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A FRESH LOOK AT ASIAN ECONOMIC PERFORMANCE: A LESS RESTRICTIVE TEST FOR MIRACLES

Abstract

The East Asian growth experience has sparked a controversy over whether growth in the region has been driven mostly by increases in productivity or by mere factor accumulation. I argue that, because of its overly restrictive assumptions, TFP analysis can never conclusively resolve the miracle debate. I try to break the stalemate with a less restrictive test of the miraculousness of growth in the region by estimating an augmented Solow growth model for OECD countries and using the coefficients from that model to predict East Asian growth rates. If the incredible growth rates were due solely to factor accumulation, than the OECD model should do a reasonable job of predicting growth in the region. I find that the model consistently underpredicts growth in the region. I repeat the experiment using a policy augmented growth model and find that these coefficients more accurately predict growth in the East Asian region, although per-capita growth rates in Hong Kong and Singapore are still significantly underpredicted. I conclude that, in many countries, high growth rates can be explained by differences in macroeconomic policy.

Resumen

La experiencia de crecimiento en Asia del Este, ha provocado una controversia sobre si el crecimiento en la región ha sido manejado principalmente para incrementar la productividad o por un mero factor de acumulación. Yo discuto esto, porque de sus suposiciones sobradamente restrictivas, el análisis del TFP puede nunca determinantemente resolver la milagrosa discusión. Tratare de romper el estancamiento con una prueba menos restrictiva de la de milagrosidad del crecimiento en la región por la apreciación de un aumento en el modelo de crecimiento Solow para los países de la OECD y usando los coeficientes a partir de que el modelo predice la velocidad de crecimiento de Asia del Este. Sí la increíble velocidad de crecimiento fuera debido solamente al factor de acumulación, entonces el modelo de OECD haría un trabajo razonable de predicción del crecimiento en la región. Yo encontré que el modelo subestima el crecimiento en la región. Repito el experimento usando una política aumentada del modelo de crecimiento y encuentro que estos coeficientes con más exactitud predicen el crecimiento en la región de Asia del Este, aunque la velocidad de crecimiento per-capita en Hong Kong y Singapur son aun significativamente subestimados. Concluyo que en algunos países, la alta velocidad de crecimiento puede ser explicada por las diferencias en la política macroeconómica.

Introduction

Although East Asia has suffered a serious economic crisis in the recent past, real GDP growth in the region in the last thirty years has been incredible. East Asia has been transformed, from countries mired in poverty and underdevelopment to some of the top-performing, most technologically advanced nations in the world. It is still too early to know if current events are temporary or will seriously dampen growth in the region for years to come.

The rapid transformation in Asia has challenged traditional ways of thinking about growth and development. Many issues regarding the East Asian phenomena have been hotly debated in the economics literature, including such questions as: is East Asian development really miraculous? does the East Asian experience deny the validity of traditional neoclassical thinking on development? and perhaps most important, can the East Asian model be successfully imitated in other developing countries?

This paper provides some new evidence on these unresolved questions. The debate around the miraculousness of East Asian development stems from the World Bank's (1993) claim that factor productivity growth is one of the major factors behind the extraordinary real GDP growth in the region. Many economists have countered this claim with evidence showing that the miracle is not really a miracle at all, and that the high levels of growth were caused by high levels of factor accumulation (see Krugman (1994) and Young (1994, 1995)). According to these studies, once the rate of accumulation slows down, the growth rates of the tiger countries will slow to the average rate seen in developed countries.

Both sides of the debate have used total factor productivity analysis (TFP) to support their respective arguments. There are serious problems with TFP analysis, including having to make strong assumptions about the underlying production function (see Rodrik (1997a,b)). The fact that both sides can use TFP based arguments to bolster their positions means that the debate will never be resolved with TFP analysis alone. In this paper, I use a different method for testing whether the East Asian experience is miraculous, one that relies on much weaker assumptions. I test to see whether statistical growth models estimated with data from other parts of the world can predict East Asian growth rates. I will call East Asian growth miraculous if it is unpredictably high, given the historical experience of the other countries. Specifically, I estimate a reduced form growth model for a sample of OECD countries and use those coefficients to predict real GDP growth in East Asia. If the East Asian growth rates were fueled totally by increases in factor accumulation within a common statistical model, then the OECD coefficients should do a good job in predicting East Asian growth. If there is something unique or different about the East Asian experience, then the OECD model should considerably underpredict growth in the region.

I estimate the empirical neo-classical growth model using data from the OECD and find that the OECD coefficients consistently under predict real GDP growth in East

Asian. The results support the argument that the East Asian experience is distinctive and not simply caused by high factor accumulation and that the Amiracle@ would not be easily transferable to other developing regions such as Latin America.

I then consider whether policy differences across countries can help to explain the high growth rates in East Asia. The inclusion of these policy variables greatly increases the accuracy of the OECD model. The OECD coefficients no longer consistently under predicts growth in the region and the miracle looks much less general. Only the economic performance of Hong Kong and Singapore significantly surpass the predictions of the OECD coefficients.

The paper is organized as follows. Section II of the paper discusses the controversy over the East Asian miracle and explains how this paper tries to resolve the issue. Section III explains the empirical method used to estimate the different growth models and discusses the variables included in the models. Section IV estimates the empirical neo-classical growth model using data from the OECD and tests whether these coefficients can accurately predict real growth rates in East Asia. In Section V, I extend the model to include several macroeconomic and policy variables considered by the World Bank to be important factors in the East Asian growth experience. Section VI compares my results to other findings in the literature, while Section VII summarizes the paper and discusses possible extensions of the model.

I. The East Asian controversy

There is currently no consensus in the growth literature on the issue of the East Asian miracle. The controversy began in earnest when the World Bank published *The East Asian Miracle: Economic Growth and Public Policy,* in which it used total factor productivity analysis to look at productivity levels in East Asia. The book claimed that a major part of the growth in the region had been fueled by factor productivity growth, and not only by increases in investment levels. Many economists have countered the World Bank claim, arguing that East Asian growth has been driven primarily by increases in factor accumulation and not by increases in factor productivity.[1] Young

[1] Krugman (1994) also has argued that the Asian miracle was not a miracle at all, and was due almost entirely to factor accumulation. In an interesting exchange, the Wall Street Journal (October 23, 1996) reported that Singapore, along with other countries in the region, were "stung" and "very upset" by Krugman's criticisms. Singapore, however, has recently created a task force to try to find ways of increasing total factor productivity.

(1994) and others have argued that the World Bank incorrectly estimated productivity in the region, and that when TFP is correctly estimated, the miraculous productivity increases disappear.[2]

I argue in this paper that there are considerable problems with using TFP analysis and that a new approach is needed. The first problem involves the estimation of total factor productivity. Discussing the gap between the World Bank estimates of productivity and other (and much reduced) estimates in the growth literature, Kwon (1994) claims that much of the discrepancy can be explained by the method of estimation and the type of data used. By using output per worker instead of output per capita measures, and by taking into account the investment-GDP ratio, Young (1994) finds that, except for Hong Kong, productivity growth in East Asia has not been significantly different than other developing countries.

The second problem with TFP analysis is that the estimation of TFP is usually based on the Cobb-Douglas production function, which assumes constant returns to scale and competitive factor markets. Kwon (1994) argues convincingly against the assumptions of the neoclassical model, claiming that "...constant returns to scale, perfect competition, and long run equilibrium with variability of all factor inputs, including capital stock--are typically unsuitable for the estimation of rapidly growing

[2] Rodrik (1997c, p.422) makes the important point that the high levels of factor accumulation in East Asia are just as remarkable a phenomena as high productivity rates. He states, Athere is surely an economic miracle at work when an economy in which saving and investment decisions are made primarily by households and private entrepreneurs goes from investing ten percent of its income to investing thirty percent within 15 years.≅ In this paper, I use the word Amiraculous≅ to describe a situation where the historical experiences of other countries in the world are unable to explain the rapid growth in East Asia.

dynamic economies."[3]

When the neoclassical assumptions are relaxed, the estimates of total factor productivity in Asia are not so miraculous. Park and Kwon (1993) allow for the possibility of nonconstant returns to scale, imperfect markets, a relatively fixed capital stock with adjustment costs, and generate productivity estimates significantly lower than the World Bank's. Norsworthy and Malimquist (1983), Nishimizu and Hulten (1978), Tsao (1985), and Choi (1987) find similar results in other East Asian countries.

Total factor productivity analysis will never resolve the debate over the miraculousness of the East Asian experience because we do not know the underlying production function, which in turn determines the size of the residual. As Rodrik (1997a) has pointed out, "it is impossible to calculate the technology 'residual' without taking a stand on the form of the underlying production function (and its change over time)."

Even if it could be proven that the right production function had been chosen to model growth, it is difficult to differentiate between Afactor-augmenting technological change from the shape of the production function,@ meaning that Aresearchers may be misattributing labor-augmenting technical change in East Asia to an assumed elasticity of substitution that is too high, with the consequence that TFP growth is underestimated.@[4]

In a similar vein, Perkins (1994) states that, "the principal calculations are at a highly aggregated level and no attempt is made to measure the contribution of improvements in the quality, as contrasted to the quantity, of capital. Factor productivity, or the residual, therefore, contains many different elements, ranging from better management to economies of scale to higher rates of importation of advanced technology." The empirical growth literature has also shown many other factors to be important determinants of economic growth, including initial conditions, and government policy.[5]

Since we can never be confident that the chosen production function is the correct one, and even if we could, the residuals of the model may reflect more than differences in productivity, I take a radically different approach to the debate. Building on the empirical growth literature, I estimate reduced form growth models for the OECD and Latin America from 1961-1990, and use the coefficients to forecast East Asian growth during the same period. The following section explains the model and methodology in more detail.

[3] See Romer (1986), Lucas (1988), Grossman and Helpman (1990) for reasons why we might expect to see increasing returns to scale in developing countries with high growth rates. Kwon and Williams (1982) and Kwon (1986) find evidence of increasing returns to scale in the Korean case.

[4] Both quotes are from Rodrik's comment on Collins & Bosworth (1997b, 192-193). The first quote is an elaboration of a theorem by Diamond, McFadden, & Rodriguez (1978).

[5] Andrés et. al. (1996) find that, in a sample of 24 OECD countries from 1960-1990, the Acoefficients of the macroeconomic performance indicators, taken as a whole, are more robust than the coefficients of the basic variables of the Solow model.=

II. Methodology and the Model

A. Methodology

I use an empirical method called cross validation (or out of sample forecasting) to see how well the empirical neo-classical model of growth using OECD data can predict real GDP growth in East Asia. Cross validation divides the data into two parts, using the estimated coefficients of the first part to forecast variables (in this case, real GDP growth) in the second. If an East Asian growth model shares a common set of coefficients with the OECD, then the procedure should forecast reasonably well.

I test whether the OECD parameters are suitable for East Asia in three ways. First, I perform a likelihood ratio test of the null hypothesis that the two sets of coefficients (from East Asia and either the OECD or Latin America) are the same. A rejection of the null hypothesis does not necessarily mean that East Asian growth is miraculous. It may merely mean that the two samples do not pool together.

Second, I use the coefficients from the OECD growth model to forecast East Asian growth. To test if the forecasts are accurate, I look at the root mean squared error of the predicted growth rate (RMSE) and the proportion of the deviation of the forecast due to bias.[6] The RMSE is expressed as a percentage of the mean value of the independent variable to give an idea of how large the average forecasting error is. If the proportion of the deviation due to bias is greater than .1 or .2, I conclude that the model has systematic bias and is not an accurate forecaster of East Asian growth.[7]

The rejection of the null hypothesis of equal coefficients does not necessarily mean that the East Asian experience is miraculous. It is possible that the coefficients for the OECD and East Asia are significantly different, but that the OECD model consistently over predicts growth in the region, which would cast doubt on the miracle hypothesis. I consider East Asian growth to be miraculous only if the coefficients from the other regions consistently and significantly under predict growth in the region. The next section discusses the model in more detail.

[6] Pindyck & Rubinfeld (1991) describe the Theil inequality coefficient, which is separated into three parts: the proportion of the simulation error due to systematic bias, differences in variance, and unsystematic error. It is worrisome to have large values of the first two proportions as they signify systematic differences between the actual series and the simulated one.

[7] See Pindyck & Rubinfield (1991) for an excellent description of forecasting and the methods of evaluating the ability of a model's ability to forecast correctly.

B. The theoretical model

There arc a ton of empirical economic growth papers. Levine & Renelt (1992) survey the literature and find that, of the more than 50 independent variables used in empirical growth models, thc majority have a weak theoretical basis and are non-robust to alternative estimations. In this paper, I use a widely recognized reduced-form equation that is theoretically based on the neo-classical growth model. Specifically, I use the augmented Solow model developed in Mankiw, Romer, & Weil (1992) (hereafter MRW). They begin with the following Cobb-Douglas production function:

$$Y(t) = K(t)^a(A(t)L(t))^{1-a} \qquad 0 < a < 1 \tag{1}$$

where Y represents output, K is capital, L is labor, A is thc level of technology, and L and A grow at the exogenous rate of n and g, respectively. MRW use equation 1 to derive the following estimatible cross country growth regression.

$$\ln(y(t))-\ln(y(0))= (1-e^{-lt})\, a/1-a-b(\ln(s_k)) + (1-e^{-lt})\, b/1-a -b\, (\ln(s_h)) \\ - (1-e^{-lt})\, a + b/1-a -b\, (\ln(n+g+d)) - (1-e^{-lt})(\ln(y(0))) \tag{2}$$

where l represents the convergence rate and is equal to (n+g+d)(1-a -b). The sum of human and physical capital is subject to diminishing returns, but the production function exhibits constant returns to scale. They assume that thc initial level of technology is constant across countries, and is thus subsumed in the intercept, and that the right hand side variables are uncorrelated with the error term, which justifies the use of least squares as an estimation technique.

I use equation 2 as my reduced form model to study East Asian growth, but depart from MRW in two ways. First, I investigate a panel of countries instead of the single cross section of MRW. Specifically, I estimate equation 2 using data from 20 OECD countries from 1961-1990.(Appendix 2 lists all countries used in the paper).[8] I average the data into 5 year intervals, which allows me to capture information both in average cross country differences and in fluctuations over time.[9] Second, I use feasible GLS instead of OLS to control for country specific error variances and serial correlation in the errors.

The economic data is from the Penn World Tables 5.6 and average secondary

[8] See Green (1993) and Kmenta (1986) for a good description of feasible generalized least squares estimation. I omit Japan, which is included in the East Asian sample, and Luxembourg, which is not included in the Barro & Lee (1989) human capital data set. Iceland is also excluded because it lacks data on income distribution, a variable I use in the next section.

[9] The use of panel data, instead of averaging over the entire sample, is increasingly popular in thc empirical growth literature. See Grier & Tullock (1989) and Andrés et.al. (1996) for a justification of using 5 year intervals instead of averaging over long periods.

school attainment levels is from Barro & Lee (1994).[10] MRW claim that the augmented Solow model Aprovides an almost complete explanation of why some countries are rich and other countries are poor.@ If this extraordinary claim is true, and there exists a single production function to explain growth across disparate countries, then a model of OECD or Latin American growth using the Mankiw et.al. variables should predict East Asian growth accurately.[11]

III. Forecasts using OECD coefficients

To answer this question, I first estimate the MRW augmented Solow growth model for the OECD for the years 1961-1990. As described above, each country has 6 5-year averaged observations. Lpcy is the log of real per-capita income the year before each 5 year average. Ngd is the log of the sum of the growth of the labor force, the depreciation rate, and technological process. Linv is the log of the investment share, and ledus is the log of secondary school attainment rates.[12] Equation 1 presents the results of the estimation for the OECD. [13]

[10] I also use the growth rate of real income per worker as the dependent variable to see if accounting for per-worker, instead of per-capita, growth increases the predictive power of the OECD and Latin American models. I do not include variables which would proxy the quality of physical and human capital. If East Asian investment in human and physical capital is more productive, then the coefficients from the OECD and Latin American models should under predict the East Asian experience. If East Asia simply has a greater quantity of schooling and investment, then the OECD (or Latin America) model should accurately predict the East Asian growth rates.

[11] Grossman & Helpman (1994) take issue with the idea of a single production function that explain worldwide growth rates. The results of two recent papers cast further doubt on Mankiw et.al=s claim. K.B. Grier (1999) finds that the paper inappropriately pools countries that do not share common coefficients and that world-wide growth rates are actually diverging. Prescott (1998), using TFP analysis, shows that there is no single production function that explains growth around the world.

[12] See Mankiw (1997) for a defense of using secondary education attainment levels as a proxy of human capital.

[13] Below are the results of estimating the same model with East Asian data:

$$\text{Avg. real per capita \%} = \underset{(1.5)}{-11.5} - \underset{(3.0)}{1.79}\log(Y/L_{t-1}) - \underset{(3.8)}{9.10}\log(n+g+d) + \underset{(2.4)}{2.3}\log(I/GDP) + \underset{(3.8)}{1.59}\log(\text{sec. educ})$$

$N = 48$; $R^2 = .6905$

t-statistics in parentheses;

Time dummies were estimated but not reported

$$\text{Avg. real per-capita \%} = \underset{(.69)}{1.94} - \underset{(9.4)}{2.2}\,(Y/L_{t-1}) - \underset{(6.5)}{4.4}\log(n+g+d) + \underset{(5.8)}{2.67}\log(I/GDP) + \underset{(2.98)}{.35}\log(\text{sec. education})$$

$N = 126$; $R^2 = .8018$
t-statistics in parentheses;
Time dummies were estimated but not reported

The results show that the log of the investment share and the log of secondary schooling are both positively and significantly related to average real GDP growth at the .01 level, while ngd is negative and significant at the .01 level. The log of initial per-capita income is negatively and significantly correlated with growth rates, indicating conditional convergence in the OECD,
where, ceteris paribus, poorer countries grow faster on average than rich ones. With an R^2 of .80, I conclude that the basic growth model explains the OECD experience very well.[14]

I estimate the same model for the East Asian tigers and construct a test of the null hypothesis of equal coefficients in the two groups of countries. The null hypothesis can be rejected at the .005 level, indicating that the OECD and the East Asian countries do not share a common set of coefficients in the augmented Solow model.[15] The two groups of countries have different production functions and data from the OECD and East Asia which is pooled into a single growth model will yield biased results.

The fact that East Asia and the OECD do not share a common set of coefficients does not necessarily mean that East Asian growth is miraculous. It may be merely idiosyncratic. To address the miracle issue, I use the OECD coefficients to forecast East Asian growth, using East Asian values of investment, population growth, secondary education, and initial incomes. The RMSE and bias statistics indicate that the OECD coefficients predictions considerably under predict growth in the region, and

[14] The constant represents what the average growth rate would be if all of the independent variables were equal to zero, a situation that we never see in the real world. If such a scenario were to occur, it would be highly unlikely that it would be accompanied with positive growth rates.
[15] The calculated Chi-square statistic is 40 with 10 degrees of freedom. The critical value at the .005 level with 10 degrees of freedom is 25.19.

that much of this forecasting error is due to systematic bias. The Root Mean Squared Error (RMSE) of the average forecast is 2.80, which is 52% of the mean value of the dependent variable dy (5.43), meaning that the average forecasting error is relatively high. The proportion of the deviation due to bias is .37, which is significantly higher than the acceptable (.1 to .2) levels of bias.

The fact that the OECD coefficients from the neo-classical growth model cannot explain East Asian growth lends support to the miracle hypothesis. Even so, the coefficients do not predict per-capita growth in each country equally bad. Specifically, Figures 1-8 show the results of using the coefficients from equation 1 to forecast growth in each of the East Asian countries in the sample. The coefficients forecast Hong Kong=s average per capita growth rate to be 2.25%, when the actual average was 6.3%. The proportion of this error due to bias is .82, indicating that the model is a poor predictor of Hong Kong growth. Real per capita growth is similarly under predicted in Singapore, Taiwan, and South Korea=s. The model=s forecast of per-capita growth in the three countries is 4.2, 3.8, and 3.7 respectively. Actual growth rates were an average of two percentage points higher than these estimates. The proportion of these errors that is due to bias is also high (.53, .79, and .57).

The model predicts growth more accurately in Japan, Malaysia, and Thailand, where the average under prediction is around one percentage points. The proportion of the deviation due to bias is likewise smaller (.45, .23, and .26, respectively) meaning that the OECD model is a more accurate forecaster of per-capita growth rates in these three countries. The model most accurately predicts Indonesian per capita growth. The coefficients actually over predicted growth in Indonesia by an average of .77 percentage points and the proportion of the error that is due to bias is extremely low at .08.

It is possible that the growth process is fundamentally different for developed and developing countries, which could explain why the OECD model does not accurately predict real growth in Asia. For that reason, I estimate the same neo-classical growth model using data from 20 Latin American countries. The results, which are discussed in more detail in Appendix 1, show that the Latin American coefficients under predict growth more severely (and with more bias) than the OECD coefficients. Figures 1 -8 show the result of using the Latin American coefficients to forecast East Asian growth.

While the results do not conclusively prove that some of the East Asian countries have higher levels of productivity than do OECD countries, it does spread doubt on the validity of the factor accumulation hypothesis for all of the countries in the region. If the high growth rates in the area were really only due to factor accumulation, then the OECD model should have done a good job in predicting real East Asian GDP rates. The fact that it considerably under predicts growth rates in four of the tigers means that there are still unspecified variables driving growth in some of the Asian countries.

A neo-classical model of growth estimated with OECD data does not accurately predict East Asian growth rates. From the point of view of the pure neo-classical model, the East Asian experience is miraculous. In the next section, I consider the question of whether there are policy factors that can explain the miracle. That is, whether the differences in growth between the two sets of countries are due to superior economic policies in East Asia.

IV. A policy-augmented Solow model

A. Important policy and macroeconomic variables

The World Bank (1993) argues that low income inequality, high levels of primary and secondary education, trade openness and export promotion, and macroeconomic stability were the crucial factors in the East Asian growth miracle. I already account for education differences by including secondary education in the growth models above. In this section, I add proxies for income inequality, trade openness, and macroeconomic stability to the basic model to test whether these factors help explain East Asian growth.

I use average Gini coefficients, called *agini*, from the Deininger and Squire's (1996) comprehensive study of income inequality to investigate if more even distributions of income is an important factor in explaining growth in the region.[16]

To proxy the level of trade openness, I create a variable called *popen*, which is the percent of time in the last five years a country has had an open trade policy. The variable is created with from Sachs & Warner (1995), who consider a country open if: (i) nontariff barriers which cover less than 40% of the country's trade, (ii) an average tariff rate of less than 40%, (iii) a black market premium less than 20% during the 1970s and 80s, (iv) is not classified by Kornai (1992) to be socialist, and (v) the government does not have a monopoly on major exports.

[16] I use averages because of data availability. Fortunately, Deininger & Squire (1996) argue that Achanges in inequality tend to be relatively modest≅ and using a 30 year average should be a decent reflection of the income distribution in each country.

I use two policy measures, the standard deviation of inflation and the growth of government consumption (as a % of GDP), to test whether policy differences between the regions are driving growth in East Asia. Hayek (1944) and Friedman (1977) argue that inflation uncertainty increases the variability of prices, which in turn hinders development and growth. To account for inflation variability and to model stable monetary policy, I include the standard deviation of inflation, called *stdinf*, over each 5 year period in the growth regression.[17]

Grier & Tullock (1989) and Grier (1997) find that the growth of government consumption spending (as a percentage of GDP) is negatively and significantly correlated with real GDP growth. I include *dgs*, which is the growth of government consumption over each 5 year period, to test whether low government consumption expenditures can help to explain East Asian growth.

B. The policy-augmented model

Equation 3 below shows the results of adding the policy and macro variables described above to the basic OECD model developed in Section IV.

$$\text{Avg. real per capita \%} = \underset{(2.7)}{7.32} - \underset{(11.7)}{2.6}\log(Y/L_{t-1}) - \underset{(5.3)}{3.38}\log(n+g+d) + \underset{(6.6)}{2.58}\log(I/GDP)$$

$$+ \underset{(3.8)}{.42}\log(\text{sec. educ}) - \underset{(8.7)}{.299}\text{dgs} - \underset{(3.8)}{.059}\text{stdinf} + \underset{(5.3)}{.011}\text{ popen} + \underset{(1.8)}{.012}\text{ agini}$$

$N = 126$; $R^2 = .8956$
t-statistics in parentheses;
Time dummies were estimated but not reported

The inclusion of the new variables significantly increases the fit of the regression, from an R^2 of .80 to .90. As was found in the basic model, the log of investment and education are positively and significantly related to real growth. The data still show signs of conditional convergence, with a negative and significant

[17] See Levi and Makin (1980), Mullineaux (1979), and Grier &Tullock (1989) for other empirical studies using the standard deviation of inflation as a proxy for inflation variability.

coefficient on the log of initial income. The standard deviation of inflation and the growth of government consumption are both negatively and significantly related to real per-capita growth, while popen is positive and significant at the .01 level. Income inequality is positively related to growth at the .10 level, indicating a weak but correlation between per capita growth and inequality.

To test whether East Asian and OECD countries share the same coefficients for this extended growth model, I construct a log likelihood test of the null hypothesis and reject the null of equal coefficients.[18] As argued earlier, this finding only indicates that East Asian growth is idiosyncratic, not miraculous. To test whether the OECD coefficients consistently under predict growth in this policy-augmented model, I look at the RMSE and bias statistics. The addition of the new variables into the model does not increase the RMSE, but the proportion of the deviation due to bias is now only .095, indicating that the extended OECD model predicts growth in East Asia with very little bias.

Figures 9-16 shows the country-by-country forecast using the new OECD coefficients and demonstrates that the policy-augmented model predicts growth rates better than the MRW model. The OECD model still significantly under predicts growth for Hong Kong and Singapore. The predicted growth rate for Hong Kong is 3.69 percent, almost 5 percentage points below the real rate of growth, and the proportion of this error due to bias is high (.62). Per-capita growth in Singapore is forecasted to be 4.6, 1.92 percentage points below the observed per-capita growth rate, and the bias proportion is similarly high (.60). The inclusion of policy variables in the augmented Solow model does not increase the forecasting power of the OECD coefficients for Hong Kong and Singapore.

For the non city-states, the model no longer consistently and significantly under predicts growth. In fact, growth rates in Indonesia and Thailand are actually over predicted on average.

Inclusion of policy variables also reduces the proportion of the deviation that due to bias. Specifically, the proportions fall to .03 in Malaysia, .37 in Taiwan, .07 in Thailand, and .28 in South Korea.

[18] The calculated Chi-square statistic is 70 with 14 degrees of freedom and the critical value at the .005 level with 14 degrees of freedom is 31.32, meaning that I can reject the null at the .005 level.

The fact that countries from the OECD and East Asia do not share a common set of coefficients does not mean growth in East Asia has been miraculous. With the exception of Hong Kong and Singapore, whose growth rates are under predicted in both models, the OECD model comes close to predicting East Asian growth when we account for differences in policy.[19]

V. Discussion

Low income inequality, an emphasis on primary and secondary schooling, export promotion, and macroeconomic stability are all considered to be key components of the East Asian growth experience. While the inclusion of these variables in the augmented Solow model greatly increases the ability of the OECD coefficients to predict growth in the region, the model does not predict growth equally well across countries. Perkins (1994) argues that no single development model can explain growth in East Asia and that there are at least three different types of economic development in the region. In this section, I briefly review his development categories and discuss whether my simple and extended models predict some groups better than others on average.

Perkins agrees that macroeconomic stability, education, and income equality have all been important to growth and productivity in the East Asian region, but argues that the similarity between the countries ends there. He categorizes Hong Kong and Singapore as small city-state economies offering free port services and dominated by commerce. Japan, Korea, and Taiwan, on the other hand, have strong government intervention, especially in the push for export-led development. Indonesia, Malaysia,

[19] Young (1994) points out that all of the tiger economies have experienced rising labor participation rates after World War II, at the same time as population growth has been declining. Thus, he argues that output per worker measures better capture the idea of productivity than ones that include all of the population. To test whether accounting for per-worker growth rates improves the predictive ability of the model, I estimate the extended growth regression for the OECD and Latin America using per-worker income as the dependent variable and the growth of the labor force instead of population growth. In both the Latin American and OECD case, I reject the null hypothesis of equal coefficients at the .005 level (the calculated Chi-square is 76 with 13 degrees of freedom)

and Thailand are economies that, in the 1960s, had an abundance of natural resources but very little accumulation of human capital.

The simple augmented Solow model of OECD growth best predicts the growth rates of countries in the last category. The model under predicts growth an average of 1.08 percentage points for Malaysia, Thailand, and Indonesia. In contrast, the model under predicts growth an average of 1.93 percentage points for Japan, Taiwan, and South Korea, and 3.3 percentage points for Hong Kong and Singapore. Accounting for macroeconomic stability and trade openness decreases the average prediction error in two of the three categories. The prediction error of Malaysia, Thailand, and Indonesia falls from an average under prediction of 1.08 percentage points to an average *over* prediction of .39 percentage points. The average under prediction for the second category of countries decreases to .68 percentage points, while the prediction error for Hong Kong and Singapore remains the same at 3.3 percentage points. In sum, the extended model still significantly and consistently under predicts growth in the two city states.

Two interesting points emerge from these results. The first is that both the basic and extended model of OECD growth more accurately predicts the growth rates of countries with lower average growth rates. Average growth in Indonesia, Thailand, and Malaysia was 5.92, 6.97, and 6.86 respectively. The model had considerably more trouble with high performers such as Hong Kong and Singapore (8.4 and 8.2 growth rates respectively).

The second interesting point is that the OECD model significantly under predicts growth in countries said by the World Bank to have experienced high TFP growth. According to the World Bank, Taiwan, Hong Kong, Japan, and Korea have the highest TFP growth rates. These are also countries where the OECD model more significantly under predicts growth. An exception to this is Singapore, who is classified by the World Bank as having one of the slowest TFP growth rates in the region. [20] My results, on the other hand, show that pure factor accumulation cannot explain growth in Singapore. Both the simple and extended OECD models consistently under predict growth in Singapore by two percentage points. This result lends support to Bosworth & Collins, who find that Singapore does not suffer from slow TFP growth.

VI. Conclusion

This paper has sought to answer the question of whether the East Asian experience is really miraculous or is merely due to factor accumulation. The literature on this subject has been dominated by total factor productivity analysis, whose results

[20] Other studies (see Young (1995) and Klenow & Rodriguez-Clare (1997)) also rank Singapore as the East Asian country with the lowest TFP growth rate.

are extremely subject to interpretation and are based on strong, restrictive assumptions. This paper uses a different, and less restrictive, method of looking at the East Asian growth experience. I estimate a MRW augmented Solow model with data from the OECD and use the coefficients to predict per-capita growth in East Asia. I find that the MRW model consistently and significantly under predicts growth in the region.

To determine if policy differences can help explain the differences in per-capita growth rates, I add various policy variables to the MRW model and find that the miracle is not as general as it originally appeared. While the OECD and East Asia do not share common coefficients in the policy-augmented model, the OECD experience no longer consistently under predicts growth in East Asia.

The two exceptions, Hong Kong and Singapore, are also the two city states in the sample. The results indicate that there is something distinct to the growth in these countries. Instead of searching for new ways to estimate total factor productivity, we should try to identify the factors that make Hong Kong and Singapore distinct and investigate whether these Amiracles@ can be replicated in other developing countries.

Appendix 1:

The equation below estimates the MRW neo-classical growth model using data from 20 Latin American countries (see Appendix 2 for a list of countries).[21]

$$\text{Avg. real per-capita \%} = \underset{(1.9)}{8.3} - \underset{(2.9)}{1.1} \log(Y/L_{t-1}) + \underset{(.57)}{.83} \log(n+g+d) + \underset{(3.8)}{1.72} \log(I/GDP) + \underset{(.07)}{.02} \log(\text{sec. educ})$$

N = 120; $R^2 = .7451$
t-statistics in parentheses;
Time dummies were estimated but not reported

The null hypothesis of equal coefficients in the Latin America and East Asia regions can be rejected at the .005 level, indicating that Latin American and the East Asian countries do not share a common set of coefficients.[22] The Root Mean Squared Error (RMSE) of the forecast is 4.64, which is 85% of the mean value of the dependent variable dy (5.43), and the proportion of the deviation due to bias is .66.

[21] I choose Latin America over other developing regions because of East Asian and Latin America are often compared and contrasted to one another in the development and growth literature (see Birdsall and Jaspersen (1997), Fishlow et. al. (1994), and Grilli & Riedel (1995)).

[22] The calculated Chi-square statistic is 58 with 10 degrees of freedom. The critical value at the .005 level with 10 degrees of freedom is 25.19.

Appendix 2:

Division of countries in the sample, by region

A. Asian Tigers (7)

Hong Kong
Indonesia
Japan
Malaysia
Singapore
South Korea
Taiwan
Thailand

B. OECD Countries (21)

Australia
Austria
Belgium
Canada
Denmark
Finland
France
Germany
Greece
Ireland
Italy
Netherlands
Norway
New Zealand
Portugal
Spain
Sweden
Switzerland
Turkey
United Kingdom
United States

C. Latin America (20)

Argentina
Bolivia
Brazil
Chile
Colombia
Costa Rica
Dom. Republic
Ecuador
El Salvador
Guatemala
Guyana
Honduras
Jamaica
Mexico
Nicaragua
Panama
Paraguay
Peru
Uruguay
Venezuela

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