

# Central Bank Swap Lines as Bilateral Sovereign Debt

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Notre Dame

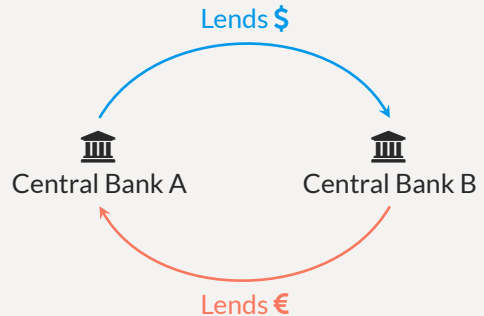
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its Executive Board, or its management.

# What is a Central Bank swap?

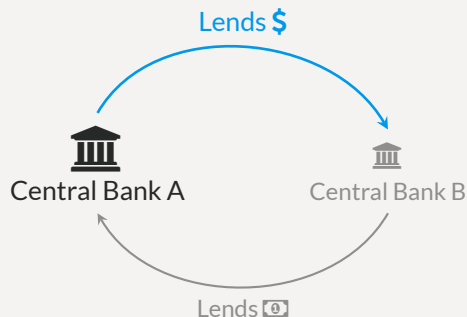
Swaps are **symmetric** currency exchanges

- A swap line is a contract between two Central Banks
- When activated, each institution provides an amount of its currency to the counterparty
- At maturity, positions are unwound



- **Symmetric** swaps (AE-AE) potentially very different from **asymmetric** ones (AE-EM)  
... Symmetric swaps better understood, growing number of *asymmetric* ones

# What is a Central Bank swap?



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in practice

- The Fed doesn't really want Mexico's pesos  
... treats them more like collateral
- Mexican authorities may need dollars for their BoP  
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## How are Central Bank Swap Lines different from Sovereign Debt?

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

For an EM using the swap line to **borrow** from an AE

### Regular debt (bond markets)

- Defaultable
- Many different lenders
- Interest rate (**spreads**) mainly reflects default risk

### Bilateral loan (swap line)

- Non-defaultable (Central Bank)
- No coordination issues
- Can be used to curb default risk
- **Interest rate?**

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# How do Central Bank Swap Lines interact with Sovereign Debt?

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## Main findings

- One type of debt affects borrowing conditions for the other
  - Borrowing from the market serves as threat in swap negotiations
  - Swap can be used when spreads on the market are high
- Lending around or in default maximizes surplus for bilateral loans
  - 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 create incentives 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 with Swaps only

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# Environment

The government of a small open economy borrows from a monopolist


- 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**


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

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# Bargaining stage with monopolist

- At income state  $z$  and loan  $m$ , solve

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

Government surplus

Lender surplus

- Government (borrower) surplus

$$\mathcal{B}(x, m, m', z) = \underbrace{u(y(z) + x) + \beta \mathbb{E}[v(m', z') | z]}_{\text{agreement: receive } x, \text{ owe } m'} - \underbrace{(u(y(z) - m) + \beta \mathbb{E}[v(0, z') | z])}_{\text{threat point: repay } m, \text{ clean slate}}$$

- Lender surplus

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

- Value functions  $v(m, z)$  and  $h(m, z)$  encode expected outcomes of future rounds

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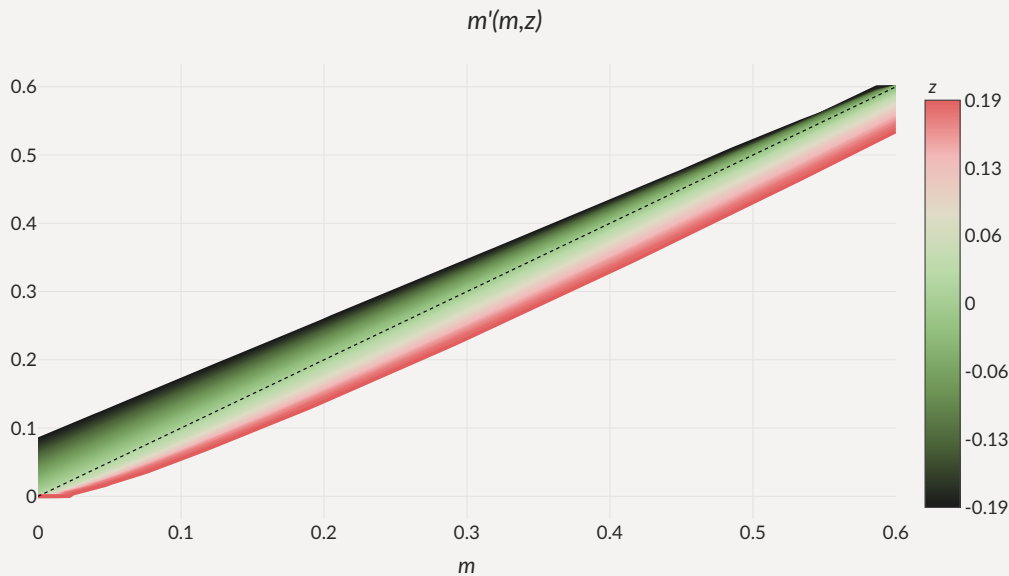
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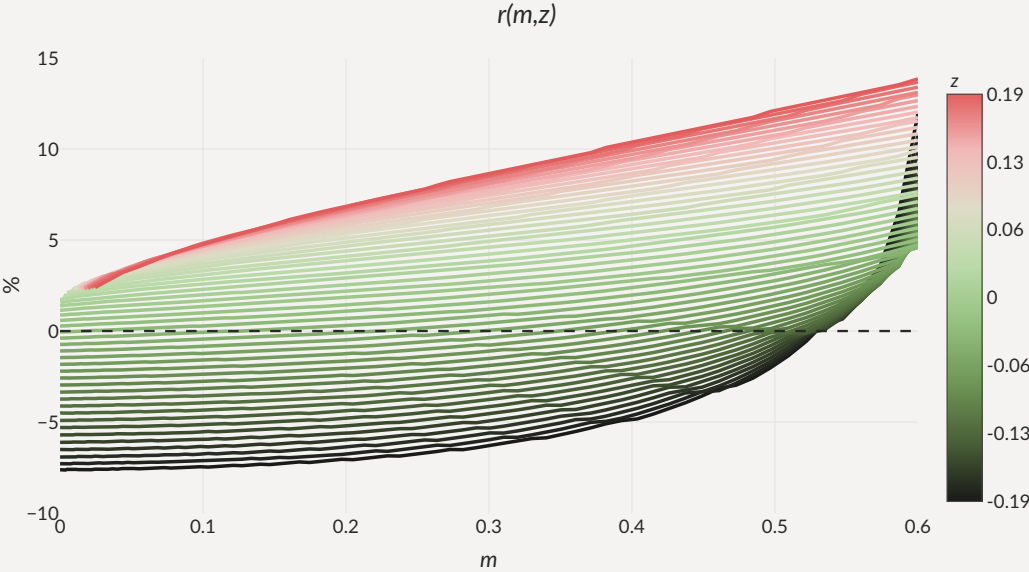
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# Swap Line Terms: Loan Dynamics

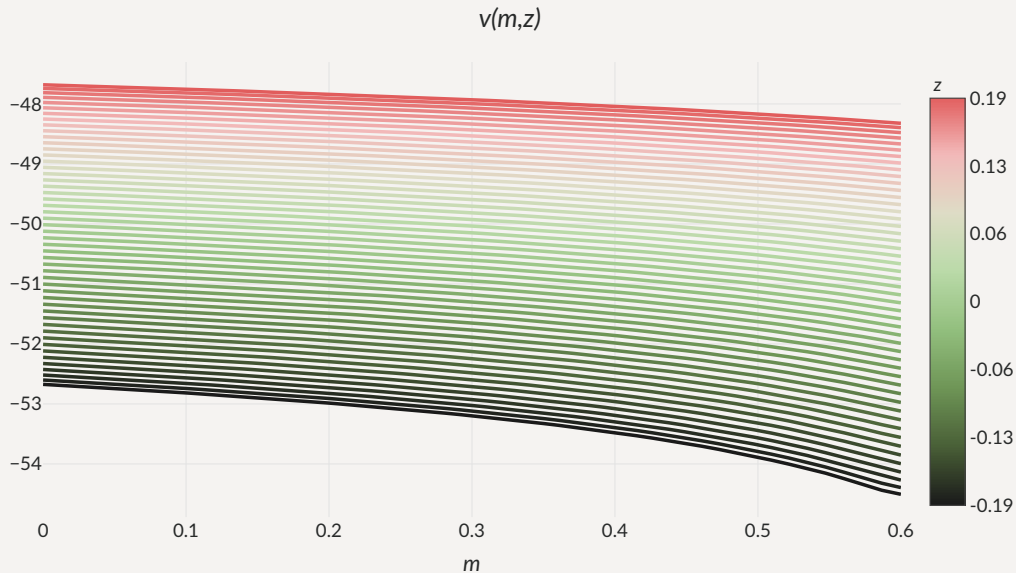




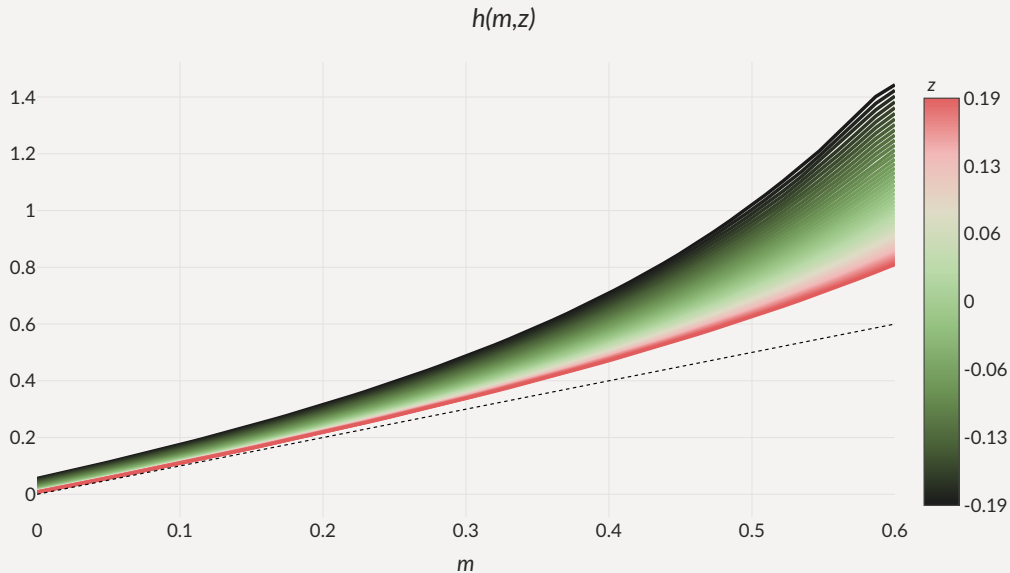
# Swap Line Terms: Implicit interest rate



## Swap Line Terms: Borrower's value function



## Swap Line Terms: Lender's value function



## Swap Line Terms: Takeaways

The threat point is less 'credible' when  $m$  is large

key requirement:

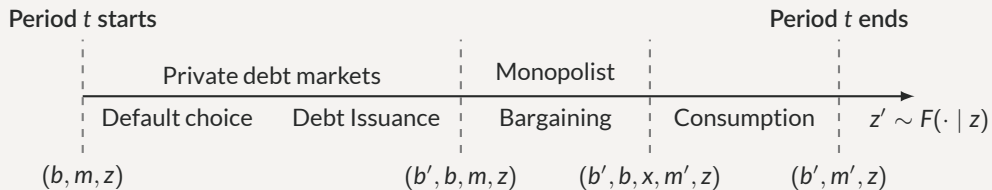
threat point value decreasing in  $m$

- This creates convexity in the lender's value function  
... making the lender act 'as if' **risk-loving**
- The lender initially subsidizes the loan to induce indebtedness and high profits
  - **Gamble for debt overhang**
- Initial subsidy and high rates consistent with B's risk aversion – 'Participation constraint'

## Model with Swaps and Debt

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# Timeline of events



## Borrowing from markets

- Debt is a geometrically-decaying coupon  
... get 1, 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

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

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same sdf as monopolist

- Same as before with extra state variables ( $b, b'$ )

$$\mathcal{L}_R(b', x, m, m', z) = (a - x + \beta_L \mathbb{E} [h(b', m', z') \mid z]) - (a + m + \beta_L \mathbb{E} [h(b', 0, z') \mid z])$$

$$\begin{aligned} \mathcal{B}_R(b', b, x, m, m', z) &= u(y(z) + B(b', b, m, z) + x) + \beta \mathbb{E} [v(b', m', z') \mid z] \\ &\quad - (u(y(z) + B(b', b, m, z) - m) + \beta \mathbb{E} [v(b', 0, z') \mid z]) \end{aligned}$$

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

## Default state

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- 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
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## Quantitative Effects of Swap Lines

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# Calibration

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

	Parameter	Value
Sovereign's discount factor	$\beta$	0.9852
Sovereign's risk aversion	$\gamma$	2
Preference shock scale parameter	$\chi$	0.02
Lender's bargaining power	$\theta$	0.5
Risk-free interest rate	$r$	0.01
Duration of debt	$\rho$	0.05
Income autocorrelation coefficient	$\rho_z$	0.9484
Standard deviation of $y_t$	$\sigma_z$	0.02
Reentry probability	$\psi$	0.0385
Default cost: linear	$d_0$	-0.24
Default cost: quadratic	$d_1$	0.3

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## How do swaps affect equilibrium?

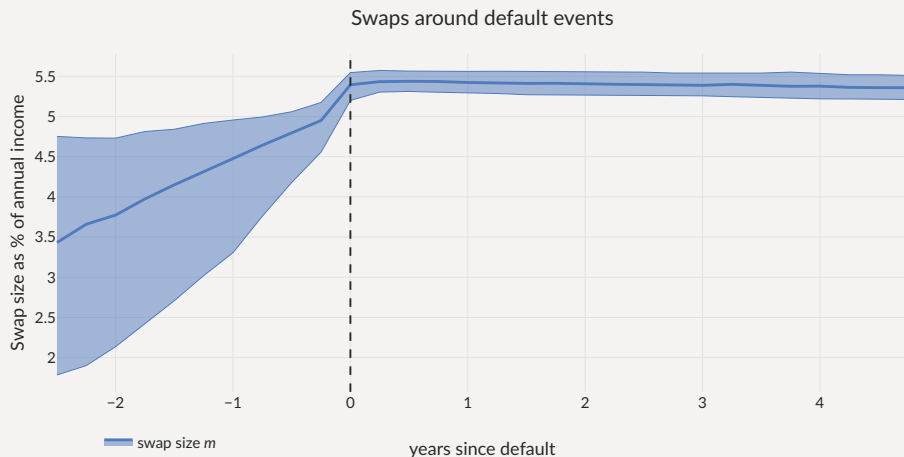
	No swap	Unrestricted, $\theta = 0.25$	Unrestricted, $\theta = 0.5$
Avg spread (bps)	901	1899	2447
Std spread (bps)	532	1137	1578
$\sigma(c)/\sigma(y)$ (%)	110	110	110
Debt to GDP (%)	20.5	20.2	19.6
Swap to GDP (%)	0	3.68	3.25
Corr. swap & spreads (%)	–	55.4	62.6
Default frequency (%)	7.07	13.2	15.2
Welfare gains (rep)	–	-0.059%	-0.36%

# When is the Swap Used?

▶ Limited

▶ More

- Swaps shoot up before *and during* defaults



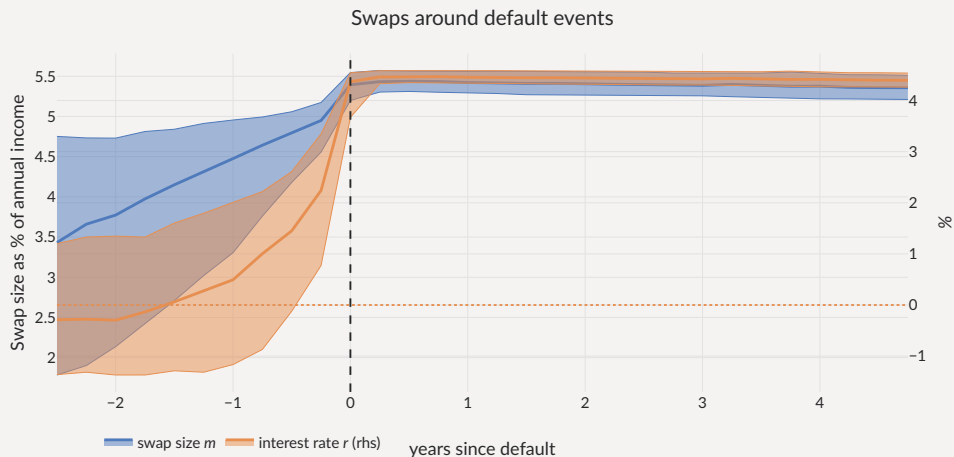
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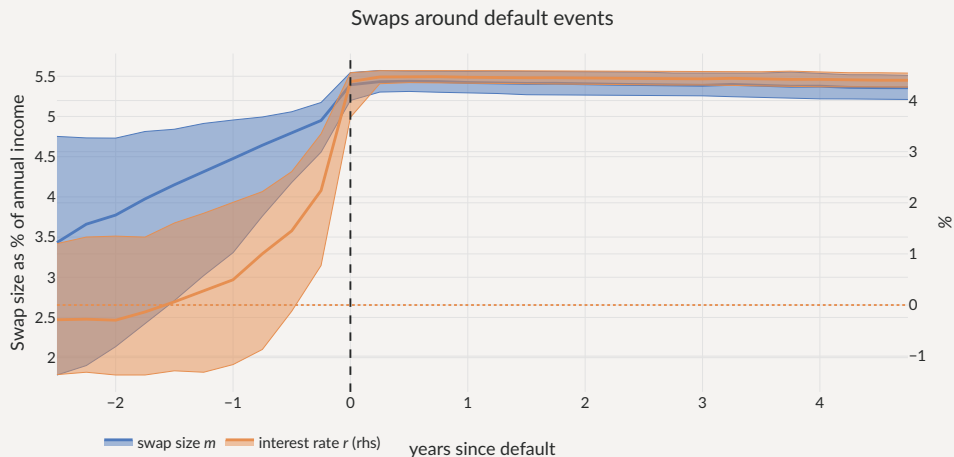
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## Limiting swaps in default

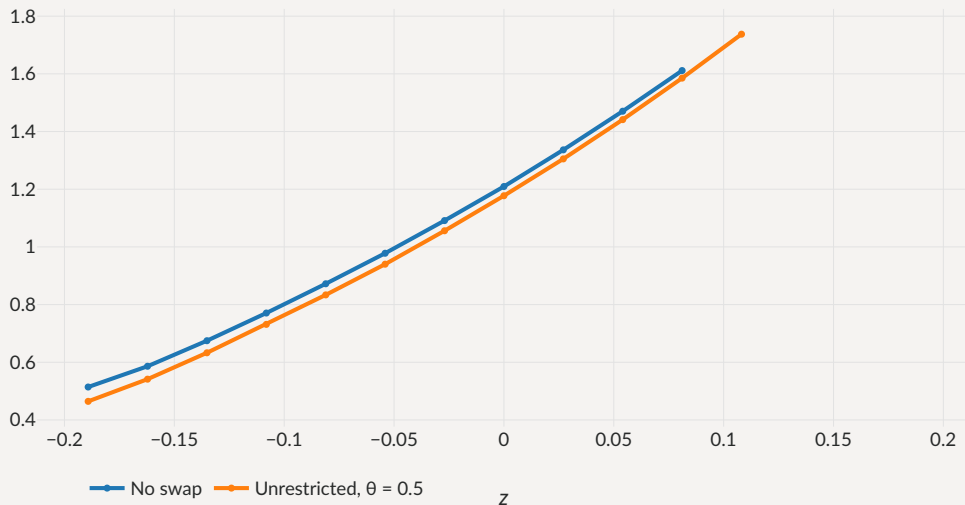
- **Unavailable:** entire swap must be repaid while in default  $\Gamma(m) = 0$

	No swap	Unrestricted, $\theta = 0.5$	Unavailable, $\theta = 0.5$
Avg spread (bps)	901	2447	1406
Std spread (bps)	532	1578	960
$\sigma(c)/\sigma(y)$ (%)	110	110	114
Debt to GDP (%)	20.5	19.6	20.5
Swap to GDP (%)	0	3.25	1.27
Corr. swap & spreads (%)	–	62.6	70.1
Default frequency (%)	7.07	15.2	10.7
Welfare gains (rep)	–	-0.36%	-0.22%

# Default Barriers with Swaps

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

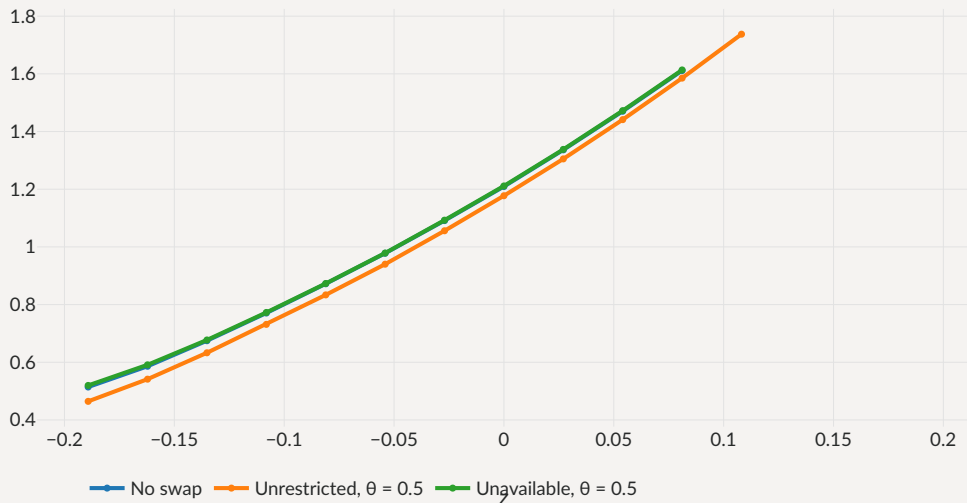
Debt levels at which  $\mathcal{P}(b,m,z)$  crosses 50%



# Default Barriers with Swaps

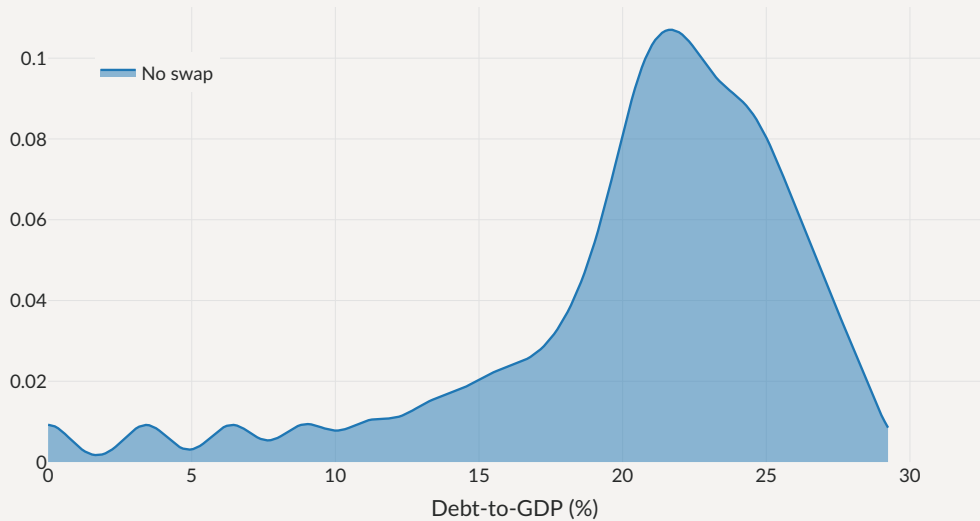
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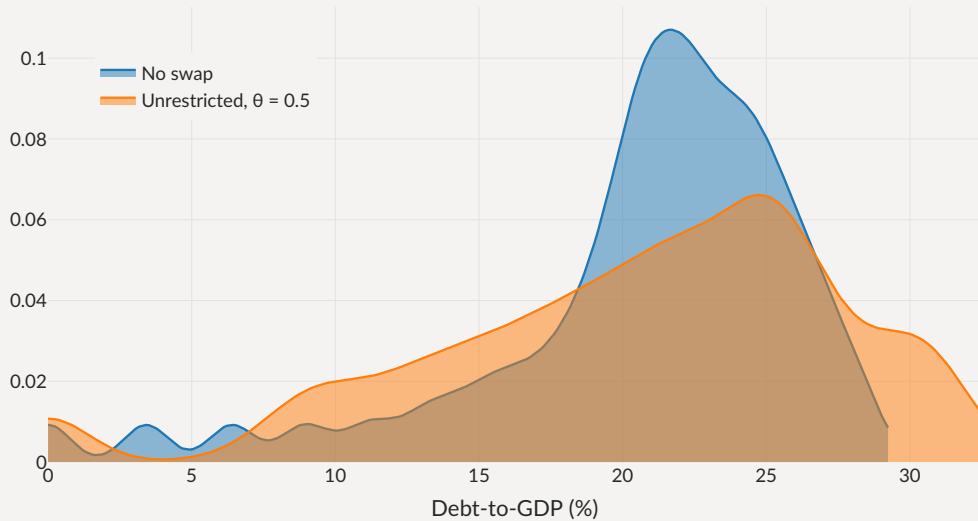
Distribution of debt levels





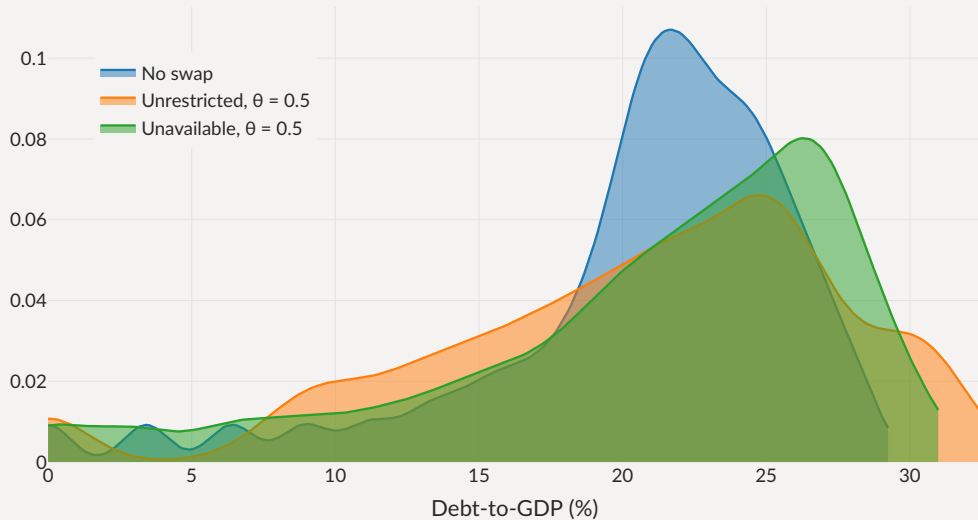
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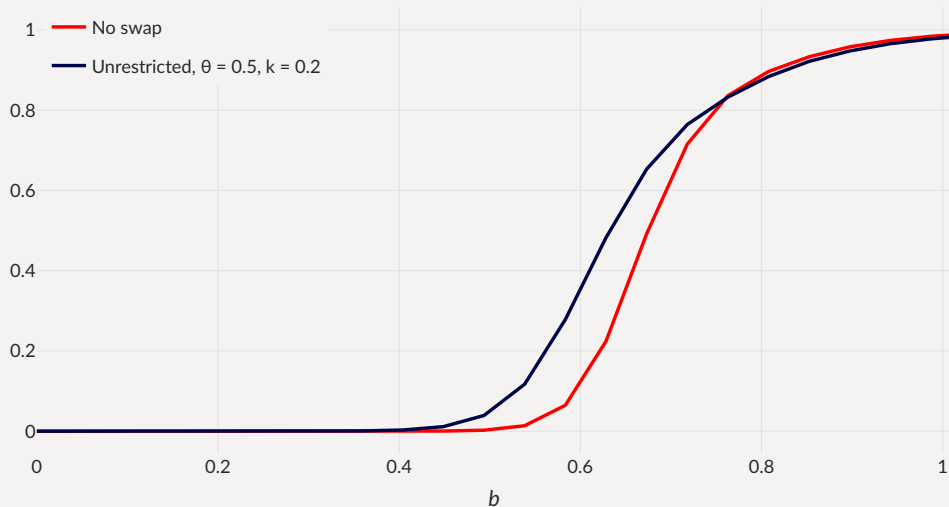
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# Debt Tolerance with Swaps

Repay less often with swaps. More often with Limited

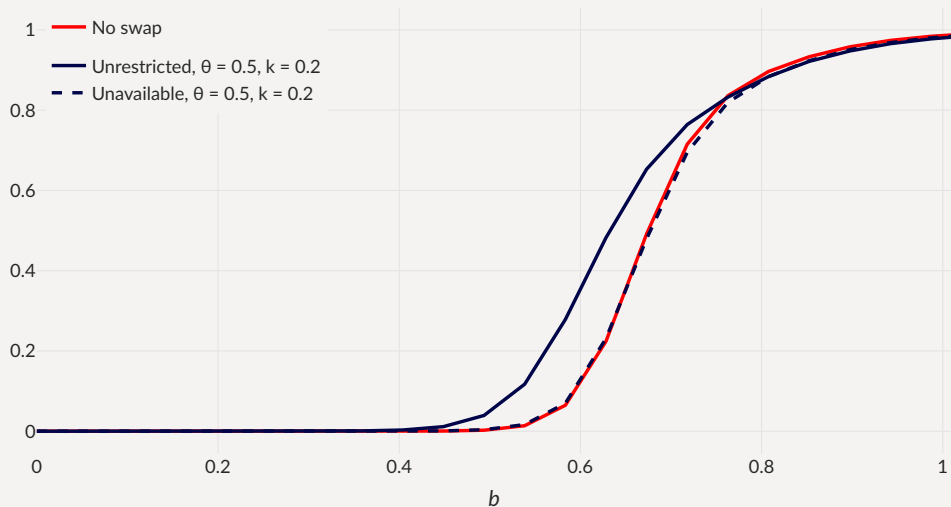
Default Probability  $\mathcal{P}(b,m,z)$



# Debt Tolerance with Swaps

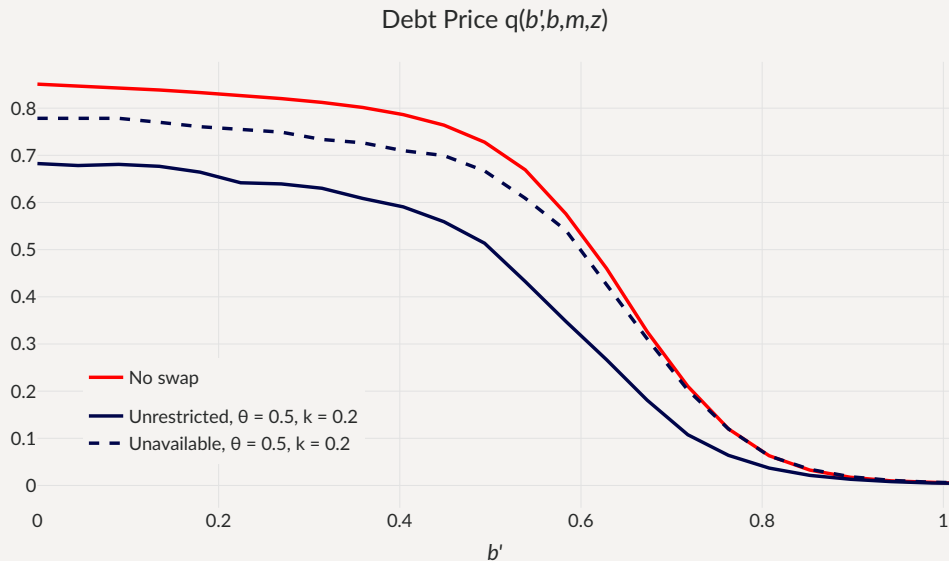
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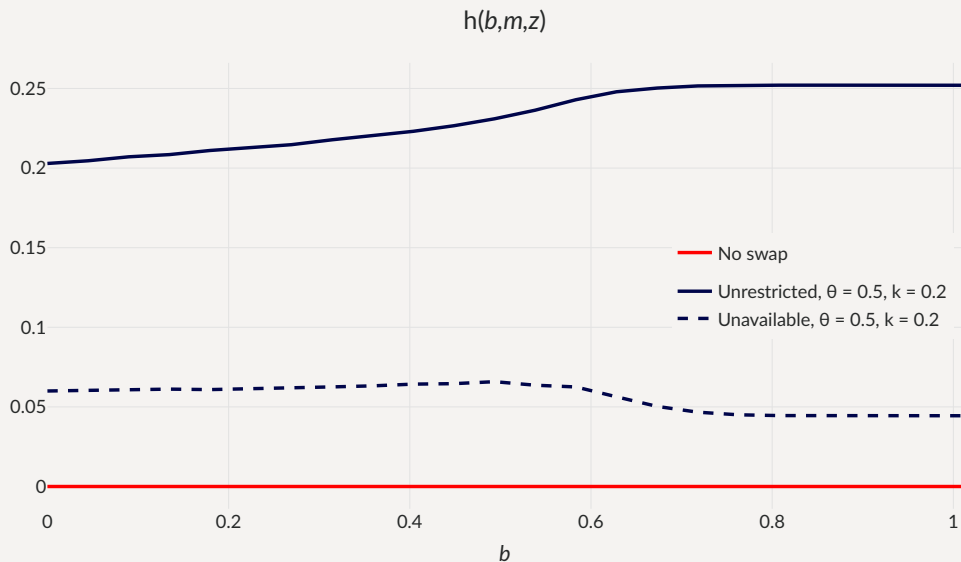
# Debt Prices with Swaps

Limited: more likely to repay but lower **prices** → Tell-tale sign of **debt dilution**?



# Monopolist's profits

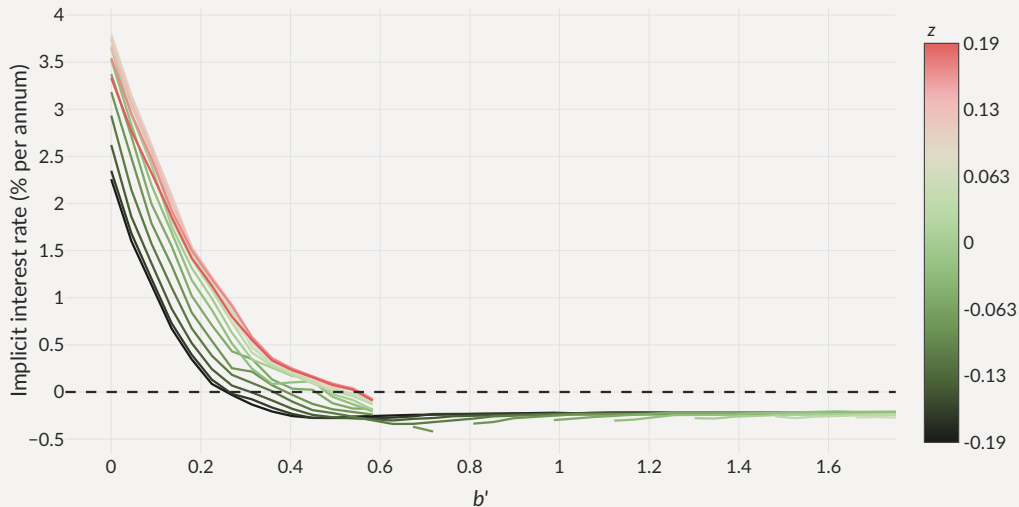
Monopolist's profits **increasing** in debt (cond. on repayment) – surplus requires spreads  $> 0$



# Risk-taking incentives

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

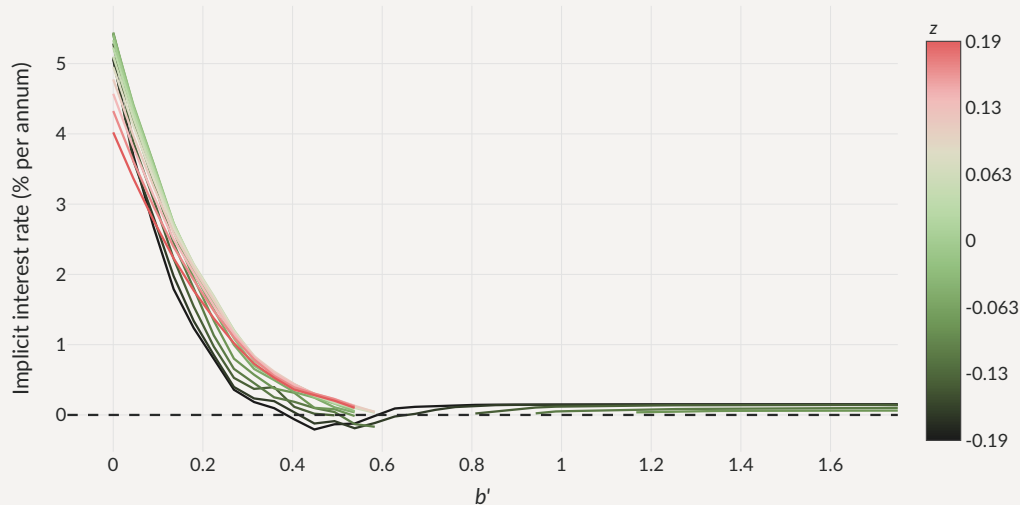
Interest rate on the swap (Unrestricted)



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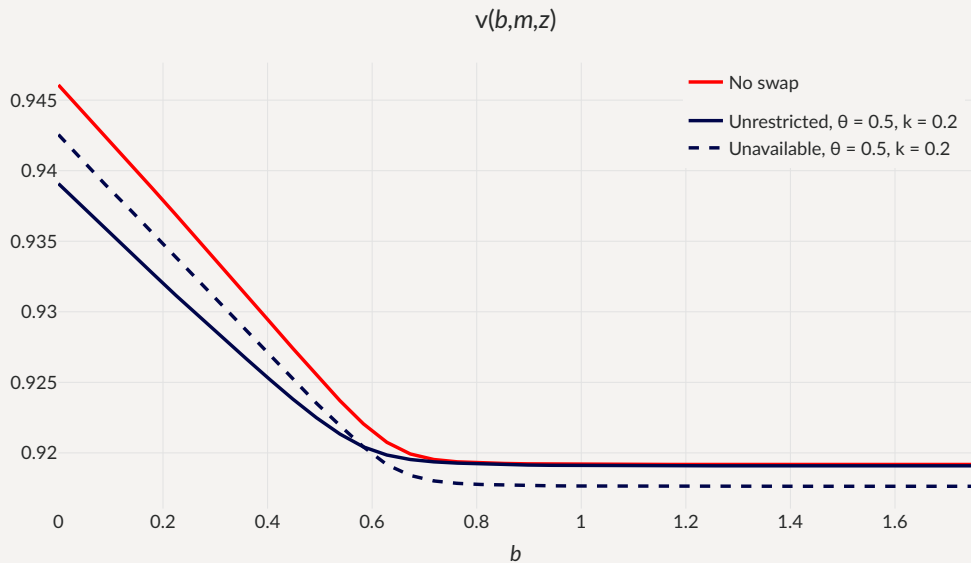
Interest rate on the swap (Unavailable)





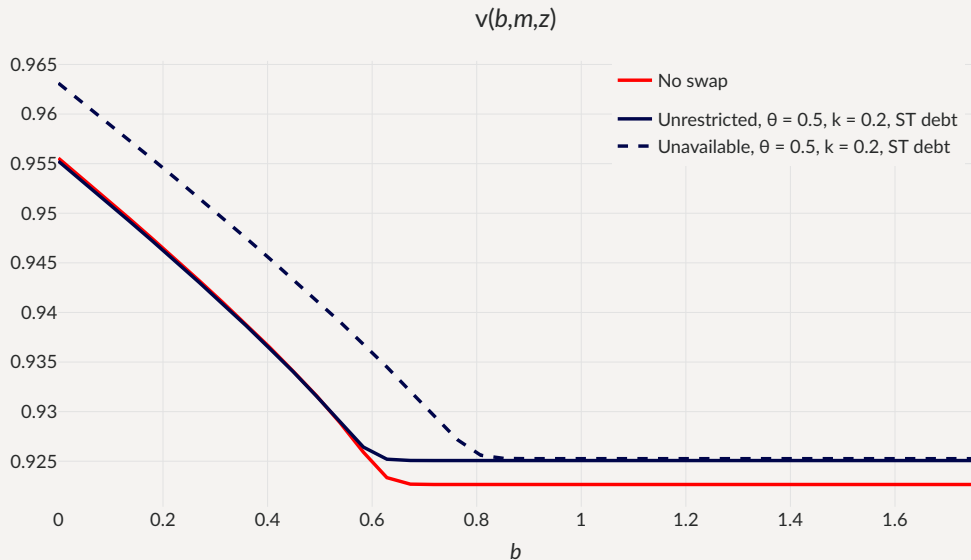
# Welfare effects of swap lines

Limited  $\succcurlyeq$  Unrestricted, but...



# Welfare effects of swap lines – Short-term debt

Solving model with **short-term debt**: gains of swaps



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

	No swap, ST	Unrestricted, $\theta = 0.5$ , ST	Unavailable, $\theta = 0.5$ , 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

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## Concluding remarks

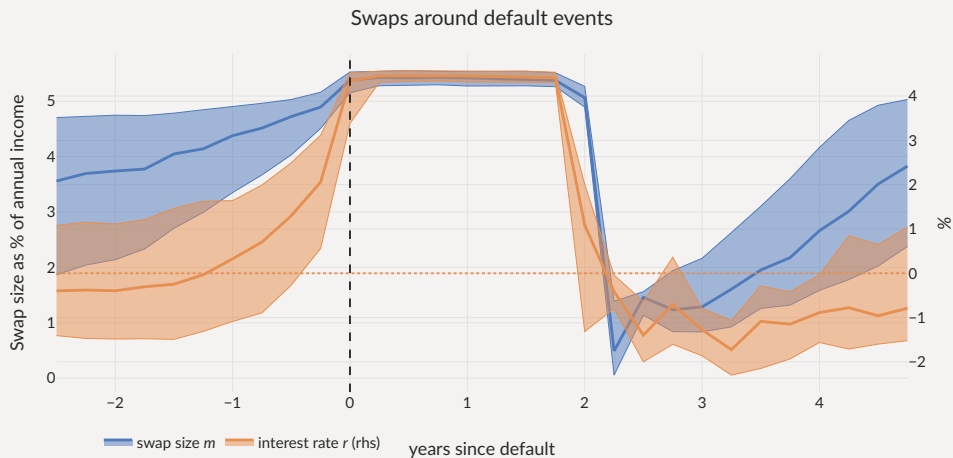
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- Simple model with monopolist/fringe structure
- Strong interaction between two markets for sovereign debt
  - ... even if swaps are not used intensely on the equilibrium path
- Market power crucial in model
  - ... how to discipline in model?
  -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



# When is the Swap Used?

- Further conditioning on default events lasting exactly two years



# When is the Swap Used?

- With Limited

