What Makes Growth Sustained?

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Preliminary

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Motivation

Fact 1 (well known): slow average per capita growth in the developing world, except for Asia, since the 1960s.

- High income countries, east Asia: about 2.7 percent per annum.
- Latin America: 1.3 percent.
- Africa: 0.6 percent.

Fact 2 (a bit less well known): the problem is not so much that Africa and Latin America can't get growth started. The problem is that growth episodes tend to end sooner. Moreover, they are typically followed by extended periods of zero or negative growth.

Hence, one way to understand lack of growth in Africa and Latin America is to focus on the determinants of the duration of growth spells: *What makes growth sustained?*

How this paper fits in

- Starting point: Pritchett's (2000) characterization of growth patterns in developing countries: "mountains", "plateaus," or "cliffs" rather than "hills."
  - Higher frequency growth regressions make no sense as they mix determinants of long term growth and abrupt shorter term movement.
  - Better to focus on explaining acceleration or slowdown episodes.
- Related literature:
  - Rodrik (1999): explaining cross-country differences in slowdown in growth after 1975.
  - Acemoglu, Johnson, Robinson (2003): explaining differences in real growth volatility.
  - Hausmann, Pritchett, Rodrik (2004): explaining onsets of growth spells.
  - Jones and Olken (2005): explaining "upbreaks" and "downbreaks" in growth

Our Approach

1. Identify upbreaks and downbreaks in per capita GDP growth, in a large cross-section of countries, using a variant of the Bai-Perron (1998, 2003) methodology for testing for structural breaks in time series,
2. Define "growth spells:" period that begins with an upbreak and ends with either a downbreak or the end of the sample, and in which growth exceeds a minimum threshold (e.g. 2 percent per capita).
3. Use survival analysis (a proportional hazards model with time-varying covariates) to relate the probability that a growth spell will end to economic and political variables.

Main Results

Can relate the length of growth spells to:

- Income distribution (unequal societies have shorter spells)
- Trade liberalization
- Variables related to "export orientation" (competitive exchange rates; current account surpluses, manufacturing share in exports)

Macroeconomic volatility and external shocks also seem related to shorter spells, but these effects do not always robust when controlling for the previous three.

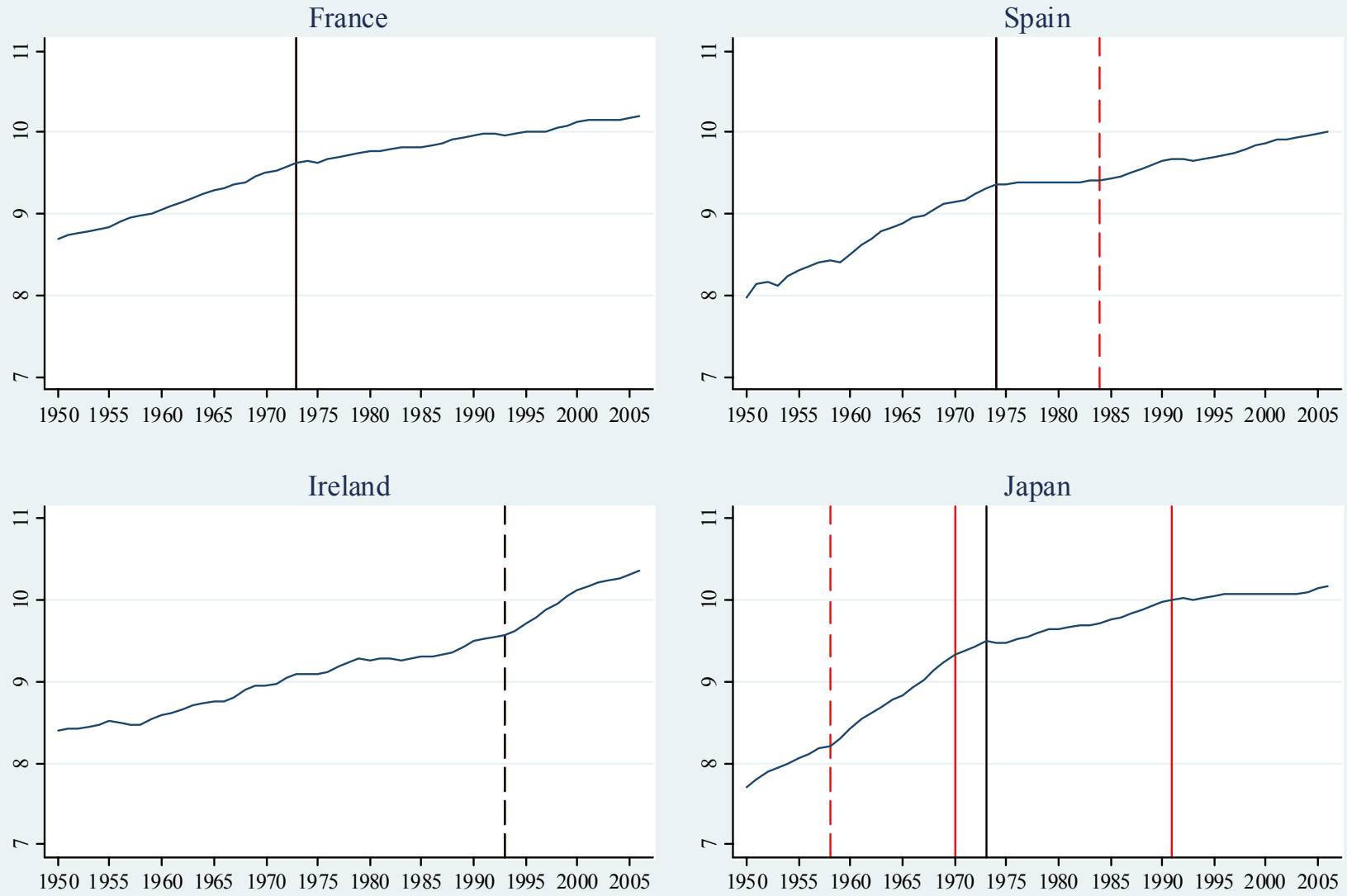
It is more difficult to relate length of spells to institutional quality. Main exception: *democratization* (within spell) extends the life of a spell. In contrast, the *initial* level of democracy does not seem relevant, in the sense that non-democratic societies can start long growth spells and keep them going if they democratize along the way)

I. Identifying Structural Breaks in Growth: Criteria

1. For each series (country), test hypothesis of 0 structural breaks against *up to m* structural breaks (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). This means conducting up to *m* F-tests. Reject null hypothesis if any of these F-tests rejects.
2. If reject, assume presence of one (optimally chosen) break. Repeat procedure on each of the two data segments created by break. If reject on any segment, assume two breaks. Repeat procedure on each of three segments; etc.
3. Critical values generated through Monte Carlo simulations at each step, based on parameters estimated on actual data and bootstrapped residuals (see companion paper by Antoshin et al, 2006)
4. Procedure allows for segment-specific heteroskedasticity (since model parameters and bootstrapped residuals are segment-specific). Use a robust estimator that corrects for the presence of autocorrelation
5. Set minimum length of segment as either $h = 5$ or $h = 8$.

Some Industrial Countries: Log Income Per Capita and Structural Breaks

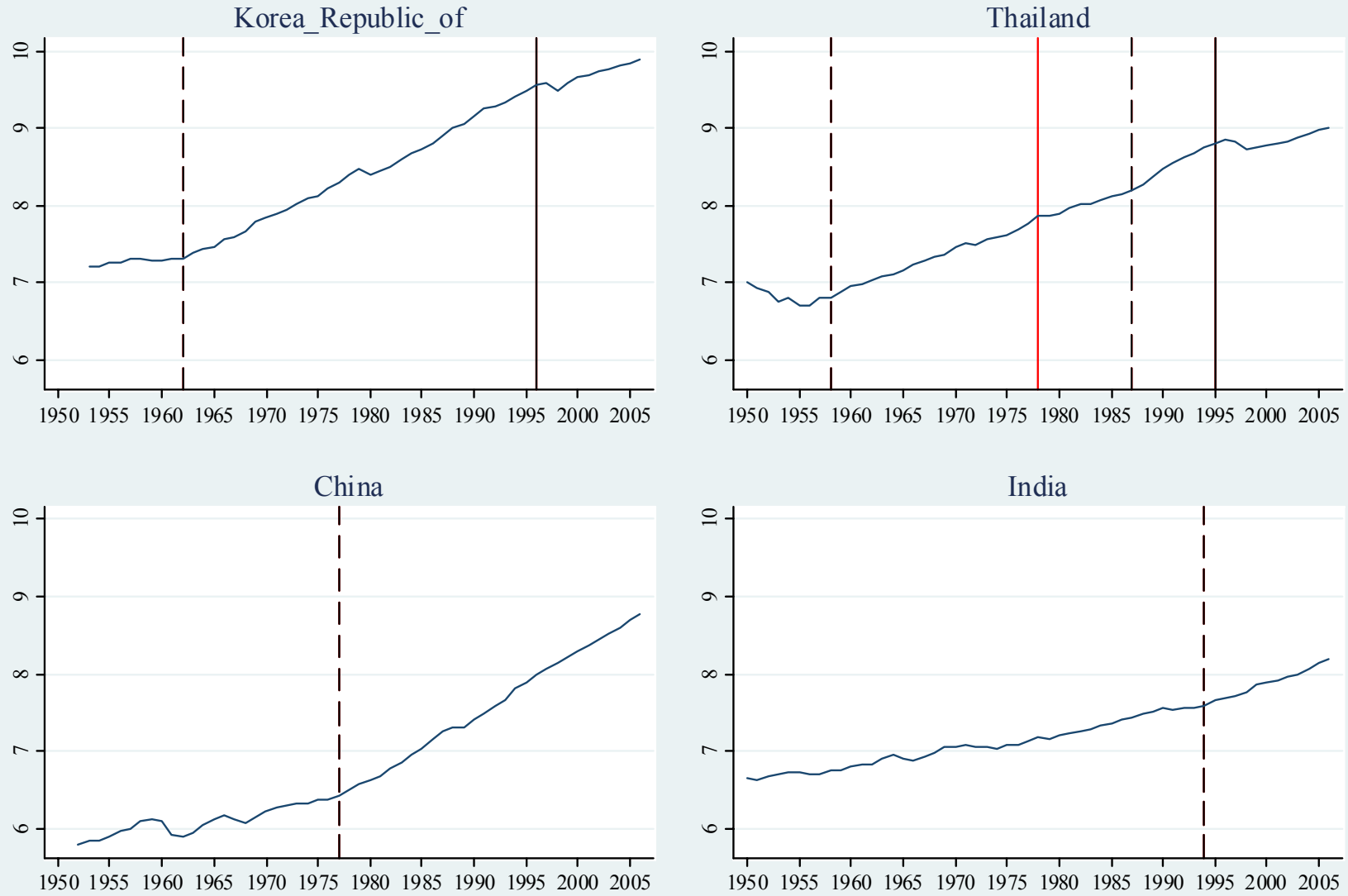
(Minimum segment set to 8 years. Breaks at p=0.10 in black, p=0.25 in red; dashes denote upbreaks)



Source: Penn World Tables and authors' calculations

Emerging Asian Countries: Log Income Per Capita and Structural Breaks

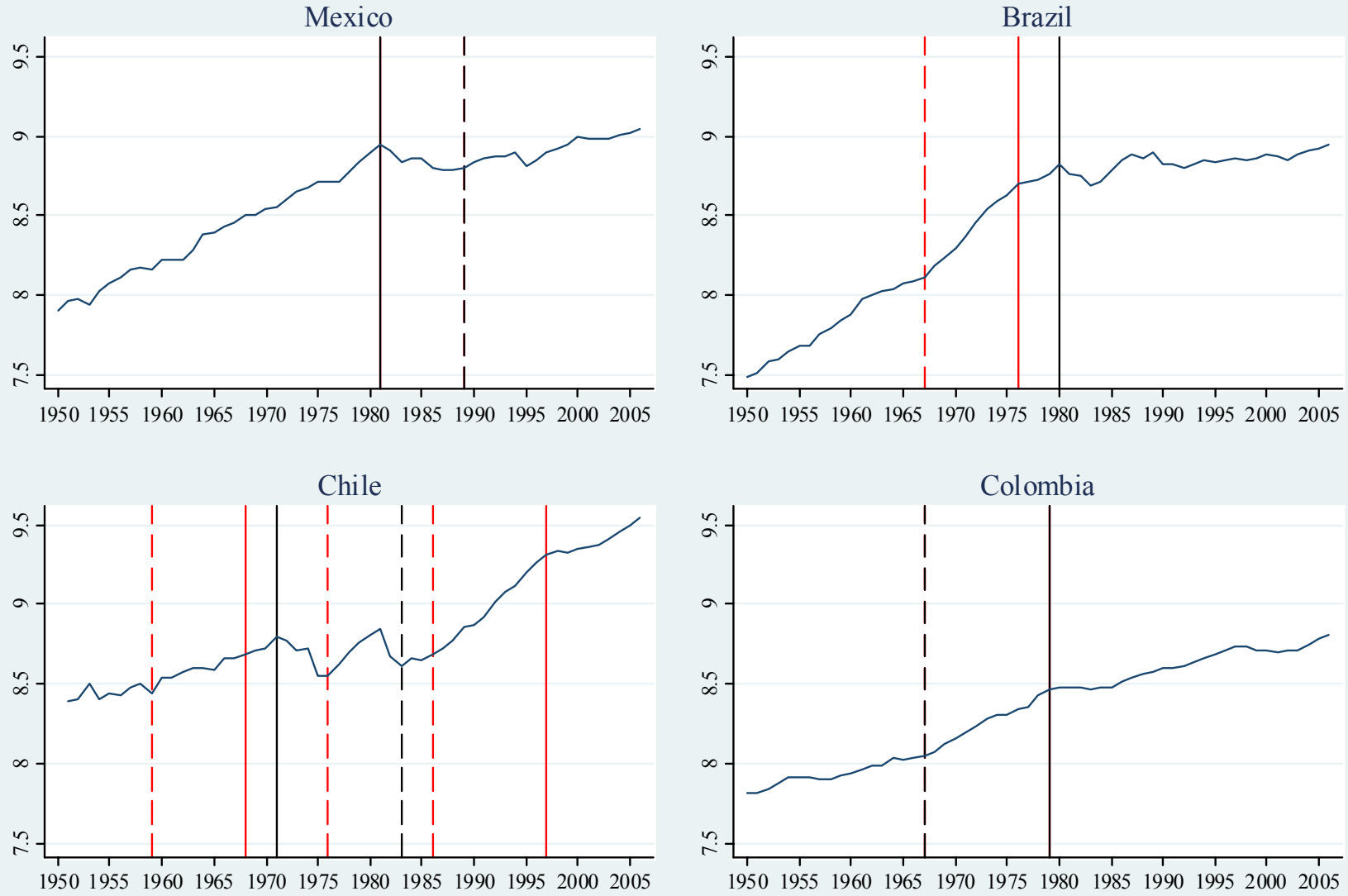
(Minimum segment set to 8 years. Breaks at p=0.10 in black, p=0.25 in red; dashes denote upbreaks)



Source: Penn World Tables and authors' calculations

Latin American Countries: Log Income Per Capita and Structural Breaks

(Minimum segment set to 8 years. Breaks at p=0.10 in black, p=0.25 in red; dashes denote upbreaks)

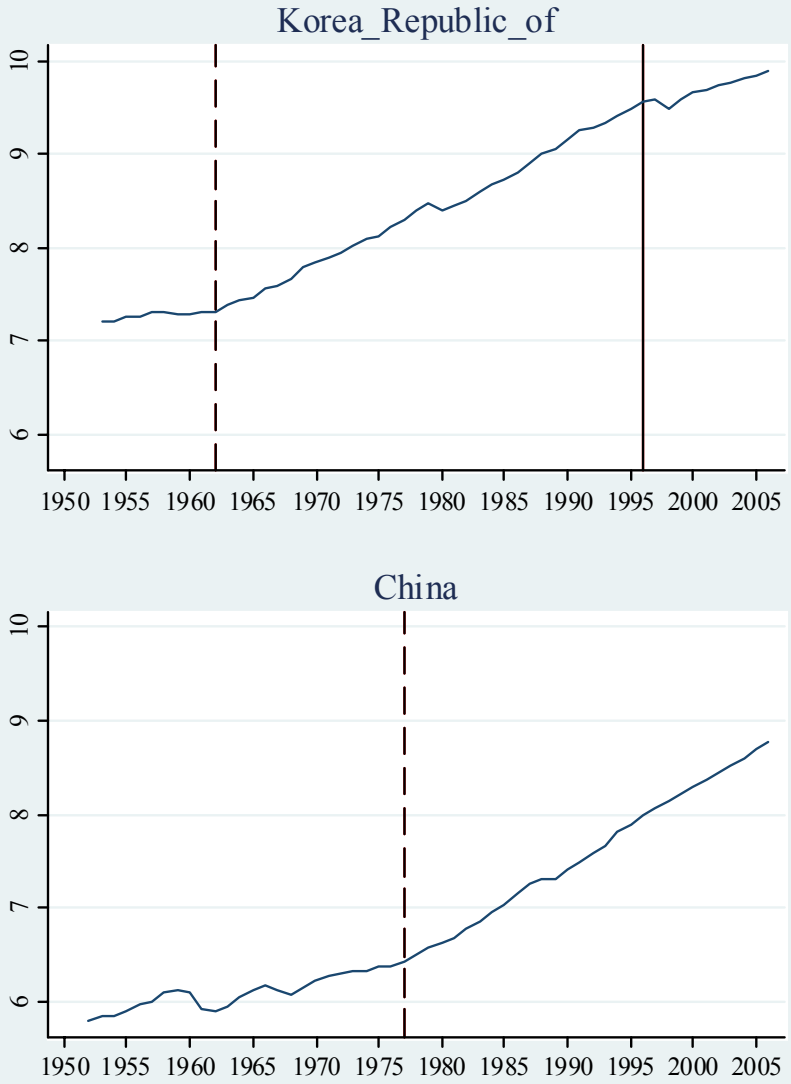


Source: Penn World Tables and authors' calculations

Emerging Asian Countries: Log Income Per Capita and Structural Breaks

$h = 5$

(Minimum segment set to 5 years. Breaks at p=0.10 in black, p=0.25 in red; dashes denote upbreaks)

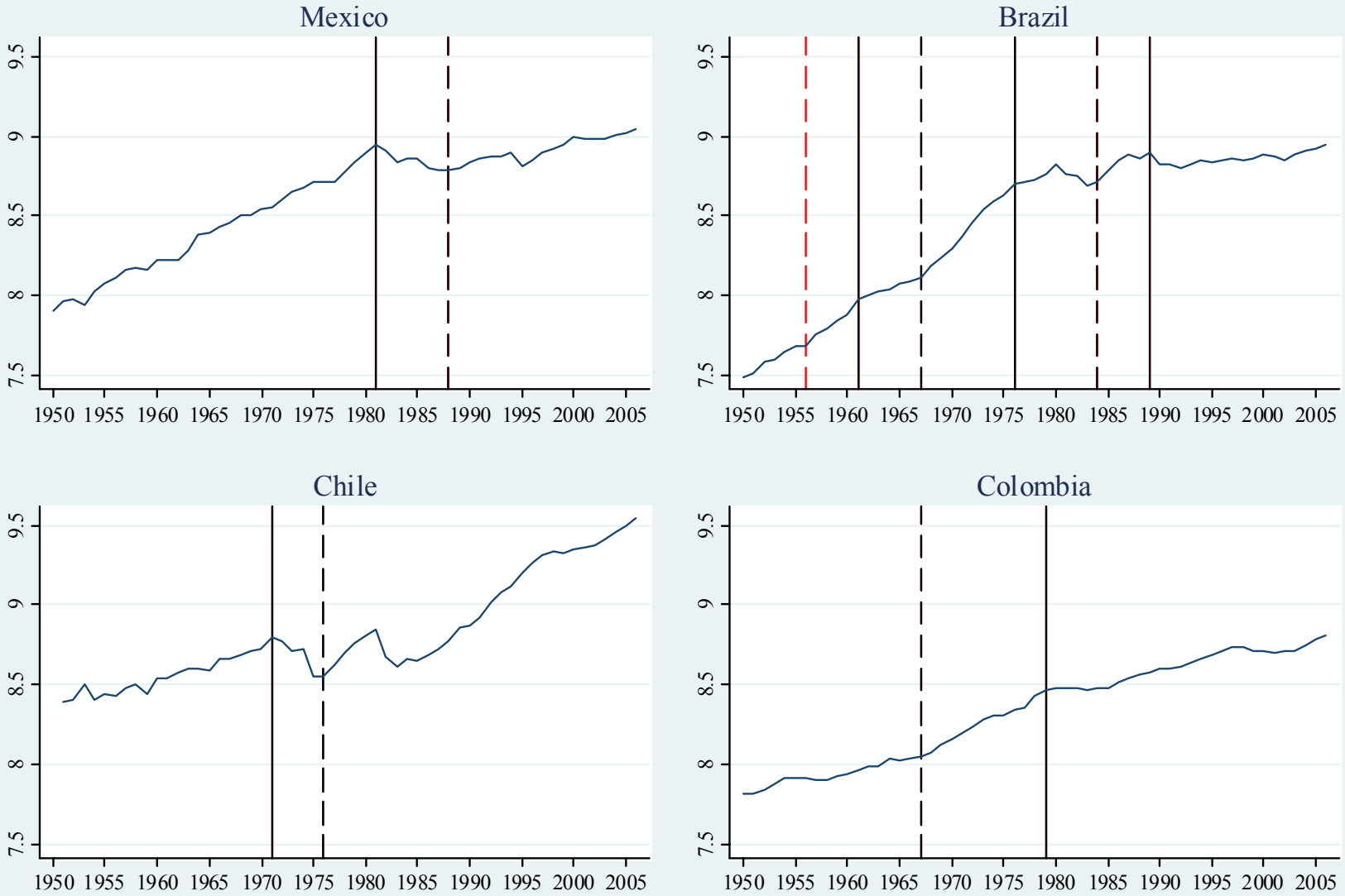


Source: Penn World Tables and authors' calculations

Latin American Countries: Log Income Per Capita and Structural Breaks

$h = 5$

(Minimum segment set to 5 years. Breaks at p=0.10 in black, p=0.25 in red; dashes denote upbreaks)



Source: Penn World Tables and authors' calculations

I. Identifying Structural Breaks in Growth: Results

Table 1. Growth Breaks by Decade and Region

		minimum segment = 5								minimum segment = 8							
		p = 0.10				p = 0.25				p = 0.10				p = 0.25			
Region	No.	50-60s	70s	80s	90s	50-60s	70s	80s	90s	50-60s	70s	80s	90s	50-60s	70s	80s	90s
Total *upbreaks*	140	34	30	33	42	50	45	57	67	17	13	20	26	25	24	37	39
Industrial	37	10	5	6	5	16	7	12	14	5	0	2	3	8	2	6	5
Emerging Asia	22	6	9	6	7	7	12	10	10	5	6	4	5	6	9	6	8
LAC	28	8	7	11	7	12	9	14	8	2	4	8	4	5	6	11	6
Africa and Middle E.	53	10	9	10	23	15	17	21	35	5	3	6	14	6	7	14	20
Total *downbreaks*	140	19	58	42	32	34	82	59	57	8	44	32	11	13	63	34	21
Industrial	37	0	23	6	10	5	29	12	19	0	13	1	5	2	20	1	9
Emerging Asia	22	4	6	6	4	4	11	9	12	0	6	6	3	1	10	6	4
LAC	28	7	10	12	6	11	15	15	9	2	11	11	1	3	12	12	4
Africa and Middle E.	53	8	19	18	12	14	27	23	17	6	14	14	2	7	21	15	4

II. Identifying Growth Spells: Criteria

A growth spell is defined as a period of time …

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

Use $g = 2$ percent per capita growth in the remainder (but also tried $g = 2.5, 3$).

II. Identifying Growth Spells: Results

Frequency of Growth Spells, by Minimum Duration and Region

Region	No. ctrs.	p = 0.10 No. spells	Mean length	% spells of length > 10 yrs	% spells of length > 16 yrs	p = 0.25 No. spells	Mean length	% spells of length > 10 yrs	% spells of length > 16 yrs
minimum length of spell = 5 years									
Industrial Countries	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 1/	20	18	13.4	39	28	23	15.6	52	39
minimum length of spell = 8 years									
Industrial Countries	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 1/	20	12	13.2	58	33	15	15.5	73	47

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

III. Covariates of Growth Spells: Empirical Strategy

Objective: Relate the length of a growth spell (or equivalently, the probability that a spell will end) to both initial conditions at the *beginning* of the spell and developments (e.g. due to shocks, policies) *during* the spell.

Challenges:

1. Model selection: weak priors; severe data constraints. Can't analyze many variables at the same time.
   - *Approach*:
   i. sequentially test for relevance of particular regressors, in the presence of some minimal controls.
   ii. summarize results in a parsimonious regression that controls for most of the variables that appeared to matter sequentially.
2. Endogeneity/feedback effects: economic conditions endogenous to whether spell ends or not.
   - *Approach*:

   Estimate effect on hazard that spell will end *conditional on its current length*

III. Covariates of Growth Spells: Regression Methodology

- t denotes time since spell began; T length of the spell; $X(t)$ a vector of possibly time-varying variables that might influence duration
- Conditional probability that spell will end at any time ("hazard rate") is:

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

- To estimate, assume and parametrize "proportional hazard model" :

$$\lambda(t, X(t), z) = \exp\{X(t)\beta]\}\lambda_0(t)$$

- When $X(t)$ are not strictly exogenous, can still estimate model consistently provided that $\lambda(t,X(t))$ depends only on realization of $X(t)$ at time t, i.e. when it neither depends on unobserved covariates nor on future realization of the covariates (for example, could consistently estimate the effect of macroeconomic crises on the hazard that a growth spell will end as along as macro crises are independent of the expectation that a growth spell will end).

As expected, terms of trade and international interest rate shocks increase the hazard that a growth spell will end

Duration Regressions: External Shocks 1/
Hazard ratios; *p* values shown below

Variable	5 year minimum spell		8 year minimum spell	
	$p_{BR} = 0.1$	$p_{BR} = 0.25$	$p_{BR} = 0.1$	$p_{BR} = 0.25$
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/	**1.29**	**1.26**	**1.51**	**1.43**
	1.2E-02	**1.9E-03**	**9.8E-03**	**4.1E-03**
Initial per capita income	1.00	1.00	1.00	1.00
	3.9E-01	6.3E-01	2.0E-01	9.8E-01
Spells/failures	88/45	139/84	55/18	82/32

1/ Survival time regressions based on spells identified using growth cutoff (g) of 2 percent.
2/ Increase means terms of trade improvement.
3/ Lagged one year, in points.

Higher inequality is associated with shorter growth spells

Duration Regressions: Income Inequality 1/
Hazard ratios; *p* values shown in scientific notation

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	Income Inequality (Gini)				
	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	Income Inequality (Gini)	**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

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

- Effect is large and robust, but size varies across samples
- Cross-sectional measures of ethnic heterogeneity did not seem to matter.

Among indicators of political institutions, *democratization* (within spell) seems to have a robust effect on duration

Duration Regressions: Political Institutions 1/

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	Democracy (Polity database)				
	Initial level	0.98	**0.96**	1.02	1.01
		2.1E-01	**4.0E-05**	5.7E-01	6.9E-01
	Change within spell	**0.99**	**0.98**	***0.99***	**0.98**
		9.9E-02	**1.6E-03**	***7.2E-02***	**4.0E-02**
	Spells/failures	66/34	107/66	41/16	63/29
2	Executive constraints				
	Initial level	0.87	0.92	0.73	**0.73**
		2.6E-01	3.0E-01	1.2E-01	**2.5E-02**
	Change within spell	0.98	0.94	0.87	0.85
		8.6E-01	4.7E-01	3.6E-01	1.8E-01
	Spells/failures	49/24	84/49	35/13	50/25

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

- Most other measures of political institutions did not seem to have robust effects

Better education—particularly *primary* education—might be associated with longer growth spells, but effect is not robust

Duration Regressions: Education 1/

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	Primary education hours (Barro-Lee)				
	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 hours (Barro-Lee)				
	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

1/ Survival time regressions based on spells defined using a growth cutoff (g) of 2 percent. Regressions control for interest shocks, terms of trade shocks, the gini coefficient, and initial income.

- Effect could be large but is very imprecisely estimated. Small samples.

Higher mortality—particularly child mortality—appears to be associated with shorter growth spells

Duration Regressions: Health 1/

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	Infant Mortality (deaths per 100)				
	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
2	Adult Mortality (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
	Change within spell	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

1/ Survival time regressions based on spells defined using a growth cutoff (g) of 2 percent. Regressions control for interest shocks, terms of trade shocks, the gini coefficient, and initial income.

- Again, effect could be large but is imprecisely estimated

Countries that liberalize trade during a growth spells appear to prolong spells

Duration Regressions: Trade Liberalization and Openness 1/

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	Trade liberalization (Wacziarg-Welch)				
	Initial level	**0.26**	**0.21**	0.31	**0.17**
		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	Openness (PWT 6.2,adjusted 2/)				
	Initial level	0.99	1.00	**0.98**	0.99
		3.2E-01	3.6E-01	**4.5E-02**	1.8E-01
	Change within spell	0.99	0.99	**0.97**	0.99
		1.4E-01	1.5E-01	**2.5E-02**	1.2E-01
	Spells/failures	74/34	118/64	49/15	73/25

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

2/ Residuals in a regression of the trade share of GDP on size, remoteness, and similar structural characteristics.

- Although effect of trade *liberalization* is robust, relationship between *openness* and duration is much weaker (whether or not adjusted measures are used)

Export orientation seems to prolong growth spells

Duration Regressions: Indicators of "Export Orientation" 1/

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	Overvaluation (residual of cross-sectional regressions of price levels on PPP GDP per capita				
	Initial level	1.00	1.00	1.01	***1.01***
		8.0E-01	3.4E-01	4.5E-01	***8.9E-02***
	Change within spell	1.00	1.00	**1.01**	**1.02**
		7.9E-01	4.4E-01	**2.0E-02**	**5.3E-03**
	Spells/failures	81/40	128/76	49/18	78/33
2	Manufacturing exports/Total exports (percent, WDI)				
	Initial level	0.99	0.99	1.00	0.99
		2.5E-01	1.5E-01	9.3E-01	2.9E-01
	Change within spell	***0.98***	**0.98**	**0.96**	**0.98**
		6.8E-02	**3.9E-02**	**2.0E-02**	**2.9E-02**
	Spells/failures	41/23	71/42	28/13	44/20
3	Current Account Balance (percent of GDP, WDI and IFS)				
	Initial level	0.95	0.93	0.84	0.88
		5.1E-01	2.1E-01	2.2E-01	2.8E-01
	Change within spell	0.95	**0.90**	**0.76**	**0.84**
		4.6E-01	**1.8E-02**	**6.5E-03**	**2.9E-02**
	Spells/failures	28/11	54/25	23/6	32/7

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

2/ Residuals in a regression of the trade share of GDP on size, remoteness, and similar structural characteristics.

Macro volatility appears to be associated with shorter spells

Duration Regressions: Macroeconomic Volatility 1/

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)				
	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

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

2/ Observations in excess of 40.5 percent per annum replaced by missing values.

- Effects can be felt even after dropping extreme values, e.g. focusing on moderate inflation only

Combined regressions: effects generally hold up

Summary Regression 1/
(hazard ratios and *p* values shown)

	5 year minimum spell		8 year minimum spell	
	$p_{BR} = 0.1$	$p_{BR} = 0.25$	$p_{BR} = 0.1$	$p_{BR} = 0.25$
Variable				
Log (1+inflation)	1.01	1.00	1.05	1.00
	1.4E-01	3.0E-01	2.7E-01	6.1E-01
Inequality (Gini Coefficient)	**1.16**	1.03	**1.14**	**1.10**
	3.7E-05	2.5E-01	**4.4E-02**	**3.3E-03**
Democratization (change within spell)	**0.98**	**0.98**	0.99	**0.97**
	1.1E-02	**2.4E-03**	4.6E-01	**5.0E-03**
Trade Liberalization	0.92	***0.40***	0.48	**0.18**
	9.0E-01	***5.6E-02***	4.5E-01	**1.3E-02**
Overvaluation	1.01	**1.01**	1.01	**1.02**
	5.9E-01	**1.2E-02**	4.6E-01	**3.8E-03**
Infant Mortality (per 100)	1.09	0.96	1.12	***1.18***
	5.1E-01	5.4E-01	6.5E-01	***7.7E-02***
Spells/failures	37/18	69/40	26/10	40/21

1/ Based on spells defined using growth cutoff of $g = 2$ percent. Regression also controls for terms of trade shocks, U.S. interest rate changes, and initial income.

Next steps

- Robustness to variations in spells criteria
- More data to be able to control for more determinants simultaneously (longer time series data for output per capita, to include spells that currently start “before” the sample).
- Look at additional covariates
  - Conflict/war
  - Economic institutions
  - Domestic savings vs. foreign savings.

Differences with respect to Bai-Perron

1. **Testing algorithm**
   - BP test *p versus p*+1 breaks in each segment, up to *m*
   - We test *p versus up to m* breaks in each segment.
2. **Critical values**
   - BP use asymptotic critical values
   - We bootstrap sample-specific critical values for each segment, based on characteristics of that segment (sample size and distribution)