International Macroeconomics

Yan Bai

Lecture: Sovereign Default

Sovereign debt

- Sovereign debt features limited mechanisms for enforcement
  - Private debt is subject to a legal authority where assets can be liquidated
  - If sovereign debtor defaults, creditors have limited legal recourse
- International borrowing and lending is substantial
- Default is not as rare as one might think, it has been present throughout history

Portugal's Debt and Default

Portugal Debt
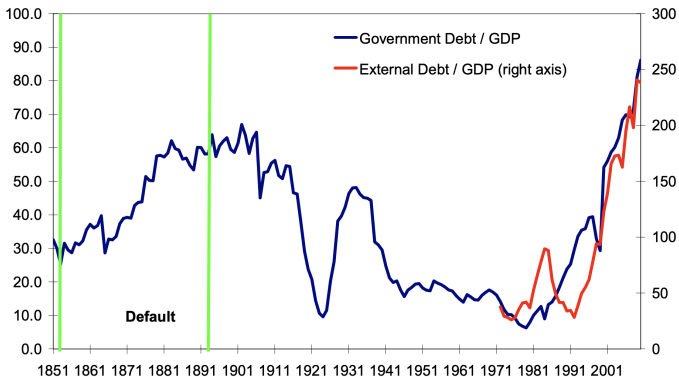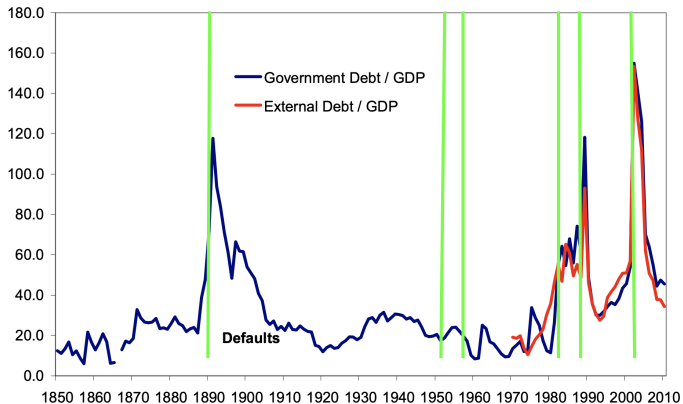
Portugal's Debt and Default

Default, Restructuring, Banking Crises, Growth Collapses and IMF Programs:
Portugal, 1800-2010

External default restructuring	Duration (in years)	Domestic default/ restructuring	Banking crisis (first year)	Hyper-inflation dates	Share of years in external default	Share of years in inflation crisis	5 worst output collapses year(decline)
1828	1	n.a.	1828	n.a.	11.0	9.5	1918(5.1)
1837-1841	5		1846				1928(9.7)
1850-1856	7		1890				1935(5.3)
1892-1901	10		1920				1936(7.6)
			1923				1940(6.5)
			1931				
			2008				
Number of episodes:							
4		0	7	0			

Memorandum item on IMF programs, 1952-2009

| Dates of programs	Total number of years
1977, 1978, 1983	3

Argentina's Debt and Default

Argentina's Debt

Argentina's Debt and Default

Default, Restructuring, Banking Crises, Growth Collapses Hyperinflation, and IMF Programs:
Argentina, 1816-2010

External default Restructuring	Duration (in years)	Domestic default/ restructuring	Banking crisis (first year)	Hyper-inflation dates	Share of years in external default	Share of years in inflation crisis	7 worst output collapses year(decline)
1827-1857	31	1890-1893	*1885*	1984-1985	32.5	24.7	1914(10.4)
1890-1893	4	1982	1890	1989-1990			1917(8.1)
1951	1	1989-1990	1914				1931(6.9)
1956-1965	10	2001-2005	1931				1959)6.5)
1982-1993	12	2007-2009	1934				1985(7.0)
1989	--		1980				1989(7.0)
2001-2005	9		*1985*				2002(10.9)
			1989				
			1995				
			2001				
Number of episodes:							
7		5	10	2			

Memorandum item on IMF programs, 1952-2009

Dates of programs

1958-1962, 1967-1968, 1976-1977, 1983-1984, 1987, 1989, 1991-1992, 1996, 1998, 2000, 2003(2)

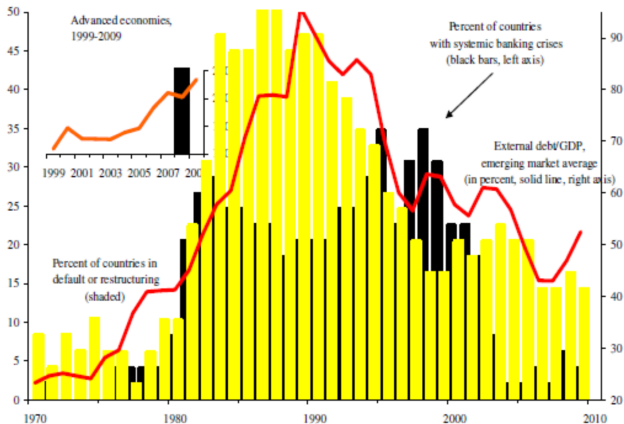Total
20

Default throughout history
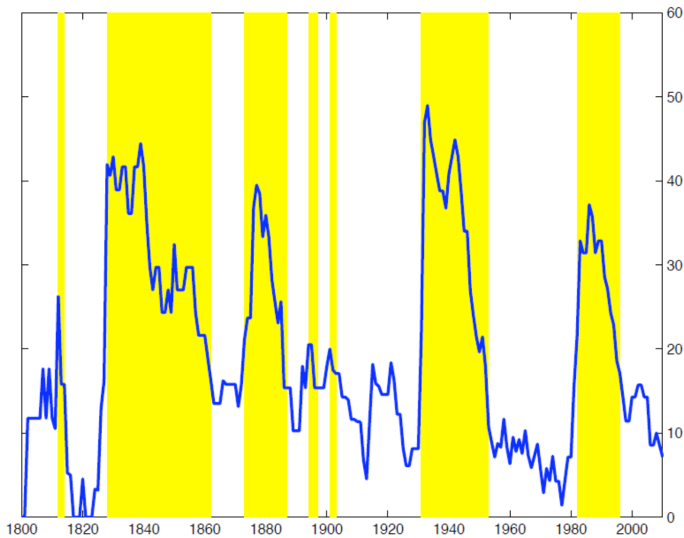
Percentage of countries in default

Default and debt

Default is associated with high debt

FIGURE 9. Gross External Debts (public and private), Sovereign Default and Systemic Banking Crises: Advanced Economies (inset only) and Emerging Markets, 1970-2009 (debt as a percent of GDP)
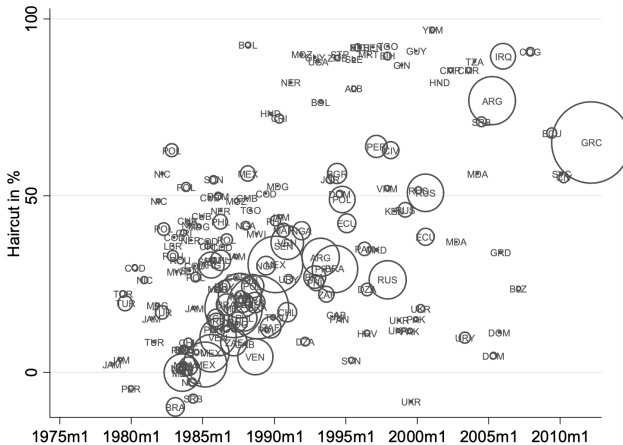
Default and debt

- But many countries have defaulted with small debt to GDP ratios

External Debt to GDP in default year	Percentage of defaults in middle income countries
<40	19
41-60	32
61-80	16
81-100	16
>100	16

Source: Reinhart & Rogoff 2009
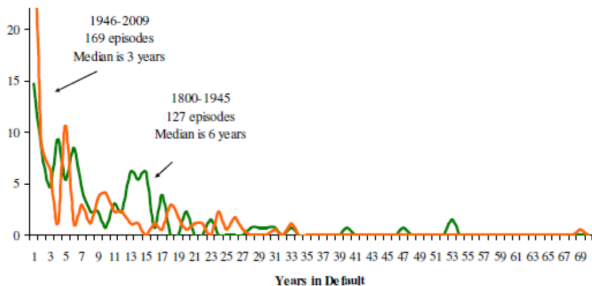
Default and Haircuts

- Defaults end up in restructuring
- Average haircut: 37%
- Source: Cruces and Trebesch (2012)

Default Duration

- Default episodes lasts on average 3 years

FIGURE 7. Duration of Default Episodes: 1800-2009
(frequency of occurrence, percent)

Sources: Lindert and Morton (1989). Macdonald (2003). Purcell and Kaufman (1993). Reinhart. Rogoff.

Default, Financial Crises and Recessions

- Defaults are more common in recessions
  - Tomz and Wright (2007) document that in across 169 defaults, output is 1.6% below trend

    (But in 1/3 of the episodes output is >= trend)
- After default, trade drops
  - Rose (2002) and Martinez Sandleris (2012) show that after defaults bilateral trade drops significantly: 8% a year for over 15 years

- Defaults and banking crises coincide
  - Reinhart and Rogoff (2010) document that banking crises often precede default and can predict it

Why do countries repay their debts?

- No clear consensus on the costs of default

- Reputation: Countries want to maintain good reputation with creditors

    - Countries that default are cutoff from international financial markets

    - Gelos et al. — Average time spent out of the market 1980's , 4- 5.4 years. In 1990's, 0-1 year

    - Ozler: countries that default face higher interest rates after reentering financial markets

- Trade: Countries want to maintain benefits from international trade

    - Default may reduce trade

- Avoid recessions, financial crises: Bocola (2016)

Two mechanism to enforce contract

- Reputation mechanism

- Sanction mechanism

    - Output loss, punishment through trade, loss of trade credit

    - Bulow Rogoff: reputation mechanism is not enough, countries can accumulate large enough asset and then default and save. They can achieve the same allocation as borrowing

Model

Eaton and Gersovitz (1981) and Arellano (2008)

Model

- Small open economy with identical consumers and a government

- Endowment of the country y_t, stochastic

- Consumers cannot borrow or lend internationally, hand-to-mouth

- Government borrows internationally and can default on its debt

- Default:
    - Debt is completely written off
    - Output loss $h(y_t) \leq y_t$
    - With probability λ, regain access to international financial markets

- International lenders are risk neutral and competitive, world risk free rate r

Recursive Formulation

State: y, b

- Default decision: $d \in \{0, 1\}$

$$V(y, b) = \max_{d \in \{0,1\}} (1 - d)V^c(y, b) + dV^d(y)$$

- Repaying value

$$V^c(y, b) = \max_{c, b'} u(c) + \beta \mathbb{E} V(y', b')$$

subject to

$$c = y - b + q(y, b')b'$$

- Defaulting value

$$V^d(y) = u(h(y)) + \beta \mathbb{E} \left[\lambda V^c(y', 0) + (1 - \lambda)V^d(y') \right]$$

- Lenders charge bond price to compensate their default risk

$$q(y, b') = \frac{1}{1 + r} \mathbb{E} \left[1 - d(y', b') \right]$$

Some Definition

- Default set:
$$D(b) = \{y \in Y : d(y, b) = 1\}$$

- Repaying set:
$$R(b) = \{y \in Y : d(y, b) = 0\}$$

Proposition 1

Proposition

Default set increases with debt

Lemma

Lemma

Under iid y shock, if for some b, default set $D(b)$ is non-empty, $D(b) \neq \emptyset$, then there are no contract available for the economy $(q(b'), b')$ such that the economy can experience capital inflows, i.e. $q(b')b' - b > 0$.

Proposition

Under iid shock, no output loss, no return to financial market after default. If a country defaults in high output, it must defaults in low output.

Proposition

If default sets are not empty, then they are closed intervals where only the upper bound depends on the level of assets.

$$D(b) = [\underline{y}, y^*(b)]$$

Recursive Formulation

Suppose there exists a cutoff of endowment $y^*(b)$ and default happens if and only if $y \leq y^*(b)$

- Default cutoff

$$V^c(y^*, b) = V^d(y^*)$$

- Repaying value

$$V^c(y, b) = \max_{c, b'} u(c) + \beta \left[\int_{y^*(b')} V^c(y', b') dy' + \int^{y^*(b')} V^d(y') dy' \right]$$

subject to

$$c = y - b + q(y, b')b'$$

- Defaulting value

$$V^d(y) = u(h(y)) + \mathbb{E} \left[\lambda V^c(y', 0) + (1 - \lambda) V^d(y') \right]$$

- Lenders charge bond price to compensate their default risk

$$q(y, b') = \frac{1}{1 + r} \left[1 - \Phi(y^*(b')) \right]$$

Calibration

Key parameters:

- return to market λ: 5 years, tends to decline to 4 month.
- discount factor β
- output loss function Arellano (2008)

$$h(y) = \min\{y, \gamma Ey\}$$

Chatterjee and Eyigungor (2012),

$$h(y) = y - \max\{0, \kappa_0 y + \kappa_1 y^2\}$$

with $\kappa_0 \leq 0$, $\kappa_1 \geq 0$

Moments:

- debt-to-output
- spread: mean and volatility

$$spread = \frac{1}{q} - (1 + r)$$

Why too low default or too low borrowings?

All depends on bond price schedule: Aguiar and Gopinath (2006)

$$V^c(y^*, b) = V^d(y^*)$$

$$q(y, b') = \frac{1}{1+r} \mathbb{E}\left[1 - \Phi(y^*(b'))\right]$$

$$\frac{dq}{db'} = -\frac{1}{1+r} \phi(y^*(b')) \frac{dy^*}{db'} = \frac{1}{1+r} \phi(y^*(b')) \frac{\partial V^c / \partial b'}{\partial V^c / \partial y - \partial V^d / \partial y}$$

Slope of q depends on $\partial V^c / \partial y - \partial V^d / \partial y$

Solution

- Punishment depends on shock y: Arellano (2008) or Chatterjee and Eyigungor (2012)

- Trend shock: Aguiar and Gopinath (2006)

- Debt recovery from renegotiation

Extensions of Standard Sovereign Default Model

- Renegotiaion
- Long-term debt
- With capital
- Endogenous output loss

Renegotiation

The benchmark model assumes afar default, lenders receive zero. However in reality, the average recovery is 60%.

$$V(B, y) = \max\{V^c(B, y), V^d(B, y)\}$$

$$V^d(B, y) = u(y^d) + \beta EW(B', y')$$

$$W(B, y) = \max\{W^r(B, y), W^{nr}(B, y)\}$$

$$W^r(B, y) = u(y - \phi(B, y)y) + \beta EV(0, y')$$

$$W^d(B, y) = u(y^d) + \beta EW(B, y')$$

Renegotiation

$$\max_{\phi} \left(W^r(B, y) - V^{aut}(y) \right)^{\theta} (\phi B - 0)^{1-\theta}$$

subject to

$$W^r(B, y) - V^{aut}(y) \geq 0$$

FOC

$$\frac{\theta u_c(y - \phi)}{W^r(B, y) - V^{aut}(y)} = \frac{1 - \theta}{\phi}$$

$$\frac{dW^r - dV^{aut}}{dy} = u_c(y - \phi B) - u_c(\lambda y)\lambda$$

Expected recovery ratio of B

$$\zeta(B, y) = z(B, y)\phi(B, y) + (1 - z(B, y))E\zeta(B', y')$$

$$q(B', y) = \frac{1}{1 + r} \left\{ \sum_{y'|y} \pi(y'|y) \left[1 - d(B', y') + d(B', y')E\zeta(B', y') \right] \right\}$$