Sovereign Default: The Role of Expectations

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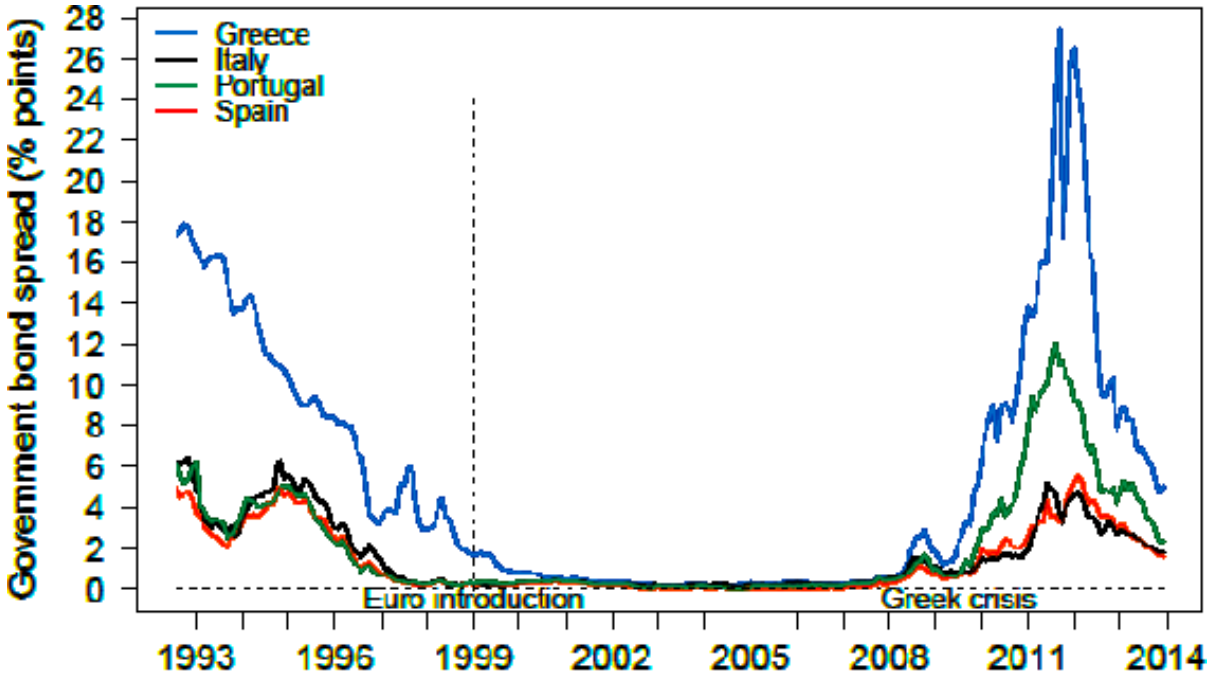
Motivated by the European sovereign debt crisis

Rise and fall of sovereign debt spreads.



- Debt accumulation during the financial crisis. Average accumulation for advanced economies between 2008 and 2011 (3 deficits) was 25%. For Portugal 72% to 108%, Spain 40% to 70%, Italy 106% to 120%.

- Long period of stagnation for Portugal, for Italy.

Motivated by the Argentine crisis of 1998-2002.

- Back in 1993, Argentina had regained access to international capital markets. The debt-to-GDP ratio between 1993 and 1999 was 35% to 45%.

- The average country risk spread on dollar-denominated bonds for the period 1993-1999 was 7%.

- Accumulated over the 1993-1999 period, this amounts to an extra 15% of GDP, almost half the debt-to-GDP ratio of Argentina in 1993.

- If Argentina had faced lower interest rates, would it have defaulted in 2002?

- Are sovereign debt crises caused by bad fundamentals or do expectations also play a role?

- Can a country be trapped in a high interest rate equilibrium where default probabilities are high because interest rates are high?

- Relevance for policy. OMTs

- Calvo (1988), more recently Lorenzoni and Werning (2013).

- Quantitative model of sovereign default: Eaton-Gersovitz (1981), Aguiar and Gopinath (2006), Arellano (2008), compute a single low interest rate equilibrium.

- Cole and Kehoe (2000): Maturity mismatch and rollover risk.

- We take a model similar to the one in Aguiar and Gopinath (2006) and Arellano (2008), and show that minor changes in modelling choices on the timing of moves by borrower and creditors generate multiple equilibria.

- The change in modelling choices is minor because there is no direct evidence to discriminate across.

- Other assumptions required to get quantitative plausibility. Hamilton (1989) regime switching.

- The reason for the multiplicity is the one in Calvo (1988): Default probabilities are high because interest rates are high.

- It is not rollover risk as in Cole and Kehoe (2000).

Two period model

- Small open economy with a low current endowment and a future random endowment.

- The endowment is 1 in the first period. In the second period it is $y \in [1, Y]$, with density $f(y)$ and cdf $F(y)$.

- The (representative) agent can borrow in a noncontingent bond. Cannot commit to repay. Penalty for default is consumption equal to 1.

- Foreign lenders are risk neutral.

The timing of moves.

- First period:
  - Creditor $i \in [0, 1]$ offers limited funds at gross interest rate R_i.
  - The borrower moves next and borrows from the low rate creditors $b = \int_0^1 b_i di$.
- (In equilibrium, $R_i = R$. Let $b_i = b$)
- Second period: The borrower decides to default fully or to pay the debt in full. Second period utility is

– $U(y - Rb)$, if the debt is paid, or

– $U(1)$, if default.

- Default threshold

$$y \leq 1 + bR.$$

- The borrower chooses b to maximize

$$U(1+b) + \beta \left[F(1+bR)U(1) + \int_{1+bR}^{Y} U(y - bR) f(y) dy \right],$$

with $b \leq b^{\max}$

Arbitrage condition for the creditors:

$$R^* = R\left[1 - F\left(1 + bR\right)\right].$$

Arbitrage condition for the creditors: A supply curve

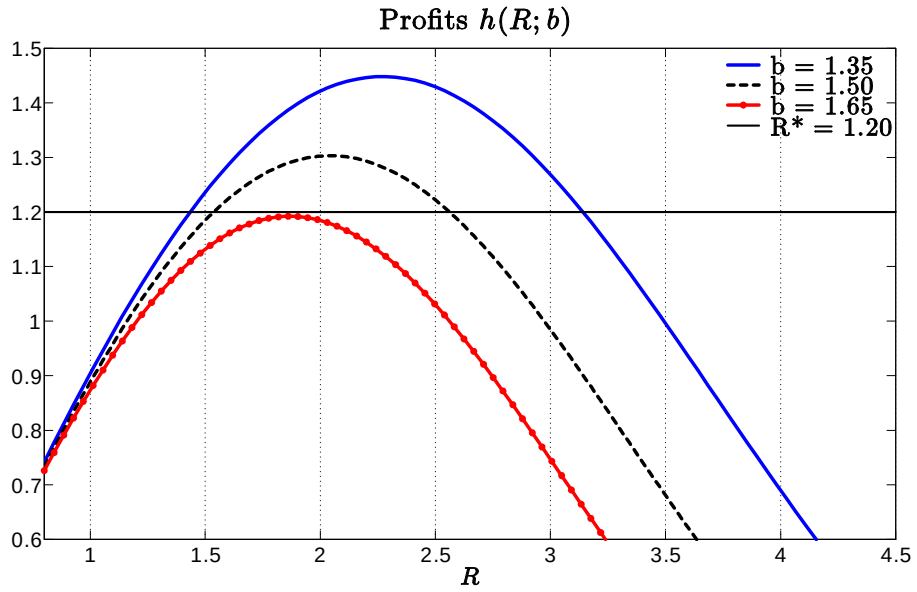
- Expected return on the debt

$$R\left[1-F\left(1+bR\right)\right]$$

  that must equal R^*

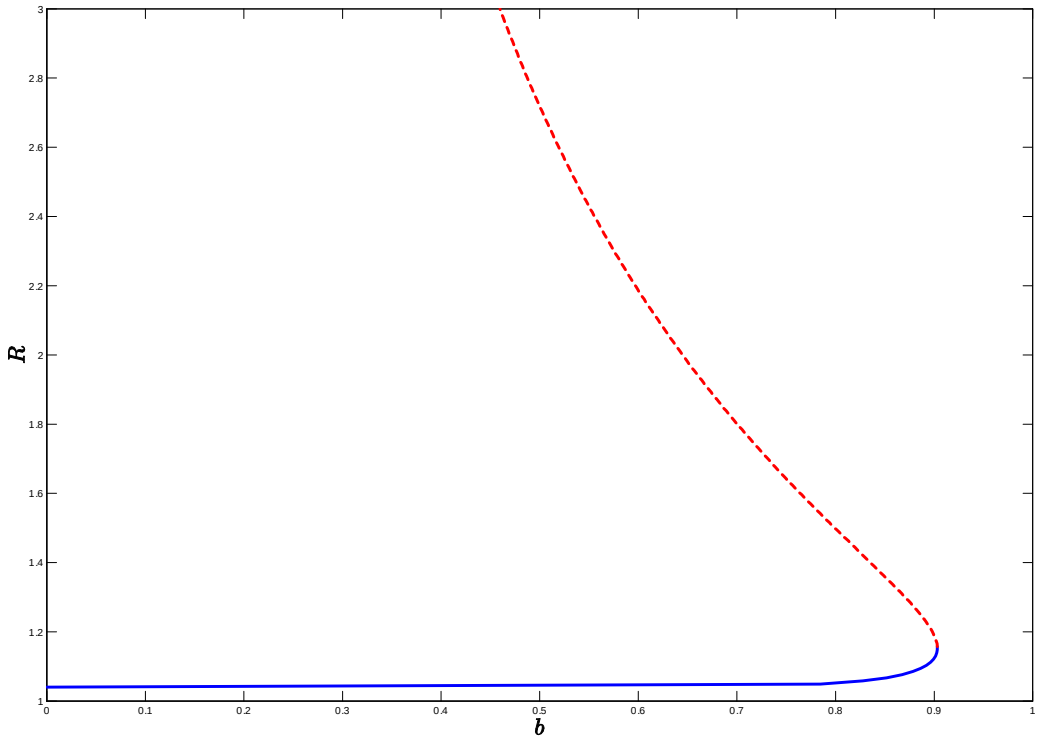
- For $R = 0$, it is zero. For R high enough, it is also zero.

- For standard distributions, the function is concave.



Expected return $h(R;b)$

- $R\left[1-F\left(1+bR\right)\right]$. An increase in b shifts the curve down.



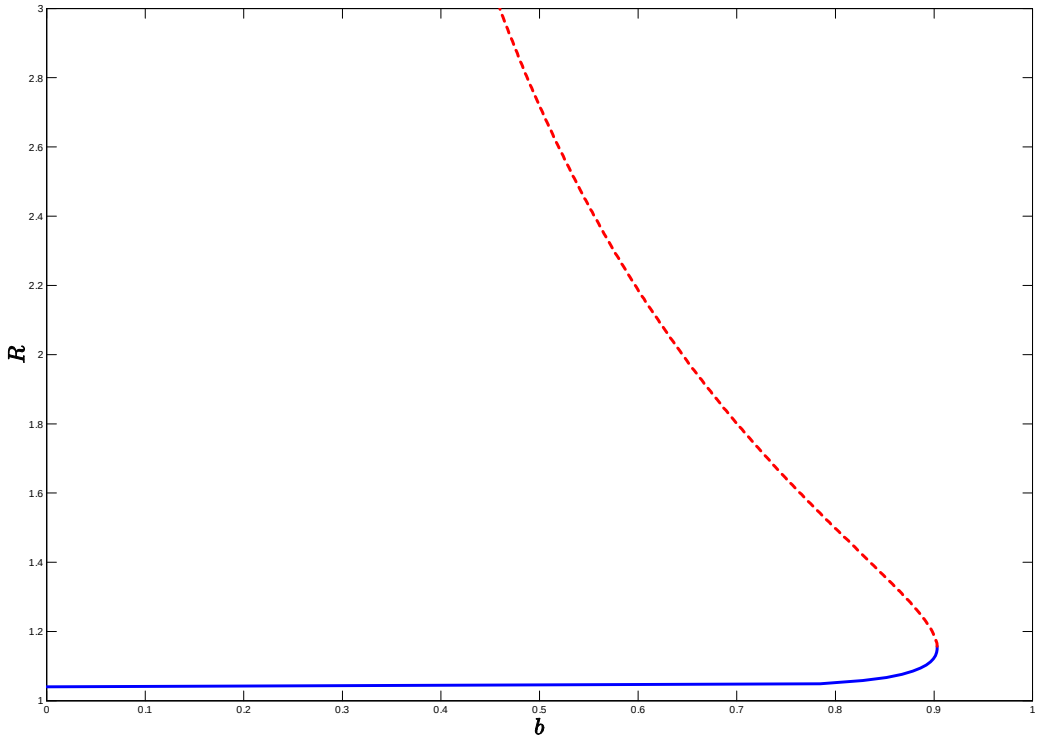
Increasing and decreasing schedule.

Decreasing schedule

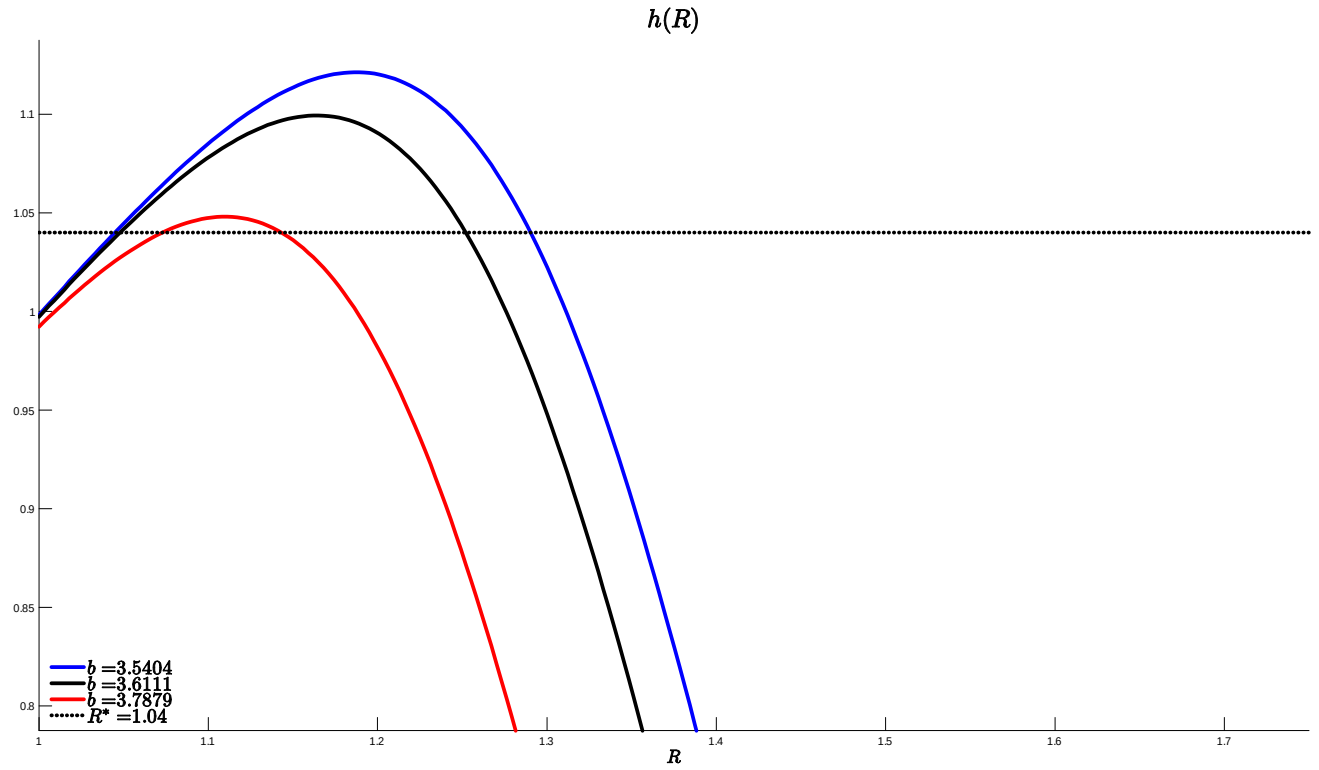
- The interest rate, probability of default and gross service of the debt decrease with the level of debt,

$$R^* = R\left[1 - F\left(1 + bR\right)\right].$$

- Perturbation of the schedule that is below it, but arbitrarily close.
  - Lenders would make positive profits.
  - Would compete those profits away.


3
2.8
2.6
2.4
2.2
2
1.8
1.6
1.4
1.2
1
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
R
b

The function for the expected return does not have to be everywhere concave...

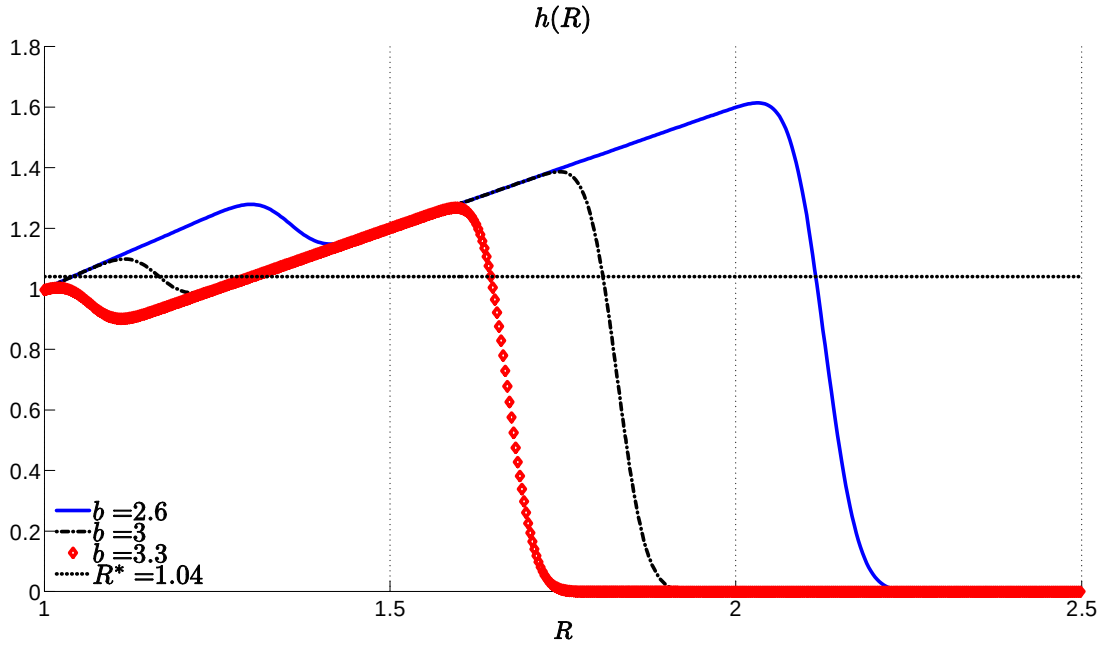


For a bimodal distribution, with good and bad times, it is not.

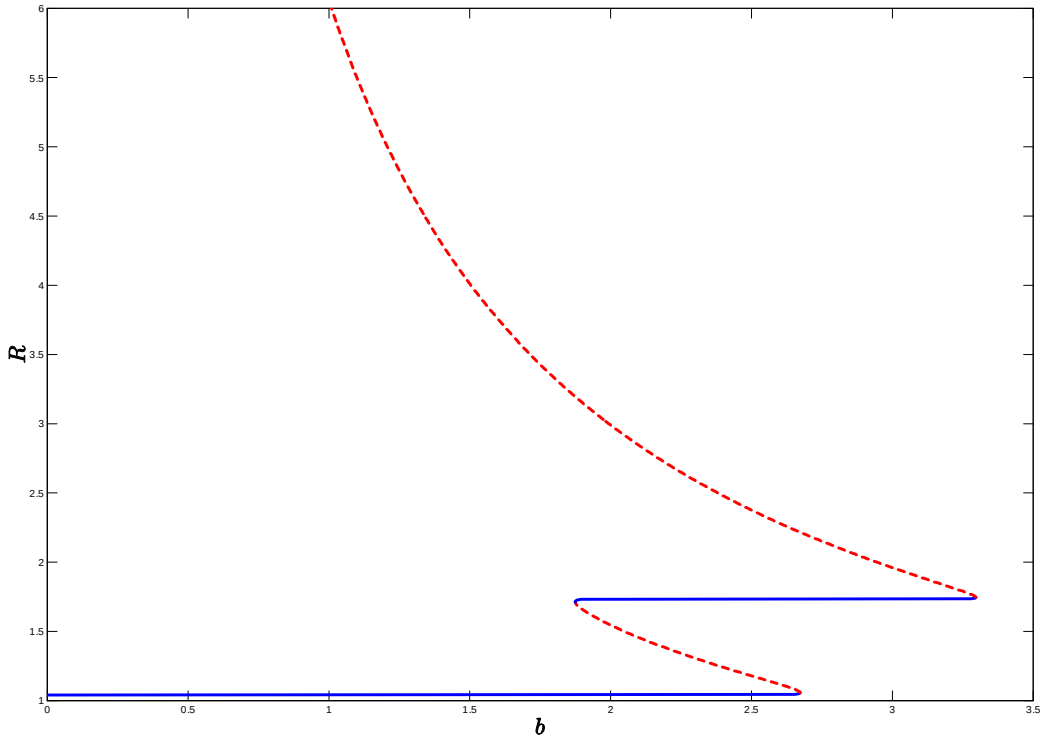
- Two independent random variables, y^1 and y^2, both normal with means μ^1 and μ^2.

- If μ^1 and μ^2 are sufficiently apart (and the standard deviation is sufficiently low) the arbitrage condition has four solutions.

- Hamilton (1989) regime switching.



$R^* = R\left[1 - F\left(1 + bR\right)\right]$. The larger is b the more likely it is that there will be more than two solutions, up to the point where there will be again two, and eventually none.


R
b
6
5.5
5
4.5
4
3.5
3
2.5
2
1.5
1
0
0.5
1
1.5
2
2.5
3
3.5

Equilibrium

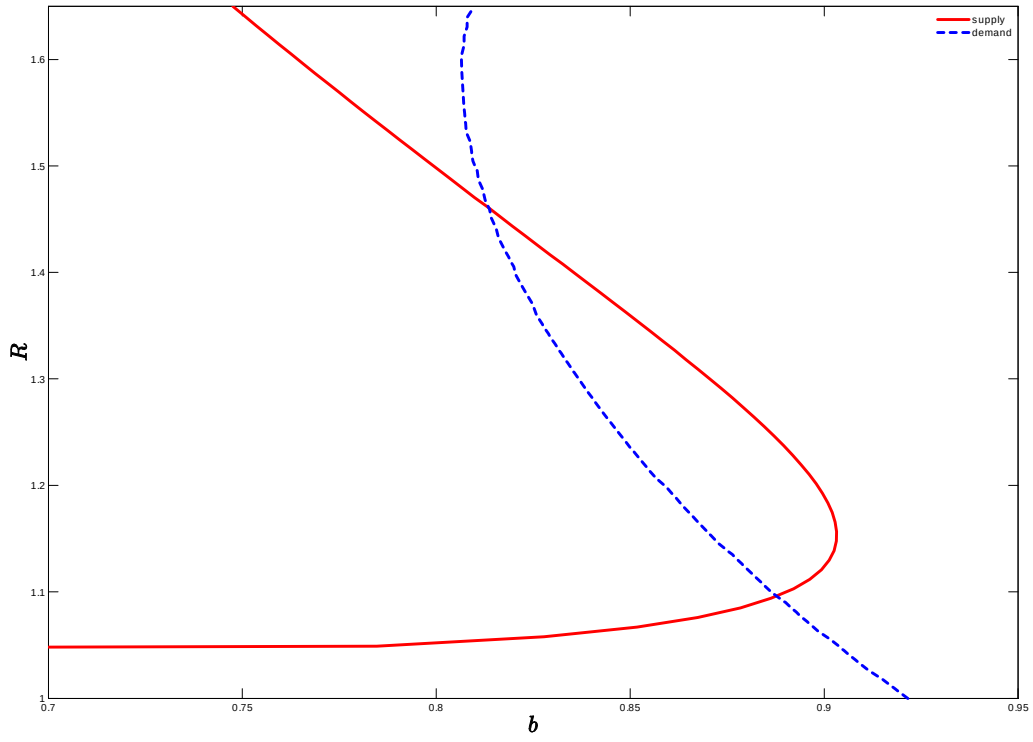
- Supply

$$R^* = R\left[1 - F\left(1 + bR\right)\right].$$

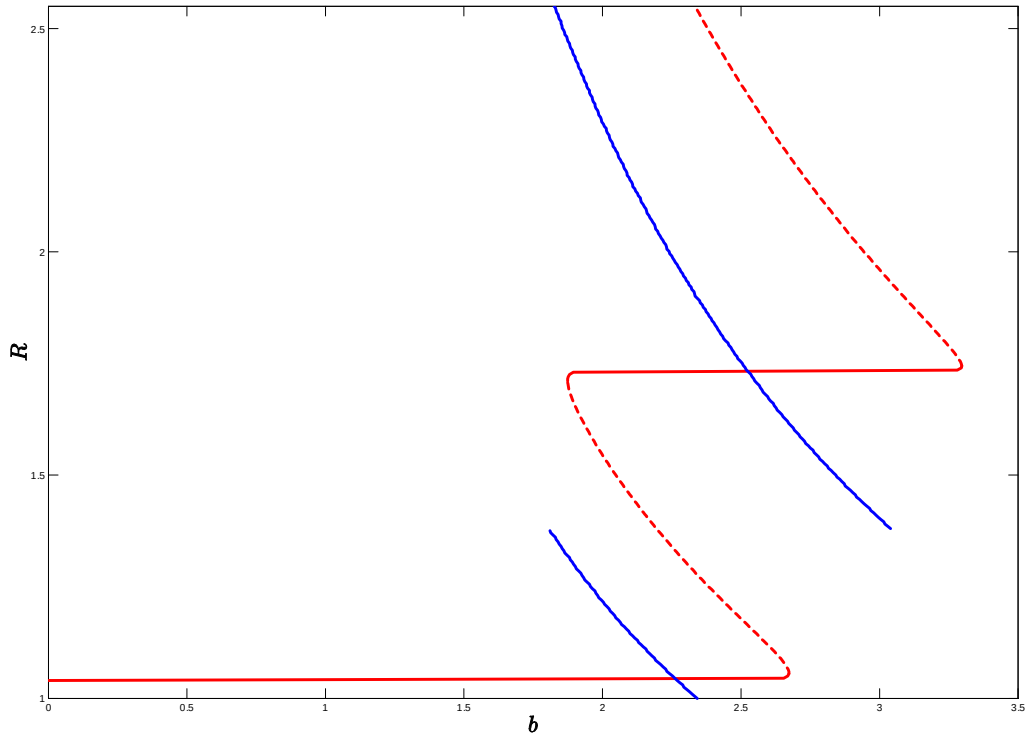
- Demand

$$U'(1+b) = R\beta \int_{1+bR}^{Y} U'(y - bR) f\left(y\right) dy$$

For the normal distribution



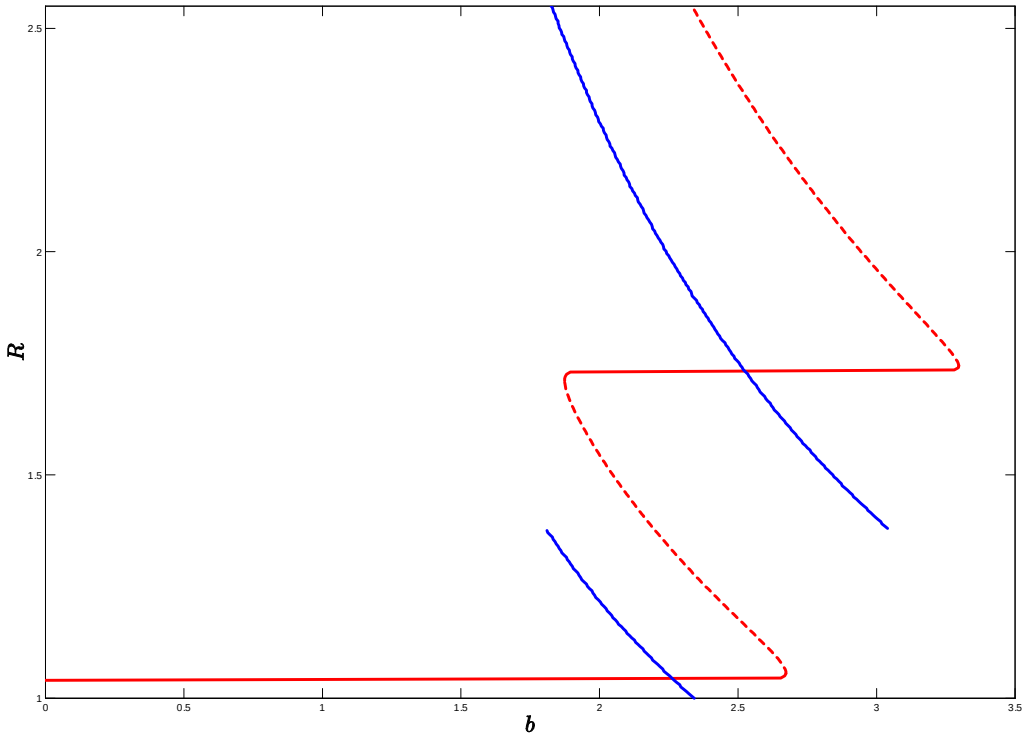
For the bimodal...



Policy

- A foreign investor that can act as a large lender, with deep pockets.

- The large lender can lend to the country, at rate R^P, any amount lower than or equal to a maximum level b^P.


2.5
2
1.5
1
R
0
0.5
1
1.5
2
2.5
3
3.5
b

- Does it matter (for multiplicity) whether the choice for the borrower is b or $a = Rb$?

- Calvo (1988), Lorenzoni and Werning (2013). Schedule in b, multiple equilibria.

- Aguiar and Gopinath (2006), Arellano (2008). Schedule in a, single equilibrium.

- Let $a = Rb$

$$R^* = R\left[1 - F\left(1 + bR\right)\right]$$

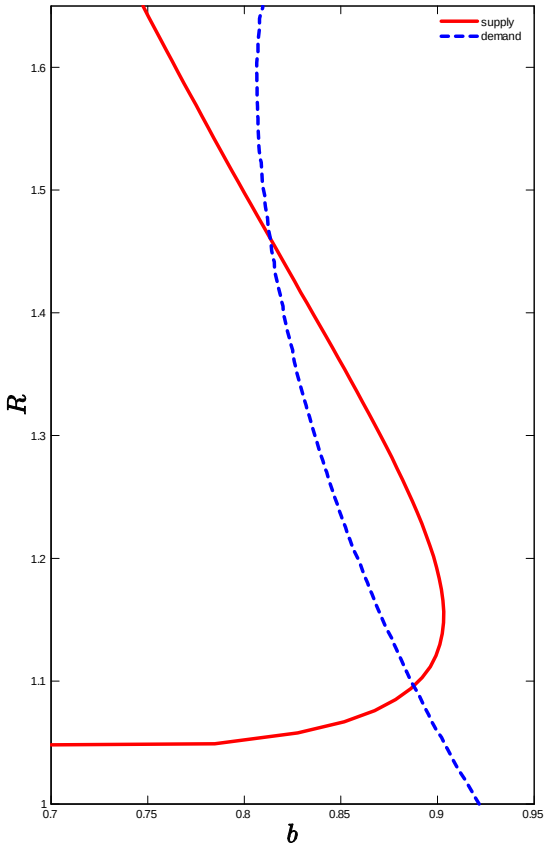
$$U'(1+b) = R\beta \int_{1+bR}^{Y} U'(y - bR) f\left(y\right) dy$$

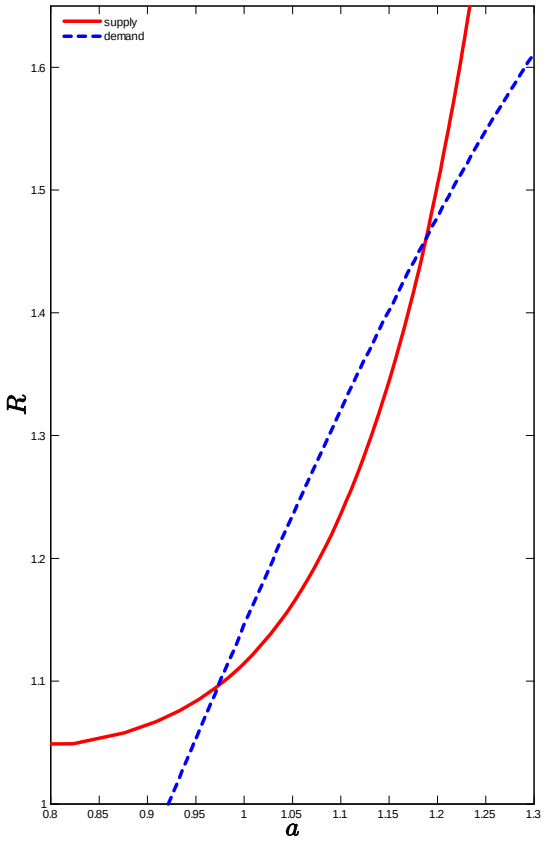
or

$$R^* = R\left[1 - F\left(1 + a\right)\right]$$

$$U'(1+\frac{a}{R}) = R\beta \int_{1+a}^{Y} U'(y - a) f(y) dy$$

- They are the same two equations in R and $a = Rb$.


supply
demand
R
b
1.6
1.5
1.4
1.3
1.2
1.1
1
0.7
0.75
0.8
0.85
0.9
0.95

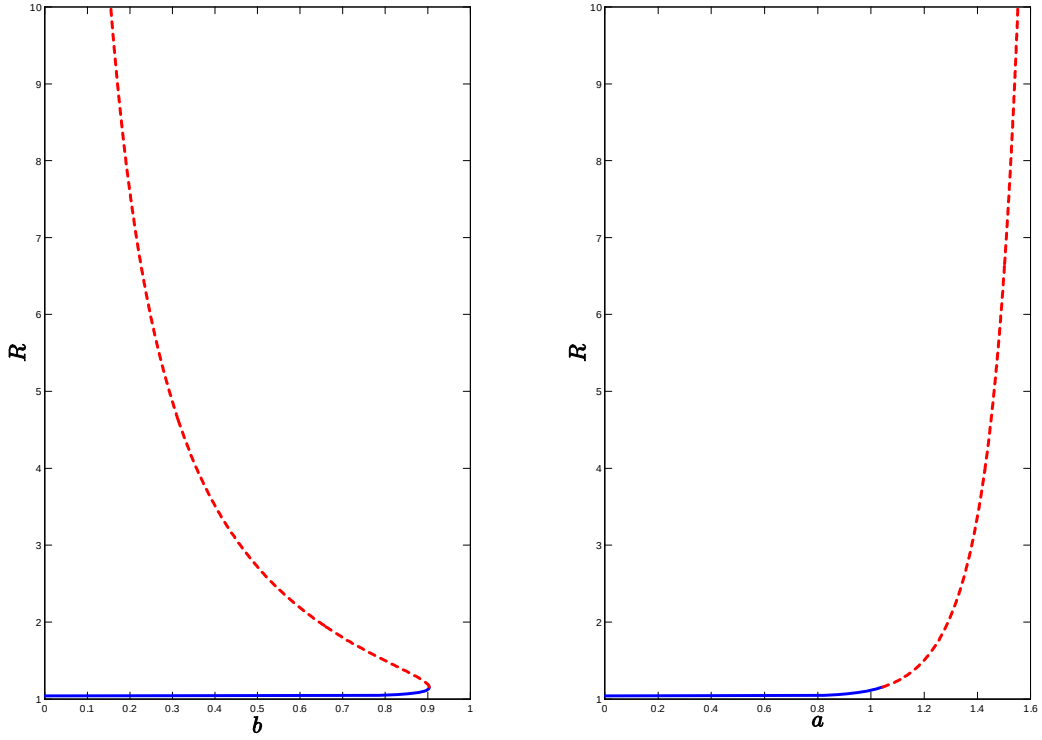

supply
demand
R
a
1.6
1.5
1.4
1.3
1.2
1.1
1
0.8
0.85
0.9
0.95
1
1.05
1.1
1.15
1.2
1.25
1.3

Other timing and action assumptions

- The borrower moves first and chooses b or a

- If the choice is b or a, creditors move next and offer schedules $R(b)$ or $R(a)$.

The borrower chooses b or a



- Picking a is like picking the probability of default, or R. Default probabilities will be on the low rate schedule.

- Literature: Aguiar and Gopinath (2006) and Arellano (2008),

- but not Eaton-Gersovitz (1981).
  - Schedule in b. Assume that $R(b)\,b$ cannot go down when b goes up.

- Calvo (1988) and Lorenzoni and Werning (2013). Schedule in b.

- Lorenzoni and Werning (2013).
  - Schedule in b.
  - Argue against schedule in a. Timing and lack of commitment.
  - Bimodal distribution, without quantitative meaning.
  - Longer maturities and debt dilution.

Timing and size

- Sovereign debt: The government is a large agent. Should it move first (or play Nash)?

- Bassetto (2005): Multiple Laffer curve equilibria.
  - If the government moves first and picks the tax, there is a single low tax equilibrium.
  - If households move first and supply labor, there is also a high tax equilibrium.

Dynamic model: Simulating sovereign debt crises.

- Government moves first and chooses b.
- The endowment y has a bimodal distribution with cdf $F(y)$
- Sunspot $s = 1, 2$, used to select one of two (increasing) interest rate schedules (p is the probability of $s = 1$).

- Upon default, utility is

$$V^{aut} = \frac{U(y^d)}{1-\beta}$$

- Interest rate schedule: $R(b', s)$.

- Threshold for default $y^d\left(b', s, s'\right)$ such that

$$V^{aut} = V\left(y^d\left(b', s, s'\right) - b'R(b', s), s'\right)$$

- Arbitrage conditions for the risk free creditors, in each state,

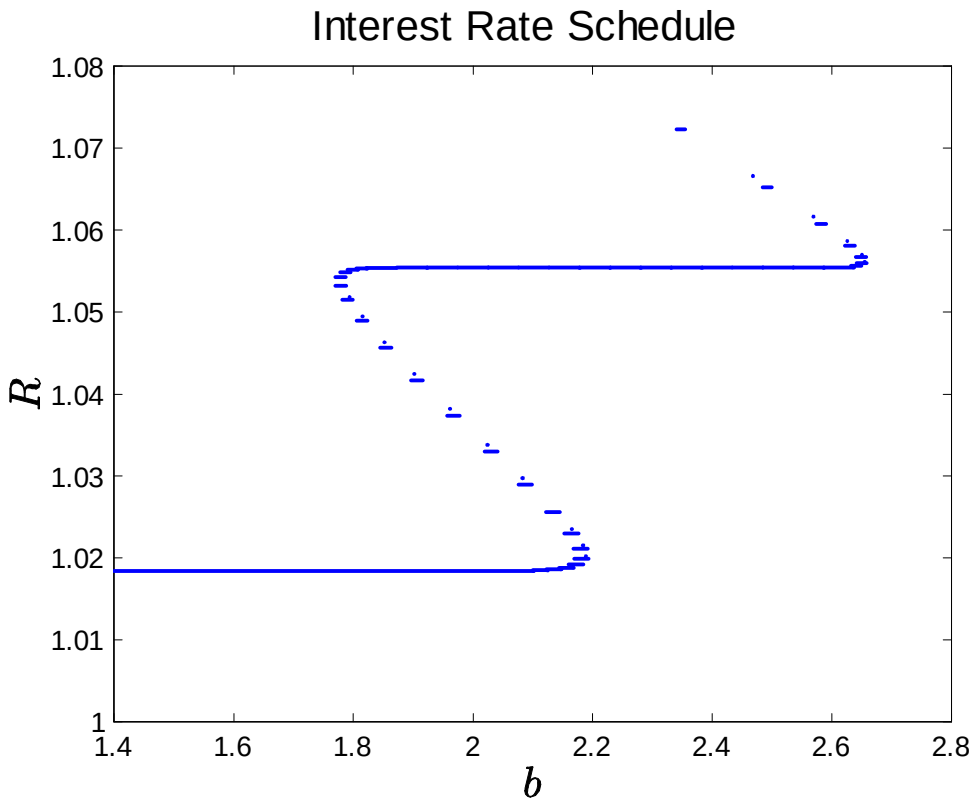
$$R^* = R(b', 1)\left[p\left(1 - F\left(y^d(b', 1, 1)\right)\right) + (1-p)\left(1 - F\left(y^d(b', 1, 2)\right)\right)\right]$$

$$R^* = R(b', 2)\left[p\left(1 - F\left(y^d(b', 2, 1)\right)\right) + (1-p)\left(1 - F\left(y^d(b', 2, 2)\right)\right)\right]$$

$$
\begin{aligned}
V(\omega, j) &= \max_{c, b', \omega'} \left\{ U(c) + \beta \mathbb{E}_{y'} \left[\begin{array}{c} p \max\left\{ V(\omega', 1), V^{aut} \right\} + \\ (1-p) \max\left\{ V(\omega', 2), V^{aut} \right\} \end{array} \right] \right\} \\
&\quad \text{subject to} \\
c &\leq \omega + b'; \\
\omega' &= y' - b' R(b', j); \\
b' &\leq b^{\max}
\end{aligned}
$$

Parameters

- Period is 10 years: $\beta = .7$, $R^* = 1.2$.
- Two normal distributions with mean 6 and 4, and a common standard deviation of 0.1.
- Probability of drawing from the bad distribution is $\pi = 0.3$.
- Probability of the bad sunspot: 20%.


Interest Rate Schedule
1.08
1.07
1.06
1.05
1.04
1.03
1.02
1.01
1
R
1.4
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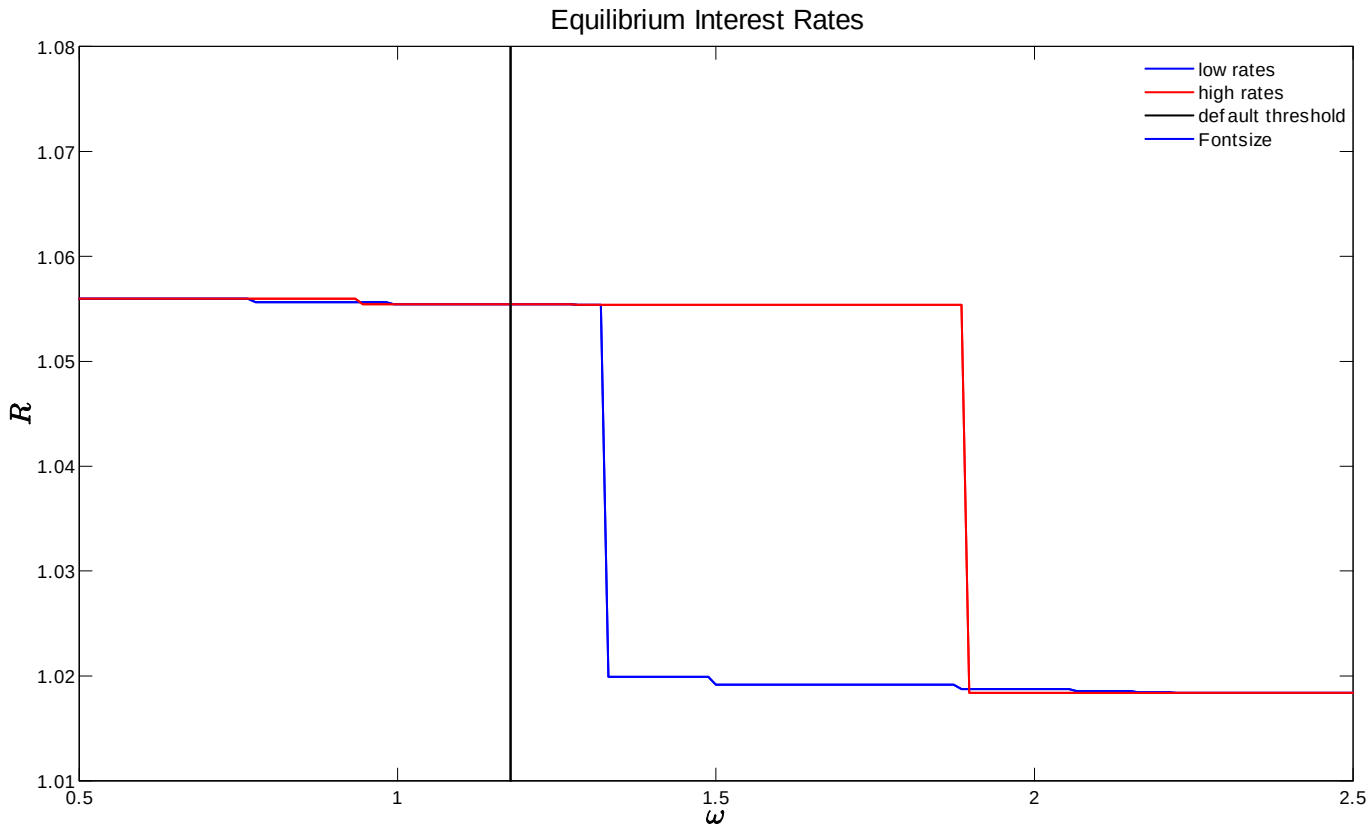
1.8
2
2.2
2.4
2.6
2.8
b


Equilibrium Interest Rates
low rates
high rates
default threshold
Fontsize
1.08
1.07
1.06
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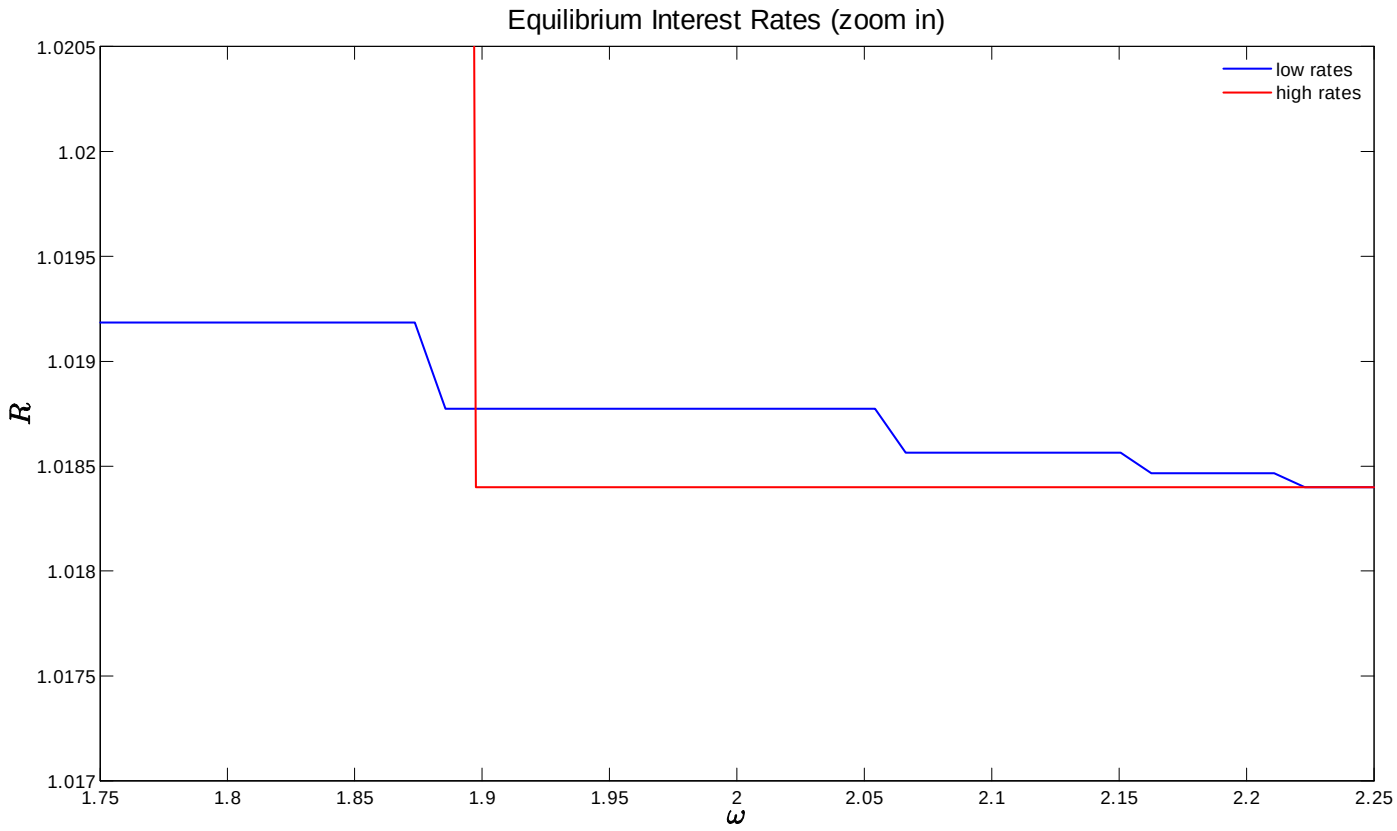
1.04
1.03
1.02
1.01
R
0.5
1
1.5
2
2.5
ω


Equilibrium Interest Rates (zoom in)
low rates
high rates
1.0205
1.02
1.0195
1.019
1.0185
1.018
1.0175
1.017
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2.05
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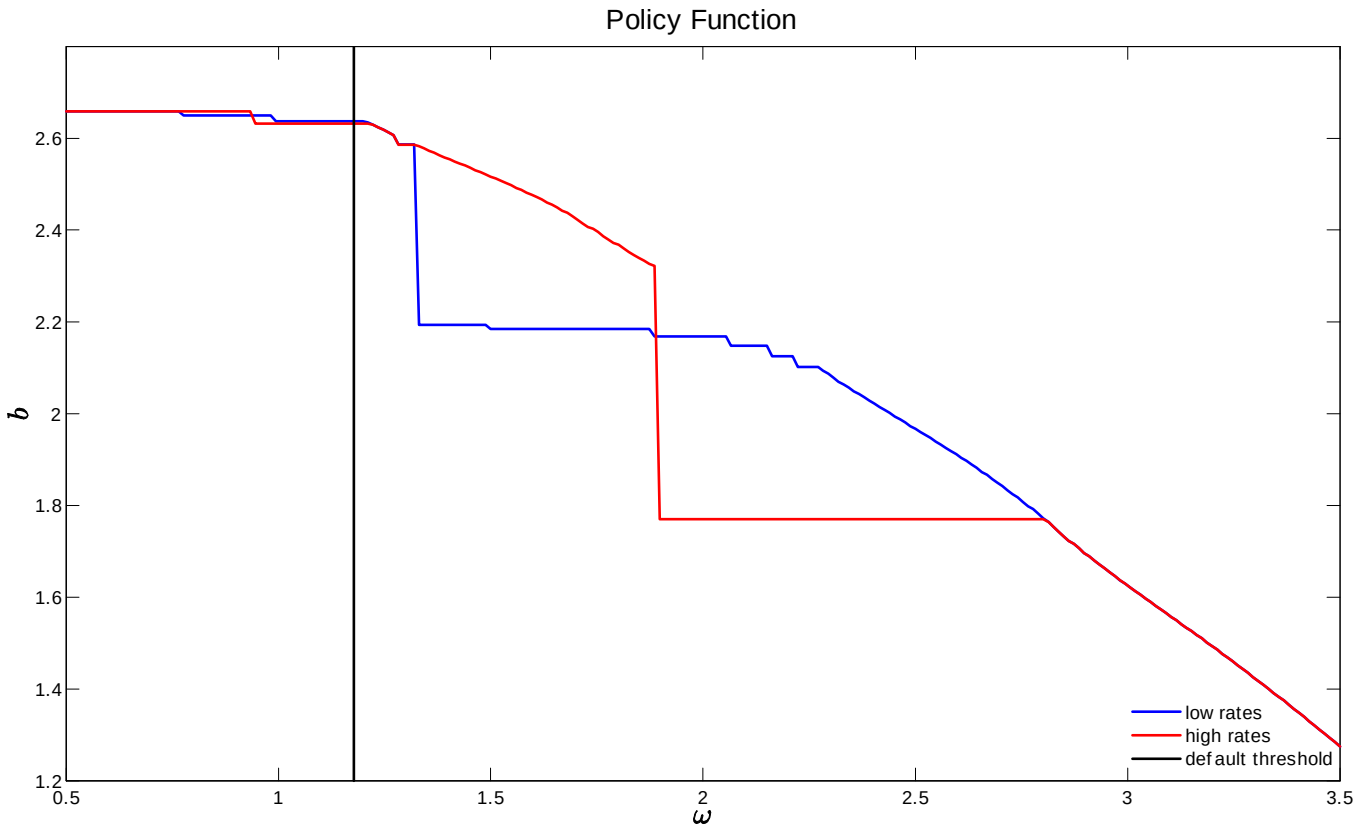
ω


Policy Function
2.6
2.4
2.2
2
1.8
1.6
1.4
1.2
b
0.5
1
1.5
2
2.5
3
3.5
ω
low rates
high rates
default threshold

- Relevance of multiplicity is endogenous. Hard to get borrower into the region of multiplicity

- Spreads jump up with the debt level.

- Role of policy and disciplinary effect of crises:
  - Debt is relatively low under the bad sunspot (before it is high).
  - Policy can bring both spreads and debt down (austerity with policy)

Conclusion

- Can a country be trapped in a high interest rate equilibrium, where default probabilities are high because interest rates are high?

- Minor deviations on the timing and actions of agents produce multiple equilibria which have the features in Calvo (1988).

- It is hard to get direct evidence on the timing or/and action assumptions.

- Indirect evidence includes the large and abrupt movements in interest rates, obtained in the model with multiple schedules and a sunspot variable that helps coordinate on the different schedules.

- Need regime switching.
- Level of debt matters.
- And policy, too.