

Sudden Stops and Sovereign Defaults.

Luis Catao (IMF), Ana Fostel (GWU), Romain Ranciere (PSE-IMF)

June 2011

- Recent debt crises in Europe : the role of asymmetric information about fiscal shocks in accounting for sudden hikes in country risk.

- Recent debt crises in Europe : the role of asymmetric information about fiscal shocks in accounting for sudden hikes in country risk.
- Model: asymmetry of information between fiscal authorities and investors + the persistence of tax shocks: sudden inward shift in the supply of loanable funds to a sovereign.

- Recent debt crises in Europe : the role of asymmetric information about fiscal shocks in accounting for sudden hikes in country risk.
- Model: asymmetry of information between fiscal authorities and investors + the persistence of tax shocks: sudden inward shift in the supply of loanable funds to a sovereign.
- Result: sudden stop (SS) shows up in *bond prices* but not in borrowing flows until outright default materializes.

- Recent debt crises in Europe : the role of asymmetric information about fiscal shocks in accounting for sudden hikes in country risk.
- Model: asymmetry of information between fiscal authorities and investors + the persistence of tax shocks: sudden inward shift in the supply of loanable funds to a sovereign.
- Result: sudden stop (SS) shows up in *bond prices* but not in borrowing flows until outright default materializes.
- Mechanism: with market access, an increase in financing needs *signals* persistent negative shock to tax revenues and hence to debt repayment capacity, which raises spreads and in turn lowers the cost of a subsequent default.

- Recent debt crises in Europe : the role of asymmetric information about fiscal shocks in accounting for sudden hikes in country risk.
- Model: asymmetry of information between fiscal authorities and investors + the persistence of tax shocks: sudden inward shift in the supply of loanable funds to a sovereign.
- Result: sudden stop (SS) shows up in *bond prices* but not in borrowing flows until outright default materializes.
- Mechanism: with market access, an increase in financing needs *signals* persistent negative shock to tax revenues and hence to debt repayment capacity, which raises spreads and in turn lowers the cost of a subsequent default.
- **Equilibrium 1: separating equilibrium where the SS precedes both the default and the eventual drop in net inflows**

- Recent debt crises in Europe : the role of asymmetric information about fiscal shocks in accounting for sudden hikes in country risk.
- Model: asymmetry of information between fiscal authorities and investors + the persistence of tax shocks: sudden inward shift in the supply of loanable funds to a sovereign.
- Result: sudden stop (SS) shows up in *bond prices* but not in borrowing flows until outright default materializes.
- Mechanism: with market access, an increase in financing needs *signals* persistent negative shock to tax revenues and hence to debt repayment capacity, which raises spreads and in turn lowers the cost of a subsequent default.
- Equilibrium 1: separating equilibrium where the SS precedes both the default and the eventual drop in net inflows
- **Equilibrium 2: pooling equilibrium in which spreads stay put and the SS will not precede a sovereign default.**

Motivating Facts from European Crisis

- 1 Uncertainty about the state of public finances

1 Uncertainty about the state of public finances

- New York Times (February 11) "tax revenues in Greece fell 5.4 billion short of its budgeted revenues last year.(...) In fact, tax collection was so poor that the Greek government decided last September to offer an amnesty program, allowing tax payers to settle their outstanding debt by paying just 55% of the bill."

- 1 Uncertainty about the state of public finances
 - New York Times (February 11) "tax revenues in Greece fell 5.4 billion short of its budgeted revenues last year.(...) In fact, tax collection was so poor that the Greek government decided last September to offer an amnesty program, allowing tax payers to settle their outstanding debt by paying just 55% of the bill."
 - Revisions in national budget figures (typically in downward direction), often announced by the respective authorities with substantial lags, all of which have been accompanied by large swings in sovereign spreads

Motivating Facts from European Crisis

1 Uncertainty about the state of public finances

- New York Times (February 11) "tax revenues in Greece fell 5.4 billion short of its budgeted revenues last year.(...) In fact, tax collection was so poor that the Greek government decided last September to offer an amnesty program, allowing tax payers to settle their outstanding debt by paying just 55% of the bill."
- Revisions in national budget figures (typically in downward direction), often announced by the respective authorities with substantial lags, all of which have been accompanied by large swings in sovereign spreads

2 Continuing and (Intensifying) Market Access.

Motivating Facts from European Crisis

1 Uncertainty about the state of public finances

- New York Times (February 11) "tax revenues in Greece fell 5.4 billion short of its budgeted revenues last year.(...) In fact, tax collection was so poor that the Greek government decided last September to offer an amnesty program, allowing tax payers to settle their outstanding debt by paying just 55% of the bill."
- Revisions in national budget figures (typically in downward direction), often announced by the respective authorities with substantial lags, all of which have been accompanied by large swings in sovereign spreads

2 Continuing and (Intensifying) Market Access.

- Countries have been able to tap markets for the most part throughout the turmoil, albeit at a much higher spread.

Motivating Facts from European Crisis

1 Uncertainty about the state of public finances

- New York Times (February 11) "tax revenues in Greece fell 5.4 billion short of its budgeted revenues last year.(...) In fact, tax collection was so poor that the Greek government decided last September to offer an amnesty program, allowing tax payers to settle their outstanding debt by paying just 55% of the bill."
- Revisions in national budget figures (typically in downward direction), often announced by the respective authorities with substantial lags, all of which have been accompanied by large swings in sovereign spreads

2 Continuing and (Intensifying) Market Access.

- Countries have been able to tap markets for the most part throughout the turmoil, albeit at a much higher spread.
- Mas Collel (FT, Jan 2011): "Catalonia, one of the richest parts of Spain, needs to raise 10 bn - 11bn in debt this year to cover deficits and repay earlier loans, we had inherited unfunded deficits from the previous, Socialist-led regional government. "We're not yet guilty of anything".

- This paper attempts to close the gap between literature on sudden stop and literature on sovereign default.
- Sudden Stop literature: Calvo (1998), Cabalero-Krishnamurt (2011), Kehoe et al. (2005), Mendoza (2006, 2009)
 - Relative Price Movement and Unhedged Debt: Currency Mismatch.
 - Focus on Quantities rather than Prices.
- Sovereign Default Literature
 - Aguiar and Gopinath (2006): Countries with higher underlying persistence of output shocks are more prone to default.
 - Symmetric Information Models cannot explain large country risk fluctuations under continuous market access.

- 1 Stylized Facts
- 2 The Model
- 3 Numerical Results

- Definition of a **debt crisis**: outright default and near default.
 - Outright defaults as per the Standard & Poor classification of sovereign defaults
 - “near-defaults” episodes of large IMF support where “large” is taken of at least twice as large as the respective country’s quota in the IMF, when all net disbursements are computed from program’s inception to end.
- Pre-2007 vs Post-2007 sample: Mostly Europe + Emerging Europe.
- Event study analysis around the default event.

Debt

Figure 1: Net External Debt Around External Debt Crises
(cross-country mean as percent of GDP)

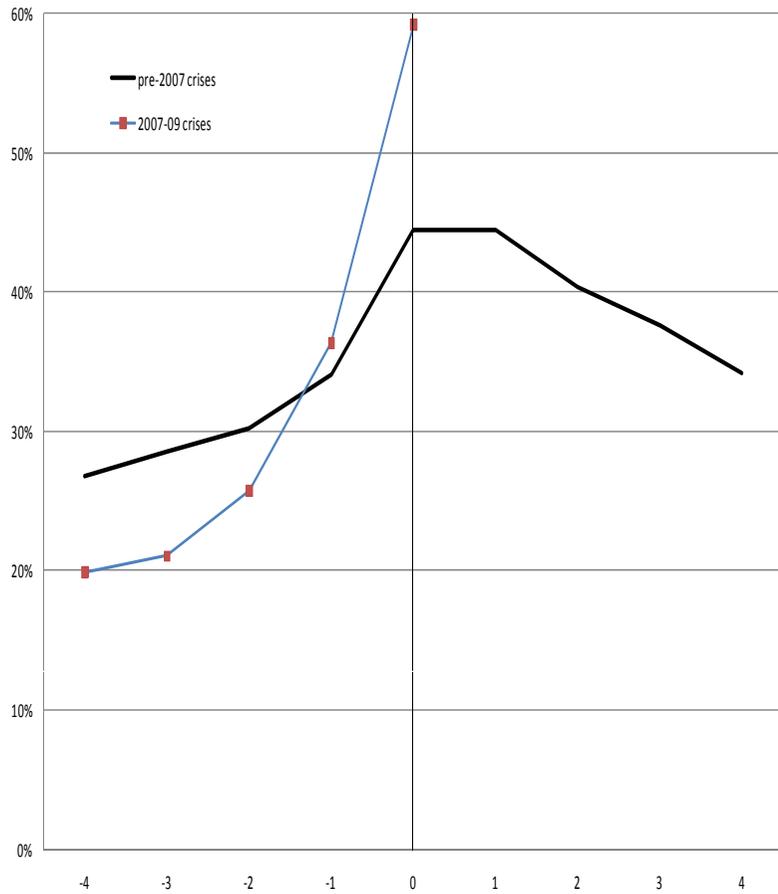
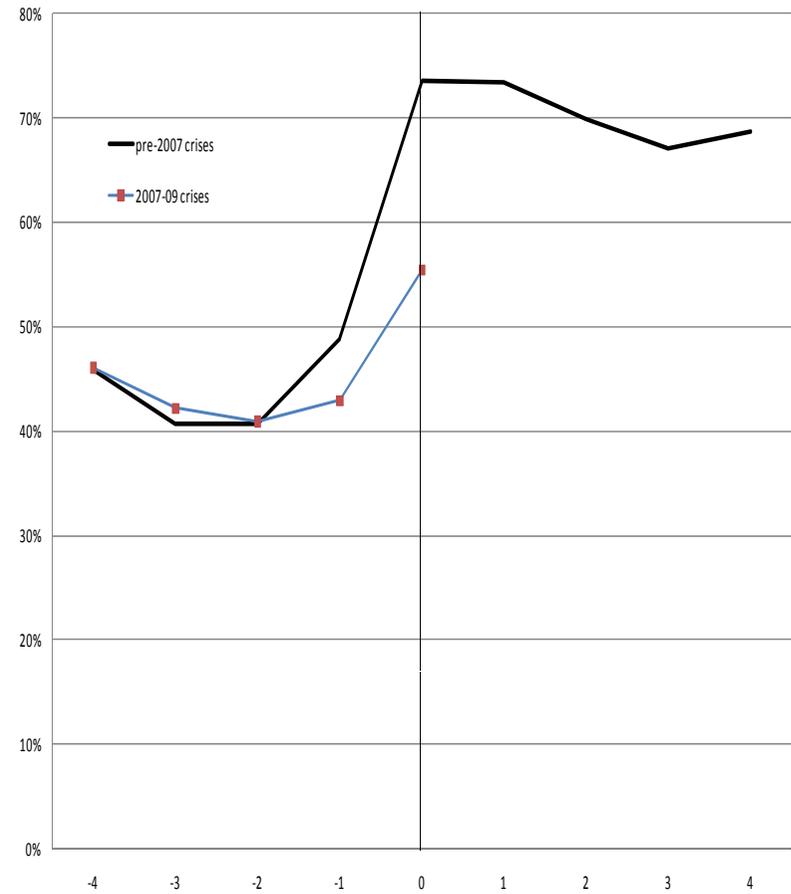
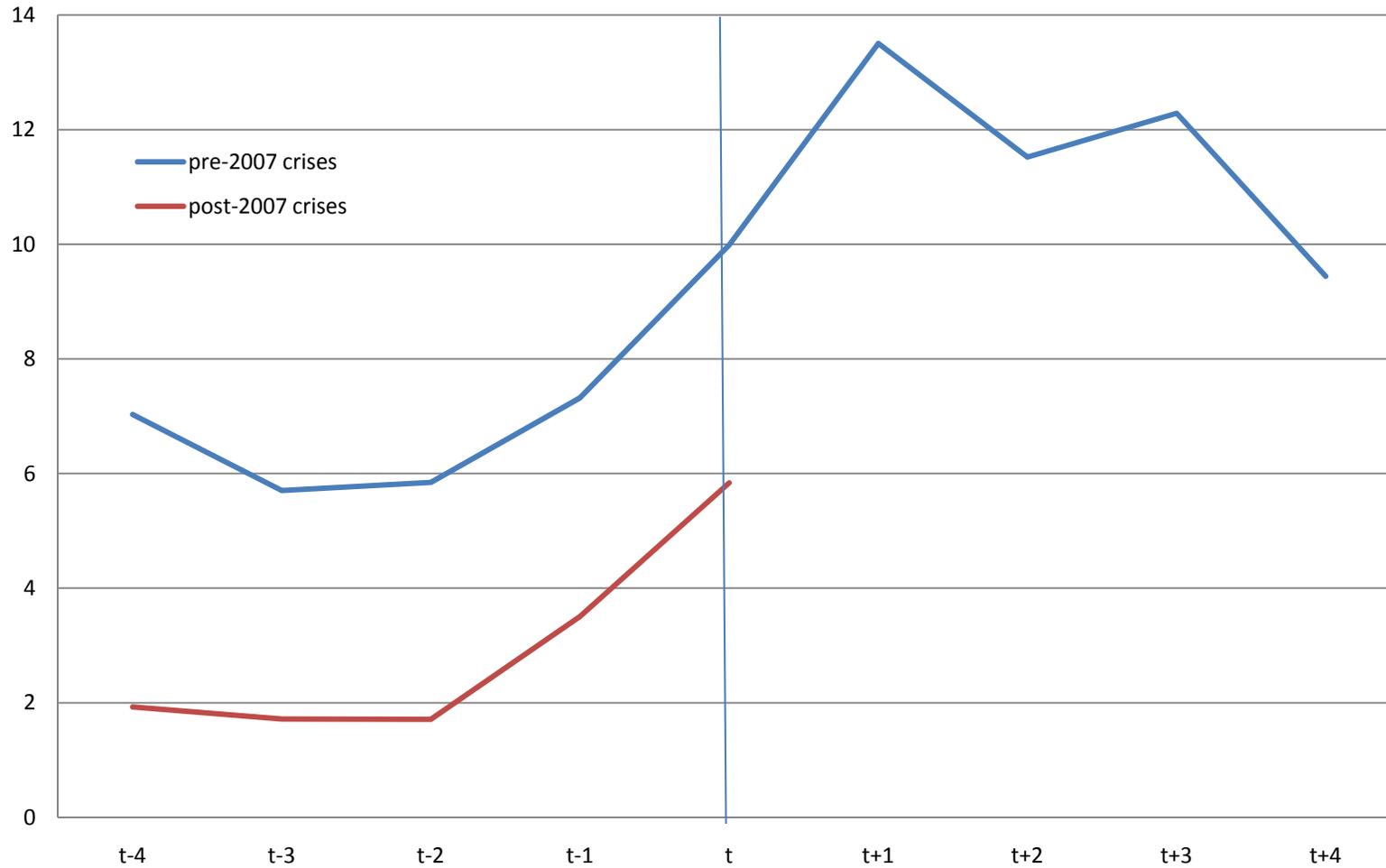


Figure 2: Gross Total Public Debt Around External Debt Crises
(ratio to GDP)

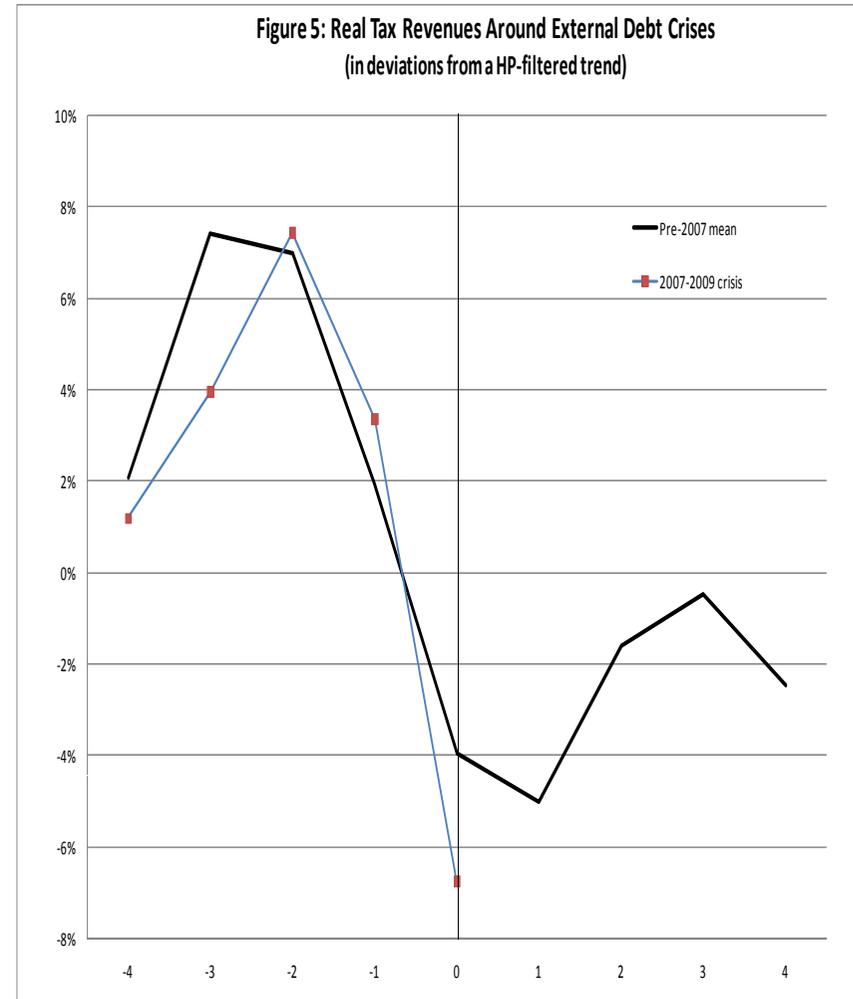
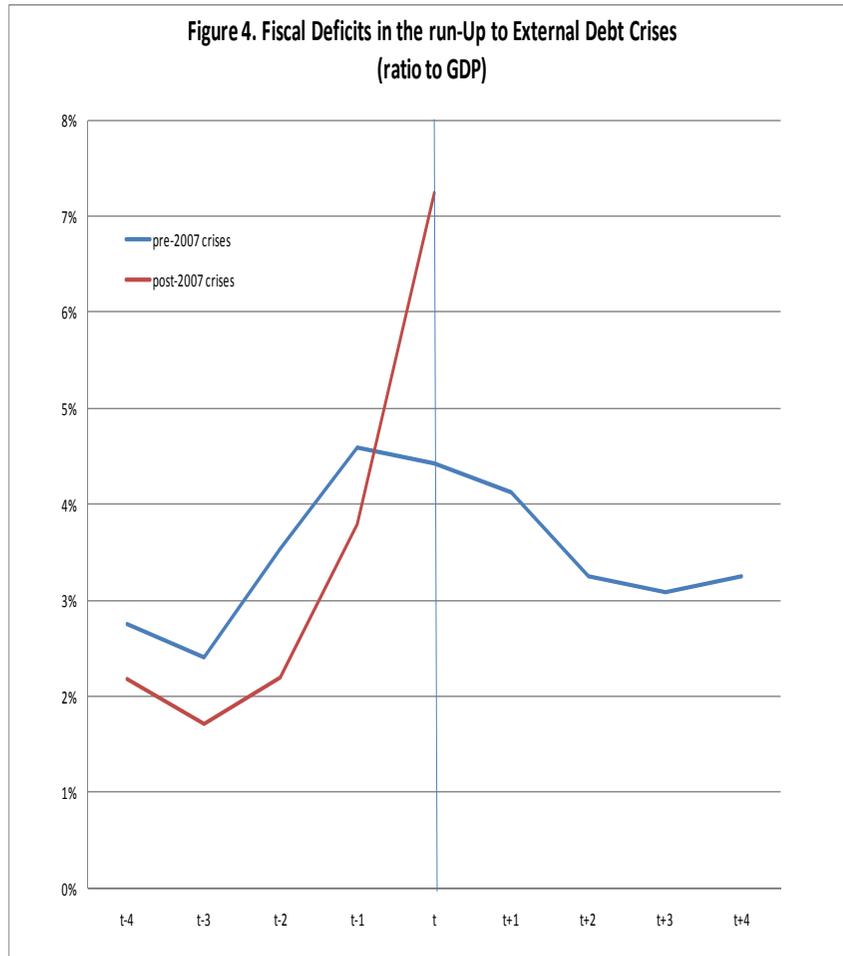


Spread

**Figure 3. Sovereign Spreads in the run-Up to External Debt Crises
(percent)**



Fiscal Deficit and Tax Revenues



Model Set-Up

- 3 period model: $t = 0, 1, 2$

Model Set-Up

- 3 period model: $t = 0, 1, 2$
- A government issues bonds in international capital markets to finance investment in a long-term project which can be related to physical infrastructure and/or human capital development (e.g. education and health).

Model Set-Up

- 3 period model: $t = 0, 1, 2$
- A government issues bonds in international capital markets to finance investment in a long-term project which can be related to physical infrastructure and/or human capital development (e.g. education and health).
- The project's investment requirement in period 0 generates fiscal revenues τ_0, τ_1 and τ_2 in periods 0, 1 and 2 respectively

Model Set-Up

- 3 period model: $t = 0, 1, 2$
- A government issues bonds in international capital markets to finance investment in a long-term project which can be related to physical infrastructure and/or human capital development (e.g. education and health).
- The project's investment requirement in period 0 generates fiscal revenues τ_0, τ_1 and τ_2 in periods 0, 1 and 2 respectively
- The sovereign issues long-term debt to be paid in period 2. It issues $D_0 = \tau_0$ at time $t = 0$, it pays interest $r_0\tau_0$ in $t = 1$ promises to pay $(1 + r_0)\tau_0$ in $t = 2$.

Model Set-Up

- 3 period model: $t = 0, 1, 2$
- A government issues bonds in international capital markets to finance investment in a long-term project which can be related to physical infrastructure and/or human capital development (e.g. education and health).
- The project's investment requirement in period 0 generates fiscal revenues τ_0, τ_1 and τ_2 in periods 0, 1 and 2 respectively
- The sovereign issues long-term debt to be paid in period 2. It issues $D_0 = \tau_0$ at time $t = 0$, it pays interest $r_0\tau_0$ in $t = 1$ promises to pay $(1 + r_0)\tau_0$ in $t = 2$.
- In period $t = 1$ government's fiscal revenue is subject to a shock $\tilde{\epsilon}_1$ which assumes two values: $\epsilon_1^H = \alpha\tau_1$ and $\epsilon_1^L = -\alpha\tau_1$, with probability p and $1 - p$ respectively, where $\alpha < 1$.

Model Set-Up

- 3 period model: $t = 0, 1, 2$
- A government issues bonds in international capital markets to finance investment in a long-term project which can be related to physical infrastructure and/or human capital development (e.g. education and health).
- The project's investment requirement in period 0 generates fiscal revenues τ_0, τ_1 and τ_2 in periods 0, 1 and 2 respectively
- The sovereign issues long-term debt to be paid in period 2. It issues $D_0 = \tau_0$ at time $t = 0$, it pays interest $r_0\tau_0$ in $t = 1$ promises to pay $(1 + r_0)\tau_0$ in $t = 2$.
- In period $t = 1$ government's fiscal revenue is subject to a shock $\tilde{\epsilon}_1$ which assumes two values: $\epsilon_1^H = \alpha\tau_1$ and $\epsilon_1^L = -\alpha\tau_1$, with probability p and $1 - p$ respectively, where $\alpha < 1$.
- **A key assumption** is that the shock in period 1 is persistent, so that $\rho\epsilon_1$ still affects the fiscal revenues in the final period.

Interim Period Borrowing Options and Default

- 1 "Renegotiate" (R). Borrower can buy back its debt paying $(1 + r_0)\tau_0$ at $t = 1$ and re-issue the same debt $D_1 = \tau_0$ at $t = 1$ promising $(1 + r_1^R)\tau_0$ at $t = 2$.

Interim Period Borrowing Options and Default

- 1 "Renegotiate" (R). Borrower can buy back its debt paying $(1 + r_0)\tau_0$ at $t = 1$ and re-issue the same debt $D_1 = \tau_0$ at $t = 1$ promising $(1 + r_1^R)\tau_0$ at $t = 2$.
 - total outstanding debt at the end of the middle period unchanged

Interim Period Borrowing Options and Default

- 1 "Renegotiate" (R). Borrower can buy back its debt paying $(1 + r_0)\tau_0$ at $t = 1$ and re-issue the same debt $D_1 = \tau_0$ at $t = 1$ promising $(1 + r_1^R)\tau_0$ at $t = 2$.
 - total outstanding debt at the end of the middle period unchanged
- 2 "New Fresh Issuance" (I). Borrower can issue new fresh debt D_1 to cover fiscal downfalls, $D_1 = \alpha\tau_1$, and promise to pay $(1 + r_1^I)\alpha\tau_1$ at $t = 2$.

Interim Period Borrowing Options and Default

- 1 "Renegotiate" (R). Borrower can buy back its debt paying $(1 + r_0)\tau_0$ at $t = 1$ and re-issue the same debt $D_1 = \tau_0$ at $t = 1$ promising $(1 + r_1^R)\tau_0$ at $t = 2$.
 - total outstanding debt at the end of the middle period unchanged
- 2 "New Fresh Issuance" (I). Borrower can issue new fresh debt D_1 to cover fiscal downfalls, $D_1 = \alpha\tau_1$, and promise to pay $(1 + r_1^I)\alpha\tau_1$ at $t = 2$.
 - total outstanding debt at the end of the middle period is $\alpha\tau_1 + \tau_0$.

Interim Period Borrowing Options and Default

- 1 "Renegotiate" (R). Borrower can buy back its debt paying $(1 + r_0)\tau_0$ at $t = 1$ and re-issue the same debt $D_1 = \tau_0$ at $t = 1$ promising $(1 + r_1^R)\tau_0$ at $t = 2$.
 - total outstanding debt at the end of the middle period unchanged
- 2 "New Fresh Issuance" (I). Borrower can issue new fresh debt D_1 to cover fiscal downfalls, $D_1 = \alpha\tau_1$, and promise to pay $(1 + r_1^I)\alpha\tau_1$ at $t = 2$.
 - total outstanding debt at the end of the middle period is $\alpha\tau_1 + \tau_0$.
- 3 At the final period, the government is subjected to another fiscal shock $\tilde{\epsilon}_2$ (ϵ_2^H or ϵ_2^L) with probability q and $1 - q$ respectively.

Interim Period Borrowing Options and Default

- 1 "Renegotiate" (R). Borrower can buy back its debt paying $(1 + r_0)\tau_0$ at $t = 1$ and re-issue the same debt $D_1 = \tau_0$ at $t = 1$ promising $(1 + r_1^R)\tau_0$ at $t = 2$.
 - total outstanding debt at the end of the middle period unchanged
- 2 "New Fresh Issuance" (I). Borrower can issue new fresh debt D_1 to cover fiscal downfalls, $D_1 = \alpha\tau_1$, and promise to pay $(1 + r_1^I)\alpha\tau_1$ at $t = 2$.
 - total outstanding debt at the end of the middle period is $\alpha\tau_1 + \tau_0$.
- 3 At the final period, the government is subjected to another fiscal shock $\tilde{\epsilon}_2$ (ϵ_2^H or ϵ_2^L) with probability q and $1 - q$ respectively.
 - After the realization of the shock, the government decides whether to pay or default in all outstanding debt.

Default Costs and Lenders/Sovereign Pay-offs.

- Hair Cut / Partial Default : $(1 - c) * total_debt$
- Punishment/Sanctions: confiscation of a fraction η of fiscal revenues by creditors.
- Risk-neutral Lenders: break-even in expected terms.
- Sovereign Maximizes discounted sum of fiscal expenditures (*reduced form welfare function*)
 - $G_0 = \tau_0$
 - $\tau = 1$ shock: $\varepsilon_1 = -/ + \alpha\tau_1$
 - decision $\tau = 1$: re-finance

$$G_1^R = \tau_1 + \varepsilon_1 - r_0\tau_0 = (1 + \alpha)\tau_1 - r_0\tau_0$$

- decision $\tau = 1$:re-issue:

$$G_1^I = \tau_1 + \varepsilon_1 - r_0\tau_0 + \alpha\tau_1 = \tau_1 - r_0\tau_0$$

- $\tau = 2$: shock: $\varepsilon_2 + \rho\varepsilon_1 = \varepsilon_2 + / - \rho\alpha\tau_1$
- decision $\tau = 2$: repay of default.

Asymmetric Information and Sudden Stop.

- **Assymmetric Information:** While the borrower can perfectly observe the realization of the middle period shock $\tilde{\epsilon}_1$, lenders cannot.

Asymmetric Information and Sudden Stop.

- **Assymmetric Information:** While the borrower can perfectly observe the realization of the middle period shock $\tilde{\epsilon}_1$, lenders cannot.
- **Information Revelation:** The only way lenders can infer some information about the realization of the shock is through the borrower's action in the middle period: to issue new debt (I) or to re-negotiate (R).

Asymmetric Information and Sudden Stop.

- **Assymmetric Information:** While the borrower can perfectly observe the realization of the middle period shock $\tilde{\epsilon}_1$, lenders cannot.
- **Information Revelation:** The only way lenders can infer some information about the realization of the shock is through the borrower's action in the middle period: to issue new debt (I) or to re-negotiate (R).
- Lenders at $t = 1$, after observing the borrower action (issue or re-negotiate) update their beliefs of future default and re-price debt accordingly.

Asymmetric Information and Sudden Stop.

- **Assymmetric Information:** While the borrower can perfectly observe the realization of the middle period shock $\tilde{\epsilon}_1$, lenders cannot.
- **Information Revelation:** The only way lenders can infer some information about the realization of the shock is through the borrower's action in the middle period: to issue new debt (I) or to re-negotiate (R).
- Lenders at $t = 1$, after observing the borrower action (issue or re-negotiate) update their beliefs of future default and re-price debt accordingly.
- We define a **sudden stop (SS)** as an inward shift in the supply curve of funds.

Asymmetric Information and Sudden Stop.

- **Assymmetric Information:** While the borrower can perfectly observe the realization of the middle period shock $\tilde{\epsilon}_1$, lenders cannot.
- **Information Revelation:** The only way lenders can infer some information about the realization of the shock is through the borrower's action in the middle period: to issue new debt (I) or to re-negotiate (R).
- Lenders at $t = 1$, after observing the borrower action (issue or re-negotiate) update their beliefs of future default and re-price debt accordingly.
- We define a **sudden stop** (SS) as an inward shift in the supply curve of funds.
- For tractability we are not modeling the quantity choice, so quantity issuance is taken exogenous.

Asymmetric Information and Sudden Stop.

- **Assymmetric Information:** While the borrower can perfectly observe the realization of the middle period shock $\tilde{\epsilon}_1$, lenders cannot.
- **Information Revelation:** The only way lenders can infer some information about the realization of the shock is through the borrower's action in the middle period: to issue new debt (I) or to re-negotiate (R).
- Lenders at $t = 1$, after observing the borrower action (issue or re-negotiate) update their beliefs of future default and re-price debt accordingly.
- We define a **sudden stop** (SS) as an inward shift in the supply curve of funds.
- For tractability we are not modeling the quantity choice, so quantity issuance is taken exogenous.
- Focus on endogenous and sudden changes in prices as opposed to quantities. Sudden Stop is characterized by the difference in rates charged by lenders in period 1: $r_1^I - r_1^R$

Credit Market Game and Equilibria.

- We model the borrower and lender interaction as a game. The borrower's strategy is to issue (I) or re-negotiate (R) in period 1 and to pay or not in period 2. The lender's strategy is to set a break-even price. Lenders will have beliefs about borrower's type (shock realization in period 1).

Theorem: *There exists a separating perfect bayesian equilibrium in this economy in which Sudden Stop associated with hiking spreads but positive net borrowing precedes a Sovereign Default.*

Credit Market Game and Equilibria.

- We model the borrower and lender interaction as a game. The borrower's strategy is to issue (I) or re-negotiate (R) in period 1 and to pay or not in period 2. The lender's strategy is to set a break-even price. Lenders will have beliefs about borrower's type (shock realization in period 1).
- A Perfect Bayesian equilibrium (PBE) is an equilibrium in which everybody's response is optimal given everybody's else response and beliefs, and beliefs are consistent with strategies and updates using Bayes' (whenever possible).

Theorem: *There exists a separating perfect bayesian equilibrium in this economy in which Sudden Stop associated with hiking spreads but positive net borrowing precedes a Sovereign Default.*

Credit Market Game and Equilibria.

- We model the borrower and lender interaction as a game. The borrower's strategy is to issue (I) or re-negotiate (R) in period 1 and to pay or not in period 2. The lender's strategy is to set a break-even price. Lenders will have beliefs about borrower's type (shock realization in period 1).
- A Perfect Bayesian equilibrium (PBE) is an equilibrium in which everybody's response is optimal given everybody's else response and beliefs, and beliefs are consistent with strategies and updates using Bayes' (whenever possible).
- **Separating Equilibria : different shocks \rightarrow different actions. Information revelation.**

Theorem: *There exists a separating perfect bayesian equilibrium in this economy in which Sudden Stop associated with hiking spreads but positive net borrowing precedes a Sovereign Default.*

Credit Market Game and Equilibria.

- We model the borrower and lender interaction as a game. The borrower's strategy is to issue (I) or re-negotiate (R) in period 1 and to pay or not in period 2. The lender's strategy is to set a break-even price. Lenders will have beliefs about borrower's type (shock realization in period 1).
- A Perfect Bayesian equilibrium (PBE) is an equilibrium in which everybody's response is optimal given everybody's else response and beliefs, and beliefs are consistent with strategies and updates using Bayes' (whenever possible).
- Separating Equilibria : different shocks \rightarrow different actions. Information revelation.
- **Pooling Equilibrium: different shocks \rightarrow same actions. No information revelation.**

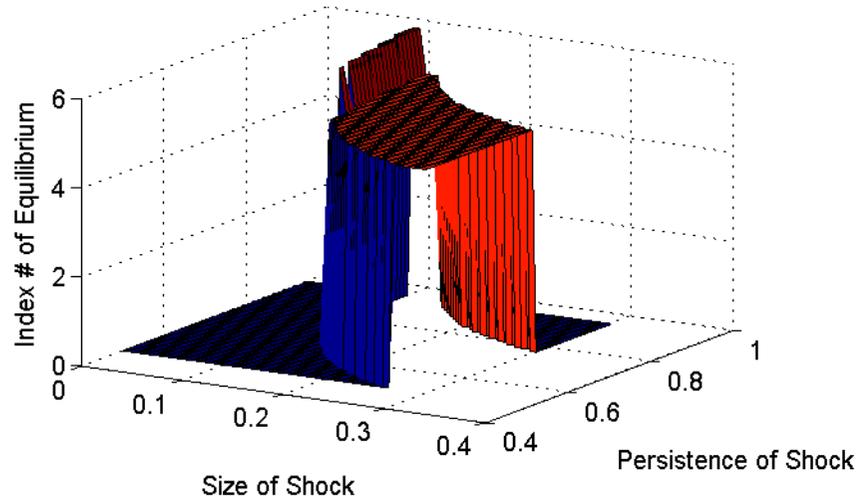
Theorem: *There exists a separating perfect bayesian equilibrium in this economy in which Sudden Stop associated with hiking spreads but positive net borrowing precedes a Sovereign Default.*

- 1 H: good shock in period 1. L bad shock in period 1.
- 2 Pooling Equilibrium: H and L re-finance.
 - Eq1: Nobody defaults.
- 3 Separating Equilibria: H re-finance; L re-issue
 - Eq 2: H never defaults, L only for a bad shock.
 - Eq 3: Both default for a bad shock.
 - Eq 4: H never defaults, L always defaults.
 - Eq 5: L always defaults, H only for a bad shock.
 - Eq 6: Both always default.
- 4 Potential Multiplicity (not robust)

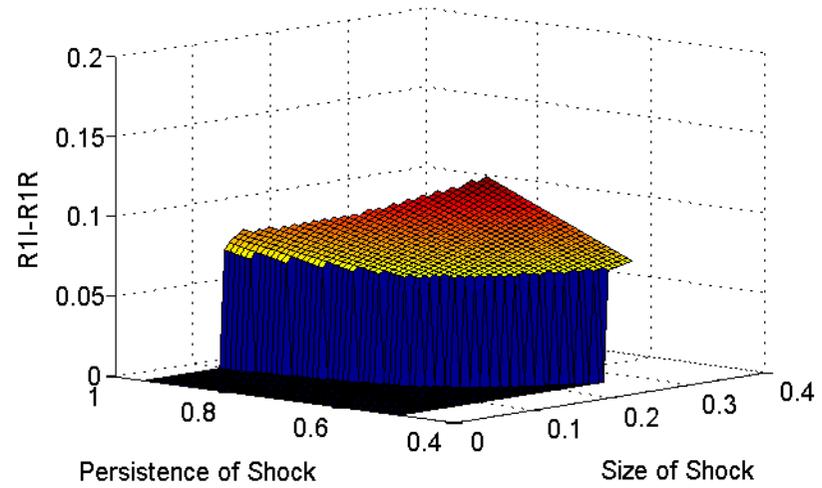
parameter	parameter name	Baseline	Alt. 1	Alt. 2
$\beta = 1/(1+r)$	Discount Factor	0.96	---	---
τ_0	Initial Borrowing	100	---	---
c	Recovery (1-Haircut)	0.70	0.75	0.8
η	Confiscated Share	0.25	---	---
p	Probability of a good shock	0.5	---	---
ρ	Persistence of Shock	[0.5, 0.95]	---	---
α_1	Fiscal Shock : $\varepsilon_1 = \alpha_1 \tau_0$	[0, 0.3]	---	---
α_2	Fiscal Shock: $\varepsilon_2 = \alpha_2 \tau_0$	$\alpha_1 = \alpha_2$	$\alpha_1 = \alpha_2$	0

BASELINE MODEL

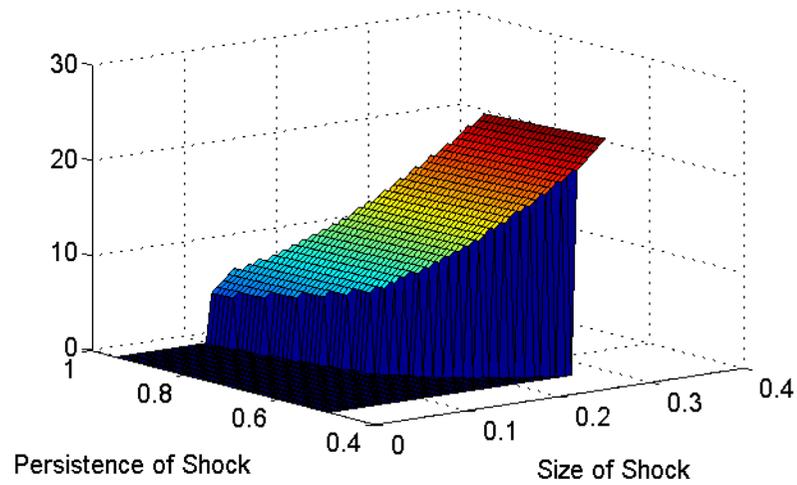
(a) Index Number of Equilibrium



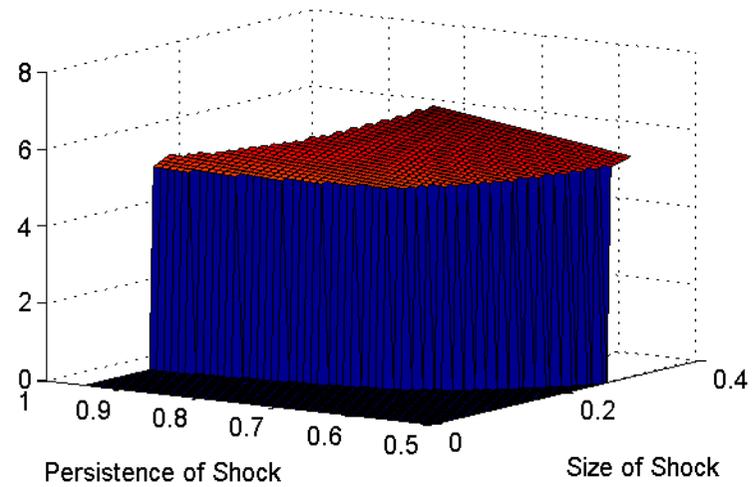
(b) Size of Sudden Stop / Interest Rate Spread Re-Issuers - Re-financiers



(c) Net Inflows / Re-issuers

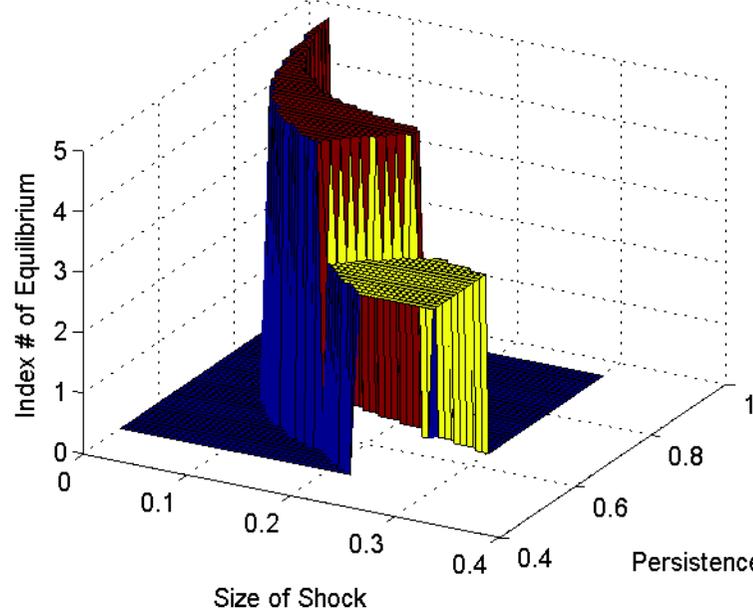


(d) Net Outflows / Re-Financiers

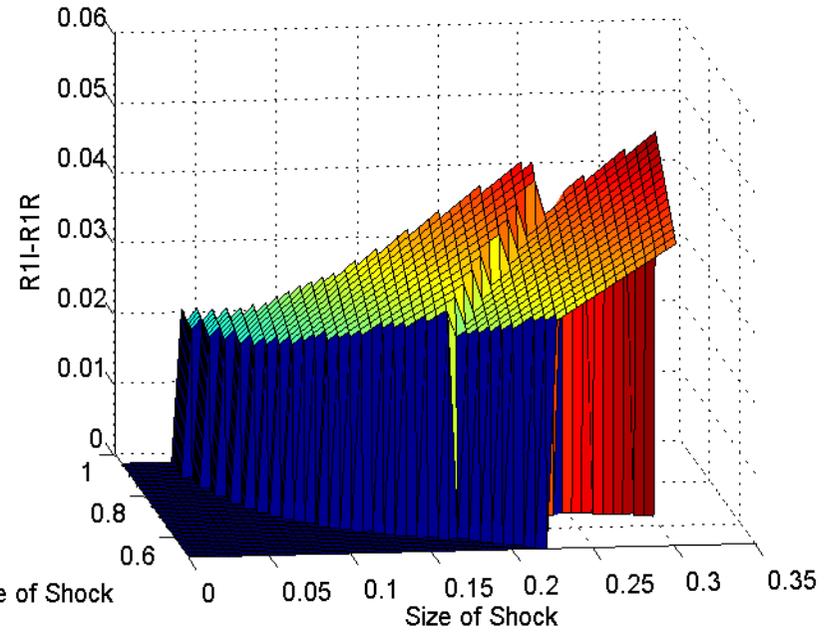


Alternative : Smaller Haircut $c=0.75$

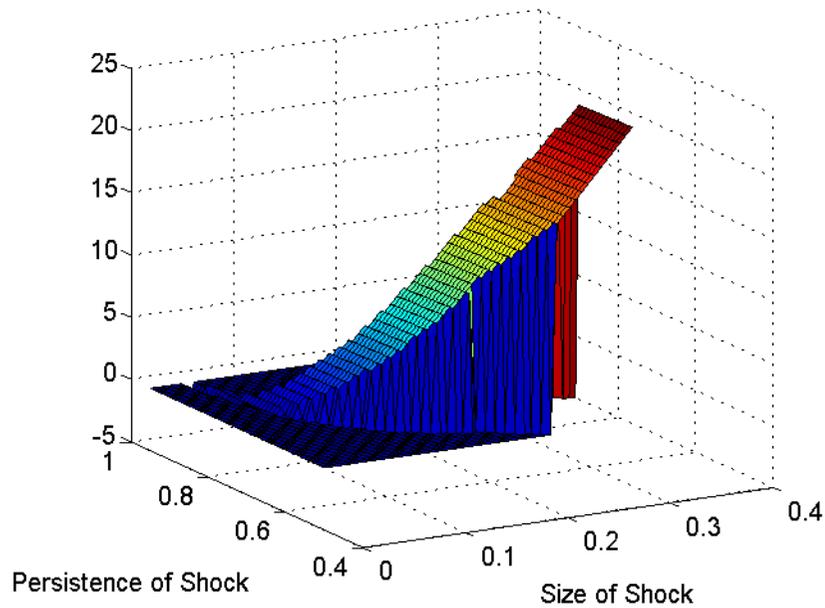
(a) Index Number of Equilibrium



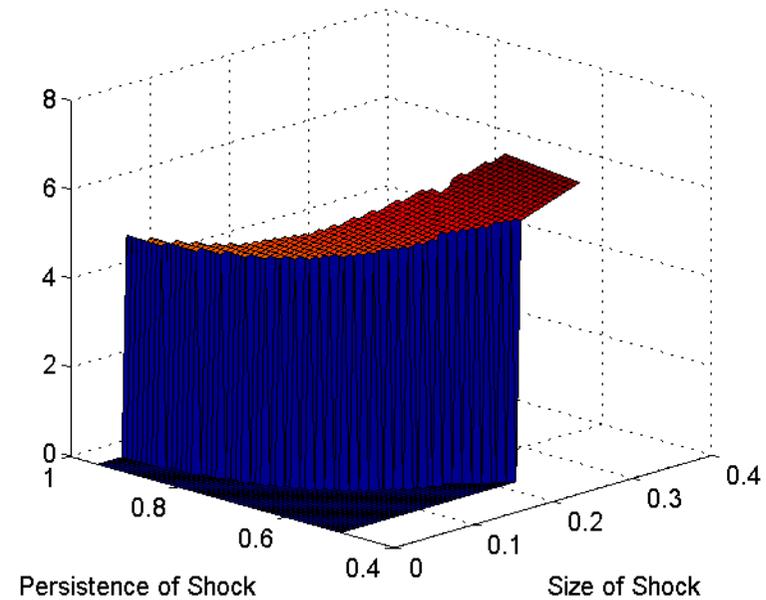
(b) Size of Sudden Stop / Interest Rate Spread Re-Issuers - Re-financers



(c) Net Outflows / Re-issuers



(d) Net Outflows / Re-Financers



Concluding Remarks

- A framework to jointly analyze SS and SD with asymmetries about fiscal fundamentals and persistence of fiscal shocks..
- **Separating Equilibrium:** borrowing (even if successful) signals to investors that debt repayment capacity has been compromised.
 - future expected ratio of debt to revenue ratio goes up, raising repayment risk.
 - Risk neutral investors hike up spreads which, in turn, increases the cost of future repayment and thus lowers the cost of a subsequent default.
- In this separating equilibrium, the SS (defined as an inward shift in lenders' supply schedule) precedes the sovereign default.
 - drop in net capital flows may take place only long after a large drop in output and tax revenues; capital inflows only dry up later once default materializes.
- Another equilibrium (**pooling equilibrium**) in which the country "fakes": despite being hit by a bad fiscal shock.