Financial Intermediation, Exchange Rates, and Unconventional Policy in an Open Economy

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Motivation

- In recent years, governments and central banks around the world have resorted to *unconventional* policies.
- Notably: new liquidity and credit facilities, manipulation of reserve requirements, intervention in foreign exchange market.
- This has happened even in countries committed to inflation targeting and not only during crises.
- For Latin America, see Chang (2007), Céspedes, Chang and Velasco (2012), forthcoming IADB Project.

Some Questions

- What are the positive and normative effects of unconventional policies in open economies?
- What is, in particular, the rationale behind exchange rate related policies such as forex intervention, provision of foreign exchange liquidity, reserves accummulation?
- Are unconventional policies effective and justifiable all the time or only during crises?

The Need for Financial Frictions

- Models that assume perfect financial markets imply that many unconventional policies are irrelevant or superfluous.
- Basically a consequence of Ricardian Equivalence (Barro 1974, Wallace 1981, Eggertsson and Woodford 2003,Cespedes, Chang and García Cicco 2011).
- In practice, policymakers often say that unconventional policies are needed "because of the breakdown of the usual transmission mechanism".

Objectives of this Paper

1. Develop a simple yet insightful open economy model in which financial intermediation can sometimes be subject to binding collateral constraints.
2. Obtain lessons for unconventional policies, including credit facilities and foreign exchange intervention.

Key Aspects of the Model

A minimum list of ingredients:

- Two goods, tradables and nontradables (so we can discuss the real exchange rate)
- Two periods (to have borrowing and lending and interest rates)
- Firms borrow from home banks which, in turn, can borrow from abroad (so we can talk about leverage and observed unconventional policies)

==> Interaction between the real exchange rate, interest rates, and financial intermediation.

- Banks finance domestic loans out of their own net worth or credit from the world market.
- Moral hazard ==> international collateral constraint: local bankers can borrow up to a multiple of their net worth (expressed in tradables)
- A real exchange rate depreciation has ambiguous effects on loan supply: it can reduce the net worth of the banks but it increases the *leverage ratio.*
- The leverage ratio effect is novel but intuitive: a depreciation increases loan rates and hence the banks' *pledgeable income.*

Main Results: Equilibria

- The collateral constraint may or may not bind in equilibrium.
- If it does not, the lending interest rate equals the world rate and the outcome is efficient
- If it does, the domestic lending rate is higher than the world interest rate and the real exchange rate is more depreciated than in the absence of financial frictions, resulting in an inefficiently low level of financial intermediation, investment, and welfare.

Main Results: Unconventional Policy

- A redistribution of initial wealth from firms or households to banks (e.g. a bank recapitalization program financed with taxes) is effective if and only if the collateral constraint binds
- This is (more surprisingly) the case even if the policy only redistributes *nontradables.*
- Key to intuition: leverage.

Main Results: Credit Policies

- If the government can borrow some amount of tradables at the world interest rate, how should those resources be used?
- Lending the borrowed tradables to domestic agents affects real outcomes only if financial constraints bind.
- In that case, government credit is more effective if directed towards banks instead of firms.
- The reason, once more, is leverage

Main Results: Sterilized Forex Intervention

- In a sterilized foreign exchange operation the government uses its available tradables (which we can think of as foreign reserves) to purchase nontradables.
- To "sterilize" the operation, the government lends the nontradables just raised back to private agents or uses them to retire existing government debt
- We show that this is equivalent to the government directly lending tradables.
- Hence the effects of sterilized interventions are explained not by the impact of the intervention on asset prices but, rather, by the impact of the sterilizing operation on financial constraints.
- This perspective starkly contrasts with dominant views (portfolio balance and signaling).

Main Results: Equilibrium Multiplicity

- Two equilibria, one efficient and one financially constrained, can coexist if the elasticity of the lending rate with respect to the exchange rate is sufficiently low.
- Hence, self fulfilling crises can occur.
- A commitment to defend the exchange rate can prevent such crises.
- Potential justification for recent episodes of reserves accumulation.

The Model

- Small open economy, two periods, two goods (tradable/foreign, nontradable/home)
- The real exchange rate is the relative price of tradables in terms of nontradables
- Households own firms and banks

Households

The household consumes only traded goods and in the second period only.

Profits are the only source of household income:

$$C = \Pi^b + \Pi^f$$

No fundamental uncertainty ==> firms and banks maximize second period profits.

Capital Production

In the first period, capital is obtained by aggregating tradables and nontradables:

$$K = \kappa I_H^{\gamma} I_F^{1-\gamma}$$

where $\kappa = 1/\gamma^{\gamma}(1-\gamma)^{1-\gamma}$.

The price of capital in terms of home goods is hence

$$Q = S^{1-\gamma}$$

where S is the price of tradables in terms of nontradables, i.e. the *real exchange rate*.

Also, the derived demand for nontradables is

$$I_H = \gamma Q K = \gamma S^{1-\gamma} K$$

Firms

Firms produce tradables in the second period with capital purchased in the first period, via a production function $Y = AK^{\alpha}$

==> They maximize (second period) profits

$$Max\ \Pi^f = Y - RL = AK^{\alpha} - RL$$

subject to their (first period) budget constraint (expressed in tradables):

$$\frac{QK}{S} = L + T_f + \frac{N_f}{S}$$

Here, L is the amount borrowed, T_f and N_f are the firm's initial endowments, and R is the loan interest rate (in tradables).

The firm's demand for capital is then given by

$$\begin{aligned} \alpha A K^{\alpha-1} &= RQ/S \\ &= RS^{-\gamma} \end{aligned}$$

since $Q = S^{1-\gamma}$

That is, the demand for capital falls with the price of capital ($S^{-\gamma}$, in tradables) and the financial cost. Together with $I_H = \gamma QK = \gamma S^{1-\gamma} K$, this will imply a crucial link between R and S.

Banks

Firms borrow from domestic banks, which in turn borrow from the world capital market subject to a collateral constraint.

Banks maximize final profits:

$$\Pi^b = RL - R^* D$$

subject to a first period budget constraint

$$L = D + T_b + \frac{N_b}{S}$$

and a *collateral constraint*

$$RL - R^* D \geq \theta RL$$

Here, R^* is the world interest rate, L the amount of bank loans, D the amount borrowed abroad, T_b and N_b the bank's initial endowments.

- That firms cannot borrow directly from the world market can be rationalized as an extreme version of Holmstrom and Tirole (1997) and others.
- The collateral constraint

$$RL - R^* D \geq \theta RL$$

can be justified in several ways. For example, assuming that, in second period, bankers can renege on the foreign debt and abscond with a fraction θ of the payments made to the bank by firms. Then the collateral constraint is necessary to prevent absconding.

- $(1-\theta)RL$ is the bank's *pledgeable income* (Holmstrom-Tirole). Note that it increases with the loan rate R.

Banks' Loan Supply

- If the collateral constraint does not bind, R must equal R^*, the amount of loans is determined by demand, and

$$L^s \leq \frac{1}{\theta}\left[T_b + \frac{N_b}{S}\right]$$

- If it collateral constraint binds,

$$L^s = \frac{R^*}{R^* - (1-\theta)R}\left[T_b + \frac{N_b}{S}\right] = \frac{1}{1-\phi(1-\theta)}\left[T_b + \frac{N_b}{S}\right]$$

  where $\phi = R/R^*$ is the interest rate *spread.*
- This says: Loan supply = leverage ratio times net worth (Interpretation: $R^* - (1-\theta)R$ is a measure of the bank's "down payment" for the credit it obtains)
- The real exchange rate S can affect L^s through net worth but also through the leverage ratio (because it affects R in equilibrium).

Characterizing Equilibrium

1. Equilibrium in nontradables market:

$$N = N_f + N_b = I_H = \gamma S^{1-\gamma} K$$

2. Combine with the firm's demand for capital, $\alpha A K^{\alpha-1} = R S^{-\gamma}$,

$$R = S^{\gamma+(1-\alpha)(1-\gamma)} \alpha A \left(\frac{\gamma}{N}\right)^{1-\alpha}$$

==> Key link between S and R

3. Defining S_0 by

$$R^* = S_0^{\gamma+(1-\alpha)(1-\gamma)} \alpha A \left(\frac{\gamma}{N}\right)^{1-\alpha}$$

we get a simpler expression in terms of the spread:

$$\phi = \frac{R}{R^*} = \left(\frac{S}{S_0}\right)^{\gamma+(1-\alpha)(1-\gamma)}$$

Equilibrium Loan Supply

The equilibrium relation between loan supply and the real exchange rate is obtained, then, from the bank's loan supply schedule:

$$\begin{aligned} L^s &\in [0, \frac{1}{\theta}(T_b + \frac{N_b}{S_0})] \text{ if } S = S_0 \\ &= \frac{1}{1-\phi(1-\theta)}\left[T_b + \frac{N_b}{S}\right] \text{ if } S > S_0 \end{aligned}$$

and the link between the exchange rate and the loan rate

$$\phi = \frac{R}{R^*} = \left(\frac{S}{S_0}\right)^{\gamma+(1-\alpha)(1-\gamma)}$$

- In the constrained region, L^s can increase or decrease with S, reflecting a net worth effect versus a leverage ratio effect. In fact,

$$\frac{S}{L^s}\frac{\partial L^s}{\partial S} = -\left[\frac{N_b/S}{T_b + N_b/S}\right] + \frac{\phi(1-\theta)}{1-\phi(1-\theta)}\left[\gamma + (1-\alpha)(1-\gamma)\right]$$

- For now, assume the leverage ratio effect dominates, as in Figure 1.

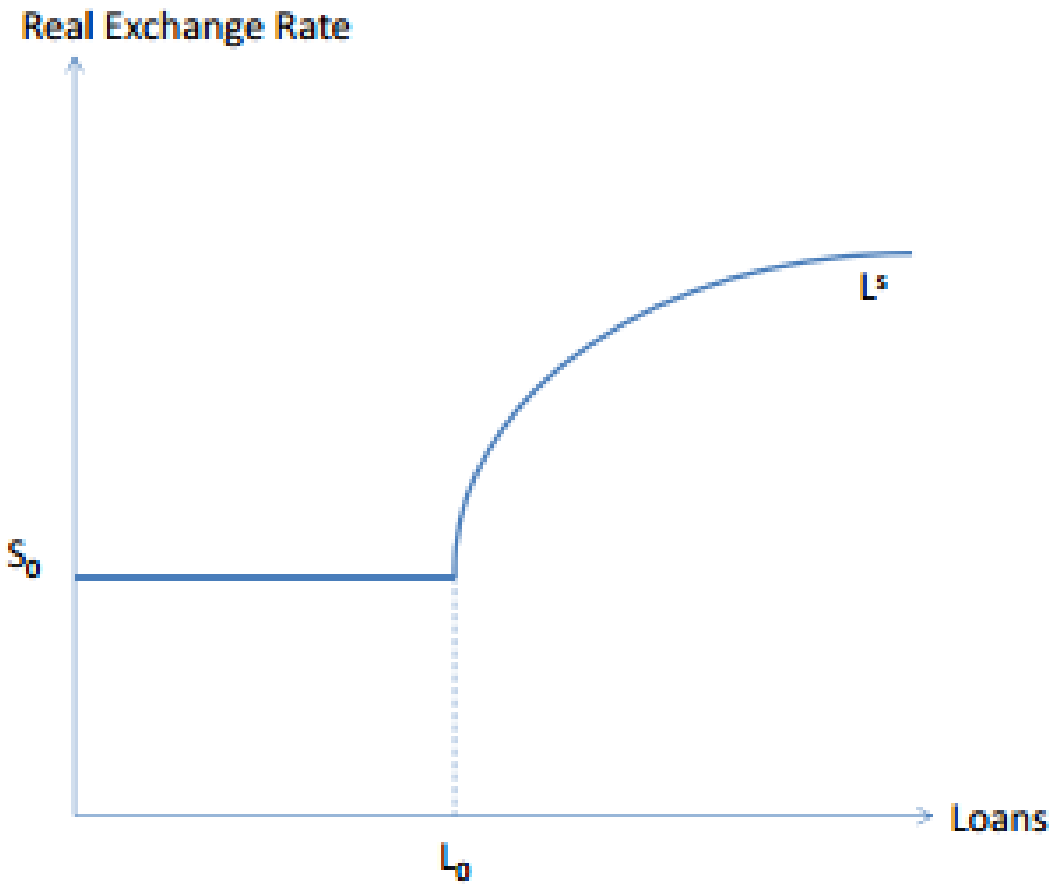

Figure 1

Loan Demand

From the firm's budget constraint,

$$
\begin{aligned}
L^d &= \frac{QK}{S} - (T_f + \frac{N_f}{S}) \\
&= S^{-\gamma}\frac{N}{\gamma S^{1-\gamma}} - (T_f + \frac{N_f}{S}), \text{ that is,} \\
L^d &= \frac{N}{\gamma S} - (T_f + \frac{N_f}{S})
\end{aligned}
$$

We assume that L^d decreases with the real exchange rate.

Equilibria

In Figure 2, the equilibrium exchange rate is $S^e = S_0$, and the economy is financially unconstrained. In this case, of course, $R = R^*$ and $\phi = 1$.

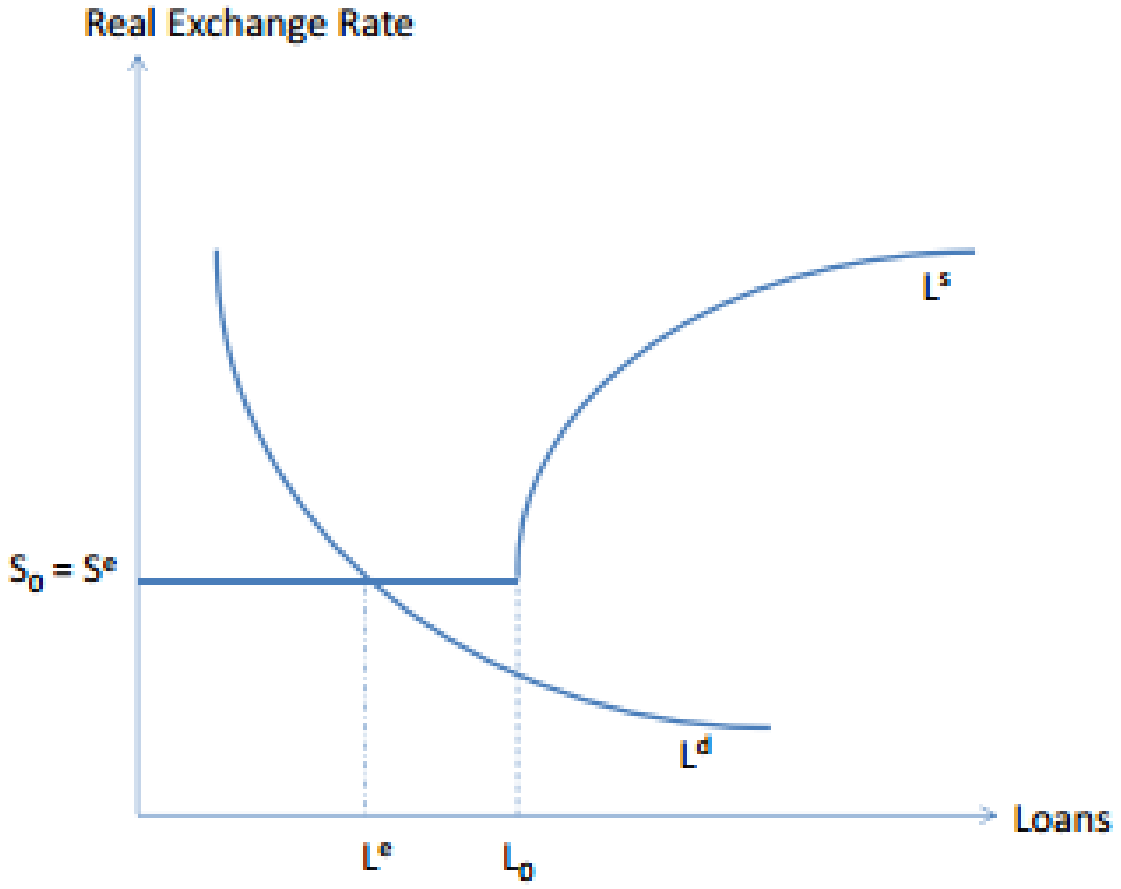

Figure 2

In Figure 3, the demand curve cuts the supply schedule at a loan amount L^e that exceeds L_0. The equilibrium real exchange rate is then given by $S^e > S_0$. The interest spread ϕ must be greater than one; equivalently, $R > R^*$. The collateral constraint binds.

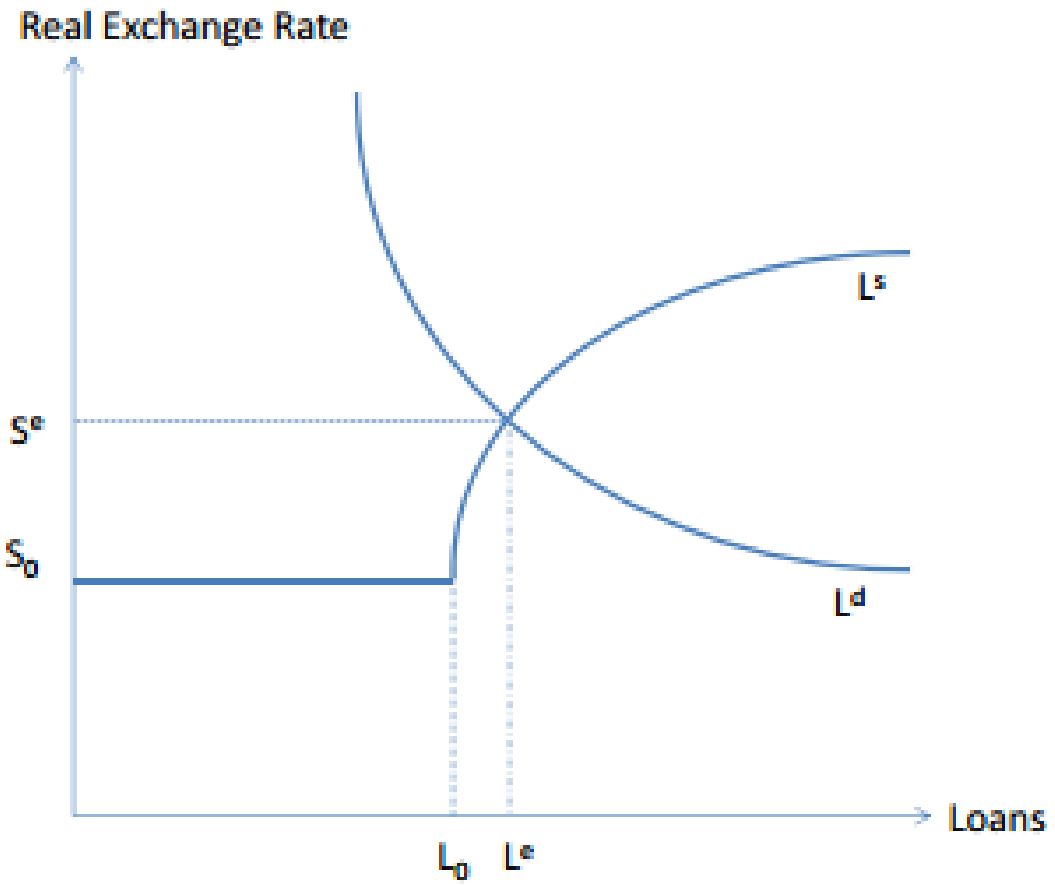

Figure 3

The comparative statics of this model are now easy to trace. Consider a fall in θ, representing less stringent collateral requirements. This moves the point L_0 to the right and (via leverage ratio) increases the slope of the loan supply curve if $S > S^0$. The result is depicted in Figure 4.

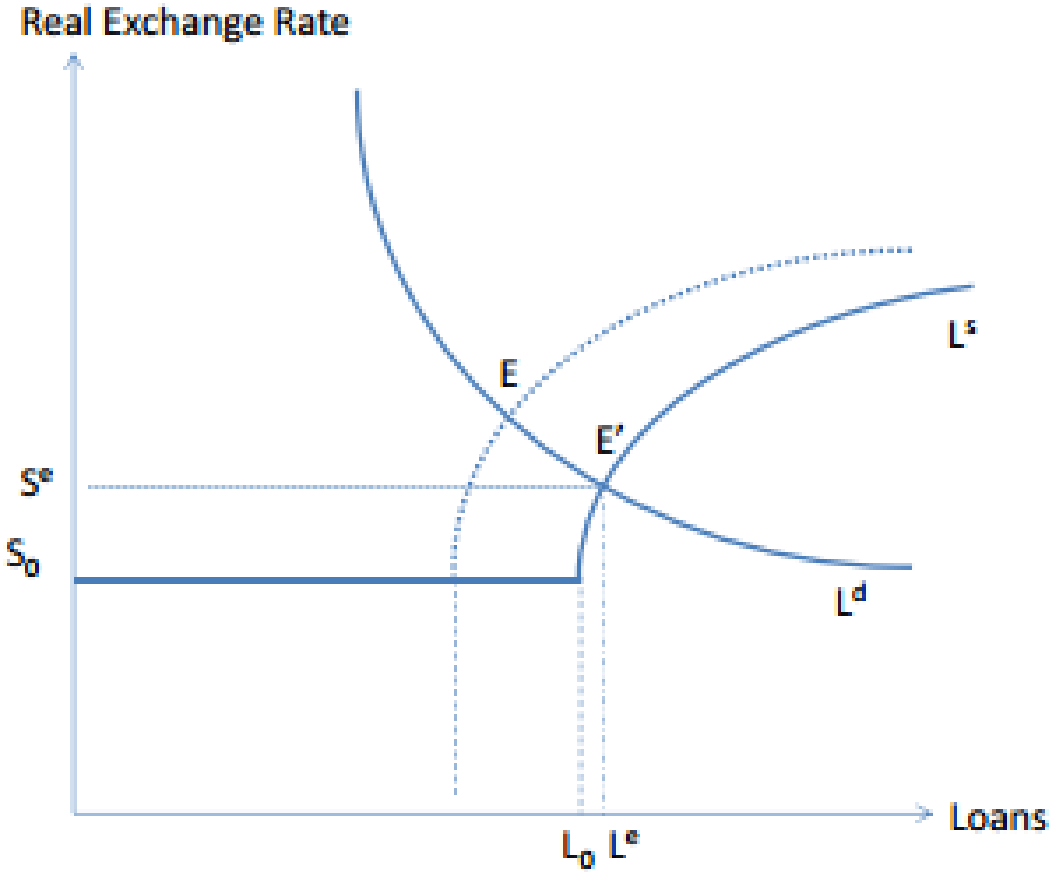

Figure 4

Policy: Redistribution and Net Worth

- Suppose that the government taxes away some of the firms' *nontradables* endowment and gives the proceeds to the banks.
- This can be regarded as a bank recapitalization policy financed with a corporate tax.
- In our notation, this entails a reduction in N_f matched by an increase in N_b, keeping N fixed.

- As in Figure 5, both loan demand and supply move horizontally to the right, but the supply schedule moves farther.

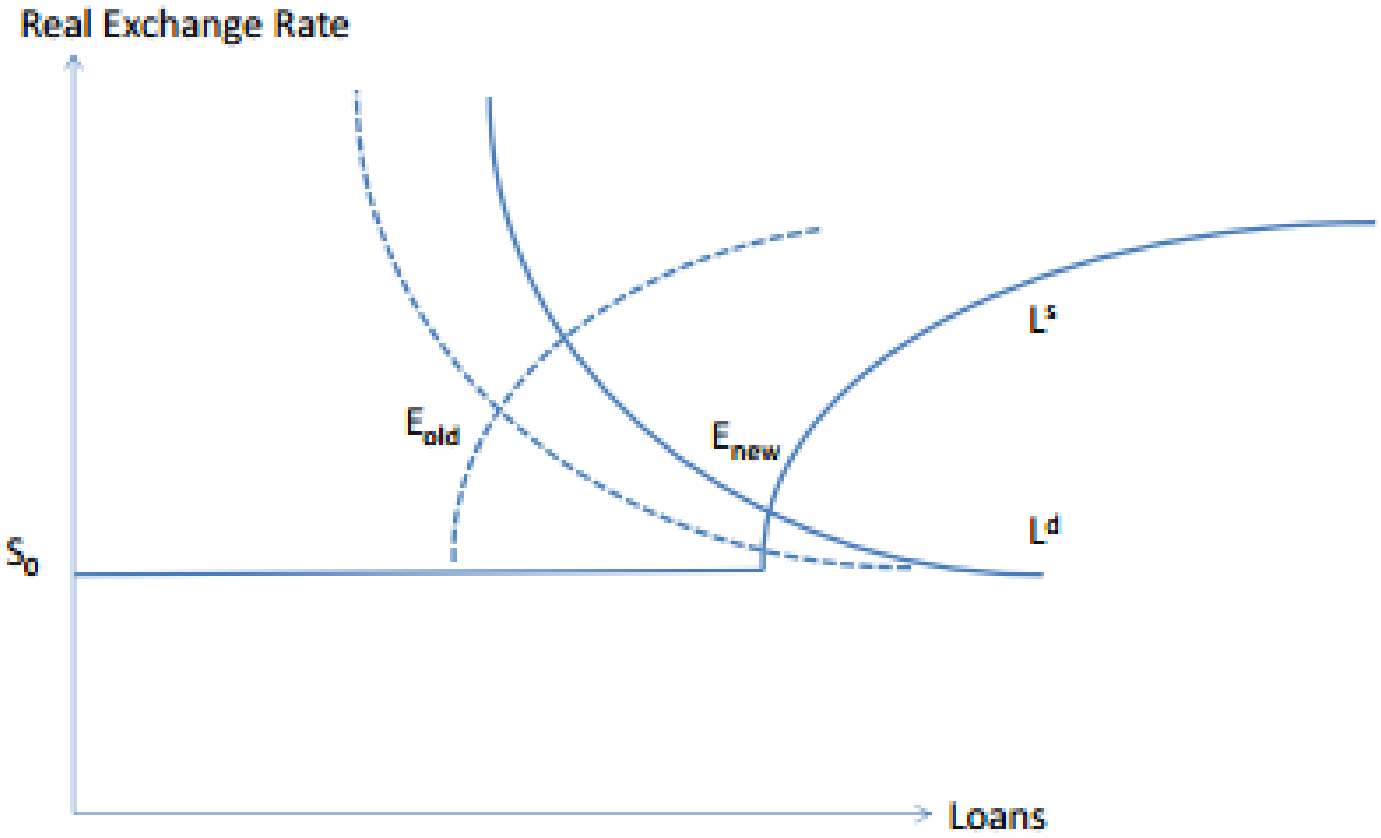

Figure 5

- The horizontal displacement of the supply schedule is equal to the displacement of the demand curve *multiplied by the leverage ratio*, which is greater than one.
- Intuition: at any S, moving a unit of nontradables from firms to banks increases the demand for loans by $1/S$ but the supply by $1/S$ times the leverage ratio.
- Financial intermediation increases, exchange rate strengthens, the spread ϕ and the lending interest rate R fall. Domestic consumption and welfare improve.
- It may be surprising that redistributing *nontraded* endowments can be useful even though the *international* collateral constraint involves only *traded* goods.
- The policy is irrelevant if financial constraints do not bind.

Policy: Credit Programs

- Assume that the government can borrow a given amount F of tradables in the world market at the interest rate R^*. How can this amount be best used?
- First, note that the credit line F is irrelevant if financial constraints do not bind.
- If they do, the outcome depends on whether the credit is given to firms or to banks.

- Suppose that the government borrows F in the first period and lends that amount to firms at the market interest rate R.
- In the second period, the government collects RF in debt repayments, cancels its foreign debt, and transfers any difference $(R - R^*)F$ to the household.
- The only change in computing outcomes is that the equilibrium in the market for loans is given not by $L^d = L^s$ but by $L^d = L^s + F$.
- If the constraint was initially binding, the policy results in increased *total* intermediation, a stronger real exchange rate, and a lower interest spread (Figure 6).
- Some crowding out: Private intermediation must fall, since the exchange rate appreciates and R and ϕ fall.

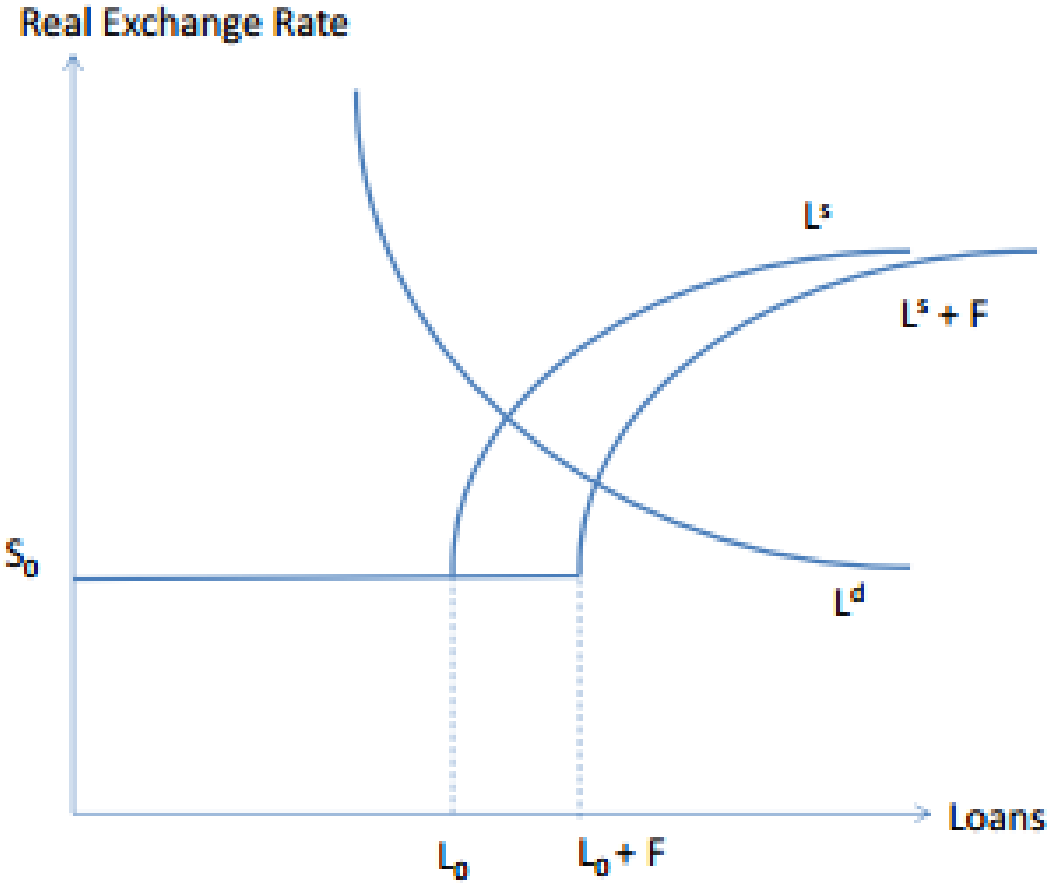

Figure 6

In fact, government credit to firms can overcome financial frictions completely if F is at least as large as

$$F^{DL} = \frac{N}{\gamma S_0} - \left(T_f + \frac{N_f}{S_0}\right) - \frac{1}{\theta}(T_b + \frac{N_b}{S_0})$$

Policy: Credit to Banks

- Alternatively, suppose lends F to the banks at the world interest rate R^*.
- Crucially, we assume that the government can enforce repayment of its loan perfectly.
- Loan supply now becomes

$$L \leq \frac{1}{1-\phi(1-\theta)}[(T_b + \frac{N_b}{S}) + F]$$

==> The bank's loan supply increases by F times the leverage ratio.

- As shown in Figure 7, the horizontal displacement of the bank's loan supply curve is greater than F.
- Financial intermediation is greater and the exchange rate stronger than when the government lends F directly to the firms.
- The minimum F that brings spreads to one is

$$F^{LB} = \theta F^{DL} < F^{DL}$$

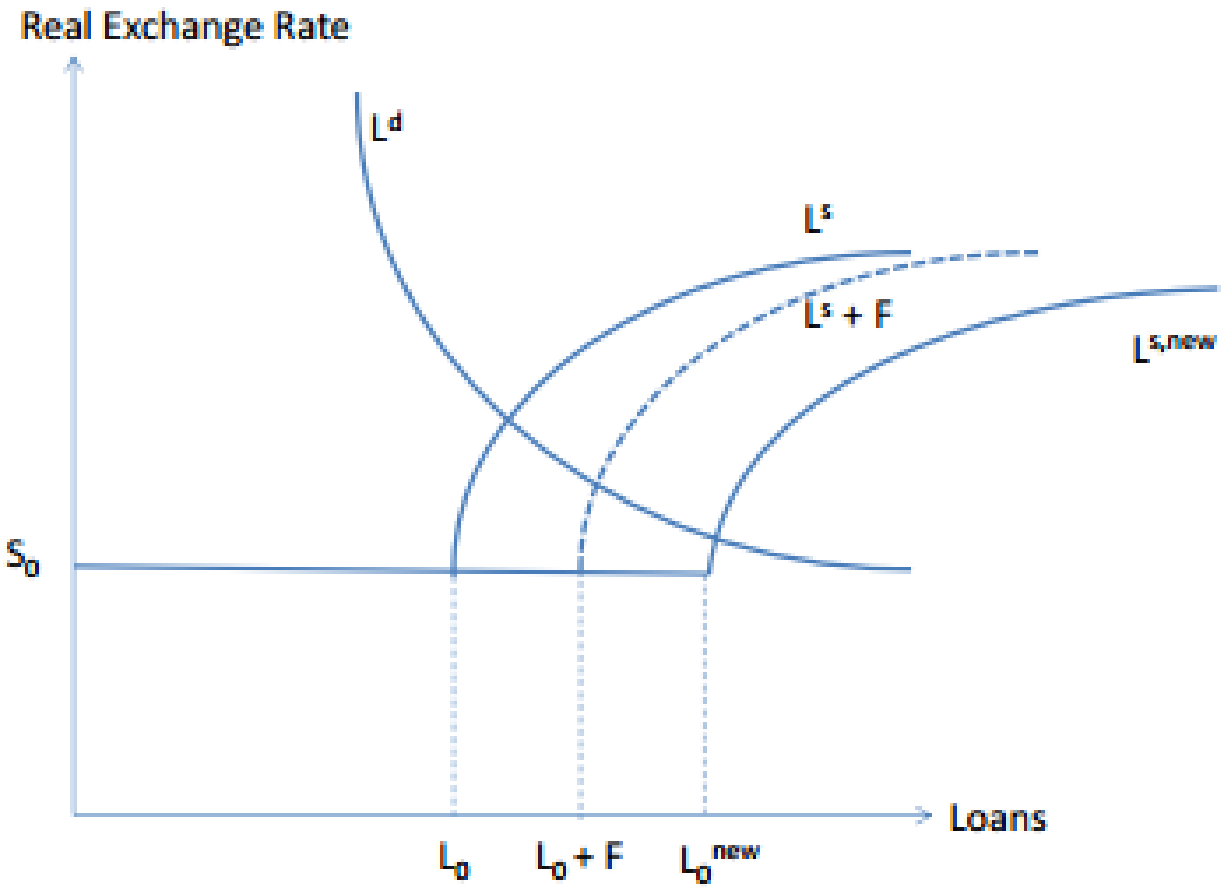

Figure 7

Sterilized Exchange Market Intervention

- Here, in an intervention operation the government uses F to buy nontradables in the market, and *sterilizes* this purchase by lending the nontradables thus obtained to the private sector.
- Suppose that the sterilizing credit goes to firms, and that the government charges firms R/S units of tradables in period 2 for each unit of nontradables lent to them.
- The outcome is then exactly *the same* as if the government had lent the F tradables directly to the firms, charging them an interest rate R.

- We have assumed that the government lends nontradables in the first period but collects tradables in the second period. This is "ugly" but easily fixed.
- Specifically, following Holmstrom and Tirole (2011), assume that households consume nontradables as well as tradables in the last period, and that the two are perfect substitutes. Also, assume that households have a sufficiently large endowment of nontradables in the second period so that, in any equilibrium, the second period real exchange rate is one.
- Then one can suppose that firms are asked to repay R/S units of nontradables in the last period per unit of nontradables borrowed in the first period. The analysis is exactly the same as before.

Similarly: if the government sterilizes forex intervention by increasing credit to the banks rather than to firms, charging the banks R^*/S interest per unit of nontradables lent, the outcome is the same as if the F tradables had been lent directly to the banks.

Finally, one can assume that the typical bank has an initial amount of *government securities*, and that the sterilizing operation is to use the nontradables (raised by selling F) to retire those securities. Then (under additional but natural assumptions) the outcome is exactly *the same* as with a sterilizing credit to banks.

Recap of Policy Analysis

- Sterilized foreign exchange intervention can affect real outcomes, alleviate financial frictions, and improve welfare
- The kind of intervention just discussed is equivalent to direct lending
- It is more powerful to give the sterilizing credit to the banks because of leverage
- Neither portfolio balance effects nor signaling effects are present in this model

Multiple Equilibria and Implications

In our basic formulation, the leverage effect of a real exchange rate depreciation dominates the net worth effect.
For this to be the case, the elasticity of the spread with respect to S must be large enough.
For more general formulations, the elasticity may be low, and the loan supply curve can change shape.

- In the paper, we extend the analysis to a more general C.E.S. function for capital production:

$$K = \left[\gamma^{1/\lambda} I_H^{1-1/\lambda} + (1-\gamma)^{1/\lambda} I_F^{1-1/\lambda}\right]^{\lambda/(\lambda-1)}$$

- We can then obtain multiple equilibria, as in Figure 9 (for small λ)

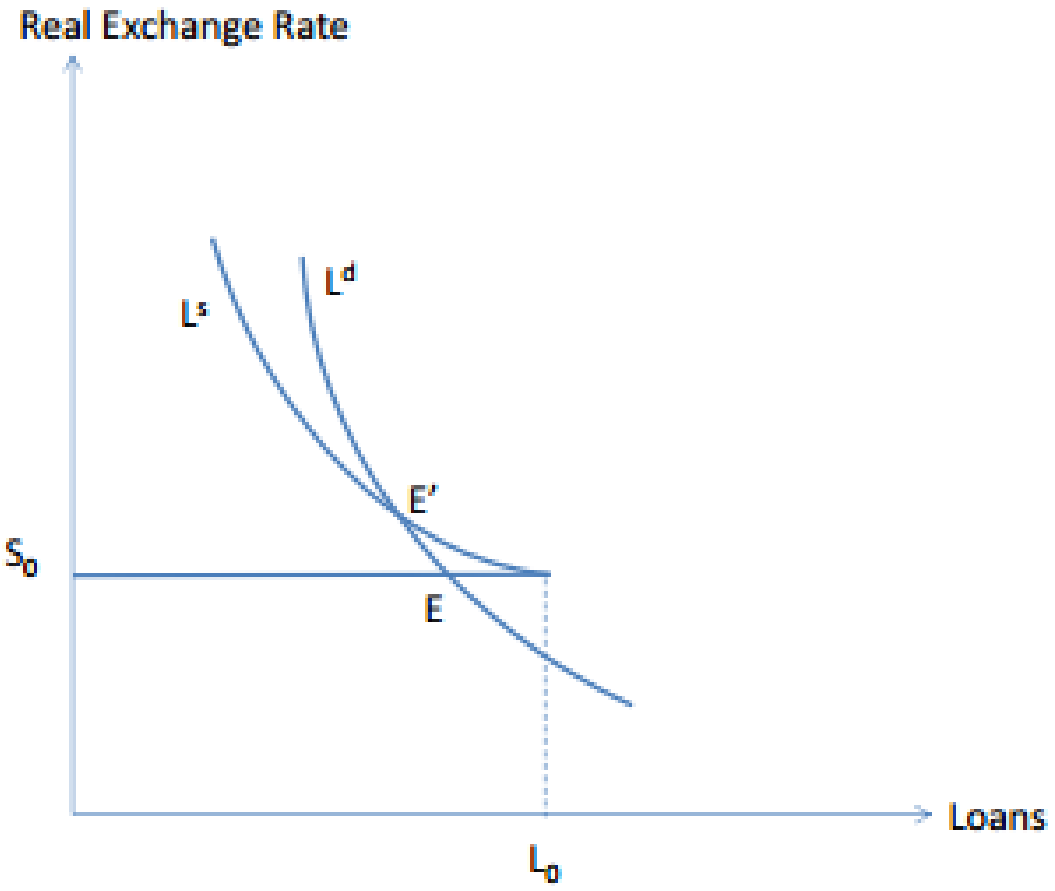

Figure 9

- In Figure 9, there is a "good " equilibrium and a "bad " equilibrium
- Self fulfilling "crises " are possible
- In such a crisis, the exchange rate depreciates, spreads increase, financial intermediation collapses, and investment and welfare fall
- The leverage ratio falls in a crisis, but this is an *endogenous* outcome

- If multiple equilibria are possible, a government commitment to "do all it takes " to prevent the real exchange rate from depreciating excessively can kill the bad equilibrium.
- But to make the claim believable, the government may find it necessary to have access to a large enough "war chest" of tradables (the F of the previous section) that it can use to intervene.
- As in other models with multiple equilibria, however, the government would not have to intervene and spend the war chest.

Final Remarks

1. The simplicity of the model is very useful to isolate the mechanisms at work. But one would want to extend the model in obvious directions (money, uncertainty, dynamics).
2. We have argued that unconventional policies can be effective if financial constraints matter. In this sense, the observed use of such policies during crises is vindicated by the model. On the other hand, the unconventional policies studied here are unnecessary in tranquil times.
3. The model offers many suggestions for empirical work (for example, on the links between exchange rate, spreads, and leverage).