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## Openness and economic growth in developing countries

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# Openness and Economic Growth in Developing Countries

By

**Erich Gundlach**

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## I. Introduction and Summary

**T**he idea that openness is one of the most important determinants of economic growth is becoming increasingly popular among governments of developing countries (DCs). Casual observation seems to suggest that more or less outward-oriented economies with few restrictions on international transactions have experienced a better economic performance than inward-oriented economies with high tariff walls and strict controls of capital movements. Hence, market-oriented economic policies, including the liberalization of international trade and capital flows, have been the centerpiece of recent reform efforts in parts of Latin America and South Asia.

Regardless of the emerging consensus on the benefits of openness among policy-makers in DCs, mainstream economists have always had some difficulties to provide the theoretical and empirical justification for the presumed positive link between undistorted trade and capital flows and the rate of economic growth. From the theoretical side, it is easy to prove that there are static economic gains from openness. But it is not straightforward to generalize from this result to a dynamic context. Static gains from openness imply a level effect, not a growth effect. And from the empirical side, the measured static gains of openness appear to be small in terms of GDP, according to most empirical estimates.<sup>1</sup>

Dynamic gains from openness may be much larger. But identifying and measuring them obviously requires an alternative theoretical ap-

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*Remark:* I thank two anonymous referees for helpful comments on an earlier version.

<sup>1</sup> This point has been emphasized by Krugman (1990) for the case of the United States. For surveys with a focus on DCs, see, e.g., Lal and Rajapatirana (1987) and Havrylyshyn (1990).

proach. The renewed interest in growth theory, mainly initiated by the seminal work of Romer (1986), seems to provide such an approach. Endogenous growth models allow for a direct and persistent link between openness and the growth rate, which is missing in the traditional neoclassical growth model (Solow 1956). For instance, Edwards (1992), Romer (1994), and Coe et al. (1995) use alternative endogenous growth models to explain a positive link between openness and the rate of economic growth as the result of the international diffusion and adoption of new technologies or new goods. Although convincing from a theoretical point of view, the major drawback of endogenous growth models is that they are difficult to reconcile with the growing body of empirical evidence on conditional convergence.<sup>2</sup>

Conditional convergence of per capita income is defined as the tendency for poor economies to grow faster than rich economies once the determinants of their steady state are held constant. Conditional convergence of per capita income is predicted by the traditional neoclassical growth model. But this model also fails for empirical reasons. The actually observed rates of convergence in the range of 2 percent can only be explained if capital's share in income is about 75 percent and if economies are closed. However, capital's share in income is about 30 percent in OECD countries on average (Maddison 1987) and capital mobility is neither severely restricted across OECD economies nor within OECD economies. If so, adjustment to the steady state should be fast and not in the range of 2 percent.

Therefore, Barro et al. (1995) suggest a neoclassical growth model for the open economy that allows for a relatively low rate of convergence in the presence of capital mobility. This model predicts that in adjusting to their steady state, open economies should grow faster than closed economies. Open economies can acquire physical capital more quickly due to the availability of international financial markets. Hence, diminishing returns set in faster, and speed of convergence to the steady state is higher. Yet for reasonable parameter values stemming from the U.S. economy, Barro et al. conclude that the speed of convergence is only marginally higher for open than for closed economies. Put differently, although capital mobility tends to raise the rate

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<sup>2</sup> See, e.g., Dowrick and Nguyen (1989) and Gundlach (1993) for convergence across OECD countries; Barro and Sala-i-Martin (1991, 1992) for convergence across U.S. states, European regions and Japanese prefectures; Jian et al. (1996) and Gundlach (1996) for convergence across Chinese provinces in the reform period; Bajpai and Sachs (1995) for convergence across Indian states; and Zini and Sachs (1996) for convergence across Brazilian states. For an overview, see Sala-i-Martin (1995).

at which poor open economies converge to their steady state, the quantitative impact of openness is held to be small, at least for industrialized countries.

My empirical findings for DCs point to a different conclusion. Physical capital's share in factor income is the crucial parameter that determines the difference in the predicted convergence rates for open and closed economies. If physical capital's share is about 60 percent, as in many DCs, the convergence rates for open and closed economies are predicted to differ by a factor of about 2.5. My regression results for open and closed DCs roughly confirm this hypothesis. I find that holding constant other determinants of the steady state, open DCs converge at a rate of about 5 percent to the steady state while closed economies converge at a rate of about 1.5 percent.

## II. Convergence to the Steady State in Neoclassical Growth Models

Mankiw et al. (1992) develop a human capital augmented neoclassical growth model for the closed economy that takes the rates of saving, labor force growth and technological progress as exogenous. Output ( $Y$ ) is produced under constant returns to scale with three inputs, capital ( $K$ ), human capital ( $H$ ), and labor ( $L$ ), which are paid their marginal products. Assuming a Cobb-Douglas production function, output at time  $t$  is given by

$$Y_t = K_t^\alpha H_t^\beta (A_t L_t)^{1-\alpha-\beta}, \quad 0 < \alpha + \beta < 1. \quad (1)$$

$A$ , the level of technology, and  $L$  are assumed to grow exogenously at rates  $g$  and  $n$ . Hence, the number of effective units of labor,  $A_t L_t$ , grows at rate  $g + n$ . Assuming constant saving ( $s_i = S_i/Y$ ) and depreciation rates ( $\delta = D/K = D/H$ ), and defining  $k$  as the stock of physical capital per effective unit of labor ( $k = K/AL$ ),  $h$  as the stock of human capital per effective unit of labor, and  $y$  as output per effective unit of labor ( $y = Y/AL$ ), it can be shown that the evolution of  $k$  and  $h$  is governed by (Mankiw et al. 1992)<sup>3</sup>

$$dk/dt = s_k y - (n + g + \delta)k \quad \text{and} \quad (2a)$$

$$dh/dt = s_h y - (n + g + \delta)h. \quad (2b)$$

<sup>3</sup> In the following, I delete time subscripts for convenience of presentation.

Furthermore, it can be shown that the economy converges to a steady state given by

$$k^* = \left( \frac{s_k^{1-\beta} s_h^\beta}{n + g + \delta} \right)^{1/(1-\alpha-\beta)} \quad \text{and} \quad (3a)$$

$$h^* = \left( \frac{s_k^\alpha s_h^{1-\alpha}}{n + g + \delta} \right)^{1/(1-\alpha-\beta)}. \quad (3b)$$

Approximating around the steady state, the speed of convergence for the closed economy ( $\lambda_{closed}$ ) can be derived as

$$\lambda_{closed} = (n + g + \delta)(1 - \alpha - \beta), \quad (4)$$

where  $\alpha$  and  $\beta$  are the production elasticities of physical and human capital (see (1)). According to the underlying assumptions of perfect competition and constant returns to scale, the production elasticities should equal physical and human capital's share in factor income.

If the rate of convergence is about 2 percent as estimated by most empirical studies,<sup>4</sup> it follows that (4) can be used to infer an estimate for  $\alpha + \beta$ , conditional on  $(n + g + \delta)$ . The standard parameterization suggested in the literature is a rate of labor force growth of 1 percent, a rate of technological change of 2 percent, and a depreciation rate of 5 percent (Barro et al. 1995), so  $n + g + \delta$  equals 8 percent. If so,  $\alpha + \beta$  should be about 75 percent in order to explain a rate of convergence of about 2 percent. At least for the United States, the sum of the predicted factor shares has roughly been confirmed: Jorgenson et al. (1987) estimate that physical capital's share in factor income is about 30 percent and human capital's share in factor income is about 50 percent. Hence, using a broad concept of capital that includes human capital solves one of the apparent empirical implausibilities of the traditional neoclassical growth model (Solow 1956).

The remaining problem for the human capital augmented neoclassical growth model arises from the implicit assumption of capital immobility. Capital immobility may or may not be a reasonable assumption in cross-country studies, but it is rather unlikely to hold across European regions or within countries such as the United States, Japan, China, India, and Brazil (for references, see footnote 2). If

<sup>4</sup> See footnote 2 for references; a rate of convergence of about 2 percent has also been estimated for a cross section of 75 countries (Mankiw et al. 1992).

capital mobility is perfect, adjustment to the steady state should be instantaneous; if capital mobility is high, convergence of per capita income should be rapid. Put differently, the observed convergence rates of about 2 percent are difficult to explain if capital is mobile, as it typically is at least within countries.

Therefore, Barro et al. (1995) suggest the assumption of imperfect capital mobility in order to bridge the apparent gap between theory and empirical evidence. They assume that physical capital is mobile across economies, but human capital is not. That is, goods and capital are tradable among economies, but labor cannot migrate. Moreover, they assume that physical capital can be used as a collateral for international borrowing, whereas human capital cannot. The further assumption introduces an asymmetry between the two stocks of capital.

Adjustment to the steady state level of physical capital will be fast due to the assumed possibility of international borrowing, but adjustment to the steady-state level of human capital will probably be slow. Hence, physical and human capital are modeled as imperfect substitutes as inputs to production, and the relative size of the accumulated stocks of physical and human capital determines the fraction of broad capital that can be used as collateral. As it turns out, all these assumptions do not change the predicted steady state itself, but they affect the rate of convergence. For the credit-constrained open economy, the convergence rate is given by (Barro et al. 1995)

$$\lambda_{open} = (n + g + \delta) \left( 1 - \frac{\beta}{1 - \alpha} \right). \quad (5)$$

The relation between the two rates of convergence for open and closed economies is given by

$$\frac{\lambda_{open}}{\lambda_{closed}} = \frac{1 - \frac{\beta}{1 - \alpha}}{1 - \alpha - \beta} = \frac{1}{1 - \alpha}. \quad (6)$$

The difference between the two convergence rates only depends on physical capital's share in income, which is the only mobile factor in the model. If physical capital's share in income is about 30 percent, which is the average for industrialized countries (Maddison 1987), the rate of convergence to the steady state is 1.5 times higher for the open economy than for the closed economy. Barro et al. (1995) argue that

the quantitative impact of this difference is likely to be small, but such an interpretation deserves second thoughts.<sup>5</sup>

In any case, it should be noted that the effect of openness on the gap between actual and steady state per capita income will increase with physical capital's share in factor income. For example, if physical capital's share is about 60 percent, the convergence rate for the open economy is predicted to be 2.5 times higher than the convergence rate for the closed economy. Thus, openness matters especially for those economies that exhibit a relatively high share of physical capital and a correspondingly low share of labor in factor income. Such a functional distribution of income is typical for many DCs.

### III. Capital's Share in Factor Income in Developing Countries

I use National Accounts Statistics provided by the UN (1994) to calculate an average physical capital share in factor income for a large number of DCs. More specifically, I derive physical capital's share as consumption of fixed capital plus operating surplus, divided by GDP less indirect taxes plus subsidies. My final sample of DCs is limited for a number of reasons. Obviously, I can only include DCs which report detailed National Accounts Statistics to the UN. Furthermore, I exclude formerly socialist economies in Central and Eastern Europe and the successor states of the former Soviet Union. I also exclude DCs with a population of less than 1 million in 1992, DCs with less than three observations in 1980–1992, and DCs with oil production as the dominant industry. Detailed results for average physical capital shares in factor income are presented in Table 1.

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<sup>5</sup> Barro et al. (1995) predict a convergence rate of 1.4 percent for the closed economy and a convergence rate of 2.2 percent for the open economy, based on their parameterization of the model which relies on estimates for the U.S. economy. This theoretical result is largely in line with the empirical findings for convergence within countries, and for convergence across European regions and OECD economies. As indicated by (6), the relatively small difference between the two rates of convergence mainly reflects that physical capital's share in factor income is set to be about 30 percent. Nevertheless, even an apparently small difference in predicted convergence rates may reappear as a relatively large effect with regard to the time span necessary to close the gap between actual and steady-state per capita income. For instance, halfway to steady state is reached in  $t$  years according to  $t = \ln(2)/\lambda$ , with  $\lambda$  as the convergence rate. Hence, if  $\lambda = 1.4$  percent for the closed economy,  $t$  equals 49.5 years; if  $\lambda = 2.2$  percent for the open economy,  $t$  equals 31.5 years. That is, the Barro et al. results imply that the open economy would reach halfway to steady state more than half a generation (18 years) earlier than the closed economy. Whether this effect of openness is small is not self-evident, to say the least.

Table 1 – *Average Shares of Physical and Human Capital in Factor Income for Selected Developing Countries, 1980–1992 (percent)*

Country	Physical capital share	Human capital share	Broad capital share	Note: Real GDP per worker, 1990 <sup>a</sup>
Algeria	53.0	–	–	12 176
Benin	77.8	–	–	1 903
Bolivia	65.6	11.3	76.9	5 315
Botswana	64.6	23.5	88.1	6 533 <sup>b</sup>
Burkina Faso	70.6	–	–	1 058
Burundi	76.6	–	–	1 062
Cameroon	68.2	–	–	2 489
Chile	56.8	21.6	78.4	11 854
Colombia	55.6	26.6	82.2	10 108
Congo	61.2	–	–	4 497
Costa Rica	46.5	28.7	75.2	10 040
Ecuador	77.2	11.7	88.9	9 032
Honduras	49.0	24.3	73.3	4 464
Hong Kong	48.0	29.6	77.6	22 827
Israel	42.1	21.9	64.0	23 780
Jamaica	47.6	27.6	75.2	5 146
Jordan	55.1	–	–	12 634
Kenya	57.9	14.9	72.8	1 863
Korea, Rep.	52.5	23.8	76.3	16 022
Malawi	75.9	6.9	82.8	1 217
Malaysia	60.4	13.7	74.1	12 527
Mauritius	51.9	–	–	10 198
Mexico	68.6	17.0	85.6	17 012
Myanmar	56.7	–	–	1 362 <sup>b</sup>
Namibia	45.8	–	–	9 528
Niger	81.3	–	–	1 043 <sup>b</sup>
Nigeria	79.2	–	–	2 082
Nepal	41.1	–	–	2 298 <sup>c</sup>
Panama	47.5	30.3	77.8	7 999
Papua New Guinea	57.3	6.8	64.1	3 020
Paraguay	68.2	19.8	88.0	6 383
Peru	67.0	12.2	79.2	6 847
Philippines	64.7	15.5	80.2	4 784
Puerto Rico	53.5	–	–	26 137 <sup>b</sup>
Rwanda	74.4	–	–	1 539
Sierra Leone	80.2	3.3	83.5	2 487
South Africa	41.9	37.1	79.0	9 595
Sri Lanka	47.2	16.1	63.3	5 742
Sudan	62.7	–	–	2 333
Tanzania	84.4	4.0	88.4	1 126 <sup>d</sup>
Thailand	71.5	18.8	90.3	6 754
Trinidad and Tobago	43.2	–	–	19 880
Turkey	71.2	–	–	8 632
Uruguay	54.1	18.9	73.0	11 828
Venezuela	63.6	15.4	79.0	17 426
Zambia	52.7	–	–	2 061
Zimbabwe	41.6	14.5	65.1	2 437
<i>Unweighted average</i>	60.3	18.4	77.6	–
Standard error	12.4	8.4	8.4	–

<sup>a</sup> 1985 international prices. – <sup>b</sup> 1989. – <sup>c</sup> 1986. – <sup>d</sup> 1988.

Source: PWT (1994); UN (1994).



The average physical capital share for developing countries is about 60 percent, with a standard error of 12.4. This figure is substantially higher than the average figure reported for samples of OECD countries (Pritchett 1996; Maddison 1987). The variation of physical capital's share in factor income across DCs is negatively correlated with labor productivity: The statistically significant correlation coefficient is  $-0.49$  for the log of the capital share and the log of real GDP per worker. That is, poor DCs tend to have a higher physical capital share than more advanced DCs.

A severe problem with these estimates is that in some cases not all factor income may be appropriately accounted for due to a lack of statistical information. For instance, income of peasant farmers and small retail shops, which represents a reasonable part of all factor income in poor countries, may be accounted for as proprietor's income. However, proprietor's income would be included in physical capital's share in factor income. A physical capital share of about 80 percent for Niger, Sierra Leone and Tanzania may simply reflect this kind of mismeasurement. Nevertheless, it is not clear that the same upward bias is equally strong in the other estimates as well. This is because the finding of an average physical capital share of about 60 percent for DCs can be supported by a simple back-of-the-envelope calculation.

Observed capital output ratios for poor countries can be used together with the presumed physical capital share in factor income to derive an implied estimate for the rate of return to capital. With a capital output ratio of 1.5 (PWT 1994) and a presumed physical capital share of 60 percent for poor countries, it follows that the rate of return is 40 percent. This compares to a rate of return of 10 percent for the United States with a capital output ratio of 3 and a physical capital share of 30 percent (Mankiw et al. 1992). Gross rate of return differentials of this size appear to be compatible with observed international capital flows, once international differences in taxes and political risk are taken into account. By implication, poor countries should have a higher share of physical capital in factor income than rich countries.

This reasoning is also supported by the findings of Elias (1992) who, after adjusting the initial National Accounts data for a number of statistical problems, finds an average physical capital share of about 60 percent for seven Latin American economies. His point estimates for 1980 and 1985 are rather close to the estimates presented in Table 1 for Chile, Colombia, Mexico, and Peru. His estimate for

Venezuela (58.2 percent) is somewhat lower than the estimate in Table 1; his estimates for Argentina (62.9 percent) and Brazil (62.1 percent) support the average finding presented in Table 1. All this seems to suggest that an average physical capital share in factor income of about 60 percent for DCs is not completely off the mark.

Given that the estimate for physical capital's share in factor income is not entirely unrealistic, it is possible to calculate human capital's share in factor income as well. For an average physical capital share of about 60 percent, the upper bound of human capital's share is 40 percent once unimproved labor does not receive any return. But obviously, unimproved labor also receives a return, so human capital's share in factor income can be expected to be lower than 40 percent in DCs. If physical capital is internationally mobile but human capital is not, then the relative lack of human capital in DCs is the very reason for their relative backwardness. Hence, it seems reasonable to presume that the poorer the country, the lower will be its human capital share in income. This implication is confirmed by the results of cross-country regression analyses (Mankiw et al. 1992; Gundlach 1995), which show that human capital is at least as important as physical capital in explaining international income differences.

Human capital's share in factor income cannot be calculated directly because there is no counterpart in the National Accounts. One way to derive an estimate for human capital's share in the *total wage bill* is to focus on the rate of return to education and average years of schooling, thereby assuming that investment in education is the same thing as an increase in the stock of human capital. For example, it would follow that investment in education raises income by a factor of three, if schooling is about 8 years on average and the social rate of return to secondary education is about 13 percent, where both figures represent worldwide averages (Psacharopoulos 1993). The derived multiplier of education in the range of three remains almost unchanged for different regions of the world, because the rate of return to education tends to decline with rising years of schooling: Sub-Saharan Africa comes up with a multiplier of 2.9, non-OECD Asia with 3.1, Latin America with 2.8, and the OECD with 3.0.<sup>6</sup>

Hence, income is predicted to be about three times higher with human capital than without. As a result, human capital's share in the total wage bill should be about two thirds. Multiplying this figure with

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<sup>6</sup> Calculated from Psacharopoulos (1993) as social rate of return to secondary education times average years of schooling, raised to the power of  $e$ .

labor's total share in factor income gives the share of human capital in factor income. If labor's share in factor income is about 70 percent as in OECD countries, human capital's share can be expected to be about 45 percent; if labor's share in factor income is about 40 percent as in DCs, human capital's share can be expected to be about 25 percent.

I use estimates of the social rate of return to education summarized by Psacharopoulos (1993) and average years of schooling from Barro and Lee (1993) to calculate human capital's share in factor income for some of the DCs listed in Table 1.<sup>7</sup> For average years of schooling below 5 years, I use the social rate of return to primary education; for more than 5 years of schooling, I use the social rate of return to secondary education. In cases where the respective social rate of return to education is not available, I use Mincerian rates of return to education.<sup>8</sup> The results are presented in the second column of Table 1.

Overall, I find that human capital's share in factor income is only about one third of physical capital's share. Together, both shares account for about 80 percent of total factor income, i.e., 20 percent of total factor income may be accounted for by low-skilled labor that does not receive a return for human capital. This result for a broad share of capital in the range of 80 percent is roughly in line with other empirical studies (Mankiw et al. 1992; Gundlach 1995; Pritchett 1996) and the standard parameterization used for the U.S. economy (Barro et al. 1995). But the relative weight of physical and human capital in DCs seems to be completely the reverse of the relative weight observed for industrialized countries. This reversal of weights has strong implications for the implied rates of convergence for open and closed DC economies.

#### IV. Openness and Convergence Reconsidered

##### 1. Theory

Depending on the size of physical capital's share in factor income, the neoclassical growth model outlined in Section II predicts different rates of convergence to the steady state (see equations (4) and (5)).

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<sup>7</sup> For the remaining DCs, rates of return to education are not reported in Psacharopoulos (1993).

<sup>8</sup> The Mincerian rate of return to education can be interpreted as the average private rate of return to one additional year of education. I use this rate instead of the social rate of return for Kenya, Malaysia, Panama, Peru, and Sri Lanka.

This difference matters in quantitative terms because for reasonable parameterizations, the model also predicts that convergence to the steady state will evolve over a relatively long time period. That is, although openness does not change the model's steady state itself, it changes the implied convergence rate. As a result, open economies are predicted to realize substantial GDP gains within a shorter time period than closed economies.

For instance, consider the standard parameterizations for the rate of technological change (2 percent) and the depreciation rate (5 percent), and an average rate of labor force growth of about 2 percent for low- and medium-income countries in 1980–1993 (World Bank 1995). For average shares of physical and human capital in factor income of about 60 and 20 percent as reported in the last section, the model would predict that the closed economy will experience a convergence rate of 1.8 percent per year (see equation (4)). By contrast, in this case the open economy is predicted to experience a convergence rate of 4.5 percent per year (see equation (5)).

These findings have two main implications. First, for both convergence rates, the time period is fairly long until adjustment to the steady state is completed (Table 2). It would take about 50 years for the open economy to reach 90 percent of the steady-state GDP, while the closed economy would only reach 60 percent of the steady-state GDP after 50 years of adjustment. That is, economic policies that influence the accumulation of physical and human capital have more

Table 2 – *Theoretical Adjustment to the Steady State for Open and Closed Economies*

Years	Adjustment to the steady state (percent)	
	Open economy ( $\lambda_{open} = 4.5$ percent)	Closed economy ( $\lambda_{closed} = 1.8$ percent)
5	20.1	8.6
15	49.1	23.7
38	81.9	49.5
50	89.5	59.3
100	98.9	83.5

*Note:* The percentage of the steady state achieved for a given convergence rate ( $\lambda$ ) after  $t$  years is given by  $1 - [1/(e^{\lambda t})]$ .

than a short-run impact on the growth rate, because transition to the steady state will take place over decades, even in the open economy.<sup>9</sup>

Second, a large portion of the adjustment to the steady state occurs within a relatively short time period, at least in the case of the open economy. The open economy will reach halfway to steady state (50 percent) in about 15 years, while the closed economy will reach halfway to steady state in about 38 years (Table 2). Put differently, the open economy will reach halfway to steady state in about one generation earlier than the closed economy. As is self-evident, one would predict other time spans for other parameterizations of technological change, depreciation, and labor force growth. But if physical capital's share in factor income is about 60 percent in a typical DC, it simply matters whether this country is open or not: independent of other variables, the two convergence rates will differ by a factor of 2.5 (see equation (6)).

This difference is large. For example, the open economy will reach a GDP level that is about twice as high as the GDP level of the closed economy after 15 years of transition to the steady state (see Table 2). Since both economies ultimately converge to the same steady state, this difference must decline over time. Still, even after five decades of transition to the steady state, the open economy will lead in terms of GDP by more than 30 percent compared to the closed economy. Hence, at least in theory, it seems to follow that especially DCs can gain a lot from policies of external liberalization.

## 2. Empirical Evidence

If the theory underlying the neoclassical model is correct, those DCs that tend to be more open should have experienced a better growth performance, i.e., a higher rate of convergence to the steady state. One major difficulty for checking the plausibility of the model is to find an appropriate empirical measure of openness. Several measures have been suggested in the literature.

For a start, measures focusing on export performance as an indicator of openness (World Bank 1993) are problematic for two reasons. The export share in output tends to be endogenous with regard to output growth, and it tends to decline with country size. Put differ-

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<sup>9</sup> Therefore, it does not come as a surprise that there is a fairly stable positive cross-country correlation of growth rates and investment rates. This correlation does not necessarily support the relevance of capital externalities (De Long and Summers 1991); it can reasonably be explained as reflecting off-steady state behavior of the economy.

ently, output growth may cause an increase in the output share of exports rather than the other way round, and such an increase is more likely to happen in small countries than in large countries.

The Dollar index of openness (Dollar 1992), focusing on a country's relative price level in tradable goods, has been criticized for being a measure of real exchange rate divergence, which lacks credibility as a measure of openness. For instance, an increase in trade restrictions can move the Dollar index in either direction (Rodrik 1994). Other measures of openness, focusing on the absence of export or import quotas and a black-market premium over the official exchange rate (Sachs and Warner 1995), are somewhat difficult to reconcile with the concept of openness used in the neoclassical growth model outlined in Section II. This model identifies capital mobility as the decisive indicator of openness. However, the link between capital mobility and the absence or presence of quotas and black-market premiums is not straightforward: net capital flows have been surprisingly low between countries with fairly liberal trade regimes and undistorted exchange rates (Feldstein and Horioka 1980).

Feldstein and Horioka measure the degree of international capital mobility by a regression of the investment share on the saving rate. The resulting so-called savings retention coefficient measures that fraction of an increase in domestic savings that ends up as domestic investment. If the savings retention coefficient equals 1, the economy is completely closed because an increase in domestic saving would lead to an identical increase in domestic investment. By contrast, if the savings retention coefficient equals 0, the economy is completely open because all additional domestic saving would end up as foreign investment.<sup>10</sup>

Montiel (1994) uses the Feldstein-Horioka approach in a time series context and finds a surprisingly high degree of capital mobility in his sample of DCs. Choosing from a number of alternative specifications, his most preferred results indicate that out of a sample of 57 DCs, 33 can be considered as open and nine can be considered as

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<sup>10</sup> Many authors have criticized this approach by showing that a high savings retention coefficient, especially in a time series context, does not necessarily imply the absence of capital mobility. By contrast, given that there are no data problems and no specification problems, it would be difficult to interpret the finding of a low savings retention coefficient as not indicating net capital flows. For a brief survey of the empirical evidence on the relation between saving and investment rates from cross-country and inter-regional studies, and for the controversies that have arisen in the literature with regard to an interpretation of the savings retention coefficient with regard to capital mobility, see Feldstein (1994).

closed, while the remaining cases remain statistically indecisive (see Montiel 1994: Table 3, columns 3 and 6). These results seem to be fairly robust, since a number of factors are controlled for which may cause a potential downward bias in the estimated savings retention coefficient. Such factors are the possible impact of development aid, the potential endogeneity of the saving rate, and the specific time series properties of the data.

Unfortunately, Montiel's sample includes countries which do not provide detailed National Accounts Statistics that allow for a calculation of physical capital's share in factor income. I delete these countries from Montiel's sample of open and closed economies to control for data quality. My resulting sample consists of 13 open and 9 closed DCs. The DCs in Table 1 that can be identified as open according to Montiel's results<sup>11</sup> are Benin, Cameroon, Chile, Colombia, Costa Rica, Ecuador, Malaysia, Mauritius, Mexico, Paraguay, Peru, Sierra Leone, and Uruguay; the DCs that can be identified as closed are Honduras, Kenya, Malawi, Nepal, Niger, Nigeria, the Philippines, Venezuela, and Zimbabwe. For this sample of 22 DCs, I estimate the two rates of convergence for open and closed economies.

Mankiw et al. (1992) show that based on the production function given in (1), the rate of convergence ( $\lambda$ ) can be estimated by regressing the log difference of output per worker at time  $t$  and some initial date 0 on the determinants of the steady state and the initial level of output. Augmenting such an equation by a slope and a level dummy for openness, I get

$$\begin{aligned} \ln(Y/L)_t - \ln(Y/L)_0 = & c + (1 - e^{-\lambda t}) \frac{\alpha}{1 - \alpha - \beta} \ln(\Delta K/Y) \\ & + (1 - e^{-\lambda t}) \frac{\beta}{1 - \alpha - \beta} \ln(\Delta H/Y) - (1 - e^{-\lambda t}) \frac{\alpha + \beta}{1 - \alpha - \beta} \ln(n + g + \delta) \\ & - (1 - e^{-\lambda t}) \ln(Y/L)_0 + OPEN - \gamma SLOPEN, \end{aligned} \quad (7)$$

where  $c$  is a regression constant,  $\Delta K/Y$  is investment in physical capital, and  $\Delta H/Y$  is investment in human capital, both expressed as shares in output.  $OPEN$  is a level dummy which equals 1 for open

<sup>11</sup> Montiel (1994) suggests a benchmark value of 0.6 for the estimated savings retention coefficient to decide whether an economy is open or closed. Whenever his IV-estimate is close to 0.6, I use his OLS-estimate to decide whether an economy should be classified as open or closed.

DCs and 0 otherwise, *SLOPEN* is a slope dummy which equals initial income for open DCs and 0 otherwise. All other variables and parameters are defined as before.

Investment in human capital as a share of output ( $\Delta H/Y$ ) is measured as the percentage of the working age population that is in secondary school, and taken from Mankiw et al. (1992). All other variables are taken from Summers and Heston (1991): Output per worker ( $Y/L$ ) is real GDP per worker in 1985 international prices, investment in physical capital as a share of output ( $\Delta K/Y$ ) is real gross domestic investment as a share of real GDP in 1985 international prices, and  $n$  is the implicit growth rate of the labor force derived from measures of real GDP and real GDP per worker. Time  $t$  is 1985, time 0 is 1960.

With only 22 observations at hand, a regression based on the specified convergence equation would result in a serious degrees of freedom problem. Therefore, I restrict the convergence equation according to the empirical results in Mankiw et al. (1992: Tab. VI, intermediate sample) as

$$\begin{aligned} \ln(Y/L)_t - \ln(Y/L)_0 - 0.506 [\ln(\Delta K/Y) - \ln(n + g + \delta)] \\ - 0.266 [\ln(\Delta H/Y) - \ln(n + g + \delta)] \\ = c - (1 - e^{-\lambda t}) \ln(Y/L)_0 + OPEN - \gamma SLOPEN. \quad (8) \end{aligned}$$

That is, my regression equation uses the conditional growth rate as the new dependent variable. The conditional growth rate controls for differences among DCs in the two rates of factor accumulation and in the rate of labor force growth, which together determine the steady state. With this approach, I estimate the following regression coefficients and the implied rates of convergence (standard errors in parentheses):

$$\begin{aligned} \text{Conditional growth rate} = & 2.53 + 3.62 \text{ OPEN} \\ & (0.73) \quad (1.09) \\ & - 0.31 \ln(Y/L)_0 - 0.41 \text{ SLOPEN} \\ & (0.09) \quad (0.13) \end{aligned}$$

Number of observations: 22  $\bar{R}^2 = 0.76$  s.s.e. = 0.22

$$\text{Implied } \lambda_{open}^{DC}: 0.051 \quad \text{Implied } \lambda_{closed}^{DC}: 0.015 .$$

(0.013) (0.006)

My empirical findings for the two rates of convergence confirm the difference between open and closed economies predicted by the neoclassical model of economic growth: Open DCs converge at a



much higher rate to their steady state than closed DCs.<sup>12</sup> For DCs with physical capital's share in factor income of about 60 percent and human capital's share in factor income of about 20 percent, the model predicts a convergence rate of 4.5 percent for the open economy and of 1.8 percent for the closed economy. My point estimates closely resemble this prediction. Put differently, although openness does not change the steady state itself, it considerably shortens the time period until the steady state is reached. Taking the point estimates for the two convergence rates literally, the open economy would reach halfway to steady state in about 23 years earlier than the closed economy. Even after five decades of transition to the steady state, the open economy would lead in terms of GDP by about 40 percent compared to the closed economy.

Summarizing, openness along with factor accumulation matters for economic growth, especially in DCs. In qualitative terms, this finding may not come as a surprise. The surprise is the quantitative importance of openness for the convergence rate, and hence the growth rate.

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<sup>12</sup> See Sachs and Warner (1995) for a similar result. They also report that open DCs show higher-than-average growth, and therefore convergence. However, their empirical results are difficult to reconcile with the model they use. First, their estimated regression coefficients on initial income either do not allow for a calculation of the convergence rate (their Table 4) or imply an inconsistent convergence rate of about 9.6 percent (their Table 5). Second, the impact of openness is measured by a level dummy, although the underlying model suggests to measure the impact of openness by a slope dummy.

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**Abstract:** Openness and Economic Growth in Developing Countries. – Openness appears to have a strong impact on economic growth especially in DCs which typically exhibit a high share of physical capital in factor income and a low share of labor. In the neoclassical growth model with partial capital mobility, physical capital's share in factor income determines the difference in the predicted convergence rates for open and closed economies. With a 60 percent share as in many DCs, the convergence rates should differ by a factor of 2.5. The regression results for a sample of open and closed DCs roughly confirm this hypothesis. JEL no. O41

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**Zusammenfassung:** Offenheit und Wirtschaftswachstum in Entwicklungsländern. – Offenheit scheint insbesondere in Entwicklungsländern, wo das physische Kapital im Vergleich zum Produktionsfaktor Arbeit typischerweise einen hohen Anteil am Faktoreinkommen aufweist, einen starken Einfluß auf das Wirtschaftswachstum zu haben. Nach dem neoklassischen Wachstumsmodell mit partieller Kapitalmobilität wird die Differenz der erwarteten Konvergenzraten für offene und geschlossene Volkswirtschaften von dieser Kapitalquote bestimmt. Bei einer Kapitalquote von 60 vH, wie sie in vielen Entwicklungsländern vorherrscht, sollten die Konvergenzraten danach mit einem Faktor von 2,5 divergieren. Diese Hypothese wird durch die Regressionsergebnisse für eine Stichprobe von offenen und geschlossenen Entwicklungsländern weitgehend bestätigt.