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What Makes Growth Sustained?

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Abstract

We identify structural breaks in economic growth in 140 countries and use these to define "growth spells:" periods of high growth preceded by an upbreak and ending either with a downbreak or with the end of the sample. Growth spells tend to be shorter in African and Latin American countries than elsewhere. We find that growth duration is positively related to: the degree of equality of the income distribution; democratic institutions; export orientation (with higher propensities to export manufactures, greater openness to FDI, and avoidance of exchange rate overvaluation favorable for duration); and macroeconomic stability (with even moderate instability curtailing growth duration).

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I. INTRODUCTION

Perhaps the most important question confronting policymakers in low-income and emerging market countries is how to embark on a process of *sustained* economic growth. Until recently, however, the economics literature provided little guidance on this issue. To be sure, since the early 1990s, a body of work centered on cross-country growth regressions aimed to explain differences in long-term growth between, say, the miracle episodes in Asia and the stagnation in sub-Saharan Africa and Latin America. However, this ignored a fundamental property of growth in developing countries, namely, its lack of persistence. If developing-country output paths look more like mountains, cliffs, and plains than the steady "hills" observed in the industrial world, then looking for an explanation of *average* cross-country growth differences can lead to misleading results (Pritchett, 2000). Furthermore, such an approach will not shed light on the critical question, from a developing-country perspective, of why some growth episodes tend to end more quickly and abruptly, or why some downturns may be relatively protracted.[2]

A more promising approach may involve exploiting the information in *turning points* in countries' growth performance. If an economy has been falling off a cliff for a number of years and then turns itself around and starts climbing a mountain, it makes sense to ask what is going on around the time of the transition, and during the growth episode, to uncover any commonalities in the experience that can plausibly be exploited in other contexts. Likewise, if a country has been growing well for a number of years, but suddenly changes course for the worse, it would be useful to know what the path out of growth looks like so that other countries can take a different fork in the road. Papers that attempt to uncover the informational content of growth transitions—inspired by Pritchett (2000) and related work, such as Easterly et al. (1993), Ben-David and Papell (1998), and Aguiar and Gopinath (2004)—include Rodrik (1999); Hausmann, Pritchett, and Rodrik (2005); Jones and Olken (2005); Patillo, Gupta, and Carey (2005); Jerzmanowki (2006); Hausmann, Rodriguez, and Wagner (2006); and Reddy and Minoiu (2007).

The results from this literature have been mixed. To some extent, they confirm some of the elements that were thought to be important based on the cross-country approach (e.g., the importance of institutions). However, the papers also suggest that growth transitions remain largely a mystery (in the sense that correlate "usual suspects" explain only a small fraction of what is going on during a transition). Beyond this, currency depreciations and political regime changes seem to be correlated with growth accelerations (Hausmann, Pritchett, and Rodrik, 2005), while collapses in investment play a role in downbreaks.[3] Growth

[2] Panel regressions shed some light on these issues, but may not capture turning points well, and are misspecified if the growth dynamics are not captured in a stable linear relationship with a set of fundamentals.

[3] Whether investment booms correlate with upbreaks is less clear, however (Jones and Olken, 2005). This is a critical issue as far as "big push" views of development are concerned. Massive scaling up of aid flows to finance capital deepening in poor countries has recently been proposed by Sachs and others. Long before, the development literature focused heavily on investment as the vehicle for generating sustained growth in poor countries (see Rosenstein-Rodan, 1943; Nurkse, 1953; Gerschenkron, 1965; and Murphy and others, 1989). The finding that investment is not a strong correlate of upbreaks would appear to cast doubt on these views.

decelerations are found to be associated with macroeconomic instability, conflict, and export collapses (Hausmann, Rodriguez, and Wagner, 2006). Hence, one tentative conclusion from this literature is that what matters for getting growth going may be different from what is important to keep it going.

The present paper contributes to this literature by focusing squarely on the second issue, namely the causes of growth *duration*. Closing the per capita income gap with rich countries requires long periods of fast growth in the developing world. While surges in growth are in fact relatively common in the developing world, even in regions that have done very badly over the past few decades, (e.g., sub-Saharan Africa), what really sets poor-performing regions apart is that their growth spells have tended to end relatively soon (e.g., in comparison with East Asian or industrial countries). The question of how to forestall the end of growth spells is thus critical, especially for the large number of developing countries that are currently enjoying strong growth.

We approach the topic somewhat differently than the literature before us. Focusing on the before and after of a deceleration episode misses a great deal of potential information, since it does not tell us what a country (or its environment) was "doing right" *prior* to its deceleration. Studies that focus on deceleration events are not well placed to draw lessons from the fact that some decelerations are preceded by much longer periods of high growth than others. We attempt to capture this information by moving the object of inquiry to *duration per se*: that is, by studying the determinants of the length of growth spells. We do so by applying duration analysis techniques that are common in medical or microeconomic applications (for example, studies that examine the length of unemployment spells). A further advantage is that the duration approach can easily take account of censored observations, that is: it can exploit the information contained in growth spells that are still ongoing.

The object of our analysis is the "growth spell:" the time period between a growth acceleration and a deceleration. To identify accelerations and decelerations, we combine structural break tests and economic criteria. Relying exclusively on ad hoc economic criteria may not be the best approach if year-to-year volatility in the underlying growth series differs substantially across countries, as is indeed the case. But relying exclusively on structural breaks in growth may not be enough, because some statistically significant breaks in growth may be too small to be of much interest economically. Having identified growth spells, we explore the potential determinants of its duration by estimating a proportional hazard model with time-varying covariates: this model relates the probability that a growth spell will end to a variety of economic and political variables. In doing so, we distinguish between "initial conditions" in place at the time of an acceleration, and changes that take place during a growth spell. The latter are particularly relevant for the question of what policies can extend the life of an ongoing growth spell.

Within the literature on growth transitions, our approach relates most closely to recent papers by Hausmann, Rodriguez, and Wagner (2006) and Jerzmanowki (2006). While Hausmann, Rodriguez, and Wagner (2006) also use duration analysis, they focus on the length of *stagnations* rather than that of growth spells. Another difference with respect to the present paper is that stagnations are identified using an economic criterion rather than statistical breaks in the growth process. Jerzmanowki (2006) is easily the most ambitious paper in this literature, and perhaps the most faithful to Pritchett's (2000) idea that developing country growth can be classified into structurally different "regimes." He estimates a Markov-switching model of growth with four such regimes: miracle growth; stable growth; stagnation; and crisis. These four regimes and the 16 transition probabilities between regimes are estimated simultaneously. However, the approach is so informationally demanding that it can examine only one potential determinant of transition probabilities at a time. In contrast, our paper identifies just two regimes using structural break analysis and then, in a second step, investigates the probability of a regime switch (from growth to stagnation) using duration analysis. In doing so, we study many potential factors influencing the probability that a growth spell might end.

Our main findings confirm some previous results in the literature—in particular, that external shocks and macroeconomic volatility are negatively associated with the length of growth spells, and that good political institutions help prolong growth spells. We also have some more surprising findings. Trade liberalization, seems to help not only in getting growth going, as emphasized by previous authors, but also in sustaining it—particularly when combined with competitive exchange rates, current account surpluses, and an external capital structure weighted toward foreign domestic investment (see also Dell'Ariccia and others (2008) on this latter point). Furthermore, we find that export composition matters. Consistent with the findings of Johnson, Ostry, and Subramanian (2006, 2007), Hausmann, Hwang, and Rodrik (2006) and Hausmann, Rodriguez, and Wagner (2006), we find that the manufacturing share in exports, and more generally, export product sophistication tend to prolong growth. Most strikingly, we find that the duration of growth spells is strongly related to income distribution: more equal societies tend to grow longer. On the whole, these results share some of the flavor of recent work on the political economy of growth and development, as briefly discussed in Section III and in our conclusions.

II. Structural Breaks and "Growth Spells"

We apply an variant of a procedure proposed by Bai-Perron (1998, 2003) for testing for multiple structural breaks in time series when both the total number and the location of breaks is unknown. Our approach differs from the Bai-Perron approach in that it uses sample-specific critical values that take into account heteroskedasticity and small sample size as opposed to asymptotic critical values; and in that it extends Bai-Perron's algorithm for sequential testing of structural breaks, as described below. Antoshin, Berg, and Souto (2008) describes these extensions in more detail and shows that they improve both the power and size properties of the test in applications such as ours.

A. Identifying Structural Breaks in Economic Growth

At the outset, we must decide on the minimum "interstitiary period:" the minimum number of years, h, between breaks. Given a given sample size T, the interstitiary period h will determine the maximum number of breaks, m for each country: $m = \text{int}(T/h)-1$. For example, if $T = 50$ and $h = 8$, then $m = \text{int}(6.25)-1 = 5$.[4] Imposing a long interstitiary period means that we could be missing true breaks that are less than h periods away from each other, or from the beginning or end of the sample period. However, allowing a short interstitiary period implies that some structural break tests may have to be undertaken on data subsamples containing as few as $2h+1$ observations. In these circumstances, the size of the test may no longer be reliable, and the power to reject the null hypothesis of no structural break on the subsample may be low. Moreover, we hypothesize that breaks at shorter frequencies may have different determinants, and in particular may embody cyclical factors that we are less interested in here. Balancing these factors, we set h either equal to 8 or to 5.

We next employ an algorithm that sequentially tests for the presence of up to m breaks in the GDP growth series. The first step is to test for the null hypothesis of zero structural breaks against the alternative of 1 *or more* structural breaks (up to the pre-set maximum m). The location of potential breaks is decided by minimizing the sum of squared residuals between the actual data and the average growth rate before and after the break. Critical values are generated through Monte Carlo simulations, using bootstrapped residuals that take into account the properties of the actual time series (that is, sample size and variance).

In the event that the null hypothesis of no structural breaks is rejected, we next examine the null of exactly one break, the location of which is again optimally chosen. This is tested by applying the same test as before—i.e. testing the null of 0 breaks against 1 or more breaks—on the *subsamples* to the right and left of the hypothesized break (up to the maximum number of breaks that the subsample length will allow given the interstitiary period). If *any* of the tests on the subsamples rejects, we move to testing the null of exactly two breaks, by testing for zero against 1 or more breaks on the three subsamples on the right, left and in between the optimally chosen two breaks, and so on. The procedure ends when the hypothesis of l structural breaks can no longer be rejected against the alternative of more than l breaks.

Table 1 and the figure summarize the results from applying these tests to income per capita growth series in 140 countries for which internationally comparable output data are available since at least the 1970s. Our data source is version 6.2 of the *Penn World Tables*, extended from 2004 to 2006 using the IMF's *World Economic Outlook* database. Table 1 shows the number of "upbreaks" and "downbreaks", at the 10 percent significance level and minimum interstitiary periods of 5 and 8 years, respectively, by region and decade. We also ran the algorithm using higher p-values to give us a chance to detect more breaks (albeit at the expense of more "false positives") in countries in which the year-to-year volatility of output is high. This increases the total number of breaks identified, but does not substantially affect the distributions of upbreaks and downbreaks across regions and time periods.

[4] In Bai and Perron's terminology, the ratio h/T is referred to as the "trimming factor". Since $T = 35\text{-}55$ observations, our choices of h imply trimming factors between 10 percent and 20 percent.

Table 1. Growth Breaks by Decade and Region

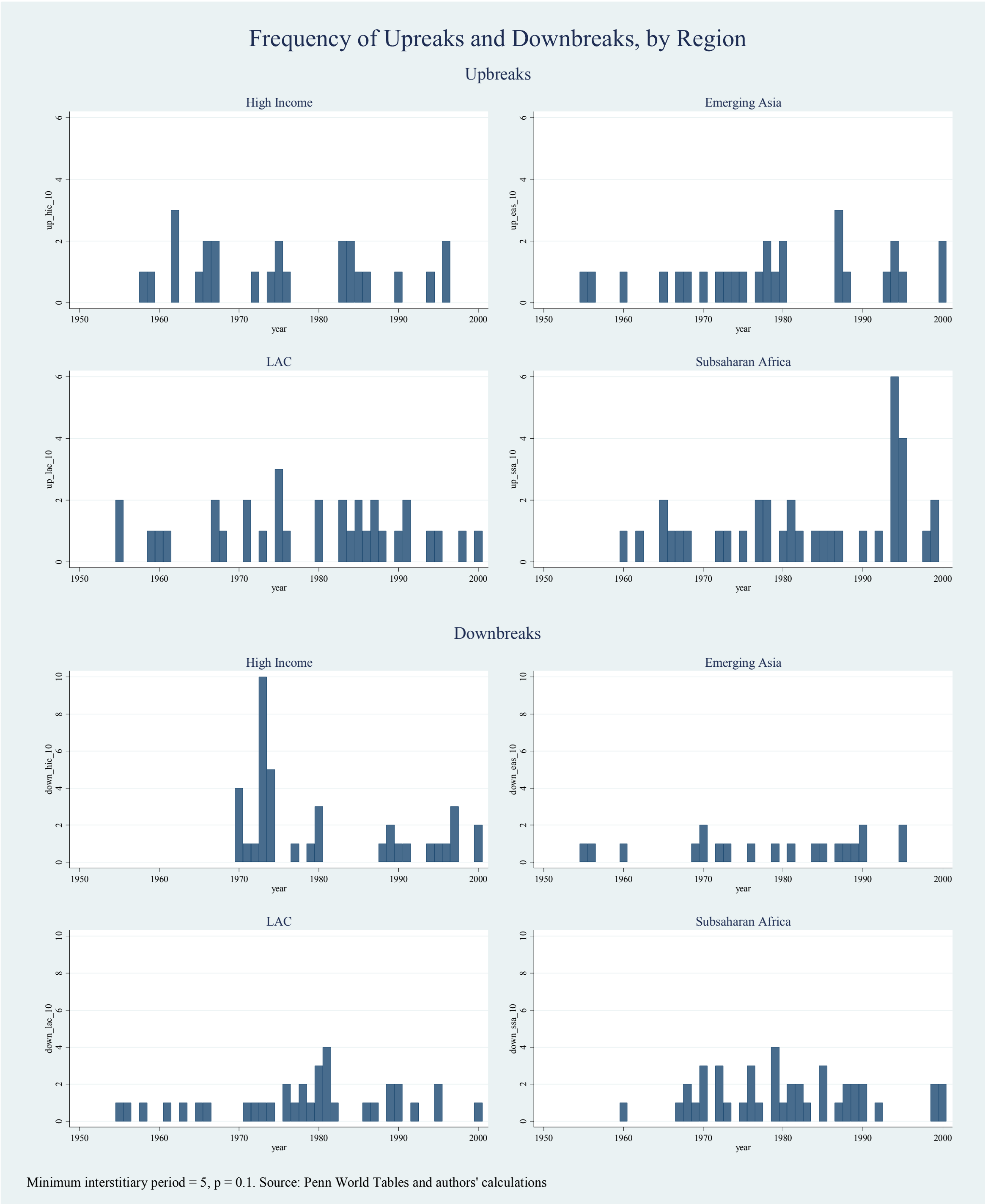
(p = 0.10)

Region	No. of countries	minimum segment = 5 Total	50-60s	70s	80s	90s	minimum segment = 8 Total	50-60s	70s	80s	90s
Total *upbreaks*	140	139	34	30	33	42	76	17	13	20	26
Industrial countries 1/	37	26	10	5	6	5	10	5	0	2	3
Emerging Asia	22	28	6	9	6	7	20	5	6	4	5
Latin America and Caribbean	28	33	8	7	11	7	18	2	4	8	4
Africa and Middle East	53	52	10	9	10	23	28	5	3	6	14
Total *downbreaks*	140	151	19	58	42	32	95	8	44	32	11
Industrial countries	37	39	0	23	6	10	19	0	13	1	5
Emerging Asia	22	20	4	6	6	4	15	0	6	6	3
Latin America and Caribbean	28	35	7	10	12	6	25	2	11	11	1
Africa and Middle East	53	57	8	19	18	12	36	6	14	14	2

1/ Includes Japan, Korea, Singapore, Hong Kong SAR and Taiwan Province of China.

At the ten percent significance level and $h = 5$, our algorithm identifies a total of 290 breaks—139 "upbreaks" and 151 "downbreaks", that is, a little more than one upbreak and one downbreak per country on average. This is dramatically higher than the total number of breaks (74) that the standard Bai-Perron algorithm identifies using the same data, p-value and interstitiary period, and is consistent with the findings reported in Antoshin, Berg, and Souto (2008). Upbreaks tend to be most common in the 1950s and 60s, driven by Europe and Latin America, and in the 1990s, driven by Africa (see figure and Table 1). Downbreaks are particularly concentrated in the 1970s. For the high income countries, the first half of the 1970s stands out; for Latin America, the period between 1978 and 1983; for Africa, the 1970s and the first half of the 1980s.

Setting the minimum period between breaks to $h = 8$ substantially reduces the total number of breaks. At the 0.1 percent significance level we find 171 breaks: 76 upbreaks and 95 downbreaks (the standard Bai-Perron approach identifies only 64 breaks in total). The fact that setting $h = 8$ leads to 40 percent fewer breaks shows that the interstitiary period matters, but it does not tell us which approach is better. With $h = 5$, we may be picking up some breaks in long-term growth that we might be missing when we require breaks to be at least 8 periods apart. However, we may also be picking up abrupt output movements at shorter frequencies that reflect volatility, business cycles, or short-lived commodity price booms or busts. These are more likely to be filtered out by setting $h = 8$. In the remainder of the paper, we hence work with both sets of breaks.


Frequency of Upreaks and Downbreaks, by Region
Upbreaks
High Income
Emerging Asia
LAC
Subsaharan Africa
up_hic_10
up_eas_10
up_lac_10
up_ssa_10
Downbreaks
High Income
Emerging Asia
LAC
Subsaharan Africa
down_hic_10
down_eas_10
down_lac_10
down_ssa_10
year
1950
1960
1970
1980
1990
2000
Minimum interstitiary period = 5, p = 0.1. Source: Penn World Tables and authors' calculations

B. From Structural Breaks to Growth Spells

The period following a growth upbreak can be thought of as a "growth spell:" a time period of higher growth than before, ending either with a downbreak or with the end of the sample. However, it is sometimes the case (after periods of very high growth) that high growth continues, albeit at a lower level. In this case, one would not want to say that a growth spell has ended. Conversely, it is sometime the case that an upbreak follows a period of sharply negative growth, leading to a period in which growth is still negative (or positive but very small). In this case, one would not want to say that a growth spell is underway.

In short, if the objective is to understand the determinants of *desirable* growth spells, the statistical criteria discussed in the previous section need to be supplemented by an economic criterion. We hence define growth spells as periods of time

- *beginning* with a statistical upbreak followed by a period of *at least g* percent average growth; and
- *ending* either with a statistical downbreak followed by a period of *less* than g percent average growth ("*complete*" growth spells) or with the end of the sample ("*incomplete*" growth spells).

Since growth in our definition means per capita income growth, growth of as low as 2 percent might be considered a reasonable threshold. We used $g = 2$, $g = 2.5$ and $g = 3$, with similar results, and focus on the $g = 2$ case below.[5]

We now characterize the growth spells that result from applying these criteria to the structural breaks summarized in Table 1, using g = 2, from several angles.

Duration of Spells

Regions do not differ much in terms of the *frequency* of growth spells. Table 2 presents the number of growth spells by region together with some rudimentary information about the distribution of the length of these spells. Focusing on the $h = 5$ case, there have been a total (both complete and incomplete) of 103 spells at the 10 percent level and 160 at the 25 percent level. For the $h = 8$ case, the number of spells is 62 and 91, respectively. A little under half of the spells identified at each level correspond to Latin America and Africa, about in line with the fraction of Latin American and African countries in the sample. Hence, in spite of the potential bias against finding growth spells in these countries as a result of their high year-to-year volatility, Latin America and Africa do not, on average, appear very unusual with respect to their ability to *get growth going*.

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[5] In the definition above, growth spells are required to begin with a *within-sample* upbreak. But there are many country cases in which there are no upbreaks in the first 20 years or so because growth started out high. This growth period could reasonably be regarded as a growth spell initiated by an upbreak outside the sample period. We are working to extend the output series backwards, or use information about economic history, to roughly "time" the beginnings of these early growth spells.

Table 2. Frequency and Duration of Growth Spells 1/

Region	No. of countries	p = 0.10 No. of spells	Mean duration	% spells lasting at least 10 years	16 years	p = 0.25 No. of spells	Mean duration	% spells lasting at least 10 years	16 years
minimum length of spell: 5 years									
Complete spells									
Industrial Countries 2/	37	9	12.8	67	22	21	10.3	48	14
Emerging Asia	22	7	18.9	71	57	16	13.6	56	38
Latin America	18	11	9.9	27	18	14	10.5	43	21
Sub-Saharan Africa	43	11	5.7	0	0	27	6.7	7	7
Other developing 3/	20	10	8.9	20	10	12	10.3	33	17
Incomplete spells									
Industrial Countries 2/	37	11	28.8	91	82	20	23.5	95	60
Emerging Asia	22	13	21.6	77	54	12	18.1	58	33
Latin America	18	3	22.7	100	67	4	18.3	75	50
Sub-Saharan Africa	43	20	14.2	70	20	23	10.7	57	17
Other developing 3/	20	8	19.0	63	50	11	21.4	73	64
Total									
Industrial Countries 2/	37	20	21.6	80	55	41	16.7	71	37
Emerging Asia	22	20	20.7	75	55	28	15.5	57	36
Latin America	18	14	12.6	43	29	18	12.2	50	28
Sub-Saharan Africa	43	31	11.2	45	13	50	8.6	30	12
Other developing 3/	20	18	13.4	39	28	23	15.6	52	39
minimum length of spell: 8 years									
Complete spells									
Industrial Countries 2/	37	2	13.0	100	0	7	16.1	71	29
Emerging Asia	22	3	20.3	67	67	7	13.6	43	29
Latin America	18	4	12.5	50	25	7	12.9	43	29
Sub-Saharan Africa	43	3	8.3	0	0	6	8.0	0	0
Other developing 3/	20	7	10.4	29	14	7	12.4	43	29
Incomplete spells									
Industrial Countries 2/	37	8	27.8	100	75	12	24.2	100	67
Emerging Asia	22	13	26.1	100	62	13	22.8	100	62
Latin America	18	2	19.0	100	50	5	16.6	100	60
Sub-Saharan Africa	43	15	14.6	80	27	19	14.5	84	26
Other developing 3/	20	5	17.2	100	60	8	18.3	100	63
Total									
Industrial Countries 2/	37	10	24.8	100	60	19	21.2	89	53
Emerging Asia	22	16	25.0	94	63	20	19.6	80	50
Latin America	18	6	14.7	67	33	12	14.4	67	42
Sub-Saharan Africa	43	18	13.6	67	22	25	13.0	64	20
Other developing 3/	20	12	13.2	58	33	15	15.5	73	47

1/ Growth cutoff set to g = 2 percent (per capita).
2/ Includes Japan, Korea, Singapore, Hong Kong SAR, and Taiwan Province of China.
3/ Middle East, North Africa, Cyprus, Turkey, and Caribbean countries.

Instead, the real problem in these regions seems to be their inability to *sustain* growth over long periods. Irrespective of which minimum interstitiary period and p-level we choose, the mean length of growth spells is always much shorter—by up to a half—for Latin America and Africa compared to the industrial countries and emerging Asia. For h = 8, 80–100 percent of growth spells in high income countries and emerging Asia lasted 10 years or more, but only about two thirds of Latin American and African spells do so. For h = 5, 70–80 percent of spells in the high income and emerging Asian countries lasted at least 10 years, but only 30–50 percent of spells in Latin America or Africa last that long.

The table also shows an interesting asymmetry between complete and incomplete growth spells for Africa and Latin America. Latin America had a fair number of (albeit short) growth spells in the past, but it has few ongoing growth spells (3–5, depending on the parameters chosen). In contrast, in Africa a large number of countries (between 15 and 23, depending on parameters) are currently enjoying an ongoing growth spell. Most of these were initiated in the mid to late 1990s, which is why they are still short on average.

Growth Before, During, and After Growth Spells

In addition to the incidence and duration of growth spells, overall growth performance will of course depend on growth levels both during and between spells. Table 3 examines whether there are systematic differences across regions in this regard, and also looks at growth immediately before and after growth spells, to see whether there is any suggestion that growth spells begin or end with economic crises.

In general, there are no big differences in growth levels *during* spells across regions (the main exception is Latin America, where growth spells that began in our sample period have tended to be somewhat less vigorous than in other countries). In contrast, there are big differences with respect to growth after spells ended. In the advanced countries and Asia, growth spells have on average ended with (relatively) "soft landings"—growth rates between -1 and 3 percent—while African spells have tended to end with deep collapses, with average growth rates between -3 and -6 percent. The remaining developing countries occupied an intermediate position, with growth rates between -3 and 1 percent.

There are also interesting differences in growth before the onset of growth spells, particularly for spells that are currently incomplete. Asian and high income countries tend to start their spells from per capita growth rates that are positive or very slightly negative. In contrast, growth spells in the remaining developing country regions tend to begin with crises. In these regions, average interstitiary rates prior to the last round of growth spells were between -1.3 and -5 percent, with even lower rates immediately prior to the onset of growth spells.

III. Analyzing the Duration of Growth Spells

We would like to relate the expected duration of growth spells—or equivalently, the probability that a spell will continue beyond a specific length—to the economic and political conditions prevailing at the beginning of the growth spell, and to policies undertaken during the growth spell. In doing so, we face two main challenges.

Table 3. Average Growth Before, During and After Growth Spells 1/

	p = 0.10					p = 0.25				
	Average growth			3 years …		Average growth			3 years …	
Region	before	during	after	before start	after end	before	during	after	before start	after end
					minimum length of spell: 5 years					
					Complete spells					
High Income	0.5	7.9	-0.6	0.1	-1.0	0.9	5.7	0.1	0.7	-0.4
Emerging Asia	-1.4	7.2	-0.7	-1.7	-1.0	-1.2	5.0	-0.3	-2.0	-0.7
Latin America	0.6	4.7	-0.1	0.0	-0.1	0.5	4.4	-0.4	0.0	-0.7
Sub-Saharan Africa	-0.9	9.5	-3.2	-3.1	-3.7	-1.7	7.4	-2.7	-3.0	-3.1
Other developing 2/	-1.4	6.2	-2.5	-1.3	-2.7	-1.0	5.7	-2.2	-0.9	-2.5
					Incomplete spells					
High Income	-0.9	5.4	…	-2.0	…	-0.9	4.1	…	-1.8	…
Emerging Asia	-0.7	4.9	…	-0.9	…	0.2	5.4	…	0.5	…
Latin America	-2.0	3.2	…	-3.9	…	-2.4	3.0	…	-3.3	…
Sub-Saharan Africa	-4.9	7.3	…	-7.5	…	-3.5	6.2	…	-5.3	…
Other developing 2/	-1.8	6.4	…	-5.1	…	-2.3	5.7	…	-3.1	…
					minimum length of spell: 8 years					
					Complete spells					
High Income	3.3	6.0	1.2	2.6	3.4	3.0	5.0	0.5	2.8	1.6
Emerging Asia	-0.9	8.7	1.4	2.0	1.9	0.3	6.4	1.2	1.4	2.4
Latin America	1.2	5.3	0.7	0.9	-0.8	1.4	4.7	-0.6	1.3	-0.1
Sub-Saharan Africa	-2.7	9.9	-3.9	-10.6	-6.5	-0.6	7.7	-2.6	-5.9	-3.5
Other developing 2/	-1.4	4.9	-0.9	-0.7	-1.9	-1.4	4.3	-1.3	-0.7	-3.1
					Incomplete spells					
High Income	1.3	5.9	…	1.1	…	0.2	5.0	…	-0.6	…
Emerging Asia	-0.2	4.9	…	0.1	…	0.1	4.5	…	-0.2	…
Latin America	-1.3	3.4	…	-3.0	…	-0.7	3.6	…	-1.3	…
Sub-Saharan Africa	-4.4	5.6	…	-7.2	…	-3.2	5.2	…	-6.5	…
Other developing 2/	-2.7	4.9	…	-4.3	…	-2.1	4.4	…	-3.6	…

1/ Growth cutoff set to *g* = 2 percent (per capita).

2/ Includes Japan, Korea, Singapore, Hong Kong SAR and Taiwan Province of China.

3/ Middle East, North Africa, Cyprus, Turkey, and Caribbean countries.

The first concerns model selection. The approach of this paper is atheoretical, in the sense that we do not base our modeling priors on a particular theory of why growth is more sustained in some cases than in others. Instead, our priors are influenced by a variety of ideas from the existing literature, including the notions that growth spells may end because of: shocks (including terms of trade shocks, capital flow reversals, and wars); a build-up of distributional conflict à la Mancur Olson or because of weaknesses in domestic institutions; an interaction between the two, as institutions may matter for the way in which societies can handle shocks (Berg and Sachs, 1988; Rodrik, 1999; Johnson, Ostry, and Subramanian, 2006, 2007); macroeconomic instability such as high inflation that may derail growth processes; and the nature of the growth itself, with some types—notably export-led or involving more sophisticated products (Rodrik 2007, Hausmann, Rodriguez, and Wagner, 2006)—more conducive to sustained growth. However, while these notions give us a little bit of structure that helps us think about model selection, they also point to a very wide range of potential determinants of growth duration and to possible interactions between those determinants.

So far, this does not sound very different from the standard model selection problem in empirical growth analysis, which has received significant attention in recent years (for example, Fernandez et al., 2001; Sala i Martin et al., 2004; Hoover and Perez, 2004; and Hendry and Krolzig, 2004). It is greatly complicated in our case, however, due to data constraints that preclude the application of a general-to-specific modeling approach. The problem is that in order to analyze growth spells that began as far back as the 1950s for 119 countries, we require data for many countries over very long time periods. Few long data series are available for many countries. Furthermore, the sample of growth spells that we start out with is small—no more than about 75 observations, even if we push the notion of statistical significance to its limit ($p = 0.5$). As a result, running any growth spells regression that includes the main "usual suspects"—to say nothing of a broader regression that includes a number of other variables—will shrink degrees of freedom considerably. The overlap in data availability between the main series we are interested in is simply too low.

A. Empirical Strategy

This leads us to the following approach. We sequentially test the relevance of particular regressors of interest, while including some minimal controls. This may be acceptable if the ordering of sequential tests, and the controls that are included, are chosen in a reasonable way. In the empirical section below, we begin by running regressions of duration on various proxies for external shocks, controlling only for per capita income levels. This is acceptable if external shocks are not correlated with other (e.g., institutional and policy) determinants of growth spells. Finding that some of these shocks matter, we then control for them while sequentially testing first for the relevance of some institutional variables and income distribution, and then for a variety of health and education related variables, variables related to trade and competitiveness, and macroeconomic policy. At the end, we summarize by showing the results of a few parsimonious regressions that control for all or most of the variables that were found to matter during the sequential testing process.

A second challenge relates to the distinction between initial conditions at the beginning of the spell and changes in determinants of duration as the spell proceeds, and to how potential reverse causality can be addressed in that context. In many cases, we will be studying potential determinants of spell length—say, an institutional index, or an educational indicator, or an economic indicator such as inflation—that changes over the course of the spell. This indicator needs to be regarded as endogenous in the sense that its level may depend on whether the country is in a growth spell or not. At the same time, however, it might be amenable to policy actions while a spell is ongoing. Hence, it would be desirable to understand not only how initial conditions affect duration, but also how ongoing changes in particularly variables influence the probability that a spell will end.

We seek to address this by distinguishing, for most variables, between the initial level of the variable at the beginning of the spell, and changes since the beginning of the spell. Reverse causality is addressed by estimating the effect of these time-varying variables on the hazard that a spell will end in the next period *conditional on its current length* (i.e. conditional on being in an ongoing spell). As explained in more detail below, this is achieved through a survival model with time-varying covariates, that can be viewed as roughly analogous to a panel estimation in which the right hand side variables are predetermined (though not strictly exogenous). While this will not eliminate all sources of endogeneity (for example, endogeneity through expectation that the end of a spell is imminent), it should prevent bias through standard feedback from the end of a spell to potential determinants (for example, from a growth collapse to higher inflation, rather than the reverse).

B. Regression Methodology[6]

Let t denote "analysis time" (time since growth accelerated) and T duration (the length of a growth spell), a random variable. $t = 1$ denotes the first year in a growth spell, $t < 1$ years prior to the beginning of the spell. $X(t)$ is a vector of time-varying variables that may influence the probability that a growth spell ends (also a random variable); x_t the realization of $X(t)$ at time t; and z a vector of non-time varying variables that may also have an impact on length of a growth spell. z could contain realizations of $X(t)$ before the beginning of a growth spell (i.e. x_t , $t < 1$) and also variables that have no time dimension at all, e.g. geographical variables. We want to estimate the effect of $X(t)$ and z of interest on T.

Duration is usually modeled by parameterizing the *hazard rate*—the conditional probability that the spell will end in the next period—and estimate the relevant parameters using maximum likelihood. In the presence of both time-varying and time invariant covariates, the hazard rate can be defined as (assuming continuous time for now):

(1) $$\lambda(t, X(t), z) = \lim_{h \to 0} \frac{P(t \le T < t + h \mid T \ge t, X(t+h), z)}{h} = \frac{f(t \mid x_t, z)}{1 - F(t \mid x_t, z)}$$

where $F(t \mid x_t, z)$ and $f(t \mid x_t, z)$ are the c.d.f. and density function of T, respectively, conditioning on z and the realization of X at time t. The most popular approach to estimating (1) is to assume a "proportional hazard model"—in effect, an assumption that the time dependence of λ, called the "baseline hazard", is multiplicatively separable from its dependence on $\{X(t), z\}$—and to parametrize it by assuming that the relationship between λ and $\{X(t), z\}$ is log linear, and that the "baseline hazard" takes a particular functional form:

(2) $$\lambda(t) = g(X(t), z)\lambda_0(t) = \exp(\beta[X(t), z])\lambda_0(t)$$

[6] For details, see Woolridge (2002), Chapter 20.

where $\lambda_0(t)$ is assumed to obey a specific distribution whose parameters can be estimated along with the coefficient vector β.

One potential problem in estimating (2) arises from the feedback of duration to the covariates *X*, i.e. the fact that *X* might depend on whether or not a spell has ended or is still ongoing. As shown by Woolridge (2002), (2) can be estimated consistently if we can assume that the hazard at time *t* conditional on the covariates at time *t* depends only on the lagged realizations of those covariates, i.e. when it neither depends on future realizations of the covariates, nor on unobserved covariates. Under this assumption, it is possible to construct a partial log likelihood function for each observation which represents the density that a growth spell will end in a particular time interval conditional on the realization of the covariates and a dummy indicating whether the observation is censored or not. The coefficient vector in (2) can then be estimated using maximum likelihood, and the maximum likelihood variance matrices and test statistics are asymptotically valid.

Intuitively, we are making three important assumptions. First, we rule out contemporaneous feedback from the end of a growth spell to the time varying covariates within the current time period. In other words, we must *either* assume that the realization of covariates at *t*-1 contains all relevant information to predict whether a growth spell will end at *t*, *or* that if realizations at *t* matter, they will not change within the time period as a result of the end of a growth spell in that period (for example, health indicators may deteriorate in a low growth environment, but this will not be felt in the first period in which a downbreak occurs).[7] Second, we must assume that duration is conditionally independent of censoring. This is automatically satisfied in our sample, since we have fixed censoring (all growth observations end in 2003). Third, and most critically, we must not omit relevant variables from the regression. Given the data availability constrains discussed at the end of the last section, this is potentially the most serious problem.

In practice, we ran the duration regressions using Stata's `streg` command, assuming that $\lambda_0(t)$ follows a Weibull distribution that allows for either positive or negative duration dependence.[8] The main results are robust to alternative distributional assumptions.

C. Results

We proceed sequentially, examining first the role of external shocks, then of institutions and variables related to social conflict (income distribution and ethnic heterogeneity), and then a variety of other, policy related indicators, using some of the previous variables as controls. This sequence is motivated by the idea that external shocks, institutions, and social

[7] In duration analysis text treatments, such as Wooldridge, Chapter 20.4.2, the second assumption is made, by postulating that the time varying covariates are constant in each time period.

[8] A spell ID variable was created, as well as dummy variables for the beginning and end of spells. To take account of the fact that a downbreak, by construction, cannot happen until 5 years into a spell at the earliest (a consequence of our interstitiary period), we created a dummy variable defining the notional start of the spell as the true start year plus four years. The data was set in survival time format using the Stata `stset` command using these variables (`stset year, id(spell_id) fail(stop) origin(startplus4))`.

heterogeneity may affect the economy both directly and through policies. Hence, omitting policies in a model that accounts for shocks, institution and inequality/heterogeneity merely changes the interpretation of the results (as effects of shocks/institutions/heterogeneity are combined), but does not necessarily misspecify the model.

External Shocks

We focus on two external shocks: changes in the terms of trade and changes in U.S. interest rates. We include first and second lags of terms of trade shocks (measured as year-to-year percentage changes) to give the model some flexibility with regard to the timing of the effect of the terms of trade, and first lags for U.S. interest rate changes. Table 4 shows the results from running these models on our basic four data samples: for growth spells based on breaks identified at the p = 0.1 and 0.25 level; and for interstitiary periods of 5 and 8, respectively.

As is standard in survival analysis, the table shows *exponentiated* regression coefficients. These can be interpreted as "hazard ratios": as the factor by which the hazard rate increases when the covariate increases by one unit. For example, a hazard ratio of 1.1 means that a unit change in the regressor increases the risk of a growth downbreak in the next period by 10 percent. A hazard ratio of 1 means there is no effect, and a hazard ratio of less than one denotes a "protective effect". The p-values shown below the hazard ratios refer to the probability that the true hazard ratio equals 1. We use the convention that hazard ratios that are significantly different from 1 at the 5 percent level or less are denoted in bold; hazard ratios significant at the 10 percent but not 5 percent level in bold and italics.

As expected—given Rodrik (1999) and related work—external shocks seem to increase the risk that growth spells will end. For the terms of trade, a hazard ratio of 0.97-0.98 means that a one percent improvement in the terms of trade will reduce the probability of a growth downbreak by 2-3 percent (though the effect is not precisely estimated, and does not show up in one of our four samples). We also find a very large and significant effect of U.S. interest rate changes on duration: depending on the sample, a one percentage point (100 basis point) increase in U.S. rates is estimated to increase the probability that a growth spell will end in the next year by 25–50 percent. Qualitatively similar (though less precise) results obtain if a 0-1 dummy variable for large hikes in the U.S. federal funds rate is used instead of continuous changes in U.S. market rates (see Becker and Mauro, 2006).

Political and Economic Institutions

There is a well-established link between long-run growth and political institutions—in particular, the extent to which they achieve political accountability and constrain the executive (Acemoglu, Johnson, and Robinson (2000, 2005; Sokoloff and Engerman, 2000; Rodrik, Subramanian, and Trebbi, 2004). Whether this link operates via more vigorous growth or more sustained growth spells or both is not obvious. One channel through which weaker institutions could lead to shorter growth spells is by making societies deal less effectively with external shocks (Rodrik, 1999). Another is that poor institutions breed economic and political problems which make countries more crisis-prone, and growth more volatile (Acemoglu et al., 2003).

Table 4. Duration Regressions: External Shocks 1/

(hazard ratios and *p* values shown)

		5 year minimum spell		8 year minimum spell	
Model	Variable	$p_{BR} = 0.1$	$p_{BR} = 0.25$	$p_{BR} = 0.1$	$p_{BR} = 0.25$
1	Terms of trade growth 2/	**0.98**	**0.98**	***0.97***	1.00
		4.3E-02	**3.3E-02**	***7.5E-02***	9.9E-01
	US Interest Rate Change 3/	0.92	0.90	0.89	0.90
		3.4E-01	9.6E-02	4.1E-01	3.3E-01
	First Lag	**1.29**	**1.26**	**1.51**	**1.43**
		1.2E-02	**1.9E-03**	**9.8E-03**	**4.1E-03**
	Spells/failures	88/45	139/84	55/18	82/32

1/ Survival time regressions based on spells using growth cutoff *g* = 2 percent. All regressions control for initial income per capita.

2/ Expressed in percentage points; increase means terms of trade improvement.

3/ Change in the average annual 3 month treasury bill rate, in percentage points.

Table 5 shows the relationship between institutions and the length of growth spells in our data. The standard "polity2" measure of democratic institutions, measured on a scale of -10 (most autocratic) to +10 (most democratic) shows a "protective" effect, which is statistically significant in most subsamples. A one point improvement in the polity score lowers the hazard that a growth spell will end in the next period by 3–9 percent (Model 1). This holds for both cross-sectional differences in the polity of societies at the beginning of a growth spell, and for changes in the polity score within a growth spell. Since the coefficient on these "initial level" and "change within spell" variables are similar, one can collapse them, and simply control for the contemporaneous level of the polity variable, with the effect that the precision of the estimate is improved (see model 2, where the reduction in hazard from a one point increase in the polity score is now between 4 and 8 percent)

Models 3 and 4 in Table 5 show that the strong relationship between the polity variable and the hazard ratio is driven by both of its main subcomponents, namely, separate assessments of "democracy" and "autocracy", which are both measure on a 0-10 point scale ("polity" is defined as the democracy score minus the autocracy score). Interestingly, the effect of "autocracy" on the hazard ratio is both stronger and more robust than that of democracy, with a one point increase in autocracy leading to an increase in the probability that a growth spell will end by 10-20 percent. Models 5-7 examine three "concept variables" in the polity database on which both the "democracy" and "autocracy" scores are based to varying degrees, namely, "executive recruitment" (i.e., how governments come to power, scored between 1 and 8, where larger means more democratic); "executive constraints" (i.e., the presence of checks and accountability, scored between 1 and 7); and "political competition" (e.g., the relevance of parties and civil society organizations, scored between 1 and 10). The results are all robust and go in the expected direction.

Table 5. Duration Regressions: Institutions 1/

(hazard ratios and *p* values shown)

		5 year minimum spell		8 year minimum spell	
		$p_{BR} = 0.1$	$p_{BR} = 0.25$	$p_{BR} = 0.1$	$p_{BR} = 0.25$
Model	Variable				
1	"Polity2" (Polity IV database)				
	Initial level	**0.93**	0.97	0.91	**0.94**
		3.3E-02	1.9E-01	1.0E-01	**4.4E-02**
	Change within spell	***0.93***	***0.94***	0.93	***0.94***
		6.5E-02	***5.3E-02***	1.3E-01	***8.0E-02***
	Spells/failures	63/32	107/65	44/16	68/29
2	"Polity2" (Polity IV database)	**0.92**	**0.96**	***0.93***	**0.94**
		3.6E-03	**1.8E-02**	***6.5E-02***	**1.5E-02**
	Spells/failures	69/34	115/69	49/16	73/30
3	Democracy (Polity IV database)	**0.87**	***0.94***	0.91	***0.92***
		6.8E-03	***6.0E-02***	2.0E-01	***8.3E-02***
	Spells/failures	69/34	115/69	49/16	73/30
4	Autocracy (Polity IV database)	**1.18**	**1.10**	**1.21**	**1.18**
		2.7E-03	**8.7E-03**	**1.7E-02**	**3.7E-03**
	Spells/failures	69/34	115/69	49/16	73/30
5	Executive recruitment (Polity IV database)	**0.82**	***0.92***	**0.80**	**0.86**
		7.6E-03	***1.0E-01***	**4.7E-02**	**4.4E-02**
	Spells/failures	69/34	115/69	49/16	73/30
6	Executive constraints (Polity IV database)	**0.76**	**0.87**	0.81	**0.81**
		2.9E-03	**1.9E-02**	1.0E-01	**3.0E-02**
	Spells/failures	69/34	115/69	49/16	73/30
7	Political competition (Polity IV database)	**0.85**	**0.91**	***0.86***	**0.86**
		4.2E-03	**1.1E-02**	***7.4E-02***	**8.8E-03**
	Spells/failures	69/34	115/69	49/16	73/30
8	Investment profile (ICRG)	0.82	0.91	0.70	**0.65**
		1.4E-01	3.5E-01	2.4E-01	**3.1E-02**
	Spells/failures	44/15	70/26	33/4	46/8

1/ Survival time regressions based on spells defined using growth cutoff of g = 2 percent. Regressions control for terms of trade shocks, US interest changes, and initial income.

What about the role of narrower, "economic institutions"? These might also matter; for example, even countries with autocratic systems might be able to develop institutions that provide a growth-friendly climate by protecting the rights of investors and entrepreneurs, or property rights more generally. The problem is that direct measures of these institutions are not available over long time periods. The longest available series appear to be those compiled by the *International Country Risk Guide* (ICRG), beginning in 1984. The third model in Table 5 includes an ICRG measure that describes economic, as distinct from political, institutions: "investment profile", which codes contract enforcement, profit repatriation and payment delays on a 0-12 point scale.[9] The results suggest a highly "protective" effect, with a one point increase (improvement) in investor protection associated with a reduction in the hazard ratio by up to 35 percent. However, the estimates are very imprecise (not surprising, given the small sample) and statistically significant in only one of the four subsamples.

[9] See http://www.prsgroup.com/ICRG_Methodology.aspx

Inequality and Fractionalization

Do more homogenous societies—either in terms of income distribution, or in terms of ethnic of religious composition—have longer growth spells? This may be the case if growth ends as a result of social or political conflict; or if more homogeneous societies (just like societies with better institutions) are more capable of adapting to shocks. Controlling for terms of trade shocks and U.S. interest shocks, we examine the effect of two measures of heterogeneity: economic, proxied by the Gini coefficient, and social, proxied by a measure of ethnic heterogeneity (Table 6).

The main result is that there is a large and statistically significant association between income inequality and duration. A one percentage point higher Gini lowers the hazard that growth will end in any given year by between 4 and 14 percent. Since the cross-sectional standard deviation of the Gini in our sample in 2000, for example, was over 10 percentage points, this is an enormous effect. Note that, unlike democratization, all the action comes from cross-sectional differences in initial levels of the Gini; "within spell" changes are estimated very imprecisely (which is perhaps not surprising, given the high persistence of the Gini over time), and do not have statistically significant effects.[10] Model 2 shows that the effect is largely preserved if one simply includes the contemporaneous Gini into the model, rather than distinguishing between Ginis at time zero and changes in the Gini. This is important because controlling only for the contemporaneous Gini allows us to work with a large sample, that includes a number of extra spells for which initial Ginis were not available.

In contrast, measures of ethnic, linguistic, or religious heterogeneity—available as cross-sectional variables only—did not seem to have a robust significant association with the length of growth spells. Model 3 shows results based on one such variable, namely, an ethnic fractionalization measure compiled by Alesina et al. (2003). Although it has the expected sign, it is statistically not significant. Related measures by Easterly and Levine (1997) and Fearon (2003) led to even weaker effects. Model 4 shows the estimated hazard ratios for the Alesina et al. measure, while controlling for income distribution. The estimated hazard ratios are now significantly higher than unity in 3 of the 4 subsamples; however, they are also extremely unstable, swinging wildly across subsamples, and reaching an implausible magnitude in the (small) subsample for $h = 8$ and $p = 0.25$ (third column). When we repeated the regressions using identical subsamples without controlling for inequality we obtained very similar results (not shown), indicating that the differences between models 3 and 4 are driven by the samples, and not by the use of income inequality as a control.

Finally, we investigated the relationship between the duration of growth spells and direct measures of violent conflict—such as wars and internal strife—taken from the Uppsala Conflict Data Program/International Peace Research Institute (UCDP/PRIO) armed conflict dataset (Gleditsch et al., 2002). Surprisingly, we did not find strong robust associations.

[10] Year-to-year Gini proxies were obtained by linearly interpolating levels from the WIDER 2a database of worldwide income inequality (June 2005). The potential mismeasurement resulting from this linear interpolation may be another reason why within-spell changes in the Gini appear to have no effect.

Table 6. Duration Regressions: Inequality and Fractionalization 1/
(hazard ratios and *p* values shown)

Model	Variable	5 year minimum spell p_{BR} = 0.1	5 year minimum spell p_{BR} = 0.25	8 year minimum spell p_{BR} = 0.1	8 year minimum spell p_{BR} = 0.25
1	Inequality (Gini Coefficient)				
	Initial level	**1.13**	**1.05**	***1.14***	1.04
		3.9E-03	**2.3E-02**	***5.3E-02***	2.0E-01
	Change within spell	1.05	0.99	0.93	0.95
		3.7E-01	8.7E-01	3.3E-01	2.8E-01
	Spells/failures	30/13	62/36	21/6	31/14
2	Inequality (Gini Coefficient)	**1.12**	**1.04**	**1.10**	***1.05***
		8.5E-05	**2.4E-02**	**1.8E-02**	***7.1E-02***
	Spells/failures	44/20	81/51	29/10	42/21
3	Ethnic fractionalization (Alesina et al., 2003)	2.17	1.46	2.71	3.19
		2.2E-01	4.3E-01	3.1E-01	1.1E-01
	Spells/failures	85/44	135/81	53/18	82/33
4	Ethnic fractionalization (Alesina et al., 2003)	**11.70**	1.53	**288.81**	**16.61**
		4.0E-02	4.9E-01	**1.3E-02**	**1.8E-02**
	Inequality (Gini Coefficient)	**1.12**	**1.04**	**1.11**	1.03
		1.8E-04	**2.7E-02**	**4.9E-02**	2.9E-01
	Spells/failures	44/20	81/51	29/10	42/21

1/ Survival time regressions based on spells defined using growth cutoff of *g* = 2 percent. Regressions control for terms of trade shocks, US interest changes, and initial income.

There are two interpretations for this. First, high violent conflict, at least according to the UCDP/PRIO scoring, is not as obviously correlated with low growth as one might expect. Simple cross-country correlations indicate a negative but not statistically significant correlation between average internal conflict and average growth, and a surprising statistically significant *positive* correlation between external conflict and growth. Second, it is possible that violent conflicts depress growth primarily through their effects *after* a growth spell has already ended, rather than by ending a growth spell.

Social and Physical Indicators

Controlling for the effect of terms of trade shocks, U.S. interest rates changes, and the contemporaneous Gini coefficient, we next show the effects of indicators related to education, health, and physical infrastructure. Table 7 shows that, although the coefficients have the expected sign, there are no significant associations between education and growth duration. The possible exception is within-spell improvements in primary education, particularly absent controls for the Gini coefficient (not shown), which has the effect of increasing the regression samples by about 25 percent.

The results for health are a bit stronger: in particular, there seems to be a positive association between child mortality and the hazard that a growth spell will end, even controlling for income inequality and initial income. However, the coefficients are very imprecisely estimated, and the point estimates are not robust across subsamples, with implausibly large effects for the (very small) $h = 8$ samples. When the Gini coefficient is dropped as a control, the sample sizes almost double, and the estimated hazard rates in the $h = 5$ and $h = 8$ samples become much more closely aligned, in the range of 1.08 to 1.15. Hence, an increase in infant mortality by one death per 100 is estimated to increase the hazard that a growth spell will end by about 10 percent per year.

Table 7. Duration Regressions: Social and Physical Indicators 1/
(hazard ratios and *p* values shown)

		5 year minimum spell		8 year minimum spell	
Model	Variable	p_{BR} = 0.1	p_{BR} = 0.25	p_{BR} = 0.1	p_{BR} = 0.25
1	Primary Education (Barro-Lee; years)				
	Initial level	0.90	0.74	0.36	***0.45***
		7.6E-01	1.5E-01	1.9E-01	***5.6E-02***
	Change within spell	0.57	0.78	***0.09***	**0.21**
		3.7E-01	5.1E-01	***9.1E-02***	**2.1E-02**
	Spells/failures	31/15	56/31	18/6	26/12
2	Secondary Education (Barro-Lee; years)				
	Initial level	0.46	0.53	0.04	**0.03**
		4.0E-01	1.8E-01	1.0E-01	**3.3E-02**
	Change within spell	2.13	1.07	0.30	**0.03**
		1.5E-01	8.7E-01	5.0E-01	**2.9E-02**
	Spells/failures	31/15	56/31	18/6	26/12
3	Infant mortality (deaths per 100 births)				
	Initial level	1.10	**1.09**	**1.64**	**1.39**
		4.3E-01	**6.2E-02**	**4.0E-02**	**1.6E-03**
	Change within spell	**1.51**	**1.36**	1.16	***1.37***
		4.5E-02	**1.7E-02**	5.6E-01	***5.4E-02***
	Spells/failures	37/16	68/41	23/7	31/13
4	Adult mortality (males; deaths per 100)				
	Initial level	0.99	**1.04**	1.08	1.06
		8.2E-01	**2.5E-02**	3.1E-01	1.4E-01
		1.02	1.02	1.11	1.02
		6.4E-01	6.4E-01	3.3E-01	7.0E-01
	Spells/failures	36/15	65/39	21/5	29/11
5	Telephone mainlines per 100 peopl	0.96	**0.96**	0.88	0.97
		1.3E-01	**1.3E-02**	1.4E-01	3.7E-01
	Spells/failures	71/31	107/56	43/11	64/20

1/ Based on spells defined using growth cutoff of *g* = 2 percent. Regressions control for terms of trade shocks, US interest changes, income inequality, and initial income.

Finally, the hazard ratio associated with an indicator of physical infrastructure development—telephone mainlines per capita, model 5—was lower than unity as expected, but was significantly so only in one subsample.

Globalization

Trade integration and openness have long been linked to growth performance through links such as market size and competition (see Romer, 1985; Dollar, 1992; Sachs and Warner, 1995; Wacziarg and Welch, 2003; and Alesina, Spolaore, and Wacziarg, 2005 for a recent survey). In contrast, the relationship between financial integration and growth is more controversial and less robust empirically (Edison et al., 2004; Kose et al., 2006). A possible interpretation is that, according to neoclassical growth theory, capital account liberalization should be linked to temporary rather than permanent increases in growth (Henry, 2007). Another is that the growth benefits of financial integration may depend on the composition of external financial assets and liabilities, and perhaps on country characteristics such as financial development or institutional quality (Dell'Ariccia et al, 2008).

Table 8 shows the role trade of integration and financial integration proxies in the duration of growth spells. Because of small sample sizes, the Gini is dropped as a control variable, but the remaining controls are retained. We will return later to the issue of robustness in the presence of other regressors.

We find a significant and very large effect of *trade liberalization* —measured by the Wacziarg-Welch dummy variable. This is regardless of whether this occurred before or within a spell. Roughly speaking (and bearing in mind that we are controlling only for external shocks and initial income at this point), countries that have liberalized trade appear to enjoy a 70–80 percent reduction in the hazard that a growth spell will end. This effect does not fully carry over to *openness*, however (regardless of whether structurally adjusted or unadjusted measures of openness are used).[11] Although openness appears to have a protective effect, it is statistically significant only in one of our four samples, and relatively small, with a one percent of GDP increase in openness decreasing the chance that a growth spell will end by 1–2 percent. The tension between these results may indicate that the Wacziarg-Welch dummy variable might be a proxy for reforms that go beyond just trade liberalization.

The effects of financial integration on growth—measured as the sum of external assets and liabilities, expressed, like trade openness, as a share of GDP—are weaker, and if anything seem to go the wrong way, as increases in financial integration over the life of a spell are associated with a marginally *higher* risk that a growth spell will end. However, a disaggregation of the financial integration shows that this effect is driven by debt flows (which in this data include public debt flows). Debt liabilities accumulation appears to be associated with less sustained growth, although the effect is very small. In contrast, FDI flows (and, less robustly, equity flows; not shown) appear to be have a significant protective effect, with an increase in FDI liabilities by 1 percent of GDP in the recipient country associated with a reduction in the probability of a growth downbreak by 4–7 percent. This provides support for the idea that the benefits of financial integration depend on the structure of the assets and liabilities that are exchanged, consistent with the findings in Dell'Ariccia et al. (2008).

[11] Following Pritchett (1996), the measure used here adjusts for cross-country differences in size, access to the sea, distance to export markets, and whether or not the country is an energy producer. That is, openness is measured as the residual in a regression of the sum of exports and imports, as a share of GDP, on these structural characteristics.

Table 8. Duration Regressions: Globalization 1/
(hazard ratios and p values shown)

Model	Variable	5 year minimum spell p_{BR} = 0.1	5 year minimum spell p_{BR} = 0.25	8 year minimum spell p_{BR} = 0.1	8 year minimum spell p_{BR} = 0.25
1	Trade Liberalization (Wacziarg-Welch Dummy Variable)				
	Initial level	**0.258**	**0.206**	0.309	**0.169**
		5.9E-03	**1.1E-05**	1.1E-01	**1.5E-03**
	Change within spell	**0.21**	**0.32**	**0.12**	**0.26**
		3.1E-04	**5.7E-04**	**5.7E-03**	**4.9E-03**
	Spells/failures	60/33	102/66	36/15	57/29
2	Trade Openness (Based on PWT data, adjusted for structural characteristics)				
	Initial level	0.995	0.996	**0.979**	0.991
		3.2E-01	3.6E-01	**4.5E-02**	1.8E-01
	Change within spell	0.991	0.993	**0.974**	0.988
		1.4E-01	1.5E-01	**2.5E-02**	1.2E-01
	Spells/failures	74/34	118/64	49/15	73/25
3	Financial Integration (Sum of External Assets and Liabilities, LMF database 2/)				
	Initial level	1.002	1.000	0.993	1.000
		4.9E-01	6.9E-01	3.3E-01	9.4E-01
	Change within spell	***1.001***	1.000	0.998	**1.002**
		6.8E-02	7.1E-01	7.4E-01	**3.9E-02**
	Spells/failures	38/18	72/37	26/7	43/12
4	External debt liabilities (Lane and Milesi-Ferretti database 2/)				
	Initial level	0.999	1.000	0.988	1.000
		8.3E-01	8.2E-01	3.7E-01	9.9E-01
	Change within spell	**1.003**	***1.002***	1.001	**1.004**
		5.0E-02	***9.6E-02***	9.2E-01	**1.8E-02**
	Spells/failures	38/18	72/37	26/7	43/12
5	FDI liabilities (Lane and Milesi-Ferretti database 2/)				
	Initial level	0.981	0.992	1.024	1.019
		3.7E-01	4.0E-01	3.5E-01	3.1E-01
	Change within spell	0.961	**0.964**	**0.925**	**0.947**
		1.5E-01	**2.4E-02**	**3.7E-02**	**3.4E-02**
	Spells/failures	38/18	72/37	26/7	43/12

1/ Based on spells defined using growth cutoff of g = 2 percent. Regressions control for terms of trade shocks, US interest changes, and initial income.
2/ See Lane and Milesi-Ferretti (2007).

The Current Account, Competitiveness, and Export Structure

Recent papers by Aizenman, Pinto, and Radziwill (2004), Rajan and Subramanian (2005), and Prasad, Rajan, and Subramanian (2007) focus on the current account and the role of role of domestic versus foreign savings in financing capital accumulation. Contrary to theories in which growth is constrained by access to capital, these papers find that foreign financing does not seem to deliver a growth bonus in developing countries. This could be related to the capacity of developing countries to absorb capital inflows, or to the macroeconomic consequences of capital inflows, which can lead to overvalued exchange rates which undermine growth in the manufacturing sector.

The second interpretation—that reliance on foreign financing is bad because it hurts the development of a manufacturing sector—suggests that the *structure* of exports (or more generally production) might matter for future growth. A possible reason for this is that manufacturing may help create a middle class that favors further strengthening of political institutions (Johnson, Ostry, and Subramanian, 2006, 2007). Another interpretation is that growth is a process by which firms discover how to produce higher productivity goods; this involves an externality which makes it easier for others entrepreneurs in the same country to produce similar goods (Hausmann, Hwang, and Rodrik, 2006). Hence, if a developing country producing relatively sophisticated goods today should predict growth tomorrow; a proposition for which Hausmann, Hwang, and Rodrik find empirical support.

Related to these ideas, Hausmann, Rodriguez, and Wagner (2006) suggest a measure of the sophistication of goods that an economy could *potentially* produce—namely, sophistication weighted by a measure of proximity to the current export basket, based on the frequency with which particular pairs of goods are exported by the same country (see Hausmann and Klinger, 2007). They argue that this measure, which they call "Open Forest", should capture the ease with which economies can shift to other export baskets of high sophistication and hence high growth promise, for example, in response to adverse shocks. They show that "Open Forest" is indeed inversely related to the length of stagnation periods. By the same token, it might be positively related to the ability of an economy to sustain growth.

Table 9 shows how the variables stressed by these literature related to the length of growth spells. In general, the results are consistent with the literatures described above, and they seem to be particularly strong for the export structure variables.

First, running a *current account surplus* during a growth spell seems to increase the chance that growth will be sustained. The effect could be large, though it is imprecisely estimated, with a one percentage point of GDP rise in surplus lowering the probability that a growth spell will end by 5–20 percent. Similarly, *overvaluation* appears to affect duration adversely at least on the samples that exclude high frequency breaks, i.e. imposing $h = 8$. On these samples, each percentage point of overvaluation increases the hazard that a growth spell will end next period by 1–2 percent. We also find that the hazard ratios associated with *domestic savings* are consistently below 1, though they are not statistically significant.

The links between of export structure and growth spells are shown in the last three models. *Manufacturing exports* and the length of growth spells show a particularly robust relationship. Consistent with Johnson, Ostry and Subramanian (2006, 2007), what seems to matter for sustained growth is not so much the share of manufacturing at the beginning of a growth spell, but whether or not manufacturing exports rise as a share of total exports during the growth spell. A one percentage point increase in manufacturing exports is associated with a reduction in the probability of a growth spell ending by 2–4 percent. Measures of actual or potential export sophistication also seem to correlate with the end of spells; and the link is particularly strong for the "Open Forest" measure proposed by Hausmann and his coauthors. The coefficients are not as easy to interpret as in the other cases, because the export sophistication variables are expressed in natural logs of complex indices; however, the standard deviation of the Hausmann, Hwang and Rodrik (log) export sophistication index is just above 0.5, while the standard deviation of the Hausmann, Rodriguez, and Wagner (log)

"Open Forest" index is just above 1. Hence, the results suggest that a one standard deviation increase in export structure flexibility as measured by "Open Forest" lowers the risks that a growth spell will end by 40–50 percent, a large effect.

Table 9. Duration Regressions: Current Account, Competitiveness, and Export Structure 1/

(hazard ratios and *p* values shown)

		5 year minimum spell		8 year minimum spell	
Model	Variable	$p_{BR} = 0.1$	$p_{BR} = 0.25$	$p_{BR} = 0.1$	$p_{BR} = 0.25$
1	Current Account Balance (percent of GDP, WDI and IFS)				
	Initial level	0.954	0.933	0.837	0.879
		5.1E-01	2.1E-01	2.2E-01	2.8E-01
	Change within spell	0.950	**0.896**	**0.763**	**0.836**
		4.6E-01	**1.8E-02**	**6.5E-03**	**2.9E-02**
	Spells/failures	28/11	54/25	23/6	32/7
2	Domestic Savings (percent of GDP, WDI)				
	Initial level	0.985	0.981	0.968	1.002
		4.7E-01	1.5E-01	4.4E-01	9.3E-01
	Change within spell	0.99	0.99	***0.92***	1.00
		6.4E-01	3.6E-01	***7.9E-02***	9.9E-01
	Spells/failures	54/26	94/51	32/11	52/19
3	Overvaluation (residual of cross-sectional regressions of price levels on PPP GDP per capita)				
	Initial level	0.999	0.996	1.005	**1.011**
		8.0E-01	3.4E-01	4.5E-01	**8.9E-02**
	Change within spell	0.998	1.003	**1.013**	**1.016**
		7.9E-01	4.4E-01	**2.0E-02**	**5.3E-03**
	Spells/failures	81/40	128/76	49/18	78/33
4	Manufacturing exports/Total exports (percent, WDI)				
	Initial level	0.988	0.989	0.999	0.988
		2.3E-01	1.4E-01	9.3E-01	3.0E-01
	Change within spell	***0.977***	**0.982**	**0.958**	**0.977**
		6.8E-02	**4.7E-02**	**2.0E-02**	**3.4E-02**
	Spells/failures	43/24	73/43	28/13	44/20
5	Sophistication of exports (Hausmann, Hwang and Rodrik, 2006)				
	Initial level	***0.304***	**0.399**	0.395	**0.114**
		9.2E-02	**4.2E-02**	4.4E-01	**1.1E-02**
	Change within spell	**0.169**	**0.223**	0.142	0.256
		3.0E-02	**5.5E-03**	1.2E-01	1.1E-01
	Spells/failures	57/30	94/54	38/12	56/21
6	"Open Forest" (Hausmann, Rodriquez and Wagner, 2006). 2/				
	Initial level	***0.748***	**0.721**	0.848	0.723
		8.2E-02	**1.7E-02**	6.0E-01	2.0E-01
	Change within spell	**0.539**	**0.632**	**0.463**	**0.540**
		3.5E-03	**1.1E-02**	**1.3E-02**	**6.0E-03**
	Spells/failures	57/30	94/54	38/12	56/21

1/ Based on spells defined using growth cutoff of *g* = 2 percent. Regressions control for terms of trade shocks, US interest changes, and initial income.

2/ Sophistication of exports of other countries weighted by country "promixity" to these exports based on frequency with which good-pairs are exported by the same country.

Macroeconomic Stability

We now examine the relationship between duration and two traditional indicators of macroeconomic volatility: inflation, and nominal exchange rate depreciation. We use the traditional log transformation for inflation and exchange rate depreciation, multiplied by 100 to make the hazard ratios easier to interpret (i.e., our inflation measure is $100*\ln(1+\pi)$, where π is the log difference of the price level). We could have used $\ln(\pi)$ instead, which some authors (Sarel, 1996; Ghosh and Phillips, 1998) have argued is more appropriate to study the effect of inflation on growth. However, this transformation would not have worked for exchange rate depreciation (negative depreciations, i.e. appreciations, being very common in our sample) and we wanted to use the same transformation for both inflation and depreciation to make the coefficients comparable; the results for inflation turn out to be insensitive to the choice of transformation in this case.

The main result is that nominal instability—inflation or depreciation—appears to be a statistically and economically significant risk factor for growth spells. Depending on the sample, the results for inflation suggest that a one point increase in $100*\ln(1+\pi)$ leads to a 1-4 percent increase in the risk of a downbreak in growth. At low inflation rates, $100*\ln(1+\pi)$ is approximately linear, so that one percentage point in inflation is about the same as a one point rise in $100*\ln(1+\pi)$. Suppose for example that inflation rises from 10 percent a year to about 50 percent. This is the same as a rise in $100*\ln(1+\pi)$ by about 30 points, which implies an increase in the annual risk that a growth spell will end by up to 120 percent relative to the baseline risk. For a depreciation in the exchange rates, the effect is even higher, with a one point increase leading to an increase in risk by 2–6 percent.

One important question is whether the strong results we obtain for inflation and exchange rate depreciation are driven by outliers, as has recently been argued in the context of conventional cross-country growth regressions (Easterly, 2005). To check this, we drop all observations from the sample in which either current or initial inflation/depreciation exceeded 50 percent per annum (this means dropping all observations in spells where inflation/depreciation at the beginning of a growth spell exceeded 50 percent, even if contemporaneous inflation/depreciation was lower). The results (model 3 in Table 9) show that this has no effect on our basic result; indeed, the hazard ratios are now even larger than before. Hence, the inflation result is not driven by hyperinflation, supporting the view that even moderate “inflation might be hazardous to your growth” (Ghosh and Phillips, 1998).

Table 10. Duration Regressions: Macroeconomic Volatility
(hazard ratios and *p* values shown)

Model	Variable	5 year minimum spell p_{BR} = 0.1	5 year minimum spell p_{BR} = 0.25	8 year minimum spell p_{BR} = 0.1	8 year minimum spell p_{BR} = 0.25
1	Log (1+inflation)				
	Initial level	1.00	1.00	1.02	**1.04**
		6.8E-01	8.9E-01	5.5E-01	**5.0E-02**
	Change within spell	**1.01**	**1.01**	1.03	**1.04**
		1.9E-02	**9.1E-03**	4.1E-01	**6.2E-02**
	Spells/failures	82/43	133/79	51/18	81/33
2	Log(1+depreciation in the parallel exchange rate)				
	Initial level	***1.01***	***1.01***	**1.06**	**1.05**
		6.0E-02	***6.0E-02***	**2.3E-02**	**8.2E-04**
	Change within spell	**1.02**	**1.02**	**1.03**	**1.03**
		3.1E-02	**3.3E-04**	**4.5E-02**	**9.2E-03**
	Spells/failures	33/16	54/33	22/9	30/18
3	Log(1+moderate inflation) 2/				
	Initial level	**1.07**	**1.06**	1.08	**1.07**
		7.8E-03	**1.9E-03**	1.1E-01	**2.1E-02**
	Change within spell	***1.04***	**1.05**	1.03	***1.04***
		5.1E-02	**7.6E-04**	4.5E-01	***9.9E-02***
	Spells/failures	75/41	126/76	46/18	75/32

1/ Based on spells defined using growth cutoff of g = 2 percent. Regressions control for terms of trade shocks, US interest changes, and initial income.
2/ Observations with inflation in excess of 50 percent per annum replaced by missing values.

A Summary View

Having concluded our tour of the main covariates that can be usefully analyzed with our data, it is important to see whether the effects hold up if they are jointly included in the model. Many of the variables that we have identified as potential factors that can lengthen growth spells—for example, more equal income distributions, and better political institutions—are correlated across countries. The question is whether or not these variables have independent power to predict longer growth spells.

As discussed before, the extent to which we can examine the covariates of growth spells jointly is limited by data availability. However, it is possible to include at least some variables from each of the groups examined in a way that maintains a reasonable sample size. The results are shown in Table 11, for two versions of the model: one using "overvaluation" among the variables from the competitiveness/export structure group, and the other using Hausmann's "Open Forest." Results for controls such as terms of trade shocks, U.S. interest rates, and initial income per capita are also shown. As in the earlier regressions, a Weibull distribution was assumed. Duration dependence is usually positive (increasing hazard in time), but not large (the duration parameter p ranges between about 0.95 and about 1.90) and not always significantly different from zero.

Table 11. Summary Regressions
(hazard ratios and p values shown)

Model	Variable	5 year minimum spell		8 year minimum spell	
		p_{BR} = 0.1	p_{BR} = 0.25	p_{BR} = 0.1	p_{BR} = 0.25
1	Log (1+inflation) (change within spell)	1.007	1.005	1.067	0.999
		1.2E-01	1.8E-01	1.4E-01	7.2E-01
	Inequality (Gini Coefficient)	**1.139**	***1.032***	**1.191**	**1.075**
		1.4E-04	***8.9E-02***	**1.9E-02**	**1.5E-02**
	Autocracy score (0-10 point scale)	1.081	1.089	**1.302**	1.148
		3.9E-01	1.0E-01	**4.9E-02**	1.4E-01
	Trade Liberalization (0-1 dummy)	0.863	**0.456**	0.527	**0.175**
		8.1E-01	**4.8E-02**	4.3E-01	**3.3E-03**
	Overvaluation (change within spell)	1.004	**1.010**	1.013	**1.019**
		7.0E-01	**3.4E-02**	1.2E-01	**3.8E-03**
	Terms of Trade Change (percent)	***0.96***	0.98	0.96	1.02
		8.3E-02	1.2E-01	1.5E-01	1.9E-01
	U.S. Interest Rate Change (points)	***1.35***	**1.36**	1.15	**1.42**
		6.9E-02	**5.1E-03**	5.9E-01	**2.5E-02**
	Initial Income Per Capita (in thousands	1.04	***1.07***	**1.71**	1.15
		8.1E-01	***6.5E-02***	**4.8E-03**	1.6E-01
	Spells/failures	37/18	73/44	26/10	40/21
2	Log (1+inflation) (change within spell)	**1.013**	**1.009**	1.059	0.998
		1.3E-02	**3.4E-02**	2.2E-01	5.8E-01
	Inequality (Gini Coefficient)	**1.163**	1.032	**1.224**	**1.070**
		2.0E-04	1.5E-01	**2.0E-02**	**4.4E-02**
	Autocracy score (0-10 point scale)	1.130	**1.158**	**1.341**	**1.213**
		1.9E-01	**1.3E-02**	**4.7E-02**	**3.5E-02**
	Trade Liberalization (0-1 dummy)	0.856	0.525	1.126	**0.326**
		8.0E-01	1.2E-01	9.0E-01	**4.1E-02**
	Open Forest	**0.306**	0.714	**0.122**	**0.349**
		3.0E-02	1.2E-01	**7.5E-03**	**1.2E-02**
	Terms of Trade Change (percent)	0.97	0.98	0.96	1.01
		1.4E-01	1.6E-01	1.9E-01	2.9E-01
	U.S. Interest Rate Change (points)	***1.37***	**1.39**	1.37	***1.30***
		7.1E-02	**4.1E-03**	2.9E-01	***9.4E-02***
	Initial Income Per Capita (in thousands	1.32	**1.12**	**2.36**	**1.37**
		1.7E-01	**2.0E-03**	**1.2E-03**	**2.7E-03**
	Spells/failures	34/17	67/40	25/9	38/20

1/ Based on spells defined using growth cutoff of *g* = 2 percent. Regressions control for terms of trade shocks, US interest changes, and initial income.

As expected, the joint inclusion of many variables weakens some of the individual results, and one variable—inflation—loses statistical in the first model (the same happens if exchange rate depreciations are included in the model instead of inflation). Most other variables, however, retain their statistical and economic significance at least on some samples. The most robust predictors of duration are income distribution and the autocracy score (or equivalently, polity2, not shown); along with "Open Forest" in Model 2. Among the other export-related variables, the current account could not be examined in conjunction with the other variables in Table 10 because this reduced the sample too much; while the ratio of manufacturing in total exports turned out not to be significant in the presence of income distribution and democratization (perhaps lending support to the political economy interpretation of this variable by Johnson, Ostry, and Subramanian). Among the statistically significant variables, the hazard ratio estimates are for the most part similar to the coefficients examined before, though they tend to be less stable across subsamples.

Finally, it is worth noting that although some of our main results have the flavor of the "East Asian Miracle"—particularly our findings with respect to income distribution and export orientation—the results hold up when all Asian observations are excluded. Hence, the results of Table 11 seem to reflect general features of growth booms.

IV. Conclusion

This paper builds on the emerging literature on growth transitions by moving the object of inquiry to the duration of growth spells. Using an extension of Bai and Perron's (1998, 2003) approach to testing for multiple structural breaks, we identified a rich set of structural breaks in economic growth paths around the world, and used these to define "growth spells." We then employed survival analysis to explore the role of a large number of economic factors that might be influencing the length of growth spells.

The paper identified a handful of economic and political characteristics that appear to sustain growth: more equal income distribution, democratic institutions, openness to trade and foreign direct investment, and an export or production structure that favors manufacturing and relatively sophisticated exports. We also found that stable macroeconomic environments, with lower inflation rates and fewer instances of high depreciation, are conducive to longer growth spells.

The associations and regularities identified in this paper seem consistent with several themes that have been prominent in the literature on economic development in the last 20 years. These include the view that less equal and cohesive societies experience lower and more volatile growth, perhaps because social conflict breeds populist policies (Sachs, 1989) or because it leads to weaker institutions and a reduced capacity for managing external shocks (Rodrik, 1999, Easterly, Ritzen, and Woolcock, 2006). They also include the notion that export orientation may help growth by building constituencies in favor of better institutions (Rajan and Zingales, 2006; Johnson, Ostry, and Subramanian, 2006, 2007); and the idea that current export or production structures matter for future growth because they favor innovation and allow economies to react more flexibly to shocks (Hausmann, Hwang, and Rodrik, 2006; Hausmann, Rodriguez, and Wagner, 2006). Exploring, differentiating, and testing these channels remains a challenge for future work.

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