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IMF Institute

**Sources of Economic Growth: An Extensive Growth Accounting Exercise**

Prepared by Abdelhak Senhadji<sup>1</sup>

Authorized for distribution by Roland Daumont

June 1999

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**Abstract**

A growth accounting exercise is conducted for 88 countries for 1960-94 to examine the source of cross-country differences in total factor productivity (TFP) levels. Two differences distinguish this analysis from that of the related literature. First, the critical technology parameter—the share of physical capital in real output—is econometrically estimated and the usual assumption of identical technology across regions is relaxed. Second, while the few studies on the determinants of cross-country differences in TFP have focused on *growth rates* of real output this analysis is on *levels*. Recent theoretical as well as empirical arguments point to the level of TFP as the more relevant variable to explain.

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## I. INTRODUCTION

The heated debate on the sources of growth in the East Asian countries initiated by Young (1994) and then Krugman (1994) has spurred a growing literature on the subject. Both authors contend that the “Asian Miracle” is a myth because the engine driving the spectacular growth in the region (at least until recently) came essentially from capital accumulation instead of total factor productivity (TFP) growth. Why does the source of growth matter? The neoclassical growth model, with its main assumption of diminishing returns in physical, capital provides the answer. If this assumption is correct—and the large empirical growth literature tends to support it—capital accumulation cannot sustain long-term growth while TFP can. Thus, the source of growth is crucial for the long-term perspective of a country. The Krugman-Young analysis has been reexamined and extended to other countries.<sup>2</sup>

All these studies use the growth accounting framework, which is based on an aggregate production function expressed in growth rates. The results of the growth accounting exercise therefore depend on the specification of the production function. The bulk of the literature has adopted the Cobb-Douglas production function whose parameter, the share of the remuneration of physical capital in aggregate output, is typically set to a benchmark value of 1/3 suggested by the national income accounts of some industrial countries.<sup>3,4</sup> This numerical specification is assumed to be the same across countries, which implies identical production technology for all countries. Although most authors provide some sensitivity analysis on the value of the share of physical capital, they do not address the issue of adequacy of the assumption of identical technologies across countries. If the data fail to support this assumption, and there is no compelling reasons to believe it does—on the contrary, one may think of many reasons why technologies differ across countries and regions—the comparison of the sources of growth across countries and regions may be flawed.

For the growth accounting exercise in this paper, the assumption of identical technologies across regions is relaxed. The 88 countries in the sample are divided into six regions. The production function is assumed to be identical across countries within regions but different among countries across regions. The estimates of the production function for each region are

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<sup>2</sup> See for example, Collins and Bosworth (1996), Hu and Khan (1997), and Sarel (1997).

<sup>3</sup> Total differentiation of any production function in logs will yield the growth rate of output as a linear combination of the growth rate of the inputs. Under constant returns to scale, the weights on the factor inputs are equal to their share in output, and thus could be estimated from national accounts data when available.

<sup>4</sup> The Cobb-Douglas production function imposes a unit elasticity of substitution between capital and labor. This assumption has been relaxed in some studies by adopting more general production functions such as the translog function. See Young (1994) and Hu and Khan (1997) for the use of the translog production function.

obtained either by averaging individual country estimates belonging to each region or through regional panel estimation.<sup>5</sup>

An argument often made in the literature against the estimation of production functions for determining the share of physical capital (the key parameter in the accounting exercise) is the problem of potential endogeneity of the explanatory variables, namely capital and labor inputs. The Fully-Modified estimator, which is used to estimate the production function of each country, corrects for this potential problem as well as for the likely autocorrelation of the error term.

The estimation of the production function also raises the issue of whether to estimate it in levels or in first differences. As is well known, the first difference operator removes all the long-run information in the data. One important insight from the cointegration literature is that we know much more about the long-run than the short-run relationship between macroeconomic variables. Consequently, differencing amounts to disregarding the most valuable part of information in the data.

In the context of production function estimation, this point is particularly relevant. It will be shown below that the growth rate of real GDP varies much more than does the growth rate of capital (both physical and human) and labor inputs; thus the link between GDP growth and input growth is likely to be very weak. Furthermore, the business cycle frequencies of the production process may be dominated by variations in capacity utilization factors which are difficult to measure, especially for developing countries. In light of the discussion above, the production function will be estimated in levels. Nonetheless, given that the Cobb-Douglas production function has traditionally been estimated in first-difference, the paper will also provide first-difference estimates for comparison.

This growth accounting exercise uses a different production function estimates for each region to break down the growth rate of real GDP into contributions from capital and labor for the 88 countries in the sample and six regional aggregates. The analysis of TFP covers the periods 1960–73, 1974–86, 1987–94, and 1960–94 and the issue of robustness is examined through extensive sensitivity analysis.

Few studies have attempted to explain cross-country differences in TFP. The ones that have, focused on cross-country differences in *growth rates* of TFP, with the notable exception of Hall and Jones (1998), who show that a significant share of the cross-country variation in

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<sup>5</sup> Even though a production function will be estimated for most countries, the growth accounting exercise will use only regional averages of individual country estimates or regional panel estimates of the share of physical capital in aggregate output. The main reason is that individual country estimates may be imprecisely estimated or biased. Averaging may reduce the imprecision and/or the bias if the bias is upward for some countries and downward for others.

TFP level can be explained by “social infrastructure”.<sup>6</sup> Three reasons describe why levels matter more than growth rates. First, growth rates are important only to the extent that they are a determining factor of levels. Second, recent contributions to the growth literature focus on levels instead of growth rates. For example, Easterly and others (1993) show that growth rates over decades are only weakly correlated, suggesting that cross-country differences in growth rates may essentially be transitory. Moreover, several recent models of technology transfer across countries imply convergence in growth rates as technology transfers prevent countries from drifting away from each other indefinitely. In these models, long-run differences in levels are the pertinent subject of analysis. And, third, the cointegration literature has clearly demonstrated the superiority of level equation versus first-difference equations when series are nonstationary. Formal unit-root tests show indeed that these variables cannot reject the unit-root hypothesis.

As in Hall and Jones (1998), this paper analyzes the determinants of cross-country differences in TFP levels, but with three important differences. First, Hall and Jones assume the same technology across-countries and regions by setting the share of physical capital to one-third for all countries, whereas this paper assumes different technologies for each of the six regions and estimates the technology parameter econometrically. Second, Hall and Jones focus on the institutions as the determining factor of cross-country differences in TFP levels. While institutions undoubtedly play a fundamental role in shaping the productive capacity of a country, it is a tour de force trying to quantify their effects, for good proxies for the quality of institutions do not exist. Third, while Hall and Jones use cross-section data to conduct their analysis, this paper uses panel data, which enriches the analysis by considering not only the cross-country differences in the TFP level but also the evolution of TFP for a given country.

The paper is organized as follows. Section II briefly reviews the growth accounting framework, discusses the estimation strategy of individual country and regional production functions, and analyses the estimation results. Section III uses the results from the previous section to conduct the growth accounting exercise for the 88 countries in the sample and for the six regions. Section IV examines the determinants of the TFP level, and the conclusions are reported in Section V.

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<sup>6</sup> See Fischer (1993), Collins and Bosworth (1996), Coe, Helpman and Hoffmaister (1997), and Harkura and Jaumotte (1999) for the standard approach of estimating in growth terms.

## II. COUNTRY AND PANEL ESTIMATES OF THE PRODUCTION FUNCTION PARAMETERS

### A. Methodology and Data Sources

The production function parameters are central to the decomposition of output growth into contributions from physical capital, labor, and productivity. This section provides estimates of these parameters for the following production function:

$$Y_t = A_t K_t^\alpha (L_t H_t)^{1-\alpha} \quad (1)$$

where  $Y_t$  is GDP in real terms,  $A_t$  is TFP,  $K_t$  is the stock of capital,  $L_t$  is total employment (or the labor force if employment is not available),  $H_t$  is an index of human capital, and thus  $L_t H_t$  is a skilled-adjusted measure of labor input. Taking logs and differentiating totally both sides of equation (1) yields:

$$\hat{y}_t = \hat{a}_t + \alpha \hat{k}_t + (1-\alpha)(\hat{l}_t + \hat{h}_t) \quad (2)$$

where the lowercase variables with a “hat” correspond to the growth rate of the uppercase variables described in equation (1).<sup>7</sup> Equation (2) decomposes the growth rate of output into the growth of TFP, and a weighted average of the growth rates of physical capital and skill-augmented labor. Under constant returns to scale (assumed here), these weights are given by the shares of these two inputs in aggregate output.<sup>8</sup>

The remainder of this section briefly describes the series  $K_t$ ,  $L_t$ , and  $H_t$ .<sup>9</sup> The measure of capital,  $K_t$ , is based on a *perpetual inventory* estimation with a common geometric depreciation rate of 0.04. Generally, estimates of the physical capital stock are considered unreliable because of lack of information about the initial physical capital stock and the rate of depreciation. However, the World Bank data set used by Collins and Bosworth (1996) incorporates the results of previous studies of individual or small groups of countries in which the physical capital stock was estimated from investment data going back to 1950.<sup>10</sup>

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<sup>7</sup> Note that the differential of the log of a variable is approximately equal to its growth rate.

<sup>8</sup> This decomposition remains valid under more general functional forms of the production function. The interpretation of the weights on physical capital and skill-augmented labor as their share in aggregate output requires only the assumption of constant returns to scale. The Cobb-Douglas production function (which imposes an elasticity of substitution of one between the two inputs) is chosen for simplicity.

<sup>9</sup> These series were kindly provided by Barry Bosworth. A more thorough discussion of the series can be found in Collins and Bosworth (1996).

<sup>10</sup> The effect of the initial capital stock on the capital stock series decreases rapidly with the  
(continued...)



The quantity of labor,  $L_t$ , is actual employment for the industrial countries. For developing countries, it is the International Labor Organization's estimate of the economically active population. The index  $H_t$  was constructed following Barro and Lee's (1994) methodology based on educational attainment. It is defined as follows:

$$H_t = \sum_{j=1}^7 W_{jt} P_{jt} \quad (3)$$

where  $P_{jt}$  represents the share of the population that completed the level of education  $j$  (where  $j$  varies from 1, corresponding to the share of the population with no schooling, to 7, corresponding to beyond secondary education) and  $W_{jt}$  represent aggregation weights based on the observed relative earnings of the different educational groups.<sup>11</sup>

## B. Time Series Estimation of the Production Function

Traditionally, equation (1) is estimated in first difference of logs—that is, equation (2). As is well known, the first difference operator removes all the long-run information (by removing the low frequencies in the data) and emphasizes the short-run fluctuations in the data. An important insight offered by the cointegration literature is that we know much more about the long-run than we do about the short-run relationships among macroeconomic variables. Consequently, differencing amounts to disregarding the most valuable part of information in the data.

This point is particularly relevant for production function estimation. As shown below, the growth rate of GDP varies much more than the growth rate of the inputs  $K_t$  and  $L_t$ . Thus the link between GDP growth and input growth is likely to be very weak. Furthermore, the business cycle frequencies of the production process may be dominated by variations in capacity utilization issues that are difficult to measure, especially for developing countries. In light of these issues, the production function in this exercise will be estimated in *levels*, but for comparison purposes, the production function will also be estimated in *first-difference* form.

### 1. Time series estimation

The estimation of the production function in levels (equation 1) requires taking into account the potential nonstationarity of the data, which leads to the following two-step strategy:

- First, test the three variables in the production function for the presence of a unit-root.
- The second step depends on how many variables contain a

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<sup>10</sup>(...continued)  
sample size of investment figures.

<sup>11</sup> For further details, see Collins and Bosworth (1996).

unit-root. If at least two of the three variables contain a unit-root, a long-run relationship between output per capita, physical capital, and skill-augmented labor will exist only if the nonstationary variables are cointegrated. The case of only one nonstationary variable is problematic because it implies that no stable relationship exists between inputs and output (this case does not occur in the data set used here). The only case where classical inference is valid is the one where all three variables are (trend) stationary. To avoid spurious regressions, two residual-based tests of cointegration are performed for cases where some of the three variables contain a unit-root. The Phillips-Ouliaris' (1990) cointegration test has non-cointegration as the null hypothesis while Shin's (1994) cointegration test has cointegration as the null.

### ***Unit-root test***

The unit-root hypothesis is tested using the Augmented-Dickey-Fuller (*ADF*) test, which amounts to running the following set of regressions for each variable:

$$x_t = \mu + \gamma t + \phi_0 x_{t-1} + \sum_{i=1}^{k-1} \phi_i \Delta y_{t-i} + \xi_t \quad k = 1, \dots, 5 \quad (4)$$

Note that for  $k=1$ , there are no  $\Delta y_{t-i}$  terms on the right-hand side of equation (4). The lag length ( $k$ ) in the *ADF* regression is selected using the Schwarz Criterion (*SIC*). Table 2 presents the results for the two variables entering the Cobb-Douglas production function—namely output and stock of physical capital expressed in terms of skill-augmented labor—for 66 countries.<sup>12</sup> For GDP per capita, the unit-root hypothesis can be rejected at 5 percent or less only for two countries, Sierra Leone and Uruguay. For physical capital per capita, the unit-root hypothesis can be rejected at 5 percent or less for the following eight countries: India, Indonesia, Italy, Malaysia, Myanmar, Pakistan, Thailand, and Uruguay. Uruguay is the only country for which the unit root can be rejected for both variables. These results show that, in general, the unit-root hypothesis cannot be rejected at conventional significance levels. Thus, the estimation of the production function requires a cointegration framework.<sup>13</sup>

### ***Estimation results***

This paper uses the Fully-Modified (FM) estimator developed by Phillips and Hansen (1990) and Hansen (1992) to estimate the production function. The FM estimator is an optimal single-equation method based on the use of OLS with semiparametric corrections for serial correlation and potential endogeneity of the right-hand variables. The FM estimator has the

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<sup>12</sup>Henceforth, these two variables will be referred to as *GDP per capita* and *physical capital per capita*.

<sup>13</sup>The caveat of low power of the augmented Dickey-Fuller test applies here.

same asymptotic behavior as the full systems maximum likelihood estimators.<sup>14</sup> The correction for potential endogeneity of the explanatory variables is an attractive property of the FM estimator since physical capital per capita and the index of human capital are likely to be endogenous.

The production function was estimated by both OLS and FM methods for 66 countries, 46 of which are developing countries. Since the literature has predominantly used the first-difference specification, this paper provides estimates of  $\alpha$  (the share of physical capital in aggregate output) in both levels and first differences for comparison (see Table 3a). Table 3b summarizes the estimation results by giving the mean, median, standard deviation, minimum, and maximum of  $\alpha$  by region for the FM method.

Estimates of  $\alpha$  vary significantly across regions, both in levels and first differences. In levels, Sub-Saharan Africa has the lowest mean value (0.43) and industrial countries the highest (0.64). The mean value for the other regions are Middle East and North Africa (0.63), Latin America (0.63), East Asia (0.48), South Asia (0.56), and the whole sample (0.55). The results are quite different in first differences. East Asia has the lowest mean estimate (0.30), while Latin America shows the highest mean estimate (0.62). However, the mean estimate for industrial countries (0.58) and the whole sample (0.53) are relatively close to the corresponding estimates in levels. There is substantial cross-country variation: the share of capital estimates range from 0.13 to 1.00 in levels, and from 0.01 to 0.99 in first differences. The estimates of  $\alpha$  are generally quite precise.

Even though estimates of  $\alpha$  in first difference regressions are statistically significant, physical capital and (skill-augmented) labor account for only a modest share of the short-term variation in GDP per capita. This corroborates the earlier discussion about estimates in levels versus in first differences. The first difference operator eliminates low frequencies, and thus emphasizes short-term fluctuations in the data. As noted earlier, at the business cycle frequencies, the production process may be dominated by capacity utilization and other short-term factors that are not measurable (at least for the large sample used). This implies that level regressions, by combining both the short- and long-term information in the data, should yield more accurate estimates of  $\alpha$ .

It is worth noting that the average estimate of the share of physical capital (0.55 in levels and 0.53 in first differences) is significantly higher than the usual values (ranging from 0.30 to 0.40) used in growth accounting exercises.

Finally, for the equations in levels, it remains to be verified whether coefficient estimates provide a meaningful economic relationship that is not the result of a spurious regression. This amounts to testing whether output and input variables are cointegrated. The cointegration tests used are the Phillips-Ouliaris (P-O) test, which has non-cointegration as

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<sup>14</sup>For more details see Phillips and Hansen (1990), Phillips and Loretan (1991) and Hansen (1992).

the null hypothesis and Shin (SH) test, which has cointegration as the null. While P-O rejects the null of non-cointegration for only 26 countries (which is likely the result of the test's low power in small samples), the SH test fails to reject the null of cointegration for all 66 countries. Thus, the combined evidence from both tests favors the hypothesis of cointegration.

## 2. Panel Estimation

In order to increase the sample size, it will be assumed that the share of physical capital differs across regions but is identical for countries from the same region. Hence, a panel for each region will be used to estimate  $\alpha$ . Since the FM estimator does not apply to panel cointegration, only results for the first differences are reported.

The Cobb-Douglas production function was estimated both with and without human capital to show the effect of human capital on estimates of  $\alpha$ . Equation (1) specifies the production function with human capital and equation  $Y_t = A_t K_t^\alpha L_t^{1-\alpha}$  specifies the production function without human capital. Robustness was also checked with respect to the estimation method by using seven different methods—pooled regression without fixed effects (pooled), generalized least squares (GLS), seemingly unrelated regressions (SUR), pooled regression with fixed effects, GLS with fixed effects, SUR with fixed effects, and GLS with random effects. Tables 4a and 4b, respectively, report results with and without human capital.

The mean over the seven estimation methods are 0.48 for Africa, 0.44 for East Asia, 0.28 for South Asia, 0.65 for Middle East, 0.72 for Latin America, 0.54 for the industrial countries, and 0.55 for the whole sample (world). Table 1 compares the regional panel estimates (third column) with the corresponding regional means of individual country estimates in levels (first column) and in first differences (second column):

Table 1. Regional estimates of the Share of Physical Capital per Capita ( $\alpha$ )

Region	Individual Country		Panel	
	Level	First Difference	First Difference With H	Without H
Africa	0.43	0.50	0.48	0.47
East Asia	0.48	0.30	0.44	0.42
South Asia	0.56	0.42	0.28	0.28
Middle East	0.63	0.54	0.65	0.62
Latin America	0.52	0.62	0.72	0.64
Industrial	0.64	0.58	0.54	0.51
World	0.55	0.53	0.55	0.52

*Note:* The first two columns are averages over the regional country estimates (from Table 3a), while columns 3 and 4 are averages over the seven panel estimates for each region (from Tables 4a and 4b). The columns labeled *with H* and *without H* report panel estimates for the equations with and without human capital.

Table 1 shows that estimates of  $\alpha$  vary substantially across regions. However, they are remarkably stable across estimation methods, approximating 0.55 for the whole sample. Regional estimates are more varied across estimation methods, even though they generally do not differ significantly except for East and South Asia. Finally, comparison of with and without human capital (the last two columns) shows that discarding the human capital variable (H) from the production function does not significantly change the estimates of  $\alpha$ .

It has often been argued in the literature that the share of physical capital ( $\alpha$ ) must be higher in developing than in developed countries since the marginal product of capital is higher in developing countries.<sup>15</sup> However,  $\alpha = (\partial Y / \partial K)(K/Y)$  is the product of the marginal product of capital (the term in parentheses) and the capital-output ratio. It is true that under decreasing returns to capital, the marginal product of capital is theoretically higher in developing countries. But by the same reasoning the capital-output ratio in developing countries is lower. Thus the product defining  $\alpha$  can be either lower or higher for developing countries. This ambiguous result is reflected in Table 1, where some developing regions have higher while others have lower estimates of  $\alpha$  than do industrial countries.

### III. A COMPARATIVE ANALYSIS OF SOURCES OF GROWTH

In section II, we saw that under a constant-returns-to-scale Cobb-Douglas production function, the only parameter determining the contribution of physical capital and skill-augmented labor to growth of output is the share of physical capital, that is parameter  $\alpha$  (see equation 2). Table 1 shows this parameter to vary significantly across countries, regions, and estimation methods. Thus, to be informative, a *sources of growth* exercise must take into account this variation of  $\alpha$ . In this exercise, the decomposition of output has been carried out with five different values of  $\alpha$ , reflecting the range shown in Table 1.

Tables 5a–5e report the decomposition of real output for five values of  $\alpha$ . Tables 5a–5c report the decomposition for the values 0.2, 0.4, and 0.6, respectively. These values are assumed to be the same for all regions, which implies identical technologies across regions. Tables 5d and 5e relax this assumption by allowing  $\alpha$  to differ across regions. The decomposition of output was computed for seven regions: East Asia, South Asia, Sub-Saharan Africa, Middle East and North Africa, Latin America, Industrial Countries, and the whole sample for the periods 1960–73, 1974–86, 1987–94 and 1960–94.

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<sup>15</sup> Collins and Bosworth (1996) on p. 155 and the references therein.

For each region and period, Tables 5a–5e provide the decomposition of real output growth ( $dy$ ) into the growth rate of TFP ( $dTFP$ ), the contribution of the stock of physical capital computed as its share in real output multiplied by its growth rate ( $dk_c$ ), the contribution of labor input computed as its share in real output multiplied by its growth rate ( $dl_c$ ), and the contribution of human capital computed as the share of labor multiplied by the growth rate of the human capital index ( $dh_c$ ). Each table contains 28 panels corresponding to the product of the seven regions and the four time periods. The first three lines of each panel show the mean, median, and the standard deviation of  $dTFP$ ,  $dk_c$ ,  $dl_c$ ,  $dh_c$ , and  $dy$  (for the countries of the region). Note that while the mean preserves the *additivity* property of the decomposition, (i.e. the sum of  $dTFP$ ,  $dk_c$ ,  $dl_c$ , and  $dh_c$  is equal to  $dy$ ) the median does not. The lines denoted by  $\rho_L$  and  $\rho_D$  give the autocorrelation coefficient of TFP, K, L, H, and Y in levels and first differences, respectively. Several points emerge from the analysis of these tables:

(i) The contribution of TFP to output growth depends crucially on the share of physical capital in real output ( $\alpha$ ). The higher is  $\alpha$ , the lower is the contribution of TFP (compare Tables 5a, 5b, and 5c). The reason is the following: decreasing  $\alpha$  lowers the contribution of K and increases the contribution of L.<sup>16</sup> This result combined with the fact that K grows generally faster than L, leads to the negative correlation between the contribution of TFP and the level of  $\alpha$ .

(ii) Even if the level of TFP series varies significantly across different values of  $\alpha$ , as Tables 5a–5e show, the TFP series may nevertheless be highly positively correlated, as is generally the case.<sup>17</sup> Table 6 gives the correlation coefficient (for each of the 88 countries in the sample) between the five TFP series corresponding to the five different values of  $\alpha$  used to compute them (see note to Table 6 for more details). Among the 10 possible correlations between the five TFP series for each country, the lowest median correlation of 0.742 is between the TFP series computed with  $\alpha = 0.2$  and  $\alpha = 0.6$ . This relatively low correlation simply reflects the large difference in  $\alpha$  used to compute the two series. Indeed, the median correlation between the TFP series computed with  $\alpha = 0.2$  and  $\alpha = 0.4$  is 0.975, and it is equal to 0.919 for the series corresponding to  $\alpha = 0.4$  and  $\alpha = 0.6$ . Thus, reasonable variations in  $\alpha$  preserves the TFP ranking of the 88 countries even if the (log) level of TFP is sensitive to the value of  $\alpha$ . This relative insensitivity of the TFP ranking across countries to changes in the value of  $\alpha$  stands out more clearly when short-term fluctuations in TFP are smoothed out by taking averages over time. Thus, if the five TFP series are averaged over

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<sup>16</sup> The contributions of K and L will be positive (negative) if the growth rate of K and L are positive (negative).

<sup>17</sup> The TFP figures are all expressed in logs so that their first differences give their approximate growth rate.

time, the correlation coefficients between them vary between 0.936 and 0.999.<sup>18</sup> These correlations remain high even in first differences (which are approximate growth rates since TFP figures are in log) and vary between 0.933 and 0.996. Finally, a detailed analysis of Table 6 shows that while the cross-country ranking is generally well preserved, even under large variations in  $\alpha$ , the individual country time series of TFP are more sensitive to variations in  $\alpha$ . For some countries, the correlation coefficients between the five TFP time series are relatively low and even negative. The last column of Table 6 reports the minimum of the 10 correlation combinations between the five TFP figures. While for some countries this minimum is high (28 of the 88 countries have a minimum correlation coefficient larger than 0.9), others show a relatively low level of the minimum correlation coefficient and for some it is even negative (33 countries have a minimum correlation coefficient less than 0.5 and 16 countries have a negative minimum correlation coefficient). To sum up, the level of TFP depends heavily on the specification of the production function—that is, the share of physical capital ( $\alpha$ ) in the simple Cobb-Douglas production function. However, the cross-country ranking is relatively robust to even large variations in  $\alpha$ , especially when short-term fluctuations in TFP are smoothed out by taking time averages for each country.

(iii) For the whole sample average of 88 countries and the period 1960–94, TFP contributed 0.74 percent to an annual average growth rate of real output of 3.80 percent when  $\alpha$  is set to a value of 0.2. This is higher than what Collins and Bosworth (1994) report, reflecting essentially the higher share of physical capital in their study ( $\alpha = 0.35$ ). The contribution of TFP decreases to 0.23 percent and -0.27 percent when the value of  $\alpha$  is increased to 0.4 and 0.6, respectively. If one believes that  $\alpha$  is closer to 0.6 than to 0.2, as the estimates of  $\alpha$  in Table 4 seem to suggest (the average estimate of  $\alpha$  for the whole sample is between 0.52 and 0.55), the contribution of TFP in real output growth has likely been negative on average for the whole sample during 1960–94. For  $\alpha = 0.6$ , Table 5c shows that physical capital brought 3.05 percent of the 3.80 percent output growth for the whole sample. In other words, most of the growth during 1960–94 came from physical capital accumulation. To a lesser extent, this remains true even if  $\alpha$  is equal to 0.4.

(iv) Africa had the lowest annual TFP growth (ranging from -0.26 percent to -0.79 percent) during 1960–94 for all 5 values of  $\alpha$ . The sources of the lower African output growth, 2.83 percent for Africa versus 3.80 percent for the whole sample during 1960–94, are lower physical and human capital accumulation and lower TFP growth. Latin America had the next worst record in productivity growth. Among the six regions, industrial countries consistently registered the second highest productivity growth. The highest performance belongs to Asia. Whether it is South Asia or East Asia, however, depends on the value of  $\alpha$ . The highest performance belongs to South Asia for high values of  $\alpha$  ( $\alpha = 0.4, 0.6$ ) and to East

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<sup>18</sup> These correlations (not reported in Table 6) are computed on the time average of the five series of TFP. After the averaging, each series contains 88 observations and each observation is the average TFP over the period 1960–94 of a particular country. This yields 10 cross-country TFP correlation coefficients. What is reported are the minimum and maximum of the correlations.

Asia for low values of  $\alpha$  ( $\alpha = 0.2$ ). For very low values ( $\alpha = 0.2$ , for example), East Asian countries (including Korea, Singapore and Taiwan)—which were the focus of much attention and heated debate lately on the sources of their growth—are ranked at the top for productivity growth.<sup>19</sup> However, for high values of  $\alpha$  ( $\alpha = 0.6$ , for example) the East Asian countries show relatively low performance in productivity growth, ranking fourth, just after Africa and Latin America. The reason is simple. These countries had very high rates of physical capital accumulation. This fact, combined with high share of physical capital in real output, leaves little room for productivity. In other words, a large share of output growth is accounted for by the growth rate of physical capital when  $\alpha$  is large. Table 4 shows that three of the four estimates of  $\alpha$  for that region lie above 0.4, which tends to corroborate the view that the engine of growth in East Asia was capital accumulation and not productivity growth.

(v) Contrary to other regions, in industrial countries the contribution of labor to output growth was modest during 1960–94 because the growth rate of their labor force was generally low. Physical capital accumulation accounted for most of their growth.

(vi) Dividing 1960–94 period into three subperiods (1960–73, 1974–86, and 1987–94) reveals some interesting insights. Except for Asian countries, growth declined steadily from the first to the third period. Loss of productivity and weakening investments were at the root of the growth slowdown. The relative importance of the two factors changed between the 1974–86 and 1987–94 periods with loss in productivity dominating during the 1974–86 period. Similarly in Africa output growth declined over the three periods as a result of lower TFP and lower investment growth. Latin America had the largest drop in output growth between the first and second periods, with growth declining from 4.98 percent in the first period—which is identical to the average growth rate over the whole sample during the first period—to 2.42 percent in the second period. A significant drop in TFP (-1.76 percent) is the main source of this sluggish growth during the second period. In contrast, Asian countries have, on average, strengthened their output growth during the second and third periods. However, this general pattern conceals some important differences between East and South Asian countries. East Asia, the region with consistently the highest growth over the three periods, had lower growth during the second period due largely to a loss in TFP. South Asia actually recorded its highest growth during the second period as a result of higher TFP and investment growth.

(vii) As discussed earlier, the question of whether to estimate the production function in *levels* or *first differences* is important. Even though the first difference specification is the most common choice in the literature, theoretical arguments favor estimation in levels. For the growth accounting exercise, the question is whether the two estimation methods yield significantly different results. Tables 2a–b show that estimates of  $\alpha$  from the two specifications can differ substantially. However, these differences are smoothed out when taking regional averages. Tables 5a–e use the regional averages of  $\alpha$  estimates in levels and

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<sup>19</sup> See Young (1994) and Krugman (1994).



first difference given in Tables 2a–b to perform the growth accounting exercise.<sup>20</sup> For all regions, except East Asia, estimates of  $\alpha$  from a production function in levels and first differences are relatively close, yielding similar decompositions of output growth. However, for the East Asian countries, the level equations yield an average estimate of  $\alpha$  of 0.48 while the first difference equations yield an average estimate of 0.30. These two values imply very different results from the growth accounting exercise (compare Tables 5d and 5e). When the level equation estimate of 0.48 for  $\alpha$  is used, the growth accounting decomposition in Table 5d shows that most of East Asia's growth came from physical capital accumulation during the 1960–94, with little no productivity gain during the period (TFP grew only at an annual rate of 0.28 percent). The poor productivity performance was not constant over the whole period. Productivity growth was negative during 1974–86 (-0.43 percent) but strongly positive during 1987–94 (1.57 percent). When the estimate of  $\alpha$  is taken from the first difference equations (0.30), the results of Table 5e lead to a different story. In this scenario, productivity growth in conjunction with high levels of investment explain the exceptional growth performance of the region. Which scenario is more likely hinges on the appropriateness of the level versus the first difference equations. As discussed earlier, level equations may be more appropriate theoretically.

(viii) Real output in developing countries—particularly in the Middle East and North Africa, Sub-Saharan Africa, and Latin America—is twice as volatile as in developed countries. It is TFP in developing countries that inherits this excess volatility (indeed TFP in developing countries is twice as volatile as in developed countries) since the volatility of capital and labor in both categories of countries are comparable. The log of real output, capital, labor, and to a lower degree TFP, are all highly autocorrelated. While the growth rate of output has only a weak positive autocorrelation coefficient, the growth rate of its inputs (physical and human capital) show stronger persistence. This explains why the estimation of the production function in first differences has a relatively poor fit. Physical and human capital and labor are too persistent in nature to explain the important short-term fluctuations in output.

#### IV. DETERMINANTS OF TFP

While the few studies on the determinants of cross-country differences in TFP have focused on *growth rates* of real output this analysis is on *levels*. Recent theoretical as well as empirical arguments (discussed in the introduction) point to the level of TFP as the more relevant variable to explain.

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<sup>20</sup> More precisely, a production function is estimated both in levels and in first differences for 66 countries over the period 1960–94, and the results reported in Table 2. Regional estimates of  $\alpha$  are then computed by averaging these estimates over the countries belonging to each region (See end of Table 2).

Table 7 reports the estimations results of a set of regressions in which the level of TFP of each country relative to the level of TFP in the United States (TFPiR where I indicates one of the five TFP series discussed in Tables 5a–e) is regressed on three sets of explanatory variables:<sup>21</sup>

- (i) *Initial conditions*: This set contains the initial ratio of TFP levels (TFPiR\_0) computed as the average of the first five years (1960–64) of the ratio of the TFP level in each country to the TFP level in the United States, the initial ratio of the stock of human capital (HKR\_0) and physical capital (KR\_0) computed both as the five-year average (1960–1964) of the ratio of the stock of human and physical capital of each country to the stock of human and physical capital of the United States, respectively, and life expectancy (LIFE).
- (ii) *External shocks*: The main external shocks for developing countries are terms of trade (TOT) shocks.
- (iii) *Macroeconomic variables*: This set contains most of the variables found in the growth literature to have a robust correlation with output growth. These are the level of inflation (INFL), public consumption (Cg), real exchange rate (RER), reserves as a share of imports (RESM), and the external debt level (DEBT).
- (iv) *Trade regime*: This set contains dummy variables for current account (CACON) and capital account (KCON) convertibility. The dummy variables take a value of one when there are restrictions on current account and capital account transactions and zero otherwise.
- (v) *Political stability*: Included in this category is the ratio of war casualties to the population (DEATH).

Table 7 shows results of two sets of four equations. The first set pertains to TFP2—that is to TFP series with  $\alpha=0.4$  for all countries—while the second set belong to TFP4—TFP for which  $\alpha$  varies across regions but is identical for countries within regions.<sup>22</sup> Equation (1) tests the convergence hypothesis for TFP by regressing the level of TFP relative to the U.S. (TFP2R) on its initial value (TFP2R\_0). A coefficient less than one on TFP2R\_0 implies unconditional convergence. This implies that countries tend to catch up with the United

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<sup>21</sup> The variables Y, K, L were provided by Barry Bosworth. The variables LIFE, INFL, Cg, RER, RESM, DEBT, CACON, KCON, and DEATH were provided by Atish Gosh and Steven Phillips.

<sup>22</sup> Where the regional  $\alpha$ 's are the average of individual country estimates of  $\alpha$  from a production function in levels (Table 3b) .

States level of TFP, though slowly as the coefficient is very close to one (0.990).<sup>23</sup> This unconditional convergence result does not depend on the particular TFP series. Indeed, equation (5) yields for TFP4 a convergence coefficient that is also close and less than one (0.994).

Equations (2)–(4) and (6)–(8) quantify the relationship between the TFP in each country relative to that the United States and the series of variables described above capturing the initial condition, external shocks facing the countries in the sample, some important macroeconomic indicators, the trade regime, and a proxy for political stability.

All variables have the expected sign. The initial level of TFP relative to the that of the United States (TFP2R\_0 and TFP4R\_0) has a coefficient less than one and is highly significant. This implies that conditional convergence also prevails. In addition, the coefficients on the initial ratios of human and physical capital (HKR\_0 and KR\_0) come out positive and significant. While both the relative endowment in human and physical capital are important determinants of relative TFP, human capital has a much stronger effect in the sense that its coefficient is approximately 10 times larger than the coefficient on physical capital. This does not reflect simply a unit problem as both variables are expressed in logs. Life expectancy (LIFE), which is another proxy for the stage of development, appears with a positive and significant coefficient. Thus, initial conditions are important determinants of TFP. Terms of trade shocks (TOT) have a positive and significant effect on relative TFP. This simply reflects an income effect that shifts the production function up (for given capital and labor inputs) as the current account improves for given export and import quantities. A good macroeconomic environment contributes significantly to the TFP level: lower inflation (INFL), lower real exchange rate (RER), lower government consumption (Cg), higher ratio of reserves to imports (RESM), and lower external debt (DEBT) are associated with higher TFP levels. Both current account (CACON) and capital account (KCON) convertibility improve TFP. Equations (2)–(5) show that CACON is significant only when KCON is excluded from the equation because these two variables are positively correlated. Not surprisingly, social harmony and relative political stability, as indicated by a low ratio of war casualties to population (DEATH), increase TFP significantly.

Regional dummy variables indicate that Africa (DUMAFR), East Asia (DUMEA), South Asia (DUMSA), and Latin America (DUMLA) have lower TFP levels than do industrial countries (the control group) have but for reasons other than those captured by the explanatory variables included in the equations. The dummy variables capture cross-regional differences in TFP levels that are not explained by the variables included in the equations. The Middle East and North Africa (DUMME) is the only region that has a higher TFP level than industrial countries once the factors captured by the explanatory variables are controlled for.

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<sup>23</sup> Note that the speed of convergence cannot be inferred from the coefficient estimate as is usually done in the growth literature. This requires a pure cross-section sample, whereas a panel is used in this paper.

The results from the empirical growth literature systematically show Africa with the largest unexplained poor growth performance, captured by the largest (in absolute value) negative coefficient on the African dummy. In contrast, equations 2–4 of Table 7 show that the African TFP dummy variable, while still negative, is the smallest among the underperforming regions and statistically insignificant. Thus, the underperformance of Africa in TFP levels can be, to a large extent, accounted for by the variables included in the equations.

Finally, the unexplained underperformance of all developing regions (i.e. the negative coefficient on the respective regional dummy variable), except the Middle East and North Africa, relative to the industrial countries is reversed once regions are allowed to have different shares of physical capital in aggregate output. This can be seen by comparing the sign on the regional dummies in equations (2)–(4) which pertain to TFP2, where  $\alpha$  is set at 0.4 for all countries, to equations (6)–(7) for TFP4, where regional averages of country estimates of  $\alpha$  were used for each region. This implies that restricting  $\alpha$  to be the same across regions and around 0.4, which is the usual value found in the literature, for all countries tends to underestimate the TFP performance of developing versus industrialized countries.

The usual caution note about the interpretations of the results generally found in the literature applies with equal force here. These regressions indicate only correlations and not causation. Even if these correlations did reflect some underlying influence of the explanatory variables on relative TFP, these regressions are silent about the precise channels through which TFP is affected.

## V. SUMMARY OF RESULTS AND CONCLUDING REMARKS

The first part of this section summarizes the estimation results of the Cobb-Douglas production function, as well as the results from the accounting exercise. The second part lists the main findings from the regression analysis for the determinants of the cross-country differences in TFP levels, and the third part gives some concluding remarks.

### **Production Function Estimation and TFP Analysis**

- The share of physical capital ( $\alpha$ ) varies significantly across regions both in levels and first differences. In levels, Sub-Saharan Africa has the lowest mean value and industrial countries the highest. The results are quite different in first differences. However, the two methods yield similar results for the whole sample average (0.55 in levels and 0.53 in first differences). The average estimate of the share of physical capital is significantly higher than the usual values (ranging from 0.30 to 0.40) used in the growth accounting exercises.

- While the estimates of  $\alpha$  in the first difference regressions are statistically significant, physical capital and (skill-augmented) labor account for only a modest share of the short-term variation in GDP per capita. This corroborates the view that while capital and labor inputs determine the long-run level of output, capacity utilization and other factors may be the main determinants of the short-term fluctuations of output.
- Sub-Saharan Africa had the lowest annual TFP growth during the period 1960–94. The sources of the lower African output growth are lower physical and human capital accumulation and a lower TFP growth. Latin America had the next worst record in terms of productivity growth. The results of this accounting exercise tend to corroborate the view that the engine of growth in East Asia has been capital accumulation, not productivity growth.
- The three sub-periods 1960–73, 1974–86, and 1987–94 reveal interesting insights. Except for Asian countries, growth declined steadily from the first to the third period. Productivity loss and a slowing down of investments were at the heart of the growth slowdown, with loss of productivity the dominating factor during 1974–86. In contrast, Asian countries have on average strengthened their output growth during the second and third periods. However, this general pattern conceals important differences between East and South Asian countries. East Asia, the region with consistently the highest growth over the three periods, had lower growth during the second period largely because of a loss in TFP, while South Asia recorded its highest growth during the second period as a result of higher TFP and investment growth.
- Real output in developing countries—particularly in the Middle East and North Africa, Sub-Saharan Africa, and Latin America—is twice as volatile as in developed countries. TFP seems to inherit this excess volatility (indeed TFP in developing countries is twice as volatile as in developed countries) since the volatility of capital and labor in both category of countries are comparable. While the growth rate of output is only weakly positively autocorrelated, the growth rate of its inputs (physical and human capital) show stronger persistence. This explains why production function estimates in first differences have a relatively poor fit. Capital and labor inputs are too persistent to explain the important short-term fluctuations in output.

### **Determinants of Cross-Country Differences in TFP Levels**

Estimations results of a set of regressions in which the level of TFP of each country relative to the level of TFP in the United States is regressed on five sets of explanatory variables. These are initial conditions, external shocks, macroeconomic environment, the trade regime, and political stability. The regression analysis yields the following results:

- There is statistical evidence for both conditional and unconditional convergence in TFP levels, indicating countries tend to catch up with the U.S. TFP level, though slowly.

- Initial conditions — as captured by the initial levels of TFP, physical and human capital — explain a large part of the differences in TFP across countries. The more favorable the initial conditions are, the higher the TFP performance is. In particular, the initial endowment in human capital plays a crucial role in determining the future level of TFP for a given country.
- Favorable terms of trade shocks are associated with higher TFP levels. This simply reflects the income effect that shifts the production function up (for given capital and labor inputs) as the current account improves for given export and import quantities.
- A good macroeconomic environment contributes significantly to the level of TFP: lower inflation, lower real exchange rate, lower government consumption, higher ratio of reserves to imports, and lower external debt are associated with higher levels of TFP.
- Both current and capital account convertibility improve TFP.
- Social harmony and political stability increase TFP significantly.
- The results from the empirical growth literature systematically show Africa with the largest unexplained growth underperformance, captured by the largest (in absolute value) negative coefficient on the African dummy. In contrast, the African dummy variable in the TFP equations, while still negative, is the smallest among the low performing regions and is statistically insignificant. Thus, the underperformance of Africa in TFP levels can be largely explained by the variables included in the equations.
- The unexplained underperformance of developing regions (that is the negative coefficient on the respective regional dummy variable) relative to the industrial countries is reversed once regions are allowed to have different shares of physical capital in aggregate output. This implies that restricting  $\alpha$  to be the same for all regions tends to underestimate the TFP performance of developing versus industrialized countries.

### **Implications of Analysis**

The contribution of TFP to output growth depends crucially on the share of physical capital in real output ( $\alpha$ ). The higher is  $\alpha$ , the lower is the contribution of TFP to growth because decreasing  $\alpha$  lowers the contribution of physical capital (K) and increases the contribution of labor (L). This result, combined with the fact that K generally grows faster than L, leads to the negative correlation between the contribution of TFP and the level of  $\alpha$ .

In view of the general sensitivity of TFP analysis to the choice of  $\alpha$ , it is useful to identify the results of the TFP analysis that are relatively sensitive to  $\alpha$  and those that are not. The results that are robust with regard to large variations of  $\alpha$  are the relative ranking of TFP levels and

TFP growth rates across countries when  $\alpha$  is assumed to be identical across all countries (especially when short-term fluctuations in TFP growth are smoothed out by taking time averages for each country), the determinants of cross-country differences in TFP levels, the convergence across countries of TFP levels, the high volatility of TFP growth rates of developing countries, and the low TFP performance of Africa. Among results that are not robust, are the level and growth rates of TFP and the relative contributions of TFP and capital stock growth to GDP growth—particularly, the famous debate on the role of TFP in the rapid growth of the East Asian countries.

Finally, a puzzling result in this paper is the relatively high estimate of  $\alpha$ —the average across 66 countries is about 0.55 which is significantly higher than the usual values of 0.3 to 0.4, used in growth accounting exercises. This high estimate is obtained under a variety of estimation methods, including methods that take into account the endogeneity problem of the factor inputs, potential autocorrelation of the error term, and the possible nonstationarity of the input and output variables.

The lower values of  $\alpha$  used in growth accounting exercises are generally based on early studies which estimated the share of physical capital in aggregate output directly from national account data by computing the share of the remuneration of capital as a share of GDP. This method, while more direct and thus probably more precise than the econometric approach used in this paper, is generally also more tedious and not always operational because of the difficulty of precisely measuring the remuneration of capital from national accounts data. This is particularly true for large cross-country studies as the reporting methodologies of national accounts differ substantially across countries, creating further inconsistencies in the estimates.

The econometric method for estimating the share of physical capital is based on estimating an aggregate production function (or alternatively, estimating an aggregate cost function by virtue of the duality principle). This method is much easier to implement, especially for a large number of countries. However, the estimates thus derived of the share of physical capital may be sensitive to the specification of the production function. Under constant returns to scale, these two methods should yield identical estimates asymptotically, and relatively close estimates in small samples. Two essential prerequisites for the result to hold are precise estimates of the stock of physical capital and labor inputs, and precise national account data used to measure directly the remuneration of physical capital. This implies that measurement errors are either negligible or that they do not contain a systematic components (i.e., they behave as white noise processes).

This points to two potential sources for the difference in the estimates of the share of physical capital from the two methods. First, there is the assumption of constant returns to scale (CRS), which may be violated in the data. If it is the case, the growth accounting framework

itself becomes fallacious, as it is based on the CRS assumption.<sup>24</sup> While there is some empirical evidence of increasing returns to scale in some sectors of industrial economies, no clear evidence exists of increasing returns at the aggregate level.<sup>25</sup> Second, the quality of the data can also create discrepancy in estimates. But the quality of the data is only part of the answer as high estimates of the share of physical capital were obtained for all regions, including industrial countries for which the quality of the data is relatively good.

Another source of discrepancy between the estimates from the two methods may be related to the important role of human capital in the production process which is, at best, only partially captured by the skill-augmented labor variable in the production function. The high estimates of the share of physical capital may be the result of not appropriately taking into account the complex channels through which human capital influences output. Unfortunately, there is neither a tractable production function that adequately captures the central role of human capital, nor good measures of human capital.

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<sup>24</sup> It is theoretically possible to reformulate the accounting framework to take into account the presence of increasing returns to scale, but at a cost of less tractability.

<sup>25</sup> See Benhabib and Jovanovic (1991).



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Table 2. Augmented-Dickey-Fuller Test for a Unit-Root

Country	Y/(H*L)		K/(H*L)		Country	Y/(H*L)		K/(H*L)	
	ADF	k	ADF	k		ADF	k	ADF	k
1 Algeria	-0.35	2	-1.38	2	34 Malta	-0.84	1	-2.33	1
2 Argentina	-1.92	1	-1.08	2	35 Malaysia	-1.79	1	-4.10 *	2
3 Australia	-3.22	1	-1.39	2	36 Mexico	-1.56	1	-1.37	2
4 Austria	-0.97	1	-1.22	2	37 Morocco	-3.08	1	-1.14	2
5 Bangladesh	-2.32	1	-2.77	2	38 Myanmar	-1.51	1	-3.75 *	2
6 Belgium	-1.53	1	-1.94	2	39 Netherlands	-0.84	1	-1.14	2
7 Bolivia	-2.35	2	-2.68	2	40 New Zealand	-1.58	1	-1.51	2
8 Cameroon	-0.42	2	-1.76	2	41 Nigeria	-2.38	2	-1.51	2
9 Colombia	-1.34	1	-3.27	2	42 Norway	-1.26	2	-2.73	2
10 Costa Rica	-2.14	2	-1.89	2	43 Pakistan	-2.46	1	-5.96 *	2
11 Cote d'Ivoire	-1.46	1	-1.20	2	44 Panama	-1.84	1	-2.30	2
12 Denmark	-2.57	1	-2.43	2	45 Paraguay	-1.78	2	-2.58	2
13 Ecuador	-0.65	1	-0.91	2	46 Philippines	-1.97	2	-2.95	2
14 Egypt	-1.05	2	-3.19	2	47 Rwanda	0.03	1	-2.49	2
15 Ethiopia	-1.28	3	-3.45	2	48 Sierra Leone	-4.42 *	1	-2.22	1
16 Finland	-2.12	2	-2.11	2	49 Singapore	-1.78	1	-1.68	2
17 France	-2.17	1	-1.76	2	50 South Africa	0.05	1	-1.38	2
18 Germany	-1.88	1	-2.15	2	51 Spain	-1.60	1	-1.79	2
19 Ghana	-1.60	1	-3.05	2	52 Sri Lanka	-2.84	1	-3.01	2
20 Greece	-2.77	1	-3.05	1	53 Sweden	-2.79	2	-2.82	2
21 Guatemala	-2.00	2	-2.39	2	54 Switzerland	-3.40	2	-3.15	2
22 Honduras	-0.89	1	-1.90	2	55 Taiwan	-3.20	1	-1.64	2
23 Iceland	-2.30	1	-2.23	1	56 Tanzania	-1.96	2	-2.11	2
24 India	-2.02	1	-4.21 *	2	57 Thailand	-2.39	2	-4.07 *	2
25 Indonesia	-3.24	1	-5.37 *	2	58 Trinidad and Tobago	-0.64	1	-1.39	3
26 Iran	-2.06	2	-0.07	3	59 Tunisia	-1.68	1	-2.11	2
27 Ireland	-1.42	1	0.74	2	60 Turkey	-1.58	1	-2.20	2
28 Israel	-1.86	1	-2.28	2	61 United Kingdom	-3.05	1	-2.19	3
29 Italy	-2.22	1	-4.14 *	1	62 United States	-1.32	2	-1.91	2
30 Jamaica	-2.35	2	-3.31	2	63 Uruguay	-3.71 *	2	-4.50 *	2
31 Japan	-1.98	2	-2.48	2	64 Venezuela	-2.57	1	-1.15	2
32 Korea	-1.88	1	-2.93	2	65 Zambia	-2.49	1	-1.59	2
33 Malawi	-0.63	1	-0.43	2	66 Zimbabwe	-2.30	2	-1.24	3

*Note:* Variables are as follows: real GDP divided by skill-augmented labor,  $Y/(L*H)$ , and physical capital divided by skill-augmented labor,  $K/(L*H)$ . These two variables are tested for the existence of a unit root using the Augmented-Dickey-Fuller (ADF) test. The optimal lag selected by the Schwarz criterion in the ADF regression is given by  $k$ . Critical values are a linear interpolation between the critical values for  $T=25$  and  $T=50$  (where  $T$  is the sample size) given in table B.6, case 4, in Hamilton (1994). Significance levels equal or less than 5 percent are indicated by the symbol \*.

Table 3a. Cobb-Douglas Production Function Estimates for 66 Countries

	Level								First Difference								Range
	OLS			FM				OLS			FM						
	$\alpha$	R <sup>2</sup>	D.W.	$\alpha$	R <sup>2</sup>	P-O	SH	$\alpha$	R <sup>2</sup>	D.W.	$\alpha$	R <sup>2</sup>	P-O	SH			
1 Algeria	0.59 6.00	0.51	0.31	0.70 5.85	0.44	-21.50	0.001	0.75 1.62	0.05	1.97	0.76 2.34	0.17	-7.98	0.047	60-94		
2 Argentina	0.26 6.80	0.57	0.52	0.33 5.73	0.45	-1.95	0.003	0.56 3.31	0.06	1.87	0.57 1.75	0.04	-5.63	0.026	60-94		
3 Australia	0.64 48.32	0.99	1.02	0.63 37.46	0.99	-3.55	0.009	0.42 2.14	0.10	2.20	0.47 3.63	0.13	-6.33	0.038	60-94		
4 Austria	0.58 66.48	0.99	0.43	0.58 38.74	0.99	-1.84	0.003	0.57 5.33	0.45	1.92	0.61 5.89	0.45	-5.32	0.026	60-94		
5 Belgium	0.82 57.12	0.99	0.44	0.82 34.75	0.99	-2.15	0.004	0.62 2.94	0.19	2.14	0.79 3.94	0.18	-6.46	0.034	60-94		
6 Bangladesh	0.29 1.60	0.04	0.40	0.17 0.58	0.10	-2.14	0.003	0.82 2.34	0.12	2.15	0.41 1.58	0.12	-6.14	0.036	60-94		
7 Bolivia	0.70 10.66	0.77	0.10	0.72 10.72	0.77	-22.81	0.000	0.67 5.46	0.47	0.74	0.63 5.17	0.47	-2.42	0.008	60-94		
8 Cameroon	0.41 8.23	0.66	0.15	0.42 6.94	0.52	0.19	0.000	0.94 3.83	0.29	1.55	0.99 4.43	0.29	-4.50	0.018	60-94		
9 Colombia	0.64 10.10	0.81	0.36	0.61 6.86	0.80	-10.94	0.004	0.44 0.95	0.00	1.04	0.11 0.20	-0.03	-2.76	0.014	70-94		
10 Costa Rica	0.26 4.18	0.33	0.14	0.32 3.32	0.06	-18.10	0.001	0.95 3.52	0.26	1.30	0.88 3.79	0.34	-3.51	0.016	60-94		
11 Côte d'Ivoire	0.41 6.91	0.58	0.09	0.52 6.75	0.46	-2.42	0.000	0.70 4.35	0.35	1.70	0.72 4.34	0.35	-5.03	0.021	60-94		

Table 3a. Cobb-Douglas Production Function Estimates for 66 Countries [continued]

	Level					First Difference									
	OLS			FM		OLS			FM						
	$\alpha$	R <sup>2</sup>	D.W.	$\alpha$	R <sup>2</sup>	P-O	SH	$\alpha$	R <sup>2</sup>	D.W.	$\alpha$	R <sup>2</sup>	P-O	SH	Range
25 Indonesia	0.49 32.57	0.97	0.22	0.47 22.23	0.95	-1.33	0.002	0.38 3.00	0.20	1.91	0.38 4.52	0.20	-5.69	0.027	60-94
26 Iran	0.06 0.72	-0.02	0.11	0.25 2.45	-0.37	-18.71	0.000	0.64 2.70	0.16	1.13	0.47 2.15	0.13	-3.24	0.011	60-94
27 Ireland	0.75 38.15	0.98	0.22	0.73 22.86	0.97	0.05	0.000	0.24 1.73	0.06	1.92	0.28 2.23	0.08	-5.08	0.028	60-94
28 Israel	0.98 16.13	0.90	0.40	1.00 14.68	0.86	-11.91	0.002	0.88 2.76	0.19	1.33	0.70 3.33	0.28	-4.09	0.019	65-94
29 Italy	0.79 84.07	1.00	0.86	0.79 57.30	1.00	-2.72	0.006	0.73 5.58	0.48	1.85	0.75 5.92	0.49	-5.03	0.026	60-94
30 Jamaica	0.91 8.36	0.67	0.10	0.81 11.05	0.67	-0.40	0.001	0.79 3.96	0.31	1.30	0.81 3.79	0.31	-3.66	0.014	60-94
31 Japan	0.55 52.78	0.99	0.22	0.55 33.08	0.99	-14.36	0.001	0.72 8.24	0.67	1.34	0.71 9.60	0.66	-3.72	0.015	60-94
32 Korea	0.54 61.13	0.99	0.46	0.54 37.15	0.99	-1.92	0.002	0.43 2.71	0.16	1.72	0.42 2.41	0.16	-4.54	0.022	60-94
33 Malawi	0.37 24.03	0.94	1.24	0.38 21.75	0.94	-3.42	0.013	0.49 2.95	0.19	2.27	0.42 3.48	0.19	-6.46	0.049	60-94
34 Malaysia	0.47 40.25	0.98	0.43	0.47 25.98	0.97	-1.44	0.002	0.38 1.70	0.05	1.73	0.30 2.15	0.05	-4.66	0.022	60-94
35 Malta	0.77 7.37	0.91	0.40	0.77 7.37	0.91	-19.27	0.012	0.68 1.68	0.09	0.47	0.53 1.09	0.41	-2.05	0.020	75-94
36 Mexico	0.21 2.26	0.12	0.10	0.38 2.70	-0.14	-1.64	0.000	1.05 6.55	0.60	1.57	0.96 11.93	0.59	-3.97	0.021	65-94
37 Morocco	0.34 12.99	0.85	1.24	0.36 11.49	0.84	-4.63	0.014	0.57 1.85	0.08	2.32	0.43 2.35	0.18	-6.51	0.084	65-94

Table 3a. Cobb-Douglas Production Function Estimates for 66 Countries [continued]

	Level								First Difference								Range
	OLS			FM				OLS			FM						
	$\alpha$	R <sup>2</sup>	D.W.	$\alpha$	R <sup>2</sup>	P-O	SH	$\alpha$	R <sup>2</sup>	D.W.	$\alpha$	R <sup>2</sup>	P-O	SH			
38 Myanmar	0.61 4.53	0.36	0.32	0.63 3.14	0.28	-1.60	0.002	0.95 1.65	0.05	2.22	0.95 1.86	0.06	-6.30	0.037	60-94		
39 Netherlands	0.64 60.17	0.99	0.92	0.64 39.62	0.99	-2.58	0.008	0.57 3.87	0.30	2.01	0.64 5.50	0.47	-5.36	0.044	60-94		
40 New Zealand	0.38 6.27	0.53	0.47	0.35 3.45	0.51	-2.02	0.004	0.82 2.33	0.12	2.18	0.76 2.43	0.13	-5.85	0.035	60-94		
41 Nigeria	0.03 0.41	-0.03	0.31	0.14 2.11	-0.19	-2.57	0.002	0.17 0.72	-0.02	1.40	0.12 0.69	0.03	-3.91	0.021	65-94		
42 Norway	0.90 41.51	0.98	0.61	0.89 29.30	0.98	-7.78	0.003	0.62 3.14	0.21	1.39	0.75 4.12	0.24	-3.77	0.018	60-94		
43 Pakistan	0.69 15.62	0.88	0.11	0.77 9.41	0.90	-3.81	0.001	0.15 1.73	0.06	2.20	0.16 1.93	0.07	-6.02	0.038	60-94		
44 Panama	0.41 11.92	0.81	0.37	0.45 9.76	0.77	-2.35	0.003	0.62 3.11	0.21	1.56	0.58 3.90	0.23	-4.34	0.019	60-94		
45 Paraguay	0.40 18.87	0.91	0.23	0.39 18.11	0.86	-14.27	0.001	0.62 4.30	0.35	1.20	0.49 5.10	0.36	-3.58	0.013	60-94		
46 Philippines	0.20 4.04	0.31	0.15	0.25 3.98	-0.02	-18.56	0.000	0.58 2.37	0.12	0.91	0.47 2.27	0.12	-2.93	0.007	60-94		
47 Rwanda	0.18 3.55	0.25	0.31	0.16 2.50	0.06	0.09	0.000	0.50 1.35	0.03	1.39	0.54 1.24	0.05	-3.85	0.016	60-94		
48 Sierra Leone	0.50 12.06	0.81	1.89	0.49 11.73	0.81	-5.64	0.026	0.54 1.17	0.01	2.85	0.48 1.97	0.01	-13.97	0.082	60-94		
49 Singapore	0.49 34.69	0.97	0.26	0.49 21.90	0.97	-1.05	0.000	0.06 0.30	-0.03	1.56	0.01 0.05	-0.03	-4.28	0.019	60-94		
50 South Africa	0.32 7.46	0.62	0.11	0.37 8.05	0.52	-1.27	0.000	0.66 4.65	0.38	1.50	0.61 4.58	0.38	-4.55	0.017	60-94		

Table 3a. Cobb-Douglas Production Function Estimates for 66 Countries [continued]

	Level							First Difference							Range
	OLS			FM				OLS			FM				
	$\alpha$	R <sup>2</sup>	D.W.	$\alpha$	R <sup>2</sup>	P-O	SH	$\alpha$	R <sup>2</sup>	D.W.	$\alpha$	R <sup>2</sup>	P-O	SH	
51 Spain	0.61 62.74	0.99	0.39	0.60 48.70	0.99	-12.46	0.006	0.59 4.27	0.34	0.82	0.60 4.40	0.56	-4.46	0.019	60-94
52 Sri Lanka	0.51 33.37	0.97	0.34	0.49 21.48	0.97	-1.96	0.004	0.23 1.83	0.07	2.34	0.29 2.66	0.07	-6.62	0.041	60-94
53 Sweden	0.56 26.84	0.96	0.26	0.55 15.46	0.96	-13.43	0.002	0.75 6.09	0.52	1.41	0.81 6.26	0.53	-3.80	0.016	60-94
54 Switzerland	0.31 8.22	0.66	0.09	0.32 4.57	0.64	-26.28	0.000	0.60 5.77	0.49	1.14	0.72 5.36	0.49	-3.24	0.012	60-94
55 Taiwan	0.57 41.64	0.98	0.22	0.57 23.02	0.98	-1.09	0.001	0.06 0.38	-0.03	1.59	0.12 0.74	-0.03	-4.42	0.019	60-94
56 Tanzania	0.25 3.43	0.27	0.22	0.26 2.44	0.08	-14.80	0.002	0.25 0.61	-0.02	0.93	0.47 1.04	0.21	-2.97	0.019	65-94
57 Thailand	0.59 40.08	0.98	0.15	0.61 23.72	0.98	-16.80	0.000	0.44 2.90	0.18	1.14	0.36 3.47	0.19	-3.58	0.011	60-94
58 Trinidad and Tobago	0.47 8.24	0.66	0.18	0.53 7.74	0.57	-1.55	0.002	0.87 3.70	0.28	2.16	0.80 3.94	0.35	-6.01	0.042	60-94
59 Tunisia	0.75 18.29	0.91	0.39	0.77 10.53	0.91	-1.95	0.003	0.51 1.80	0.06	2.18	0.59 2.30	0.06	-6.34	0.034	60-94
60 Turkey	0.63 24.59	0.95	0.19	0.62 14.55	0.95	-1.76	0.001	0.46 1.36	0.03	1.53	0.24 0.62	0.03	-5.00	0.021	60-94
61 United Kingdom	0.53 35.47	0.97	0.45	0.53 20.63	0.97	-1.80	0.003	0.27 1.63	0.05	1.68	0.28 2.29	0.05	-4.36	0.020	60-94
62 United States	0.70 6.15	0.52	0.33	0.68 3.59	0.55	-2.08	0.002	0.14 0.66	-0.02	1.23	0.43 1.68	-0.07	-3.88	0.014	60-94
63 Uruguay	0.32 1.77	0.06	0.36	0.24 1.36	0.07	-13.59	0.002	0.52 1.53	0.04	1.12	0.24 0.99	0.02	-3.25	0.010	60-94

Table 3a. Cobb-Douglas Production Function Estimates for 66 Countries [concluded]

64 Venezuela	0.78 5.25	0.66	0.79	0.64 4.28	0.71	-2.99	0.027	0.64 0.45	-0.07	1.74	0.74 1.25	-0.06	-2.98	0.056	80-94
65 Zambia	0.66 18.97	0.91	0.53	0.60 12.87	0.90	-2.51	0.004	0.44 2.06	0.09	2.32	0.52 3.61	0.09	-6.59	0.043	60-94
66 Zimbabwe	0.82 3.02	0.19	0.22	0.76 2.31	0.27	-12.97	0.002	0.60 1.46	0.03	1.37	0.50 1.52	0.03	-3.83	0.015	60-94

Note: Table 3a provides OLS and Fully Modified (FM) estimates of the share of physical capital ( $\alpha$ ) for the following Cobb-Douglas production function:  $Y_t = A_t K_t^\alpha (L_t H_t)^{1-\alpha}$ , where  $A_t$  is total factor productivity,  $K_t$  is the stock of physical capital,  $L_t$  is the active population, and  $H_t$  is an index of human capital, both in *levels* and *first difference* for 66 countries. For following statistics are provided: the adjusted  $R^2$  ( $\bar{R}^2$ ), the Dubin-Watson statistic (D.W.), the Phillips-Ouliaris (P-O) and Shin's (SH) cointegration tests. The 1%, 5%, and 10% critical values are -4.29, -3.5, and -3.22 for P-O, and 0.184, 0.121, and 0.097 for SH, respectively. The superscripts *a,b,c* indicate significance at 1, 5, and 10 %percent, respectively.



Table 3b. Summary Statistics of Cobb-Douglas Production Function Estimates

	Statistics by Region						
	Sub-Saharan Africa	Middle East & North Africa	Latin America	East Asia	South Asia	Industrial	World
Mean							
Level	0.43	0.63	0.52	0.48	0.56	0.64	0.55
Difference	0.50	0.54	0.62	0.30	0.42	0.58	0.53
Median							
Level	0.40	0.66	0.49	0.49	0.63	0.64	0.57
Difference	0.49	0.56	0.68	0.36	0.31	0.62	0.51
Std							
Level	0.23	0.22	0.18	0.11	0.21	0.14	0.20
Difference	0.21	0.16	0.25	0.16	0.27	0.19	0.23
Min							
Level	0.13	0.25	0.24	0.25	0.17	0.32	0.13
Difference	0.12	0.24	0.11	0.01	0.16	0.28	0.01
Max							
Level	0.91	1.00	0.81	0.61	0.77	0.89	1.00
Difference	0.99	0.76	0.96	0.47	0.95	0.81	0.99
N	12	8	14	7	5	20	66

*Note:* Table 3b gives regional summary statistics for Table 3a which shows the OLS and Fully Modified (FM) estimates of the share of physical capital ( $\alpha$ ) for the following Cobb-Douglas production function:  $Y_t = A_t K_t^\alpha (L_t H_t)^{1-\alpha}$ , where  $A_t$  is total factor productivity,  $K_t$  is the stock of physical capital,  $L_t$  is the active population, and  $H_t$  is an index of human capital, both in *levels* and *first difference* for 66 countries.

Table 4a. Panel Estimates of the Cobb-Douglas Production Function (with Human Capital)

	<u>Africa</u>		<u>East Asia</u>		<u>South Asia</u>		<u>Middle East</u>		<u>Latin America</u>		<u>Industrial</u>		<u>World</u>	
Estimation Method	$\alpha$	$\bar{R}^2$	$\alpha$	$\bar{R}^2$	$\alpha$	$\bar{R}^2$	$\alpha$	$\bar{R}^2$	$\alpha$	$\bar{R}^2$	$\alpha$	$\bar{R}^2$	$\alpha$	$\bar{R}^2$
Pooled	.44 (6.84)	.10	.46 (8.38)	.25	.38 (4.27)	.09	.63 (6.52)	.14	.72 (13.98)	.30	.55 (16.89)	.31	.55 (23.59)	.21
GLS	.47 (8.20)	.10 .14	.48 (8.87)	.25 .33	.28 (4.18)	.08 .17	.65 (8.48)	.14 .29	.68 (14.11)	.30 .33	.55 (18.11)	.31 .36	.55 (29.82)	.21 .37
SUR	.49 (9.63)	.10	.51 (10.46)	.25	.28 (4.44)	.08	.65 (9.51)	.14	.67 (15.81)	.30	.54 (22.11)	.31	--- ---	--- ---
Pooled with Fixed Effects	.47 (6.58)	.10	.35 (5.04)	.25	.32 (3.14)	.08	.63 (6.28)	.17	.77 (13.56)	.30	.53 (14.68)	.33	.56 (19.55)	.22
GLS with Fixed Effects	.51 (7.83)	.10 .14	.39 (5.92)	.27 .33	.23 (3.20)	.07 .17	.67 (8.12)	.17 .33	.74 (14.00)	.30 .54	.53 (15.97)	.33 .38	.54 (24.26)	.22 .43
SUR with Fixed Effects	.53 (9.66)	.09	.41 (6.77)	.27	.21 (3.08)	.07	.69 (9.88)	.17	.73 (16.29)	.30	.53 (19.84)	.33	--- ---	--- ---
GLS with Random Effects	.43 (6.90)	.09 .09	.45 (8.03)	.26 .26	--- ---	---	.63 (6.42)	.19 .17	.71 (14.05)	.29 .30	.54 (15.33)	.35 .34	.56 (21.90)	.23 .23
Mean	.48		.44		.28		.65		.72		.54		.55	
Median	.47		.45		.28		.65		.72		.54		.56	
Sample Size	N=408		N=205		N=170		N=255		N=444		N=644		N=2126	

Note: Table 4a provides different estimates of the share of physical capital ( $\alpha$ ) for the following Cobb-Douglas production function:  $Y_t = A_t K_t^\alpha (L_t H_t)^{1-\alpha}$ , where  $A_t$  is total factor productivity,  $K_t$  is the stock of physical capital,  $L_t$  is the active population, and  $H_t$  is an index of human capital. The production function is estimated in first difference. Note that for the GLS equations, both the unweighted (first line) and weighted (second line)  $\bar{R}^2$  are given.

Table 4b. Panel Estimation of a Cobb-Douglas Production Function (with no Human Capital)

	<u>Africa</u>		<u>East Asia</u>		<u>South Asia</u>		<u>Middle East</u>		<u>Latin America</u>		<u>Industrial</u>		<u>World</u>	
<u>Estimation Method</u>	$\alpha$	$\bar{R}^2$	$\alpha$	$\bar{R}^2$	$\alpha$	$\bar{R}^2$	$\alpha$	$\bar{R}^2$	$\alpha$	$\bar{R}^2$	$\alpha$	$\bar{R}^2$	$\alpha$	$\bar{R}^2$
Pooled	.43 (6.60)	.09	.45 (7.98)	.23	.36 (4.14)	.09	.59 (5.87)	.12	.64 (11.11)	.22	.54 (16.43)	.30	.54 (22.17)	.19
GLS	.46 (7.78)	.09 .13	.47 (8.36)	.23 .32	.28 (4.20)	.08 .20	.61 (7.69)	.11 .29	.61 (12.15)	.22 .35	.52 (17.94)	.29 .38	.53 (28.85)	.19 .42
SUR	.48 (9.06)	.09	.51 (10.46)	.23	.28 (4.52)	.08	.61 (8.52)	.11	.56 (11.94)	.21	.51 (21.25)	.29	--- ---	--- ---
Pooled with Fixed Effects	.48 (6.50)	.09	.32 (4.36)	.26	.31 (3.07)	.07	.60 (5.76)	.14	.68 (10.65)	.21	.51 (13.74)	.31	.52 (17.38)	.20
GLS with Fixed Effects	.51 (7.63)	.09 .13	.35 (5.04)	.26 .33	.24 (3.33)	.07 .20	.64 (7.48)	.14 .32	.69 (11.86)	.29 .81	.49 (15.22)	.31 .39	.50 (22.22)	.20 .59
SUR with Fixed Effects	.53 (9.40)	.09	.41 (6.47)	.26	.22 (3.29)	.07	.66 (9.01)	.14	.64 (12.51)	.21	.47 (16.30)	.31	--- ---	--- ---
GLS with Random Effects	.42 (6.62)	.07 .09	.44 (7.46)	.25 .24	--- ---	---	.60 (5.85)	.16 .15	.63 (11.21)	.20 .21	.53 (15.44)	.32 .31	.53 (20.57)	.21 .20
Mean	.47		.42		.28		.62		.64		.51		.52	
Median	.48		.44		.28		.61		.64		.51		.53	
Sample Size	N=408		N=205		N=170		N=255		N=444		N=644		N=2126	

*Note:* Table 4b provides different estimates of the share of physical capital ( $\alpha$ ) for the following Cobb-Douglas production function:  $Y_t = A_t K_t^\alpha L_t^{1-\alpha}$ , where  $A_t$  is total factor productivity,  $K_t$  is the stock of physical capital, and  $L_t$  is the active population. The production function is estimated in first difference. Note that for the GLS equations, both the unweighted (first line) and weighted (second line)  $\bar{R}^2$  are given.

Table 5a. Decomposition of the Growth Rate of Real GDP ( $\alpha = 0.2$ )

	60-73					74-86					87-94					60-94				
	dTFP	dk <sub>c</sub>	dl <sub>c</sub>	dh <sub>c</sub>	dy	dTFP	dk <sub>c</sub>	dl <sub>c</sub>	dh <sub>c</sub>	dy	dTFP	dk <sub>c</sub>	dl <sub>c</sub>	dh <sub>c</sub>	dy	dTFP	dk <sub>c</sub>	dl <sub>c</sub>	dh <sub>c</sub>	dy
<b>EASIA</b>																				
Mean	2.08	2.00	2.14	0.59	6.81	1.24	1.87	2.08	0.70	5.88	3.01	1.60	1.57	0.80	6.97	1.97	1.85	1.98	0.68	6.49
Median	2.36	2.02	2.19	0.62	7.23	1.86	1.93	2.15	0.61	6.42	2.99	1.63	1.57	0.80	6.99	2.38	1.87	1.89	0.64	6.97
Std	2.60	0.40	0.45	0.16	2.81	3.27	0.40	0.39	0.30	3.40	1.80	0.22	0.19	0.01	1.85	2.88	0.53	0.50	0.26	3.05
$\rho_L$	0.92	1.00	1.00	0.99	0.99	0.88	1.00	1.00	0.99	0.98	0.93	1.00	1.00	1.00	0.99	0.98	1.00	1.00	1.00	1.00
$\rho_D$	0.03	0.51	0.31	0.48	0.18	0.11	0.72	0.56	0.76	0.15	0.36	0.59	0.34	0.60	0.31	0.21	0.72	0.53	0.71	0.25
<b>SASIA</b>																				
Mean	0.76	0.97	1.59	0.40	3.72	2.04	1.16	1.90	0.44	5.54	1.53	1.06	1.69	0.46	4.74	1.43	1.06	1.73	0.43	4.66
Median	1.12	0.91	1.64	0.45	4.26	2.12	1.14	1.84	0.40	5.57	2.13	1.09	1.69	0.46	5.46	1.84	1.00	1.72	0.45	5.33
Std	6.80	0.50	0.19	0.25	6.93	2.71	0.36	0.26	0.21	2.74	3.05	0.19	0.14	0.01	3.08	4.86	0.57	0.33	0.32	5.00
$\rho_L$	0.62	1.00	1.00	0.93	0.91	0.95	1.00	1.00	0.99	0.99	0.72	1.00	1.00	1.00	0.93	0.92	1.00	1.00	1.00	0.99
$\rho_D$	-0.12	0.45	0.34	0.64	-0.06	-0.10	0.75	0.59	0.71	-0.04	0.19	0.32	0.23	0.02	0.17	-0.03	0.78	0.65	0.83	0.04
<b>AFRICA</b>																				
Mean	0.93	1.06	1.85	0.22	4.06	-1.00	0.82	2.00	0.35	2.17	-0.97	0.47	2.04	0.36	1.91	-0.26	0.83	1.95	0.30	2.83
Median	1.03	1.04	1.91	0.22	4.20	-0.94	0.80	1.97	0.31	2.19	-0.99	0.44	2.05	0.36	1.93	-0.12	0.77	1.94	0.35	3.09
Std	5.45	0.44	0.35	0.19	5.47	4.96	0.46	0.31	0.16	5.10	3.69	0.22	0.16	0.01	3.71	5.48	0.57	0.39	0.21	5.58
$\rho_L$	0.73	0.99	1.00	0.95	0.90	0.75	0.99	1.00	0.98	0.75	0.67	0.95	1.00	1.00	0.70	0.89	1.00	1.00	0.99	0.98
$\rho_D$	-0.09	0.47	0.09	0.62	-0.05	0.11	0.60	0.28	0.70	0.11	0.02	0.39	0.12	-0.11	-0.02	0.13	0.73	0.38	0.79	0.15
<b>MENA</b>																				
Mean	2.59	1.30	1.57	0.40	5.86	1.22	1.47	1.95	0.64	5.28	-0.14	0.88	1.98	0.62	3.35	1.43	1.27	1.81	0.54	5.05
Median	3.26	1.27	1.25	0.42	6.54	1.34	1.39	1.68	0.63	5.38	0.04	0.86	1.86	0.62	3.73	1.69	1.28	1.76	0.59	5.56
Std	6.11	0.36	0.91	0.25	6.12	5.34	0.52	0.76	0.27	5.32	3.98	0.22	0.61	0.02	4.10	5.90	0.56	0.97	0.33	5.93
$\rho_L$	0.89	1.00	0.96	0.96	0.96	0.65	1.00	0.98	0.88	0.96	0.66	0.99	0.92	1.00	0.77	0.95	1.00	1.00	1.00	0.99
$\rho_D$	0.05	0.39	0.18	0.69	0.10	0.19	0.72	0.18	0.66	0.22	-0.11	0.45	0.04	0.25	-0.03	0.25	0.71	0.39	0.87	0.25
<b>LATAM</b>																				
Mean	1.71	1.06	1.88	0.33	4.98	-1.32	0.97	2.19	0.58	2.42	-0.54	0.48	2.06	0.51	2.51	0.02	0.89	2.04	0.47	3.42
Median	1.72	1.04	1.81	0.28	5.12	-0.67	1.00	2.23	0.55	2.88	-0.08	0.45	2.05	0.51	2.98	0.22	0.88	2.07	0.45	3.64
Std	3.48	0.30	0.59	0.24	3.44	4.50	0.50	0.40	0.28	4.76	3.63	0.24	0.21	0.01	3.70	4.43	0.51	0.54	0.29	4.54
$\rho_L$	0.86	0.99	0.99	0.98	0.96	0.83	0.97	1.00	1.00	0.86	0.61	0.90	1.00	1.00	0.81	0.94	1.00	1.00	1.00	0.98
$\rho_D$	-0.05	0.45	0.08	0.65	0.00	0.27	0.79	0.24	0.75	0.32	0.02	0.59	0.02	-0.01	0.05	0.32	0.79	0.34	0.82	0.34
<b>INDUS</b>																				
Mean	2.67	1.27	0.70	0.43	5.07	0.57	0.73	0.62	0.54	2.46	0.99	0.56	0.37	0.23	2.15	1.47	0.90	0.59	0.43	3.39
Median	2.75	1.27	0.71	0.34	5.33	0.75	0.74	0.67	0.50	2.65	1.11	0.57	0.63	0.23	2.34	1.50	0.83	0.67	0.32	3.42
Std	1.86	0.15	0.78	0.43	2.04	2.01	0.20	1.10	0.42	2.21	1.54	0.14	1.47	0.01	2.19	2.17	0.37	1.19	0.48	2.61
$\rho_L$	0.96	1.00	0.88	0.97	0.99	0.84	1.00	0.88	0.98	0.97	0.66	1.00	0.74	1.00	0.79	0.98	1.00	0.96	1.00	1.00
$\rho_D$	-0.02	0.17	0.19	0.65	-0.06	0.07	0.80	0.28	0.73	0.08	0.17	0.68	0.40	-0.09	0.36	0.26	0.75	0.43	0.78	0.33
<b>WORLD</b>																				
Mean	1.84	1.22	1.55	0.37	4.98	-0.06	1.02	1.70	0.52	3.19	0.22	0.68	1.56	0.44	2.90	0.74	1.02	1.61	0.44	3.80
Median	1.95	1.12	1.60	0.30	5.10	0.63	0.93	1.95	0.48	3.16	0.69	0.59	1.76	0.42	3.34	0.90	0.95	1.86	0.41	3.97
Std	3.95	0.32	0.58	0.27	4.02	3.87	0.40	0.59	0.28	4.03	2.96	0.20	0.55	0.01	3.17	4.17	0.50	0.70	0.32	4.35
$\rho_L$	0.85	1.00	0.96	0.97	0.96	0.80	0.99	0.97	0.97	0.89	0.68	0.96	0.92	1.00	0.80	0.94	1.00	0.99	1.00	0.99
$\rho_D$	-0.04	0.38	0.16	0.63	0.00	0.14	0.73	0.30	0.72	0.16	0.08	0.53	0.18	0.03	0.13	0.22	0.75	0.41	0.80	0.26

Note: Assume output follows a Cobb-Douglas production function:  $Y_t = A_t K_t^\alpha (L_t H_t)^{1-\alpha}$  where  $Y_t$  is aggregate output,  $A_t$  is total factor productivity,  $K_t$  is the stock of physical capital,  $L_t$  is the active population and  $H_t$  is an index of human capital. Hence,  $dTFP = \log(A_t/A_{t-1})$ ,  $dk_c = \alpha \log(K_t/K_{t-1})$ ,  $dl_c = (1-\alpha) \log(L_t/L_{t-1})$ ,  $dh_c = (1-\alpha) \log(H_t/H_{t-1})$ , and  $dy = \log(Y_t/Y_{t-1})$ . The statistics are computed by varying both the time and the regional cross-section dimensions (for example, the mean TFP for AFRICA is computed by taking the average over the countries in AFRICA of the individual African countries' average over 1960-1994 period). The statistics  $\rho_L$  and  $\rho_D$  provide the autocorrelation coefficients of the corresponding variable in level and in first difference. The regions are: East Asia (EASIA), South Asia (SASIA), Sub-Saharan Africa (AFRICA), Middle East and North Africa (MENA), Latin America (LATAM), and Industrial Countries (INDUS).

Table 5b. Decomposition of the Growth Rate of Real GDP ( $\alpha = 0.4$ )

	60-73					74-86					87-94					60-94				
	dTFP	dk <sub>c</sub>	dl <sub>c</sub>	dh <sub>c</sub>	dy	dTFP	dk <sub>c</sub>	dl <sub>c</sub>	dh <sub>c</sub>	dy	dTFP	dk <sub>c</sub>	dl <sub>c</sub>	dh <sub>c</sub>	dy	dTFP	dk <sub>c</sub>	dl <sub>c</sub>	dh <sub>c</sub>	dy
<b>EASIA</b>																				
Mean	0.76	4.00	1.61	0.44	6.81	0.06	3.73	1.56	0.52	5.88	2.00	3.19	1.18	0.60	6.97	0.79	3.71	1.49	0.51	6.49
Median	0.85	4.03	1.64	0.46	7.23	0.63	3.86	1.61	0.46	6.42	1.91	3.26	1.18	0.60	6.99	1.00	3.74	1.42	0.48	6.97
Std	2.55	0.80	0.34	0.12	2.81	3.21	0.81	0.29	0.22	3.40	1.85	0.45	0.14	0.01	1.85	2.87	1.05	0.37	0.20	3.05
$\rho_L$	0.71	1.00	1.00	0.99	0.99	0.73	1.00	1.00	0.99	0.98	0.85	1.00	1.00	1.00	0.99	0.95	1.00	1.00	1.00	1.00
$\rho_D$	-0.00	0.51	0.31	0.48	0.18	0.11	0.72	0.56	0.76	0.15	0.42	0.59	0.34	0.60	0.31	0.21	0.72	0.53	0.71	0.25
<b>SASIA</b>																				
Mean	0.28	1.95	1.19	0.30	3.72	1.47	2.31	1.43	0.33	5.54	1.01	2.12	1.27	0.35	4.74	0.91	2.13	1.30	0.32	4.66
Median	0.33	1.82	1.23	0.33	4.26	1.53	2.28	1.38	0.30	5.57	1.59	2.19	1.26	0.34	5.46	1.32	1.99	1.29	0.34	5.33
Std	6.73	1.01	0.15	0.19	6.93	2.71	0.73	0.19	0.16	2.74	2.98	0.39	0.10	0.01	3.08	4.83	1.14	0.25	0.24	5.00
$\rho_L$	0.52	1.00	1.00	0.93	0.91	0.84	1.00	1.00	0.99	0.99	0.69	1.00	1.00	1.00	0.93	0.90	1.00	1.00	1.00	0.99
$\rho_D$	-0.10	0.45	0.34	0.64	-0.06	-0.08	0.75	0.59	0.71	-0.04	0.20	0.32	0.23	0.02	0.17	0.01	0.78	0.65	0.83	0.04
<b>AFRICA</b>																				
Mean	0.39	2.12	1.39	0.16	4.06	-1.23	1.64	1.50	0.26	2.17	-0.84	0.95	1.53	0.27	1.91	-0.52	1.66	1.46	0.23	2.83
Median	0.49	2.07	1.43	0.16	4.20	-1.14	1.59	1.48	0.23	2.19	-0.86	0.88	1.53	0.27	1.93	-0.43	1.55	1.46	0.26	3.09
Std	5.43	0.88	0.26	0.15	5.47	4.89	0.92	0.23	0.12	5.10	3.70	0.43	0.12	0.01	3.71	5.36	1.14	0.29	0.16	5.58
$\rho_L$	0.65	0.99	1.00	0.95	0.90	0.77	0.99	1.00	0.98	0.75	0.64	0.95	1.00	1.00	0.70	0.86	1.00	1.00	0.99	0.98
$\rho_D$	-0.09	0.47	0.09	0.62	-0.05	0.10	0.60	0.28	0.70	0.11	0.04	0.39	0.12	-0.11	-0.02	0.10	0.73	0.38	0.79	0.15
<b>MENA</b>																				
Mean	1.79	2.60	1.18	0.30	5.86	0.41	2.93	1.46	0.48	5.28	-0.37	1.77	1.48	0.47	3.35	0.75	2.53	1.36	0.41	5.05
Median	2.50	2.53	0.94	0.31	6.54	0.63	2.78	1.26	0.47	5.38	-0.26	1.72	1.40	0.46	3.73	0.95	2.57	1.32	0.44	5.56
Std	6.03	0.71	0.68	0.18	6.12	5.16	1.04	0.57	0.20	5.32	3.85	0.45	0.46	0.01	4.10	5.73	1.11	0.73	0.25	5.93
$\rho_L$	0.88	1.00	0.96	0.96	0.96	0.78	1.00	0.98	0.88	0.96	0.63	0.99	0.92	1.00	0.77	0.93	1.00	1.00	1.00	0.99
$\rho_D$	0.05	0.39	0.18	0.69	0.10	0.17	0.72	0.18	0.66	0.22	-0.14	0.45	0.04	0.25	-0.03	0.23	0.71	0.39	0.87	0.25
<b>LATAM</b>																				
Mean	1.20	2.12	1.41	0.25	4.98	-1.59	1.93	1.64	0.43	2.42	-0.38	0.96	1.55	0.38	2.51	-0.24	1.78	1.53	0.35	3.42
Median	1.13	2.08	1.36	0.21	5.12	-1.02	2.00	1.67	0.41	2.88	0.11	0.91	1.54	0.38	2.98	-0.02	1.76	1.55	0.34	3.64
Std	3.37	0.59	0.44	0.18	3.44	4.29	1.01	0.30	0.21	4.76	3.58	0.49	0.15	0.01	3.70	4.22	1.03	0.41	0.22	4.54
$\rho_L$	0.81	0.99	0.99	0.98	0.96	0.84	0.97	1.00	1.00	0.86	0.64	0.90	1.00	1.00	0.81	0.93	1.00	1.00	1.00	0.98
$\rho_D$	-0.06	0.45	0.08	0.65	0.00	0.24	0.79	0.24	0.75	0.32	0.00	0.59	0.02	-0.01	0.05	0.28	0.79	0.34	0.82	0.34
<b>INDUS</b>																				
Mean	1.68	2.54	0.53	0.33	5.07	0.13	1.46	0.46	0.41	2.46	0.58	1.12	0.28	0.17	2.15	0.83	1.79	0.44	0.32	3.39
Median	1.75	2.55	0.53	0.25	5.33	0.39	1.49	0.50	0.37	2.65	0.69	1.14	0.47	0.17	2.34	0.95	1.65	0.50	0.24	3.42
Std	1.85	0.29	0.58	0.33	2.04	2.01	0.41	0.83	0.32	2.21	1.58	0.27	1.10	0.01	2.19	2.04	0.73	0.90	0.36	2.61
$\rho_L$	0.92	1.00	0.88	0.97	0.99	0.71	1.00	0.88	0.98	0.97	0.54	1.00	0.74	1.00	0.79	0.96	1.00	0.96	1.00	1.00
$\rho_D$	-0.02	0.17	0.19	0.65	-0.06	0.09	0.80	0.28	0.73	0.08	0.22	0.68	0.40	-0.09	0.36	0.20	0.75	0.43	0.78	0.33
<b>WORLD</b>																				
Mean	1.10	2.44	1.16	0.27	4.98	-0.52	2.04	1.27	0.39	3.19	0.05	1.36	1.17	0.33	2.90	0.23	2.03	1.21	0.33	3.80
Median	1.20	2.24	1.20	0.22	5.10	0.09	1.87	1.46	0.36	3.16	0.47	1.17	1.32	0.32	3.34	0.53	1.91	1.39	0.31	3.97
Std	3.90	0.64	0.44	0.20	4.02	3.77	0.81	0.44	0.21	4.03	2.95	0.41	0.41	0.01	3.17	4.03	1.00	0.52	0.24	4.35
$\rho_L$	0.78	1.00	0.96	0.97	0.96	0.77	0.99	0.97	0.97	0.89	0.63	0.96	0.92	1.00	0.80	0.92	1.00	0.99	1.00	0.99
$\rho_D$	-0.04	0.38	0.16	0.63	0.00	0.13	0.73	0.30	0.72	0.16	0.10	0.53	0.18	0.03	0.13	0.19	0.75	0.41	0.80	0.26

Note: Assume output follows a Cobb-Douglas production function:  $Y_t = A_t K_t^\alpha (L_t H_t)^{1-\alpha}$  where  $Y_t$  is aggregate output,  $A_t$  is total factor productivity,  $K_t$  is the stock of physical capital,  $L_t$  is the active population and  $H_t$  is an index of human capital. Hence,  $dTFP = \log(A_t/A_{t-1})$ ,  $dk_c = \alpha \log(K_t/K_{t-1})$ ,  $dl_c = (1-\alpha) \log(L_t/L_{t-1})$ ,  $dh_c = (1-\alpha) \log(H_t/H_{t-1})$ , and  $dy = \log(Y_t/Y_{t-1})$ . The statistics are computed by varying both the time and the regional cross-section dimensions (for example, the mean TFP for AFRICA is computed by taking the average over the countries in AFRICA of the individual African countries' average over 1960-1994 period). The statistics  $\rho_L$  and  $\rho_D$  provide the autocorrelation coefficients of the corresponding variable in level and in first difference. The regions are: East Asia (EASIA), South Asia (SASIA), Sub-Saharan Africa (AFRICA), Middle East and North Africa (MENA), Latin America (LATAM), and Industrial Countries (INSUS).

Table 5c. Decomposition of the Growth Rate of Real GDP ( $\alpha = 0.6$ )

	60-73					74-86					87-94					60-94				
	dTFP	dk <sub>c</sub>	dl <sub>c</sub>	dh <sub>c</sub>	dy	dTFP	dk <sub>c</sub>	dl <sub>c</sub>	dh <sub>c</sub>	dy	dTFP	dk <sub>c</sub>	dl <sub>c</sub>	dh <sub>c</sub>	dy	dTFP	dk <sub>c</sub>	dl <sub>c</sub>	dh <sub>c</sub>	dy
<b>EASIA</b>																				
Mean	-0.55	6.00	1.07	0.30	6.81	-1.11	5.60	1.04	0.35	5.88	1.00	4.79	0.79	0.40	6.97	-0.40	5.56	0.99	0.34	6.49
Median	-0.39	6.05	1.09	0.31	7.23	-0.61	5.80	1.07	0.31	6.42	0.78	4.89	0.78	0.40	6.99	-0.22	5.62	0.95	0.32	6.97
Std	2.57	1.20	0.23	0.08	2.81	3.21	1.21	0.20	0.15	3.40	1.95	0.67	0.10	0.01	1.85	2.97	1.58	0.25	0.13	3.05
$\rho_L$	0.80	1.00	1.00	0.99	0.99	0.73	1.00	1.00	0.99	0.98	0.54	1.00	1.00	1.00	0.99	0.92	1.00	1.00	1.00	1.00
$\rho_D$	0.03	0.51	0.31	0.48	0.18	0.12	0.72	0.56	0.76	0.15	0.47	0.59	0.34	0.60	0.31	0.26	0.72	0.53	0.71	0.25
<b>SASIA</b>																				
Mean	-0.20	2.92	0.79	0.20	3.72	0.90	3.47	0.95	0.22	5.54	0.49	3.17	0.85	0.23	4.74	0.39	3.19	0.87	0.22	4.66
Median	-0.32	2.72	0.82	0.22	4.26	0.93	3.42	0.92	0.20	5.57	1.03	3.28	0.84	0.23	5.46	0.87	2.99	0.86	0.23	5.33
Std	6.75	1.51	0.10	0.13	6.93	2.77	1.09	0.13	0.10	2.74	2.92	0.58	0.07	0.01	3.08	4.91	1.71	0.17	0.16	5.00
$\rho_L$	0.62	1.00	1.00	0.93	0.91	0.90	1.00	1.00	0.99	0.99	0.59	1.00	1.00	1.00	0.93	0.89	1.00	1.00	1.00	0.99
$\rho_D$	-0.06	0.45	0.34	0.64	-0.06	-0.03	0.75	0.59	0.71	-0.04	0.20	0.32	0.23	0.02	0.17	0.08	0.78	0.65	0.83	0.04
<b>AFRICA</b>																				
Mean	-0.16	3.18	0.93	0.11	4.06	-1.47	2.46	1.00	0.18	2.17	-0.72	1.42	1.02	0.18	1.91	-0.79	2.49	0.98	0.15	2.83
Median	-0.15	3.11	0.95	0.11	4.20	-1.48	2.38	0.99	0.16	2.19	-0.74	1.32	1.02	0.18	1.93	-0.78	2.32	0.97	0.17	3.09
Std	5.45	1.32	0.17	0.10	5.47	4.88	1.38	0.16	0.08	5.10	3.72	0.65	0.08	0.01	3.71	5.32	1.72	0.19	0.11	5.58
$\rho_L$	0.65	0.99	1.00	0.95	0.90	0.77	0.99	1.00	0.98	0.75	0.58	0.95	1.00	1.00	0.70	0.89	1.00	1.00	0.99	0.98
$\rho_D$	-0.07	0.47	0.09	0.62	-0.05	0.10	0.60	0.28	0.70	0.11	0.06	0.39	0.12	-0.11	-0.02	0.09	0.73	0.38	0.79	0.15
<b>MENA</b>																				
Mean	0.98	3.90	0.79	0.20	5.86	-0.41	4.40	0.98	0.32	5.28	-0.60	2.65	0.99	0.31	3.35	0.07	3.80	0.91	0.27	5.05
Median	1.63	3.79	0.62	0.21	6.54	-0.04	4.18	0.84	0.32	5.38	-0.58	2.58	0.93	0.31	3.73	0.19	3.85	0.88	0.30	5.56
Std	6.00	1.07	0.46	0.12	6.12	5.06	1.57	0.38	0.13	5.32	3.73	0.67	0.31	0.01	4.10	5.64	1.66	0.48	0.16	5.93
$\rho_L$	0.81	1.00	0.96	0.96	0.96	0.82	1.00	0.98	0.88	0.96	0.71	0.99	0.92	1.00	0.77	0.91	1.00	1.00	1.00	0.99
$\rho_D$	0.05	0.39	0.18	0.69	0.10	0.17	0.72	0.18	0.66	0.22	-0.17	0.45	0.04	0.25	-0.03	0.23	0.71	0.39	0.87	0.25
<b>LATAM</b>																				
Mean	0.69	3.18	0.94	0.17	4.98	-1.87	2.90	1.10	0.29	2.42	-0.21	1.44	1.03	0.26	2.51	-0.50	2.66	1.02	0.23	3.42
Median	0.53	3.13	0.91	0.14	5.12	-1.38	2.99	1.12	0.27	2.88	0.29	1.36	1.03	0.26	2.98	-0.26	2.64	1.03	0.23	3.64
Std	3.29	0.89	0.30	0.12	3.44	4.15	1.51	0.20	0.14	4.76	3.55	0.73	0.10	0.01	3.70	4.08	1.54	0.27	0.15	4.54
$\rho_L$	0.70	0.99	0.99	0.98	0.96	0.87	0.97	1.00	1.00	0.86	0.65	0.90	1.00	1.00	0.81	0.94	1.00	1.00	1.00	0.98
$\rho_D$	-0.06	0.45	0.08	0.65	0.00	0.21	0.79	0.24	0.75	0.32	-0.01	0.59	0.02	-0.01	0.05	0.26	0.79	0.34	0.82	0.34
<b>INDUS</b>																				
Mean	0.70	3.80	0.35	0.22	5.07	-0.31	2.19	0.31	0.27	2.46	0.16	1.69	0.18	0.12	2.15	0.19	2.69	0.30	0.21	3.39
Median	0.71	3.82	0.36	0.17	5.33	-0.01	2.23	0.33	0.25	2.65	0.27	1.72	0.31	0.12	2.34	0.34	2.48	0.34	0.16	3.42
Std	1.87	0.44	0.39	0.22	2.04	2.06	0.61	0.55	0.21	2.21	1.69	0.41	0.73	0.00	2.19	1.99	1.10	0.60	0.24	2.61
$\rho_L$	0.78	1.00	0.88	0.97	0.99	0.65	1.00	0.88	0.98	0.97	0.64	1.00	0.74	1.00	0.79	0.87	1.00	0.96	1.00	1.00
$\rho_D$	-0.01	0.17	0.19	0.65	-0.06	0.12	0.80	0.28	0.73	0.08	0.27	0.68	0.40	-0.09	0.36	0.16	0.75	0.43	0.78	0.33
<b>WORLD</b>																				
Mean	0.36	3.66	0.78	0.18	4.98	-0.99	3.07	0.85	0.26	3.19	-0.13	2.04	0.78	0.22	2.90	-0.27	3.05	0.80	0.22	3.80
Median	0.47	3.36	0.80	0.15	5.10	-0.66	2.80	0.98	0.24	3.16	0.29	1.76	0.88	0.21	3.34	-0.04	2.86	0.93	0.20	3.97
Std	3.89	0.96	0.29	0.14	4.02	3.74	1.21	0.29	0.14	4.03	2.96	0.61	0.28	0.01	3.17	3.98	1.50	0.35	0.16	4.35
$\rho_L$	0.73	1.00	0.96	0.97	0.96	0.78	0.99	0.97	0.97	0.89	0.62	0.96	0.92	1.00	0.80	0.90	1.00	0.99	1.00	0.99
$\rho_D$	-0.03	0.38	0.16	0.63	0.00	0.13	0.73	0.30	0.72	0.16	0.12	0.53	0.18	0.03	0.13	0.18	0.75	0.41	0.80	0.26

Note: Assume output follows a Cobb-Douglas production function:  $Y_t = A_t K_t^\alpha (L_t H_t)^{1-\alpha}$  where  $Y_t$  is aggregate output,  $A_t$  is total factor productivity,  $K_t$  is the stock of physical capital,  $L_t$  is the active population and  $H_t$  is an index of human capital. Hence,  $dTFP = \log(A_t/A_{t-1})$ ,  $dk_c = \alpha \log(K_t/K_{t-1})$ ,  $dl_c = (1-\alpha) \log(L_t/L_{t-1})$ ,  $dh_c = (1-\alpha) \log(H_t/H_{t-1})$ , and  $dy = \log(Y_t/Y_{t-1})$ . The statistics are computed by varying both the time and the regional cross-section dimensions (for example, the mean TFP for AFRICA is computed by taking the average over the countries in AFRICA of the individual African countries' average over 1960-1994 period). The statistics  $\rho_L$  and  $\rho_D$  provide the autocorrelation coefficients of the corresponding variable in level and in first difference. The regions are: East Asia (EASIA), South Asia (SASIA), Sub-Saharan Africa (AFRICA), Middle East and North Africa (MENA), Latin America (LATAM), and Industrial Countries (INDUS).

Table 5d. Decomposition of the Growth Rate of Real GDP (mean  $\alpha$  from level equations)

	60-73					74-86					87-94					60-94				
	dTFP	dk <sub>c</sub>	dl <sub>c</sub>	dh <sub>c</sub>	dy	dTFP	dk <sub>c</sub>	dl <sub>c</sub>	dh <sub>c</sub>	dy	dTFP	dk <sub>c</sub>	dl <sub>c</sub>	dh <sub>c</sub>	dy	dTFP	dk <sub>c</sub>	dl <sub>c</sub>	dh <sub>c</sub>	dy
<b>EASIA</b>																				
Mean	0.20	4.85	1.38	0.38	6.81	-0.43	4.52	1.33	0.45	5.88	1.57	3.88	1.00	0.51	6.97	0.28	4.50	1.27	0.44	6.49
Median	0.34	4.89	1.41	0.40	7.23	0.04	4.68	1.38	0.39	6.42	1.41	3.96	1.00	0.51	6.99	0.47	4.54	1.21	0.41	6.97
Std	2.55	0.97	0.29	0.10	2.81	3.20	0.97	0.25	0.19	3.40	1.88	0.54	0.12	0.01	1.85	2.90	1.27	0.32	0.17	3.05
$\rho_L$	0.47	1.00	1.00	0.99	0.99	0.72	1.00	1.00	0.99	0.98	0.74	1.00	1.00	1.00	0.99	0.90	1.00	1.00	1.00	1.00
$\rho_D$	0.00	0.51	0.31	0.48	0.18	0.12	0.72	0.56	0.76	0.15	0.44	0.59	0.34	0.60	0.31	0.23	0.72	0.53	0.71	0.25
<b>SASIA</b>																				
Mean	-0.09	2.67	0.91	0.23	3.72	1.09	3.11	1.09	0.25	5.54	0.71	2.81	0.96	0.26	4.74	0.55	2.87	0.99	0.25	4.66
Median	-0.12	2.50	0.94	0.26	4.26	1.11	3.07	1.05	0.23	5.57	1.28	2.91	0.95	0.26	5.46	1.04	2.67	0.98	0.26	5.33
Std	6.76	1.36	0.11	0.14	6.93	2.77	0.99	0.15	0.12	2.74	2.95	0.51	0.08	0.01	3.08	4.90	1.53	0.19	0.18	5.00
$\rho_L$	0.61	1.00	1.00	0.93	0.91	0.91	1.00	1.00	0.99	0.99	0.62	1.00	1.00	1.00	0.93	0.89	1.00	1.00	1.00	0.99
$\rho_D$	-0.07	0.45	0.34	0.64	-0.06	-0.04	0.75	0.59	0.71	-0.04	0.20	0.32	0.23	0.02	0.17	0.06	0.78	0.65	0.83	0.04
<b>AFRICA</b>																				
Mean	0.31	2.28	1.32	0.15	4.06	-1.27	1.76	1.43	0.25	2.17	-0.82	1.02	1.45	0.26	1.91	-0.56	1.79	1.39	0.22	2.83
Median	0.39	2.23	1.36	0.16	4.20	-1.18	1.71	1.40	0.22	2.19	-0.84	0.95	1.46	0.26	1.93	-0.49	1.67	1.38	0.25	3.09
Std	5.43	0.94	0.25	0.14	5.47	4.88	0.99	0.22	0.11	5.10	3.70	0.46	0.12	0.01	3.71	5.35	1.23	0.27	0.15	5.58
$\rho_L$	0.65	0.99	1.00	0.95	0.90	0.77	0.99	1.00	0.98	0.75	0.63	0.95	1.00	1.00	0.70	0.86	1.00	1.00	0.99	0.98
$\rho_D$	-0.08	0.47	0.09	0.62	-0.05	0.10	0.60	0.28	0.70	0.11	0.05	0.39	0.12	-0.11	-0.02	0.10	0.73	0.38	0.79	0.15
<b>MENA</b>																				
Mean	0.86	4.09	0.73	0.18	5.86	-0.54	4.61	0.90	0.30	5.28	-0.64	2.78	0.91	0.29	3.35	-0.03	3.99	0.84	0.25	5.05
Median	1.48	3.98	0.58	0.19	6.54	-0.17	4.39	0.78	0.29	5.38	-0.63	2.71	0.86	0.29	3.73	0.08	4.04	0.81	0.27	5.56
Std	6.00	1.12	0.42	0.11	6.12	5.05	1.64	0.35	0.12	5.32	3.72	0.71	0.28	0.01	4.10	5.63	1.75	0.45	0.15	5.93
$\rho_L$	0.78	1.00	0.96	0.96	0.96	0.84	1.00	0.98	0.88	0.96	0.72	0.99	0.92	1.00	0.77	0.91	1.00	1.00	1.00	0.99
$\rho_D$	0.05	0.39	0.18	0.69	0.10	0.17	0.72	0.18	0.66	0.22	-0.17	0.45	0.04	0.25	-0.03	0.23	0.71	0.39	0.87	0.25
<b>LATAM</b>																				
Mean	0.90	2.76	1.13	0.20	4.98	-1.76	2.52	1.31	0.35	2.42	-0.28	1.25	1.24	0.31	2.51	-0.39	2.31	1.22	0.28	3.42
Median	0.75	2.71	1.09	0.17	5.12	-1.23	2.59	1.34	0.33	2.88	0.22	1.18	1.23	0.31	2.98	-0.15	2.28	1.24	0.27	3.64
Std	3.32	0.77	0.35	0.14	3.44	4.20	1.31	0.24	0.17	4.76	3.56	0.63	0.12	0.01	3.70	4.13	1.33	0.33	0.18	4.54
$\rho_L$	0.75	0.99	0.99	0.98	0.96	0.86	0.97	1.00	1.00	0.86	0.65	0.90	1.00	1.00	0.81	0.94	1.00	1.00	1.00	0.98
$\rho_D$	-0.06	0.45	0.08	0.65	0.00	0.22	0.79	0.24	0.75	0.32	-0.01	0.59	0.02	-0.01	0.05	0.27	0.79	0.34	0.82	0.34
<b>INDUS</b>																				
Mean	0.50	4.06	0.32	0.20	5.07	-0.40	2.34	0.28	0.24	2.46	0.08	1.80	0.17	0.10	2.15	0.06	2.87	0.27	0.19	3.39
Median	0.51	4.07	0.32	0.15	5.33	-0.11	2.38	0.30	0.22	2.65	0.18	1.83	0.28	0.10	2.34	0.22	2.65	0.30	0.14	3.42
Std	1.88	0.47	0.35	0.20	2.04	2.08	0.65	0.50	0.19	2.21	1.72	0.43	0.66	0.00	2.19	2.00	1.17	0.54	0.22	2.61
$\rho_L$	0.72	1.00	0.88	0.97	0.99	0.66	1.00	0.88	0.98	0.97	0.66	1.00	0.74	1.00	0.79	0.87	1.00	0.96	1.00	1.00
$\rho_D$	-0.00	0.17	0.19	0.65	-0.06	0.13	0.80	0.28	0.73	0.08	0.28	0.68	0.40	-0.09	0.36	0.16	0.75	0.43	0.78	0.33
<b>WORLD</b>																				
Mean	0.53	3.31	0.93	0.20	4.98	-0.88	2.75	1.02	0.30	3.19	-0.14	1.83	0.95	0.26	2.90	-0.16	2.75	0.97	0.25	3.80
Median	0.65	3.07	0.96	0.18	5.10	-0.42	2.52	1.17	0.25	3.16	0.36	1.65	1.13	0.23	3.34	0.08	2.56	1.12	0.23	3.97
Std	3.89	0.83	0.32	0.15	4.02	3.76	1.06	0.31	0.15	4.03	2.96	0.54	0.27	0.01	3.17	3.99	1.32	0.37	0.18	4.35
$\rho_L$	0.69	1.00	0.96	0.97	0.96	0.77	0.99	0.97	0.97	0.89	0.66	0.96	0.92	1.00	0.80	0.89	1.00	0.99	1.00	0.99
$\rho_D$	-0.03	0.38	0.16	0.63	0.00	0.14	0.73	0.30	0.72	0.16	0.11	0.53	0.18	0.03	0.13	0.18	0.75	0.41	0.80	0.26

Note: Assume output follows a Cobb-Douglas production function:  $Y_t = A_t K_t^\alpha (L_t H_t)^{1-\alpha}$  where  $Y_t$  is aggregate output,  $A_t$  is total factor productivity,  $K_t$  is the stock of physical capital,  $L_t$  is the active population and  $H_t$  is an index of human capital. Hence,  $dTFP = \log(A_t/A_{t-1})$ ,  $dk_c = \alpha \log(K_t/K_{t-1})$ ,  $dl_c = (1-\alpha) \log(L_t/L_{t-1})$ ,  $dh_c = (1-\alpha) \log(H_t/H_{t-1})$ , and  $dy = \log(Y_t/Y_{t-1})$ . The statistics are computed by varying both the time and the regional cross-section dimensions (for example, the mean TFP for AFRICA is computed by taking the average over the countries in AFRICA of the individual African countries' average over 1960-1994 period). The statistics  $\rho_L$  and  $\rho_D$  provide the autocorrelation coefficients of the corresponding variable in level and in first difference. The regions are: East Asia (EASIA), South Asia (SASIA), Sub-Saharan Africa (AFRICA), Middle East and North Africa (MENA), Latin America (LATAM), and Industrial Countries (INDUS).

Table 5e. Decomposition of the Growth Rate of Real GDP (mean  $\alpha$  from first difference equations)

	60-73					74-86					87-94					60-94				
	dTFP	dk <sub>c</sub>	dl <sub>c</sub>	dh <sub>c</sub>	dy	dTFP	dk <sub>c</sub>	dl <sub>c</sub>	dh <sub>c</sub>	dy	dTFP	dk <sub>c</sub>	dl <sub>c</sub>	dh <sub>c</sub>	dy	dTFP	dk <sub>c</sub>	dl <sub>c</sub>	dh <sub>c</sub>	dy
<b>EASIA</b>																				
Mean	1.37	3.08	1.85	0.51	6.81	0.62	2.87	1.79	0.60	5.88	2.46	2.47	1.35	0.69	6.97	1.34	2.86	1.71	0.59	6.49
Median	1.54	3.10	1.89	0.53	7.23	1.27	2.97	1.85	0.53	6.42	2.41	2.52	1.34	0.69	6.99	1.69	2.88	1.63	0.55	6.97
Std	2.56	0.61	0.40	0.14	2.81	3.23	0.61	0.34	0.26	3.40	1.82	0.34	0.17	0.01	1.85	2.86	0.80	0.43	0.23	3.05
$\rho_L$	0.83	1.00	1.00	0.99	0.99	0.79	1.00	1.00	0.99	0.98	0.89	1.00	1.00	1.00	0.99	0.97	1.00	1.00	1.00	1.00
$\rho_D$	0.00	0.51	0.31	0.48	0.18	0.11	0.72	0.56	0.76	0.15	0.39	0.59	0.34	0.60	0.31	0.21	0.72	0.53	0.71	0.25
<b>SASIA</b>																				
Mean	0.24	1.97	1.20	0.31	3.72	1.53	2.24	1.44	0.33	5.54	1.13	1.99	1.27	0.35	4.74	0.94	2.08	1.31	0.33	4.66
Median	0.38	1.84	1.24	0.34	4.26	1.54	2.22	1.39	0.30	5.57	1.75	2.06	1.26	0.35	5.46	1.36	1.92	1.30	0.34	5.33
Std	6.76	0.98	0.15	0.19	6.93	2.74	0.72	0.19	0.15	2.74	3.01	0.36	0.11	0.01	3.08	4.87	1.11	0.25	0.24	5.00
$\rho_L$	0.52	1.00	1.00	0.93	0.91	0.81	1.00	1.00	0.99	0.99	0.68	1.00	1.00	1.00	0.93	0.90	1.00	1.00	1.00	0.99
$\rho_D$	-0.10	0.45	0.34	0.64	-0.06	-0.07	0.75	0.59	0.71	-0.04	0.20	0.32	0.23	0.02	0.17	0.02	0.78	0.65	0.83	0.04
<b>AFRICA</b>																				
Mean	0.12	2.65	1.16	0.14	4.06	-1.35	2.05	1.25	0.22	2.17	-0.78	1.18	1.27	0.23	1.91	-0.66	2.08	1.22	0.19	2.83
Median	0.19	2.59	1.19	0.14	4.20	-1.28	1.99	1.23	0.20	2.19	-0.80	1.10	1.28	0.23	1.93	-0.62	1.94	1.21	0.22	3.09
Std	5.43	1.10	0.22	0.12	5.47	4.87	1.15	0.20	0.10	5.10	3.71	0.54	0.10	0.01	3.71	5.33	1.43	0.24	0.13	5.58
$\rho_L$	0.65	0.99	1.00	0.95	0.90	0.77	0.99	1.00	0.98	0.75	0.61	0.95	1.00	1.00	0.70	0.87	1.00	1.00	0.99	0.98
$\rho_D$	-0.08	0.47	0.09	0.62	-0.05	0.10	0.60	0.28	0.70	0.11	0.05	0.39	0.12	-0.11	-0.02	0.09	0.73	0.38	0.79	0.15
<b>MENA</b>																				
Mean	1.22	3.51	0.90	0.23	5.86	-0.17	3.96	1.12	0.37	5.28	-0.53	2.39	1.14	0.36	3.35	0.28	3.42	1.04	0.31	5.05
Median	1.90	3.41	0.72	0.24	6.54	0.20	3.76	0.96	0.36	5.38	-0.48	2.33	1.07	0.36	3.73	0.41	3.46	1.01	0.34	5.56
Std	6.01	0.96	0.52	0.14	6.12	5.08	1.41	0.44	0.15	5.32	3.76	0.61	0.35	0.01	4.10	5.66	1.50	0.56	0.19	5.93
$\rho_L$	0.84	1.00	0.96	0.96	0.96	0.81	1.00	0.98	0.88	0.96	0.69	0.99	0.92	1.00	0.77	0.92	1.00	1.00	1.00	0.99
$\rho_D$	0.05	0.39	0.18	0.69	0.10	0.17	0.72	0.18	0.66	0.22	-0.16	0.45	0.04	0.25	-0.03	0.23	0.71	0.39	0.87	0.25
<b>LATAM</b>																				
Mean	0.64	3.29	0.89	0.16	4.98	-1.89	3.00	1.04	0.28	2.42	-0.20	1.49	0.98	0.24	2.51	-0.52	2.75	0.97	0.22	3.42
Median	0.48	3.23	0.86	0.13	5.12	-1.41	3.09	1.06	0.26	2.88	0.31	1.41	0.98	0.24	2.98	-0.29	2.72	0.98	0.22	3.64
Std	3.29	0.92	0.28	0.11	3.44	4.14	1.56	0.19	0.13	4.76	3.54	0.75	0.10	0.01	3.70	4.07	1.59	0.26	0.14	4.54
$\rho_L$	0.70	0.99	0.99	0.98	0.96	0.87	0.97	1.00	1.00	0.86	0.64	0.90	1.00	1.00	0.81	0.94	1.00	1.00	1.00	0.98
$\rho_D$	-0.06	0.45	0.08	0.65	0.00	0.20	0.79	0.24	0.75	0.32	-0.01	0.59	0.02	-0.01	0.05	0.26	0.79	0.34	0.82	0.34
<b>INDUS</b>																				
Mean	0.80	3.68	0.37	0.23	5.07	-0.27	2.12	0.32	0.28	2.46	0.20	1.63	0.19	0.12	2.15	0.25	2.60	0.31	0.22	3.39
Median	0.81	3.69	0.37	0.18	5.33	0.04	2.16	0.35	0.26	2.65	0.31	1.66	0.33	0.12	2.34	0.41	2.40	0.35	0.17	3.42
Std	1.86	0.43	0.41	0.23	2.04	2.05	0.59	0.58	0.22	2.21	1.68	0.39	0.77	0.00	2.19	1.99	1.06	0.63	0.25	2.61
$\rho_L$	0.80	1.00	0.88	0.97	0.99	0.65	1.00	0.88	0.98	0.97	0.63	1.00	0.74	1.00	0.79	0.88	1.00	0.96	1.00	1.00
$\rho_D$	-0.01	0.17	0.19	0.65	-0.06	0.12	0.80	0.28	0.73	0.08	0.27	0.68	0.40	-0.09	0.36	0.16	0.75	0.43	0.78	0.33
<b>WORLD</b>																				
Mean	0.67	3.17	0.93	0.22	4.98	-0.74	2.61	1.01	0.31	3.19	0.04	1.67	0.92	0.27	2.90	-0.02	2.60	0.96	0.26	3.80
Median	0.77	3.09	0.93	0.16	5.10	-0.23	2.48	1.11	0.25	3.16	0.43	1.56	1.04	0.22	3.34	0.11	2.51	1.07	0.22	3.97
Std	3.88	0.82	0.33	0.15	4.02	3.74	1.07	0.33	0.16	4.03	2.95	0.54	0.30	0.01	3.17	3.97	1.31	0.40	0.18	4.35
$\rho_L$	0.73	1.00	0.96	0.97	0.96	0.78	0.99	0.97	0.97	0.89	0.66	0.96	0.92	1.00	0.80	0.91	1.00	0.99	1.00	0.99
$\rho_D$	-0.04	0.38	0.16	0.63	0.00	0.13	0.73	0.30	0.72	0.16	0.11	0.53	0.18	0.03	0.13	0.17	0.75	0.41	0.80	0.26

Note: Assume output follows a Cobb-Douglas production function:  $Y_t = A_t K_t^\alpha (L_t H_t)^{1-\alpha}$  where  $Y_t$  is aggregate output,  $A_t$  is total factor productivity,  $K_t$  is the stock of physical capital,  $L_t$  is the active population and  $H_t$  is an index of human capital. Hence,  $dTFP = \log(A_t/A_{t-1})$ ,  $dk_c = \alpha \log(K_t/K_{t-1})$ ,  $dl_c = (1-\alpha) \log(L_t/L_{t-1})$ ,  $dh_c = (1-\alpha) \log(H_t/H_{t-1})$ , and  $dy = \log(Y_t/Y_{t-1})$ . The statistics are computed by varying both the time and the regional cross-section dimensions (for example, the mean TFP for AFRICA is computed by taking the average over the countries in AFRICA of the individual African countries' average over 1960-1994 period). The statistics  $\rho_L$  and  $\rho_D$  provide the autocorrelation coefficients of the corresponding variable in level and in first difference. The regions are: East Asia (EASIA), South Asia (SASIA), Sub-Saharan Africa (AFRICA), Middle East and North Africa (MENA), Latin America (LATAM), and Industrial Countries (INDUS).



Table 6. Correlations between TFP figures in 88 countries from five different values of  $\alpha$

	R(1,2)	R(1,3)	R(1,4)	R(1,5)	R(2,3)	R(2,4)	R(2,5)	R(3,4)	R(3,5)	R(4,5)	Min
1 Algeria	0.961	0.819	0.784	0.873	0.945	0.925	0.973	0.998	0.994	0.987	0.784
2 Argentina	0.667	0.300	0.424	0.273	0.910	0.956	0.898	0.990	0.999	0.986	0.273
3 Australia	0.987	0.570	0.098	0.717	0.686	0.246	0.813	0.847	0.960	0.738	0.098
4 Austria	0.991	-0.268	-0.707	0.030	-0.141	-0.608	0.159	0.861	0.943	0.675	-0.707
5 Bangladesh	0.978	0.932	0.939	0.973	0.983	0.987	0.997	0.999	0.988	0.991	0.932
6 Belgium	0.998	0.972	0.952	0.981	0.985	0.969	0.991	0.996	0.997	0.991	0.952
7 Bolivia	0.968	0.792	0.886	0.755	0.919	0.973	0.895	0.984	0.997	0.972	0.755
8 Brazil	0.969	0.711	0.870	0.658	0.861	0.964	0.823	0.964	0.996	0.943	0.658
9 Cameroon	0.820	0.340	0.753	0.579	0.817	0.994	0.941	0.874	0.964	0.972	0.340
10 Canada	0.815	0.280	0.186	0.333	0.780	0.714	0.813	0.992	0.996	0.985	0.186
11 Chile	0.993	0.972	0.983	0.967	0.992	0.997	0.990	0.998	0.999	0.997	0.967
12 China	0.996	0.973	0.991	0.999	0.990	0.999	0.999	0.995	0.981	0.995	0.973
13 Columbia	0.993	0.959	0.977	0.946	0.983	0.994	0.975	0.996	0.998	0.992	0.946
14 Costa Rica	0.856	0.596	0.696	0.577	0.924	0.966	0.915	0.990	0.999	0.987	0.577
15 Cote d'Ivoire	0.871	0.500	0.825	0.694	0.861	0.996	0.958	0.902	0.970	0.979	0.500
16 Cyprus	0.998	0.986	0.981	0.991	0.994	0.991	0.998	0.999	0.999	0.998	0.981
17 Denmark	0.930	-0.536	-0.682	-0.430	-0.196	-0.373	-0.077	0.979	0.989	0.949	-0.682
18 Dominican Republic	0.816	0.213	0.463	0.163	0.738	0.890	0.702	0.964	0.998	0.949	0.163
19 Ecuador	0.996	0.978	0.988	0.974	0.992	0.998	0.990	0.998	1.000	0.997	0.974
20 Egypt	0.960	0.216	0.010	0.602	0.481	0.290	0.801	0.977	0.908	0.804	0.010
21 El Salvadore	0.990	0.963	0.974	0.960	0.991	0.996	0.990	0.999	1.000	0.998	0.960
22 Ethiopia	0.753	0.562	0.715	0.647	0.967	0.998	0.988	0.980	0.994	0.995	0.562
23 Finland	0.995	0.931	0.875	0.951	0.962	0.917	0.976	0.989	0.997	0.980	0.875
24 France	0.986	-0.406	-0.749	-0.069	-0.252	-0.630	0.095	0.898	0.919	0.700	-0.749
25 Germany	0.995	0.909	0.814	0.941	0.943	0.863	0.968	0.977	0.992	0.959	0.814
26 Ghana	0.987	0.942	0.982	0.969	0.984	0.999	0.996	0.989	0.995	0.998	0.942
27 Greece	0.992	0.746	0.428	0.828	0.821	0.535	0.890	0.918	0.989	0.859	0.428
28 Guatemala	0.961	0.732	0.858	0.696	0.889	0.965	0.865	0.976	0.997	0.964	0.696
29 Guyana	0.999	0.996	0.998	0.996	0.999	0.999	0.998	1.000	1.000	1.000	0.996
30 Haiti	0.956	0.890	0.916	0.885	0.984	0.993	0.982	0.998	1.000	0.997	0.885
31 Honduras	0.952	0.756	0.857	0.723	0.918	0.972	0.897	0.984	0.996	0.974	0.723
32 Iceland	0.990	0.889	0.833	0.916	0.943	0.900	0.962	0.990	0.996	0.982	0.833
33 India	0.977	0.725	0.827	0.969	0.853	0.927	0.998	0.984	0.869	0.939	0.725
34 Indonesia	0.879	-0.594	0.351	0.991	-0.140	0.754	0.935	0.542	-0.480	0.474	-0.594
35 Iran	0.949	0.852	0.837	0.882	0.973	0.967	0.985	1.000	0.998	0.996	0.837
36 Ireland	0.994	0.901	0.826	0.924	0.943	0.882	0.959	0.987	0.997	0.978	0.826
37 Israel	0.996	0.976	0.968	0.986	0.991	0.986	0.996	0.999	0.998	0.996	0.968
38 Italy	0.998	0.983	0.968	0.987	0.991	0.979	0.994	0.996	0.998	0.994	0.968
39 Jamaica	0.986	0.927	0.957	0.916	0.976	0.992	0.970	0.995	0.999	0.993	0.916
40 Japan	0.976	-0.543	-0.736	-0.337	-0.348	-0.572	-0.125	0.966	0.972	0.884	-0.736
41 Jordan	0.737	0.314	0.265	0.420	0.873	0.846	0.922	0.999	0.993	0.986	0.265
42 Kenya	0.993	0.975	0.990	0.985	0.994	0.999	0.998	0.996	0.998	0.999	0.975
43 Korea	0.978	-0.700	0.835	0.998	-0.536	0.931	0.989	-0.193	-0.654	0.868	-0.700
44 Madagascar	0.995	0.982	0.994	0.990	0.995	0.999	0.998	0.996	0.998	0.999	0.982
45 Malawi	0.144	-0.665	-0.109	-0.478	0.641	0.964	0.798	0.813	0.973	0.923	-0.665
46 Malaysia	0.859	-0.766	0.062	0.991	-0.332	0.559	0.918	0.593	-0.675	0.193	-0.766
47 Mali	0.989	0.935	0.982	0.967	0.975	0.998	0.993	0.984	0.993	0.997	0.935
48 Malta	0.998	0.989	0.986	0.993	0.996	0.994	0.998	1.000	0.999	0.999	0.986
49 Mexico	0.869	0.541	0.679	0.503	0.885	0.952	0.863	0.984	0.998	0.975	0.503
50 Morocco	0.835	0.305	0.233	0.462	0.777	0.729	0.873	0.996	0.984	0.969	0.233
51 Mozambique	0.996	0.981	0.993	0.989	0.995	1.000	0.998	0.997	0.999	0.999	0.981

Table 6. Correlations between TFP figures in 88 countries from five different values of  $\alpha$  [concluded]

	R(1,2)	R(1,3)	R(1,4)	R(1,5)	R(2,3)	R(2,4)	R(2,5)	R(3,4)	R(3,5)	R(4,5)	Min
52 Muaritus	0.994	0.977	0.993	0.987	0.994	1.000	0.998	0.995	0.998	0.999	0.977
53 Myanmar	0.972	0.882	0.908	0.967	0.966	0.980	0.999	0.997	0.972	0.984	0.882
54 Netherlands	0.993	0.579	0.149	0.764	0.657	0.246	0.825	0.868	0.944	0.727	0.149
55 New Zealand	0.851	0.505	0.445	0.544	0.880	0.846	0.900	0.996	0.995	0.990	0.445
56 Nicaragua	0.994	0.978	0.986	0.975	0.995	0.998	0.993	0.999	1.000	0.998	0.975
57 Nigeria	0.942	0.867	0.928	0.901	0.984	0.999	0.994	0.990	0.997	0.998	0.867
58 Norway	0.997	0.975	0.961	0.980	0.987	0.977	0.991	0.995	0.997	0.994	0.961
59 Pakistan	0.972	0.738	0.818	0.963	0.874	0.929	0.999	0.991	0.892	0.942	0.738
60 Panama	0.724	-0.017	0.241	-0.068	0.676	0.842	0.637	0.965	0.998	0.951	-0.068
61 Paraguay	0.512	-0.461	-0.227	-0.496	0.525	0.719	0.490	0.968	0.999	0.957	-0.496
62 Peru	0.998	0.993	0.996	0.993	0.998	0.999	0.997	0.999	0.999	0.999	0.993
63 Philippines	0.817	0.581	0.714	0.941	0.944	0.986	0.962	0.984	0.820	0.907	0.581
64 Portugal	0.986	0.772	0.628	0.829	0.867	0.748	0.910	0.977	0.994	0.954	0.628
65 Rwanda	0.841	0.622	0.798	0.721	0.946	0.997	0.981	0.968	0.991	0.993	0.622
66 Senegal	0.997	0.987	0.993	0.990	0.995	0.998	0.997	0.996	0.998	0.998	0.987
67 Sierra Leone	0.877	0.270	0.815	0.633	0.696	0.991	0.925	0.776	0.914	0.962	0.270
68 Singapore	0.885	-0.628	0.333	0.990	-0.194	0.732	0.941	0.524	-0.513	0.462	-0.628
69 South Africa	0.716	0.277	0.649	0.475	0.868	0.994	0.953	0.910	0.977	0.976	0.277
70 Spain	0.992	0.264	-0.374	0.567	0.379	-0.259	0.662	0.789	0.936	0.545	-0.374
71 Sri Lanka	0.919	-0.505	-0.282	0.874	-0.126	0.117	0.993	0.967	-0.026	0.217	-0.505
72 Sudan	0.963	0.910	0.954	0.936	0.988	0.999	0.996	0.992	0.998	0.998	0.910
73 Sweden	0.943	-0.006	-0.249	0.159	0.319	0.078	0.469	0.963	0.977	0.908	-0.249
74 Switzerland	0.658	0.173	0.114	0.201	0.854	0.822	0.869	0.997	0.999	0.995	0.114
75 Taiwan	0.974	-0.169	0.872	0.997	0.055	0.959	0.988	0.333	-0.098	0.905	-0.169
76 Tanzania	0.917	0.677	0.895	0.811	0.913	0.998	0.976	0.933	0.979	0.986	0.677
77 Thailand	0.978	0.112	0.902	0.997	0.318	0.972	0.990	0.530	0.185	0.931	0.112
78 Trinidad and Tobago	0.879	0.469	0.648	0.419	0.833	0.932	0.801	0.976	0.998	0.963	0.419
79 Tunisia	0.980	0.817	0.771	0.904	0.913	0.879	0.969	0.996	0.984	0.968	0.771
80 Turkey	0.970	0.522	0.330	0.776	0.713	0.549	0.905	0.976	0.942	0.850	0.330
81 Uganda	0.993	0.974	0.991	0.985	0.994	1.000	0.998	0.995	0.998	0.999	0.974
82 United Kingdom	0.950	-0.380	-0.590	-0.255	-0.081	-0.315	0.053	0.964	0.985	0.925	-0.590
83 United States	0.969	0.874	0.831	0.884	0.954	0.929	0.957	0.986	0.987	0.986	0.831
84 Uruguay	0.979	0.927	0.953	0.925	0.981	0.993	0.980	0.995	0.999	0.994	0.925
85 Venezuela	0.998	0.992	0.995	0.992	0.998	0.999	0.997	0.999	1.000	0.999	0.992
86 Zaire	0.998	0.995	0.998	0.997	0.999	1.000	1.000	0.999	1.000	1.000	0.995
87 Zambia	0.971	0.656	0.954	0.884	0.815	0.997	0.969	0.851	0.930	0.983	0.656
88 Zimbabwe	0.993	0.971	0.992	0.986	0.991	0.999	0.998	0.992	0.996	0.998	0.971
Median	0.975	0.742	0.832	0.903	0.919	0.968	0.970	0.988	0.996	0.984	0.710

*Note:*  $R(i,j)$  gives the correlation coefficient between  $TFP_i$  and  $TFP_j$ , where  $i,j=1,...,5$ .  $TFP_1$ ,  $TFP_2$ , and  $TFP_3$  refer to the time series of individual country TFP figures from 1960 to 1994 computed with the values of  $\alpha=0.2$ , 0.4, and 0.6, respectively.  $TFP_4$  refers to TFP figures computed with individual regional estimates of  $\alpha$  (average of individual country estimates belonging to each region) from Cobb-Douglas production functions in levels while  $TFP_5$  refers to TFP figures computed with individual regional estimates of  $\alpha$  from Cobb-Douglas production functions in first differences (see Table 3b). The column Min gives the minimum correlation for each country.

Table 7. Determinants of TFP

Independent var.	Dependent variable: TFP2R				Dependent variable: TFP4R			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
TFP2R_0	0.99019 (0.00098)a	0.95100 (0.00580)a	0.95777 (0.00564)a	0.95166 (0.00578)a	0.99486 (0.00080)a	0.93041 (0.00574)a	0.93501 (0.00556)a	0.93066 (0.00573)a
HKR_0		0.25712 (0.06345)a	0.22457 (0.06321)a	0.25603 (0.06289)a		0.25756 (0.06065)a	0.22912 (0.06061)a	0.27127 (0.06032)a
KR_0		0.02526 (0.00311)a	0.02025 (0.00302)a	0.02492 (0.00310)a		0.03223 (0.00274)a	0.02918 (0.00264)a	0.03214 (0.00274)a
LIFE		0.00242 (0.00072)a	0.00255 (0.00074)a	0.00254 (0.00072)a		0.00167 (0.00070)a	0.00188 (0.00071)a	0.00162 (0.00069)a
TOT		0.06122 (0.01388)	0.05657 (0.01373)	0.06040 (0.01385)		0.03765 (0.01386)	0.03356 (0.01372)	0.03765 (0.01385)
INFL		-3.18E-05 (8.49E-06)	-3.45E-05 (8.79E-06)	-3.20E-05 (8.50E-06)		-2.63E-05 (7.42E-06)	-2.90E-05 (7.71E-06)	-2.62E-05 (7.43E-06)
Cg		-0.03275 (0.01287)	-0.04040 (0.01292)	-0.03435 (0.01283)		-0.03510 (0.01218)b	0.03767 (0.01217)b	-0.03374 (0.01217)b
RER		-0.09480 (0.01151)a	-0.08677 (0.01155)a	-0.09218 (0.01137)a		-0.07403 (0.01090)a	-0.06871 (0.01087)a	-0.07198 (0.01087)a
RESM		0.00386 (0.00137)a	0.00395 (0.00138)a	0.00372 (0.00137)a		0.00247 (0.00134)a	0.00229 (0.00135)b	0.00229 (0.00133)a
DEBT		-0.05658 (0.00555)a	-0.05422 (0.00552)a	-0.05710 (0.00553)a		-0.07431 (0.00519)a	-0.07211 (0.00520)a	-0.07495 (0.00518)a
CACON		-0.01498 (0.01201)	-0.04647 (0.01014)a			-0.00651 (0.01150)	-0.02826 (0.00965)a	
KCON		-0.06571 (0.04066)a		-0.07432 (0.01177)a		-0.04722 (0.01252)a		-0.05181 (0.01055)a
DEATH		-0.10324 (0.01589)a	-0.10610 (0.01607)a	-0.10294 (0.01552)a		-0.12187 (0.01568)a	-0.12229 (0.01581)a	-0.11725 (0.01529)a
DUMAFR		-0.05093 (0.04066)a	-0.08997 (0.04028)a	-0.05348 (0.04063)a		0.23209 (0.04793)a	0.20315 (0.04784)a	0.22801 (0.04823)a
DUMEA		-0.12954 (0.03629)a	-0.14515 (0.03708)a	-0.12761 (0.03628)a		0.09298 (0.04454)b	0.08142 (0.04504)b	0.09165 (0.04489)b
DUMSA		-0.11649 (0.03424)a	-0.14525 (0.03396)a	-0.11909 (0.03421)a		0.05698 (0.04186)b	0.03724 (0.04207)b	0.05569 (0.04220)b
DUMME		0.16554 (0.03880)b	0.11948 (0.03814)	0.16198 (0.03883)b		0.25446 (0.04428)a	0.22305 (0.04413)a	0.25283 (0.04459)a
DUMLA		-0.11095 (0.03841)a	-0.13397 (0.03857)a	-0.11319 (0.03842)a		0.12846 (0.04449)a	0.11534 (0.04480)b	0.12440 (0.04494)a
N	3080	1194	1194	1196	3080	1194	1194	1196
$\bar{R}^2$	0.997	0.998	0.998	0.998	0.997	0.998	0.997	0.998

*Note:* The variables are: Initial level of TFP, human capital, and physical capital, all three variables are relative to the level in the United States (TFP2R\_0, HKR\_0, and KR\_0, respectively). Life expectancy (LIFE), terms of trade (TOT), public consumption (Cg), terms of trade (TOT), real exchange rate (RER), reserve-import ratio (RESM), external debt-GDP ratio (DEBT), dummy variables for current and capital account convertibility with one indicating convertibility (CACON and KCON, respectively), ratio of war casualties to population (DEATH), and regional dummies for Sub-Saharan Africa (DUMAFR), East Asia (DUMEA), South Asia (DUMSA), Middle East and North Africa (DUMME), and Latin America (DUMLA).





