Sustained Investment Accelerations

Libman, E., Montecino, J. and Razmi, A.

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Background and Motivation

- Investment and the level of the capital stock per capita are important determinants of long-run growth and per capita income
- We are interested in *sustained accelerations*
- Studies of export acceleration (Freund and Pierola 2008), growth acceleration (Hausmann et. al. 2005), consumption booms (Montiel 2000), etc.
- None to our knowledge of investment surges

Some stylized facts

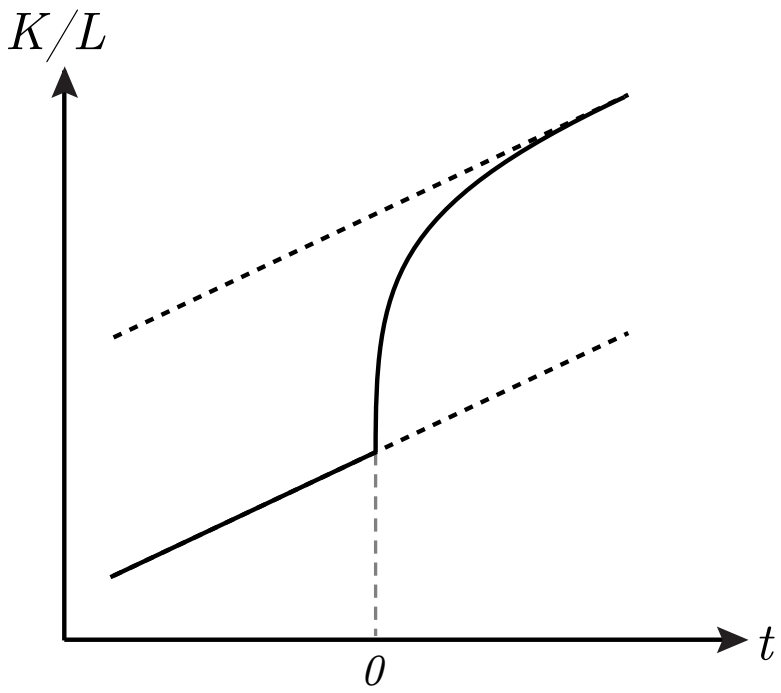
- Capital stock per worker varies widely across countries (from 725 in Zimbabwe to 302,000 in Qatar in 2011)
- Rates of investment vary widely across countries (29% in East Asia to less than 20% in South Asia and Latin America between 1950-2011)
- Within country growth rates of capital stock per worker vary significantly across time

More characteristics of investment

- Investment continues to be correlated with domestic savings (Feldstein-Horioka puzzle)
- Similar saving rates give rise to different investment rates across countries (East Asia vs. the Middle East and North Africa)
- Similar initial conditions can lead to divergent investment outcomes

Theoretical considerations

- In the Solow framework with technological progress, the steady state level of investment per worker is constant.
- However, the half-lives can be quite long (slow speed of adjustment during transition)

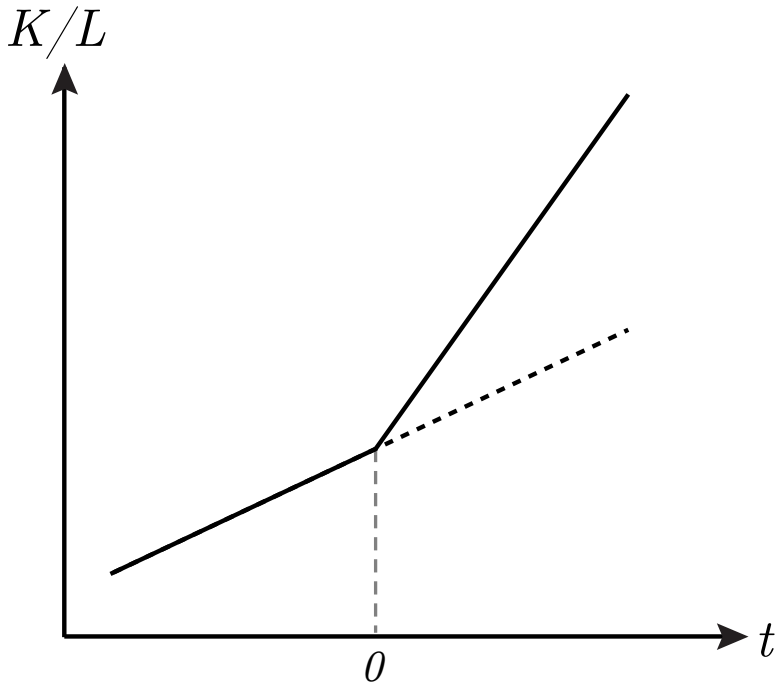


Theoretical considerations

- In the AK growth model framework capital stock growth (externalities and human capital)
- Policy can have *permanent* effects
- In models with underemployed labor, capital stock growth is endogenous, even with constant returns to scale and even in the absence of labor force growth or technological progress.
- Harrod-Domar growth model, etc.

Theoretical considerations (contd.)

With or without transitional dynamics



Structure of Presentation

- Episode identification
- Frequency and nature of episodes
- What happens before and after episodes?

A Preview of the main results

- Episodes are quite common. Any given country will experience about 1 or 2 in 50 years.
- They are more common in middle income, Asian countries
- Episodes seems to be related to real exchange rate undervaluation, capital outflows and prudent macro policies (crisis are not good, as expected)
- During episodes, exchange rates seems to promote sector allocation of resources between the tradable and the non-tradable sector. Exports increase, by imports increase even more.

Episode identification

Episodes must satisfy...

1. Annual per capita capital stock growth over a seven-year period must be over 3.5 percent
2. Annual per capita capital stock growth must have accelerated by at least 2 percentage points during the seven-year period
3. The level of capital per worker after the seven year period must exceed its historical peak

Episode identification

Filtering program steps:

1. Calculate fitted-growth rate of $k_{it} = K_{it}/L_{it}$ over 7-year windows
2. Apply criteria 1-3
3. Choose optimal episode start date

Episode identification

- Run rolling regressions over 7-year windows w for each country i:

$$\ln k_{it}^{w} = \alpha_i^{w} + g_i^{w} t + u_{it} \tag{1}$$

- Obtain fitted $\hat{g}_i^{w}$

Episode identification

- Run rolling regressions over 7-year windows w for each country i:

$$\ln k_{it}^{w} = \alpha_i^{w} + g_i^{w} t + u_{it} \tag{1}$$

- Obtain fitted $\hat{g}_i^{w}$
- Identify candidate episode starting years
- Need to rule out competing candidate years

Episode identification

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- Obtain fitted $\hat{g}_i^{w}$
- Identify candidate episode starting years
- Need to rule out competing candidate years
- Run Chow tests for each candidate start year τ:

$$\ln k_{it} = \alpha_i + t \cdot (\beta_{1i} \mathbf{1}(t < \tau) + \beta_{2i} \mathbf{1}(t > \tau)) + u_{it} \tag{2}$$

Episode identification

- Run rolling regressions over 7-year windows w for each country i:

$$\ln k_{it}^{w} = \alpha_i^{w} + g_i^{w} t + u_{it} \tag{1}$$

- Obtain fitted $\hat{g}_i^{w}$
- Identify candidate episode starting years
- Need to rule out competing candidate years
- Run Chow tests for each candidate start year τ:

$$\ln k_{it} = \alpha_i + t \cdot (\beta_{1i} \mathbf{1}(t < \tau) + \beta_{2i} \mathbf{1}(t > \tau)) + u_{it} \tag{2}$$

- Choose τ that maximizes F-stat

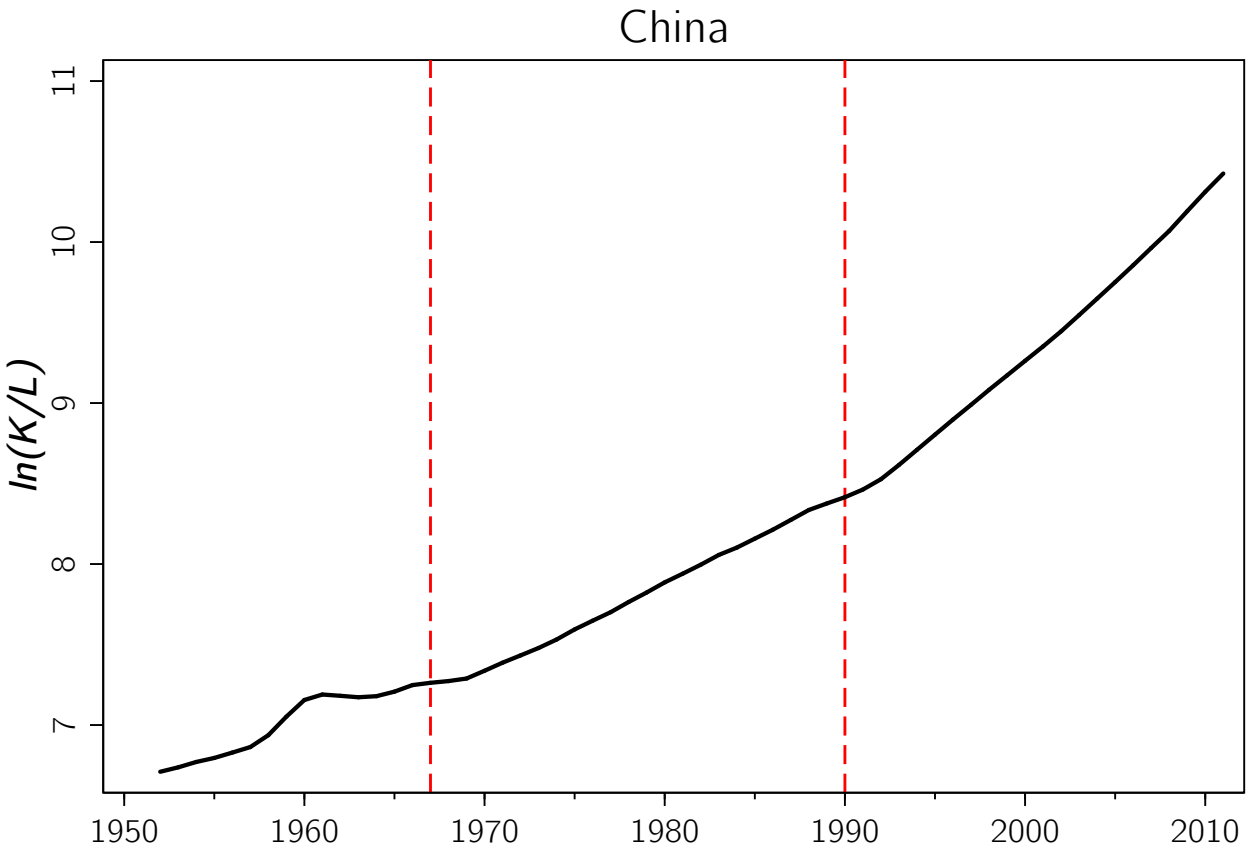
Episode identification

- Increasingly stricter growth and acceleration criteria as robustness check

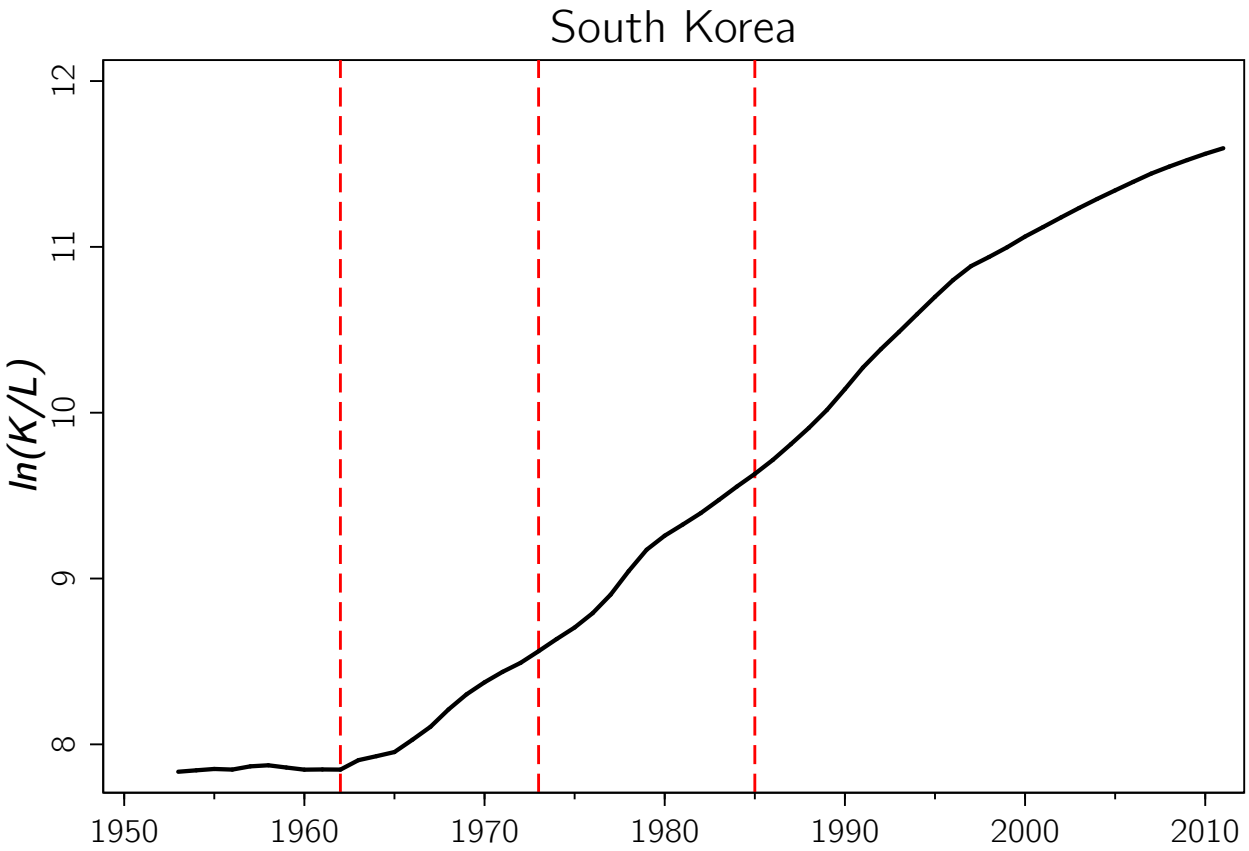
	Growth threshold (g_i^w)	Acceleration threshold (Δg_i^w)
Baseline filter	> 3.5	> 2
Strict filter	> 5	> 3
Very strict filter	> 7	> 4

- **Baseline filter**: 190 total episodes
- **Strict filter**: 100 total episodes
- **Very strict filter**: 38 total episodes

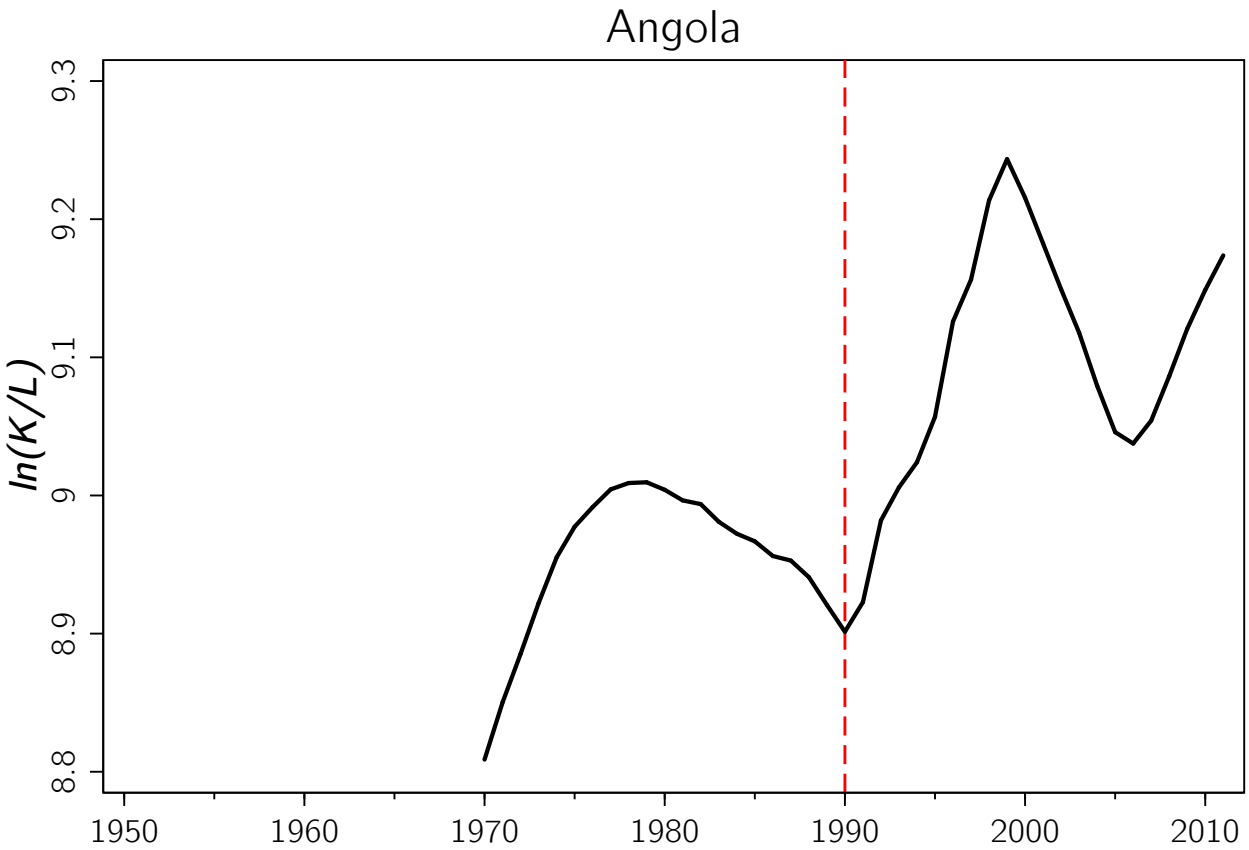
A few episodes...



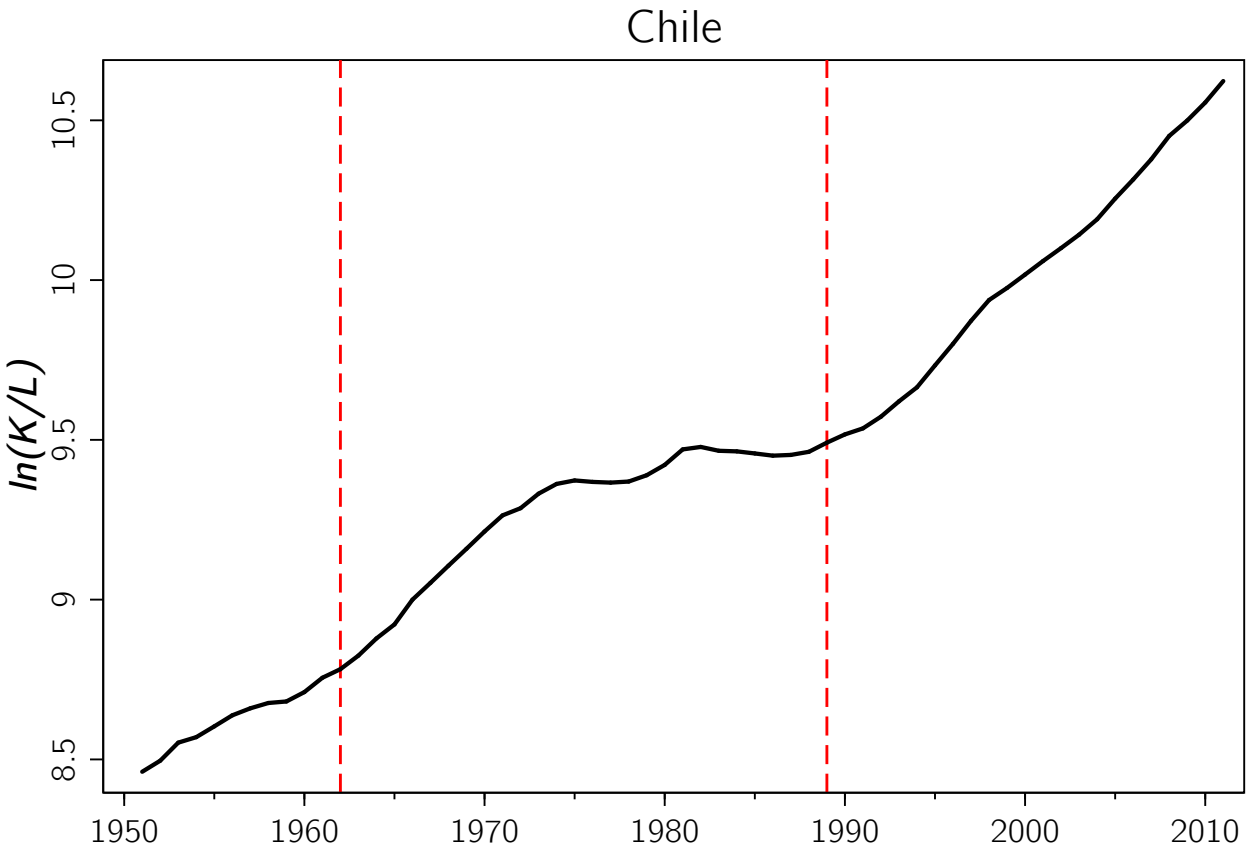
A few episodes...



A few episodes...



A few episodes...



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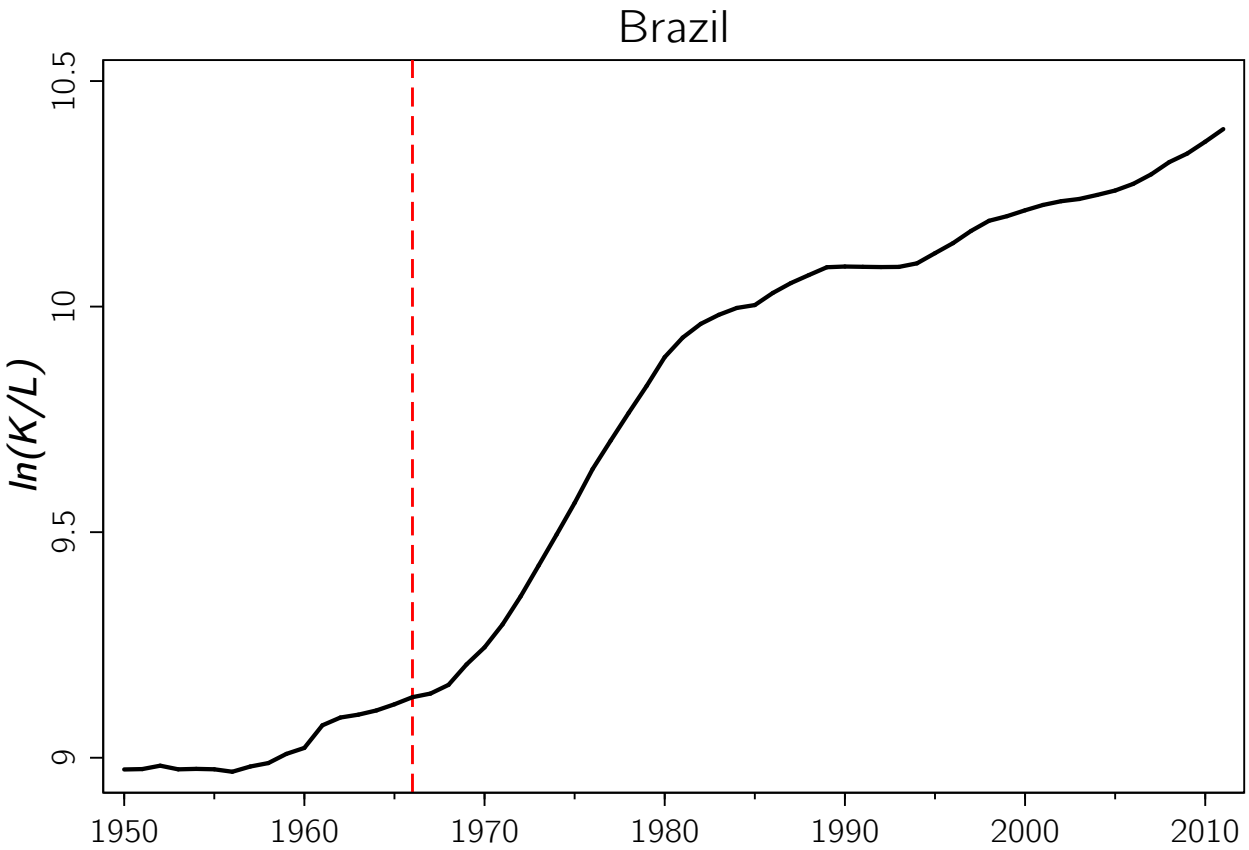
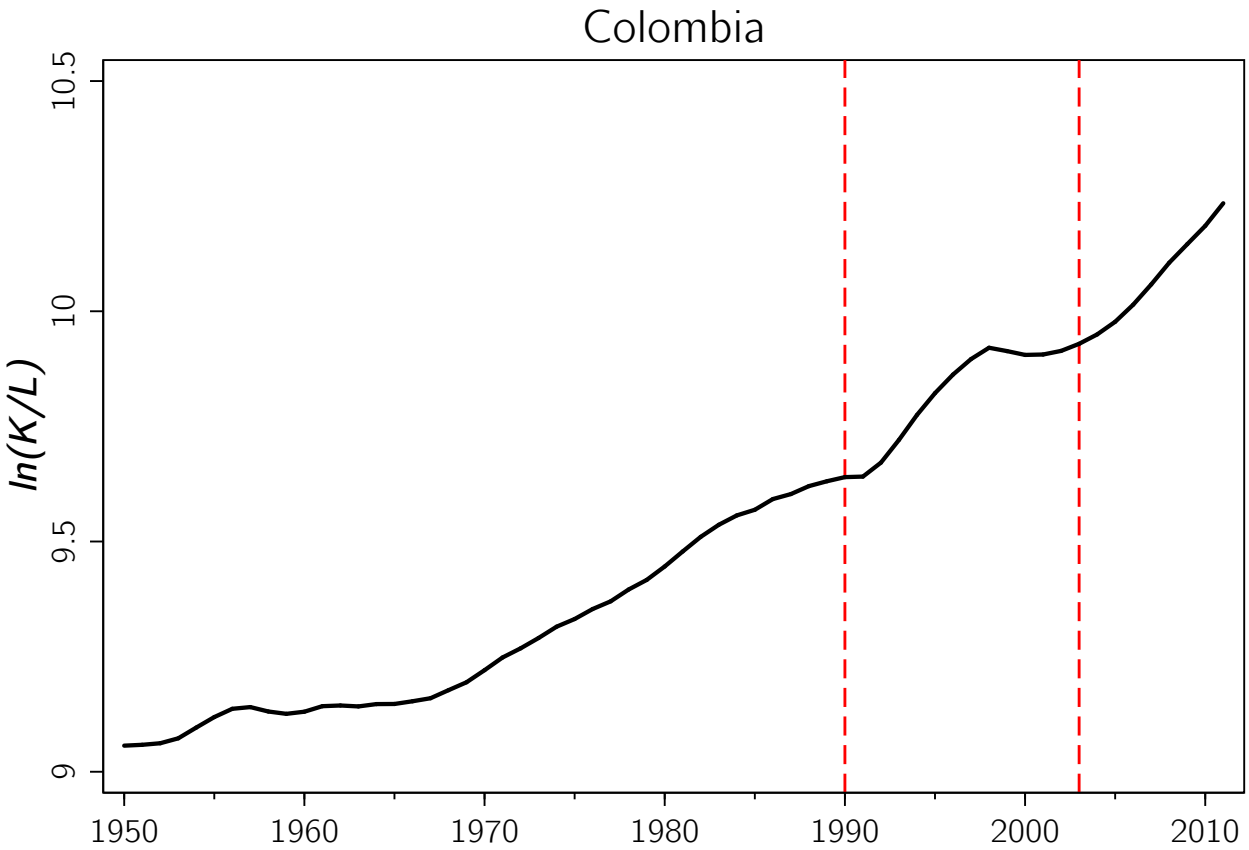


A few episodes...



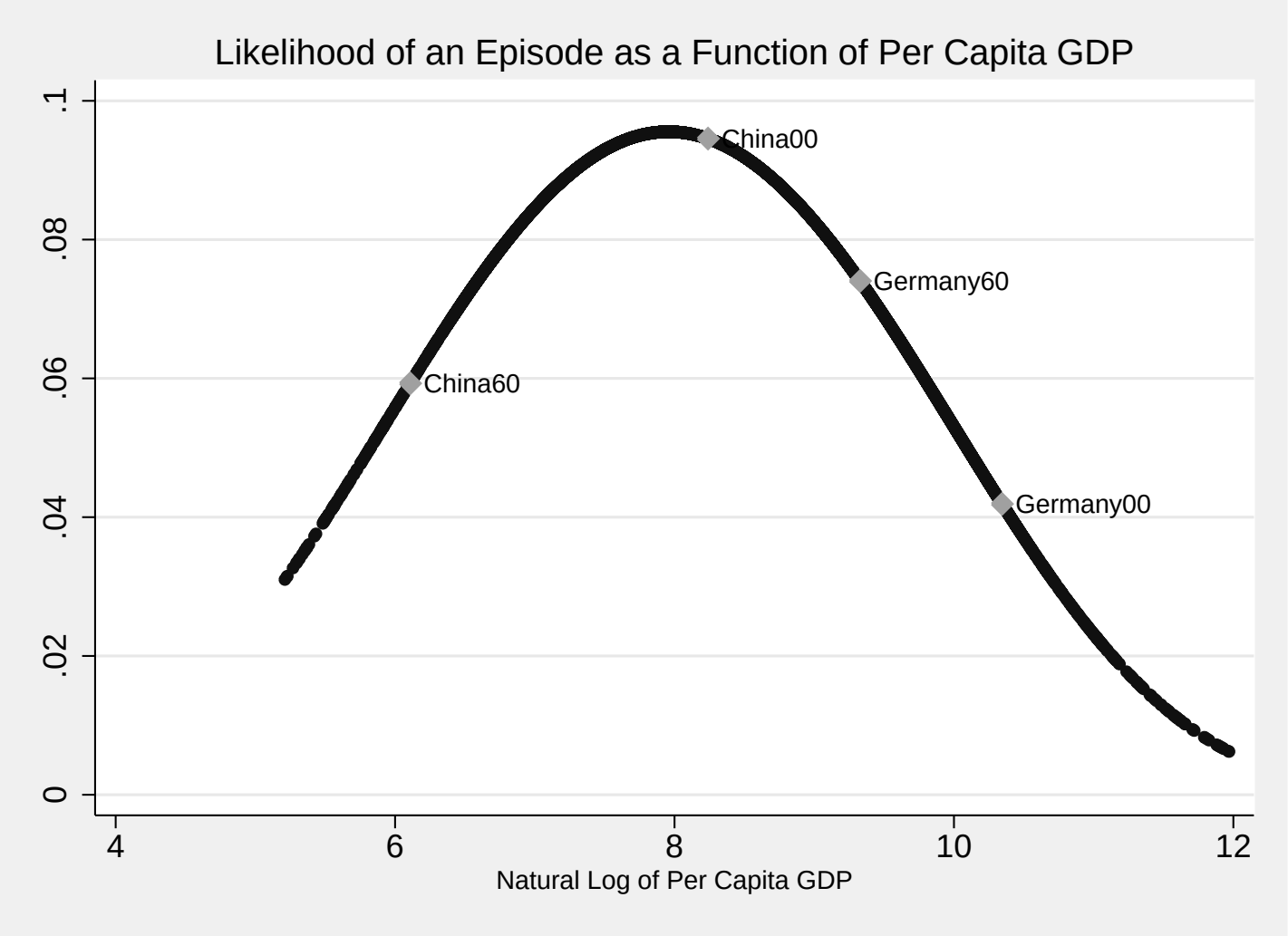
Unconditional Probabilities by Region

Decade	1950s	1960s	1970s	1980s	1990s	2000s	Total
East Asia and Pacific	0.0286	0.0362	0.0574	0.0311	0.0403	0.0430	0.0395
Latin-American and the Caribbean	0.0089	0.0259	0.0357	0.0160	0.0287	0.0432	0.0269
Middle East and North Africa	0.0508	0.0067	0.0833	0.0216	0.0196	0.0690	0.0367
South Asia	0.0000	0.0156	0.0556	0.0385	0.0172	0.107	0.0352
Sub-Saharan Africa	0.0000	0.0164	0.0280	0.0201	0.0180	0.0380	0.0206
Developed	0.0000	0.0102	0.0062	0.0020	0.0162	0.0394	0.0111
Total	0.0092	0.0168	0.0299	0.0152	0.0211	0.0450	0.0223

Unconditional Probabilities by Income

Decade	1950s	1960s	1970s	1980s	1990s	2000s	Total
1st Quintile	0.0351	0.0230	0.0271	0.0180	0.0240	0.0373	0.0250
2nd Quintile	0.0141	0.0229	0.0420	0.0217	0.0233	0.0382	0.0280
3rd Quintile	0.0500	0.0563	0.0647	0.0221	0.0244	0.0536	0.0407
4th Quintile	0.0000	0.0253	0.0432	0.0298	0.0234	0.0785	0.0357
5th Quintile	0.0000	0.0000	0.0122	0.0061	0.0133	0.0206	0.0119
Total	0.0092	0.0168	0.0299	0.0152	0.0211	0.0450	0.0223

And it looks like...



Preliminary empirical results

We estimate the following probit model:

$$Episode_{it} = \alpha_0 + \mathbf{X}_{it}\boldsymbol{\beta} + u_{it} \tag{3}$$

where $\mathbf{X}_{it}$ includes:

- **Policy Variables**: undervaluation index (*Underval81*), fiscal procyclicality (*Fiscal*), inflation (*Inflation*), and exchange rate stability (*XR_Stability*).
- **Internal Variables**: crisis (banking, currency, debt, etc.) (*Crisis_5y*), natural resource rents on GDP (*Rents*), and per capita GDP (*Capita_GDP*).
- **External Variables**: net capital flows (*NET_Inflows*), the FED reserve Federal Funds interest rate (*FFend*), world stock markets volatility (*Global_uncertainty*), terms of trade (*TOT*), trade openness (*Trade*), and capital account openness (*KA_open*).
- **Institutional Variables**: human capital (*Human_Capital*), and the durability of the political regime (*Durable*)

Variable Descriptions

POLICY VARIABLES	Description	Source
Underval81	Undervaluation index	PWT 8.1
Fiscal	5 year corr. of GDP and Gov. Cons (dev. from trends)	WDI
Inflation	Rate of Inflation	WDI
XR_Stability	Chin-Ito-Aizenmann Exchange Rate Stability Index	Aizenmman et. al.
INTERNAL VARIABLES		
Crisis_5y	Dummy for a crisis episode in any of the previous 5 years	Laeven and Valencia
Rents	Share or natural resource rent on GDP	WDI
Capita_GDP	Per Capita GDP	PWT 8.1
EXTERNAL VARIABLES		
NET_Inflows	Net capital Inflows / Trend GDP (3 year avg.)	Broner et. al.
FFend	Federal Funds Rate (end of period)	FRED
Global_uncertainty	Volatility of World Stock Market Index	FRED
TOT	Log of Terms of Trade	Spatafora and Tytel
Trade	De Facto Trade Openness	PWT 8.1
KA_open	Chin-Ito-Aizenmann Capital Account Openness Index	Aizenmman et. al.
INSTITUTIONAL VARIABLES		
Human_Capital	Years of education adjusted by the return of schooling	PWT 8.1
Durable	Political Regime Durability (years)	Polity IV Dataset

Summary Statistics

POLICY VARIABLES	Observations	Mean	SD	Max / Min	Expected Sign
Underval81	8275	0.0000	0.4086	2.1638 / -2.2791	+
Fiscal	4609	0.3498	0.5085	1 / -1	-
Inflation	5852	0.3192	3.9813	237.73 / -0.1764	+/-
XR_Stability	7333	0.6939	0.3282	1 / 0.0013	+/-
INTERNAL VARIABLES					
Crisis_5y	3963	0.0664	0.2489	1 / 0	-
Rents	6591	10.0348	14.3107	89.3287 / 0	+/-
Capita_GDP	8275	8.4326	1.2324	5.2112 / 11.9692	+/-
EXTERNAL VARIABLES					
NET_Inflows	2769	0.0080	0.0759	0.8167 / -0.5092	+/-
FFend	9686	5.2991	3.3649	16.38 / 0.1	-
Global_uncertainty	5678	20.2568	6.4431	40.82 / 9.8	-
TOT	3493	4.6615	0.2871	5.8793 / 3.0576	+/-
Trade	6767	0.7675	0.5010	5.6206 / 0.0531	+/-
KA_open	5595	0.0000	1.5244	0.24390 / -1.8640	+/-
INSTITUTIONAL VARIABLES					
Human_Capital	6927	0.6913	0.3115	0.0180 / 1.2861	+/-
Durable	7499	22.1756	28.9124	202 / 0	+/-

Baseline Probits - Marginal Effects

VARIABLES	Epil	Epil	Epil	Epil	Epil	Epil	Epil
Underval81	0.025***	0.061***	0.057***	0.047**	0.046**	0.045*	0.041*
Fiscal		0.021**	0.001	0.006	0.003	-0.000	-0.002
Inflation		-0.035*	-0.069***	-0.055***	-0.056***	-0.054***	-0.054***
XR_Stability		0.022	-0.009	-0.024	-0.026	-0.022	-0.022
Crisis_5y			-0.029**	-0.028**	-0.025**	-0.024*	-0.020
Rents			0.001	-0.000	-0.000	-0.000	-0.000
Trade			-0.020*	-0.013	-0.011	-0.013	-0.012
KA_open			-0.005	0.002	0.000	0.001	0.000
NET_Inflows			-0.201*	-0.425***		-0.351**	
FDI_Inflows					-0.001		0.001
Port_Inflows					-0.003***		-0.002**
TOT			-0.076**	-0.002	-0.005	0.007	0.002
FFend			-0.005**	-0.004*	-0.004*	0.001	-0.004
Global_Uncertainty			-0.003**	-0.002*	-0.002*	-0.003	-0.003
Human_Capital				0.030	0.026	0.019	0.015
Capita_GDP				-0.028**	-0.026**	-0.026**	-0.022*
Durable				-0.000	-0.000	-0.000	-0.000
Time Fixed Effects	No	No	No	No	No	Yes	Yes
Observations	6,129	3,114	1,023	982	970	860	848

*** p<0.01, ** p<0.05, * p<0.1

"Boom Probits" - Variable Descriptions

POLICY VARIABLES	Description	Expected Sign
Underval_change	Fifth quintile dummy of the 3 year change in undervaluation	+ / -
Regime_change	3 year change in Reinhart and Rogoff exchange rate regime classification	+ / -
INTERNAL VARIABLES		
Rents_boom	Fifth quintile dummy of the 3 year change in the share of natural resource rents	+ / -
EXTERNAL VARIABLES		
NET_boom	Fifth quintile dummy of the 3 year change in NET capital inflows	+ / -
TOT_boom	Fifth quintile dummy of the 3 year change in the terms of trade	+ / -
Trade_boom	Fifth quintile dummy of the 3 year change in trade openness	+ / -
KAopen_boom	Fifth quintile dummy of the 3 year change in the capital account openness	+ / -
INSTITUTIONAL VARIABLES		
Fiveregime	Changes of more than three points (up and down) in the polity index	+ / -

"Boom Probits" - Marginal Effects

VARIABLES	Epil	Epil	Epil	Epil	Epil	Epil
Underval_change	0.008	-0.004	-0.018	-0.015	-0.030**	-0.029**
Rchange		-0.010*	-0.017**	-0.014**	-0.019***	-0.018**
KA_open_boom		0.019*	-0.000	-0.005	-0.004	-0.007
Trade_boom		0.035***	0.035**	0.030**	0.044***	0.042***
TOT_boom		-0.012	-0.005	-0.002	0.009	0.007
Rents_boom		0.044***	0.056**	0.044**	0.049**	0.043*
NET_boom			-0.008		-0.004	
FDI_boom				0.016		0.002
Port_boom				-0.041***		-0.029**
Fiveregime		-0.010	-0.003	-0.004	-0.004	-0.005
Time Fixed Effects	No	No	No	No	Yes	Yes
Observations	5,826	2,615	1,557	1,532	1,409	1,384

*** p<0.01, ** p<0.05, * p<0.1

Episode Structure

We compare the change during 7 years of the share of value added and employment of manufacture and tradable sectors, and the 7 year change in the share of exports, imports and the trade balance on GDP:

$$SHARE_{i,t+6} - SHARE_{i,t} = \beta_0 + \beta_1 Trend_{i,t} + \beta_2 Epil_{i,t} + f_t + f_i + u_{i,t}$$

The sign of β_2 captures the effect of an episode on the share of each of these variables. To gain further insights on the structure of a typical episode, we replicate the previous table but we include the change in the share in the 6 years before an episode:

$$SHARE_{i,t} - SHARE_{i,t-6} = \beta_0 + \beta_1 Trend_{i,t} + \beta_2 Epil_{i,t} + f_t + f_i + u_{i,t}$$

Episode Structure - Effects after 7 years

VARIABLES	Manshare	Manemp	Tradshare	Tradaemp	Tbshare	Exposhare	Imposhare
EpiendI	0.003	0.007**	-0.012***	-0.012***	-0.023***	0.017***	0.040***
Trend	-0.000***	-0.001***	-0.000	-0.000	0.000	0.000*	0.000
Constant	0.011	0.008	-0.013	-0.036***	-0.062***	-0.018	0.044***
Time and Country Fixed Effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	2,018	1,934	2,009	1,934	7,219	7,219	7,219
R-squared	0.224	0.396	0.223	0.218	0.108	0.157	0.150

*** p<0.01, ** p<0.05, * p<0.1

Episode Structure - Effects at the begining

VARIABLES	Manshare	Manemp	Tradshare	Tradaemp	Tbshare	Exposhare	Imposhare
EpiendI	0.007***	0.003	0.007*	-0.000	0.029***	-0.007	-0.035***
Trend	0.000	-0.000***	-0.000**	-0.000	-0.001**	0.000	0.001***
Constant	-0.016	-0.004	0.002	-0.027***	-0.031*	-0.006	0.025*
Time and Country Fixed Effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1,885	1,843	1,882	1,843	6,832	6,832	6,832
R-squared	0.257	0.407	0.226	0.217	0.113	0.157	0.151

*** p<0.01, ** p<0.05, * p<0.1

Episode Sustainability

To analyze sustainability, we extend our filter to account for the behavior of capital accumulation during the 7 years after the end of an episode. We define "sustainable capital accumulation" to each observations that satisfies the original definition of an episode, plus:

- Annual per capita capital growth stock over a seven-year period after an episode must be at least 3.5 percent.

Likewise, we define "unsustainable capital accumulation" as:

- Each observation that satisfies the original definition, but per capita capital growth stock over a seven-year period after an episode is less than 3.5 percent.

According to the first filter, 123 cases are classified as "sustainable episodes" (out of a sample of 190), while the second and third filters classify 58 and 18 cases as sustained (out of a total of 100 and 38).

Sustainability Probits - Marginal Effects

VARIABLES	SusI	SusI	SusI	SusI	SusI	SusI	SusI
Underval81	0.020***	0.044***	0.041**	0.030*	0.029*	0.038*	0.034
Fiscal		0.009	0.003	0.008	0.005	0.001	-0.001
Inflation		-0.029*	-0.057***	-0.042***	-0.043***	-0.046***	-0.045***
XR_Stability		-0.007	-0.004	-0.020	-0.022	-0.019	-0.020
Crisis_5y			-0.018*	-0.016*	-0.014	-0.016	-0.013
Rents			0.001	-0.000	-0.000	-0.001	-0.001
Trade			-0.020*	-0.011	-0.011	-0.018	-0.017
KA_open			-0.006	0.002	0.000	0.000	-0.001
NET_Inflows			-0.137	-0.335**		-0.350**	
FDI_Inflows					0.000		0.001
Port_Inflows					-0.003**		-0.003*
TOT			-0.059**	0.023	0.018	0.034	0.026
FFend			-0.007***	-0.006*	-0.006*	-0.007	-0.006
Global_Uncertainty			-0.003**	-0.002*	-0.002*	-0.005	-0.004
Human_Capital				0.029	0.025	0.023	0.019
Capita_GDP				-0.027**	-0.025**	-0.033**	-0.028*
Durable				-0.000	-0.000	-0.000	-0.000
Time Fixed Effects	No	No	No	No	No	Yes	Yes
Observations	6,129	3,114	1,023	982	970	802	790

*** p<0.01, ** p<0.05, * p<0.1

Unsustainability Probits - Marginal Effects

VARIABLES	UnsusI	UnsusI	UnsusI	UnsusI	UnsusI	UnsusI	UnsusI
Underval81	0.004	0.014**	0.002	0.000	0.000	0.000	0.000
Fiscal		0.011*	-0.000	0.000	-0.000	0.000	0.000
Inflation		-0.006	-0.001	-0.000	-0.000	-0.000	-0.000
XR_Stability		0.030***	-0.000	0.000	0.000	-0.000	-0.000
Crisis_5y			-0.001	-0.000	-0.000	-0.000	-0.000
Rents			-0.000	-0.000	-0.000	-0.000	-0.000
Trade			-0.000	-0.000	-0.000	-0.000	-0.000
KA_open			0.000	0.000	0.000	0.000	0.000
NET_Inflows			-0.005	-0.000		0.000	
FDI_Inflows					-0.000		0.000
Port_Inflows					0.000		0.000
TOT			-0.001	-0.000	-0.000	-0.000	-0.000
FFend			0.000	0.000	0.000	-0.000	-0.000
Global_Uncertainty			0.000	0.000	0.000	-0.000	-0.000
Human_Capital				-0.000	-0.000	-0.000	-0.000
Capita_GDP				0.000	0.000	0.000	0.000
Durable				-0.000	-0.000	0.000	0.000
Time Fixed Effects	No	No	No	No	No	Yes	Yes
Observations	6,129	3,114	1,023	982	970	243	243

*** p<0.01, ** p<0.05, * p<0.1

Preliminary empirical results

- Episodes of fast capital accumulation are not uncommon, most likely at middle income level.
- RER undervaluation, capital outflows (portfolio flows), macroeconomic stability (i.e., no domestic crisis and an externally favorable financial condition) and exceptionally large increases in natural resources robustly predict investment acceleration episodes.
- There is some evidence that episodes allocates resources towards the tradable sector (mainly manufacturing) during episodes.
- Exports increase during an episode, but imports increase by more. Imports are below average before an episode starts.
- Most episodes seems to be sustained over time (most results apply to sustained episodes).

Thank You :)