

# Online Appendix for

## Sovereign Debt Issuance and Selective Default

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December 2025

### 1 Definitions and Default Episodes

We follow the definitions of [Reinhart and Rogoff \(2011\)](#) for default episodes. Their dataset contains several types of crisis including three dummy indicators: for a country being in foreign default, for a country being in domestic default and for a country being in an instance of hyperinflation. Default is defined as failure to meet a principal or interest payment on the due date. Inflation above 20% per annum is classified as hyperinflation. We further define the beginning of foreign default as an instance when the dummy indicator switches from zero to one. We combine domestic default and hyperinflation to define the beginning of domestic default. As [Reinhart and Rogoff \(2011\)](#) point out “Domestic public debt is issued under home legal jurisdiction. In most countries, over most of their history, it has been denominated in the local currency and held mainly by residents.” Consequently, the instance of inflation is essentially partial default on domestic debt. We define the beginning of domestic default as when either the dummy indicator for domestic default or the dummy indicator for hyperinflation switches from zero to one. The total default is defined as a situation when both domestic and foreign defaults happen simultaneously. All instances of foreign and domestic defaults according to our definition are listed in the table below.

Table 1: Default Episodes

	Foreign	Domestic	Domestic <i>de jure</i>
Albania	1991		
Algeria	1991	1991	
Angola	1985	1964, 1967, 1974, 1976, 1991, 1992	1976, 1992
Antigua Barbuda	1996	1998	1998

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Argentina	1951, 1956, 1982, 2001, 2013	1957, 1962, 1971, 1982, 1989, 2001, 2002, 2008, 2010	1982, 1989, 2001
Australia		1951, 1956, 1975	
Bangladesh	1974		
Belize	2006, 2012		
Bolivia	1980, 1986	1950, 1973, 1979, 1982, 1991	1982
Bosnia Herzegovina	1992		
Brazil	1961, 1983	1954, 1959, 1961, 1974, 1986, 1990	1986, 1990
Bulgaria	1990		
Burkina Faso	1983		
Cameroon	1985	2004	2004
Cape Verde	1981		
Central African Rep	1981, 1983	1971, 1994	
Chile	1961, 1963, 1965, 1972, 1983	1951, 1953, 1958, 1962, 1967, 1983, 1985, 1990	
China		1994	
Colombia		1950, 1963, 1973, 1979, 1985, 187	
Congo (Brazzaville)	1983		
Congo (Kinshasa)	1976	1979	1979
Cook Islands	1995		
Costa Rica	1962, 1981	1974, 1981, 1988, 1991, 1995	
Cote D'Ivoire	1983, 2000	1958, 1977, 1979, 1994	
Croatia	1992	1993	1993
Cuba	1960, 1982		
Czechoslovakia	1959	1959	1959
Domenican Republic	1982, 2005	1980, 1981, 1984, 1988, 2003	1981
Dominica	2003	2003	2003
Ecuador	1982, 1999, 2008	1973, 1983, 1999, 2008	1999, 2008
Egypt	1984	1980, 1986, 1989, 1992	
Ethiopia	1991		
Gabon	1978, 1986, 1999	1999	1999
Gambia	1986		
Ghana	1966, 1987	1965, 1973, 1975, 1979, 1982, 1986, 1993, 2000, 2003	1979, 1982
Greece	2012	1957, 1980, 1983, 1985, 1990, 2012	2012
Grenada	2004, 2012	2005	2005
Guatemala	1986, 1989	1974, 1986, 1990	
Guinea	1986, 1991		
Guinea-Bissau	1983		
Guyana	1979, 1982		
Haiti	1952, 1965, 1982		
Honduras	1981	1990, 1994	
Hungary		1951, 1990, 1995	
India	1958, 1969	1973	
Indonesia	1966, 1999, 2002	1950, 1955, 1957, 1960, 1973, 1979, 1998	

Iran	1978		
Iraq	1987		
Italy		1974, 1980	
Jamaica	1970, 1978, 1981, 1987, 2010	2010	2010
Japan		1974	
Jordan	1989		
Kenya	1994, 2000	1984, 1992	
Korea		1952, 1961, 1964, 1974, 1980	
Kuwait		1990	1990
Liberia	1963, 1968, 1981	1989	1989
Macedonia	1992		
Madagascar	1981	2002	2002
Malawi	1982, 1988		
Malaysia		1950	
Mali	1967, 1988, 1992, 2012	2012	2012
Mauritania	1992		
Mauritius		1974, 1980	
Mexico	1982	1973, 1976, 1979, 1982, 1990, 1995	1982
Moldova	1998, 2002		
Mongolia		1997	1997
Morocco	1983, 1986	1951	
Mozambique	1980, 1983	1980	1980
Myanmar	1997	1966, 1973, 1984, 1987, 1988, 1997, 2001, 2006	1984, 1987
Nauru	2002		
Nicaragua	1979	1973, 1979, 2003, 2008	2003, 2008
Niger	1982		
Nigeria	1987, 2004	1975, 1977, 1981, 1983, 1988, 1992	
North Korea	1974		
Pakistan	1972, 1981, 1998		
Panama	1983	1988	1988
Paraguay	1968, 1986, 2003	1974, 1979, 1984, 1994	
Peru	1969, 1976, 1978, 1980, 1983	1975, 1985	1985
Philippines	1983	1971, 1974, 1984	
Poland	1981	1953, 1981, 1987	
Portugal		1974, 1982	
Romania	1981, 1986		
Russia	1991	1993, 1998	1998
Rwanda		1995	1995
Sao Tome Principe	1987	1981, 1985, 1990, 1993	1981
Senegal	1981, 1990, 1992		
Serbia and Mon- tenegro	2003		
Seychelles	2000, 2008		
Sierra Leone	1983, 1986	1995	1995
Singapore		1950, 1973	
Slovenia	1992		

Solomon Islands	1998	1995	1995
South Africa	1985, 1989, 1993		
Spain		1977	
Sri Lanka	1979, 1981	1996	1996
St Kitts Nevis	2011		
Sudan	1979	1991	1991
Suriname		2001	2001
Tanzania	1984		
Thailand		1974	
Togo	1979, 1982, 1988, 1991		
Trinidad Tobago	1988	1974	
Tunisia	1956, 1958, 1963, 1979		
Turkey	1956, 1958, 1963, 1978, 1982	1958, 1977	
Uganda	1980		
Ukraine	1998	1998	1998
United Kingdom		1975	
Uruguay	1965, 1983, 1987, 1990, 2003	1959, 1963, 1971, 1983	
Venezuela	1983, 1990, 1995, 2004	1980,1987, 1995, 2002, 2008	1995
Vietnam	1985	1975	1975
Yemen	1985		
Yugoslavia	1965, 1983		
Zambia	1983	1985	
Zimbabwe	1965, 2000	1983, 1991, 1994, 1997, 2006	2006

## 2 Debt Currency and Debt Holdings

Table 2: Domestic and Foreign Public Debt in Emerging Economies

Debt-to-GDP		47%
Local currency debt (% of total)		63.5%
Foreign currency debt (% of total)		36.5%
Domestic holding (% of total)		60.7%
Foreign holding (% of total)		39.3%
USD-denominated debt	Domestic holding	37%
	Foreign holding	63%
Local currency debt	Domestic holding	81.5%
	Foreign holding	18.5%

Source: [Borri and Shakhnov \(2017\)](#), [Paczos and Shakhnov \(2022\)](#)

Notes: The data is as of 2019Q4. The sample of emerging economies with available data on currency composition and residency of debt holders composition are: Argentina, Brazil, Bulgaria, Chile, China, Colombia, Egypt, Hungary, India, Indonesia, Latvia, Lithuania, Malaysia, Mexico, Peru, Philippines, Poland, Romania, Russia, South Africa, Thailand, Turkey, Ukraine, and Uruguay

## 3 Solution Algorithm

1. Discretize two exogenous AR(1) processes for  $y$  and  $\tau$  (Tauchen with 3 std. devs.).
2. Create a grid for  $b_d$  and  $b_f$ <sup>1</sup>.
3. Guess price schedules  $q_f^0$  and  $q_d^0$ .
  - (a) Calculate consumption in autarky  $c^{aut}$  and the value of permanent autarky  $V^{aut}$ . Guess four value functions  $V^{0,0}$ ,  $V^{0,fd}$ ,  $V^{0,dd}$  and  $V^{0,td}$  using  $V^{aut}$ .
  - (b) Calculate  $b'_d$  and  $b'_f$  in repayment given prices and  $V^{0,0}$  as continuation value.

<sup>1</sup>Given that domestic discount price is a 6-dimensional object, we quickly run into the curse of dimensionality. We spread the maximum size of array over the six dimensions so that results are not affected by the grid size in any dimension. More than 10 points for the exogenous states is enough. We use 23 points for  $y$ , 25 points for  $\tau$ , 33 for  $b_d$  and 31 for  $b_f$ . This results in an array of size for prices, totaling 601,754,175 elements. If stored as double precision (8 bytes per value), this array requires approximately 4.83 GB of memory.

- (c) Calculate value of repayment  $V^r$  given optimal policies and continuation value.
  - (d) Repeat (b) and (c) for foreign and domestic default to obtain  $V^{1,fd}$  and  $V^{1,dd}$ .
  - (e) Calculate the value of total default  $V^{1,td}$  given  $V^{1,fd}$  and  $V^{1,dd}$  and  $V^{0,0}$ .
  - (f) Derive default policies comparing four value functions at each grid point.
  - (g) Derive the new value function  $V^{1,0}$  as the maximum of the four value functions.
  - (h) Substitute  $V^{0,0} := V^{1,0}$ .
  - (i) Repeat (b)-(h) until convergence in value function.
4. Given optimal default policies calculate  $q_f^1$  and  $q_d^1$  using pricing rules (9) and (10).
  5. Update prices  $q_f^0 = \alpha^f q_f^0 + (1 - \alpha^f) q_f^1$  and  $q_d^0 = \alpha^d q_d^0 + (1 - \alpha^d) q_d^1$ .
  6. Repeat until convergence in prices.

After prices converge, we use the policy functions to simulate the model economy 10000 times over 200 periods. We burn the first 10 observations to avoid any dependence on the starting conditions. We also discard the first 10 periods after reentry following each default. We do this because the model economy reenters capital markets without any debt, while countries always emerge from each default/restructuring episode with a positive level of debt. By ignoring the first 10 years following reentry, we ignore years with counter-factually low debt levels. To calculate all moments (other than default frequencies) we use only data for repayment periods.

## 4 Data for Simulations

**Data sources.** For empirical moments presented in Table 6 we utilize the data from several sources:

1. Quarterly data from the OECD database . We use: gross domestic product, final consumption expenditure, and external balance of goods and services. The data is quarterly, in chain-linked volumes of national currency. The economies in the sample are 21 emerging economies: Argentina, Brazil, Bulgaria, Chile, Columbia, Costa Rica, Croatia, Czechia, Hungary, India, Indonesia, Latvia, Lithuania, Mexico, Poland, Romania, Russia, Slovakia, Slovenia, South Africa and Turkiye. The span of the data is 1991Q1 to 2024Q4. To calculate the cyclical components of output and consumption, we take Hodrick-Prescott detrended seasonally adjusted quarterly series.

2. We use the calculations of foreign debt spread and domestic debt spread prepared by [Borri and Shakhnov \(2017\)](#). They calculate the spread on foreign debt as the difference between the JPMorgan Emerging Market Bond Index (EMBI) 30-days T-bills for each country, and the spread on domestic debt as the difference between the JPMorgan Government Bond Index (GBI) in local currency and synthetic country-specific risk-free rate. 3. The primary balance is calculated as the difference between tax revenue and government expenditure  $PB/y = (T - G)/y$ . However, primary balance series are not available at quarterly frequency, so we use annual data.

In the model, we follow the literature and calculate net export as the change in net foreign asset (NFA) position:  $NX = (b'_f q_f - b_f)$  . The government budget constrain defines primary balance as:  $PB = T - G = -(b'_f q_f - b_f) - (b'_d q_d - b_d)$ .

**Transformations.** Flow variables, which are expressed in relative terms are independent of frequency. The ratio of stocks over flows, such as foreign and domestic debt-to-GDP, when transformed from quarterly to yearly need to be divided by four. The similar procedure applies to the exclusions. We need to take a square root to the power of four for the remaining variables, such as discount factor  $\beta_a = \beta_q^4$  and annual spreads  $\frac{1}{q_a} - R_f = \left(\frac{1}{q_q}\right)^{1/4} - R_f$ . To calculate spreads we invert the discount prices and subtract the risk free rate. We use  $R_f$  to calculate spreads on both domestic and foreign debt.

## References

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