

The Anatomy of Start-Stop Growth^{*}

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ABSTRACT

This paper investigates the remarkable extremes of growth experiences within countries and examines the changes that occur when growth starts and stops. We find two main results. First, virtually all but the very richest countries experience both growth miracles and failures over substantial periods. Second, growth accelerations and collapses are asymmetric phenomena. Collapses typically feature reduced investment amidst increasing price instability, whereas growth takeoffs are primarily associated with large and steady expansions in international trade. The results show that even very poor countries regularly grow rapidly, but sustaining growth is difficult and may pose a very different set of challenges than starting it.

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1. Introduction

Since World War II, economic development has witnessed a few distinct “miracles” and a larger number of “failures”. A few countries, such as Singapore and Botswana, experienced consistently high rates of growth. Meanwhile, many countries found themselves only modestly more developed, if not poorer, at the close of the 20th century than they were several decades before. Explaining why a few countries have succeeded while many others have failed over this fifty-year period has motivated an enormous range of research that seeks to unlock key mechanisms and causes of growth and draw lessons that can guide policy.

In this paper, we demonstrate that growth “miracles” and “failures” appear to be ubiquitous at ten and fifteen year time scales. Only the very richest countries are immune to these dramatic fluctuations. Despite talk of poverty traps, almost all countries in the world have experienced rapid growth lasting a decade or longer, during which they converge towards income levels in the United States. Conversely, nearly all countries have experienced extended periods of abysmal growth. Circumstances or policies that produce ten years of rapid economic growth appear easily reversed, often leaving countries no better off than they were prior to the expansion. The basic challenge in poor countries thus appears to center less on triggering growth and more on sustaining it.

Given the dramatic changes in growth regimes, we further establish several facts about these transitions. We find that growth accelerations are little associated with capital accumulation and strongly associated with increased international trade. Growth collapses meanwhile are strongly associated with monetary instability and, in some cases, the outbreak of civil war. Thus, accelerations and collapses are asymmetric events, and the problem of sustaining growth thus appears different in kind from the problem of triggering economic expansion.

2. Growth Extremes within Countries

Long-run growth averages within countries often mask distinct periods of success and failure. This point was first made by Easterly et al. (1993), and has been discussed subsequently by Pritchett (2000) and Hausmann et al. (2005). In this section we build on this literature by showing not just that periods of success and failure exist, but that they are both extreme and ubiquitous. In particular, we show that growth “miracles” and “failures” over ten year periods (and longer) appear within the experience of most countries.

To begin, Figure 1 presents the best 10-year growth episode and the worst 10-year growth episode for all 125 countries in the Penn World Tables v 6.1 (Heston et al. 2002) with at least 20 years of growth data. Countries are ranked from the poorest to richest based on their income level in 1960. For comparison, the graph highlights the best 10-year average in the United States (3.3% per annum) and the worst 10-year average in the United States (1.0% per annum).

Figure 1 indicates a remarkable degree of heterogeneity within national growth experiences, with sustained periods of both high and low growth. Nearly all countries have experienced a growth episode substantially better than the U.S. best and a different episode substantially worse than the U.S. worst. Moreover, extreme highs and extreme lows in growth are common across the income spectrum. Only among the very richest countries is there a drop in the magnitude of the extremes.

The capacity of countries across the income spectrum to produce sustained episodes of high growth suggests that rapid increases in welfare have been within the reach of most economies. This point is clarified in Figure 2, which compares the income level at the end of the best 10-year growth episode to the prior peak level of income. We see that large income

expansions are quite common. In fact, 80% of the episodes show income expansions of at least 25%, with 50% showing expansions of at least 50% and many examples where per-capita income doubled or more. Meanwhile, in only 6% of the cases do countries arrive at income levels equal to or below their prior peak. The 10-year growth booms in Figure 2 are not simply recovery after bad episodes, but rather represent new growth.¹ The medium run variation in growth exposes large shifts in welfare.

A different way to view these growth extremes is through the lens of convergence. It is well known that income levels of poor countries have typically diverged from the wealthiest countries, with some notable exceptions (Jones, 1997, Pritchett, 1997). For example, since 1960, among those countries with initially below-median income, only 24% have grown faster on average than the United States while the other 76% have grown slower. As indicated in Figure 1, however, the story over the medium run is considerably richer.

Table 1 examines whether countries have converged to US income levels and diverged from US income levels over 10-year periods. By convergence and divergence, we mean that average growth is higher or lower than average US growth over the same 10-year period.² As before, the analysis includes all 125 countries in the Penn World Tables with at least 20 years of growth data. The mean number of growth observations for all countries in this sample is 44, so 10-year periods are typically about one-quarter of their growth history.

The striking fact is that 90% of all countries have converged on the US over some 10-year period, while 94% have diverged over some 10-year period. Even excluding growth

¹ Since the growth data is truncated (typically in 1960 for developing countries), it is possible that in some cases there is recovery from an un-witnessed pre-period. However, when examining the subset of those growth accelerations in Figure 2 that come later in a country's data series, we find similar patterns. Recovery has little to do with these 10-year growth booms.

² One might be concerned that convergence and divergence are made more likely due to U.S. growth volatility. However, as seen in Figure 1, similar results still obtain even comparing to the best and worst U.S. experiences.

episodes that follow 10-year or longer periods of contraction, to eliminate possible growth recoveries and focus on new growth, we still find that 86% of countries have experienced convergence. Dividing countries by region or by initial income level, we find that high propensities for medium-run convergence and divergence are general phenomena. Among the poorest 1/3rd of countries in 1960, 92% have experienced a sustained episode of convergence.³ Even 76% of countries in Sub-Saharan Africa, most of which are considered long-run growth “failures”, have converged on the US over sustained periods.⁴ These facts suggest that both miracles and failures in the medium run are within the experience of almost all countries – growth within countries is a “start-stop” process.

3. Characterizing Growth Transitions

3.1. Identifying structural breaks in growth

Given the prevalence of both miracles and failures, the natural next step is to try to characterize the transitions between these states. To identify specific transition dates for further investigation, we use the structural break econometric technique of Bai and Perron (1998, 2003), which locates and tests for multiple structural breaks within a time series.⁵ In our case, we look at a growth series within a country:

³ In results not reported, we find that convergence and divergence are also common over longer-periods. For example, 85% of countries experienced convergence and 87% experienced divergence over some 15-year period.

⁴ The 10 African countries that do not experience a 10-year or longer period of convergence are Benin, Central African Republic, Comoros, Ethiopia, Guinea, Madagascar, Mozambique, Niger, Senegal, and Sierra Leone.

⁵ The intuition for the Bai and Perron method is straightforward. First, an algorithm searches all possible sets of breaks (up to a maximum number of breaks) and determines for each number of breaks the set that produces the maximum goodness-of-fit (R^2). The statistical tests then determine whether the improved fit produced by allowing an additional break is sufficiently large given what would be expected by chance (due to the error process), according to asymptotic distributions the authors derive. Starting with a null of no breaks, sequential tests of k vs. $k+1$ breaks allow one to determine the appropriate number of breaks in a data series. Bai and Perron determine critical values for tests of various size and employ a “trimming” parameter, expressed as a percentage of the number of observations, which constrains the minimum distance between consecutive breaks. For our main results, we focus on a specification with 10% asymptotic size and a 10% trimming parameter, although the main conclusions that follow are broadly robust to these choices.

$$g_t = a_R + e_t$$

where g_t is the annual growth rate in purchasing-power-parity per-capita income, a_R is the mean growth rate during regime R , and e_t is an error term drawn from a common distribution across regimes. As before, the data is taken from the Penn World Tables v6.1.

Since the Bai and Perron structural break method relies on asymptotic tests, we have undertaken a Monte-Carlo exercise to assess the method in small samples. In particular, we model a growth process with 40 years of data, an autocorrelation parameter of 0.1 (similar to what is present in actual growth data), and structural mean shifts equal to 0.5, 1, and 2 times the standard deviation in the error term. We find that a single break 2 standard deviations in size will be detected 91% of the time, but a single break 0.5 standard deviations in size will be detected only 24% of the time. The method is therefore conservative in detecting breaks, capturing only major accelerations and collapses, as opposed to every growth turnaround suggested by Figure 1. We also find that the size of the test is appropriate in small samples; a test with 10% asymptotic size produces false positives in about 11% of the cases.

Using the Bai and Perron method, we detect a total of 73 structural breaks in 48 of the 125 countries that have at least 20 years of Penn World Table data. We classify these breaks as either “up-breaks” or “down-breaks” depending on whether the average growth rate in the regime after the break is above or below the average growth rate before. Table 2 lists the countries and years with structural growth breaks. The majority of the detected breaks coincide with well known historical examples, such as China in 1978 and Cote d’Ivoire in 1979. Given the low power of the Bai and Perron test for detecting relatively small changes in growth rates,

this list is not meant to be exhaustive, but rather to provide a set of dates where growth transitions happened with very high probability that we can use for further analysis.⁶

We detect slightly more down-breaks than up-breaks (43 down-breaks vs. 30 up-breaks). Structural breaks are found in all regions of the world and in all decades, although there is an unusual propensity for down-breaks in the 1970s, which is consistent with the large literature on the 1970s slowdown in the OECD.⁷ We detect fewer breaks in very poor countries (0.8% percent of country-years in the poorest third of countries as ranked by 1960 income, as opposed to 1.5% of country-years in the middle third and 1.6% of country-years in the upper third).

3.2. Coincident changes during growth transitions.

Given these structural breaks in growth, we can examine changes in macroeconomic and institutional variables that appear coincident with these changes. The purpose of this section is not to make statements about the direction of causality between the variables examined here and the dramatic changes in growth we observe; rather, by examining how other variables change during these transitions, we will be able to further our understanding of what these events actually entail.

For each variable considered, Table 3 presents a number of statistics. For both up-breaks and down-breaks, we report the mean change in the variable across the break and the p-value from a t-test of the hypothesis that the variable does not change across the break. We calculate the change as the difference between the mean value in the prior growth regime with the mean

⁶ The fact that the Bai and Perron technique primarily detects very large breaks (1-2 standard deviations of the annual growth rate) may explain why several examples discussed by Hausmann et al. (2005), such as India in 1982 and Chile in 1986, are not detected by this method. However, as shown in Jones and Olken (2005), our qualitative results characterizing growth transitions appear robust to a variety of alternative methods of identifying break dates.

⁷ See, for example, Griliches (1980) and Wolff (1996).

value in the posterior growth regime.⁸ For each variable considered, we also report the p-value from a test of whether up-breaks and down-breaks are symmetric. Specifically, we test the null hypothesis that the average change across an up-break is equal in magnitude and opposite in sign to the average change across a down-break.

We begin by examining changes in the growth rate of the capital stock. The growth rate of the capital stock is computed using the perpetual inventory method with investment data from the Penn World Tables, assuming a depreciation rate of 7%. As can be seen in Table 3, up-breaks are associated with relatively small, and not statistically significant, increases in the growth rate of capital.⁹ By contrast, down-breaks are associated with much larger decreases in the growth rate of capital. Using a standard growth accounting framework, one can further show that changes in capital accumulation explain only 7% of the increase in growth during up-breaks but 32% of the decrease in growth during down-breaks.^{10,11} Although the implied large role for TFP in explaining growth transitions may not be surprising given other results in this literature (e.g., Klenow and Rodriguez-Clare 1997, Hall and Jones 1999, Hsieh 2002, and Caselli 2005), what is surprising here is the asymmetry between up-breaks and down-breaks, with TFP playing a relatively larger role in up-breaks and changes in capital accumulation playing a relatively larger

⁸ For up-breaks, the mean length of the growth regimes is 13.3 years prior to the break and 16.7 years after the break. For down-breaks, the mean regime length is 19.7 years (prior) and 18.4 years (after). Performing the calculations using 5-year periods before and after the break produces very similar results (see Jones and Olken 2005 for more details).

⁹ By contrast, Hausmann, Pritchett, and Rodrik (2005) argue that investment increases during growth accelerations. Our data and their data are in fact similar regarding investment, but we have a different interpretation. While investment does increase somewhat with up-breaks, it is a very modest increase that can explain very little of the acceleration, as shown through our growth accounting exercise.

¹⁰ This calculation is made under the standard assumptions that factors are paid their marginal products, that output is fully exhausted in factor payments, and that the capital share is 0.33. During up-breaks, growth increases by 6.8 percentage points, whereas capital accumulation increases by 1.4 percentage points. This implies a capital contribution of $0.33 \times 1.4 / 6.8 = 0.07$. Full calculations can be found in the working paper version of this paper (Jones and Olken 2005).

¹¹ The modest role of capital in accelerations also appears when we limit the analysis to accelerations that do not follow prior collapses. For example, excluding growth up-breaks that come 10 years or less after a down-break, we find that capital explains only 11% of the acceleration.

role in down-breaks. Analyzing capital growth alternatively using data on electricity consumption, which allows one to additionally incorporate capital utilization effects (and avoid the potentially unreliable aggregate investment data), produces very similar results.¹²

Given that most of the changes – particularly with up-breaks – appear associated with TFP rather than factor accumulation, we next consider international trade behavior as a type of economic activity that may suggest efficiency gains through resource reallocation. Table 3 shows that in fact the trade share of GDP rises substantially with up-breaks, by about 25% over the regime average. This large increase in international trade is due, in equal parts, to expanding shares of both exports and imports, with no shift in the trade balance. Meanwhile, growth collapses show no systematic changes in the trade share. Table 3 further shows that terms of trade changes are modest, suggesting that trade liberalizations are a more likely driver of the income expansions than the luck of international prices.¹³ The dramatic increase in trade during accelerations provides additional evidence that changes in the allocation of resources lie behind the changes in growth during accelerations.

Finally, it is also useful to consider how other important variables behave around these events. We consider three types of variables – the country’s monetary policy (measured by the growth rate in the GDP deflator, nominal exchange rate, and real exchange rate), the level of conflict (measured from the PRIO dataset from Gledditch et al. 2002), and the country’s institutions (measured by the Rule of Law and Corruption variables described in Barro 1999b and a democracy measure, POLITY2, as described in Marshall et al. 2004).

¹² Electricity consumption helps capture both the size and the utilization of the capital stock. Moreover, electricity consumption and the capital stock are linearly related in cross-country data. Thus the growth rate of electricity consumption may serve as a useful proxy measure for growth in capital.

¹³ Furthermore, we find that 23% of up-breaks (7 of 23) experienced a permanent trade liberalization, as defined by Sachs-Warner (1995), within 5 years before or after the break. By contrast only 2% (1 of 43) down-breaks were associated with an opening in trade within 5 years before or after the break.

The most striking result is that down-breaks are closely associated with substantial increases in monetary instability. Of 39 down-breaks in the sample with data, 33 show increases in inflation.¹⁴ Unstable prices are further reflected in large nominal exchange rate devaluations. By contrast, only two (Mexico and Indonesia) of 23 up-breaks are associated with substantial declines in inflation, and there is little movement in exchange rates. Further asymmetry appears with military conflict, which increases around down-breaks, while there is only a mild (and statistically insignificant) decrease in average conflict for up-breaks.

We find no statistically significant changes in the institutional measures associated with either up-breaks or down-breaks, whether we measure corruption, rule of law, or democracy.¹⁵ Conversely, however, political institutional measures do predict structural breaks in growth. The baseline probability of structural breaks is 70% higher in autocracies than democracies, and 170% higher during political interregnum or transition periods.¹⁶ These results are consistent with a literature that finds increased growth volatility in autocracies (Quinn and Woolley 2001; Acemoglu et al. 2003) and our earlier work which shows that leader change in autocracies has a substantial, causative influence on economic growth (Jones and Olken 2005).

4. Conclusion

This paper shows that dramatic changes in growth are common features of the growth experience for many countries. As a result, long-run views of growth, including ideas about convergence and poverty traps, may miss an important part of the picture. Over substantial periods – ten years or more – the typical poor country has proven capable of both rapid

¹⁴ Note that the typical contraction would present deflationary pressures rather than inflationary ones, which suggests that the inflationary price instability is more likely to be a cause than a consequence of the contraction.

¹⁵ The democracy results in Table 3 are reported net of common (worldwide) time fixed effects, because there is a background trend toward democracy in the Polity IV data.

¹⁶ Regression results are available from the authors upon request. The regressions control for log income per-capita and country fixed effects.

expansions and rapid collapse. If the long-run is the summation of a few medium-run experiences, than the difference between a country that converges and one that stagnates (or worse) over the post-war period may be a single break in the growth process.

After systematically identifying the dates of growth transitions, we further characterize these events. The results suggest that growth decelerations and accelerations are asymmetric. Accelerations show very little increase in investment, and are associated with substantial increases in trade. Meanwhile, declines in growth are associated with declines in investment, increasing inflation, devaluation and, in several cases, a rise in internal conflict. The results suggest that the roads into and out of rapid growth expansions are both well trodden, but they are different roads.

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Table 1: Everybody's Doing It: Convergence and Divergence over the Medium Term

| | <i>Region</i> | | | | <i>Income in 1960</i> | | |
|-------------------------|---------------|--------------------|---------------------------|------|---------------------------|--------------------------|---------------------------|
| | All | Sub Saharan Africa | Latin America & Caribbean | Asia | Poorest 1/3 rd | Middle 1/3 rd | Richest 1/3 rd |
| Percentage of Countries | 90% | 76% | 93% | 100% | 92% | 79% | 97% |
| Percentage of Countries | 86% | 66% | 89% | 100% | 84% | 79% | 92% |
| Percentage of Countries | 94% | 100% | 89% | 81% | 100% | 92% | 97% |
| Country Observations | 125 | 42 | 28 | 16 | 37 | 38 | 37 |

Notes: Convergence is defined by whether country has an average growth rate higher than US growth over the same period. Divergence is defined by having lower average growth rate than the US. Convergence excluding growth recoveries does not count convergence episodes that follow a ten-year period in which income contracted. Growth calculations are made from the Penn World Tables v6.1. Countries with less than 20 years of available GDP data are not included in this table. Observation counts by income tercile do not sum to 125 because 13 countries have growth series that begin after 1960.

Table 2: Structural Breaks in Growth

| Country | Year of Break by Type | | Country | Year of Break by Type | |
|--|-----------------------|------|---------------------------------------|-----------------------|------------|
| | UP | DOWN | | UP | DOWN |
| <i>Sub-Saharan Africa & Indian Ocean</i> | | | <i>Latin America & Caribbean</i> | | |
| Botswana | 1966 | | Brazil | | 1980 |
| Burkina Faso | 1966 | | Ecuador | 1971 | 1977 |
| Cameroon | 1993 | 1987 | El Salvador | 1983, 1991 | 1978 |
| Congo, Dem. Rep. | | 1974 | Guatemala | 1955, 1987 | 1980 |
| Cote d'Ivoire | | 1979 | Jamaica | 1976 | 1972 |
| Equatorial Guinea | 1995 | 1974 | Mexico | 1995 | 1981 |
| Mauritius | 1960 | | Nicaragua | | 1977 |
| Mozambique | 1986 | 1973 | Puerto Rico | | 1972 |
| Sierra Leone | | 1990 | Venezuela | | 1970 |
| South Africa | | 1981 | | | |
| Zambia | | 1964 | <i>Middle East & North Africa</i> | | |
| Zimbabwe | | 1976 | Algeria | | 1981 |
| | | | Egypt | 1975 | 1970, 1980 |
| <i>Europe</i> | | | Iran | 1981 | 1976 |
| Austria | | 1974 | Tunisia | 1967 | 1972 |
| Belgium | 1958 | 1974 | | | |
| Finland | | 1973 | <i>Asia & Pacific</i> | | |
| France | | 1973 | Bangladesh | 1973 | |
| Greece | | 1973 | China | 1978 | |
| Hungary | | 1979 | Indonesia | 1967 | 1996 |
| Ireland | 1994 | | Japan | 1959 | 1970, 1991 |
| Italy | | 1974 | South Korea | 1962 | |
| Luxembourg | 1983 | | Papua New Guinea | 1991 | 1994 |
| Poland | 1981 | 1977 | Philippines | 1986 | 1956, 1981 |
| Portugal | 1966 | 1973 | Thailand | 1955, 1986 | 1995 |
| Romania | | 1985 | | | |
| Spain | | 1974 | | | |
| Sweden | | 1970 | | | |
| Switzerland | | 1973 | | | |

Notes: Structural breaks are determined using the Bai and Perron (2003) methodology with a size of 10% and a trimming parameter of 10%. UP breaks are those where the growth rate in the regime after the break is larger than in the regime before. DOWN breaks are the opposite cases. The break year marks the final year of the prior growth regime.

Table 3: Characterizing Growth Transitions

| | UP-BREAKS | | | | DOWN-BREAKS | | | | Symmetry |
|----------------------------------|---------------------|----------------|-----------------|-----|---------------------|----------------|-----------------|-----|--------------------------------------|
| | Change Across Break | | One-Sample Test | | Change Across Break | | One-Sample Test | | Two-Sample Test |
| | Mean Change | Standard Error | P-value | Obs | Mean Change | Standard Error | P-value | Obs | P-value H ₀ : UP=-DOWN |
| Growth in GDP per capita | 0.068*** | 0.009 | 0.000 | 30 | -0.060*** | 0.006 | 0.000 | 43 | 0.472 |
| <i>Growth in...</i> | | | | | | | | | |
| K (Capital p.c.) | 0.014 | 0.012 | 0.238 | 30 | -0.046*** | 0.005 | 0.000 | 43 | 0.007 |
| E (Electricity consumption p.c.) | 0.016 | 0.010 | 0.112 | 17 | -0.059*** | 0.005 | 0.000 | 34 | 0.000 |
| <i>Trade Shares (%GDP)</i> | | | | | | | | | |
| Exports | 12.2*** | 3.4 | 0.001 | 30 | 2.0 | 1.9 | 0.283 | 43 | 0.002 |
| Imports | 12.8** | 5.2 | 0.020 | 30 | 0.4 | 3.0 | 0.886 | 43 | 0.000 |
| Exports + Imports | 25.1*** | 8.3 | 0.005 | 30 | 2.5 | 4.3 | 0.572 | 43 | 0.021 |
| Exports – Imports | -0.6 | 2.9 | 0.837 | 30 | 1.6 | 2.5 | 0.524 | 43 | 0.796 |
| Terms of Trade (% change) | 6.48 | 12.2 | 0.599 | 30 | -2.38 | 6.96 | 0.735 | 43 | 0.756 |
| <i>Prices (growth in)</i> | | | | | | | | | |
| GDP Deflator | -0.038 | 0.044 | 0.400 | 23 | 0.141*** | 0.041 | 0.002 | 39 | 0.109 |
| Nominal Exchange Rate | -0.010 | 0.042 | 0.814 | 29 | 0.146*** | 0.036 | 0.000 | 42 | 0.017 |
| Real Exchange Rate | 0.013 | 0.017 | 0.445 | 19 | -0.001 | 0.017 | 0.955 | 33 | 0.633 |
| <i>War (level)</i> | | | | | | | | | |
| Any Conflict | -0.108 | 0.176 | 0.547 | 28 | 0.185 | 0.118 | 0.127 | 40 | 0.708 |
| Internal Conflict | -0.072 | 0.152 | 0.641 | 28 | 0.275** | 0.114 | 0.021 | 40 | 0.279 |
| <i>Institutions (level)</i> | | | | | | | | | |
| Democracy (POLITY2) | 0.043 | 0.041 | 0.300 | 28 | 0.067 | 0.043 | 0.132 | 39 | 0.069 |
| Rule of Law | 0.083 | 0.054 | 0.160 | 10 | 0.042 | 0.057 | 0.492 | 7 | 0.143 |
| Corruption | 0.018 | 0.054 | 0.746 | 10 | -0.008 | 0.047 | 0.869 | 7 | 0.899 |

Notes: Results are for regime averages before and after structural growth breaks. As described in the text, the democracy variable has been purged of world-wide year dummies before constructing the changes listed in the table. Results for immediate 5-year periods before and after breaks are qualitatively similar.

Figure 1: Amazing Highs, Amazing Lows
The Best and Worst 10-Year Average Growth Rates Within Countries

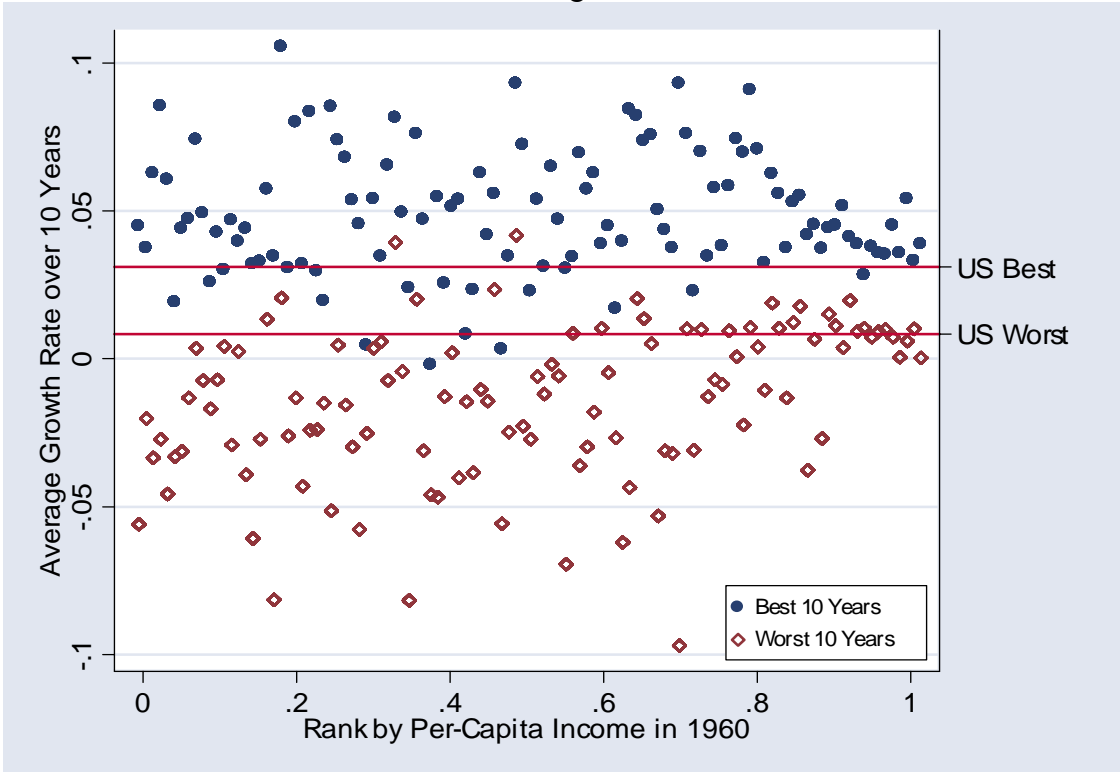


Figure 2: Growth Spurts are not Pure Recovery
Income after Best 10-Yr Growth Episode Relative to Prior GDP Peak

