Sovereign swaps and sovereign default

Fundamental versus confidence risk

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Intro

Maturity management

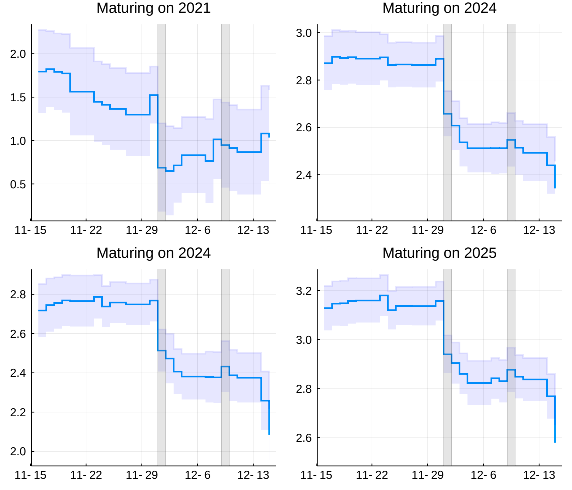
- Countries manage their debt portfolio
  - Issue bonds of different maturities
  - Buy back bonds
  - Swap bonds
- Sovereign debt models (going back to Bulow-Rogoff):
  - Maturity management via secondary markets is costly and a bad idea when default risk is high

Dominican Republic
December 2020 Swap

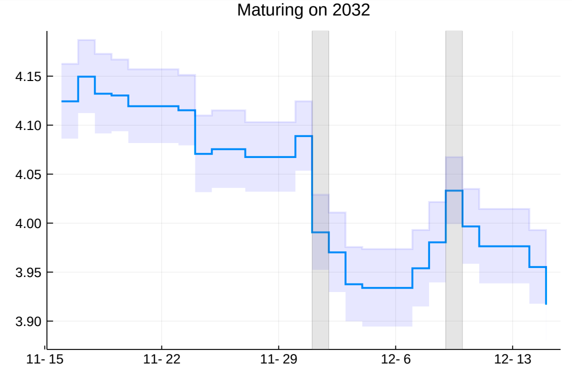
Details

- December 1st:
  - DR offers to buy back its short-term USD bond stock
  - Offer contingent on long-term issuance on Dec 8
- Involved 15% of the external bond stock
  - (Total external bond stock is 23% of GDP)
- No current resources used: zero-cost trade

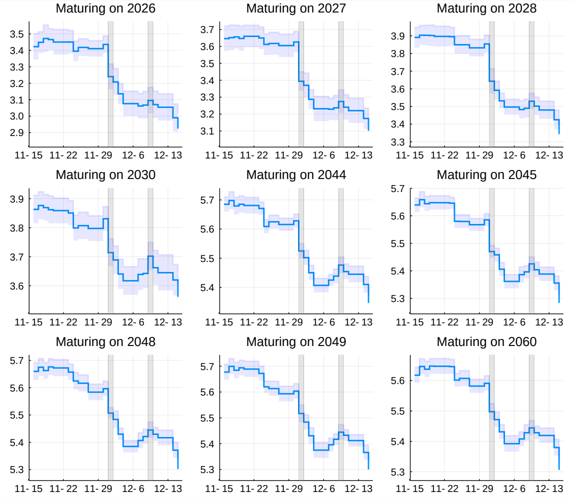
Effect on yields: Bonds bought back



Effect on yields: Bond issued



Effect on yields: All other bonds



yield curve

Summary of example

- Unexpected
- All bond yields decreased on announcement

  Including the bond to be issued

- Outcome:
  - Retired 85% of principal due in 2021
  - 40% of principal due in 2024
  - 15% of principal due in 2025

Questions

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- Was this swap a good idea?
    - Standard sovereign debt models would say no

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- Was this swap a good idea?
    - Standard sovereign debt models would say no
- Revisit this question

Swaps

- Informative about fundamental vs confidence risk
- Re-evaluate their benefit

Model

Environment

- Based on Aguiar-Amador-Hopenhayn-Werning (2019)
- Small open economy model
  - Discrete time $t = 0, 1, \ldots$
- Domestic government:
  - Constant endowment (one good): y
  - Utility flows: $u(c)$
  - Discount: β
- Foreign markets:
  - Risk-neutral, atomistic, discount $R = 1 + r$
- Assumption (not key): $\beta R = 1$

Asset market structure

- Government debt's portfolio composed of two assets:
- Perpetuity, b_L:
  - Promises to pay r every period
  - Price q_L

Asset market structure

- Government debt's portfolio composed of two assets:
- Perpetuity, b_L:
  - Promises to pay r every period
  - Price q_L
- One-period bond, b_S:
  - Promises to pay R next period
  - Price q_S
- Both prices $= 1$ without default risk

Debt management

Government inherits portfolio (b_S^0, b_L^0)

No long bond issuances

Assumption: Government issues only b_S

Note: this is without loss with only fundamental risk

Budget constraint

Government budget constraint (no default):

$$c = y - rb_L - Rb_S + q_S b'_S$$

where b'_S new stock of bonds

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Note: Long-term bond price is irrelevant

Lack of commitment

$V(b_S, b_L)$: Repayment value function

In case of a government default:

- Foreigners receive a payoff of 0
- Government receives outside value V^d

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Two sources of default risk: Fundamental and Confidence

Fundamental risk

Fundamental risk

- Prob $1 - \lambda$: $V^d = \underline{V}$
- Prob λ: $V^d \in [\underline{V}, \overline{V}]$ is drawn i.i.d. $F(.)$

Government defaults if $V(b_S, b_L) < V^d$

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Government defaults if $V(b_S, b_L) < V^d$

Default probability:

$$\lambda \times (1 - F(V(b_S, b_L)))$$

Confidence risk

Confidence risk (Cole-Kehoe)

- Prob η: lenders refuse to roll over bonds

Government defaults if:

$$u(y - rb_L - Rb_S) + \beta \mathbb{E} V(0, b_L) < \underline{V} \tag{1}$$

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$$\eta \times \mathbb{1}\{(b_S, b_L) \in C\}$$

C: (b_S, b_L) such that (1) holds

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C: (b_S, b_L) such than (1) holds

(ignoring $\eta \times \lambda$)

Government's problem

$$V(b_S, b_L) = \max_{b'_S} \Bigg\{ u(c) + \\ +\beta \Big[(1 - \lambda(1 - F(\tilde{V})) - \eta \mathbb{1}_{(b'_S, b_L) \in C}) \tilde{V} + \\ + \lambda \int_{\tilde{V}}^{\overline{V}} v^d dF(v^d) + \eta \mathbb{1}_{(b'_S, b_L) \in C} \underline{V} \Big] \Bigg\}$$

subject to:

$$c = y - rb_L - Rb_S + q_s(b'_S, b_L) b'_S$$

$$\tilde{V} = V(b'_S, b_L)$$

$\mathcal{B}_S$: an optimal policy

Pricing

One period bond price:

$$q_S(b_S, b_L) = 1 - \underbrace{\lambda(1 - F(V(b_S, b_L)))}_{\text{fundamental}} - \underbrace{\eta \mathbb{1}_{(b_S, b_L) \in C}}_{\text{confidence}}$$

Note: function of both value and portfolio (capturing the two risks)

Equilibrium definition

Markov Equilibrium

V, q_S, C such that (i) government optimizes, (ii) C is defined by (1), and (iii) pricing equation holds

Long term bond pricing

Given an equilibrium (and a corresponding $\mathcal{B}_S$)

$\Rightarrow q_L$ is a fixed point:

$$q_L(b_S, b_L) = q_S(b_S, b_L)\frac{r + q_L(\mathcal{B}_S(b_S, b_L), b_L)}{R}$$

Represents the secondary market price of the long bond

Zero-cost trades

Unexpected zero-cost trades

Let V, q_S, C be an equilibrium

Suppose government has just issued to b_S^A, b_L^A, then

Zero-cost trade: (b_S^B, b_L^B) such that

$$q_S^B b_S^B + q_L^B b_L^B = q_S^B b_S^A + q_L^B b_L^A$$

where

$$q_S^B = q_S(b_S^B, b_L^B), \qquad q_L^B = q_L(b_S^B, b_L^B)$$

$\Rightarrow$ Market value at ex-post prices is unchanged

An unexpected zero-cost trade . . .

Does not affect current consumption

But changes continuation value:

$$\mathbb{E}V(b_S^B, b_L^B) = \left[1 - \lambda(1 - F(\tilde{V})) - \eta \mathbb{1}_{(b_S^B, b_L^B) \in C}\right] \tilde{V} + \\ + \lambda \int_{\tilde{V}}^{\overline{V}} v^d dF(v^d) + \eta \mathbb{1}_{(b_S^B, b_L^B) \in C} \underline{V}$$

where $\tilde{V} = V(b_S^B, b_L^B)$

The fundamental case

Fundamental risk

Consider $\eta = 0$ (no confidence risk)

AAHW:

- Govt does not trade long-term bonds
- Zero-cost trades reduce government's utility

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Convexity of the value function + envelope condition

Convexity and tangency

$V(b_S^A, b_L^A) = v_A$

Dual:

$$
\begin{aligned}
Rb_S^A = \max_{\{c_t, v_t, \Gamma_t\}} \Big\{ \quad & y - rb_L^A - c_1 + \\
& + \Gamma_1(y - rb_L^A - c_2) \\
& + \Gamma_2(y - rb_L^A - c_3) + \dots \Big\}
\end{aligned}
$$

subject to:

$$
\begin{aligned}
v_t &= U(c_t, c_{t+1}, \dots) \text{ with } v_0 = v_A \\
\Gamma_t &= \Gamma_{t-1}(1 - \lambda(1 - F(v_t)))/R
\end{aligned}
$$

Convexity and tangency

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Dual: Budget constraint

$$Rb_S^A = \max_{\{c_t, v_t, \Gamma_t\}} \Big\{ y - rb_L^A - c_1 + \\ + \Gamma_1(y - rb_L^A - c_2) \\ + \Gamma_2(y - rb_L^A - c_3) + \dots \Big\}$$

subject to:

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subject to:

utility – PK

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survival probability (discounted)

Convexity and tangency

$$V(b_S^A, b_L^A) = v_A \qquad = (r + q_L^{A,1}) b_L^A$$

Dual:

$$Rb_S^A = \max_{\{c_t, v_t, \Gamma_t\}} \Big\{ y - rb_L^A - c_1 + \Gamma_1 (y - rb_L^A - c_2) + \Gamma_2 (y - rb_L^A - c_3) + \dots \Big\}$$

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Fundamental shocks: Iso-V lines

For $V(b_S^A, b_L^A) = V(b_S^B, b_L^B) = v_A$:

$$Rb_S^B \geq Rb_S^A - (r + q_L^{A,1})(b_L^A - b_L^B)$$

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$$\mathbb{E}v = (1 - \lambda(1 - F(v_A)))v_A + \lambda \int_{v_A}^{\overline{V}} v^d dF(v^d)$$

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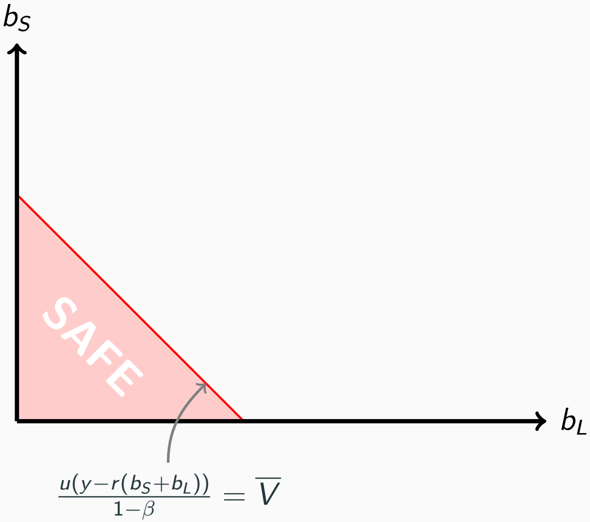
and prices are the tangent:

$$-\frac{r + q_L^{A,1}}{R} = -\frac{(1 - \lambda(1 - F(v))))(r + q_L^{A,1})/R}{(1 - \lambda(1 - F(v))))} = -\frac{q_L^A}{q_S^A}$$

Fundament shocks: A zero-cost trade



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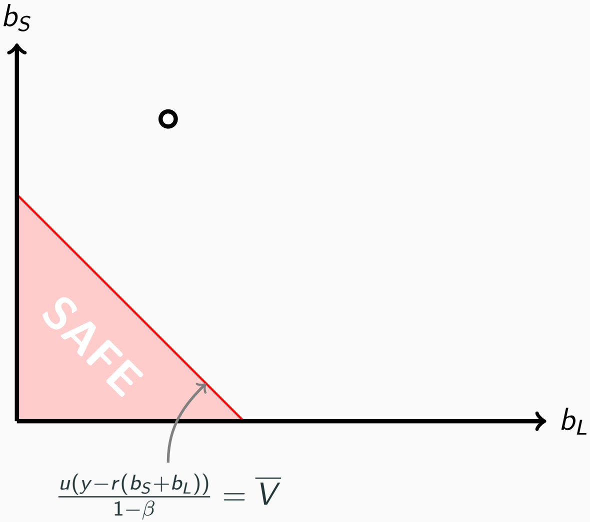

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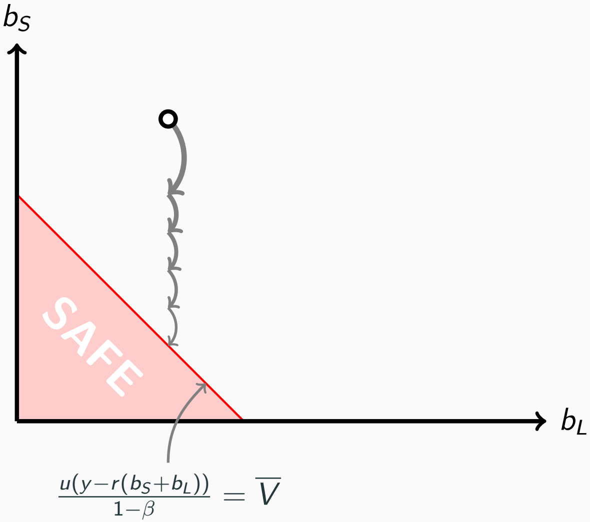

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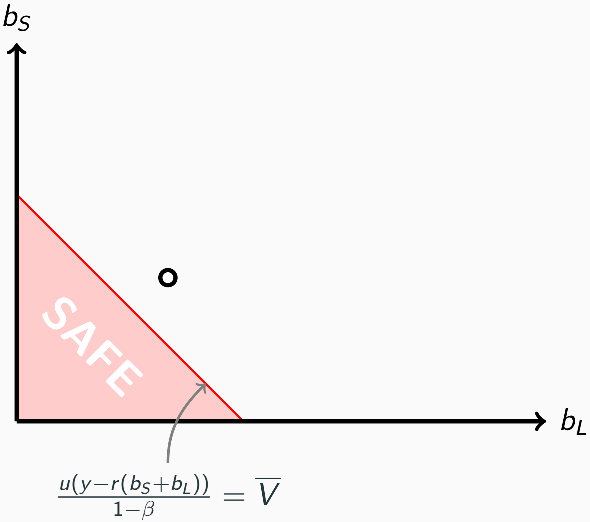

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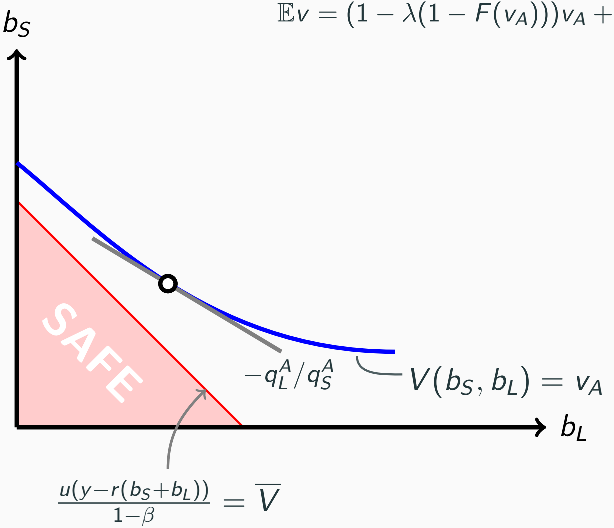

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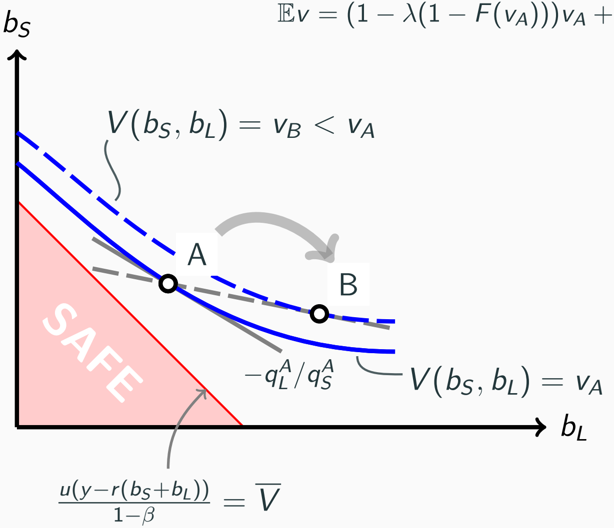

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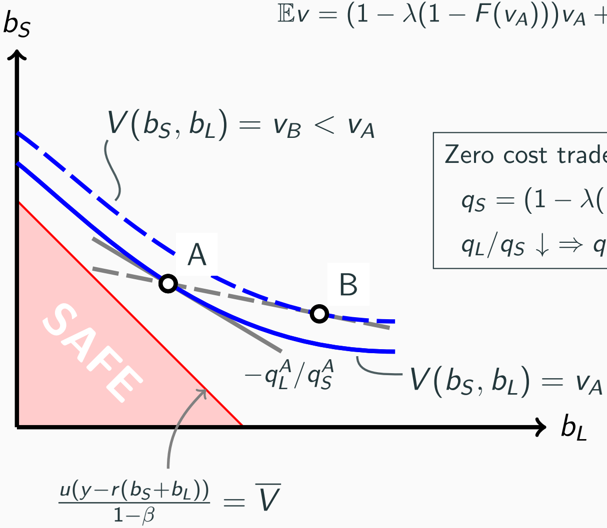

Zero cost trade: (A) to (B)

$q_S = (1-\lambda(1-F(v\downarrow)))\downarrow$

$q_L/q_S \downarrow \Rightarrow q_L \downarrow$

Results for fundamental shocks

1. Impossibility result

No zero-cost trade can increase the price of the one-period bond

Result 1 is general – holds for finite/infinite horizons, non-separable u, and arbitrary maturity structures!

Results for fundamental shocks

1. Impossibility result

No zero-cost trade can increase the price of the one-period bond

2. Maturity extension

A zero-cost trade that increases maturity lowers the long-term bond price

Result 1 is general – holds for finite/infinite horizons, non-separable u, and arbitrary maturity structures!

Main takeaway

With only fundamental shocks:

- Debt swaps are a bad idea
- And some prices necessary decrease after a swap:
    - One-period bond price decreases
    - Long-term price decreases if maturity extended

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> We cannot explain DR's swap with only fundamental shocks

The case with confidence crises

Confidence crises

Suppose now that $\lambda = 0$ (no fundamental shocks)

But $\eta > 0$

The confidence crisis induces a default even when

$$V(b_S, b_L) > V^d$$

More crucially, maturity determines exposure to risk

(Dual approach above fails)

Confidence crises

Exploiting $\beta R = 1$:

$$V(b_S, b_L) \leq \underbrace{\frac{u(y - r(b_S + b_L))}{1 - \beta}}_{\text{first best}}$$

Confidence crises

Exploiting $\beta R = 1$:

$$V(b_S, b_L) \leq \underbrace{\frac{u(y - r(b_S + b_L))}{1 - \beta}}_{\text{first best}}$$

With $b_S = 0$, first best is attainable as long as:

$$V(0, b_L) = \frac{u(y - rb_L)}{1 - \beta} \geq \underline{V}$$

Let $\underline{b}_L$ be the threshold

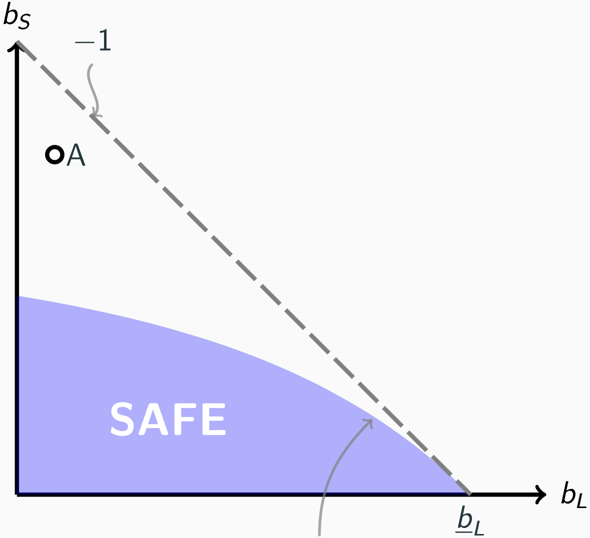
Confidence crises

Consider $(b_S, b_L) \in C$ with $b_S + b_L \leq \underline{b}_L$. Then

$$\mathbb{E}V(b_S, b_L) = \eta \underline{V} + (1-\eta) V(b_S, b_L) < \frac{u(y - r(b_S + b_L))}{1-\beta}$$

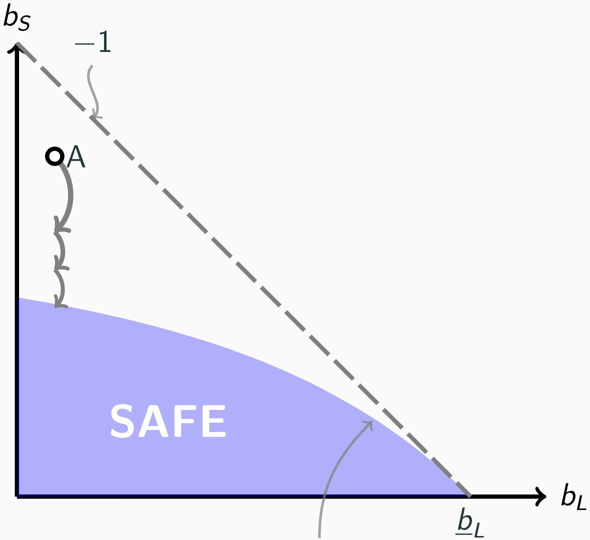
(not indifferent when defaulting!)

Confidence crises: A graphical analysis



$$u(y - rb_L - Rb_S) + \beta \frac{u(y - rb_L)}{1-\beta} = \underline{V}$$

Confidence crises: A graphical analysis



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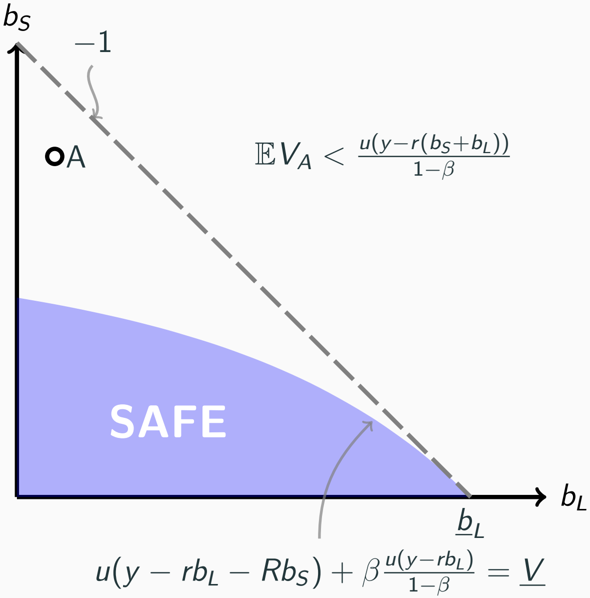

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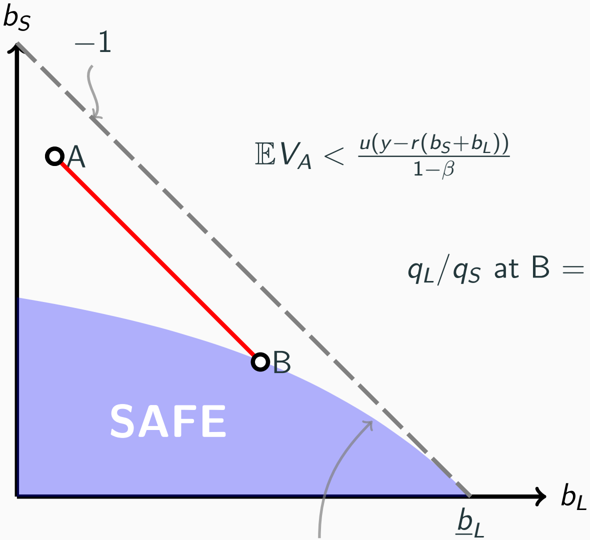
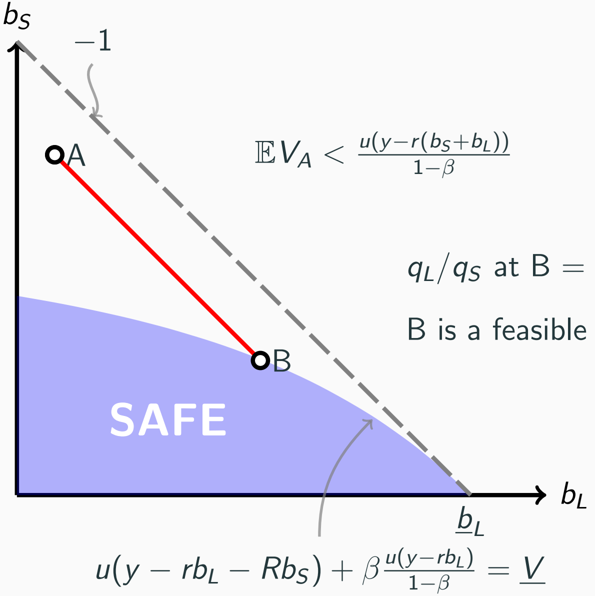


$\mathbb{E}V_A < \frac{u(y - r(b_S + b_L))}{1-\beta}$

q_L/q_S at B $= -1$ (no risk)

$u(y - rb_L - Rb_S) + \beta\frac{u(y-rb_L)}{1-\beta} = \underline{V}$

Confidence crises: A graphical analysis



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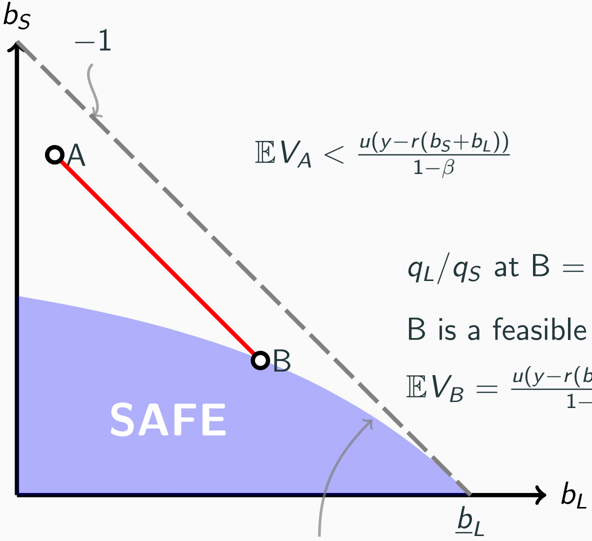
B is a feasible trade

Confidence crises: A graphical analysis



q_L/q_S at B $= -1$ (no risk)

B is a feasible trade

$\mathbb{E}V_B = \frac{u(y-r(b_S+b_L))}{1-\beta} > \mathbb{E}V_A$

$$u(y - rb_L - Rb_S) + \beta\frac{u(y-rb_L)}{1-\beta} = \underline{V}$$

Confidence crises: The benefits of swaps

Let $(b_S^A, b_L^A) \in C$ with $b_S^A + b_L^A < \underline{b}_L$

Then exists a zero-cost trade to (b_S^B, b_L^B) with $b_L^B > b_L^A$, $q_S^B = q_L^B = 1$ and

$$\mathbb{E}V(b_S^B, b_L^B) > \mathbb{E}V(b_S^A, b_L^A)$$

Note that $(b_S^A, b_L^A) \in C \Rightarrow q_S^A < 1$ and $q_L^A < 1$

There is a swap that extends maturity, raises all prices, and increases welfare

But extreme in this case (all risk goes away)

The two risks together

Simulations with two shocks

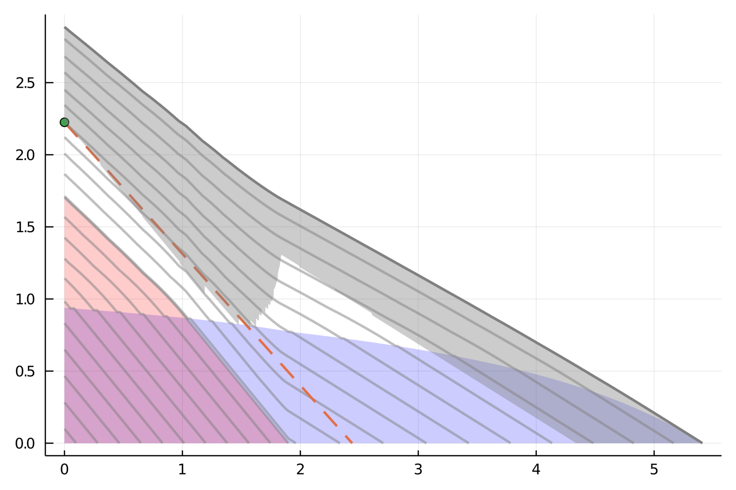
Two shocks $\eta > 0$ and $\lambda > 0$

Assume mass point:

$$F(v^d) = \begin{cases} 0 & ; v^d < \overline{V} \\ 1 & ; \text{otherwise} \end{cases}$$

Simulation result: Case 1

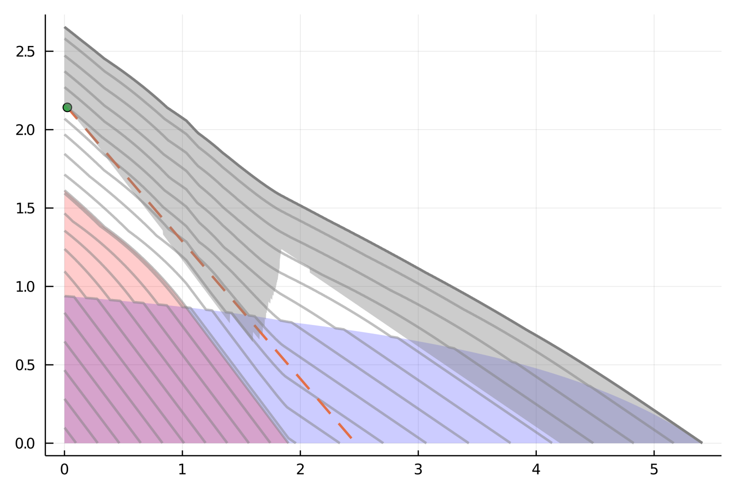
Lower η



sim details

Simulation result: Case 2

Higher η



sim details

Simulation results

- As η increases $\Rightarrow$: maturity extending swaps become useful
- We haven't found a case where maturity reduction is beneficial

Conclusion

Conclusion

Swaps are informative about the nature of shocks

- Increase in all prices consistent with confidence (roll-over) risk having a major role
- When confidence risk is major concern $\Rightarrow$

  Swaps can be a good idea

Conclusion

Next steps:

- Quantify/decompose the risks?
- In process: collecting more data on swaps

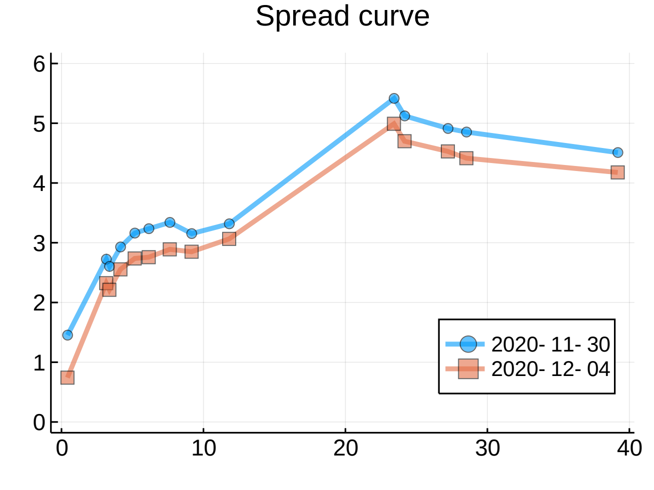
Missing elements:

- Hedging fundamental shocks
- Variation in risk premia
- Preferred Habitat / Liquidity
- Signaling – Asymmetric Information

Thank you!

Backup slides

Spread curve



back

Simualtion details

$$\underline{V} = \frac{u(y(1-\overline{\tau}))}{1-\beta}$$

$$\overline{V} = \frac{u(y(1-\underline{\tau}))}{1-\beta}$$

Case 1:

$u = \log, \beta = 0.95, \bar{\tau} = 0.2, \underline{\tau} = 0.1, \lambda = 0.05, \eta = 0.01$

Case 2:

$u = \log, \beta = 0.95, \bar{\tau} = 0.2, \underline{\tau} = 0.1, \lambda = 0.05, \eta = 0.03$

back