Serial Defaulters: an attempt to account for the unobservable

Vivian Norambuena

Skopje, Republic of Macedonia. April, 2014

Three main stylized facts:

- First, most of Emerging Market Economies (EMEs) display a history of multiple sovereign debt defaults episodes, behaving like *serial defaulters*.
- Secondly, these economies are prone to default at relatively low levels of external debt, thus, showing *debt intolerance*
- Thirdly, default episodes are highly persistent; once an EME enters the state of default, it spends on average 9 years in it.

Motivation

Definition of sovereign debt default (according to S&P):

- the central government fails to pay scheduled debt service on the due date (interest or principal) or when
- rescheduling of principal/interest is agreed at less-favorable terms than the original loan

Motivation

When does the country exit the state of default?

- Each year a country is in default it is accumulating arrears on either principal, interests, or both
- To exit the state of default the country has to go through a debt re-negotiation process with creditors
- The above culminates in the exchange of newly issued debt for old debt
- When S&P concludes "that no further negotiation claim is likely, the country exits from default."

Table 1: Serial defaulters

COUNTRY PERIOD	NUMBER OF DEFAULTS (1800-2010)	YEARS IN DEFAULT (%)[1] (1800-2010)	EXTERNAL DEBT/GDP (%)[2] (1970-2010)
Argentina	6	32	25
Brazil	9	27	25
Chile	9	27	27
Colombia[3]	6	35	---
Costa Rica	8	35	82
Dominican Republic	7	28	19
Ecuador	9	57	43
Guatemala	7	31	28
Mexico	8	44	30
Nicaragua	6	47	69
Paraguay	7	23	46
Peru	8	40	36
Turkey/Ottoman Empire	9	15	20
Uruguay	9	13	47
Venezuela	9	36	33
Average	7.8	33	38

1. Percentage of years in default since independence year or 1800, whichever comes later.

2a. PPG external debt: long-term external public debt, plus private debt guaranteed for repayment by a public entity.

2b. Average PPG external debt the country had one year prior default.

3. Colombia did not have a default episode between 1970-2010.

Source: Author's calculation from data in Reinhart and Rogoff (2011) and World Bank (WDI).

Motivation

- Why sovereign debt defaults are so persistent in most of EMEs, even at relatively low levels of debt?
- The empirical literature has invoked history to explain this phenomenon, arguing that the country's record of defaults is the main determinant of the future default risk.
- However, there are two factors that have not been disentangled behind the effect of history on the probability of default: state dependence and unobserved heterogeneity.

Two possible explanations

- **State dependence:** the fact that a country experienced a default in the past makes it more likely to default again: ▸ Examples1
- **Unobserved heterogeneity:** time invariant characteristics such as different historical, political, cultural and religious factors that have shaped institutions and economic development of countries that influence the probability of default: ▸ Examples2
- An estimate of it could be seen as a sufficient statistic for the institutional background of a country.

Why is this distinction important?

- State dependence gives the long-run impact of policies that affect the current default status, measuring it accurately is important.
- It is crucial to have precise estimates of the parameters, to better determine safe thresholds of debt that a country should target to avoid a default
- Since unobserved heterogeneity is correlated over time, the failure to account for it could give a spurious degree of state dependence or at least an overstated one.
- If the same unobserved heterogeneity that is determining the probability of default is also influencing any other explanatory variable, endogeneity might arise.

External debt and default risk

- Countries that have defaulted in the past are perceived by the market as riskier than countries that have never defaulted even if they sustain the same level of debt: ▸ Figure1

Question

Is a country more likely to default because it has experienced a default in the past (state dependence)

or

has the country some specific characteristics that make it more prone to default (unobserved heterogeneity)?

Different behaviors across countries:

- Some EMEs tend to behave like serial defaulters: ▸ Table1
- Some countries default less often: ▸ Table2
- Some other countries have never defaulted: ▸ Table3
- Some serial defaulters from the past and some at risk again: ▸ Table4

Literature

Empirical literature

- Reinhart & Rogoff (2003) called this phenomenon debt intolerance. To explain the "serial defaulters" phenomenon they invoke history (cross-section estimation)
- Most of the studies focus on the beginning of a default, excluding the observations of the continuation of the default episode, by doing this persistence can not be properly captured
- They estimate by binary response models that are either pooled or random effects (using probit or logit)

Literature

Empirical literature

- However, pooled or random effects are inadequate when specific-country effects influence the probability of experiencing a default and are correlated with other regressors.
- In this context estimators are inconsistent and a fixed effects model is a more reasonable approach
- However, the estimates from a non-linear model with fixed effects and dynamics can be seriously biased by the incidental parameter problem.

Literature

Empirical literature

- Dealing with the incidental parameter problem has been technically challenging
- In the econometric literature Hahn & Kuersteiner (2011), Arellano & Hahn (2006), Carro (2007), Fernandez-Val (2007), Fernandez-Val & Vella (2011) have introduced biased corrected estimators
- Dhaene & Jochmans (2012) propose a jackknife method to reduce the bias of the maximum likelihood estimator (MLE) of non-linear dynamic fixed effect panel models.

Methodology

The probability of sovereign debt default:

$$d_{it}^{*} = \tau d_{i,t-1} + x_{it}^{'}\beta_1 + \alpha_i + \delta_t + v_{it} \tag{1}$$

$$d_{it} = \begin{cases} 1 & \text{if } d_{it}^{*} > 0 \\ 0 & \text{otherwise} \end{cases}$$

The inclusion of the lagged dependent variable ($d_{i,t-1}$) allows to disentangle the time invariant (α_i) unobserved heterogeneity from the role of state dependence.

Methodology

- The probability of default described above can be written more briefly as:

$$d_{it} = 1\left\{\tau d_{i,t-1} + x_{it}^{'}\beta_1 + \alpha_i + \delta_t + v_{it} > 0\right\} \qquad (2)$$

- Equation (2) is estimated by a Probit Fixed effects
- In this way, the endogeneity coming from the time invariant effects is controlled
- Estimators need to be biased corrected for the incidental parameter problem

Incidental Parameter Problem

Let $f_{it}(\theta, \alpha_i) = f(y_{it}/x_{it}; \theta, \alpha_i)$ be the MLE density function of θ_0 where $\theta = (\tau, \beta, \delta)$.

$$\hat{\alpha}_i(\theta) \equiv \arg\max \frac{1}{T} \sum \log f_{it}(\theta, \alpha_i)$$

$$\hat{\theta} \equiv \arg\max \frac{1}{NT} \sum\sum \log f_{it}(\theta, \hat{\alpha}_i(\theta))$$

So, $\hat{\theta}$ is inconsistent for θ_0 because it includes estimates of the incidental parameters $\alpha_1, ..., \alpha_N$. (Neyman and Scott, 1948)

Bias Correction

- The form of the bias-corrected estimator is the following:

$$\tilde{\theta} \equiv \hat{\theta} - \frac{\hat{B}}{T}$$

where $\theta = (\tau, \beta, \delta)$, $\hat{\theta}$ is the unadjusted fixed effect estimate, $\hat{B}$ is the estimate of the bias term and T is the number of years in the sample

- Hahn and Kuersteiner (2011) proposed an analytical expression for $\hat{B}$
- The bias-corrected fixed effect, $\hat{\alpha}_i(\tilde{\theta})$, is the estimate of α_i at $\tilde{\theta}$.
- Marginal effects are computed at the bias-corrected estimates (Arellano and Hahn, 2006b)

Empirical Evidence

Determinants of the probability of default:

- Theoretical papers consider mainly three variables: level of debt, GDP shock and political uncertainty.
- Indebtedness scaled to GDP or to exports:
  - PV of external public and publicly-guaranteed (PPG) debt
  - Nominal external PPG debt
  - Debt service on external PPG debt
- Governance indicator: The Political Risk Rating
- The GDP growth is included as a measure of shock
- The GDP per-capita

Table 2: Summary Statistics (%), 1970-2010

VARIABLE	1 YEAR PRIOR TO DEFAULT	DEFAULT		NON-DEFAULT	
	Mean	Mean	Std. Dev.	Mean	Std. Dev.
External debt-to-GDP	32.1	63.4	80.0	23.4	19.1
PV external debt-to-EXP	333	685	3527	197	1157
Debt service-to-EXP	30.0	61.5	294.0	23.0	19.1
Political Risk Index	54.7	54.2	9.4	62.7	10.7
GDP growth (real)	0.3	2.1	5.2	4.6	4.3
Share of short-term debt	20.2	13.7	8.5	16.5	10.7
Reserves/imports	34.3	96.0	727.0	37.0	53.0
Inflation rate	209	210	1417	20	175
Observations		428		1244	

Source: Author's calculation from data in Reinhart and Rogoff (2011) and World Bank (WDI).

Table 3: Dependent variable: default dummy, 1985-2010

	INDEX COEFFICIENTS		
VARIABLE	Pooled MLE	FE MLE	BC MLE
Default lag	2.633***	1.685***	1.866***
	(0.158)	(0.199)	(0.204)
		[0.347]	[0.350]
PPG external debt-to-GDP (%)	0.012***	0.015*	0.015*
	(0.003)	(0.008)	(0.008)
		[0.013]	[0.013]
GDP growth lag (%)	-0.061***	-0.059**	-0.061**
	(0.019)	(0.024)	(0.025)
		[0.033]	[0.034]
Political Risk Indicator	-0.026***	-0.077***	-0.075***
	(0.009)	(0.016)	(0.017)
		[0.028]	[0.028]
Log GDP per capita	-0.208*	-0.620	-0.538
	(0.120)	(0.537)	(0.545)
		[0.817]	[0.816]
Observations	936	650	

Note: Asymptotic standard errors in parenthesis, bootstrap standard errors in brackets (999 replications). Country and year dummies included. Sample size: N=36, T=26.

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

Table 4: Dependent variable: default dummy, 1985-2010

	AVERAGE MARGINAL EFFECTS		
VARIABLE	Pooled MLE	FE MLE	BC MLE
Default lag	0.289***	0.219***	0.247***
	(0.013)	[0.055]	[0.072]
PPG external debt-to-GDP (%)	0.001***	0.001	0.001
	(0.000)	[0.001]	[0.001]
GDP growth lag (%)	-0.007***	-0.005*	-0.005*
	(0.002)	[0.003]	[0.003]
Political Risk Indicator	-0.003***	-0.006***	-0.006***
	(0.001)	[0.002]	[0.002]
Log GDP per capita	-0.023*	-0.051	-0.042
	(0.013)	[0.058]	[0.053]

Note: Asymptotic standard errors in parenthesis, bootstrap standard errors in brackets (999 replications). Country and year dummies included. Sample size: N=36, T=26.

*** p<0.01, ** p<0.05, * p<0.1 (using bootstrap standard errors)

Table 5: Predicted probability of default evaluated at different Xs and FE percentiles

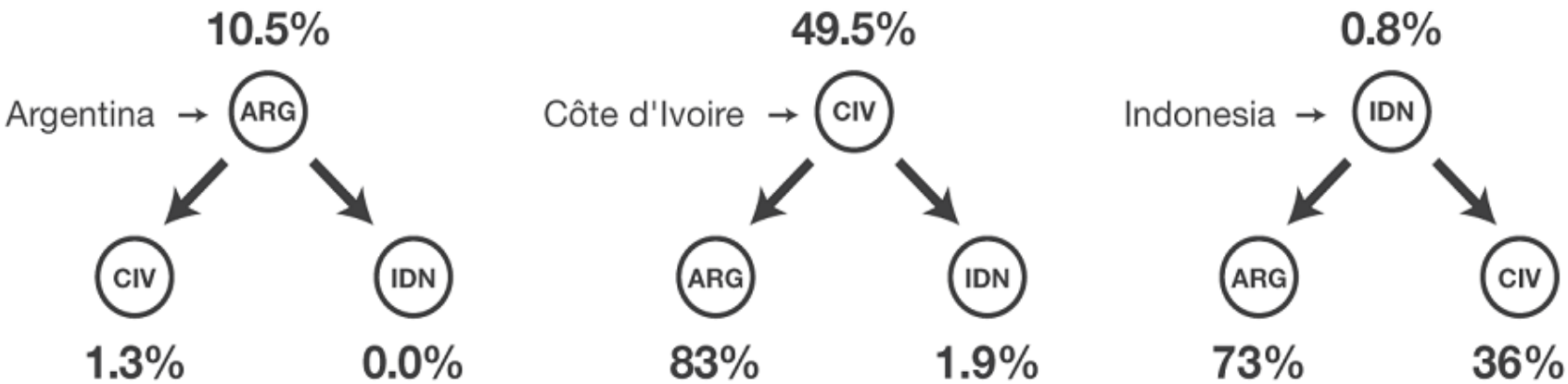
PERCENTILES	CONDTIONAL PROBABILITY OF DEFAULT (MEAN OVER COUNTRIES)				
	FE	PPG external debt-to-GDP	GDP growth	Political Risk Indicator	Log (GDP per capita)
5th	0.3	2.1	10.1	26.3	13.0
15th	0.7	2.4	7.0	18.9	10.1
25th	1.8	2.8	6.1	11.6	8.2
35th	3.5	3.1	5.5	8.1	6.8
45th	4.6	3.7	5.0	5.4	5.7
55th	12.4	4.4	4.6	4.3	4.7
65th	15.8	5.3	4.3	3.5	3.7
75th	19.3	6.3	4.0	2.8	3.1
85th	21.3	8.8	3.5	1.9	2.5
95th	41.4	16.1	2.9	1.2	1.6
MAX	46.5	59.6	1.1	0.5	1.1

Note: The predicted probabilities of each country in column are computed moving the amount of the ...fixed effect from the 5th to the 95th percentile of its distribution and keeping the rest of the variables constant at the country's median; while the ones computed in columns 2-5 move one explanatory variable; throughout its distribution (every other variable is held constant at the country's median and the fi...xed effect at its country's value).

Analyzing the impact of unobserved heterogeneity:

$$\hat{P}_{ij}(D_t / D_{t-1}, \tilde{X}_i, \tilde{\alpha}_j, \tilde{\beta}) = \Phi(\tilde{\alpha}_j + \tilde{\beta}_1 * D_{i,t-1} + \tilde{\beta}' \tilde{X}_i)$$

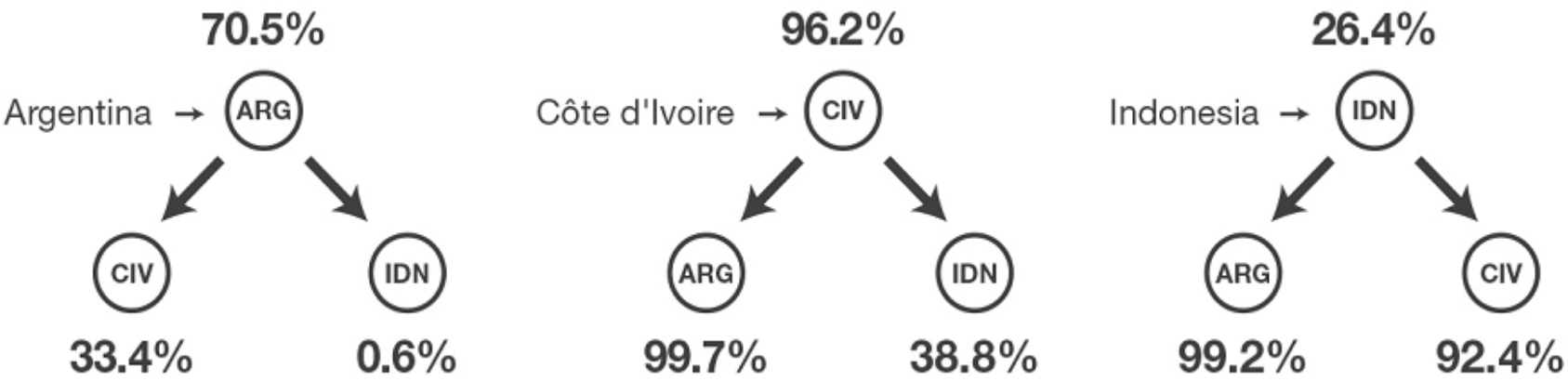
Figure 1a: Conditional probability of default at different α_j, $D_{t-1} = 0$



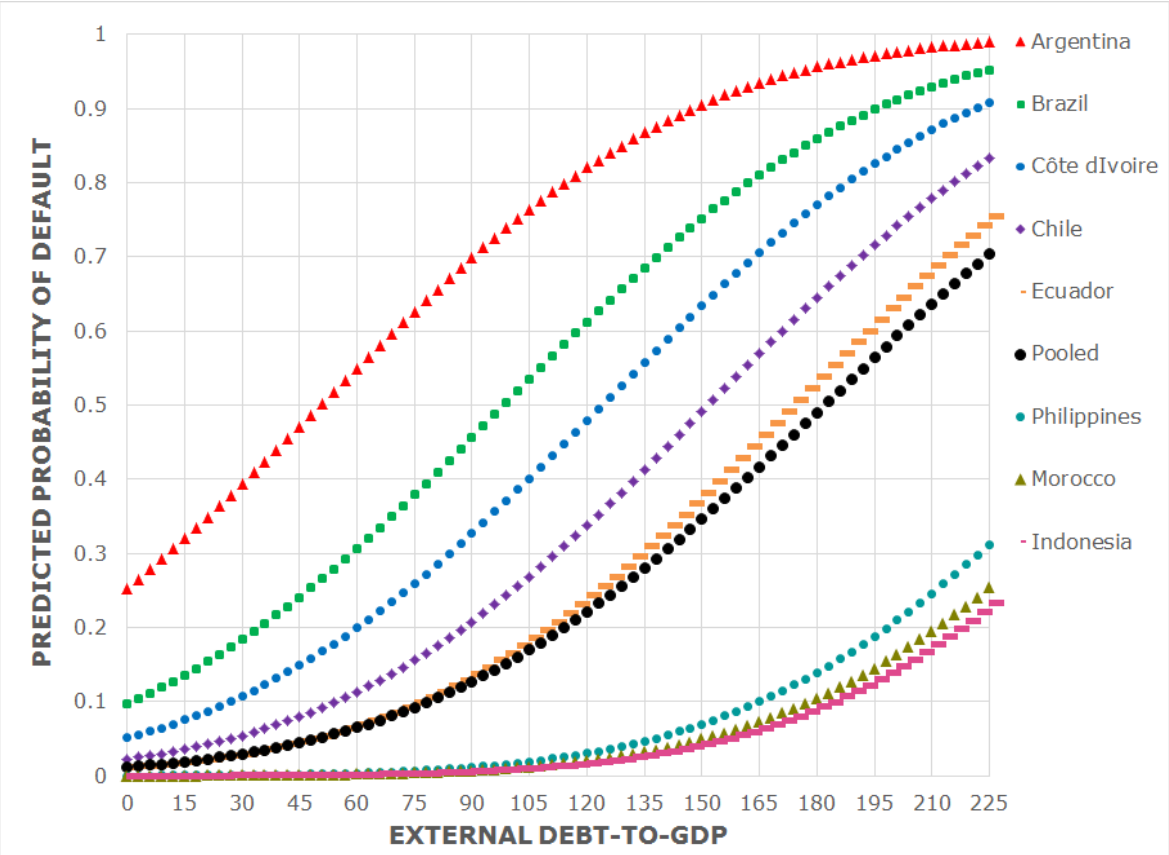
Analyzing the impact of unobserved heterogeneity:

$$\hat{P}_{ij}(D_t / D_{t-1}, \tilde{X}_i, \tilde{\alpha}_j, \tilde{\beta}) = \Phi(\tilde{\alpha}_j + \tilde{\beta}_1 * D_{i,t-1} + \tilde{\beta}' \tilde{X}_i)$$

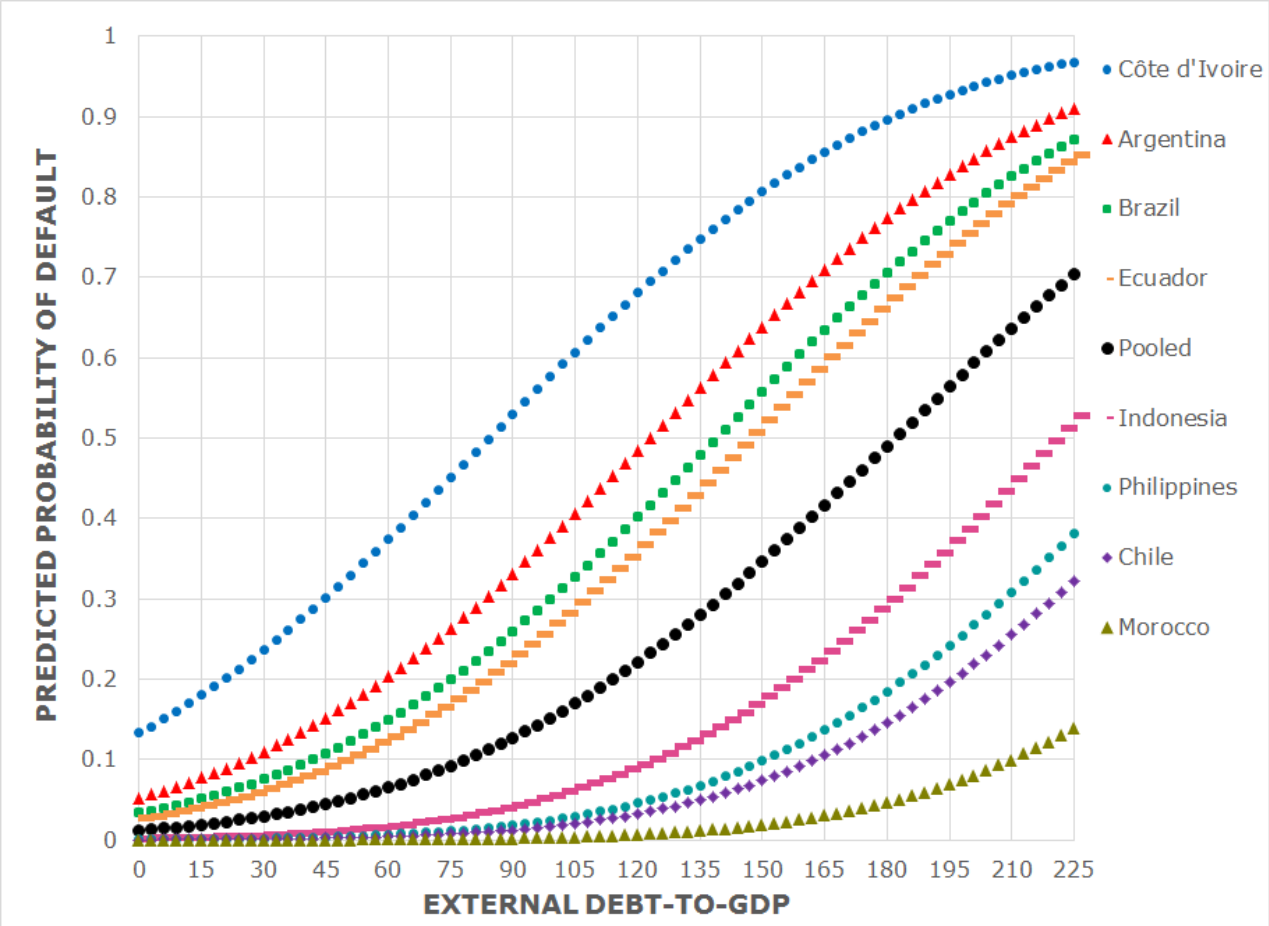
Figure 1b: Conditional probability of default at different α_j, $D_{t-1} = 1$



$$\hat{P}_i(D_t / D_{t-1}, \tilde{X}_{sample}, \tilde{\alpha}_i, \tilde{\beta}) = \Phi(\tilde{\alpha}_i + \tilde{\beta}_1 * D_{t-1} + \tilde{\beta}' \tilde{X}_{sample})$$



$$\hat{P}_i(D_t / D_{t-1}, \tilde{X}_i, \tilde{\alpha}_i, \tilde{\beta}) = \Phi(\tilde{\alpha}_i + \tilde{\beta}_1 * D_{t-1} + \tilde{\beta}' \tilde{X}_i)$$



Conclusions

Main findings of this paper:

- The variation in the country-specific effects is the main factor behind the differences across countries' propensities to default
- State dependence effects are large, significant, and highly heterogeneous across countries
- There are countries with significantly high risk of default even if negligible levels of debt are assigned to them.
- Conversely, other countries show a low probability of default even with assigned levels of debt far higher than observed ones

Conclusions

Policy implications:

- A policy that dismisses unobserved heterogeneity, i.e. that pools all the countries, has drastic consequences when assessing a country's risk of default, as such risk could be greatly under (over) stated.
- Therefore, EMEs would be imposed to target "safe" debt thresholds that could end up being too restrictive or to loose
- A debt threshold that is restrictive might have negative consequences in terms of growth, if, for example, public investment that could boost productivity is not carried out.
- While debt thresholds that are too loose will increase the risk of default.

Examples1

▸ Two possible explanations

1. A default might lead to political instability and uncertainty that will change the future probability of default
2. A default carries a punishment by the markets, i.e. a country in default will normally face worsened borrowing terms
3. Reputation: under incomplete information, past defaults affect lenders' decisions since governments' actions signal their type

Examples2

▸ Two possible explanations

- Ecuador's defaulted on two bonds in 2008 with no liquidity or solvency issues. The authorities announced that those securities were "illegal" (ideological and political grounds)
- Venezuela 1998. The government claimed that the person who was supposed to sign the checks was unavailable at the time

Figure1 ▸ Motivation: External debt

Ratings and net external debt to GDP

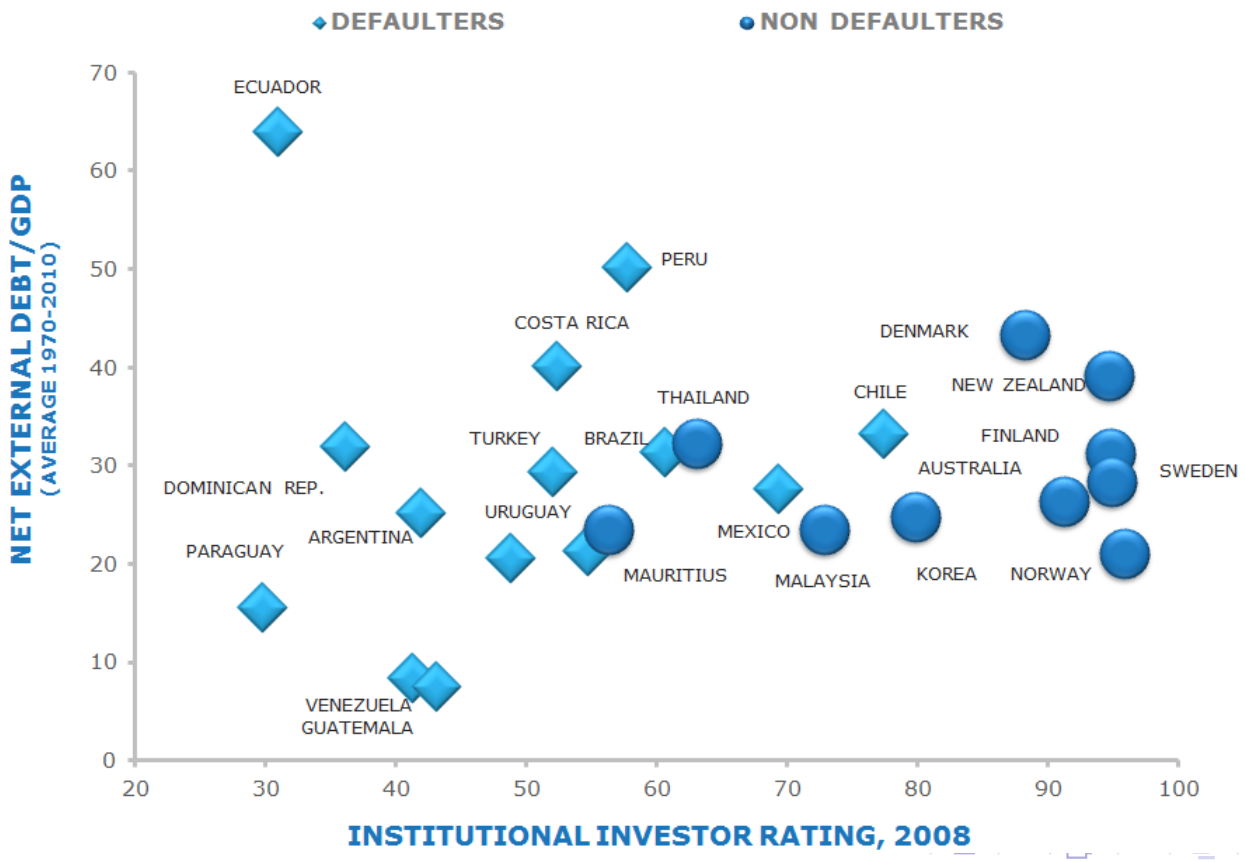


Table1

▸ Motivation

Table 1: Serial defaulters

COUNTRY PERIOD	NUMBER OF DEFAULTS (1800-2010)	YEARS IN DEFAULT (%)[1] (1800-2010)	EXTERNAL DEBT/GDP (%)[2] (1970-2010)
Argentina	6	32	25
Brazil	9	27	25
Chile	9	27	27
Colombia[3]	6	35	---
Costa Rica	8	35	82
Dominican Republic	7	28	19
Ecuador	9	57	43
Guatemala	7	31	28
Mexico	8	44	30
Nicaragua	6	47	69
Paraguay	7	23	46
Peru	8	40	36
Turkey/Ottoman Empire	9	15	20
Uruguay	9	13	47
Venezuela	9	36	33
Average	7.8	33	38

1. Percentage of years in default since independence year or 1800, whichever comes later.
2. Average PPG external debt the country had one year prior default.
3. Colombia did not have a default episode between 1970-2010.

Source: Author's calculation from data in Reinhart and Rogoff (2011) and World Bank (WDI).

Table2

▸ Motivation

COUNTRY PERIOD	NUMBER OF DEFAULTS (1800-2010)	% OF YEARS IN DEFAULT* (1800-2010)	EXTERNAL DEBT TO GDP (%) (1970-2010)
Asia			
China	2	12.8	12
India	3	10.9	20
Indonesia	4	14.5	54
Myanmar	1	14.3	63
Philippines	1	18.5	59
Sri Lanka	2	6.3	48
Average		12.9	43
Africa			
Côte d'Ivoire	2	52.9	101
Zimbabwe	2	43.5	55
Zambia	1	26.7	149
Kenya	2	20.8	66
Tunisia	1	12.7	56
Egypt	2	2.8	47
Average		26.6	79

*Percentage of years in default since independence year (or 1800, whichever comes later).
Source: Author's calculation from data in Reinhart and Rogoff (2011).

Table3

▸ Motivation

COUNTRY	NUMBER OF DEFAULTS	EXTERNAL DEBT TO GDP, %
PERIOD	(1800-2010)	(1970-2010)
Emerging market economies with no external default history		
Korea	0	31
Malaysia	0	41
Mauritius	0	27
Singapore	0	95
Taiwan	0	16
Thailand	0	36
Average		34
Advanced economies with no external default history		
Australia	0	40
Belgium	0	145
Canada	0	54
Denmark	0	87
Finland	0	68
New Zealand	0	55
Norway	0	62
Sweden	0	73
United States	0	36
Average	0	69

Table4

▸ Motivation

COUNTRY	NUMBER OF DEFAULTS		PERCENTAGE OF YEARS IN DEFAULT*	EXTERNAL DEBT TO GDP (%)
PERIOD	(1501-1813)	(1814-2010)		(1990-2010)
Spain	6	7	23.7	84
France	8	0	0.5	107
Austria	1	6	17.1	132
Germany	4	3	15.7	99
Greece	n.a	5	47.8	85
Portugal	n.a	6	10.9	128
Netherlands	1	1	6.2	185
Italy	n.a	1	3.3	79
Japan	n.a	1	5.2	34
United Kingdom	n.a	1	3.8	252
Average			13.4	119

*Percentage of years in default since independence year.
Source: Author's calculation from data in Reinhart and Rogoff (2011).

Quote

▸ Literature

"In models with full information and no political uncertainty, debt and output are sufficient statistics for the default probability, so there is no role for the history of default" (D'Erasmo, 2011)

However ▸ Literature

However, literature is still not able to explain the fact that some countries default more often than others even when they have similar GDP growth paths and levels of debt