

Central Bank Swap Lines as Bilateral Sovereign Debt

Francisco Roldán
IMF

César Sosa-Padilla
Notre Dame

Society for Economic Dynamics
June 2024

The views expressed herein are those of the authors and should not be attributed to the IMF,
its Executive Board, or its management.

Symmetric and Asymmetric Swap Lines

- **Swap** line: two lines of credit involving two central banks
 - ... Each makes available some of its own currency to the other, for a fixed term
 - ... Short-term arrangements (typically one year, typically renewed)
- Used to mainly involve **AEs** Fed-ECB-BoE-BoJ-SNB
 - ... to support lender-of-last-resort functions with multinational firms
- Large increase in bilateral swaps and loans involving **EMs** since early 2000s
 - ... for EM, swap resources are hard currency
 - ... for EM, swap can be used for financing BoP (or as borrowed reserves)

Question

How do swap lines interact with sovereign debt?

Symmetric and Asymmetric Swap Lines

- **Swap** line: two lines of credit involving two central banks
 - ... Each makes available some of its own currency to the other, for a fixed term
 - ... Short-term arrangements (typically one year, typically renewed)
- Used to mainly involve **AEs** Fed-ECB-BoE-BoJ-SNB
 - ... to support lender-of-last-resort functions with multinational firms
- Large increase in bilateral swaps and loans involving **EMs** since early 2000s
 - ... for EM, swap resources are hard currency
 - ... for EM, swap can be used for financing BoP (or as borrowed reserves)

Question

How do swap lines interact with sovereign debt?

Symmetric and Asymmetric Swap Lines

- **Swap** line: two lines of credit involving two central banks
 - ... Each makes available some of its own currency to the other, for a fixed term
 - ... Short-term arrangements (typically one year, typically renewed)
- Used to mainly involve **AEs** Fed-ECB-BoE-BoJ-SNB
 - ... to support lender-of-last-resort functions with multinational firms
- Large increase in bilateral swaps and loans involving **EMs** since early 2000s
 - ... for EM, swap resources are hard currency
 - ... for EM, swap can be used for financing BoP (or as borrowed reserves)

Question

How do swap lines interact with sovereign debt?

Symmetric and Asymmetric Swap Lines

- **Swap** line: two lines of credit involving two central banks
 - ... Each makes available some of its own currency to the other, for a fixed term
 - ... Short-term arrangements (typically one year, typically renewed)
- Used to mainly involve **AEs** Fed-ECB-BoE-BoJ-SNB
 - ... to support lender-of-last-resort functions with multinational firms
- Large increase in bilateral swaps and loans involving **EMs** since early 2000s
 - ... for EM, swap resources are hard currency
 - ... for EM, swap can be used for financing BoP (or as borrowed reserves)

Question

How do swap lines interact with sovereign debt?

How do Central Bank Swap Lines affect the Market Structure of Sovereign Debt?

We abstract from **currencies**, **collateral**, and focus on the **borrowing**

Tradeoff

- Borrowing with bonds
 - ... interest rate reflects **default** risk
- Borrowing from the swap line
 - ... interest rate and drawings **negotiated**

!! Defaulting on the debt does not mean defaulting on the swap

How do Central Bank Swap Lines affect the Market Structure of Sovereign Debt?

We abstract from **currencies**, **collateral**, and focus on the **borrowing**

Tradeoff

- Borrowing with bonds
 - ... interest rate reflects **default** risk
- Borrowing from the swap line
 - ... interest rate and drawings **negotiated**

!! Defaulting on the debt does not mean defaulting on the swap

How do Central Bank Swap Lines affect the Market Structure of Sovereign Debt?

We abstract from **currencies**, **collateral**, and focus on the **borrowing**

Tradeoff

- Borrowing with bonds
 - ... interest rate reflects **default** risk
- Borrowing from the swap line
 - ... interest rate and drawings **negotiated**

!! Defaulting on the debt does not mean defaulting on the swap

The Dangers of Borrowing through Swap Lines

Main findings

- Swap drawings small relative to debt, but
 - Presence of swaps affects sovereign debt markets
 - ... can provide financing when other sources dry up
 - ... can increase risk-taking
- Lending around or in default maximizes surplus in swap negotiations
 - Availability of swaps in default:
 - ... raises the value of default
 - ... which increases the default frequency
 - ... and worsens borrowing terms in bond markets
 - Without restricting swaps in default, welfare losses for the government
- Swap lines induce relational overborrowing similar to the debt dilution problem
 - Surplus requires spreads — spreads require risk

The Dangers of Borrowing through Swap Lines

Main findings

- Swap drawings small relative to debt, but
 - Presence of swaps affects sovereign debt markets
 - ... can provide financing when other sources dry up
 - ... can increase risk-taking
- Lending around or in default maximizes surplus in swap negotiations
 - Availability of swaps in default:
 - ... raises the value of default
 - ... which increases the default frequency
 - ... and worsens borrowing terms in bond markets
 - Without restricting swaps in default, welfare losses for the government
- Swap lines induce relational overborrowing similar to the debt dilution problem
 - Surplus requires spreads — spreads require risk

The Dangers of Borrowing through Swap Lines

Main findings

- Swap drawings small relative to debt, but
 - Presence of swaps affects sovereign debt markets
 - ... can provide financing when other sources dry up
 - ... can increase risk-taking
- Lending around or in default maximizes surplus in swap negotiations
 - Availability of swaps in default:
 - ... raises the value of default
 - ... which increases the default frequency
 - ... and worsens borrowing terms in bond markets
 - Without restricting swaps in default, welfare losses for the government
- Swap lines induce relational overborrowing similar to the debt dilution problem
 - Surplus requires spreads — spreads require risk

- Central Bank swaps among advanced economies
... Bahaj and Reis (2021); Cesa-Bianchi, Eguren-Martin, and Ferrero (2022)
- Data on Central Bank swaps for EMs
... Perks, Rao, Shin, and Tokuoka (2021); Horn, Parks, Reinhart, and Trebesch (2023)
- Sovereign debt/default with interactions from 'official' debt
... Boz (2011), Hatchondo, Martinez, and Onder (2014), Arellano and Barreto (2023)

Model

Environment

The government of a small open economy borrows from a monopolist and from markets


- Income $y(z_t)$ follows an AR(1) process in logs
 - ... Only one good, representative risk-averse household, expected utility
- **Renegotiate** the swap m each period
 - ... Involves a transfer x and a new loan size m'
 - ... Swap is non-defaultable \implies Repaying m is the natural threat point
- Should expect
 - ... Implicit interest rate r to vary over time
 - ... Interest rate to reflect **market power**
 - ... Interest rate to reflect **outside options**


$$x = \frac{1}{1+r} m' - m$$

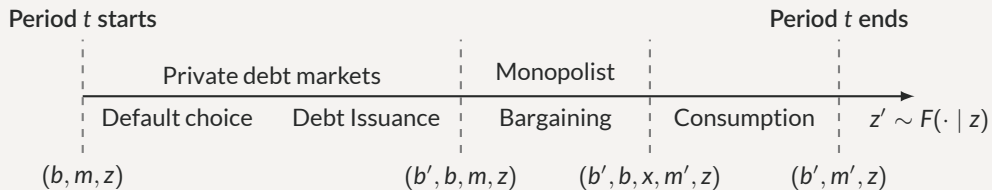
Environment

The government of a small open economy borrows from a monopolist and from markets

- Income $y(z_t)$ follows an AR(1) process in logs
 - ... Only one good, representative risk-averse household, expected utility
- **Renegotiate** the swap m each period
 - ... Involves a transfer x and a new loan size m'
 - ... Swap is non-defaultable \implies Repaying m is the natural threat point
- Should expect
 - ... Implicit interest rate r to vary over time
 - ... Interest rate to reflect **market power**
 - ... Interest rate to reflect **outside options**


$$x = \frac{1}{1 + r} m' - m$$

Timeline of events



Borrowing from markets

- Debt is a geometrically-decaying coupon
... for each unit, get q , pay $\kappa, (1 - \rho)\kappa, \dots (1 - \rho)^{s-1}\kappa$
- Government enters first stage owing b in debt, m in swaps, income state z

$$v(b, m, z) = \max \{ v_R(b, m, z) + \epsilon_R, v_D(m, z) + \epsilon_D \}$$

$$v_R(b, m, z) = \max_{b'} w_R(b', b, m, z)$$

- Lenders in competitive markets need to anticipate interactions with the monopolist

$$q(b', b, m, z) = \beta_L \mathbb{E} [(1 - 1_{\mathcal{D}}(b', m', z')) (\kappa + (1 - \rho)q(b'', b', m', z')) \mid z]$$

$$m' = m'(b', b, m, z)$$

$$b'' = b'(b', m', z')$$

Borrowing from markets

- Debt is a geometrically-decaying coupon
... for each unit, get q , pay $\kappa, (1 - \rho)\kappa, \dots (1 - \rho)^{s-1}\kappa$
- Government enters first stage owing b in debt, m in swaps, income state z

$$v(b, m, z) = \max \{ v_R(b, m, z) + \epsilon_R, v_D(m, z) + \epsilon_D \}$$

$$v_R(b, m, z) = \max_{b'} w_R(b', b, m, z)$$

- Lenders in competitive markets need to anticipate interactions with the monopolist

$$q(b', b, m, z) = \beta_L \mathbb{E} [(1 - 1_{\mathcal{D}}(b', m', z')) (\kappa + (1 - \rho)q(b'', b', m', z')) \mid z]$$

$$m' = m'(b', b, m, z)$$

$$b'' = b'(b', m', z')$$

Borrowing from markets

- Debt is a geometrically-decaying coupon
... for each unit, get q , pay $\kappa, (1 - \rho)\kappa, \dots (1 - \rho)^{s-1}\kappa$
- Government enters first stage owing b in debt, m in swaps, income state z

$$v(b, m, z) = \max \{ v_R(b, m, z) + \epsilon_R, v_D(m, z) + \epsilon_D \}$$

$$v_R(b, m, z) = \max_{b'} w_R(b', b, m, z)$$

- Lenders in competitive markets need to anticipate interactions with the monopolist

$$q(b', b, m, z) = \beta_L \mathbb{E} [(1 - 1_D(b', m', z')) (\kappa + (1 - \rho)q(b'', b', m', z')) \mid z]$$

$$m' = m'(b', b, m, z)$$

$$b'' = b'(b', m', z')$$

same sdf as monopolist

Bargaining stage with monopolist

- At state z , owing debt b bonds and m on the swap and having issued b'

$$\max_{x,m} \mathcal{L}_R(b', x, m, m', z)^\theta \times \mathcal{B}_R(b', b, x, m, m', z)^{1-\theta}$$

↙ Lender surplus
↘ Government surplus

- Lender's surplus

$$\mathcal{L}_R(b', x, m, m', z) = \underbrace{(a - x + \beta_L \mathbb{E}[h(b', m', z') | z])}_{\text{agreement}} - \underbrace{(a + m + \beta_L \mathbb{E}[h(b', 0, z') | z])}_{\text{threat point}}$$

- Government's surplus

$$\begin{aligned} \mathcal{B}_R(b', b, x, m, m', z) = & \underbrace{u(y(z) + B(b', b, m, z) + x) + \beta \mathbb{E}[v(b', m', z') | z]}_{\text{agreement}} \\ & - \underbrace{(u(y(z) + B(b', b, m, z) - m) + \beta \mathbb{E}[v(b', 0, z') | z])}_{\text{threat point}} \end{aligned}$$

with $B(b', b, m, z) = q(b', b, m, z)(b' - (1 - \rho)b) - \kappa b$

Bargaining stage with monopolist

- At state z , owing debt b bonds and m on the swap and having issued b'

$$\max_{x,m} \mathcal{L}_R(b', x, m, m', z)^\theta \times \mathcal{B}_R(b', b, x, m, m', z)^{1-\theta}$$

Government surplus
Lender's surplus

- Lender's surplus

$$\mathcal{L}_R(b', x, m, m', z) = \underbrace{(a - x + \beta_L \mathbb{E}[h(b', m', z') | z])}_{\text{agreement}} - \underbrace{(a + m + \beta_L \mathbb{E}[h(b', 0, z') | z])}_{\text{threat point}}$$

same sdf as markets

- Government's surplus

$$\begin{aligned} \mathcal{B}_R(b', b, x, m, m', z) = & \underbrace{u(y(z) + B(b', b, m, z) + x) + \beta \mathbb{E}[v(b', m', z') | z]}_{\text{agreement}} \\ & - \underbrace{(u(y(z) + B(b', b, m, z) - m) + \beta \mathbb{E}[v(b', 0, z') | z])}_{\text{threat point}} \end{aligned}$$

with $B(b', b, m, z) = q(b', b, m, z)(b' - (1 - \rho)b) - \kappa b$

Bargaining stage with monopolist

- At state z , owing debt b bonds and m on the swap and having issued b'

$$\max_{x,m} \mathcal{L}_R(b', x, m, m', z)^\theta \times \mathcal{B}_R(b', b, x, m, m', z)^{1-\theta}$$

- Lender's surplus

$$\mathcal{L}_R(b', x, m, m', z) = \underbrace{(a - x + \beta_L \mathbb{E} [h(b', m', z') | z])}_{\text{agreement}} - \underbrace{(a + m + \beta_L \mathbb{E} [h(b', 0, z') | z])}_{\text{threat point}}$$

- Government's surplus

$$\begin{aligned} \mathcal{B}_R(b', b, x, m, m', z) = & \underbrace{u(y(z) + B(b', b, m, z) + x) + \beta \mathbb{E} [v(b', m', z') | z]}_{\text{agreement}} \\ & - \underbrace{(u(y(z) + B(b', b, m, z) - m) + \beta \mathbb{E} [v(b', 0, z') | z])}_{\text{threat point}} \end{aligned}$$

$$\text{with } B(b', b, m, z) = q(b', b, m, z)(b' - (1 - \rho)b) - \kappa b$$

Default state

- In default,

$$v_D(m, z) = u \left(y(z) - \underbrace{\phi(y(z))}_{\text{default cost}} + \underbrace{x_D(m, z)}_{\text{swap transfer}} \right) + \beta \mathbb{E} [\psi v(0, m'_D, z') + (1 - \psi) v_D(m'_D, z') \mid z]$$

- Negotiate $x_D(m, z)$ and $m'_D(m, z)$ with common knowledge of **default** status
- Bargaining in default not **disciplined** by market
 - ... similar to model with monopolist only: gambling for debt overhang
 - ... extra dimension of gambling for delayed reentry

Default state

- In default,

$$v_D(m, z) = u \left(y(z) - \underbrace{\phi(y(z))}_{\text{default cost}} + \underbrace{x_D(m, z)}_{\text{swap transfer}} \right) + \beta \mathbb{E} [\psi v(0, m'_D, z') + (1 - \psi) v_D(m'_D, z') \mid z]$$

- Negotiate $x_D(m, z)$ and $m'_D(m, z)$ with common knowledge of **default** status
- Bargaining in default not **disciplined** by market
 - ... similar to model with monopolist only: gambling for debt overhang
 - ... extra dimension of gambling for delayed reentry

Quantitative Effects of Swap Lines

Calibration

- Calibrate to Argentina without swaps (as in Roch & Roldán, 2023)

	Parameter	Value
Sovereign's discount factor	β	0.9504
Sovereign's risk aversion	γ	2
Preference shock scale parameter	χ	0.02
Lender's bargaining power	θ	0.5
Risk-free interest rate	r	0.01
Duration of debt	ρ	0.05
Income autocorrelation coefficient	ρ_z	0.9484
Standard deviation of y_t	σ_z	0.02
Reentry probability	ψ	0.0385
Default cost: linear	d_0	-0.24
Default cost: quadratic	d_1	0.3

Calibration

- Calibrate to Argentina without swaps (as in Roch & Roldán, 2023)

	Parameter	Value
Sovereign's discount factor	β	0.9504
Sovereign's risk aversion	γ	2
Preference shock scale parameter	χ	0.02
Lender's bargaining power	θ	0.5
Risk-free interest rate	r	0.01
Duration of debt	ρ	0.05
Income autocorrelation coefficient	ρ_z	0.9484
Standard deviation of y_t	σ_z	0.02
Reentry probability	ψ	0.0385
Default cost: linear	d_0	-0.24
Default cost: quadratic	d_1	0.3

How do swaps affect equilibrium?

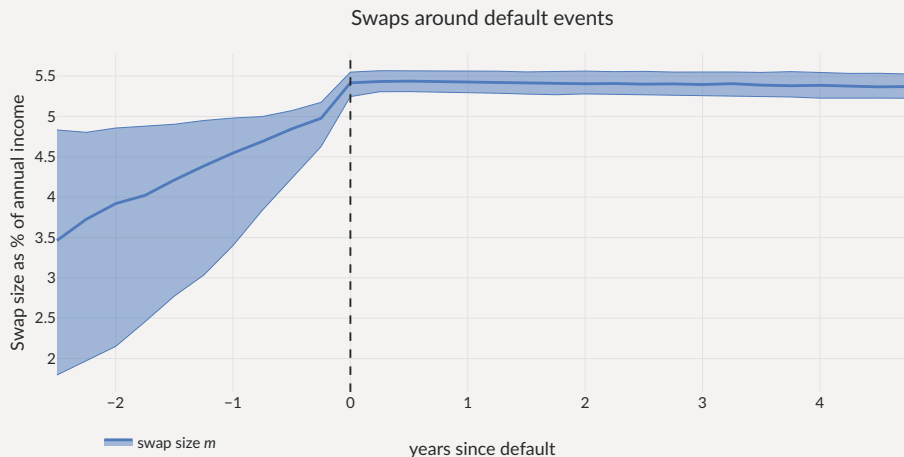
	No swap	Unrestricted, $\theta = 0.25$	Unrestricted, $\theta = 0.5$
Avg spread (bps)	804	1841	2396
Std spread (bps)	470	1099	1541
$\sigma(c)/\sigma(y)$ (%)	111	111	110
Debt to GDP (%)	21.4	20.8	20.2
Swap to GDP (%)	0	3.74	3.32
Corr. swap & spreads (%)	–	53.8	62.2
Default frequency (%)	6.53	13.0	14.7
Welfare gains (rep)	–	-0.082%	-0.41%

When is the Swap Used?

▶ Limited

▶ More

- Swaps shoot up before *and during* defaults



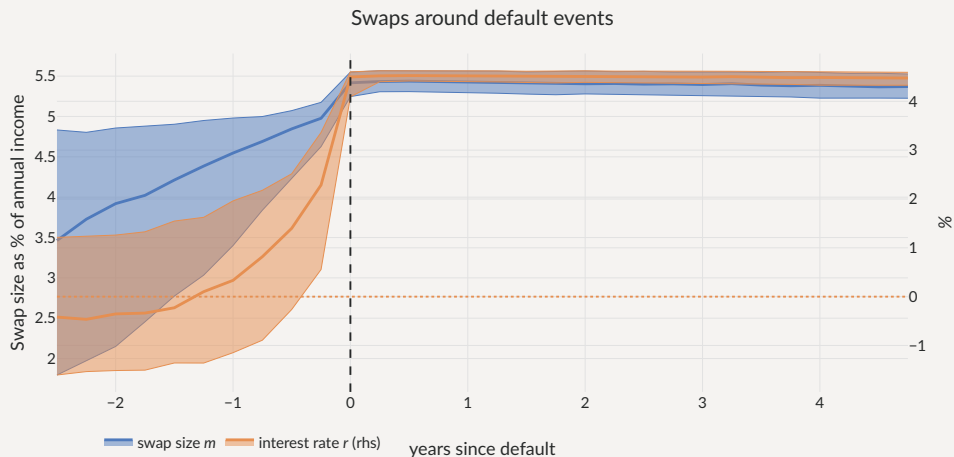
- Also consider **Limited** versions: $m' \leq \Gamma(m)$ while in default

When is the Swap Used?

▶ Limited

▶ More

- Swaps shoot up before *and during* defaults



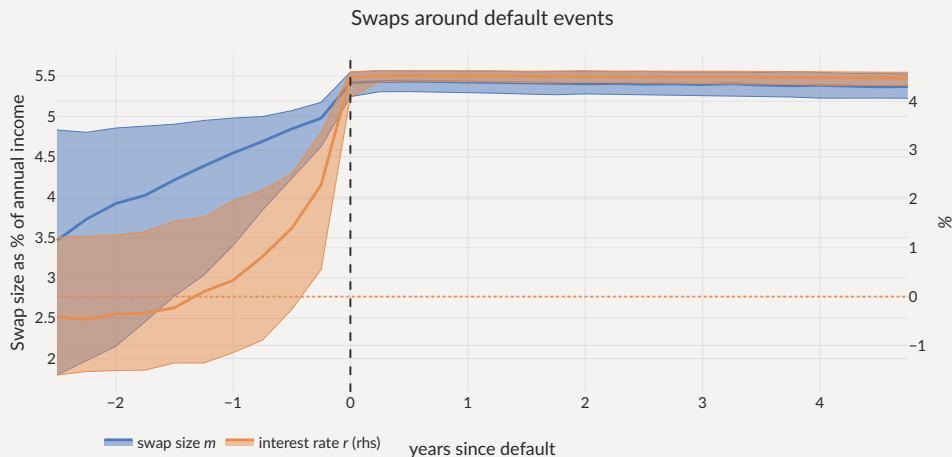
- Also consider **Limited** versions: $m' \leq \Gamma(m)$ while in default

When is the Swap Used?

▶ Limited

▶ More

- Swaps shoot up before *and during* defaults



- Also consider **Limited** versions: $m' \leq \Gamma(m)$ while in default

Limiting swaps in default

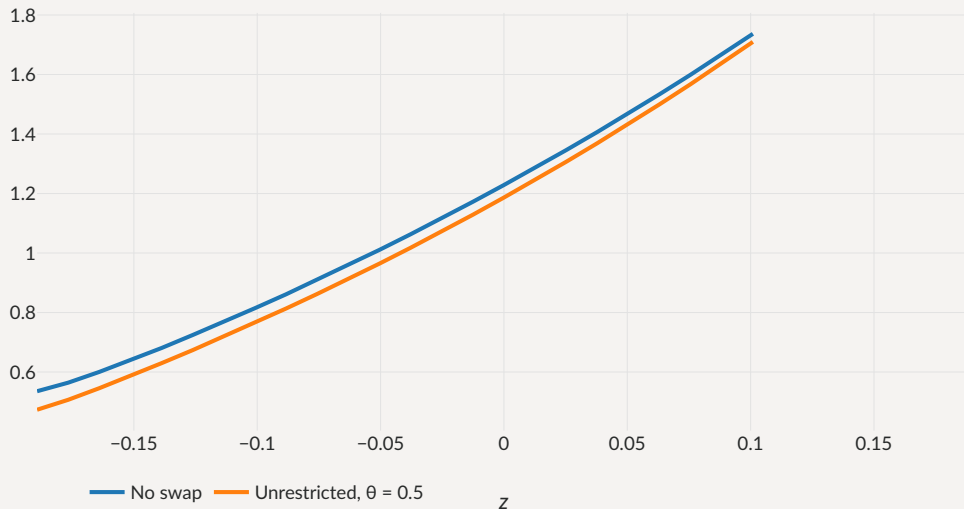
- Limited: entire swap must be repaid while in default $\Gamma(m) = 0$

	No swap	Unrestricted, $\theta = 0.5$	Limited, $\theta = 0.5$
Avg spread (bps)	804	2396	1216
Std spread (bps)	470	1541	779
$\sigma(c)/\sigma(y)$ (%)	111	110	113
Debt to GDP (%)	21.4	20.2	21.7
Swap to GDP (%)	0	3.32	1.05
Corr. swap & spreads (%)	-	62.2	69.4
Default frequency (%)	6.53	14.7	9.34
Welfare gains (rep)	-	-0.41%	-0.084%

Default Barriers with Swaps

- Unrestricted: default barrier moves inward, Limited: marginal impact

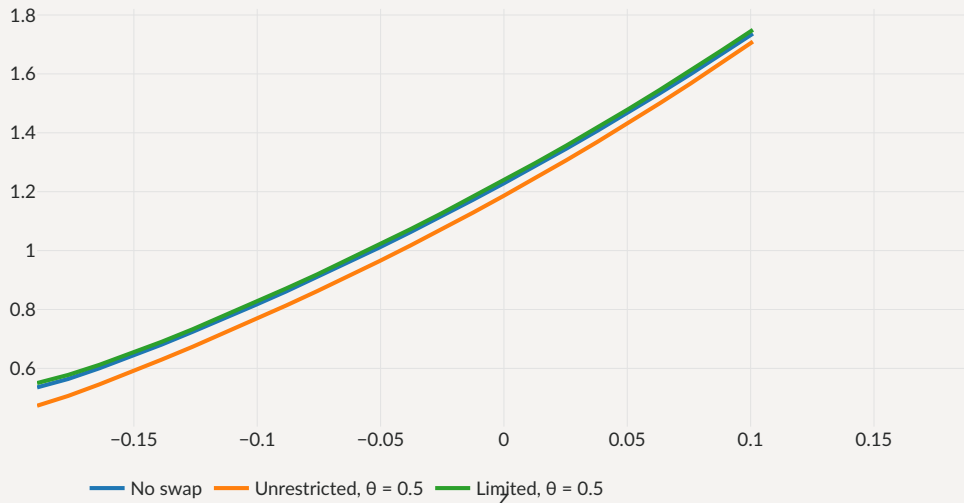
Debt levels at which $\mathcal{P}(b,m,z)$ crosses 50%



Default Barriers with Swaps

- Unrestricted: default barrier moves inward, Limited: marginal impact

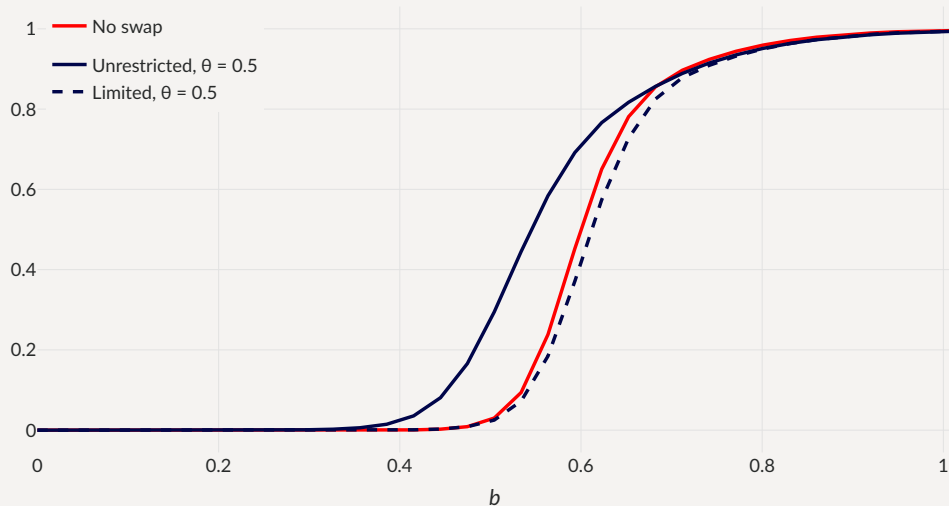
Debt levels at which $\mathcal{P}(b,m,z)$ crosses 50%



Debt Tolerance with Swaps

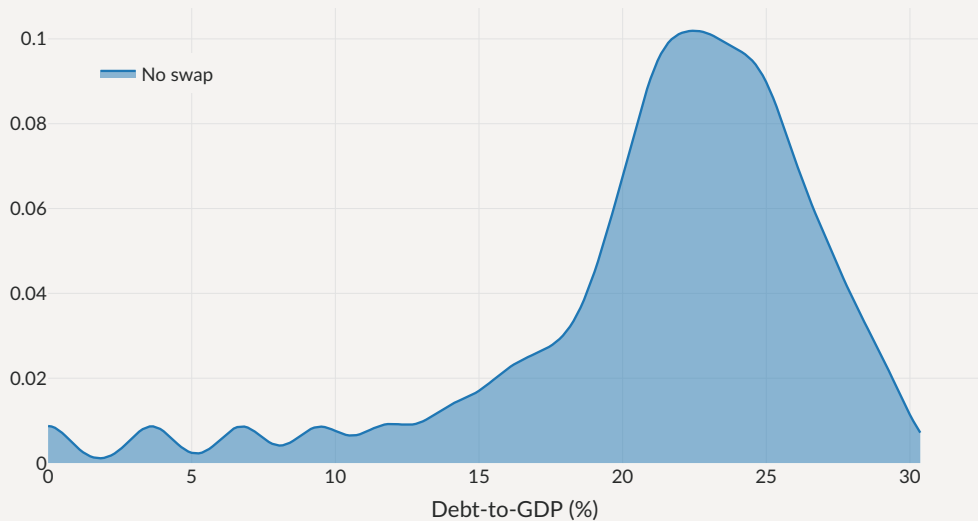
- Unrestricted: default more often, Limited: marginal impact

Default Probability $\mathcal{A}(b, m, z)$



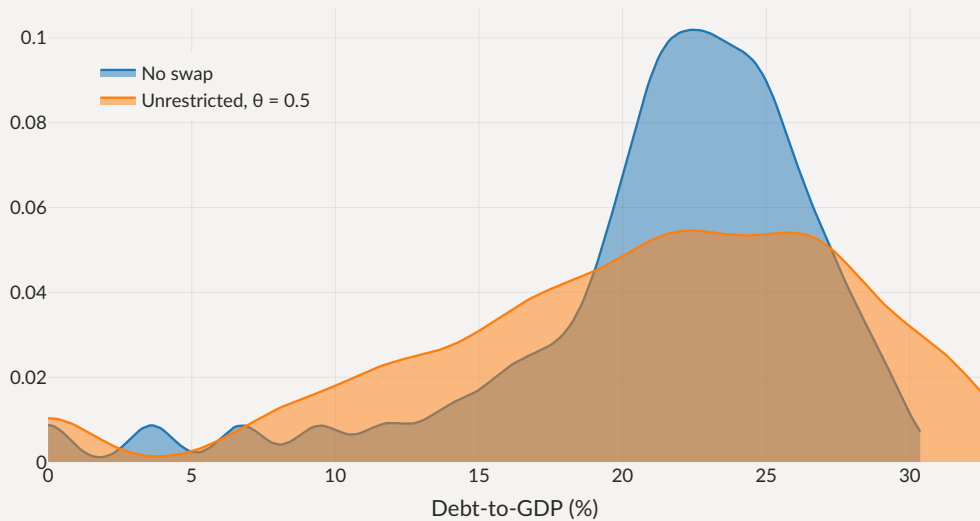
Debt Levels with Swaps

Distribution of debt levels



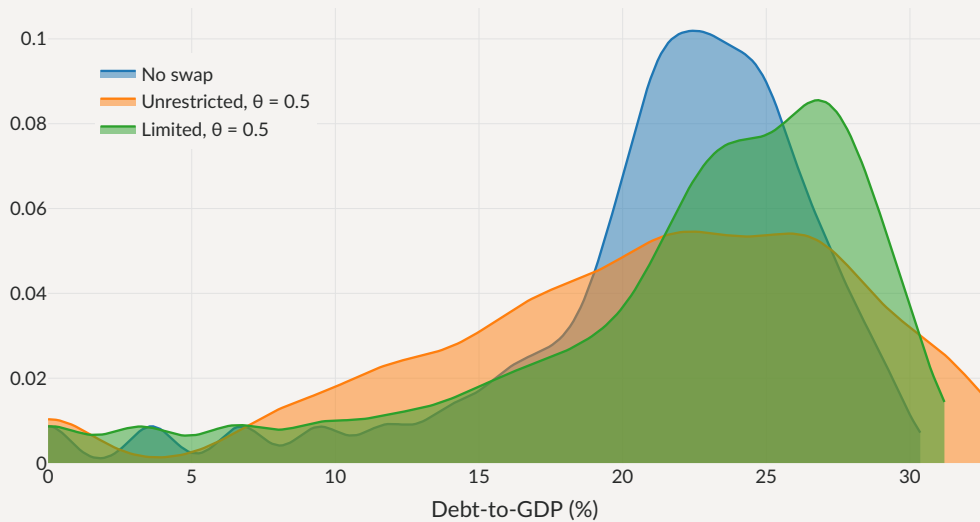
Debt Levels with Swaps

Distribution of debt levels



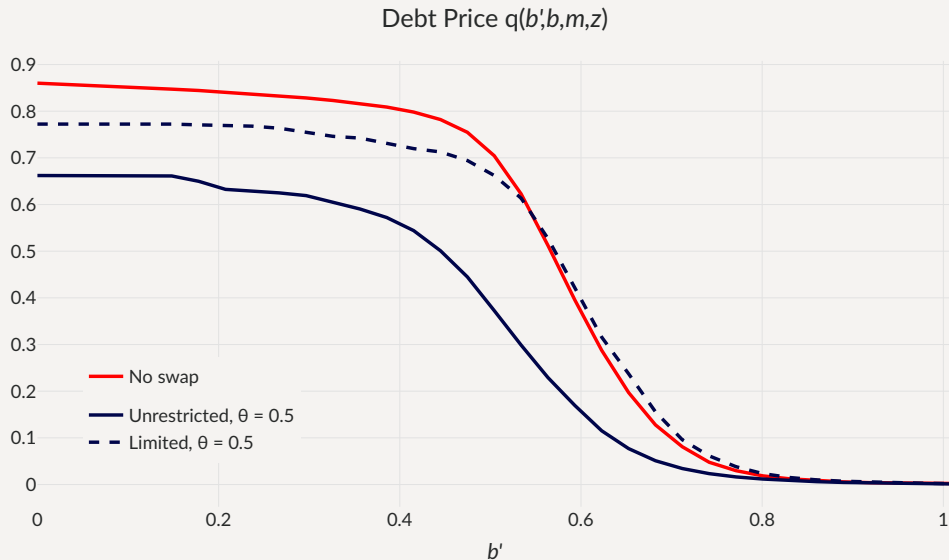
Debt Levels with Swaps

Distribution of debt levels



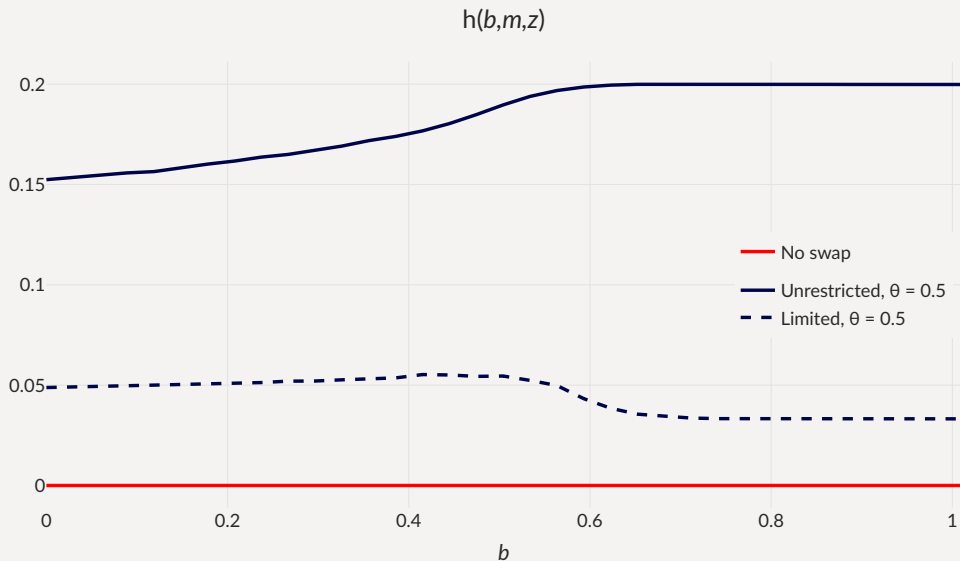
Debt Prices with Swaps

Lower prices with same default rates: [relational overborrowing](#) similar to debt dilution



Monopolist's profits

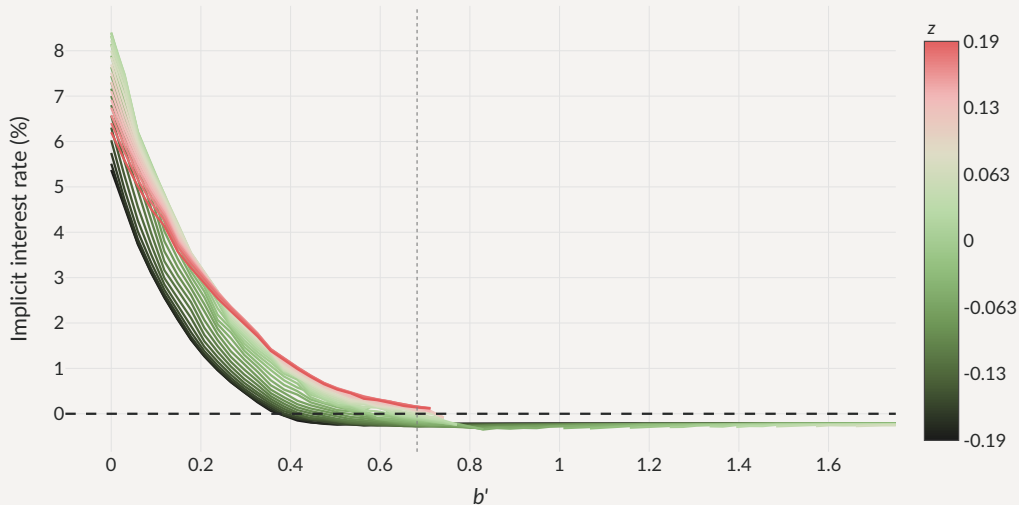
Monopolist's profits **increasing** in debt (cond. on repayment) – surplus requires spreads > 0



Risk-taking incentives

Surplus on swap requires spreads > 0 : monopolist provides **incentives** for risk taking

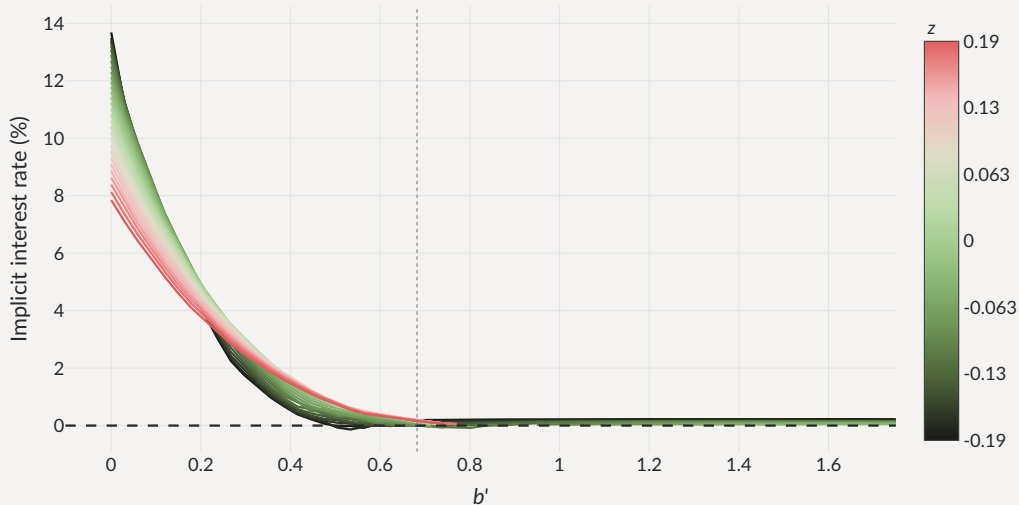
Interest rate on the swap (Unrestricted)



Risk-taking incentives

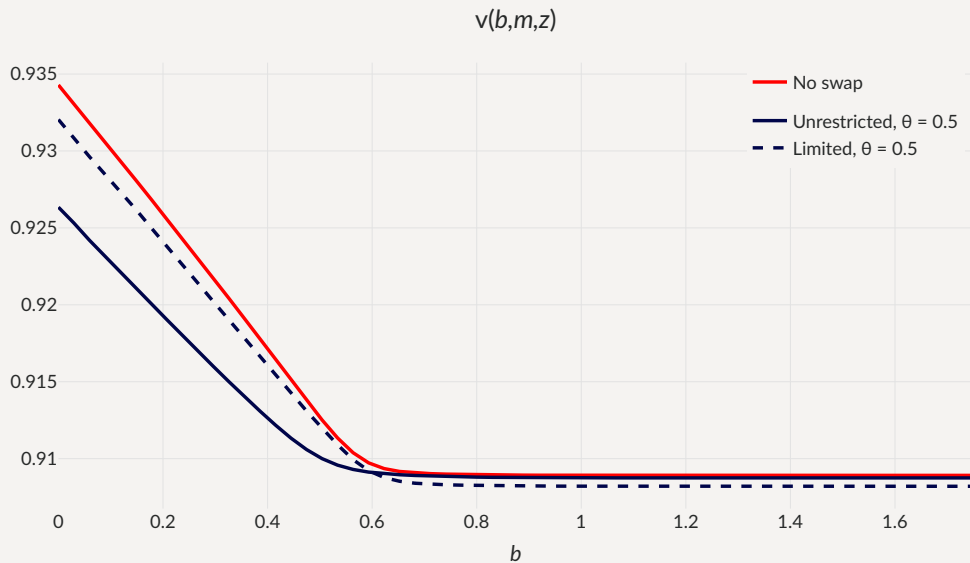
Surplus on swap requires spreads > 0 : monopolist provides **incentives** for risk taking

Interest rate on the swap (Limited)



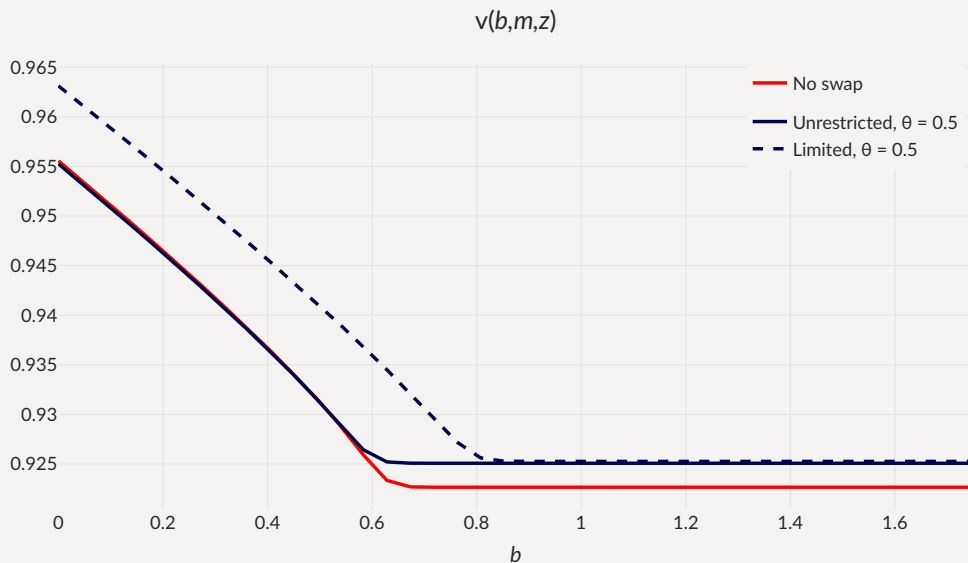
Welfare effects of swap lines

Limited \succcurlyeq Unrestricted, but...



Welfare effects of swap lines – Short-term debt

Short-term debt: swaps beneficial – interest on the swap **small** wrt to *whole* debt stock



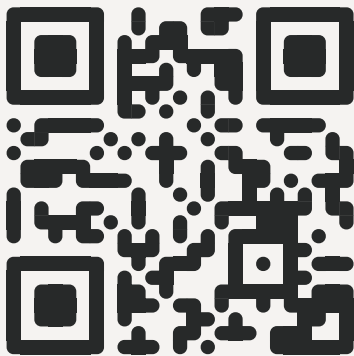
Welfare effects of swap lines – Short-term debt (cont'd)

	No swap, ST	Unrestricted, $\theta = 0.5$, ST	Limited, $\theta = 0.5$, ST
Avg spread (bps)	80.7	377	247
Std spread (bps)	110	373	197
$\sigma(c)/\sigma(y)$ (%)	129	130	138
Debt to GDP (%)	19.0	18.7	23.5
Swap to GDP (%)	0	3.13	3.65
Corr. swap & spreads (%)	–	54.9	50.3
Default frequency (%)	0.574	3.14	1.97
Welfare gains (rep)	–	-0.074%	0.8%

Concluding remarks

Concluding remarks

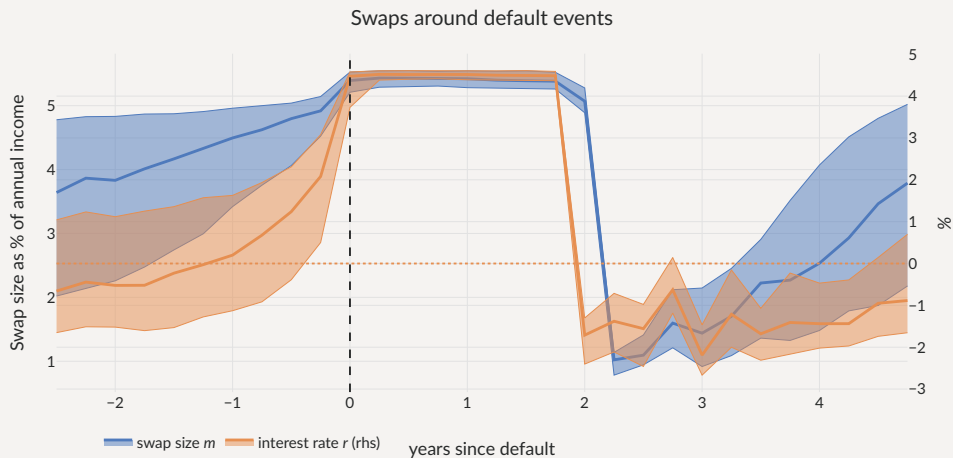
- Simple model with monopolist/fringe structure
- Strong interaction between two markets for sovereign debt
 - ... even if swaps are not used intensely on the equilibrium path
- Market power crucial in model
 - ... how to discipline in model?
 - ... how to affect in reality?
- Large welfare effects, policy challenges
 - How to limit their use during defaults?
 - Relational overborrowing – more gains from fiscal rules, state-contingent debt?



Scan to find the paper

When is the Swap Used?

- Further conditioning on default events lasting exactly two years



When is the Swap Used?

- With Limited: $\Gamma(m) = m$

