.

[3] A standard endogenous growth model on growth and trade relationship is Grossman and Helpman (1991). In this model trade causes increased investment in the R&D sector. Consequently better quality non-traded intermediate inputs are produced and the stock of knowledge in the economy also increases. This in turn improves efficiency in other sectors. In addition concepts such as knowledge spill-overs resulting from trade in goods, foreign direct investment, ability to imitate the products and methods of production of foreign producers and learning by doing were introduced as engines of endogenous growth. Barro and Sala-i-Martin (1995) also consider similar effects. In their model poor countries with more openness find imitation is relatively less costly than creating knowledge. The cost of openness can be seen as proportional to the degree of openness. Therefore, open countries grow faster, sometimes faster than the advanced countries, by utilising knowledge which already exists and created by the advanced countries.

[4] Edwards (1998) has used an alternative method which is particularly useful for estimates with panel data. In his approach *TFP* is computed as the residual from the growth accounting exercises for each country. Their averages over ten year panels were used as the dependent variable. Using alternative measures of trade openness he found that they all have significant effects on *TFP* which is a good proxy for the steady state growth rate.

$$y_t = A_0 e^{(g_1+g_2 TRA_t)T} k_t^{\alpha} \quad (5)$$

$$y_t = A_0 e^{\left(g_3 - g_4 \frac{1}{TRA_t}\right)T} k_t^{\alpha} \quad (6)$$

A third alternative is to introduce TRA as a shift variable into the production function as in equation (2). This can be justified by assuming that

$$A_t = A_0 e^{gT} TRA_t^{\beta} \quad (7)$$

These formulations can also be used, in a similar way, to test for the growth effects of other growth enhancing variables like aid. For example, to test the well known Burnside and Dollar (2000) conditionality assumption in the literature on aid and growth that good policies (*GP*) increase the growth effects of aid (*AID*), g_2 in equation (5) can be made a function of *GP* to give the $Aid \times Policy$ type specification of Burnside and Dollar

$$y_t = A_0 e^{(g_1+g_2 AID_t + g_3 AID_t \times GP_t)T} k_t^{\alpha} \quad (8)$$

Since a similar conditionality view is also taken in the trade-growth relationship by Rodriguez and Rodrick (2001) and Winters (2004), it would be appropriate here to test this conditionality assumption, even in a rudimentary form due to some limitations of the time series data on variables like institutional reforms, good governance and corruption etc.

In country specific studies some often used proxy variables for trade openness are the ratio of exports plus imports to output (*TRA*), average tariff rates and black market premium of the exchange rate etc. For responsible economic policies the proxies are the share of government expenditure in output *(GS)* and the proportion of budget deficit to output etc. To proxy good institutional environment Dollar and Kraay (2004) have used the ratio of cash and time deposits, i.e., *M2*, to output (*MRA*). However, these proxies are not beyond controversy. Nevertheless, they are often used, especially in the country specific time series studies, because these data are available on a consistent basis for longer periods and for many developing countries.[5] For this reason Dollar and Kraay

[5] Some other measures of openness are exchange rate fluctuations and measures of non-tariff restrictions etc. Edwards (1998) has used 9 such measures. In the cross-section studies the Sachs-Warner (1995) binary index of

(2004) have used *TRA* and *MRA* in their panel data study of 101 countries. In our empirical work we shall mainly use *TRA* and *GS,* except for Thailand where *MRA* is used in place of *GS* because *GS* did not give plausible results.

Modified production functions with simpler specifications for *TFP* and with the above conditionality variable *GS* can be specified as:

$$y_t = A_0 e^{(g_1 + g_2 TRA_t - g_3 TRA_t \times GS_t)T} k_t^{\alpha} \tag{9}$$

$$y_t = A_0 e^{\left(g_4 - g_5 \frac{1}{TRA_t} - g_6 GS_t \times TRA_t\right)T} k_t^{\alpha} \tag{10}$$

$$A_t = A_0 e^{gT} TRA_t^{\beta_1} GS_t^{-\beta_2} \tag{11}$$

It may be noted that the Burnside-Dollar type multiplicative conditionality is specified in equation (10) linear in *TRA*. We have used this specification because in our empirical work, specifications such as:

$$y_t = A_0 e^{\left(g_4 - g_5 \frac{1}{TRA_t} - g_6 \frac{GS_t}{TRA_t}\right)T} k_t^{\alpha} \tag{10a}$$

the coefficient g_6 turned out to be insignificant for all the countries in our sample. The effect of *TRA* would be still positive on the growth of output and *SSGR,* for any given level of *GS*, as long as the absolute value of g_5 exceeds the absolute value of $g_6 GS \times TRA^2$, and this condition is satisfied for all countries in our sample at all the values of *GS* and *TRA*. Therefore, equation (10) is a valid specification.[6]

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openness is popular. This is a zero-one dummy —one if one or more of the following 5 conditions are satisfied and zero otherwise: (1) average tariff rate are over 40 percent on capital goods and intermediate inputs, (2) non-tariff barriers cover 40 percent or more of imports of capital goods and intermediate inputs, (3) the country is a socialist economic system, (4) state monopolises major exports, and (5) the black market premium on its official exchange rate exceeded 20 percent.

[6] From the exponent in equation (10), the following can be derived:

$$\frac{d \ln y / dT}{dTRA} = g_5 \frac{1}{TRA^2} - g_6 GS$$

$\Rightarrow$ this derivative is positive when $g_5 > g_6 GS \times TRA^2$.

This condition is satisfied in all our subsequent empirical results for values of *GS* and *TRA*.

These alternative specifications imply that the corresponding *SSGR*s are:

$$\Delta \ln y^* = g_1 + (g_2 - g_3 GS)TRA \qquad (9')$$

$$\Delta \ln y^* = g_4 - g_5 TRA^{-1} - g_6 GS \times TRA \qquad (10')$$

$$\Delta \ln y^* = g + \beta_1 \Delta \ln TRA - \beta_2 \ln GS \qquad (11')$$

Jones (1995) is one of the earliest to evaluate endogenous growth models with country specific time series data. With a reduced form VAR methodology he found that there is no support for the presence of scale effects between the rate of growth of output and growth enhancing variables like R & D expenditure in the USA and the OECD countries. Kocherlakota and Kei-Mu Yi (1996) and Greiner, Semler and Gong (2004) have also found that there is not much support for the presence of the scale effects between output growth and some growth enhancing variables identified in the endogenous growth literature. Furthermore, Romer (1994) argued that trade liberalization may give an one-off large effect to *TFP* at the outset and such effect may taper off over time. These works thus imply that the effects of many growth enhancing variables like *R&D* and *TRA* eventually seem to taper off. Therefore, the specification in equation (6) for the evolution of *TFP* may empirically perform better than those in equations (5) and (7). Nevertheless, in the first instance we shall use all the 3 specifications in our empirical work and then select the best for subsequent estimation.

4. Empirical Results

Singapore

We first estimated the implied ARDLs by the formulations in (5'), (6') and (7') with Singapore data which yielded some robust results. Singapore is one of the earliest East Asian countries to liberalize trade along with Hong Kong, Korea and Taiwan. However, there is some controversy on whether Korea is an open or closed economy compared to countries like Singapore; see Edwards (1998). The specifications of our basic equations for estimation are as follows.

$$\Delta \ln y_t = -\lambda[\ln y_{t-1} - (lnA_0 + (g_1 + g_2 TRA_{t-1})T + \alpha \ln k_{t-1}] + \sum_{i=0}^{n1} \gamma_{1i} \Delta \ln k_{t-i} + \sum_{i=0}^{n2} \gamma_{2i} \Delta TRA_{t-i} + \sum_{i=0}^{n3} \gamma_{3i} \Delta \ln y_{t-i} \quad (5'')$$

$$\Delta \ln y_t = -\lambda[\ln y_{t-1} - (lnA_0 + (g_3 - g_4 TRA_{t-1}^{-1})T + \alpha \ln k_{t-1}] + \sum_{i=0}^{n4} \gamma_{1i} \Delta \ln k_{t-i} + \sum_{i=0}^{n5} \gamma_{2i} \Delta TRA_{t-1}^{-1} + \sum_{i=0}^{n6} \gamma_{3i} \Delta \ln y_{t-i} \quad (6'')$$

$$\Delta \ln y_t = -\lambda[\ln y_{t-1} - (lnA_0 + gT + \beta \ln TRA_{t-1} + \alpha \ln k_{t-1}] + \sum_{i=0}^{n7} \gamma_{1i} \Delta \ln k_{t-i} + \sum_{i=0}^{n8} \gamma_2 \Delta \ln TRA_{t-1} + \sum_{i=0}^{n9} \gamma_{3i} \Delta \ln y_{t-i} \quad (7'')$$

The definitions of variables and data sources are in the Appendix. Trade openness is measured with the ratio of exports plus imports to output. These equations are estimated with the non-linear two stage instrumental variables method (NL2SLS-IV) to minimize any endogenous variable bias and are given in Table 1.[7] Estimates of equation (5'') with linear effects of *TRA* are shown as equation (I). Estimates corresponding to equations (6'') and (7'') are given in equations (II) and (III) respectively. The Ericsson-MacKinnon (2002) test statistic, based on the response surface function, adjusted for the sample size, for testing cointegration in the general to the specific method (*GETS*) of Hendry is used for cointegration.

(insert Table 1)

Estimates in equation (I) look impressive and all the coefficients are significant at the conventional levels of 5% or 10% except that of *DUMFC*. We have added a dummy variable *DUMFC* to capture the negative effects of the Asian financial crisis in all the specifications. The summary χ^2 tests for serial correlation and normality of residuals are insignificant. The Sargan χ^2 test indicates that the choice of instruments is appropriate. Trade openness in Singapore has increased over 3 decades by about 115% from 0.8 in the

[7] Lagged values of the variables are used as instruments and the Sargan χ^2 test statistics is used to test the validity of selected instruments. In all our estimates this test statistic is insignificant validating the choice of instrumental variables.

early 1970s to 2.5 by the mid 2000. Consequently, the *SSGR* has increased from 2.5% in the early 1970s to about 3.5% by mid 2000s.[8] The latter is close to the mean *SSGR* of 3.3% implied by this equation for the sample period. However, there was no cointegration among the variables of this equation even at the 10% level. The test statistic given by the t-ratio of ? at 3.35 is less than the 10% critical value (*CV*) in Ericsson and MacKinnon of $k_{ct}(3) = 3.70$. Therefore, this equation is re-estimated by dropping the insignificant *DUMFC* and is shown as equation (II) in Table 1. The estimates in (II) are close to those in equation (I). The absolute value of the t-ratio of the adjustment coefficient λ of (II) is 3.93 and exceeds the 10% *CV*. The 5% and 10% *CV*s of the Ericsson and MacKinnon test, respectively, are $k_{ct}(3) = 4.11$ and 3.70. Therefore, there is cointegration between the variables at the 10% but not at the 5% level and this equation is just satisfactory.

Estimates corresponding to equation (6) with the non-linear growth effects of *TRA* are given as equation (III) in Table 1. All of its coefficients, including *DUMFC*, are significant at the conventional levels. Its summary statistics are an improvement on equations (I) and (II) with an $\bar{R}^2 = 0.55$ compared to $\bar{R}^2 = 0.42$ of equation (I) and 0.44 of equation (II). Furthermore, the absolute t-ratio of the adjustment coefficient ? of 4.47 exceeds at the 5% the Ericsson-MacKinnion CV of $k_{ct}(3) = 4.11$, implying a more robust cointegration of its variables. The estimated share of profits in income at 35% is closer to its stylized value of one third compared to the 20% and 22% estimate in equations (I) and (II). This equation implies that the *SSGR* which was in the vicinity of about 1.4% in the early 1970s has increased and converged to about 3.0% by mid 2000s due to trade openness in Singapore. However, the implied mean *SSGR* for the sample period is only 2.22% which seems to be close to those of the advanced economies. It seems that it is hard to improve this growth rate any further through increasing openness alone. For example if *TRA* can be doubled, perhaps an impossible target, Singapore's *SSGR* can be further increased by only 0.3% to 2.5%.

[8] The mean values of *TRA* for 1970-1974 and 2000-2004 are used for estimation.

Estimates with the specification in equation (7) where *TRA* is a shift variable are in equation (IV). Although this equation passes the Ericsson-MacKinnon cointegration test at the 10% level, the coefficient of log *TRA* is insignificant and the $\bar{R}^2$ at 0.39 is the lowest. Furthermore, the estimated share of profits at only 13% and insignificant even at the 10% level is very low. The implied *SSGR*s show large variation ranging from a low of 1% in the early 1970s to 6.4% towards the mid 2000s. The average *SSGR* for the sample is 3.8% and seems to be high.

Among the three alternative specifications, equation (III) with the non-linear effects of *TRA* seems the best and will be used in the subsequent estimates for the other countries and to test conditionality. Estimates with this specification modified for the good policy conditionality variable, which is proxied with the share of the government expenditure in output *GS,* are in equation (V). The implication is that good and responsible policy environment improves the growth effects of variables like openness. The mean of *GS* at 8% for Singapore is lowest in the Asian countries. It turns out that estimates with this conditionality variable, without *DUMFC*, is the best of estimate of the equations in this table. The $\bar{R}^2$ at 0.68 for this equation is the highest. When the *DUMFC* variable in included its coefficient was insignificant but its parameter estimates are nearly the same as in equation (V). These estimates are not shown to conserve space. The Ericsson-MacKinnon test for cointegration shows that there is cointegration between the variables since the t-ratio of λ at 8.01 exceeds the 5% *CV* of 4.11. The implied share of profits at about 25% is a bit low but plausible. The Wald test (not reported) showed that it is not significantly different from the stylized value of one third. On the basis of the goodness of fit and summary statistics, we may justify that this is the best equation in Table 1. The average *SSGR* at 2.75% implies that good economic policies made trade openness more effective by an extra 0.5% which is the difference between the average *SSGR* estimates of this and that of equation (III).

Other Asian Countries

The specifications in equations (III) and (V) of Table 1 with convergent non-linear effects of *TRA*, which are found to be the best for Singapore, are estimated for Malaysia, Hong Kong, India and Thailand. Malaysia and Thailand have liberalized trade almost a decade earlier than India.[9] Estimates for these four countries are given in Table 2. Estimates for Malaysia are given equation (VI), (VIa) and (VII). Although these equations could be estimated in a straightforward manner and their summary statistics are good, equation (VI) with the nonlinear effects of *TRA* and *DUMFC* failed the cointegration test. All the coefficients in (VI) are significant at the 5% level. However, when this equations is re-estimated without this dummy variable as in equation (VIa), the estimates of its coefficients are close to those in (VI), but it easily passes the cointegration test. The t-ratio of ? at 6.24 exceeds the 5% *CV* of 4.11. It is well known that Malaysia had a turbulent economic and political environment during and after the Asian financial crisis and imposed restrictions on the capital account and our equation without the good policies variable may not have adequately captured their effects.[10] However, when *GS* variable is introduced, which is given as equation (VII) in Table 2, *DUMFC* became significant and the equation easily passed the Ericsson-MacKinnon cointegration test with a t-ratio for ? of 9.54 grater than the 5% *CV* of 4.11. All other coefficients except one are significant at the 5% level. Removal of the only insignificant variable $\Delta(TRA_t^{-1} \times GS_t)$ has caused serial correlation in the residuals. The estimated profit shares in both equations are not significantly different from the stylized value of one third. While the mean value of the SSGR is 1% in equation (VI), this has decreased to less than half percent in equation (VII). This is mainly because the share of government expenditure has been increasing in

[9] We have also estimated specifications implied by equations (I) and (IV) in Table 1 for these countries. In all cases the non-linear specification in equation (III) is found to be far better. In addition we have estimated all three specifications for Korea and the Philippines, but they yielded implausible results. Neither country is well known for their open trade policies. Nevertheless, data from these countries and a few more countries are worth examining carefully but this is beyond the scope of our present paper.

[10] Some developments in Malaysia were due to the political problems when Prime Minister Mahathir sacked his deputy Anwar Ibrahim, and the persistent criticisms of capital controls by international financial organisations. For a discussion of these problems see Johnson and Mitton (2001).

Malaysia after its political and financial crises from a low value of about 15% in 1998 to 20% by 2004.

For the other countries we have encountered a few problems. For Hong Kong it was necessary to assume a non-linear trend to get any meaningful estimates. This may be due to Hong Kong being the earliest East Asian country with free markets and openness and their initial large growth effects might have decreased over time. Furthermore, other East Asian countries have become competitors to Hong Kong. When the two equations for India and Thailand were freely estimated without constraints, the share of profits India turned out to be negative and for Thailand it was near 60%. Therefore, for these two countries we have constrained that the profit share is 0.3 which is a widely used stylized value in growth accounting exercises.

Estimates for Hong Kong, with and without the good policies variable *GS* and with a non-linear trend are in equations (VIII) and (IX) in Table 2. All the coefficients have the expected signs and are significant at the 5% level. Both equations pass the cointegration test at the 5% level and their summary statistics are impressive. The adjusted correlation coefficients are high and more than 80%. The significant financial crisis dummy implies that growth rate in Hong Kong has declined by 2 to 4 per cent due to the financial crisis. The estimate of profit share in equation (VIII) is slightly higher at about 40 percent but it is not significantly different from the stylized value of one third. The mean values implied for *SSGR*s by equations (VIII) and (IX) are respectively 2.3 and 2.5 percent, implying that Hong Kong consistently perused low government expenditure policies. Consequently the additional contribution of *GS* to the *SSGR* is small at only 0.2 percent.

Insert Table 2

Estimates of the two corresponding equations for India, with the constraint that profit share is one third, are in equations (X) and (XI) in Table 2. A dummy variable *DUM79* is added to capture the disruptions and slowdown of the economy due to the imposition of emergency in 1979.[11] Estimates of both equations are good with high adjusted correlation

[11] Without this variable the adjusted correlation coefficient drops below 0.4.

coefficients of near 70%. Other summary statistics are also impressive. There is no serial correlation and the residuals are normally distributed. The t-ratios of the adjustment coefficients ? are well over the Ericsson-MacKinnon 5% critical value of 4.11 indicating cointegration. The implied mean values of *SSGR*s without and with the good policy variable *GS* are almost the same at 1.7 percent, indicating that India has further scope to improve policy environment to increase its *SSGR*. The share of government expenditure in output during the 2000s has been near 30% and if this is decreased to below 20%, India's *SSGR* can be increased by another 0.5%.

Finally, estimates of the two equations for Thailand are respectively in equations (XII) and (XIII) in Table 2. *GS* which adequately captured good policy environment so far, turned out to be inadequate for Thailand. Its coefficient was positive and highly insignificant. Therefore, we have experimented with other alternative proxies like the ratio of the budget deficit to output and the ratio of M2 to output (*MRA*). Dollar and Kraay (2004) and Edwards (1998) have used the latter as a proxy to capture the extent to which contractual obligations are honored and effectively implemented in a country. Of these two alternative proxies *MRA* gave plausible results. Therefore, it is used to estimate of equation (XIII). Note that unlike the coefficient of the multiplicative term with *GS*, the coefficient of $MRA \times TRA$ should be positive.

When the equation with the inverse trade effects was estimated (not shown to conserve space), it is well determined and the coefficients had the expected signs and significant at the 5% level. The share of profits was 0.287, which is near the stylized value of one third, but significant only at the 10% level. However, there was serial correlation in the residuals of the equation and it failed the Ericsson-MacKinnon cointegration test at the 10% level. The t-ratio of ? at 3.12 was less than the 10% CV of 3.7. However, when this equation was re-estimated with the profit share constrained to one third, the t-ratio of ? increased to 6.2 and implying that the variables in this equation are cointegrated at the 5% level. Furthermore, serial correlation in the residuals has also become insignificant. Equation (XII) in Table 2 gives the estimates with the constraint that the share of profits is 0.3. This equation implies that the mean value of the *SSGR* is 2.4%.

An alternative specification of (XII), with only linear effects of *TRA* with the same constraint on the share of profits, has also given very good and almost identical results, but these are not reported to conserve space. We have stated this specification because we encountered problems in getting plausible results with the good policy interactive variable $MRA \times TRA$. This may be due to the high correlation of 0.95 between *TRA* and *MRA*. Consequently, when the equation similar to the other countries was estimated, the coefficients of TRA^{-1} and $TRA \times MRA$ were insignificant and the coefficient of TRA^{-1} was positive. We have also estimated this equation with only linear effects of *TRA,* but the coefficients of *TRA* and the interactive term were insignificant. These results are not reported to conserve space.

Therefore, it became necessary to estimate this equation with only a linear interactive term $TRA \times MRA$ and these estimates are given in equation (XIII) in Table 2. All the coefficients are significant at the 5% level and the t-ratio of ? of 5.74 exceeds the 5% *CV* of Ericsson-MacKinnon of 4.11. Therefore, there is cointegration among the variables. The summary $?^2$ statistics indicate that there is no serial correlation and the residuals are normally distributed. This equation implies that the mean *SSGR* in Thailand is 2.5% which is only marginally higher than 2.4% implied by equation (XII). Therefore, it seems necessary for Thailand to explore also other possibilities to improve its *SSGR* because to increase this rate by another 0.25 points to 2.75%, both *TRA* and *MRA* should be more than doubled.

5. Conclusions

In this paper we have developed extensions to the exogenous growth model of Solow to make TFP endogenous. Although our method did not use an inter-temporal optimization model, such as the ones used in the endogenous growth models, our reasoning is based on commonsense and empirical in nature. Therefore, our method is more akin to an extension to the Solow model within an endogenous framework than a full fledged endogenous growth model.

Our empirical results to capture the permanent growth effects of trade liberalization policies have been impressive. Further, we also found that good policy environment has increased the permanent growth effects of trade liberalization in countries like Singapore. In Hong Kong these effects have been small and in Malaysia *SSGR* seems to have decreased after the Asian financial crisis and some political developments. Both in India and Thailand the effects of good policy environment is small, implying that these two countries must pay attention to other factors, e.g., learning by doing, to improve their *SSGRs*. The highest SSGR of 2.75% is in Singapore, closely followed by Hong Kong and Thailand with about 2.5%. India's *SSGR* is below 2% and that of Malaysia is the lowest at about 0.5%. However, in both countries it is possible to increase their *SSGR*s by another 0.5% through improvements in trade liberalization and good economic management.

Needless to say that our approach can be easily extended to other countries to estimate the permanent effects of trade liberalization and good economic policies on their *SSGR*s. However, there are a few weaknesses in our paper. Although estimates for Singapore have been very robust and obtained in a straightforward manner, some problems we have identified in the estimates for the other four countries need further attention. For Hong Kong the non-linear trend needs further justification. For Malaysia it seems necessary to develop an appropriate *DUMFC* variable to capture the effects of political disturbances and so called excessive cronyism of the Mahathir government. Both for India and Thailand perhaps it is necessary to examine the suitability and accuracy of capital stock estimates with the standard perpetual inventory method because it has been necessary to constrain that the share of profits is one third. We have imposed this constraint with some confidence not only because it is a widely used practice in growth accounting but also due to the fact that its estimates in the other three Asian countries are not significantly different from one third.

Finally, we hope that our paper is useful to other researchers, especially to avoid specification errors with country specific time series data. We also hope that our method will be extended and improved by others interested in developing country specific growth policies.

DATA APPENDIX

Y is the real GDP at constant 1990 prices (in millions and national currency). Data are from the UN National accounts database.

L is labour force or population in the working age group (15-64), whichever is available. Data obtained from the World Development Indicator CD-ROM 2002 and new WDI online. URL:http://www.worldbank.org/data/onlinedatabases/onlinedatabases.html

K is real capital stock estimated with the perpetual inventory method with the assumption that the depreciation rate is 4%. The initial capital stock is 1.5 times the real GDP in 1969 (in million national currency). Investment data includes total investment on ?xed capital from the national accounts. Data are from the UN National accounts database.

TRA is computed as a ratio of exports and imports of goods and services on GDP. Data are obtained from UN's national accounts.

MRA is the ratio of M2 definition of money to GDP and data are from CD-ROM, International Financial Statistics, IMF.

DUMFC is a dummy variable to capture the effects of the East Asian financial crisis during 1997-98. For Singapore, Hong Kong and Thailand this is 1 during 1998 and zero in all other periods. For Malaysia it is 1 in 1998 and 2001 and zero in all other periods. 2001 is an outlier due to adverse political developments in this country.

DUM79 is 1 in 1979 and zero in all other periods to capture the adverse economic effects of emergency rule in India.

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Table-1: Results for Singapore

N L2SLS -IV Estimates (1974-2004)

	I	II	III	IV	V
Const.	7.550 (10.73)*	7.342 (9.53)*	5.941 (4.49)*	8.255 (8.86)*	7.083 (7.58)*
λ	-0.642 (3.35)*	-0.691 (3.93)*	-0.693 (7.96)*	-0.522 (3.36)*	-0.860 (8.05)*
Trend	0.027 (8.25)*	0.026 (5.51)*	0.040 (8.99)*	0.037 (11.05)*	0.053 (10.74)*
$TRA_{t-1} \times Trend$	0.003 (2.22)*	0.003 (1.73)**			
$TRA^{-1}_{t-1} \times Trend$			-0.029 (4.63)*		-0.030 (8.51)*
$\ln TRA_{t-1}$				0.077 (1.55)	
$GS_{t-1} \times TRA_{t-1} \times Trend$					-0.043 (3.54)*
$\ln k_{t-1}$	0.201 (3.22)*	0.221 (3.26)*	0.351 (2.91)*	0.133 (1.58)	0.247 (2.87)*
$\Delta \ln k_t$	1.011 (4.22)*	1.084 (3.22)*	0.984 (2.38)*	0.902 (3.44)*	0.736 (2.93)*
$\Delta \ln k_{t-1}$	-0.399 (3.28)*	-0.451 (3.86)*		-0.441 (4.04)*	
$\Delta \ln y_{t-1}$	0.353 (1.73)**	0.414 (2.51)*		0.349 (1.73)**	
ΔTRA^{-1}_t			-0.262 (1.73)**		

$\Delta(TRA_t^{-1} \times GS_t)$					0.034 (2.05)**
DUMFC	-0.013 (0.93)		-0.020 (1.82)**	-0.008 (0.56)	
Mean SSGR	3.33%	3.42%	2.22%	3.84%	2.75%
$\overline{R}^2$	0.421	0.435	0.551	0.397	0.682
Sargan's χ^2	0.981 [0.81]	1.128 [0.77]	3.363 [0.64]	1.107 [0.76]	6.388 [0.50]
$\chi^2(sc)$	0.514 [0.47]	0.401 [0.53]	1.103 [0.29]	0.662 [0.42]	0.019 [0.89]
$\chi^2(n)$	0.909 [0.64]	1.066 [0.59]	1.037 [0.17]	1.579 [0.08]	0.361 [0.84]

Notes: (1) Absolute t-ratios (Newey-West adjusted) are reported in parenthesis below coefficients and those below the summary statistics in the square brackets are p-values. (2 Significance at 5% and 10% are indicated with * and ** respectively. The three ? ^{2} tests are, respectively, for the choice of instruments, serial correlation and non-normality of residuals.

Table-2: Results for Other Asian Countries NL2SLS -IV Estimates (1974-2004)									
	MAL VI	**MAL VIA**	**MAL VII**	**HK VIII**	**HK IX**	**IND# X**	**IND# XI**	**THA XII**	**THA XIII**
Const.	6.410 (5.23)*	6.231 (6.24)*	5.632 (5.47)*	6.541 (5.47)*	7.334 (9.18)*	-3.611 (76.06)*	-3.596 (95.03)*	6.861 (237.45 *	6.830 (277.80) *
λ	-0.468 (2.25)*	-0.680 (6.24)*	-0.524 (4.81)*	-1.180 (12.21)*	-0.944 (7.65)*	-0.389 (5.10)*	-0.412 (4.53)*	-0.323 (6.61)*	-0.306 (5.74)*
$Trend$	0.024 (3.07)*	0.021 (4.84)*	0.024 (2.62)*	0.042 (4.15)*	0.064 (8.09)*	0.025 (35.29)*	0.030 (11.13)*	0.029 (35.54)*	0.024 (11.09)*
$Trend^2$				-0.000 (3.96)*	-0.001 (8.66)*				
$TRA^{-1}_{t-1} \times T$	-0.013 (2.06)*	-0.012 (3.26)*	-0.020 (5.77)*	-0.025 (7.73)	-0.042 (8.14)*	-0.124 (6.22)*	-0.191 (5.16)*	-0.003 (2.45)*	
$GS_{t-1} \times TRA_{t-1} \times T$			-0.012 (1.71)**		-0.054 (3.13)*		-0.000 (2.23)*		
$M2RAT_{t-1} \times TRA_{t-1} \times T$									0.003 (2.26)*
$\ln k_{t-1}$	0.280 (2.06)*	0.301 (3.58)*	0.370 (3.29)*	0.391 (3.71)*	0.320 (4.85)*	0.3 (c)	0.3 (c)	0.3 (c)	0.3 (c)
$\Delta \ln k_t$	0.848 (5.16)*	1.014 (5.06)*	0.857 (4.71)*	2.495 (14.50)*	1.963 (9.53)*	1.561 (2.70)*	1.464 (3.02)*	1.140 (7.90)*	1.192 (6.22)*
ΔTRA_t								0.121 (1.86)**	0.130 (2.19)*
ΔTRA_{t-1}						0.894 (2.76)*	0.935 (2.78)*		

$\Delta(TRA_t^{-1} \times GS_t)$					-6.982 (4.54)*				
DUMFC	-0.036 (2.38)*		-0.055 (5.64)*	-0.023 (4.52)*	-0.043 (5.44)*	--	–	-0.099 (9.78)*	-0.096 (7.50)*
DUM79						-0.083 (14.92)*	-0.083 (14.72)*		
$\Delta \ln L_t$				0.879 (3.14)*	0.732 (6.51)*				
$\Delta \ln L_{t-1}$				-1.433 (6.42)*	-1.211 (7.66)*				
$\Delta \ln L_{t-2}$				-0.787 (6.64)*					
Mean SSGR	1.33%	1.09%	0.40%	2.31%	2.50%	1.75%	1.74%	2.42%	2.50%
$\overline{R}^2$	0.616	0.611	0.791	0.869	0.889	0.695	0.690	0.794	0.790
Sargan's χ^2	6.683 [0.25]	7.484 [0.19]	11.403 [0.12]	8.722 [0.46]	4.910 [0.88]	3.346 [0.65]	3.273 [0.66]	3.056 [0.55]	2.826 [0.42]
$\chi^2(sc)$	0.032 [0.86]	1.405 [0.24]	1.633 [0.20]	0.025 [0.87]	2.856 [0.09]	0.285 [0.59]	0.266 [0.61]	3.482 [0.06]	2.607 [0.11]
$\chi^2(n)$	0.064 [0.97]	1.224 [0.54]	0.224 [0.64]	1.307 [0.52]	2.823 [0.24]	0.944 [0.62]	1.214 [0.55]	1.391 [0.50]	1.535 [0.46]

Notes: See notes for Table 1. # The dummy variable for India is not for the Asian financial crisis, but to capture the turbulence caused by the 1979 emergency.