25 June 2005

Can the Poor Countries Catch Up? Mixed Results from Extended Sources of Growth Projections for the Early 21st Century

Lance Taylor and Codrina Rada*

Abstract: Illustrative projections of per capita income gaps between two regional groups of transition/developing economies and the rich economies for the period 1998-2030 are made on the basis of an extended sources of growth equation which correctly accounts for interactions between trends in capital and labor productivity – *not* a feature of many such studies in the past. The equation takes into consideration Kaldor-Verdoorn effects, possible impacts on labor productivity of trade liberalization and/or astute industrial policy, human and physical capital accumulation, employment and population growth, shifting shares of labor in income and traded goods in output, shifts in capital productivity, productivity growth retardation due to convergence, and specific regional effects. Under optimistic assumptions about all these factors and in the historically unprecedented absence of adverse macroeconomic shocks over three decades, relative and absolute convergence of both regions to the rich countries may be possible (especially for the East Asian "Tiger" economies).

In the wake of Lucas's (2000) hymn to technological grace, the idea has spread that diffusion of knowledge should allow the income distribution across the nations of the world to narrow substantially – according to Lucas by the year 2100 we should all be "equally rich and growing." Without venturing so far as to offer forecasts for a century, in this paper we apply an extended growth accounting framework based on simple theory and accounting identities to try to say something about economic prospects for two major regions of the world over the next 20-30 years.

---

* Center for Economic Policy Analysis, New School University. Comments by Andrea Cornia, Jesus Felipe, Richard Jolly, Angus Maddison, Jose Antonio Ocampo, Jaime Ros, and referees as well as research support from the Carnegie Corporation, The Ford Foundation and the United Nations Department of Economic and Social Affairs are gratefully acknowledged.

The projections, although derived from a model biased towards optimism, are more modest than Lucas suggests. Their bottom line is that over the next generation or so, narrowing of their *relative* income gaps with the rich economies is possible for the two regions we consider in an illustrative calculation. A*bsolute* income gaps also narrow, but only modestly for Latin America.

It is important to recognize, moreover, that relative per capita income growth of poor countries as compared to the rich can only occur under very favorable circumstances. There would have to be positive, non-linear feedback among several potential sources of productivity increases – Kaldor-Verdoorn effects, more rapid labor productivity growth due to astute industrial policy and/or economic opening, and physical and human capital accumulation -- taking place consistently over time. Absent such interactions, baseline projections for Latin America generate a widening relative income disparity with rich nations. Even for upper middle income Asian countries (or "Tigers"), relative improvement would be slow. Moreover, the gaps will narrow only if poor countries' growth is steady and uninterrupted over several decades – certainly not the case during the latter part of the 20^{th} century (Weisbrot et.al., 2001; Taylor, 2001). In effect, we rule out all adverse shocks that could divert a region from its projected "full employment" growth path.

The analysis is presented as follows: Section 1 gives a brief review of historical growth experience for major regions of the world, based upon Maddison's (2001) canonical compilation of country-level data on per capita GDP at purchasing power parity (or PPP). Section 2 sets out the basics of our projection methodology, with technicalities added in Appendix A. To illustrate how the model functions, section 3 presents the details of projections for Latin America which in the year 2000 had a per capita income equal to 0.31 of the OECD average. Section 4 summarizes results for the "Tigers". Section 5 pulls together the analysis and offers conclusions.

1. Historical Growth Experience

When it comes to economic convergence for the last 180 years we can at most hope to find supporting evidence *within* major regions. Convergence *between* the rest of the world and the advanced regions of 1820 - Western Europe and its Western Offshoots - did not take place.

Instead the gap widened considerably in both relative and absolute terms. If we take a look at growth rates of GDP per capita, we see that the countries that were most advanced in 1820 grew fastest throughout the 19th and 20th centuries. According to Maddison, Western Europe by 1992 had a 13-fold increase in GDP per capita over its level in 1820. The Western Offshoots enjoyed a 17-fold increase, while Latin America and Asia respectively increased seven and six times compared to 1820. Figure 1 shows ratios of per capita incomes at purchasing power parity in the regions emphasized by Maddison (2001) to per capita income in the "old" OECD or his "Group A" of countries (Western Europe and Western Offshoots but not Japan) for reference years during 1820-1998.

The generally negative slopes of the curves are disheartening. Over the long period, PPP per capita income ratios for Latin America and Eastern Europe fell by more than 50%, and the proportional loss for Africa was even greater. Toward the end of 20th century the ratios for China and India began to go up from levels of less than 0.1. "Asia" which includes about 12.5% of Asia's population without Japan, China and India (with Indonesia as the most populous country followed by Korea) moved parallel at a somewhat higher income ratio.

Figure 1

Figure 2 shows PPP ratios for selected regions in the second half of the last century (the rich country group now includes Japan). The "Tigers" are the only group showing a sustained increase over most of the period, with modest catching-up on the part of the Asian regions in the last 25 years. The ratios for the other regions declined, most notably for the Middle East and the formerly socialist countries after 1975. The diagram is disturbing especially because the downward paths of the ratios in several instances are due to stagnation or a decrease in the absolute value of GDP per capita of the follower countries. For example, Africa's GDP per capita decreased from a high of 1,433 Geary-Khamis dollars[1] in 1977 to 1,217 in 1998. The Middle East

[1] Geary-Khamis dollars for the year 1990 are Maddison's preferred benchmark numeraire for computing PPP income levels.

fell to 4,053 Geary-Khamis dollars in 1998 from 4,716 in 1977. Lastly, the former USSR lost ground in record time, from 7,078 Geary-Khamis dollars per capita in 1989 to 3,893 in 1998.[2]

Figure 2: Catching up: GDP per capita of developing countries vs OECD (1950-1998)

There are a few success cases from which we can learn about potential factors that help economic convergence become reality. After 1950, the Tiger countries considerably narrowed the gap between themselves and the Western advanced economies and Japan. Japan itself, more or less miraculously, caught up with the other advanced economies. The purported sources of growth that the economic literature emphasizes are technical progress, levels of physical capital and labor productivity, the quality of human capital, the extent of trade openness, economic structure, the institutional framework, and last but not least the "insertion" of a national economy into the global framework (aid and debt relationships, patterns of trade, commodity price shifts, access to technology, etc.). The theoretical implications of these factors will be discussed in the section on our model of catching-up. By way of introduction, it makes sense to review historical trends for some of them as summarized by Maddison (1995).

Capital stock and technological progress

The Japanese case in which the stock of machinery and equipment per worker (K / L) increased 207-fold (at an annual growth rate of about 5.4%) from 1890 to 1992 is the clearest example of the strong correlation of capital stock for growth. Unfortunately data for capital stocks are not available for developing countries for same period but only for the last decades of the 20th century. Even so, one cannot ignore the differences in the accumulation of physical capital between different countries and regions for the recent period. There are also differing trends in the growth of average capital productivity, with implications to be discussed below.

The most impressive examples are the Tiger countries where between 1968 and 1998 the capital stock grew on average at a rate of 9.2% per year (calculation are based on Extended

[2] Needless to say, Figures 1 and 2 run completely counter to Lucas's (2000) a historical optimism. His model resembles a horserace with a staggered start. Each successive group of poor countries leaves the gate some time after its immediate predecessor and then appropriates existing technology to run faster than all the rest to catch up. Because the USSR must now be reckoned a failure, over almost 200 years Japan and possibly the Tigers are the only observed successes among new entrants to the race.

Penn World Tables, by Marquetti, 2002) while Latin America's annual rate of accumulation was only 3.8% per year between 1964 and 1998

It is also worth emphasizing that the positive effects on growth of rapid capital accumulation often appear to be offset by negative capital productivity growth rates. In the following section, it is shown that this feature arises almost automatically in growth accounting. In many historical cases, it has contributed to a "Marx bias" in technological change incorporating positive labor and negative capital productivity growth rates. Because of this fact, it may be easy to overstate the true significance of capital accumulation for output growth.

Human Capital

Japan's average years of education[3] increased from 1.50 in 1820 to 14.87 in 1992 meaning almost a 10-fold increase. The numbers for the USA are 1.75 in 1820 and 18.04 in 1992. Data for our regions are not available for the same period but only start in 1950 for selected countries. For Latin American and Asian countries for which Maddison (1995) provides estimates, the education level rose considerably. Argentina's years of schooling increased from 4.8 in 1950 to 10.7 in 1992, Chile's from 5.47 to 10.93, and Venezuela's from 2.21 to 10.18. In Asian countries education increased from 3.62 years in Taiwan in 1950 to 13.83 in 1992, in Korea from 3.36 to 13.55, while in India from 1.35 to 5.55.

Two observations arise from these data. First, we see that there is a certain intra-regional convergence between countries in terms of educational level, e.g. Venezuela caught up with other Latin American countries. Second, as with physical capital and GDP growth, Tiger countries surpassed Latin America in raising their levels of education. One may argue for the importance of human capital accumulation for economic growth but a strict causal relationship is difficult to establish. In the model simulations, we postulate a direct linkage between growth rates of the level of education and labor productivity.

Trade openness

[3] The data on education presented in this section come from Maddison (1995) who uses a different computational procedure for average years of schooling than does the UN *Human Development Report* from which we got the education growth rates used in the model simulations.

Trade openness is another important explanatory factor (at least for orthodox economists) for economic growth. All the countries represented in Maddison's data set had positive growth rates in the value of merchandise exports. The volume of exports, at constant prices, of Latin America had a 105-fold increase from 1870 to 1998, Eastern Europe's a 113-fold increase, Asia's exports grew 225 times by 1998 compared to 1870, and Africa's exports were 66 times higher in 1998 relative to 1870.

Figure 3: Merchandise Exports as Per Cent of GDP

Scaling the value of exports to the GDP, we see in Figure 3 that exports generally increased more rapidly then output. Therefore, we include increasing openness to trade as a potential source of growth in our model, satisfying the orthodox paradigm which postulates positive effects of trade integration on overall labor productivity.

2. Potential Sources of Growth

Differential growth rates of labor productivity have historically been the most important force behind diverging income levels across countries. Following Ocampo (2001), productivity growth in the medium run can be viewed as the outcome of two positive feedback loops building up from basic input factors such as the accumulation of physical and human capital, jumps in productivity resulting from successful industrial and trade policy, and the exploitation of technological backwardness. As will be seen, this system has strong implications for employment growth as well.

The first loop is from output and/or capital stock growth to labor productivity growth, as emphasized by Verdoorn (1949) and Kaldor (1957). We build this linkage into the simulations at the aggregate level, and also follow these authors in treating industrial expansion as a key factor in transmitting technological advance.

The second loop runs from labor productivity growth to output growth. Potential channels include stimulation of investment demand and relaxation of foreign exchange shortages via more rapidly growing production for export.

Finally, the growth rate of employment is equal to the difference between the growth rates of output and productivity. As illustrated in Figure 4, one can plot "Employment growth contours” with slopes of 45 degrees. Each line shows combinations of the output growth rate (“*X*-hat” or $\hat{X} = (dX/dt)/X$) and labor productivity growth rate (ξ_L) that hold the employment growth rate ($\hat{L} = \hat{X} - \xi_L$) constant.[4] Employment growth is more rapid along contours further to the SE. The diagram also contains illustrative schedules for a “Kaldor-Verdoorn” technical progress function (the first loop mentioned above) and “Output growth” (second loop).

Figure 4 here

Traditional “sources of growth” analysis, the dominant approach in the literature, has ignored the first loop and used a particular version of the output growth equation of the form

$$\hat{X} = \alpha_t(\hat{L} + \xi_L) + (1-\alpha_t)(\hat{K} + \xi_K) = \alpha_t\hat{L} + (1-\alpha_t)\hat{K} + \xi \qquad (1)$$

in which the growth rate of capital stock is $\hat{K}$, the growth rate of average capital productivity is $\xi_K = \hat{X} - \hat{K}$, and the observed wage or labor share of output at time *t* is α_t. The term $\xi = \alpha_t(\hat{X} - \hat{L}) + (1-\alpha_t)(\hat{X} - \hat{K})$ is total factor productivity growth as conventionally measured.

This equation has at least two peculiar features. To illustrate the first, we can suppose for the moment that the labor force and population maintain a constant ratio. In line with neoclassical production theory, causality in (1) will run from right to left ($\hat{X}$ is determined by the variables on the right-hand side). For a *given* level of ξ (the standard mainstream presumption) slower population and labor force growth $\hat{L}$ can then be seen to reduce output growth by a factor α_t. Hence it *increases* the growth rate of output per capita by a factor $1-\alpha_t$.

The implication is that per capita output growth should be especially rapid in Eastern Europe, Russia, and Japan where population growth is in fact negative. This assertion is not consistent with recent growth experience. It is easy to see that this same problem occurs if instead of neoclassical production theory one adopts a vintage-1950s Kaldorian technical progress of the form $\xi_L = \eta(\hat{K} - \hat{L})$. This is one reason why we adopt a Kaldor-Verdoorn specification instead.

[4] The equations just stated are set up in continuous time as are all growth rate expressions in this section. Better to fit the data, discrete time formulations are introduced below.

Secondly, the identity $X = X$ can be restated as $(X/L)L = (X/K)K$ whence

$$\xi_L + \hat{L} = \xi_K + \hat{K} \tag{2}$$

by logarithmic differentiation. But then after substitutions of terms equation (1) becomes either $\hat{X} = \xi_L + \hat{L}$ or $\hat{X} = \xi_K + \hat{K}$ *but not both.* In other words one must "explain" output expansion in terms of growth rates of *either* employment and labor productivity *or* capital stock and capital productivity.

For example, combining $\hat{X} = \xi_L + \hat{L}$ with a Kaldor-Verdoorn relationship of the form $\xi_L = \bar{\xi}_L + \gamma\hat{X}$ allows us to solve for $\hat{X}$ and ξ_L given $\hat{L}$. In terms of Figure 4, this procedure amounts to combining a specific employment growth contour with the Kaldor-Verdoorn schedule to pick out the output growth rate. But then either $\hat{K}$ or ξ_K has to be endogenously determined from $\hat{X} = \xi_K + \hat{K}$. A "supply-based" output analysis based on employment growth leaves little independent role for capital accumulation, and vice-versa!

The projections described below utilize exogenous values of $\hat{L}$ and $\hat{K}$ along with a Kaldor-Verdoorn relationship. Hence capital productivity growth is determined endogenously and serves as a check on the reliability of the calculations.

There are of course other ways to make the schedules in Figure 4 consistent with one another. One is to ignore the technical progress function while combining a predetermined employment growth rate with the Output growth function as at point C. When $\hat{K}$ is predetermined, both productivity growth rates become purely "endogenous," precisely as in New Growth Theory.

A third approach to Figure 4 is to combine Kaldor-Verdoorn and Output growth schedules, letting employment growth be determined along one of its contour lines as at point D. In a developing country context, one might reasonably take effective demand or available foreign resources as binding restrictions on $\hat{X}$.[5] With such a growth rate "closure," effects on

---

[5] Demand-driven growth models are discussed in Taylor (2004). External constraints can be modeled in a "gap" model framework (Taylor, 1994), taking into account foreign aid, capital movements, and shifts in the

employment of shifts in the two schedules become of interest. The employment growth rate is higher for combinations of $\hat{X}$ and ξ_L values lying below the contour running through D than at the point itself, and lower for combinations above. Faster overall productivity growth in the sense of an upward shift of the Kaldor-Verdoorn schedule would reduce $\hat{L}$ due to “labor-shedding;” and outward shifts in the Output growth schedule (for example, due to more rapidly growing aggregate demand and/or more availability of foreign exchange) would speed up job creation.

Insofar as increased employment growth is a policy objective, it may or may not transpire depending on how the schedules shift. Fragmentary evidence reported in Taylor (2001) and elsewhere suggests that external liberalization in many developing countries in the 1980s and 1990s was associated with faster productivity than demand growth (especially in traded goods sectors), leading to reductions in $\hat{L}$.

2.1 Methodology

Our basic approach was to set up simulations from 1998-2000 until 2030 of per capita income ratios for two test regions as discussed above. Base period levels of regional output in PPP terms, population, employment, investment, capital stock, and mean years of schooling were obtained from various sources, along with their average rates of growth during the 1990s. These growth rates were extrapolated forward “through” the base period level variables, starting in 1998. During the simulation period, the rates were modified by several factors to be discussed immediately below. Projected levels of per capita output followed from the growth rates. Per capita growth in the rich economies was set exogenously to allow us to simulate future income ratios.

A form of negative feedback that becomes important over a longer time frame centers on the dynamics of "catching-up" or "convergence." During the period 1960-75 labor productivity growth in Japan fell from levels exceeding 10% per year to the 2-3% more characteristic of rich countries. This productivity slowdown happened while the ratio of Japan’s per capita income to that of the United States rose from about 0.4 to 0.75. The usual interpretation is that Japan was

---

terms of trade. Using a counterfactual methodology, Taylor and Rada (2003) show that output growth rates in the late 20th century in sub-Saharan Africa and Latin America might have been substantially higher if the debt crisis and adverse terms-of-trade shocks “had not happened.”

able to absorb existing Western technologies rapidly during its "miracle" but ultimately that well went dry as its per capita income level caught up. Looking forward, it becomes of interest to examine the effects of a narrowing income gap on their productivity growth when ratios of per capita incomes in poor regions to those of rich regions are simulated to rise. These effects turn out to be rather strong, especially in the simulations for the Tigers.

2.2 A Model of Catching-up

Our model specification (more details in Appendix A) restates the standard sources of growth equation in terms of identities from the national income and product accounts (NIPA) instead of a mythical aggregate production function, and includes the forces just mentioned: short- and medium-term labor productivity dynamics and a longer run story about technological backwardness and convergence. The accounting is set up in discrete time, incorporating "interactions" among variables as they move from step to step. Time subscripts are written as *t* at the beginning of a period ($t = 0$ at the beginning of the simulation's base year) and $t+1$ at the end.

The output growth rate in discrete time is $\hat{X} = (X_{t+1} - X_t)/X_t$. As explained in Appendix A it can be decomposed as in equation (1) into a weighted average of input and productivity growth rates by "first differencing" the standard national accounts decomposition of value-added into wage and profit flows and ignoring "interaction effects."

As discussed above, we focus on determination of output growth from growth rates of the labor force and labor productivity. To derive an equation, we can begin with the exact discrete time version of (2), which is

$$\frac{\hat{X} - \hat{L}}{1 + \hat{L}} + \hat{L} = \frac{\hat{X} - \hat{K}}{1 + \hat{K}} + \hat{K} \ .$$

with $(1+\hat{L})^{-1}$ and $(1+\hat{K})^{-1}$ capturing interactions. We can now define discrete time productivity growth rates as

$$\xi_L = (1+\hat{L})^{-1}(\hat{X} - \hat{L}) \quad \text{and} \quad \xi_K = (1+\hat{K})^{-1}(\hat{X} - \hat{K}) \tag{3}$$

Substituting into (1) then gives

$$\hat{X} = \hat{L} + \xi_L \tag{4}$$

as our basic formula for growth.

Equation (4) can be combined with an inter-sectoral decomposition of ξ_L. Briefly, let θ_t^j and ε_t^j respectively stand for the shares of sector *j* in total output and employment. Then overall labor productivity growth becomes

$$\xi_L = (1+\hat{L})^{-1}(S+R) \quad . \tag{5}$$

In this expression,

$$S = \sum_i \theta_t^i (\hat{X}^i - \hat{L}^i) \tag{6}$$

is a weighted average of sector-level rates of productivity growth, and

$$R = \sum_i (\theta_t^i - \varepsilon_t^i)\hat{L}^i \tag{7}$$

represents shifts in productivity growth due to reallocation of labor across sectors (Syrquin, 1986). A sector with relatively high labor productivity will have a higher share of output than of the labor force, $\theta_t^i > \varepsilon_t^i$, so that if its employment growth is positive, $\hat{L}^i > 0$, reallocation of labor toward the sector generates a positive contribution to labor productivity economy-wide.

Historical data coming into the model's base year will satisfy the decomposition (5). We focus on just two sectors, traded (*T*) and non-traded (*N*), so that *i* takes the values *T* and *N* in (6) and (7).

In the "future" simulation period, labor productivity growth rates in the two sectors are assumed to obey the rules

$$\xi_L^T = \bar{\xi}_L^T + \Gamma + \gamma\hat{X} + \eta\hat{H} + Z \tag{8T}$$

and

$$\xi_L^N = \bar{\xi}_L^N + \Gamma + \gamma\hat{X} + \eta\hat{H} \quad . \tag{8N}$$

The terms $\bar{\xi}_L^T$ and $\bar{\xi}_L^N$ are trend rates coming into the base year. Over the simulation period, they are shifted by the growth factors Γ, $\gamma\hat{X}$, $\eta\hat{H}$, and *Z.* The term Γ refers to technological backwardness, and is discussed immediately below. In sector 2.3, we take up the analytics of Kaldor-Verdoorn effects ($\gamma\hat{X}$), human capital accumulation ($\eta\hat{H}$), and possible productivity-enhancing effects of external openness and/or industrial policy aimed at raising productivity in the traded goods/manufacturing sector (Z).

Because $\theta_t^T + \theta_t^N = 1$, overall labor productivity growth (in discrete time) can be written as

$$\xi_L = (1+\hat{L})^{-1}(\bar{\xi}_L + \Gamma + \gamma\hat{X} + \eta\hat{H} + \theta_t^T Z + R) \tag{9}$$

with $\bar{\xi}_L = \theta_0^T \bar{\xi}_L^T + \theta_0^N \bar{\xi}_L^N$ in the base year and R standing for productivity changes in the simulation period due to reallocation effects. The shift term Z gets weighted by θ_t^T, the share of traded goods in total output.

To avoid double counting when the human capital growth rate has a non-zero incoming value, we utilized a "purged" base year labor productivity growth rate $\bar{\xi}_{LP}$. It is defined as $\bar{\xi}_{LP} = \bar{\xi}_L - \eta\hat{H}$ with $\hat{H}$ as the incoming growth rate of human capital, and replaces $\bar{\xi}_L$ in equation (9) for the first year of the simulation exercise. From the second year onwards we use the incoming growth rate of productivity and the education enhancement factor. For simulations when the education enhancement effect is not included we use the incoming value of the productivity growth.

Plugging (9) into (4) gives the following equation for output growth,

$$\hat{X} = A + B\Gamma \tag{10}$$

with

$$A = [1-(1+\hat{L})^{-1}\gamma]^{-1}[\hat{L} + (1+\hat{L})^{-1}(\bar{\xi}_{LP} + \eta\hat{H} + \theta_t^T Z + R)] \tag{11}$$

and

$$B = [1-(1+\hat{L})^{-1}\gamma]^{-1}(1+\hat{L})^{-1} \quad . \tag{12}$$

These expressions involve many terms that in a simulation will change over time. However, their basic role can be illustrated in a fixed coefficients scenario about catching up which will be discussed at the end of this section.

To complete the model, we employ the ratio λ_t between GDP per capita in the poor countries relative to rich countries.

$$\lambda_t = (X_t / L_t) / Y_t \tag{13}$$

in which Y_t is per capita income in the rich region and it is assumed for the moment that participation and employment rates in the poor region stay constant so that its labor force L_t is strictly proportional to its population. Taking differences and substituting from (10), one has

$$\hat{\lambda} = (1+\hat{L})^{-1}(\hat{X} - \hat{L}) - (1+\hat{Y})^{-1}\hat{Y} = (1+\hat{L})^{-1}(A + B\Gamma - \hat{L}) - (1+\hat{Y})^{-1}\hat{Y} \tag{14}$$

As already noted, Japan's experience in catching-up with the then-rich regions of the world sheds light on the dynamics of economic convergence. The productivity history is illustrated in Figure 5, which suggests a simple relationship of the form

$$\Gamma = D - E\lambda \tag{15}$$

with an approximate slope *E* of 0.12. The intuition is that as the income ratio λ increases there is less room for technological catching-up, i.e. there is growth rate retardation or "convergence." Setting $\Gamma = 0$ in the base year of the simulation model permits *D* to be identified as $D = E\lambda_0$ from the slope parameter *E* and the initial value λ_0 of the per capita income ratio. Japan's "miracle" was very unusual, so in model simulations we set *E* to a value of 0.06.

Figure 5: Japan's growth rate of labor productivity and ratio of Japan vs US GDP per capita

Plugging (15) into (14) gives a final equation for the growth rate of λ,

$$\hat{\lambda} = (1+\hat{L})^{-1}[A + B(D - E\lambda) - \hat{L})] - (1+\hat{Y})^{-1}\hat{Y}$$

or in difference form,

$$\lambda_{t+1} - \lambda_t = [(1+\hat{L})^{-1}(A + BD - \hat{L}) - (1+\hat{Y})^{-1}\hat{Y}]\lambda_t - [(1+\hat{L})^{-1}BE]\lambda_t^2 \quad . \tag{16}$$

If its coefficients stayed constant, (16) would be a discrete time analog to the well-known Bernoulli differential equation $d\lambda / dt = a\lambda - b\lambda^2$ with solution $\lambda = [(b/a) + const(e^{-at})]^{-1}$ and *const* as a constant of integration. The solution trajectory for λ rises steadily from its initial value to an asymptote a/b. The path is a concave function of time in the sense that $d^2\lambda/dt^2 < 0$. As will be seen below, the non-linearities and feedback loops built into the simulations based on equations (10)-(12) can visibly perturb this simple pattern.

2.3 Details on the Sources of Growth

In practice the simulation model includes seven potential contributing factors to growth, which we discuss in this section. They take into account both heterodox and orthodox traditions of economic analysis as they apply to aggregate supply (with some effects coming in from demand as well).

1. **The effect of Verdoorn elasticity (γ):** On the heterodox side, the labor productivity growth rate ξ_L in (9) is assumed to respond to the output growth rate $\hat{X}$ with a "Verdoorn elasticity" γ. Under favorable circumstances (including the policy environment) γ could rise over time. Since the terms A and B in (10) increase with γ, $\hat{X}$ speeds up. Econometric estimates of γ in industrialized economies are typically in the range of 0.5. Because of short time series and on-and-off growth performances, few estimates are available for the rest of the world. In the simulations, we assume that the incoming value of γ is zero for Latin America and 0.5 for the Tigers.
2. **The effect of industrialization (*Z*):** We introduce the effect of industrialization from both heterodox and orthodox perspectives: Heterodox authors emphasize a potential positive effect of industrialization (measured, say, by the industrial sector's share of output or the labor force) on economy-wide labor productivity. As already discussed in connection with Figure 3, the analogous orthodox idea is that greater openness to trade (say the ratio of imports plus exports to GDP) is supposed to enhance labor productivity, with foreign direct investment (FDI) at times emphasized as the transmission mechanism. Although orthodoxy described reality badly in the 1990s when greater trade openness was *not* associated with faster economy-wide labor

productivity,[6] we still optimistically assume that output per worker in the traded goods sector (in which manufacturing plays a major role) will rise over time. Perhaps due to opening the economy or the application of astute industrial policy there may be an autonomous upward shift *Z* in the rate of productivity growth in (8T). The effect on output growth via a shift in *S* from (5) at time *t* is given by $(1+\hat{L})^{-1}\theta_t^T Z$ where θ_t^T is the share of traded goods in total output[7]. The reallocation effect *R* in (9) may also change from its historical value over time.

3. **The effect of human capital accumulation ($\hat{H}$):** Also as pointed out above, the orthodox view is that labor productivity growth can be accelerated by human capital accumulation, e.g. more average years of schooling. Because the industrialized economies grow no faster now than they did decades ago despite notably higher levels of education, it is realistic to assume that a more rapid *increase* in average years of schooling ($\hat{H}$) leads to faster productivity growth. The rate in both traded and non-traded sectors is supposed to rise by an amount $\eta\hat{H}$ so that from (1) output growth goes up by $(1+\hat{L})^{-1}\eta\hat{H}$ [8]. Adopting Maddison's (1995) optimism, we set the elasticity $\eta = 1$.[9]

4. **The effect of physical capital accumulation ($\hat{K}$):** As discussed in section 1, all sides agree that more rapid accumulation of physical capital (a greater flow of net investment) is associated with faster output growth. In the simulation model we use, this effect is muted, basically because $\hat{L}$, $\hat{K}$, and ξ_L jointly determine the growth rate of capital productivity ξ_K in (3). A higher level of $\hat{K}$ just makes ξ_K go down.

[6] The correlation coefficients for productivity growth rate and share of tradables in total output for our regions during 1990s have negative signs, meaning that the positive effect of greater openness was absent.

[7] When the Verdoorn effect is present as in (6), this expression is multiplied by $[1-(1+\hat{L})^{-1}\gamma]^{-1}$

[8] Again multiplied by $[1-(1+\hat{L})^{-1}\gamma]^{-1}$ if the Verdoorn effect is present.

[9] By contrast, Ros (2000) suggests a value in the range of 0.3 for η.

5. **The effect of labor force growth ($\hat{L}$):** Leaving aside all other effects and assuming that the labor force and population grow at the same rates, combining the Kaldor-Verdoorn effect with an exogenous labor growth rate gives the expression $\hat{X} - \hat{L} = (1-\gamma)^{-1}(\gamma\hat{L} + \bar{\xi}_L)$ for the growth rate of per capita output. More rapid employment growth will have a stronger positive effect on per capita income growth, the higher is the value of γ. The strength of this effect is illustrated numerically below.

6. **The retardation effect (Γ_t):** In honor of Gerschenkron (1962) and the poor country/rich country income gap, the term Γ stands for productivity effects of "backwardness." As discussed above, it is used to shift their overall productivity trends as poor countries catch up with richer ones. A positive value of the parameter *E* in (11) means that productivity growth *decelerates* as a poor region's income ratio λ increases toward unity from below. This "retardation effect" turns out to be important in the regional simulations, especially for the Tigers.

7. **Other factors influencing growth:** All this algebra omits many factors that affect economic growth. For example, UNCTAD (2002) emphasizes how "resource constraints" (basically, sources of saving) hold down accumulation in the Least Developed Economies. Trade, debt, and financial linkages between rich and poor countries (notably adverse trends in the terms of trade) all contribute to such external strangulation. More optimistically, do the successful growth performances Spain and Greece after the joined the European Union augur well for the future prospects of Eastern Europe? Such issues of insertion of regional economies into the global system cannot easily be captured in formal terms, but as discussed below we did try to take them into account in specifying parameters for the regional simulations.

3. Simulations for Latin America

Taking Latin America as an example[10], here are the numbers that we used for simulation:

[10] The numbers for Latin America are based on appropriate weighted averages of data from Argentina, Brazil, Chile, Columbia, Mexico and Venezuela.

Population for the region grew at 1.7% per year on average in the 1990s. It is projected to drop steadily to 0.7% in 2030.

Employment growth ($\hat{L}$) averaged 1.8% prior to 1998. We assume that the growth rate decreases by an amount of 0.05% in each year until it reaches 0.6% in 2022 and stabilizes thereafter.

Capital stock growth ($\hat{K}$) is initially assumed to be 4.3% per year and to slow to 3.8% in 2030, with both rates being higher than the 2% growth observed in the 1990s.

Labor productivity growth (ξ_L) averaged 1% per year in the 1990s. After purging the effects of human capital accumulation as discussed in Section 2.22, it decreases at -0.45% in the base year. Its growth picks up in the simulation period for several reasons to be discussed below.

The tradable share (θ^T) in total output is set to 0.31 in the base year, 1998, and is assumed to be increasing by an amount 0.004 per year, reaching 0.44 by 2030.

Tradable goods productivity enhancement (*Z*) is set to zero in the base year, and rises to a value of 0.04 by 2030

The Verdoorn parameter (γ) starts at zero in 1998 and increases by a factor of 0.045 until it reaches 0.45 in 2008, after which we keep it constant.

Growth rate of average years of schooling ($\hat{H}$ *)* is 1.44% and is kept constant throughout the whole period, raising the education level from 5.95 in 1998 to 9 mean years of schooling in 2030 (a rise of 50% in 32 years). As discussed above, this increase passes through into output growth with a coefficient of α because we set the elasticity η equal to one.

The reallocation effect (R) is set to .0011, equal to the shift in the productivity growth due to labor reallocation across sectors for the region during 1994-1998.

The retardation parameter (*E*) was set to 0.06. With the region's *income ratio* (λ) taking a value of 0.3 in 1997, the intercept term (*D*) in (11) takes a value of 0.018.

The average growth rate of GDP per capita in OECD countries for 1980-1998 was 1.8% with higher rates for the end of 1990s and 1980s and lower or negative rates for the early 1990s. Throughout all the simulations we maintained a fixed rich country growth rate of GDP per capita of 1.8%

TABLE 1: Incoming growth rates and values for variables which enter the simulation:

Figure 6 shows the key impacts of these parameter shifts. The lowest curve represents a "base run" simulation in which traded goods productivity growth, human capital, and Verdoorn effects on $\hat{X}$ are suppressed. Population growth is assumed to decline as discussed above, and the labor share to increase. The share of traded goods in output is held constant, and the growth rates of capital and capital productivity follow the trends mentioned above. As can be seen, the baseline result is that Latin America's per capita income ratio declines by six points from its initial level of 0.31.

Figure 6: Latin America vs OECD (1998-2030)

By itself, the Verdoorn effect leads to a minimal increase in the income per capita of Latin America relative to OECD while traded sector productivity growth and human capital accumulation add 0.06 and 0.07 to the base year value of λ respectively. The curve for "all effects" (including retardation) shows that λ increases by 0.43 over the simulation period. This increment exceeds the (approximate) sum relative to the base year of 0.3 of the three effects taken separately. In other words, there appears to be positive feedback among all sources of productivity increase.

If the retardation factor Γ is omitted, λ rises to above one – obviously not a plausible result. Also note that the curve for "all effects" becomes less steep over time. That is, $d^2\lambda / dt^2 < 0$ or λ is a concave function of time along the lines of the discussion in section 2.2.

To illustrate feedback mechanisms a bit further, we ran simulations in which the traded goods productivity, education, and Verdoorn effects entered pairwise. The second-last entry in the column for Latin America in Table 2 shows that combining human capital accumulation with a Verdoorn effect raises λ in 2030 by about 0.16 above its value late in the 20th century. Combinations of the Verdoorn effect with faster traded goods productivity growth, and of productivity growth with more education add about .15 and respectively .14 to the initial value of λ. The total contribution of pairwise interactions is 0.45, exceeding slightly the overall increase of 0.43. The non-linearities built into the model strongly affect its outcomes.

Table 3: Differences in λ between 1998 and 2030

Over the entire period, the simulation for "All effects" gives a growth rate of λ of 2.7% and per capita income growth is in the range of 4.7%. These are plausible numbets but as already noted they depend on strong assumptions about full employment, no adverse economic shocks that could push the regional economy below its simulated trajectory for a significant amount of time, and optimistic specifications regarding the Verdoorn effect, traded goods productivity growth, and growth of physical and human capital. All these sources of growth would have to be present because they act synergistically. Designing a package that would force them all to be in action together for an extended period time is a non-trivial policy task.

4. Simulations for the Tigers

Figures 7 and 8 illustrate simulation results for the Tigers. In comparison to Latin America, their dynamism already shows up in the base run in which λ increases from 0.48 to 0.67 by 2030. The "All effects" curve shows an increase in λ of 0.52, with a growth rate of two percent per year. By 2030, the East Asian economies reach 90% of the OECD income level. Taken individually, education, traded sector productivity growth, and the Verdoorn linkage respectively add 0.34, 0.31, and 0.22 to the base year λ .Figure 8 shows that enhancement factors taken two-by-two are stronger still.

Figures 7 and 8 here

Without retardation λ rises to 4.59, basically showing that retardation becomes very powerful when a developing region approaches rich country income levels. This observation also shows up in the form of decreasing rate of labor productivity growth – from 0.055 in 2005 to 0.017 in 2030.

The growth projections are also rather sensitive to changes in the retardation parameter *E*. When it takes values of 0.05, 0.06, and 0.07 changes in λ over the simulation period are 0.62, 0.52, and 0.44 respectively. The corresponding numbers for Latin America are 0.51, 0.45, and 0.4. In effect, retardation becomes more powerful, the higher the level of λ , which provides a useful check on the overall robustness of the specification.

5. Summary, Conclusions, and Recommendations

It is unlikely that any poor country or region will be able to sustain rapid and steady per capita income growth for a period of three decades. There are very few cases on record, e.g. Brazil between the 1950s and the 1980s, Malaysia and South Korea between the 1960s and 1990s, and not many others. Moreover, the assumptions we have made with regard to the effects on growth of Verdoorn-Kaldor linkages, labor productivity increases in the traded goods sector, and human capital accumulation are all at the optimistic ends of the plausible parameter ranges.

If these hypotheses hold true, the Tigers may indeed converge to rich country income levels over the next generation. Even in absolute terms their income gap narrows from $12063 in 1998 to $1728 in 2030. Latin America, however, catches up far more slowly, with the absolute gap only narrowing from $15,475 to $12,063.

Beyond these somewhat disheartening results, the analysis herein suggests lines of thought that may be worth pursuing.

First, the discussion around Figure 4 illustrates how tightly interlinked are rates of output, employment, and productivity growth. In particular if at the macro level growth in the economy (as opposed to the simulations here) is largely driven by the figure's Output growth and Kaldor-Verdoorn relationships, then employment growth at a "socially" acceptable level is by no means assured. Slow employment growth has been characteristic of many developing economies in the recent period, which opens serious policy questions.

Second, the accounting and data built into the simulations herein suggest policy directions that different regions (and countries) may wish to explore if output growth is the major objective. The results in Table 2 imply, for example, that extra education and traded sector productivity growth may make bigger growth contributions than Verdoorn effects. Such outcomes could of course differ for other regions.

Third, because it is based on a consistent accounting scheme the model can trace observed accounting data fairly accurately. A previous version was tested for Japan (1960-1990) and the present one for the Tigers (1979-2000) with $\gamma = 0.4$, $Z = 0.02$, $E = 0.06$, and $\hat{H}$ and $\hat{L}$ from historical data. While the simulation was unable to capture shocks from factors not included in the specification, it did provide an accurate representation of the trend in convergence dynamics between the East Asian economies and the OECD.

Appendix A: Growth Accounting

The accounting that underlies the simulations described in the text is presented in this appendix. Because the data are available for discrete periods of time (typically years), the analysis is set up with variables at the beginning of period *t* denoted by that subscript. For simplicity, equations are often written just with subscripts 0 and 1 standing for the beginning and end of a period respectively.

Although it is unrealistic for developing countries in which much economic activity is undertaken by independent proprietors (peasants, vendors, small manufacturers) who receive a mixture of capital and labor incomes, we follow convention in assuming that wage payments and profits can be cleanly separated in the determination of costs of production,

$$P_t X_t = w_t L_t + r_t P_t K_t \tag{A1}$$

in which X_t is real output at time *t*, P_t is a corresponding price index (such as a GDP deflator), w_t is an index of nominal wages, L_t is employment (measured in the text as numbers of workers in lieu of person-hours), r_t the overall rate of profit, and K_t the real capital stock (constructed by the perpetual inventory method, for example). For simplicity, a separate price index for capital goods is *not* used in (A1).

Subtracting terms in equation (A1) at time zero from those at time one and some manipulation give

$$\hat{P} + \hat{X} = \alpha_0(\hat{w} + \hat{L}) + (1-\alpha_0)(\hat{r} + \hat{P} + \hat{K}) + \alpha_0(\hat{w}\hat{L} - \hat{P}\hat{X}) + (1-\alpha_0)(\hat{r}\hat{P} + \hat{r}\hat{K} + \hat{P}\hat{K} - \hat{P}\hat{X})$$

where $\alpha_0 = w_0 L_0 / P_0 X_0$ is the share of wages in output at time zero (and $1-\alpha_0$ the share of profits), and the last two terms on the right gather products of growth rates or "interaction effects."

Interactions become important when some variable grows very rapidly (for example the price index under conditions of high inflation) or else the span between times 0 and 1 is long so that the difference between final and initial values of a variable is more than a few percentage points of the latter. When these conditions don't apply, it is usually safe to ignore the interaction terms and write

$$\hat{P} + \hat{X} = \alpha_0(\hat{w} + \hat{L}) + (1 - \alpha_0)(\hat{r} + \hat{P} + \hat{K})$$

to a good approximation. The equation can be rearranged to give a decomposition of quantity and price log-changes in "Divisia indexes" with weights α_0 and $1 - \alpha_0$ that will typically vary over time:

$$0 = \alpha_0[(\hat{w} - \hat{P}) - (\hat{X} - \hat{L})] + (1 - \alpha_0)[\hat{r} - (\hat{X} - \hat{K})] \quad . \tag{A2}$$

The terms $(\hat{X} - \hat{L})$ and $(\hat{X} - \hat{K})$ respectively measure shifts in the output/labor and output/capital ratios, or average "productivity" levels of the two inputs.

If we let $\omega_t = w_t / P_t$ be the real wage at time *t*, then one can show that

$$\hat{\omega} = (1 + \hat{P})^{-1}(\hat{w} - \hat{P}) \approx \hat{w} - \hat{P}$$

in which the term $(1 + \hat{P})^{-1}$ represents interactions.

A "stylized fact" that is often not falsified by the data and built into many growth models is that real wage growth $\hat{\omega} \approx \hat{w} - \hat{P}$ tends to run at about the same rate as labor productivity growth $(\hat{X} - \hat{L})$, when both variables are averaged over time. If this relationship is observed, then persistently negative trend growth $(\hat{X} - \hat{K})$ in capital productivity has to be associated with a falling rate of profit ($\hat{r} < 0$) in (A2) because the bracketed term multiplied by α_0 will be close to zero. Marx-biased productivity changes as discussed in the text go together with the traditional Marxist distributive theme that a falling rate of profit is to be expected under modern capitalism.

A further step taken by the mainstream throws in another identity,

$$\hat{X} = \alpha_0[\hat{L} + (\hat{X} - \hat{L})] + (1 - \alpha_0)[\hat{K} + (\hat{X} - \hat{K})] \quad , \tag{A3}$$

which basically states that $\hat{X} = \hat{X}$ for any value of α_0. If rates of labor and capital productivity growth are defined as $\xi_L = \hat{X} - \hat{L}$ and $\xi_K = \hat{X} - \hat{K}$ (thereby ignoring interactions) then this expression becomes

$$\hat{X} = \alpha_0(\hat{L} + \xi_L) + (1-\alpha_0)(\hat{K} + \xi_K) = \alpha_0\hat{L} + (1-\alpha_0)\hat{K} + \xi \tag{A4}$$

which is restated as equation (1) in the text with α_0 set equal to the labor share.

Finally, suppose that one has data on employment and output for several sectors over time. As in the text, let $\theta_0^i = X_0^i / X_0$ be the share of sector *i* in real output in period zero, with $\sum_i X_0^i = X_0$. Similarly for employment: $\varepsilon_0^i = L_0^i / L_0$ with $\sum_i L_0^i = L_0$. The level of labor productivity in sector *i* is X_0^i / L_0^i with an exact growth rate $\xi_L^i = (1+\hat{L}^i)^{-1}(\hat{X}^i - \hat{L}^i) \approx \hat{X}^i - \hat{L}^i$.

After a bit of manipulation, an exact expression for the rate of growth of economy-wide labor productivity emerges as

$$\xi_L = (1+\hat{L})^{-1}\sum_i [\theta_0^i(\hat{X}^i - \hat{L}^i) + (\theta_0^i - \varepsilon_0^i)\hat{L}^i] \quad . \tag{A5}$$

Aside from the interaction term $(1+\hat{L})^{-1}$, ξ_L decomposes into two parts. One is a weighted average $\sum_i \theta_0^i(\hat{X}^i - \hat{L}^i)$ of sectoral rates of productivity growth as conventionally measured. The weights are the output shares θ_0^i. The other term, $\sum_i (\theta_0^i - \varepsilon_0^i)\hat{L}^i$, captures "reallocation effects."

For the record, another expression for ξ_L emerges after some manipulation of (A5),

$$\xi_L = (1+\hat{L})^{-1}\sum_i [\lambda_0^i(\hat{X}^i - \hat{L}^i) + (\theta_0^i - \varepsilon_0^i)\hat{X}^i] \quad . \tag{A6}$$

In (A6), sectoral productivity growth rates are weighted by employment shares, and the reallocation effect is stated in terms of output growth rates. The message is basically the same as in (A5).

Equations (5) through (7) in the text follow from (A5) when we set

$$S = \sum_i \theta_t^i(\hat{X}^i - \hat{L}^i) \quad .$$

as an average of sector-level rates of productivity growth weighted by output shares, and

$$R = \sum_i (\theta_t^i - \varepsilon_t^i)\hat{L}^i$$

representing shifts in productivity growth do to reallocation of labor across sectors. Historical data coming into the model's base year will satisfy the decomposition $\xi_L = (1+\hat{L})^{-1}(S+R)$.

References

Foley, Duncan K., and Thomas R. Michl (1999) *Growth and Distribution*, Cambridge MA: Harvard University Press

Gerschenkron, Alexander (1962) *Economic Backwardness in Historical Perspective*, Cambridge MA: Harvard University Press

Kaldor, Nicholas (1957) "A Model of Economic Growth," *Economic Journal*, *67*: 591-624

Maddison, Angus (1995) *Monitoring the World Economy 1820-1992*, Paris: Organisation for Economic Co-operation and Development

Maddison, Angus (2001) *The World Economy: A Millennial Perspective*, Paris: Organisation for Economic Co-operation and Development

Maddison, Angus (2002) “The West and the Rest in the International Economic Order” in Jorge Braga de Macedo, Colm Foy, and Charles P. Oman (eds.), *Development in Back,* Paris: Organisation for Economic Co-operation and Development

Marquetti, Adalmir (2002) *Extended Penn World Tables: Economic Growth Data on 118 Countries*, http://homepage.newschool.edu/~foleyd/epwt/.

Ocampo, Jose Antonio (2001) “Structural Dynamics and Economic Development” (mimeo), Santiago: Economic Commission for Latin America and the Caribbean

Ros, Jaime (2000) *Development Theory and the Economics of Growth*, Ann Arbor MI: University of Michigan Press

Syrquin, Moshe (1986) “Productivity Growth and Factor Reallocation,” in Hollis B. Chenery, Sherman Robinson, and Moshe Syrquin, *Industrialization and Growth*, New York: Oxford University Press

Taylor, Lance (1994) "Gap Models," *Journal of Development Economics, 45*: 17-34

Taylor, Lance (ed., 2001) *External Liberalization, Economic Performance, and Social Policy*, New York: Oxford University Press

Taylor, Lance (2004) *Reconstructing Macroeconomics: Structuralist Proposals and Critiques of the Mainstream*, Cambridge MA: Harvard University Press

Taylor, Lance, and Codrina Rada (2003) "Would Better Terms of Trade and Capital Inflows Have Improved Economic Performance in Latin America and Africa in the 1970s through the 1990s?" New York: Center for Economic Policy Analysis, New School University

United Nations Conference on Trade and Development (UNCTAD, 2002) *The Least Developed Countries Report,* Geneva: UNCTAD

Verdoorn, P. J. (1949) "Fattori che Regolano lo Sviluppo della Produttivita del Lavoro," *L'Industria*, *1*: 3-10

Weisbrot, Mark, Dean Baker, Egor Kraev, and Judy Chen, "The Scorecard on Globalization 1980-2000: Twenty Years of Diminished Progress," Washington DC: Center for Economic and Policy Research

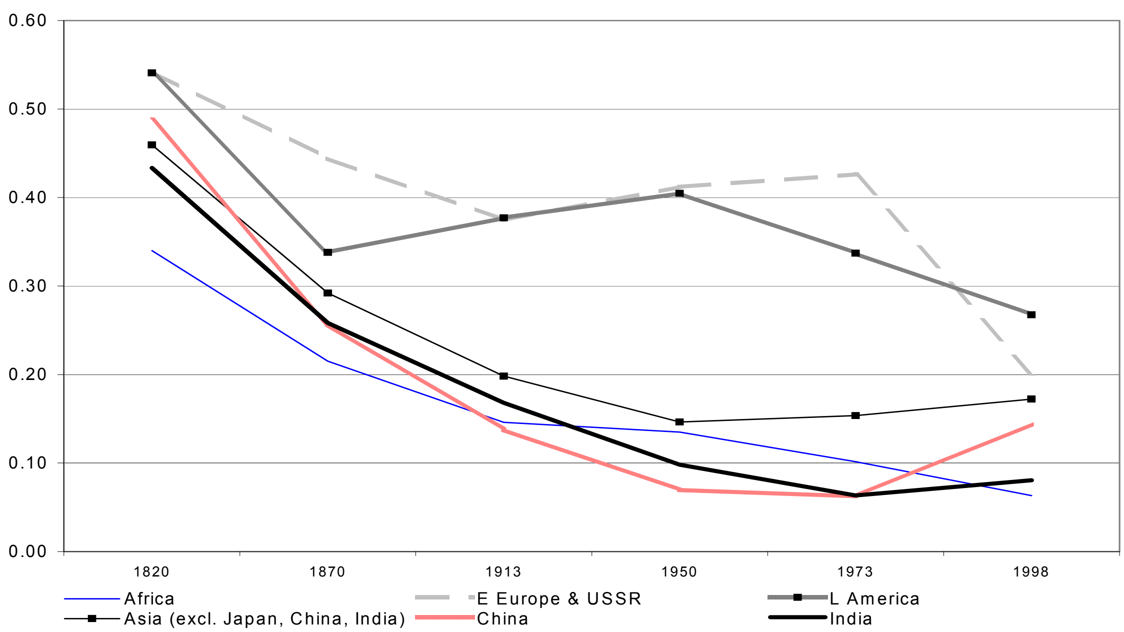

Figure 1: Ratios of GDP per capita (Developing countries/OECD)

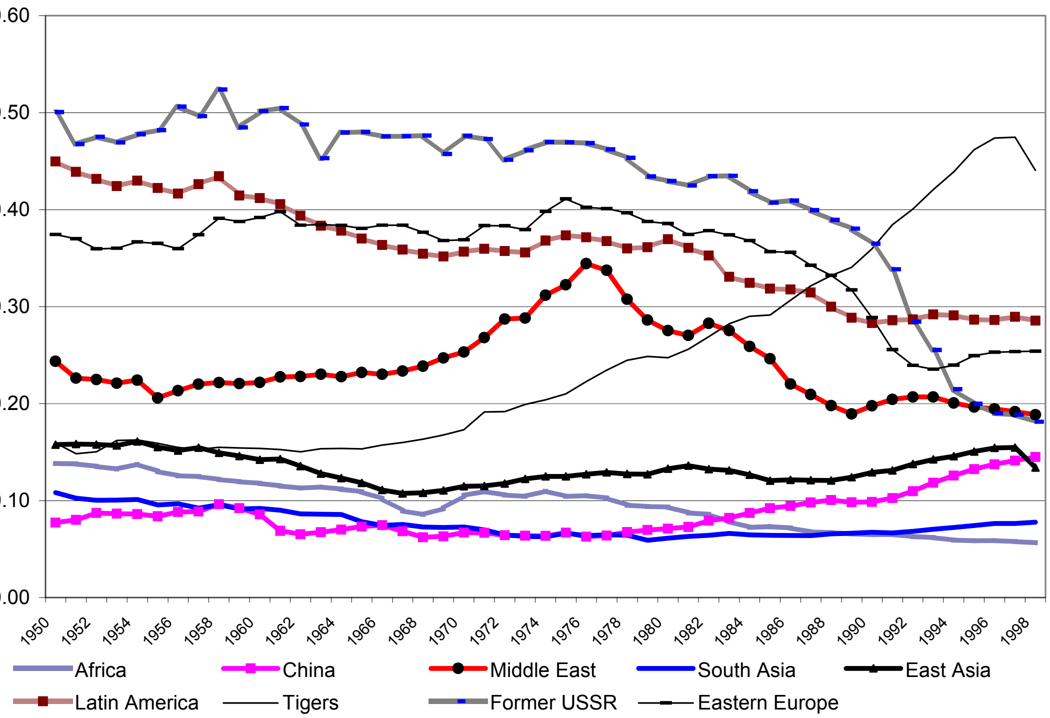

Figure 2: Catching up: GDP per capita of developing countries vs OECD (1950-1998)

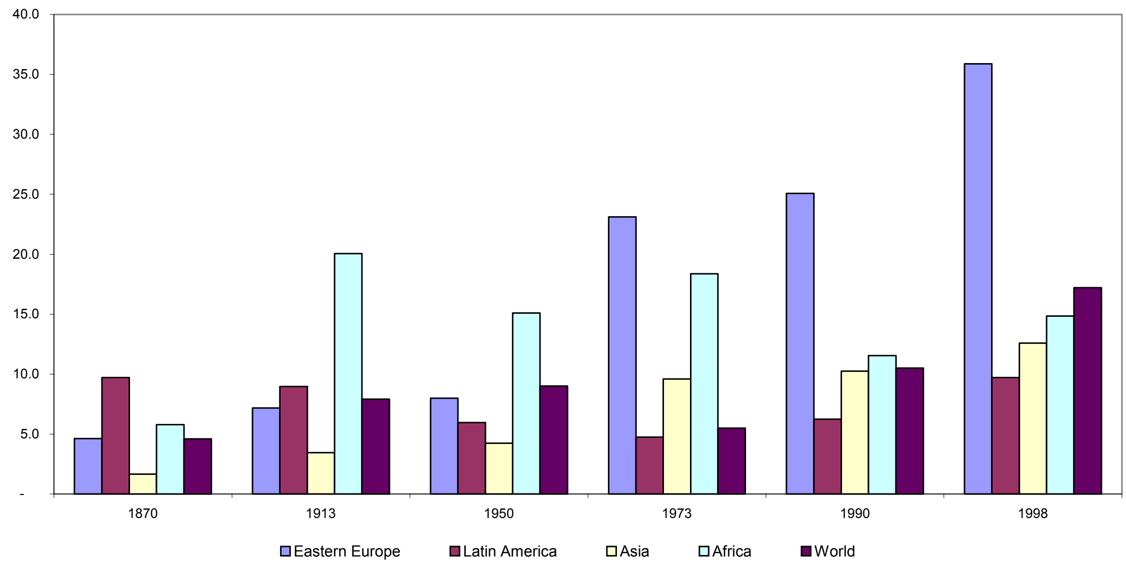

Figure 3: Merchandise Export as Per Cent of GDP

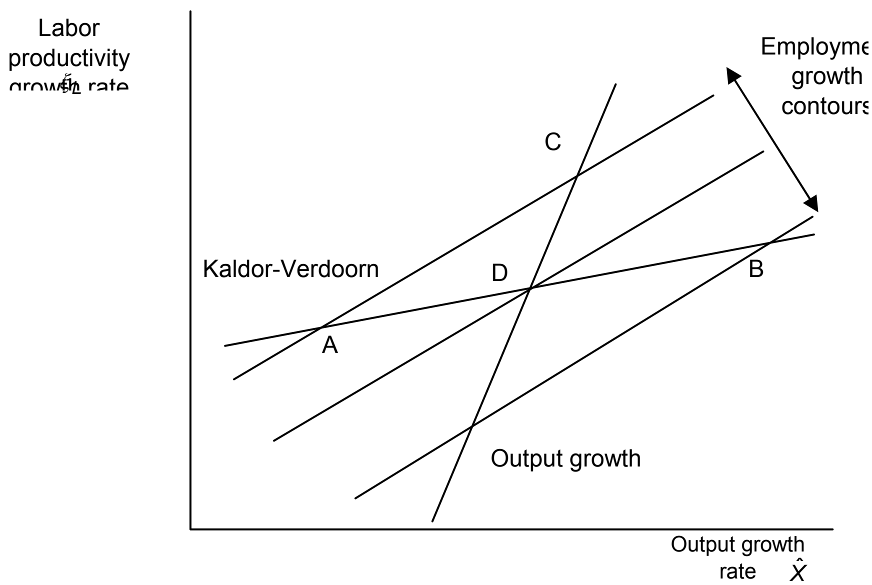

Figure 4: Joint determination of output, labor productivity, and employment growth rates

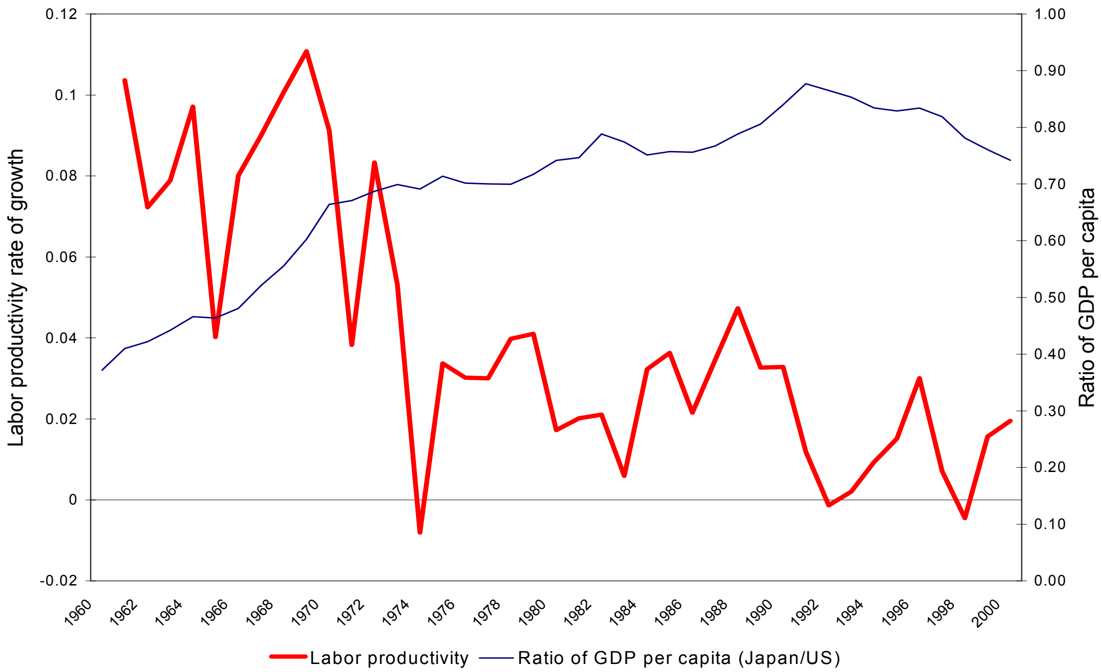

Figure 5: Japan's growth rate of labor productivity and ratio of Japan vs US GDP per capita

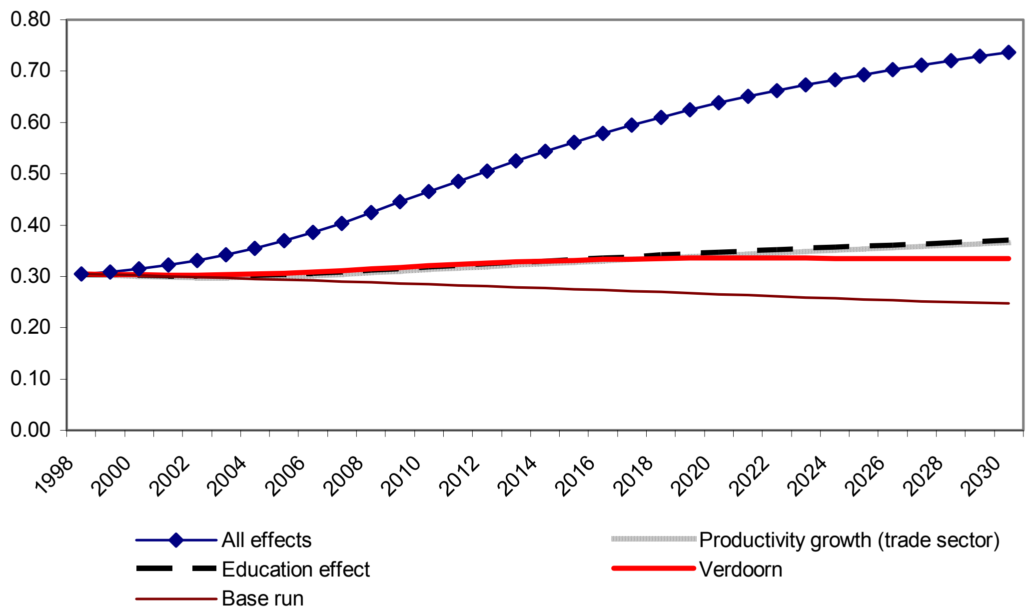

Figure 6: Effects of enhancement factors on catch-up scenario – Latin America vs OECD (1998-2030)

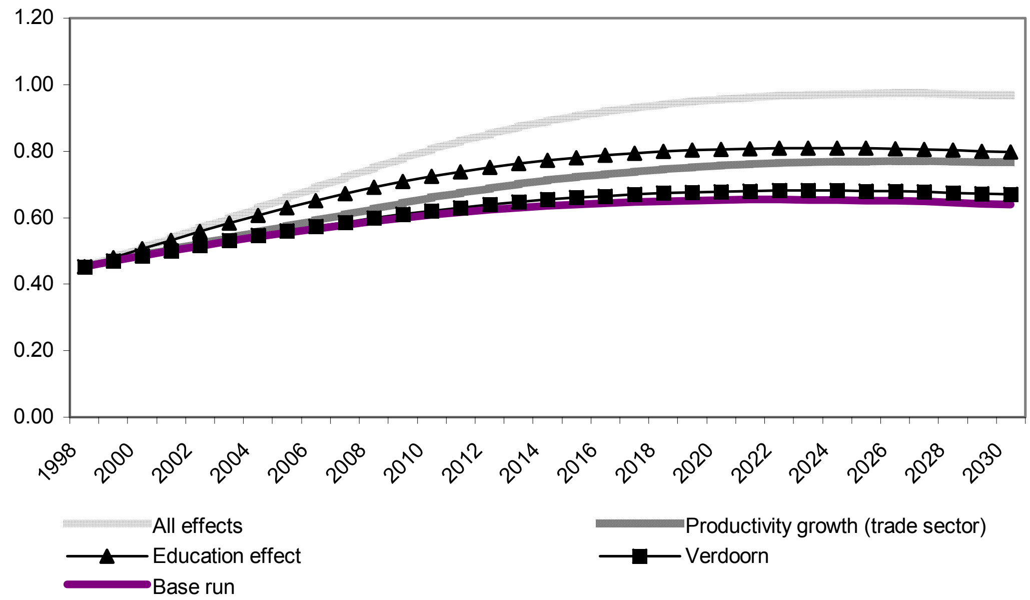

Figure 7: Effects of enhancement factors on catch-up scenario – Tigers vs OECD (1998-2030)

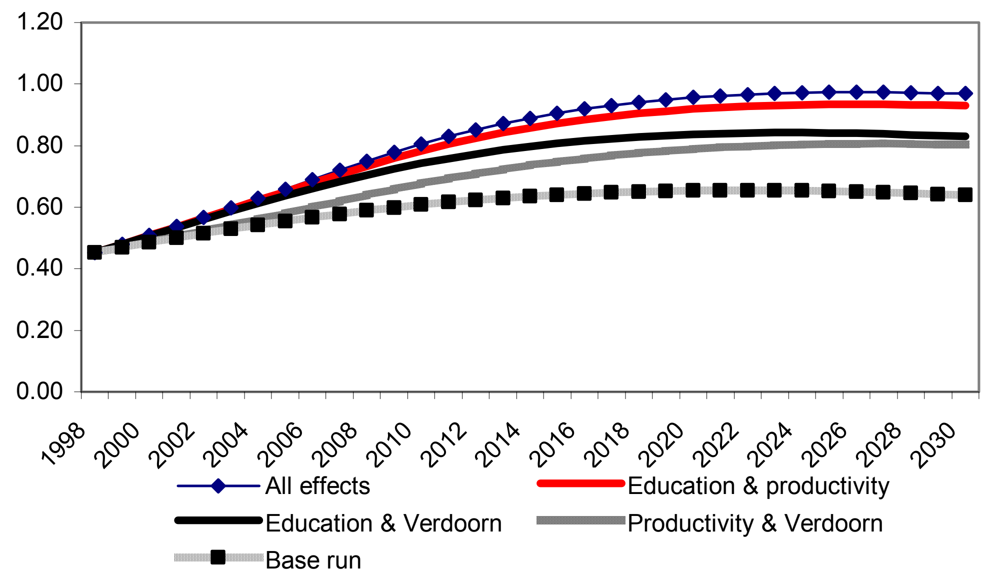

Figure 8: Combined effects of enhancement factors on catch-up scenario, Tigers vs. OECD

Regions	Population growth	GDP growth	$\hat{L}$	$\hat{K}$	ξ_L purged	ξ_K	θ_T	Z	γ	α	$\hat{H}$	R	S	D, E
Latin America	.014 (1998) ↓ .007 (2030)	.03	.0182 (1998) ↓ .006 (2022-'30)	.043 ↓ .038 (2030)	.-.0038	-.019 ↓ .005 (1998-'30)	.31 (1998) ↓ .44 (2030)	0 (1998) ↓ .019 (2030)	0 (1998) ↓ .45 (2030)	.40 (1998) ↓ .56 (2030)	.0137 (1998-2030)	.0011	.0087	.018 .06
Notes	Avrg. 1990s .017	Avrg. 1990s	Avrg. 1994-1998: .0182 Decreases at .0005	Avrg. 1990-1998 .02 decreses at .00015	Avrg. 1994-1998 .01	Avrg. 1990-1998 .018 Increases at. 002	Avrg. 1994-1998: .30 Increases at .004	Increases at .0006	Increases at .045	Increases at .005	5.95 (1998) 9 (2030)	1994-1998	1994-1998	λ ('97) =.30
Tigers	.011 (1998) ↓ .0045 (2030)	.055	.013 (1998) ↓ .0 (2027-'30)	.08 (1998) ↓ .03 (2030)	.009	-.03 ↓ .0 (2030)	.32 (1998) ↓ .45 (2030)	0 (1998) ↓ .019 (2030)	.5 (1998) ↓ .61 (2030)	.40 (1998) ↓ .50 (2030)	.012 (1998) ↓ .01 (2012-'30)	.0	.043	.029 .06
Notes	Avrg. 1990s .012	Avrg. 1990s	Avrg. 1990-1998: .0177 Decreases at .0006	Avrg. 90-1998 .095 Decreases at .0018	Avrg. 90-98 .033 adjusted by γ .021	Avrg. 1990-1998 -.048	Avrg. 1994-1998: .32 Increases at .004	Increases at .0006	Increases at .0034	Increases at .0032	8.12 (1998) 11.28 (2030)	1990-1998	1990-1998	λ ('97) =.47

TABLE 1: Incoming growth rates and values for variables which enter the simulation:

	Tigers	Latin America
Lambda 97	0.48	0.31
Increase in lambda 2030 vs 1998		
All Effects	0.52	0.43
All Effects (no retardation)	4.59	1.20
Productivity growth (trade sector)	0.31	0.06
Education effect	0.34	0.07
Verdoorn	0.22	0.03
Base run	0.19	-0.06
Education & productivity	0.48	0.14
Education & Verdoorn	0.38	0.16
Productivity & Verdoorn	0.35	0.15

Table 2: Differences in λ between 1998 (base year levels) and 2030 (levels from simulations)