Long-Run Growth Miracles And Failures And Human Capital

Chander Kant

ORCID ID: 0000-0003-2746-756X

Seton Hall University*

Abstract

The recent empirical growth literature has noted that few countries' incomes grow uniformly over periods longer than a decade or so. Several authors have drawn attention to start-stop growth experience, growth accelerations and decelerations, and within-country regime changes. We extend the above literature as follows: we ignore income variations over the short run, consider growth variations over a long period (up to 66 years), study growth relative to a benchmark country, and collapse the varieties of growth experiences to two: where a country is growing faster than the benchmark country/relative convergence, and where it is growing slower/divergence. To minimize parameter heterogeneity, we consider one geographical region, Sub-Saharan Africa (SSA). Sub-Saharan countries are eminently suitable for this examination because they experience both regimes copiously The average catching-up duration is 17.8 years, average falling-behind is 27.2 years and the number of periods for the two experiences is almost the same. We use panel estimation, including the "between" estimator, separately for the two sets of periods, and examine proximate factors for relative income changes, The main difference of the divergence panels from the r-convergence panels is on the role of human capital. Catching-up relatively is mostly explained by human capital and for the catching-up panels, total factor productivity (TFP) is less important than human capital.

JEL Classifications: I25, J24, O47

Keywords: growth empirics; catching-up relatively versus falling-behind; proximate factors for relative income changes; short-run versus long-run effects

Correspondence: kant@kresearch.org; Telephone 1-973-202-5964

Acknowledgments: Versions of this paper based on the earlier PWT data (version 9.1) have been presented at the RCEA Growth, Innovation and Entrepreneurship conference held at Wilfrid Laurier University, Waterloo, ON, Canada September 20-21, 2019, and at the 94th Annual Conference of Western Economic Association International held at San Francisco, CA, June 28 to July 2, 2019. I am grateful to my discussants, two reviewers, and an associate editor (at a different journal) for very detailed and helpful comments on the paper's earlier versions

*Department of Economics, Seton Hall University, 400 South Orange Avenue, South Orange NJ 07079, U.S.A. Chander.Kant@shu.edu; Fax: 1-973-761-9217. Website: www.kresearch.org

Long-Run Growth Miracles And Failures And Human Capital

The recent empirical growth literature has noted that only very few countries' incomes grow uniformly over periods longer than a decade or so. Several authors have drawn attention to variation in growth, turning points, start-stop growth experience, growth accelerations and decelerations, and within-country regime changes. Easterly et al. (1993) examined the correlations of decadal income growth rates (for 1960-69, 1970-79 and 1980-88) in a sample of 115 countries from Penn World Tables (PWT) version 5 and found them to be quite low (0.1 - 0.3). The poor persistence of growth rates across decades is hard to reconcile with high persistence (with correlations of 0.6 to 0.9) of explanatory variables (e.g., quality of institutions). They suggest random shocks (rather than country characteristics) are more important in explaining variation in income growth.

Pritchett (2000, 2003) finds annual income growth rates overtime of a country generally vary and their variation across countries is even stronger. He finds six distinct patters of growth based on growth before and after statistically chosen structural break and places each country in one of these six groups. He gives the six patterns topological names and defines them as follows: steep hills (growth of more than 3% in both periods), hills (growth of more than 1.5% in both periods), plateaus (growth of more than 1.5% before the break and less than 1.5% after the break), mountains (growth of more than 1.5% before the break and negative after the break), plains (growth of less than 1.5% in both periods), and accelerators or "Denver" (growth of less than 1.5% before the break and more than 1.5% after the break). Given these stylized facts, he is pessimistic that econometric investigation of income growth determinants will be informative; but is more hopeful of the potential of research into what initiates (or halts) episodes of growth.

Hausmann et al. (2005) report very few countries experience consistently high growth over several decades and look instead for growth acceleration episodes (increase in income growth rate by at least two points for eight years).[1] They define a sustained episode as where for two years after the episode, income growth was at least 3.5%. Countries can have more than one episode if they are they five years apart. Although they find 37 of their 69 episodes were sustained, 25 out of these sustained episodes had negative or poor growth before the start of the acceleration period. Further, they find vast majority of accelerations are unrelated to standard determinants and most instances of economic reforms do not produce accelerations; concluding "The determinants of growth episodes, whether of the sustained or un-sustained kind, are very poorly captured by our explanatory variables."

Building on Pritchett (2000), Jerzmanowski (2006) highlights that identical average growth rates can mask very distinct growth paths and classifies variation over time in income growth within a country into four distinct regimes. These are stable growth (at 2% rate per year), stagnation (on average, zero to slightly negative growth), crises (highly volatile growth ranging from double-digit negative to double-digit positive growth), and miracle-growth (at 6% annually). He first estimates a Markov-switching regression to characterize these regimes, then determines the probabilities of countries switching/transitioning between them and of ignition and termination of growth episodes. Extending Pritchett (2000, 2003) and Jerzmanowski (2006), Kerekes (2012) groups countries in three clusters based on similarities of their transition probabilities. These

[1] In addition, (to rule out recoveries) the post-period income must be higher than the previous peak.

clusters are successful growth cluster (countries growing at 2% most of the time), moderately successful growth cluster (growing at 2% for 45% and stagnating for 37% of the time), and growth failures cluster (stagnating for most of the time).

This paper extends the above literature in the following ways: first, it ignores income variations over period of less than ten years. Its focus is on variation of income growth over the long-run, i.e., a period longer than ten years. To minimize measurement errors and the effects of business cycle fluctuations, growth regressions are generally run-on data averaged over five or ten non-overlapping years. See, Barro (2015). This paper takes a similar long-term perspective. Second, it considers income growth variations over a longer period, varying from 40 to 66 years for different countries, average period being 52 years. Third, it collapses the varieties of growth experiences to two: first where a country is growing faster than a benchmark country, and the second where it is growing slower.

The literature in this area (reviewed above) i) either suggests random shocks (rather than country characteristics) are more important in explaining income growth variations or ii) is pessimistic that econometric panel data investigation of income growth determinants will be useful or iii) finds growth episodes determinants are very poorly captured by explanatory variables. We show that econometric panel data investigation may still be useful (not for examining the turning points, but) for enquiring whether growth factors during long **periods** of different growth experiences differ. Further, we take each country's income as a ratio of income of a bench-mark country. Taking a bench-mark country's income as the numeraire makes changes in all countries' incomes comparable to each other – even more so when the base year's ratio for each country is taken as 1 or 100. It also makes data on each country's income more granular/discriminating.

We take US as the bench-mark country - because its income is among the least volatile

since the Second World War (see, Jones and Olken, 2008), it is taken as the bench-mark country in most empirical growth studies and taking it as the numeraire makes the country data somewhat immune to global or region-wide factors (hopefully making quest for growth less "elusive"). Taking US as the numeraire does not imply that the US and Sub-Saharan (geographical region considered in this paper) countries have the same steady-state path. In fact, we recognize that US (with among the least volatile income growth in the world) and Sub-Sharan countries (whose incomes have been among the most volatile) do not have the same steady-state path.

The two varieties of growth experiences can now be identified more clearly. These are: periods when a country's growth rate is higher than the US (and its income ratio increases) and periods when a country's growth rate is lower than the US (and its income ratio decreases). In the former case, it is catching-up (relatively) and in the latter, falling-behind.

This paper defines growth narrowly. It uses a relative, i.e., one reducing the income ratio (rather than increasing absolute income) definition of growth and tries to discover proximate factors for it. It considers reducing income gaps directly as an objective (rather than growth per se) because as shown by Kant (2019), catching-up growth is a necessary (though not a sufficient) condition for income gap reduction. Mill (1907) observes "Men do not desire to be rich, but richer than other men. The avaricious or covetous man would find little or no satisfaction in the possession of any amount of wealth, if he were the poorest amongst all his neighbors or fellow-countrymen." Similarly, Luttmer (2005) finds with their incomes unchanged, when people come to know the neighbors' income is higher, their own happiness decreases. Moreover, it is cold comfort if a $500 income country is growing, say, at 2% while a $50,000 country is also growing at the same rate – the income gap between them would increase indefinitely.

Other authors consider catching-up and falling behind indirectly. Their growth regimes

can be interpreted in terms of relative catching-up/falling-behind as follows. Pritchett (2000, 2003)'s five growth patterns (hills, plateaus, mountains, plains, accelerators or Denvers) allow for falling back/divergence/income gaps to increase; and only one, (steep hills) gives catching up to the US (at higher than 0.6% rate - since US per capita income grew by 2.4% annually for the relevant period) in relative income. Of the four growth regimes considered by Jerzmanowski (2006) and Kerekes (2012), even stable growth means falling behind while miracle-growth means catching-up relatively at 3.6 % rate.

Parameter heterogeneity is a persistent issue in empirical growth literature. Durlauf and Johnson (1995) show the hypothesis of homogeneous marginal effects of explanatory variables across countries is not empirically borne out. To minimize, parameter heterogeneity we consider one geographical region, Sub-Saharan Africa (SSA) since SSA countries experience both catching-up relatively /falling-behind copiously. For example, for countries in our sample, Botswana and Niger are uber examples of "growth miracle" and "growth failure." Comparable data for them is available since 1964. In that year, their incomes were about one-33rd (2.8%) and one-ninth (11%) of US income, respectively. After that, Botswana grew faster than the U.S. at 4.09% rate so that by 2019 (55 years later), its income was more than one-fourth (26.5%) of US income while Niger grew slower than the U.S. at 3.11% rate so that by 2019 its income was about one-fiftieth (1.9%) of the US income.

Pritchett (2000) points out Cote d'Ivoire's per capita income first grew at 3.1 percent (from 1960 to 1980) then fell at 4.1 percent (from 1980 to 1992) giving an average growth of 0.22% over the entire period while Senegal grew throughout 1960-1992 at 0.18%. The growth experience over time of the two countries is widely different that the average growth rate does not reveal. The first task of this paper is to identify varieties of Sub-Saharan experience over space and time of

more than ten years. We separate periods during which Sub-Saharan countries experience (relative) catching-up to the US from those during which they fall behind. We perform this task in Section I. The second task of this paper, done in Section II, is to undertake panel estimation of proximate factors for income ratio changes separately of the relative catching-up periods from that for the falling-behind periods. We find catching-up relatively (as opposed to falling behind) is mostly explained by human capital and for the relative catching-up panels, total factor productivity (TFP) to be less important than human capital. The last section gives the conclusions.

1. Sub-Saharan Countries' Catching-Up/Falling-Behind Over The Long-Run

In this section, we identify a variety of Sub-Saharan growth experiences that abstract from region-wide or global growth. To affect this abstraction, we use relative growth, the catch-up index, and relative and absolute convergence/ divergence from Kant (2019).

1.1 The catch-up index, and relative and absolute convergence/divergence

Let y_{J0} and y_{US0} represent Country J's per-capita RGDP (defined below) for the base year and the US per-capita RGDP for Country J's base year, and R_{J0} Country J's base per capita RGDP ratio. Assuming the US is the richer country,

$$R_{J0} = (y_{J0}/y_{US0}) < 1. \qquad (1)$$

For each subsequent year, similar ratios of a country's annual per-capita RGDP to that of the US are computed. The catch-up index for Country J for year t is the ratio of its per capita RGDP ratio for year t to its base per capita RGDP ratio. Let I_{Jt} represent this index and define $R_{Jt} = (y_{Jt}/y_{USt})$. Then,

$$I_{Jt} = (R_{Jt}/ R_{J0}) \qquad (2)$$

The catch-up index is calculated year by year and so it helps in understanding variation in a country's relative income over time. If the value of the catch-up index rises, it indicates an increase

in Country J's (poorer country's) income ratio to that of the US. This increase in the poorer country's income ratio is called relative convergence. Similarly, relative divergence is a decrease in the value of the catch-up index and a decrease in Country J's income ratio to that of the US. On the other hand, absolute convergence is a reduction in the excess of richer country income-level over the poorer country's income-level while absolute divergence is an increase in this income-levels gap.[2] Since relative divergence is a sufficient condition for absolute divergence, a fall in Country J's catch-up index (or in its income ratio) unambiguously means falling behind (or for Country J's income gap to increase) and we will call relative divergence simply as divergence (both relative and absolute). On the other hand, relative convergence is a necessary condition but not a sufficient condition for absolute convergence: faster growth is consistent with absolute divergence. Therefore, we will have to distinguish between relative convergence and absolute convergence. A rise in Country J's catch-up index (or in its income ratio, means only catching-up in relative income and will be called r-convergence or relative caching-up in this paper (since r-convergence may mean absolute divergence or an increase in income gap).

An equation for determining the years, n, for closing income gaps, or full convergence can be derived. This equation is:

$$n = \log (1/R_{J,0}) / \log(1 + r_I),$$

where $r_I = r_J - r_{US.}$ and r_I, r_J, and r_{US} are exponential growth rates of the catch-up index, and of Country J's and US's income. No simple algebraic expression (like that derived for years for full

[2] Jones and Olken (2008) define a rise in a country's income ratio to the US as convergence and a decrease as divergence. They do not distinguish between relative and absolute convergence/ divergence.

convergence) can be derived for the number of years of relative convergence it would take for absolute convergence to start or for absolute income-levels gap to starts decreasing - it may take generations of higher growth of the poorer country. A heuristic exercise, summarized in Table 1, shows if the US initial income is $24,000, Country J's $300, and the catching-up rate is 0.5%, it will take 851 years of relative convergence (at continued 0.5% annual rate) for absolute convergence to start, i.e., income differences will continue to widen for 850 years. On the other hand, if Country J's initial income is $4,800 and it is catching up at 4.5% rate, it will take 11 years of relative convergence for absolute convergence to start.

"place Table 1 here"

1.2 Sub-Saharan long-run growth and growth miracle/failure by country

We now examine catch-up for Sub-Saharan countries for which reliable data for both income and the explanatory variables are available. It had been the practice at PWT to simply discard earlier benchmark prices when prices for a different benchmark year became available. The new generation of PWT, i.e., those starting from 8/8.1, link different benchmark years' prices by chained indices. The real GDP numbers then become comparable not only across countries for one benchmark year but also over time and over different benchmark years. See, Feenstra et al. (2015) who also explain that the new generation of PWT real GDP numbers (rather than of versions before 8.0) are well-suited for comparisons across countries and over time. They call these numbers as RGDP.

We employ the RGDP and explanatory variables data from PWT 10.0, available at http://www.rug.nl/ggdc/productivity/pwt. Such data are available for 27 Sub-Saharan countries. These countries are: Angola, Benin, Botswana, Burkina Faso, Burundi, Cameroon, Cen. Afr. Rep.. Côte d'Ivoire, Eswatini, Gabon, Kenya, Lesotho, Mauritania, Mauritius, Mozambique, Namibia,

Niger, Nigeria, Rwanda, Senegal, Sierra Leone, South Africa, Sudan, Tanzania, Togo, Zambia, and Zimbabwe and we use data from the earliest year it is available for all variables for a country.[3] These years are 1954 (for three), 1958 (one), 1959 (one), 1960 (one), 1963 (one), 1964 (nine), 1977 (for one), and 1980 (for the rest). The average period of data for a country is 52 years.

Annual catch-up index shows sharp changes in some years/countries. These swings are explained by a country's business cycle not synchronizing with the US, fluctuations in GDP caused by fluctuations in FDI and capital flows to some countries, sudden primary products' price changes, political upheavals and civil-wars in a country/group of countries in a year. For example, Kant (2016) reports annual FDI as a proportion of GDP varies from -4.58 to 22.71 for Sub-Saharan countries during 2000s. To smooth out yearly fluctuations, three-year moving average of a country's catch-up index is used.

Catching-up/falling-behind experience differ greatly among countries. As stated above, we discuss only two growth experiences: catching-up to the US (relatively) and falling behind (both relatively and absolutely). We focus on long-term catching-up/falling-back and ignore ups and downs episodes in the index that each last for less than 10 years.[4] We perform cusum test for stability of parameters for linear regression using recursive residuals. See, Galpin and Hawkins (1984), Harvey and Collier (1977) and Brown, Durbin, and Evans (1975). Six countries pass this test: five showing falling behind throughout and one catching-up relatively throughout. The catch-up index of five that experience falling-behind (divergence) only is shown in Figures 1 (Niger, Senegal, Burundi, Central African Republic, and Lesotho); of one, Botswana, that exhibits

[3] Eswatini is the new name of Swaziland since April 2018.

[4] The numerical values of the index for each year/country are available from the author.

catching-up (r-convergence) only is shown in Figure 6.

"place Figures 1 and 6 here"

Most countries have both falling behind and relative catching-up periods. We similarly place other countries in four groups depending on their catching-up experiences. These are a) relative catching-up after initial falling-behind ('valleys' or 'U'-shaped) in Figures 2A and 2B; b) with a more complicated experience, viz. 'valleys' followed by 'hills' that are again followed by 'valleys (except for Cameroon), in Fig 3; c) falling-behind after initial relative catching-up ('hills' or inverted 'U'-shaped) - depicted in Figure 4 (including one where this pattern is repeated); d) and 'hills' that are followed by 'valleys, in Fig 5.[5] The figures are not very symmetrical. For example, the left arm of the 'valleys' is either steeper or longer than the right arm. Nevertheless, they illustrate both that we ignore ups and downs episodes in the index that each last for less than 10 years and that most Sub- Saharan countries have relative catching-up periods also.[6] Countries

[5] The break-point years for different countries (in parenthesis) are: in Figure 2A: Kenya (2003), South Africa (1999), Burkina Faso (1994), Côte d'Ivoire (2005), Mozambique (1993), and Namibia (1999); in Figure 2B: Angola (2001), Sudan (1996), Mauritania (2001), Benin (1995), Togo (2008), and Sierra Leone (2006); in Figure 3: Mauritius (1969, 1996, and 2006), Zimbabwe (1978, 1995, and 2007); and Cameroon (1975 and 1985), in Figure 4:, Gabon (1977, 1998, and 2007), and Eswatini (1996); and in Figure 5: Zambia (1968 and 1998), Nigeria (1976 and 1997), Rwanda (1995), and Tanzania (1975 and 1995).

[6] For example, we ignore the fluctuations in the index of South Africa (from 1954 to 1981) and Côte d'Ivoire (from 1964 to 1978) in Fig. 2A; and of Sierra Leone (from 1980 to 1994) in Fig. 2B.

that show both catching-up relatively and falling-behind (Figures 2A, 2B, 3, 4 and 5), grow faster than the US for an average of about 17.8 years. See, Table 2 (discussed below).

"place Figures 2A, 2B, 3, 4 and 5 here"

As discussed above, Pritchett (2000, 2003)'s five growth patterns (hills, plateaus, mountains, plains, accelerators or Denvers) allow for falling back/divergence/income gaps to increase; and only one, (steep hills) gives catching up to the US (at higher than 0.6% rate - since US per capita income grew by 2.4% annually for the relevant period) in relative income. He uses PWT 5.6. data beginning in 1960 for 111 countries with at least 25 years of data (with the final year of data varying from 1985 to 1992).[7] Of the Sub-Saharan countries in our sample, Pritchett finds only Botswana in the steep hills category. However, we find, in addition, Cameroon, Gabon, Mauritius, Nigeria, Eswatini (Swaziland), Tanzania, Zambia, and Zimbabwe, (one-third of countries, including Botswana, in our sample) r-converged during the period considered by him. All these countries are included in the 36 Sub-Saharan countries considered by him. Using our terminology, Pritchett finds one out of 36 (about 3%) of Sub-Saharan countries r-converged in the period up to 1992, we find 33% did.

Of the four growth regimes considered by Jerzmanowski (2006), his stable growth,

[7] The countries (whether those with less than 20/25 years of data or with population of less than a million or those with interruptions in data are) excluded, the income variable (whether GDP per capita or GDP per worker is) used, and the end year (whether early 1990s or 2003) differs among the papers discussed. We use US income growth from 1961 to 1994 (at 2.41%) to compare it to Pritchett's (2000) and Jerzmanowski's (2006) and from 1961 to 2003 (at 2.39%) to Kerekes (2012).

stagnation, and miracle growth correspond to falling behind at 0.4% rate, falling-behind at a minimum of 2.4% rate, and catching-up relatively at 3.6% rate, respectively. He uses PWT 6.1 data on income per worker for 1962-1994) for 89 countries (including 19 out of 27 countries considered in this paper),[8] We show of these 19 countries, only four (Cameroon, Nigeria, Tanzania and Zimbabwe) exhibit both relative catching-up and falling-back periods. The other 15 largely follow one growth experience, either relative catching-up (Mauritius, at 2.8%) or stable growth or stagnation, i.e., falling back, for almost the entire 32 years (1962-1994) period. The falling-behind rate varies from 1.3% to 11.9% with the median being 2.2%. The minimum falling-behind rate of 1.3% means no Sub-Saharan country has stable growth during its falling-behind periods during 1962-1994.

Jones and Olken (2008) focus on the medium run of ten or fifteen years. Using PWT 6.1 for 125 countries with at least 20 years of per capita income data, they find growth miracles and growth failures are ubiquitous. Excluding growth episodes that follow previous ten-year (or longer) periods of contraction (to exclude recoveries and to focus on new growth), they find 86% of all countries, 92% of the poorest one-third countries (in 1960) and 76% of Sub-Saharan countries have experienced higher growth than the US over at least one ten-year period. Excluding recoveries would mean excluding countries that did not re-attain the initial value of the catch-up index of 100 while growing faster than US means increase in the catch-up index for at least one

[8] These countries are Angola, Benin, Burkina Faso, Burundi, Cameroon, Central African Republic, Cote d'Ivoire, Kenya, Mauritania, Mauritius, Mozambique, Niger, Nigeria, Rwanda, Senegal, South Africa, Tanzania, Togo, and Zimbabwe.

ten-year period. In our analysis, seven Sub Saharan countries (i.e., 26% of 27) meet these criteria.[9]

Kerekes (2012) uses GDP per capita for the years 1961–2003 from PWT 6.2. Using Jerzmanowski's (2006) four growth regimes, she groups countries in three clusters: successful growth (countries growing at 2% most of the time), moderately successful growth (growing at 2% for 45% and stagnating for 37% of the time), and growth failures (stagnating for most of the time).[10] That is, her successful growth cluster also does not imply catching-up relatively. She finds countries remain in the same cluster all through out. Nevertheless, for the period and Sub-Saharan countries considered by her, we find the following countries all of which she considers as growth failures, catching-up relatively (with the catching-up periods in the parenthesis) Cameroon (1976-1985), Mozambique (1994 -2019), Nigeria ((1960-1976), Tanzania (1964-1975), Zambia (1959-1968), and Zimbabwe ((1979-1995). The relative catching-up of all of these, (except Mozambique) takes their income ratios relative to the base year above the initial level of 100.

2. Proximate Factors for R-Convergence/Divergence

We now analyze the economic factors that explain Sub Saharan countries' relative income level increases or falls. First, we present the model used, then explain the relevant panel estimation

[9] These countries and the periods (in parenthesis) are Botswana (1964-2018, Eswatini/Swaziland (1980-1996), Gabon (1964-77), Mauritius (2007-2019), Nigeria (1960-1976), Tanzania (1964-1975), and Zambia (1959-1968). Further, they find Burundi and Lesotho experience at least a ten-year period of r-convergence while we find they fell-behind all through-out (from 1980 to 2019).

[10] We ignore a different growth regime for less than 10 years – the 17%, 16%, and 19% of time of her 42 years period.

methods before presenting and discussing the results.

2.1 The model

Following Solow (1956), the standard growth theory explains output by capital, labor, and the technology embodied in the production function. Subsequently, capital was understood as meaning physical capital; human capital was included in labor by redefining it in efficiency units; and the residual *A* of the Solow model came to represent total factor productivity (TFP) or technical efficiency or the exogenously given technology. We use it to explain income levels, proxied by income per worker, in terms of human capital, physical capital intensity, and TFP. See, Caselli (2005) and Feenstra et al. (2015). These factors have been called "proximate" causes by Rodrik (2003) and distinguished from "fundamentals" for growth like trust, geography, institutions, culture, and genetic distance. We use the proximate factors in empirical analysis. [11] Most of the fundamental factors are unlikely to differ among Sub-Saharan countries; consistent and reliable data on these and other potential explanatory variables are unavailable for all 27 countries for the 40 to 66 years periods considered; and the literature's findings (noted above) that random shocks are more important than explanatory variables in explaining income growth variations, all lead us to adopt a parsimonious framework. We ignore growth variations of less than 10 years, consider two major variations, r-convergence and divergence, and attempt to find useful econometric panel data results of whether the proximate causes for r-convergence differ from those for divergence.

[11] That is, we do not consider fundamental factors like trust (Knack and Keefer 1997), geography (Hall and Jones 1999), institutions (Acemoglu et al., 2001; Engerman and Sokoloff, 2002; Rodrik, et al., 2004), culture (Guiso, et al., 2006), and genetic distance (Spolaore and Wacziarg, 2009).

Let *kl* represent physical capital per unit of employed labor, *hc* average human capital (that is based on years of schooling and Mincerian returns to education), and *A* the efficiency with which the factors are used, i.e., TFP. Then, ignoring the country time sub-scripts, we have for Country J

$$y_J = A_J \, kl_J^{\,\alpha} \, hc_J^{\,1-\alpha} \qquad (3)$$

We are interested in explaining relative income levels. Then, from (3), Country J's income relative to the US is,

$$(y_J/y_{US}) = (A_J/A_{US}) \, (kl_J/kl_{US})^{\alpha} \, (hc_J/hc_{US})^{1-\alpha} \qquad (4)$$

That is, we take explanatory variables also as ratios.[12] (4) tells us Country J's relative income depends on its relative TFP, relative capital-labor ratios and relative average human capital (all relative to the US). Taking total derivative $\Delta(y_J/y_{US})/\Delta t$, letting $\Delta t = 1$, adding constant, μ, and error, ε, terms, and representing coefficients of the derivatives of the RHS ratio variables by β_1, β_2, and β_3, respectively, we have

$$\Delta(y_J/y_{US}) = \mu + \beta_1 \, \Delta(A_J/A_{US}) + \beta_2 \, \Delta(kl_J/kl_{US}) + \beta_3 \, \Delta(hc_J/hc_{US}) + \varepsilon \qquad (5)$$

The slope coefficients of (5) are assumed positive and are interpreted as follows: a greater increase in Country J's explanatory variable relative to the US, leads to an increase in Country J's income relative to the US. That is, it causes Country J's income ratio to the US to increase and causes relative convergence. On the other hand, a smaller increase in Country J's explanatory variable

[12] Peron and Rey (2012), Cuberes and Jerzmanowski (2009), Jones and Olken (2008), and Fuchs-Schundeln (2008), use income relative to the US as the dependent variable; but do not take explanatory variables as relative to the corresponding US/benchmark country's numbers in their econometric investigation. Further, for this part of our analysis, we do not take 3-year moving-averages thereby obtaining data for each beginning year and 2019 also. well.

relative to the US, leads to a decrease in Country J's income relative to the US. That is, it causes Country J's income ratio to the US to decrease and causes divergence. In both cases, the expected sign of the right-hand side ratio-variables is positive. For most of our analysis, we take annual data rather than that averaged over five or ten non-overlapping years since the latter throws away too much information. See, Attanasio et al. (2000).

We have seen above that most countries have a breakpoint in their growth experience – from r-convergence to divergence or vice versa - and some have two or more. Table 2 lists the r-convergence and divergence periods and rates for the sample countries. [13] The number of periods for the two are almost the same, although the average number of years for the former is lower (17.8 versus 27.2).

"place Table 2 here"

Table 3 gives data's summary statistics separately for the two groups of observations. It presents average annual change in a variable from its initial-year value to the final-year value for each period/country. The arithmetic means of changes for the two groups of observations are also presented. As expected, for the r-convergence periods, income ratios and explanatory variables ratios (to the corresponding US numbers) both increase. For the divergence periods, income ratios and K/L and TFP ratios decrease – but the human capital ratio increases.

We estimate the two groups of observations separately by panel data. As noted by Durlauf

[13] We prefer geometric mean (GM) as the average – like median, (and unlike arithmetic mean) it is not affected much by extreme values (e.g., GM of 8, 27, and 125 is 30); and unlike median, it incorporates the values of all observations in it. However, GM cannot be used when any of the observation is non-positive (i.e., is either zero or negative).

et al. (2005), the use of panel data is likely to increase efficiency but at the expense of potential bias if the parameter homogeneity assumption is incorrect. We minimize this bias by taking countries from the same geographical region.

"place Table 3 here"

2.2 Panel estimation

Consider the model

$$y_{it} = v_i + \bar{x}_i \beta_1 + (x_{it} - \bar{x}_i) \beta_2 + \varepsilon_{it} \qquad (6),$$

where i refers to an individual or country, v_i to intercept for that individual or country, t to time, $\bar{x}_i$ is the average value of the independent variable x_i, $(x_{it} - \bar{x}_i)$ is the deviation of x_i at time t from its mean, y is the dependent variable and ε_{it} is IID. This model postulates that the average value $\bar{x}_i$ of the independent variables for an individual or country, has a different effect from temporary departures $(x_{it} - \bar{x}_i)$ from the average.

If we assume temporary departures from the average do not affect the dependent variable, we have the "between" model that estimates slope, β_1, by running OLS on the data averaged across time for each individual i,

$$y_i = v_i + \bar{x}_i \beta_1 + \varepsilon_i \qquad (7),$$

and if we assume the average values do not affect the dependent variable, we have the "within-groups" or fixed effects model[14]

$$(y_{it} - \bar{y}_i) = (x_{it} - \bar{x}_i) \beta_2 + (\varepsilon_{it} - \bar{\varepsilon}_i) \qquad (8).$$

[14] It may be noted the "between" estimator allows the differing intercepts to play a prominent role in estimating the slope. By eliminating the intercepts, fixed effects wipes out this influence.

The "between" model estimates β_1, the fixed effects model β_2 and neither estimates the other. It is not sufficiently recognized that the time-series-based fixed effects estimator is a function of temporary departures from the average and measures short-run effects, while the cross-section based "between" estimator is a function of average values for an individual or country and measures long-run effects. See. Kennedy (2008), Asteriou and Hall (2007, p. 347) who state that by differencing, the fixed effects estimator "can certainly remove any long run effects," and similar (and other) criticism(s) of the fixed effects model by Pritchett (2000) and Durlauf et al. (2005). To estimate or include the long-run effects, either the not-so-widely used "between" estimator; or the random effects estimator (that is a matrix-weighted average of "between" and "within-groups" estimators) should be used. However, the random effects estimator may suffer from the omitted variable bias.

2.3 Analysis and Results

The estimation procedure is as follows. First test the null of equal intercepts. If this null is not rejected, use the pooled panel OLS since it is efficient. If it is rejected, use Hausman test to test the null that random effect estimator is unbiased. If this null is not rejected, use random effects estimator; otherwise use the fixed effects estimator. In either case, estimate the "between" estimator also. The number of averaged observations for this estimator equals the number of units/periods in the panel.

Three successively larger panels for both r-convergence and divergence periods/countries are formed. These are: 1) Countries that only diverged or only r-converged - as identified in Figures 1 and 6, respectively; 2) Periods/countries with the catching-up relatively/falling back rate in the top one-half of r-convergers (called fast r-convergers) and divergers (called fast divergers);

3) all r-convergers and all divergers. [15]

Only one country only r-converged and five that only diverged. The number of observations being one and five, respectively, the between estimator is not defined for the r-convergence country and all variables are insignificant for the divergence panel. The within estimator results for estimating equation (5) for these countries are presented in Table 4. The r-convergence country (being only one) is estimated by OLS. Based on the considerations given above, random effects estimator is chosen for the divergence panel (that is unbalanced). Robust s.e. (to handle misspecifications like when the disturbances are not identically distributed over the panel or there is serial correlation in ε_{it}) given by the Huber/White/sandwich VCE estimator are used. See, Arellano (2003) and Woodbridge (2016). In addition, between and within-groups estimator results for the fast and all r-covergers/divergers panels are presented in Tables 5 and 6, respectively.

Examining the results in Table 4, all variables except human capital for the divergence panel are statistically significant. Although TFP accounts for about as much of r-convergence as for divergence, K/L ratio accounts about two times for divergence as compared to for r-convergence. More noticeable is the different marginal effects of human capital for the two panels. When a country is r-converging and its income ratio is rising, a rise in its human capital (relative

[15] Using 1 or 2 after a country's name to indicate the first or second episode of relative catching-up/falling-behind, fast r-convergers periods are for Angola, Gabon1, Gabon2, Rwanda, Sierra Leone, Togo, Zimbabwe2, Botswana, Cameroon1, Côte d'Ivoire, Kenya, Nigeria2, Estawan, and Zambia2. Those for fast divergers are for, in addition to the first seven fast-convergers, Benin, Mauritania, Mauritius1, Niger, Nigeria1, Tanzania1, Zambia1

to the US), increases its income ratio. When it is diverging and its income ratio is falling, a rise in its human capital (relative to the US), has no statistically significant effect on its income ratio.[16] Human capital contributes to relative catching up but does not mitigate (even partly) falling behind.

"place Table 4 here"

For the fast r-convergers/divergers panels (Table 5), human capital is statistically not significant for fast divergers in both the within-groups and between models. That is, there is no statistical evidence whether increase in human capital mitigates falling behind. Again, in 12 out of 14 fast divergers human capital increases at a higher rate than in the US. [17] However, the negative sign indicates that a rise in human capital at higher rate than in the US is associated with a **decrease** in their income ratio to the US. Now K/L ratio and TFP account for about as much of falling behind as of catching up relatively. For the catching up (r-convergence) panels, human capital is the most important factor for the within model while it is statistically not significant for the between model.

"place Table 5 here"

Estimation for all divergers are compared to those for all r-convergers in Table 6. Again, there is no statical evidence by either estimator that human capital (that increases for all divergers), reduces their falling behind. For the "between" estimator (reported in Table 6's Part B) nonparametric bootstrap s.e. are used. See, Brownstone and Valletta (2001) and MacKinnon

[16] Four of the five only diverging countries (Niger, Senegal, Burundi, and Central African Republic), increased their human capital at a faster rate than the US (see, Table 3).

[17] These countries are Angola, Benin, Gabon1, Gabon2, Mauritania, Niger, Rwanda, Sierra Leone, Tanzania1, Togo, Zambia1 and Zimbabwe1). See Table 3.

(2006). For the catching up (r-convergence) panels, human capital is again the most important factor for the within model while it is statistically not significant for the between model. Other factors' contribution does not differ materially for relative catching-up as compared to falling-behind, except that physical capital is now twice as powerful for r-convergence as for divergence for the within model.

"place Table 6 here"

Table 7 presents the results using five non-overlapping years averaged data in line with empirical studies of growth referred to above to minimize measurement errors and business cycles effects. Now, the effects of physical capital are statistically significant only for the r-convergence between model and human capital is statistically significant for both panels at 10% level for the between model The effects of TFP for both the models and panels and of human capital for the between model for the two panels are the same as with annual data (in Table 6). What it means is that any measurement errors/business cycle do not materially affect the results given in Table 6.

"place Table 7 here"

The main difference of the divergence panels from the r-convergence panels is on the role of human capital. Under-performance of many developing countries is often attributed to capture by the rulers/elite, and absenteeism of education and health workers. [18] Our results show these issues manifest themselves in making human capital insignificant in mitigating (even partly) falling-behind. In all four within estimations, when human capital is contributing to growth in a positive and statistically significant way, countries are catching up relatively; when it is not, they

[18] Banerjee et al. (2004) and Chaudhry et al. (2006) find 35-45% absenteeism of health and education workers in developing countries.

are falling behind.[19] Kant (2021) shows that accepting and implementing EU rules, regulations and norms (upon joining it) permitted skilled labor in ex-socialist countries to create value it was capable of. Although the link between institutions and human capital's contribution to output has not been sufficiently examined in the literature, our results suggest that diverging periods in Sub-Saharan countries may have experienced deterioration in their institutions that made the marginal effect of human capital negative/not statistically significant.

3. Conclusions

The starting point of this paper is the finding of recent empirical growth literature that only a few countries grow uniformly over periods longer than a decade or so. The existing empirical growth literature has evidently not examined that income-growth experience of the same country over twenty/thirty years may differ from the previous twenty/thirty years. We examine growth over the long run, study whether proximate factors for one long-run growth experience differ from another long-run growth experience, and study growth relative to a numeraire country. We take US as the numeraire since its income is among the least volatile since the Second World War, it is taken as the bench-mark country in most empirical growth studies and taking it as the numeraire makes the country data somewhat immune to global or region-wide factors.

We consider two experiences: catching-up (in relative income or relative convergence - r-convergence) and falling-behind (in relative and absolute income or simply divergence) and separate out the former periods/countries from the latter. We define growth as catch-up growth or income growth higher than 2.4% per annum (US rate). We do that because growth higher than the US is a necessary (but not a sufficient) condition for income gap reduction. To minimize,

[19] These results are like what we had found using PWT 9.1 data. See, Kant (2021).

parameter heterogeneity we consider one geographical region and choose Sub-Saharan Africa (SSA) also because SSA countries experience both relative catching-up and falling-behind copiously. The number of periods for the two experiences are almost the same, although the average number of years for r-convergence is lower than that for divergence.

Using the standard growth model for relative income estimation, we examine the proximate factors for the two sets of periods separately by panel estimation. We use either a fixed effects estimator or a random effects estimator based on relevant tests, for four groupings of countries/periods; and the "between" estimator also for three out of the four groupings. The main difference of the divergence panels from the r-convergence panels is on the role of human capital. In all the four within estimations, when human capital is contributing to income in a positive and statistically significant way, countries are catching up (in relative income); when it is not, they are falling behind both relatively and absolutely.

We now relate our results to some of the recent work on human capital and growth. Erosa et al. (2010) find human capital to be about four times more important than TFP in explaining income differences. Using a sample of 1,528 regions from 83 countries, Gennaioli et al. (2014) find human capital (and geography) to be as important for regional growth as for national growth. Fernald et al. (2017) and Hanushek et al. (2017) adopt development accounting framework. Fully accounting for the cyclical effects that should have implied faster recovery, Fernald et al. (2017) report it is the slower growth of TFP (and decline in labor force participation rate) that account for slower recovery in the US since the Great Recession. On the other hand, Hanushek et al. (2017) show differences in human capital account for 20 to 30% of differences in per-capita GDP of states within the US. We compare proximate factors for relative income changes for fast-growers (those catching-up relatively) versus for slow growers (those falling behind), take long periods of

catching-up/falling behind that average about 20 years (for catching-up relatively) to about 30 years (for falling behind), find TFP to be less important than human capital, and find relative catching-up (as opposed to falling behind) mostly explained by human capital.[20]

[20] We consider periods as long as 66 years (for Kenya, Mauritius, and South Africa).

Funding and/or Competing interests:

No funds, grants, or other support was received.

Author certifies that he has no affiliations with or involvement in any organization or entity with any financial interest or non-financial interest in the subject matter or materials discussed in this manuscript.

Data Availability Statement:

Data associated with the article can be found at: http://www.rug.nl/ggdc/productivity/pwt.

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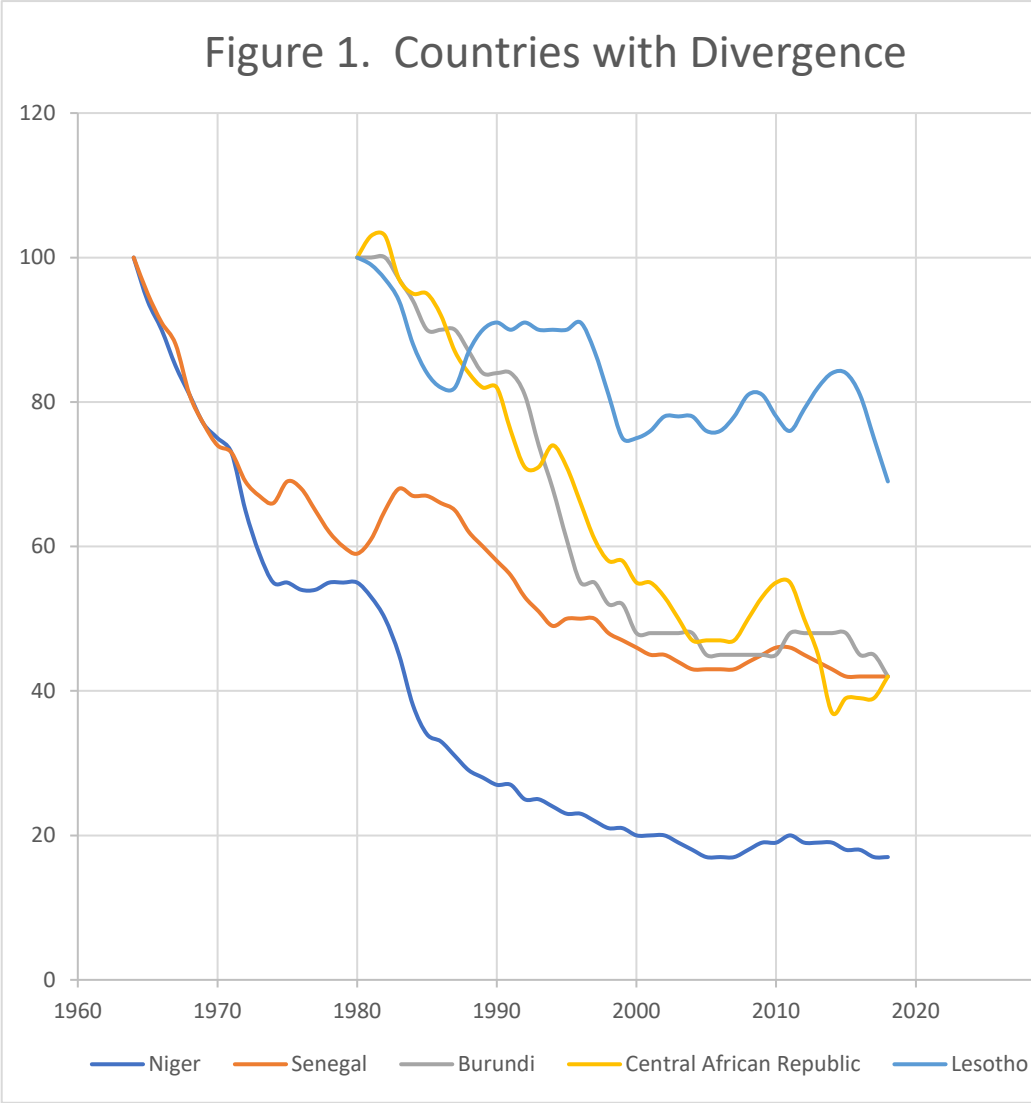
Figure 1. Countries with Divergence
120
100
80
60
40
20
0
1960
1970
1980
1990
2000
2010
2020
Niger
Senegal
Burundi
Central African Republic
Lesotho

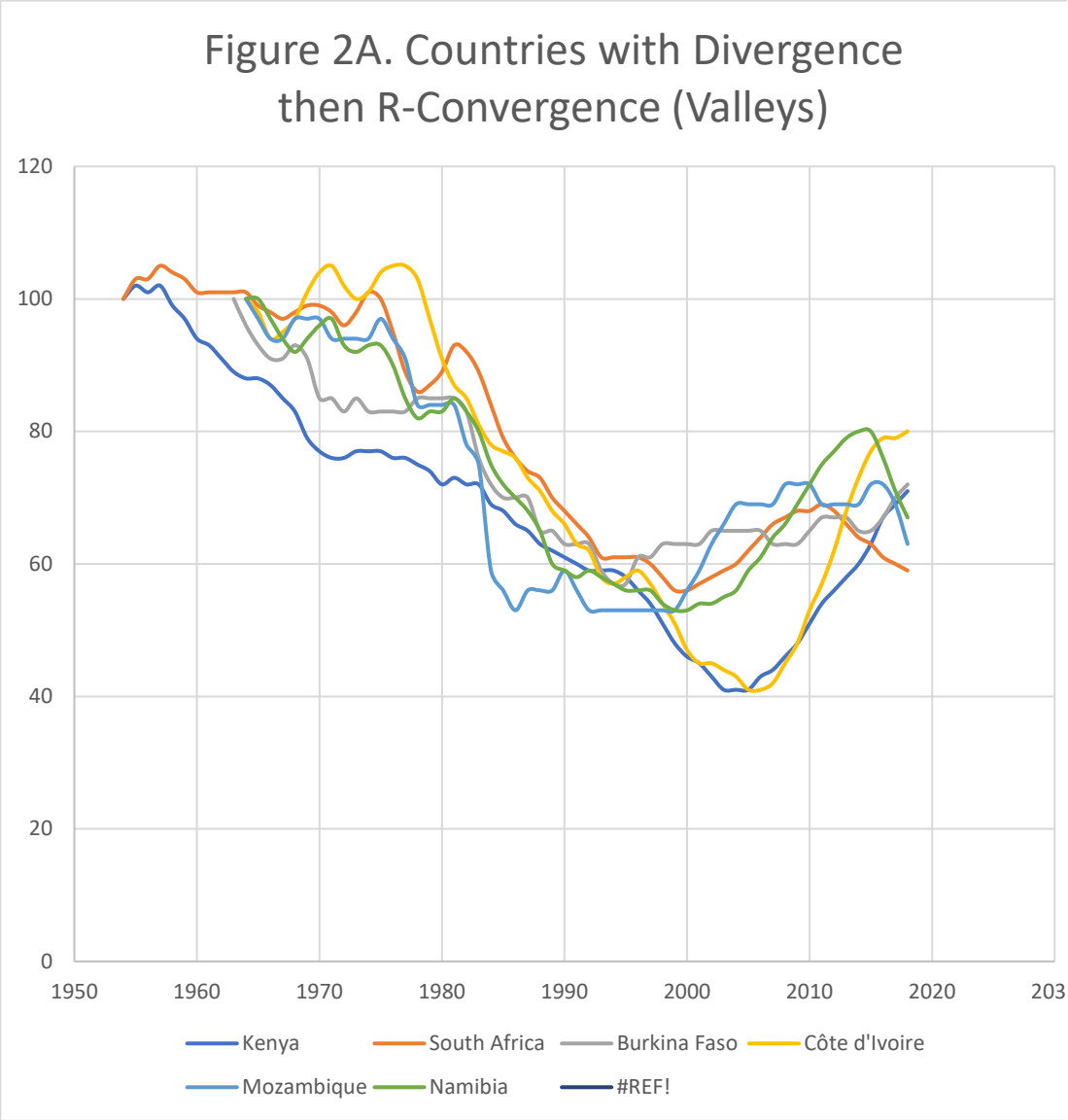
Figure 2A. Countries with Divergence then R-Convergence (Valleys)
120
100
80
60
40
20
0
1950
1960
1970
1980
1990
2000
2010
2020
203
Kenya
South Africa
Burkina Faso
Côte d'Ivoire
Mozambique
Namibia
#REF!

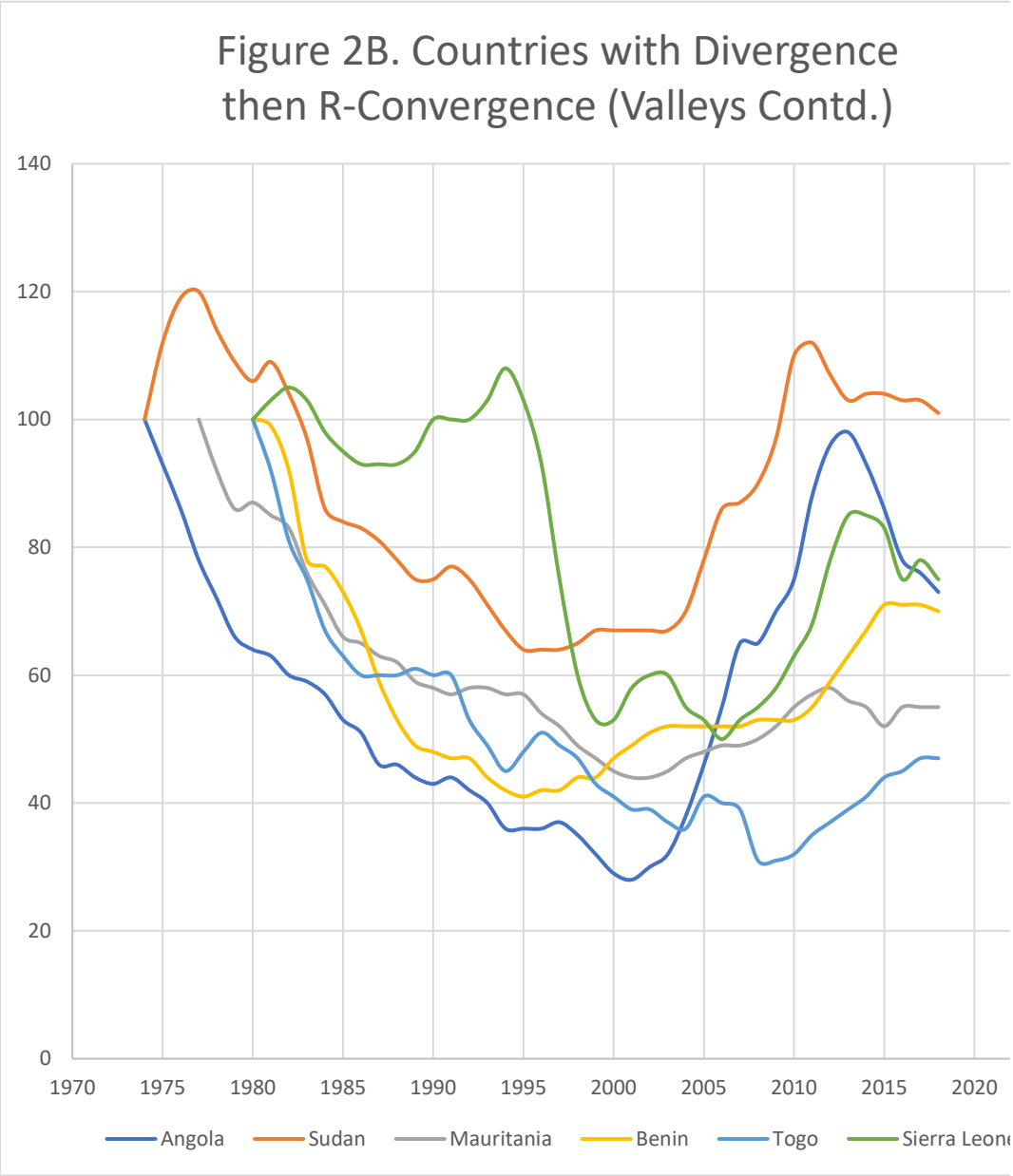
Figure 2B. Countries with Divergence then R-Convergence (Valleys Contd.)
140
120
100
80
60
40
20
0
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020
Angola
Sudan
Mauritania
Benin
Togo
Sierra Leone

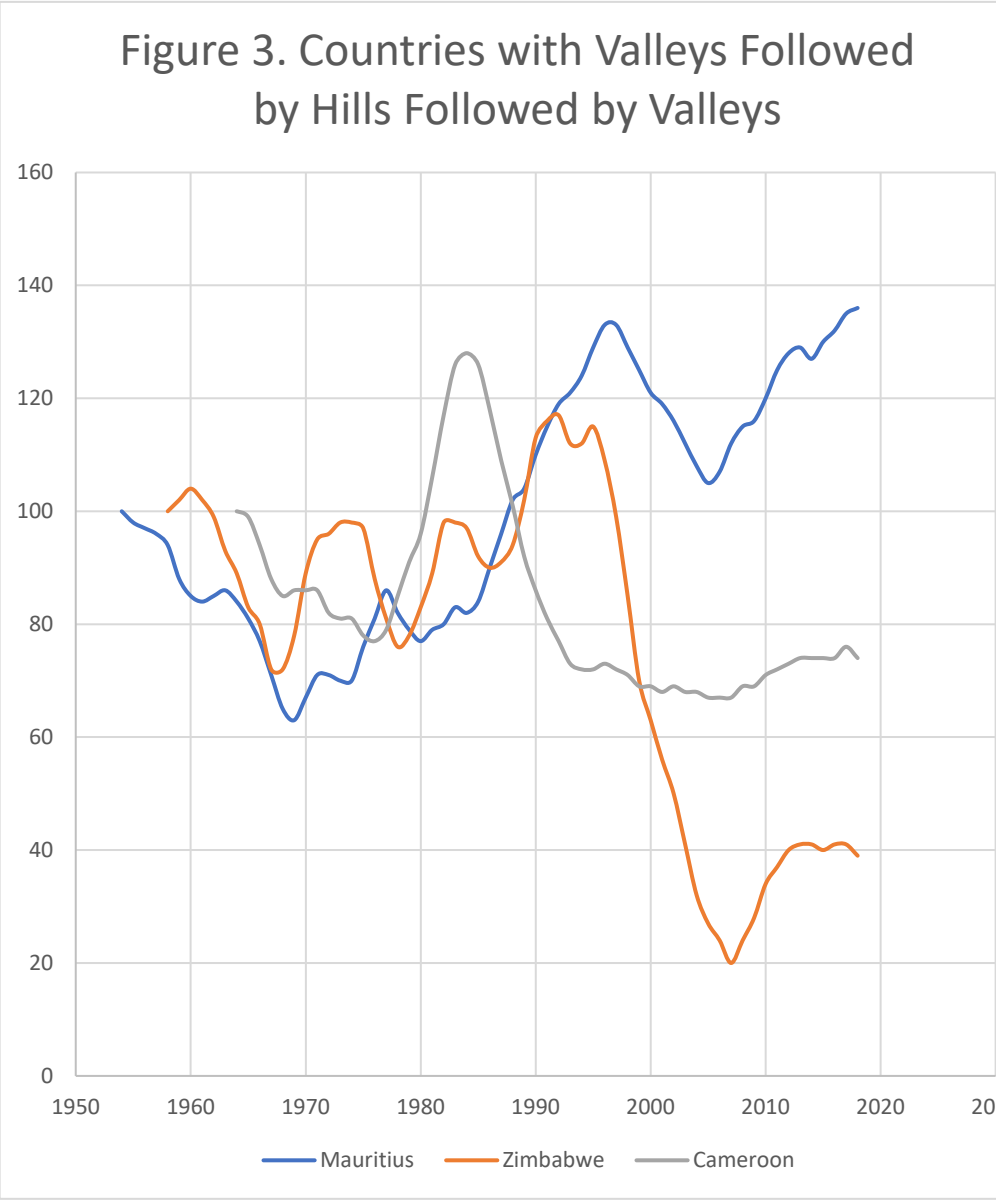
Figure 3. Countries with Valleys Followed by Hills Followed by Valleys
160
140
120
100
80
60
40
20
0
1950
1960
1970
1980
1990
2000
2010
2020
20
Mauritius
Zimbabwe
Cameroon

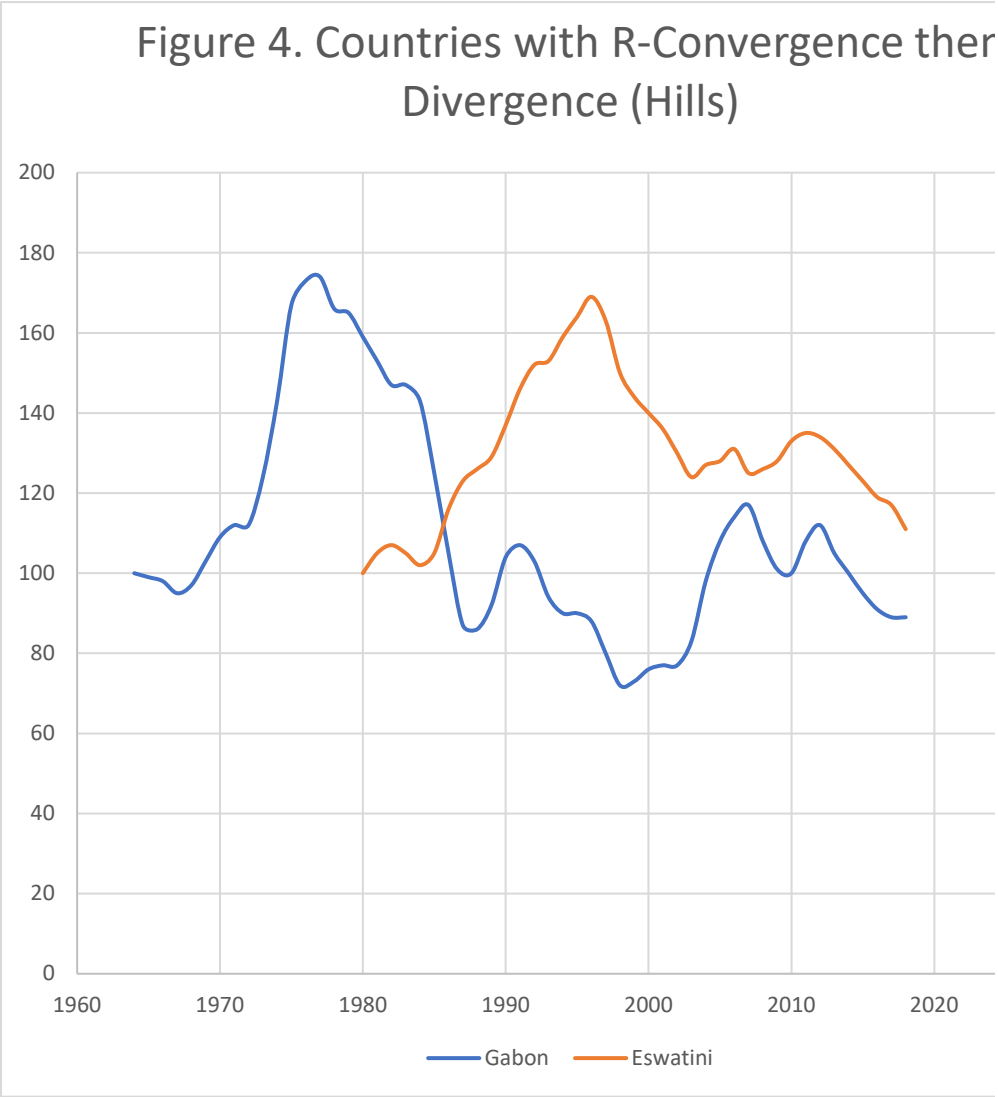
Figure 4. Countries with R-Convergence ther
Divergence (Hills)
200
180
160
140
120
100
80
60
40
20
0
1960
1970
1980
1990
2000
2010
2020
Gabon
Eswatini

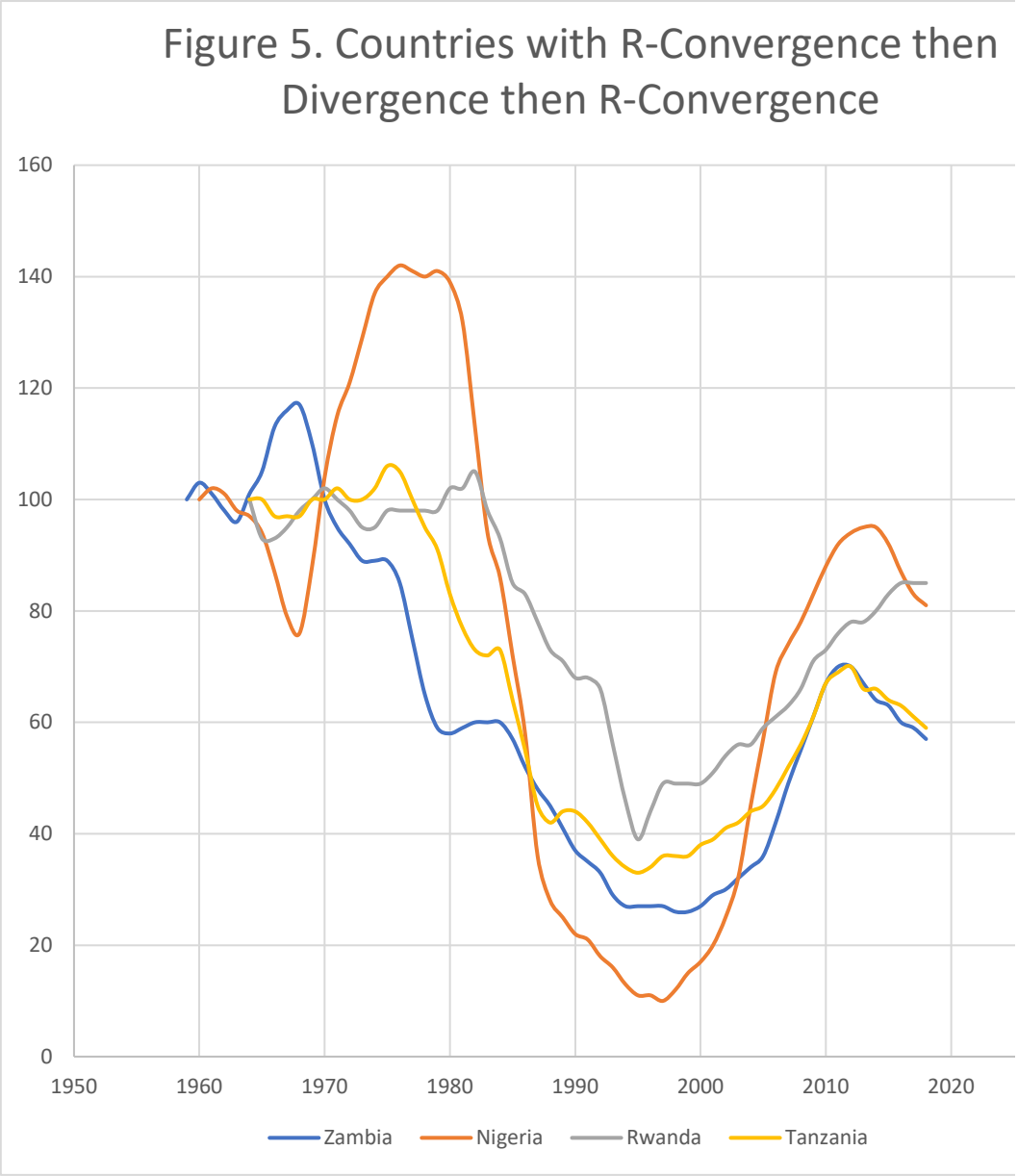
Figure 5. Countries with R-Convergence then Divergence then R-Convergence
160
140
120
100
80
60
40
20
0
1950
1960
1970
1980
1990
2000
2010
2020
Zambia
Nigeria
Rwanda
Tanzania

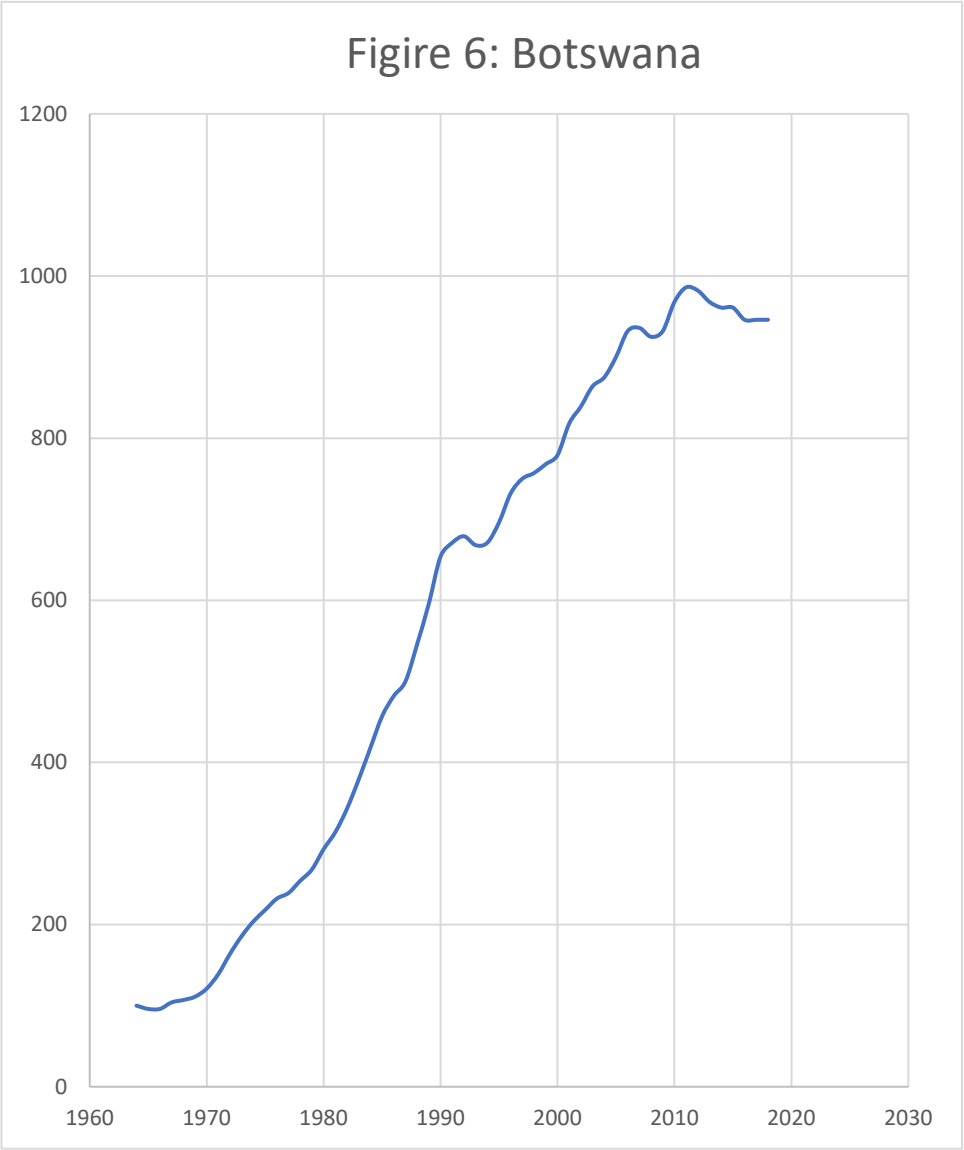
Figire 6: Botswana
1200
1000
800
600
400
200
0
1960
1970
1980
1990
2000
2010
2020
2030

Table 1: Years for Start of (Absolute) Income Convergence

Country J's	Catch-up or R-Convergence rate				
Initial PPP PCY	0.5%	1.5%	2.5%	3.5%	4.5%
300	851	263	149	101	76
600	710	216	120	81	60
1200	568	168	92	60	44
2400	427	121	63	40	28
4800	285	73	34	19	11

Note: The above table assumes US PPP PCY was $24,000 (in 1971, it was $24,185); and was growing at 2% per year.

Table 2. Total Years, R-Convergence & Divergence Periods, Rates, and Period-end Catch-up Index Values

			R-Convergence				Divergence			
Country	**FirstYear**	**TotYrs**	**Period**	**Yrs.**	**End-Value**	**Rates**	**Period**	**Yrs.**	**End-Value**	**Rates**
Angola	1974	46	2002-2019	18	73	5.5	1974-2001	28	28	-4.4
Benin	1980	40	1996-2019	24	79.0	2.8	1980-1995	16	41.0	-5.4
Botswana	1964	56	1964-2019	56	946.0	4.1				
Burkina Faso	1963	57	1995-2019	25	72.0	0.9	1963-1994	32	57.0	-1.7
Burundi	1980	40					1980-2019	40	42.0	-2.2
Cameroon1	1964	56	1976-1985	10	126.0	4.9	1964-1975	12	78.0	-2.1
Cameroon2							1986-2019	34	74.0	-1.6
Cen. Afr. Rep	1980	40					1980-2019	40	42.0	-2.2
Côte d'Ivoire	1964	56	2006-2019	14	80.0	4.9	1964-2005	42	41.0	-2.1
Gabon1	1964	56	1964-1977	14	174.0	4.0	1978-1998	21	72.0	-4.1
Gabon2			1999-2007	9	117.0	5.5	2008-2019	12	89.0	-2.3
Kenya	1954	66	2004-2019	16	71.0	3.5	1954-2003	50	41.0	-1.8
Lesotho	1980	40					1980-2019	40	69.0	-0.9
Mauritania	1977	43	2002-2019	18	55.0	1.3	1977-2001	25	44.0	-3.2
Mauritius1	1954	66	1970-1996	27	133.0	2.8	1954-1969	16	63.0	-2.9
Mauritius2			2007-2019	13	136.0	1.9	1997-2006	10	107.0	-2.2
Mozambique	1964	56	1994-2019	26	63.0	0.7	1964-1993	30	53.0	-2.1
Namibia	1964	56	2000-2019	20	67.0	1.2	1964-1999	36	53.0	-1.8
Niger	1964	56					1964-2019	56	17.0	-3.1
Nigeria1	1960	60	1960-1976	17	142.0	2.1	1977-1997	21	10.0	-11.9
Nigeria2			1998-2019	22	82.0	10.0				
Rwanda	1964	56	1996-2019	24	85.0	3.3	1964-1995	32	39.0	-2.9
Senegal	1964	56					1964-2019	56	42.0	-1.5
Sierra Leone	1980	40	2007-2019	13	75.0	3.2	1980-2006	27	50.0	-2.5
South Africa	1954	66	2000-2019	20	59.0	0.3	1954-1999	46	56.0	-1.3
Sudan	1974	46	1997-2019	23	101.0	2.0	1974-1996	23	64.0	-1.9
Swaziland	1980	40	1980-1996	17	169.0	3.1	1997-2019	23	111.0	-1.8
Tanzania1	1964	56	1964-1975	12	106.0	0.5	1976-1995	20	33.0	-5.7
Tanzania2			1996-2019	24	59.0	2.5				
Togo	1980	40	2009-2019	11	123.0	13.4	1980-2008	29	31.0	-4.0
Zambia1	1959	61	1959-1968	10	117.0	1.6	1969-1998	30	26.0	-4.9
Zambia2			1999-2019	21	57.0	3.8				
Zimbabwe1	1958	62	1979-1995	17	115.0	2.5	1958-1978	21	76.0	-1.3
Zimbabwe2			2008-2019	12	39.0	5.7	1996-2007	12	20.0	-13.6
GeoMean		51.8		17.8				27.2		
No. of Periods			28				30			

Note: 1 and 2 after a country's name indicate the first and second r-convergence and/or divergense periods.

Table 3. Summary Statistics
Average Annual Change in Variables Over Country-Periods

	R-Convergence Periods				Divergence Periods			
Country	**Income**	**H. Capital**	**K/L Ratio**	**TFP**	**Income**	**H. Capital**	**K/L Ratio**	**TFP**
Angola	0.004	0.002	0.001	0.012	-0.004	0.002	0.001	-0.014
Benin	0.001	0.005	0.000	0.007	-0.002	0.003	0.001	-0.027
Botswana	0.004	0.007	0.005	0.004				
Burkina Faso	0.000	0.002	0.001	0.003	-0.001	-0.002	0.000	-0.012
Burundi					0.000	0.001	0.000	-0.002
Cameroon1	0.004	0.003	0.000	0.034	-0.001	-0.002	0.001	-0.004
Cameroon2					-0.001	0.003	0.000	-0.007
Cen. Afr. Rep.					-0.001	0.002	0.000	-0.005
Côte d'Ivoire	0.003	0.003	0.003	0.006	-0.002	0.001	0.000	-0.009
Gabon1	0.014	0.000	0.019	0.009	-0.014	0.009	-0.002	-0.034
Gabon2	0.012	0.007	0.079	-0.011	-0.009	0.010	-0.050	0.003
Kenya	0.002	0.004	0.001	0.001	-0.001	0.002	0.000	-0.002
Lesotho					-0.001	-0.001	0.001	0.000
Mauritania	0.001	0.004	0.003	0.001	-0.003	0.001	-0.005	-0.012
Mauritius1	0.007	0.005	0.004	-0.008	-0.007	-0.001	-0.001	-0.021
Mauritius2	0.005	0.003	0.001	0.001	-0.007	0.004	-0.008	0.004
Mozambique	0.000	0.000	0.001	-0.003	-0.001	-0.002	0.000	-0.008
Namibia	0.001	0.002	0.002	-0.006	-0.003	0.001	0.002	-0.010
Niger					-0.002	0.000	-0.001	-0.003
Nigeria1	0.002	-0.004	0.004	0.013	-0.007	0.001	-0.007	-0.026
Nigeria2	0.003	0.006	0.002	0.018				
Rwanda	0.001	0.006	0.000	0.004	-0.001	0.000	0.000	-0.008
Senegal					-0.001	0.001	-0.001	-0.006
Sierra Leone	0.001	0.003	0.000	0.009	-0.001	0.002	0.000	-0.025
South Africa	0.000	0.010	0.005	-0.009	-0.004	-0.002	0.001	-0.001
Sudan	0.001	0.002	0.002	0.004	-0.001	0.001	0.000	-0.014
Swaziland	0.005	0.001	0.010	0.016	-0.003	0.004	-0.004	-0.017
Tanzania1	0.000	-0.004	0.001	0.003	-0.002	0.000	0.000	-0.017
Tanzania2	0.001	0.002	0.000	0.005				
Togo	0.001	0.000	0.001	0.006	-0.002	0.004	-0.001	-0.009
Zambia1	0.002	0.000	-0.003	0.017	-0.003	0.004	0.000	-0.012
Zambia2	0.001	0.006	0.003	0.005				
Zimbabwe1	0.002	0.006	0.001	-0.002	-0.001	0.000	-0.001	0.013
Zimbabwe2	0.002	0.008	-0.001	0.016	-0.010	0.005	-0.001	-0.059
Mean	0.003	0.003	0.005	0.006	-0.003	0.002	-0.003	-0.011

Notes: See above. H. capital stands for human capital. All varibles are defined as ratios of corresponding numbers for the US. The data above are avearge annual change in a variable over the r-convergence and divergence periods, respectively, and are rounded to three decimal places.

Table 4. Estimation for Countries that only R-Converged or Diverged

	Only R-Convergence Country		Only Divergence Countries	
	Est. Coeff.	**S.E.**	**Est. Coeff.**	**S.E.**
Human Capital	0.3106[a]	0.0273	0.0349	0.0314
K/L Ratio	0.3819[a]	0.0355	0.6576[a]	0.1754
TFP	0.1067[a]	0.0069	0.0939[a]	0.0129
Balanced?	NA		Unbalanced	
Estimation Method	OLS		Random Effects	
No. of Obs.	56		232	
R-sq	0.9945		0.8758 (overall)	

Notes: Robust S.E. given by the Huber/White/ sandwich VCE estimator is used in the random effects model. 1%, 5%, and 10% significance levels are indicated by superscripts a, b, c, respectively on the estimated coefficients. For countries, see Figures 1 and 6.

Table 5. Estimation for Fast R-Convergers and Fast Divergers only

	R-Convergence Periods		Divergence Periods	
	A. Fixed or Random Effects Model			
	Est. Coeff.	**S.E.**	**Est. Coeff.**	**S.E.**
Human Capital	0.3440[a]	0.0898	-0.0535	0.1503
K/L Ratio	0.2585[b]	0.1018	0.2570[a]	0.0802
TFP	0.1393[a]	0.0414	0.1590[a]	0.0483
Model Used	Fixed Effects		Random Effects	
No. of Obs.	257		345	
R-sq	0.8853 (within)		0.8484 (overall)	
	B. Between Model			
	Est. Coeff.	**S.E.**	**Est. Coeff.**	**S.E.**
Human Capital	-0.0561	0.1337	-0.0025	0.1074
K/L Ratio	0.2626[a]	0.0633	0.3326[a]	0.0587
TFP	0.2068[a]	0.0458	0.1862[a]	0.0319
No. of Units/Periods	14		14	
R-sq	0.8263 (between)		0.9194 (between)	

Notes: As above. Conventionally derived variance estimator for generalized least-squares regression are used in the "between" model and robust standard errors in faxed and random effects models. Both the panels are unbalanced. Fast r-conconvergers and divergers are periods with the catching-up/falling back rate in the top half of r-convergers and divergers. These periods are for Gabon, Mauritania, Namibia, Nigeria2, Rwanda, Sierra Leone, Tanza-nia2 Botswana, Mozambique, Sudan, and Swaziland (fast r-convergers). and, in addition to the firstseven countries already listed, for Benin, Central African Republic, Niger, and Zimbabwe (fast divergers).

Table 6. Estimation for All R-Convergers and Divergers

	R-Convergence Periods		Divergence Periods	
	A. Fixed Effects			
	Est. Coeff.	**S.E.**	**Est. Coeff.**	**S.E.**
Human Capital	0.3461[a]	0.0183	-0.0319	0.0312
K/L Ratio	0.2775[a]	0.0157	0.1204[a]	0.0217
TFP	0.1009[a]	0.0076	0.1278[a]	0.0061
No. of Obs.	533		880	
R-sq	0.7974 (within)		0.4265 (within)	
	B. Between Model			
	Est. Coeff.	**S.E.**	**Est. Coeff.**	**S.E.**
Human Capital	0.1076	0.0826	0.2436	0.0882
K/L Ratio	0.2619[a]	0.0552	0.2717[a]	0.0581
TFP	0.2075[a]	0.0260	0.1732[a]	0.0270
No. of Units/Periods	28		30	
R-sq	0.8203 (between)		0.8605 (between)	

Notes: As above. Both panels are unbalanced. Neither model uses robust or bootstrap SE.

Table 7. Estimation for All R-Convergers and Divergers - 5 Yr Avg. Data

	R-Convergence Periods		Divergence Periods	
	A. Fixed Effects			
	Est. Coeff.	**S.E.**	**Est. Coeff.**	**S.E.**
Human Capital	0.3880[a]	0.0648	- 0.0386	0.0704
K/L Ratio	0.5478	0.0551	0.0863	0.0544
TFP	0.1617[a]	0.0243	0.1224[a]	0.0148
No. of Obs.	88		175	
R-sq	0.6664 (within)		0.4162 (within)	
	B. Between Model			
	Est. Coeff.	**S.E.**	**Est. Coeff.**	**S.E.**
Human Capital	0.1281[c]	0.0789	0.2255[c]	0.1125
K/L Ratio	0.3184[a]	0.0568	0.2936	0.2066
TFP	0.1924[a]	0.0262	0.1727[a]	0.0442
No. of Units/Periods	28		30	
R-sq	0.8430 (between)		0.8609 (between)	

Notes: As above.