Financial Crises and Lending of Last Resort in Open Economies

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Motivation

- Financial panic:
  - Banks lose access to short-term funding
  - Asset prices drop
  - Credit crunch
- Classic recipe for response: lending of last resort
- For emerging economies panics are worse:
  - They come with capital flight and depreciation
  - Depreciation acts as amplifier (dollarized liabilities)
- Harder to do lending of last resort for domestic authorities
  - Hard to replace dollar funding when in crisis
  - Foreign currency reserves can help (Obstfeld-Shambaugh-Taylor, Gourinchas-Obstfeld)

Questions

- How do panics play out in open economies with flexible exchange rates?
- What challenges for domestic lender of last resort?
- Why domestic borrowers take dollar liabilities?
- Does accumulation of foreign currency reserves help?

Ingredients

- Small open economy with a financial sector
  - Households: save in pesos and dollars
  - Banks: borrow in pesos and in dollars
- Tradable/non-tradable structure $\rightarrow$ real exchange rate
- Central bank with strict inflation target
- Government with limited fiscal capacity

Overview of the talk

1. Model

2. Equilibria without government intervention
   - $t = 1, 2$: continuation equilibria (panics)
   - $t = 0$: endogenous dollarization (why dollar debt?)

3. Lending of last resort
   - $t = 1, 2$: Ex-post interventions and credibility
   - $t = 0$: Does reserves accumulation help? (yes)
     Moral hazard? (in some cases no)

Model

- Small open economy, three periods $t = 0, 1, 2$
- Two domestic agents: households and bankers
- Two goods: tradable (T) and non-tradable (N)
- Two units of account: pesos and dollars

Model: Households

- Preferences

$$\mathbb{E}\left[\sum_{t=0}^{2}\beta^t U\left((c_t^T)^{\omega}(c_t^N)^{1-\omega}\right)\right]$$

- Supply 1 unit of labor to tradable sector
- Endowment e^N of non-tradables
- Budget constraint

$$\frac{a_{t+1}}{1+i_t}+s_t\frac{a^*_{t+1}}{1+i^*_t}+p_t^T c_t^T+p_t^N c_t^N = w_t+p_t^N e^N+\Pi_t+a_t+s_t a^*_t$$

Model: Technology

- Production of tradables

$$y_t^T = k_t^\alpha l_t^{1-\alpha}$$

- Adjustment technology: to produce ι_t units of new capital requires $G(\iota_t)$ tradable goods
- Supply of capital goods

$$G'(\iota_t) = \frac{Q_t}{p_t^T}$$

- No depreciation at $t = 0, 1$

$$k_{t+1} = k_t + \iota_t$$

- Full depreciation at $t = 2$

Model: Banks

- Bankers: risk neutral agents, consume only tradables at $t = 2$
- Only bankers can own capital goods
- Budget constraint at $t = 0, 1$

$$Q_t k_{t+1} = \underbrace{(Q_t + r_t)\, k_t - b_t - s_t b_t^*}_{\text{net worth}} + \frac{1}{1 + i_t} b_{t+1} + s_t \frac{1}{1 + i_t^*} b_{t+1}^*$$

- Collateral constraint

$$\frac{1}{1 + i_t} b_{t+1} + s_t \frac{1}{1 + i_t^*} b_{t+1}^* \leq \theta Q_t k_{t+1}$$

Model: Foreign Investors and Currencies

- Foreign investors: risk neutral, consume only tradables, discount the future at rate β

- Units of account:
  - dollar = tradables (dollar price of T is 1)
  - so by law of one price

$$p_t^T = s_t$$

  - peso = domestic consumption basket

$$\left(p_t^T\right)^{\omega} \left(p_t^N\right)^{1-\omega} = 1$$

Continuation equilibrium

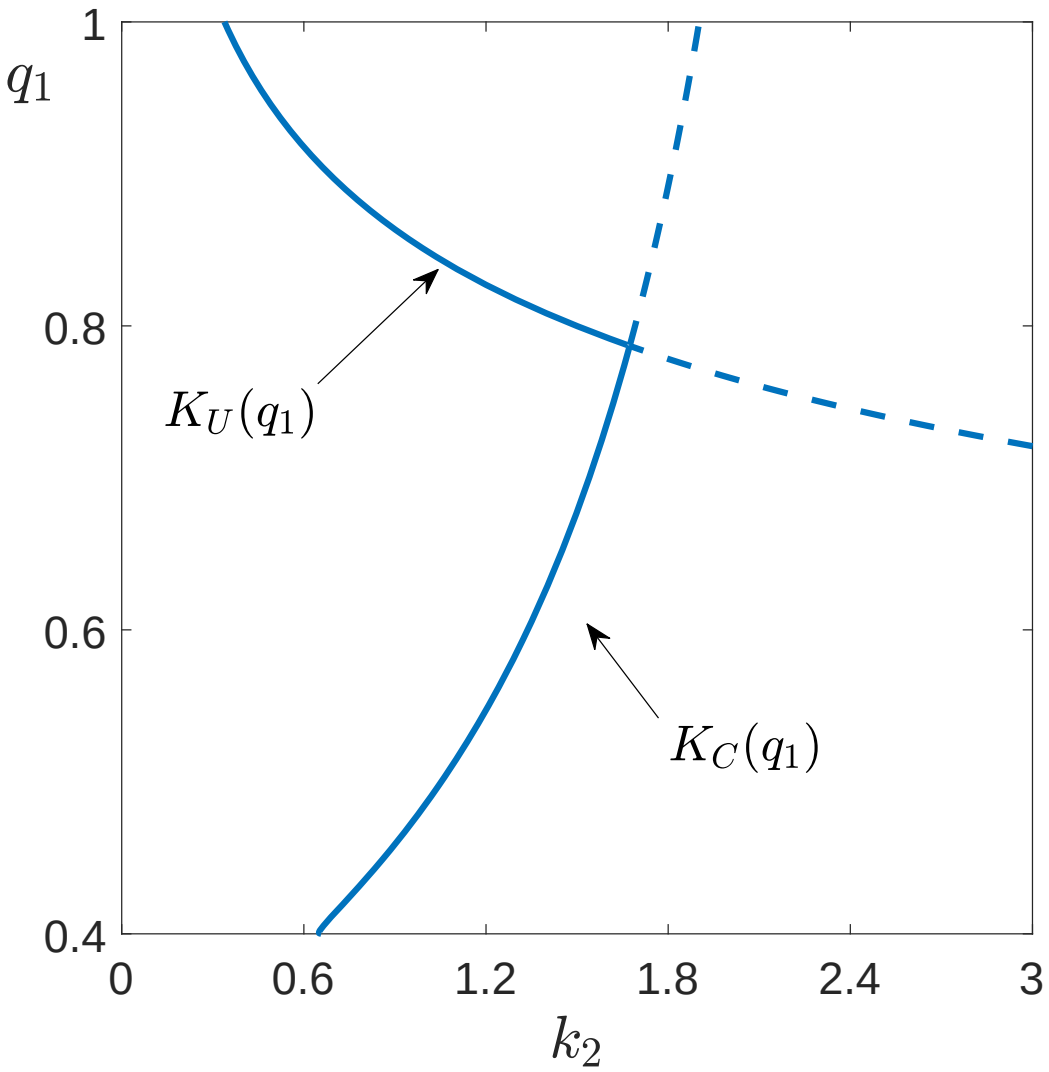
- Start economy at $t = 1$
- Derive demand and supply of k_2 as function of $q_1 = Q_1/p_1^T$ so that all other markets in equilibrium
- Demand of k_2 can be unconstrained

$$q_1 = \beta\alpha k_2^{\alpha-1}$$

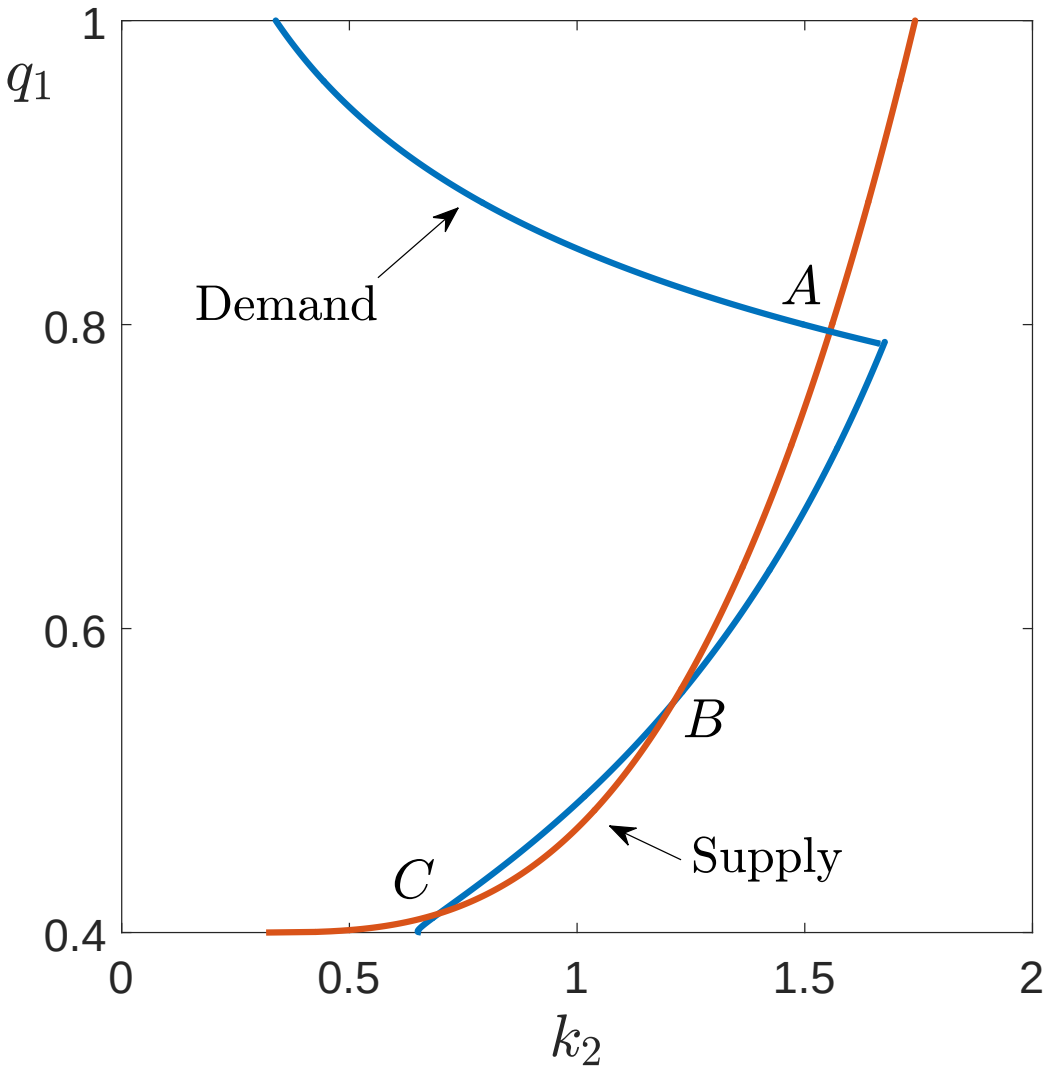
- ...or constrained

$$k_2 = \frac{1}{(1-\theta)q_1}\left[(q_1 + r_1)k_1 - \frac{b_1}{s_1(q_1)} - b_1^*\right]$$

The demand of capital



Multiple equilibria in the capital market



Twin crises

In the low-price equilibrium:

- Investment is lower
- Consumption is depressed because of low permanent income,

$$c^T = \frac{1}{1+\beta}\left[(1-\alpha)k_1^{\alpha} + \beta(1-\alpha){k_2}^{\alpha} + \pi_1(q_1) + \frac{a_1}{s_1} + a_1^*\right]$$

- The current account balance is larger (sudden stop)
- The real and nominal exchange rate depreciates

$$\frac{p^N}{p^T} = \frac{1-\omega}{\omega}\frac{c^T}{e^N}$$

Sources of Fragility

What makes demand for capital increasing in q_1?

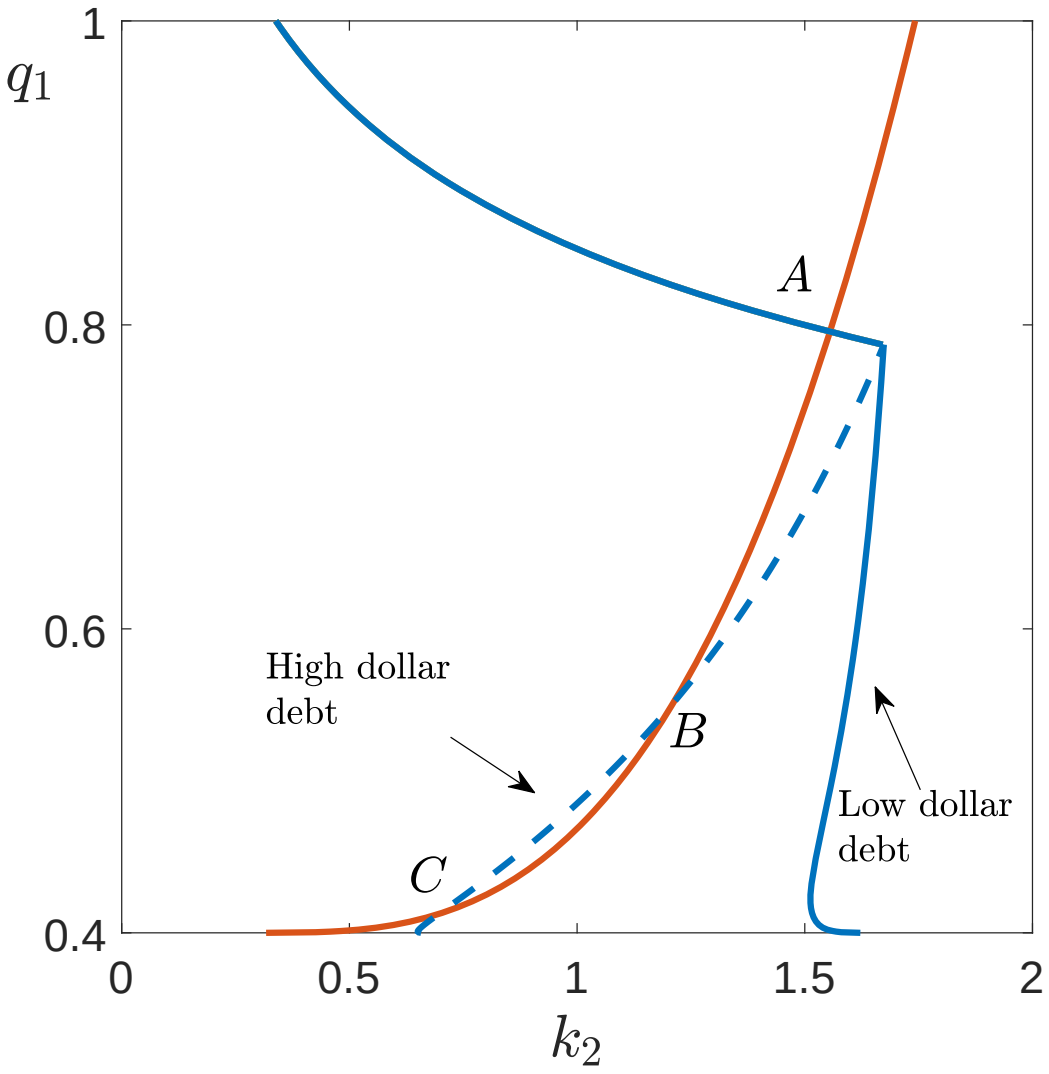
$$k_2 = \frac{1}{(1-\theta)q_1}\left[(q_1 + r_1)k_1 - \frac{b_1}{s_1(q_1)} - b_1^*\right]$$

Two forces

- High total debt $b_1/s_1 + b_1^*$
- Relatively more dollar debt

Second result follows because $ds_1/dq_1 < 0$ (Balassa-Samuelson)

Dollar debt and twin crises



Back to time 0

- Will agents choose positions that expose them to a crisis?
- Household choice between dollar and peso assets

$$1 + i_0 - \mathbb{E}_0 \left[(1 + i_0^*) \frac{s_1}{s_0} \right] = \text{Cov}_0 \left[(1 + i_0^*) \frac{s_1}{s_0}, \frac{U'(C_1)}{U'(C_0)} \right]$$

- If dollars are a good hedge against depreciation, then positive premium required on peso bonds

Nondollarized equilibrium

$$1 + i_0 - \mathbb{E}_0\left[(1 + i_0^*)\frac{s_1}{s_0}\right] = \text{Cov}_0\left[(1 + i_0^*)\frac{s_1}{s_0}, \frac{U'(C_1)}{U'(C_0)}\right] = 0$$

- Banks have mostly peso debt, unique cont. equilibrium
- Consumption constant
- Household consumption not exposed to exchange rate volatility $\rightarrow$ happy to save in pesos
- For banks is cheap to borrow in pesos

Dollarized equilibrium

$$\mathbb{E}_0\left[(1+i_0^*)\frac{s_1}{s_0}\right]-(1+i_0)=-\text{Cov}_0\left[(1+i_0^*)\frac{s_1}{s_0},\frac{U'(C_1)}{U'(C_0)}\right]>0$$

- Banks have more dollar debt, multiple cont. equilibria
- Consumption volatile with sunspot
- Dollars good hedge for sunspot shocks $\rightarrow$ household prefer saving in dollars
- For banks is more expensive to borrow in pesos

Non-dollarized equilibria

	Non-dollarized
a_1, b_1	0.703
a_1^*	0.000
b_1^*	-0.280
Stdev$(\tilde{w}_1)$	0.000
Corr$(\tilde{w}_1, \tilde{s}_1)$	0.000
Stdev$(\tilde{c}_1)$	0.000
$\mathbb{E}[(1 + i_0^*)(s_1/s_0)]$	1.000
$(1 + i_0)$	1.000

- Households save only in pesos
- Banks' debt all in pesos. Unique unconstrained equilibrium from $t = 1$
- Labor income constant

Dollarized equilibria

	Non-dollarized	Dollarized
a_1, b_1	0.703	0.050
a_1^*	0.000	0.710
b_1^*	-0.280	0.360
Stdev$(\tilde{w}_1)$	0.000	0.043
Corr$(\tilde{w}_1, \tilde{s}_1)$	0.000	-0.969
Stdev$(\tilde{c}_1)$	0.000	0.015
$\mathbb{E}[(1+i_0^*)(s_1/s_0)]$	1.000	0.941
$(1+i_0)$	1.000	1.034

- Households save mostly in dollars
- Banks' debt mostly in dollars. Multiple equilibria from $t = 1$
- Labor income risky: dollar assets provide insurance

A refinement

- Add nominal shock to dollar price of tradables, two sources of exchange rate volatility:
  - Sunspot selecting bad equilibrium (if multiplicity present)
  - Nominal shock moving s_1 independently of domestic variables
- This eliminates indeterminacy of portfolio in nondollarized equilibrium
- Consumers like pesos better than dollars absent financial fragility

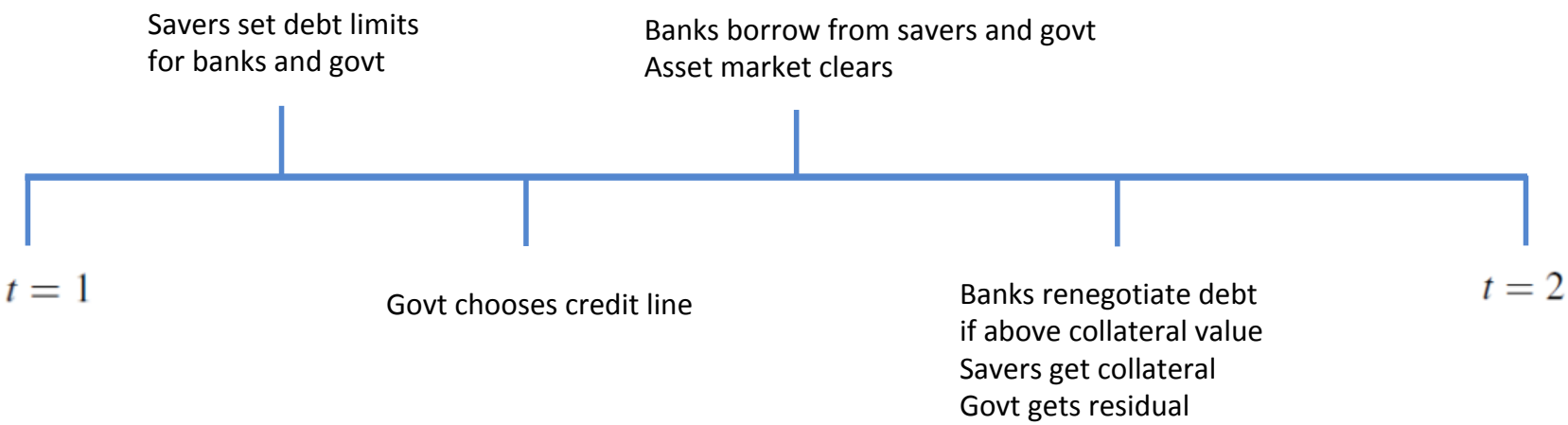
Lending of Last Resort

Introduce a benevolent government

- Extends a credit line $\bar{b}_2^{*g}$ to banks at $t = 1$
- It borrows, raises distortionary labor taxes
- Gov't financial positions A_t, A_t^*

- In Walrasian market easy to eliminate bad equilibrium
- To capture issues of credibility, we specify a sequential game between private sector and government

Timing



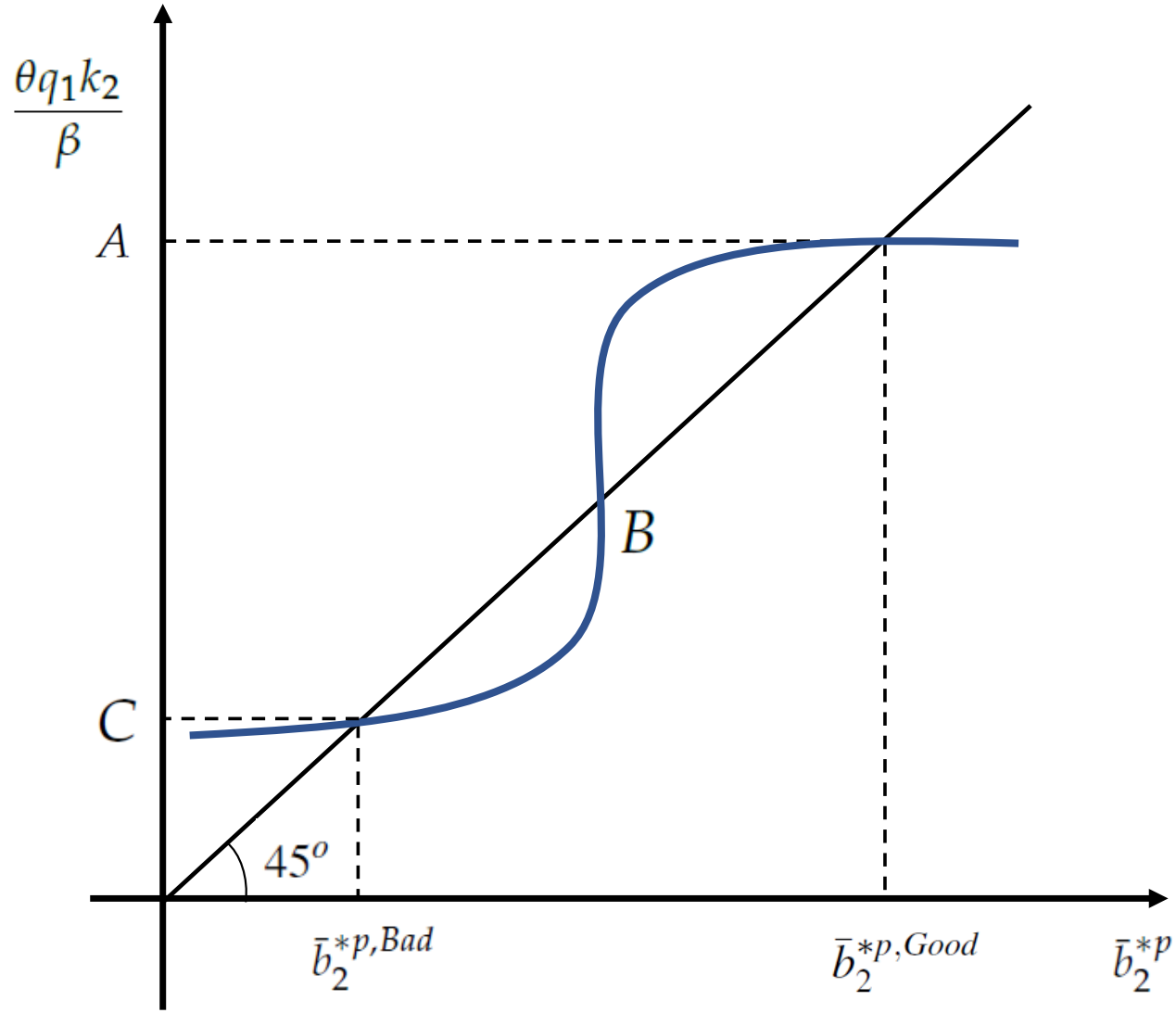
Equilibrium:

1. Gov't maximizes, taking credit limits as given
2. Savers set credit limits under rational expectations

$$\bar{b}_2^{*p} = \theta q_1 k_2 / \beta$$

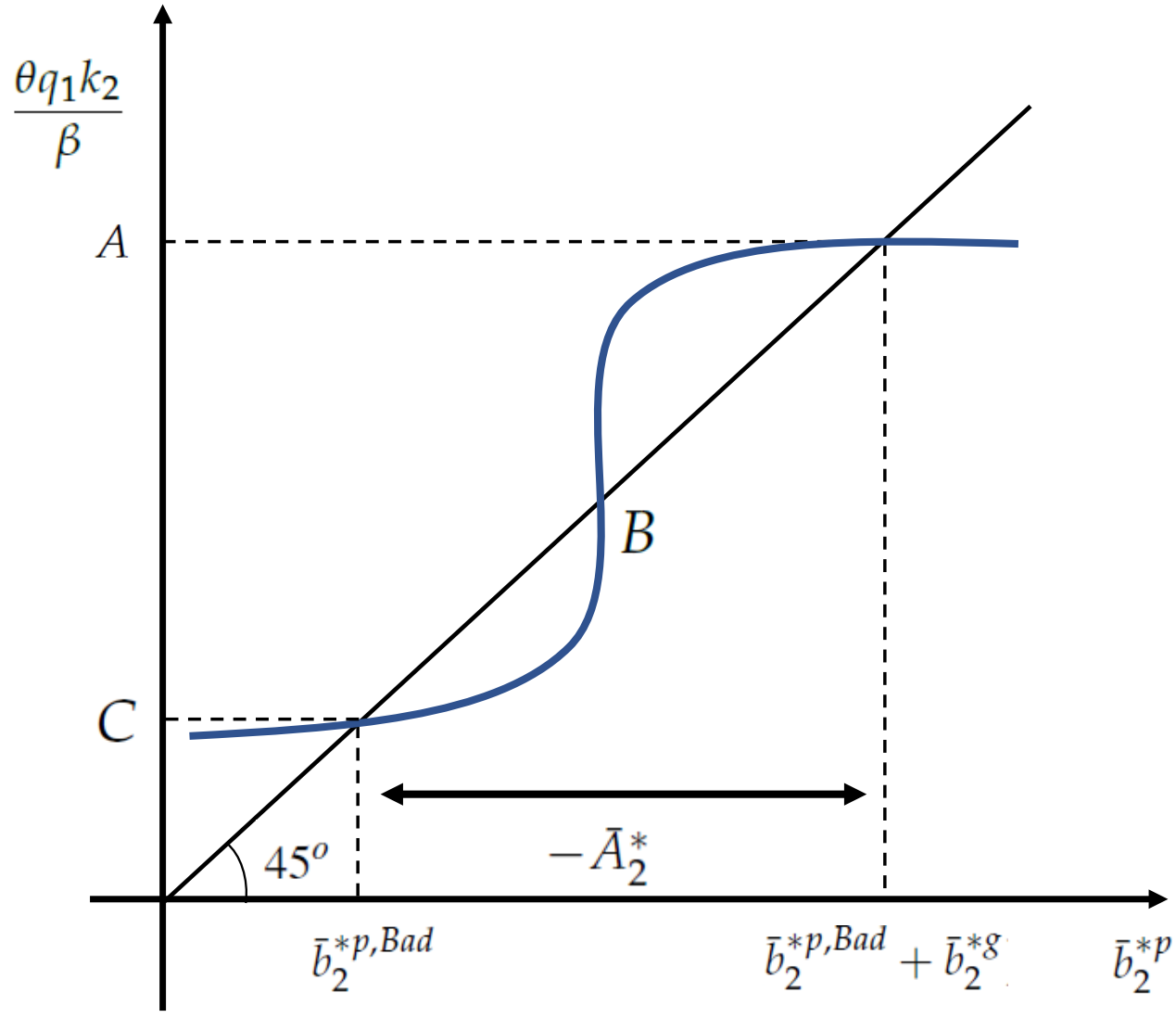
$$-\bar{A}_2^* = \hat{b}_2^{*g} + \Xi k_2^{\alpha \frac{1+\phi}{\alpha+\phi}}$$

Equilibria without interventions



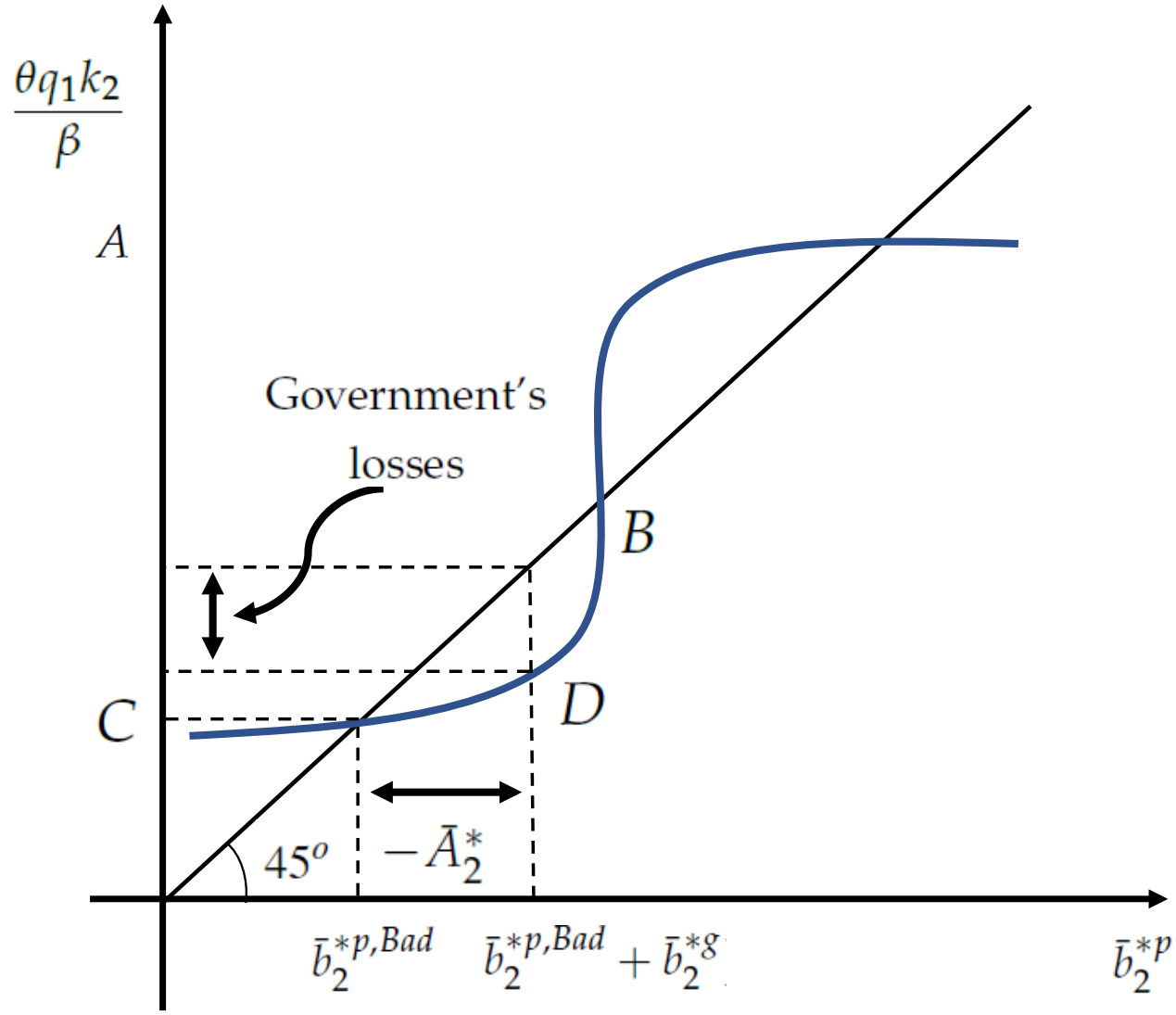
The higher $\bar{b}_2^{*p}$, the more banks invest, the higher $\theta q_1 k_2$

Government's best response



If $-\bar{A}_2^*$ large enough, implement good equilibrium

Government's best response



If $-\bar{A}_2^*$ small, trade-off between LOLR and distortionary taxation

When is LOLR unsuccessful?

Bad equilibria can survive

- Savers hold pessimistic beliefs
- They extend little credit to banks and government
- Government needs to finance interventions with distortionary taxes
- Optimal intervention small, leads to low investment

Government ability to borrow depends on endogenous fiscal capacity

$$-\bar{A}_2^* = \hat{b}_2^{*g} + \Xi k_2^{\alpha \frac{1+\phi}{\alpha+\phi}},$$

The role of reserves

Initial position $A_1 < 0$ and $A_1^* > 0$

- Government gets a transfer when exchange rate depreciates
- These are states in which required intervention are large and the fiscal capacity of government is low

If positions large enough, government eliminates bad equilibrium

Remarks:

- Required reserves increase with the leverage of the financial sector. Obstfeld et al. (2010); Ainzemann and Lee (2007)
- Reserve might never be used in equilibrium. Aizeman and Sun (2012); Jeanne and Sandri (2016)
- Reserves reduce exchange rate volatility

Ex-ante effects of reserves

Two effects at date 0

1. For given interest rates, bankers have incentives to issue more dollar debt $\Rightarrow$ More risk taking from banks
2. Households save more in pesos, UIP gaps reduce, bankers have less incentives to borrow in dollars $\Rightarrow$ Less risk taking from banks

If LOLR successful second effects dominates. The economy features

- Less dollarized financial sector
- More stable exchange rate

Conclusion

- What does it mean to have a stable currency?
- One item: having a financial sector funded in that currency
- Stable inflation is important, but not all
- Also needs financial stability, so agents more willing to save in local currency
- Future work: explore more interactions with other policy tools (monetary policy, regulation, currency interventions)