Optimal Bank Reserve Remuneration and Capital Control Policy

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Starting Point

A large literature argues that financial frictions in the form of collateral constraints cause emerging economies to overborrow.

Observations

• Existing open-economy models of international overborrowing assume that domestic agents borrow directly from foreign lenders.

• In reality, private agents seldom borrow directly from foreign lenders. Instead, capital inflows are intermediated by banks operating in domestic markets.

Questions

How does abstracting from bank intermediation affect the overborrowing prediction of this class of models?

What does the optimal macroprudential policy look like in an open economy model with collateral constraints and bank intermediation?

How Collateral Constraints Work in these Models

• collateral constraints create a pecuniary externality because the price of the objects pledged as collateral is not internalized by individual agents.

• as a result, the economy borrows too much (**overborrowing**) when it is close to a binding constraint and runs into a binding constraint too often.

• the optimal macroprudential policy is a capital control tax that discourages borrowing, especially when the economy is close to a binding collateral constraint.

This Paper studies an open economy with:

(1) a collateral constraint: household debt is limited by a fraction of income (Mendoza, 2002; Bianchi, 2011; Korinek, 2011; Benigno et al., 2013; Schmitt-Grohé and Uribe, 2021).

(2) bank intermediation: banks receive deposits from foreign investors and lend them to domestic households.
— bank intermediation is costly.
— banks can mitigate the cost of originating loans by holding reserves at the central bank.
(Cúrdia and Woodford, 2011; Eggertsson et al., 2019).

(3) A benevolent government sets the interest rate on bank reserves and levies capital controls.

Main Results

• under plausible calibrations, the economy **underborrows**: the economy without government intervention has too little external debt relative to the economy in which the government sets optimally the interest rate on bank reserves and capital controls.

• under the optimal policy regime, bank reserve policy is countercyclical: interest on reserves and reserves increase during contractions and decline during booms.

• absent policy intervention, by contrast, bank reserves are procyclical.

Intuition for the Underborrowing Result

• look at the balance sheet of the bank:

$$\textbf{domestic loans} + \textbf{bank reserves} = \textbf{foreign deposits}$$

• bank reserves act as a buffer between loans and foreign deposits.

• when the economy suffers a negative shock that causes a sharp contraction in loans due to households being collateral constrained (household delevaraging), the government expands bank reserves to avoid a collapse in external borrowing (economy wide deleveraging).

• the government's increased holdings of bank reserves make their way into the household's budget constraint via a more relaxed fiscal policy (lender of last resort to households).

• this mechanism is absent in models in which households borrow directly from foreign lenders.

The model

- Banks
- Households
- Foreign lenders
- The government

Banks

The bank's sequential budget constraint

$$l_t + r_t + (1+i^d_{t-1})d_{t-1} + \pi_t + \underset{+}{\Gamma}(l_t, \underset{-}{r_t}) = (1+i^l_{t-1})l_{t-1} + (1+i^r_{t-1})r_{t-1} + d_t$$

Notation:

d_t, l_t, r_t = deposits, loans, and bank reserves

i^d_t, i^l_t, i^r_t = interest rates on deposits, loans, and reserves

π_t = bank dividends

$\Gamma(l_t, r_t)$ = convex bank operating costs

Dividend Policy

$$\pi_t = (1 + i^l_{t-1})l_{t-1} + (1 + i^r_{t-1})r_{t-1} - (1 + i^d_{t-1})d_{t-1}$$

Bank's Problem

Pick $l_t \geq 0$ and $r_t \geq 0$ to maximize

$$\pi_{t+1} = (i_t^l - i_t^d)l_t + (i_t^r - i_t^d)r_t - (1 + i_t^d)\Gamma(l_t, r_t),$$

taking as given i_t^d, i_t^r, i_t^l.

Bank's Optimality Conditions

$$\frac{i_t^l - i_t^d}{1 + i_t^d} = \Gamma_l(l_t, r_t)$$

$$\frac{i_t^r - i_t^d}{1 + i_t^d} = \Gamma_r(l_t, r_t)$$

$$l_t + r_t + \Gamma(l_t, r_t) = d_t$$

The first two conditions equate the bank's marginal revenue of extending loans and holding reserves to their respective marginal costs. The third condition is the bank's balance sheet.

Households

$$\max E_0 \sum_{t=0}^{\infty} \beta^t u(c_t),$$

subject to the aggregation technology

$$c_t = A(c_t^T, c_t^N),$$

to the sequential budget constraint,

$$c_t^T + p_t c_t^N + (1 + i_{t-1}^l) l_{t-1} = (1 - \tau_t)[y_t^T + p_t y_t^N + \pi_t] + l_t,$$

and to the collateral constraint

$$l_t \leq \kappa(y_t^T + p_t y_t^N).$$

Pecuniary Externality: p_t on the RHS of the collateral constraint is taken as given by households, but is endogenously determined in equilibrium.

Notation:
c_t, c_t^T, c_t^N = consumption, consumption of tradables/nontradables;
p_t = relative price of nontradables in terms of tradables;
y_t^T, y_t^N = exogenous endowments of tradables/nontradables;
τ_t = income tax (subsidy) rate.

Foreign Lenders

Banks take deposits from foreign lenders at the world interest rate i^* and pay capital control taxes at the rate τ_t^c.

Thus, the effective rate banks pay on deposits is

$$1 + i_t^d = (1 + \tau_t^c)(1 + i^*)$$

The Government

— levies income taxes at the rate τ_t
— levies capital control taxes at the rate τ_t^c
— remunerates bank reserves at the interest rate i_t^r
— incurs a cost $\Gamma^r(r_t)$ of running the bank reserve facility

Its budget constraint is

$$\tau_t(y_t^T + p_t y_t^N + \pi_t) + \tau_{t-1}^c(1+i^*)d_{t-1} + r_t = (1+i_{t-1}^r)r_{t-1} + \Gamma^r(r_t),$$

with $\Gamma^r(\cdot)$ increasing and convex.

Quantitative Analysis

Calibration of Financial Frictions

Collateral constraint: $l_t \leq \kappa(y_t^T + p_t y_t^N)$
Bank cost function: $\Gamma(l_t, r_t) = A l_t^{1+\alpha}[1 + \phi(r_t - \bar{r})^2 I(r_t < \bar{r})]$
Central bank cost function: $\Gamma^r(r_t) = B r_t^{1+\alpha}$

The 6 parameters defining these financial frictions, κ, A, α, ϕ, $\bar{r}$, and B, are set by SMM to match 6 empirical first moments in emerging countries under laissez faire:

(1) The lending spread, $(i^l - i^d)/(1 + i^d) = 0.0499$
(2) The reserve-to-deposit ratio, $r/d = 0.0644$
(3) Debt to GDP ratio, $d/(y^T + py^N) = 0.29$
(4) The bank operating cost as a fraction of the volume of deposits, $\Gamma(l, r)/d = 0.0175$
(5) The central bank's operating cost as a fraction of reserves, $\Gamma^r(r)/r = 0.0205$.
(6) The frequency of a binding collateral constraint, 0.05

This results in $\kappa = 0.3205$, $A = 0.0089$, $\alpha = 1.8104$, $\phi = 6.7983$, $\bar{r} = 0.5848$, $B = 2.6852$.

Optimal Policy versus Laissez Faire

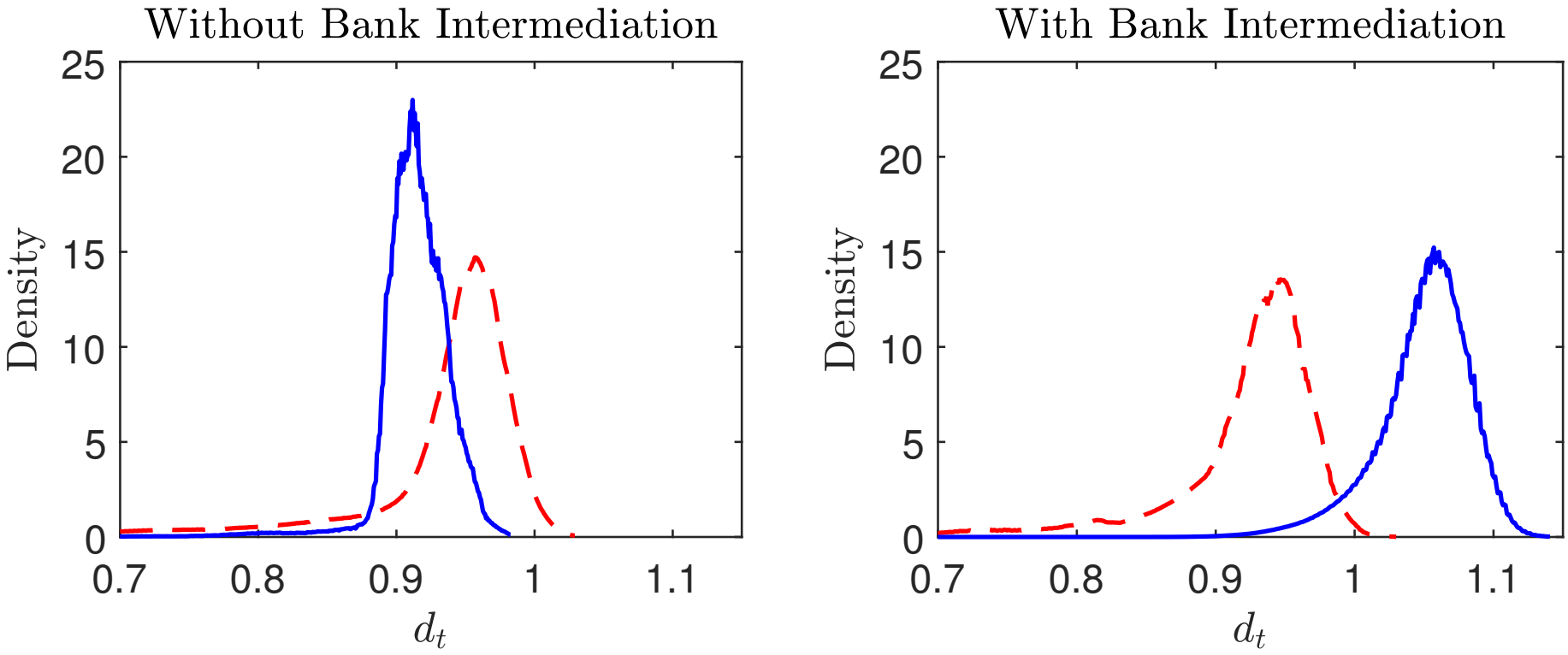
We will compare two equilibria:

– the **constrained optimal allocation:** the best competitive equilibrium attainable with interest on reserves and capital control policy (i_t^r, τ_t^c)

– the **unregulated economy:** the competitive equilibrium with $i_t^r = 0$ and $\tau_t^c = 0$

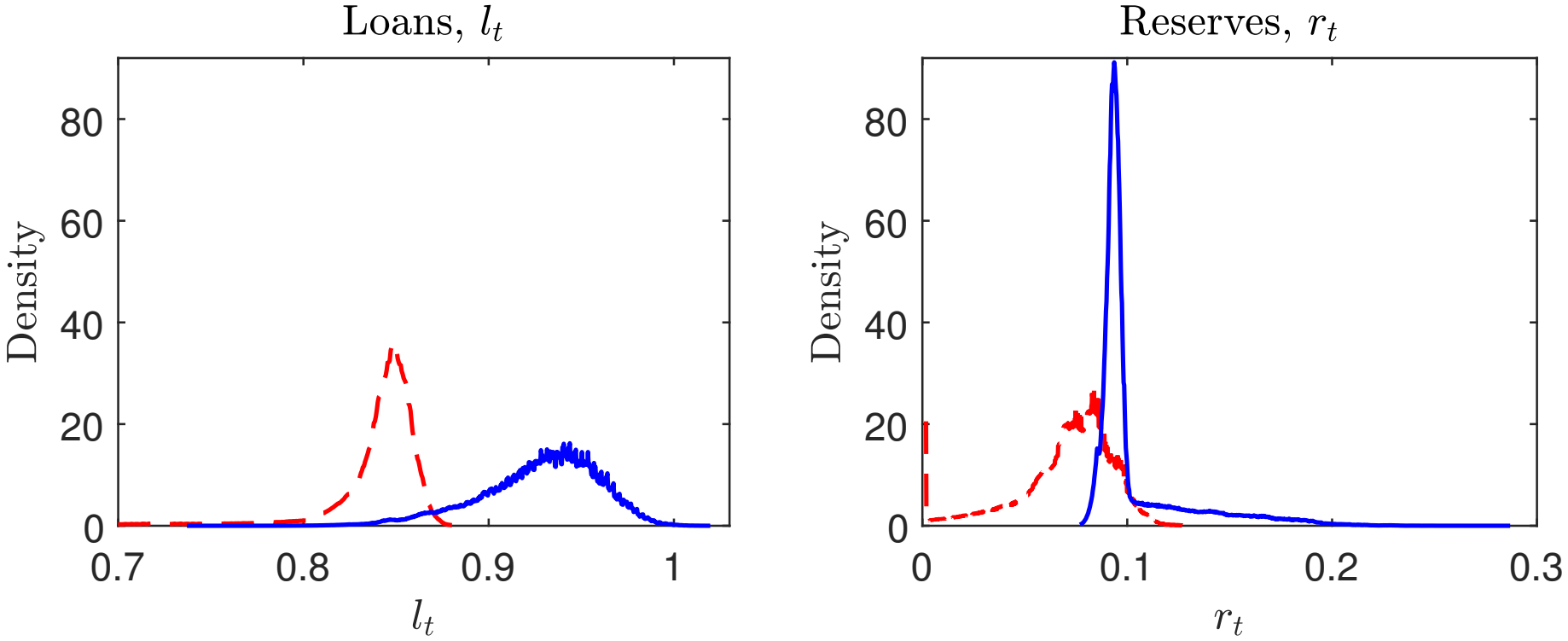
Underborrowing

Unconditional Distributions of Debt With and Without a Bank Intermediation Channel



Solid lines: constrained optimal allocation
Broken lines: unregulated economy
The figure shows that in the absence of the banking channel there is **overborrowing**, whereas in its presence there is **underborrowing**.

Unconditional Distributions of Loans and Reserves



Solid lines: constrained optimal allocation (i_t^r and τ_t^c set optimally).
Broken lines: unregulated economy ($i_t^r = \tau_t^c = 0$).
The figure shows that housholds borrow more under the optimal macroprudential policy. Of particular interest is the fat right tail of bank reserves under the optimal policy, reflecting their insurance role.

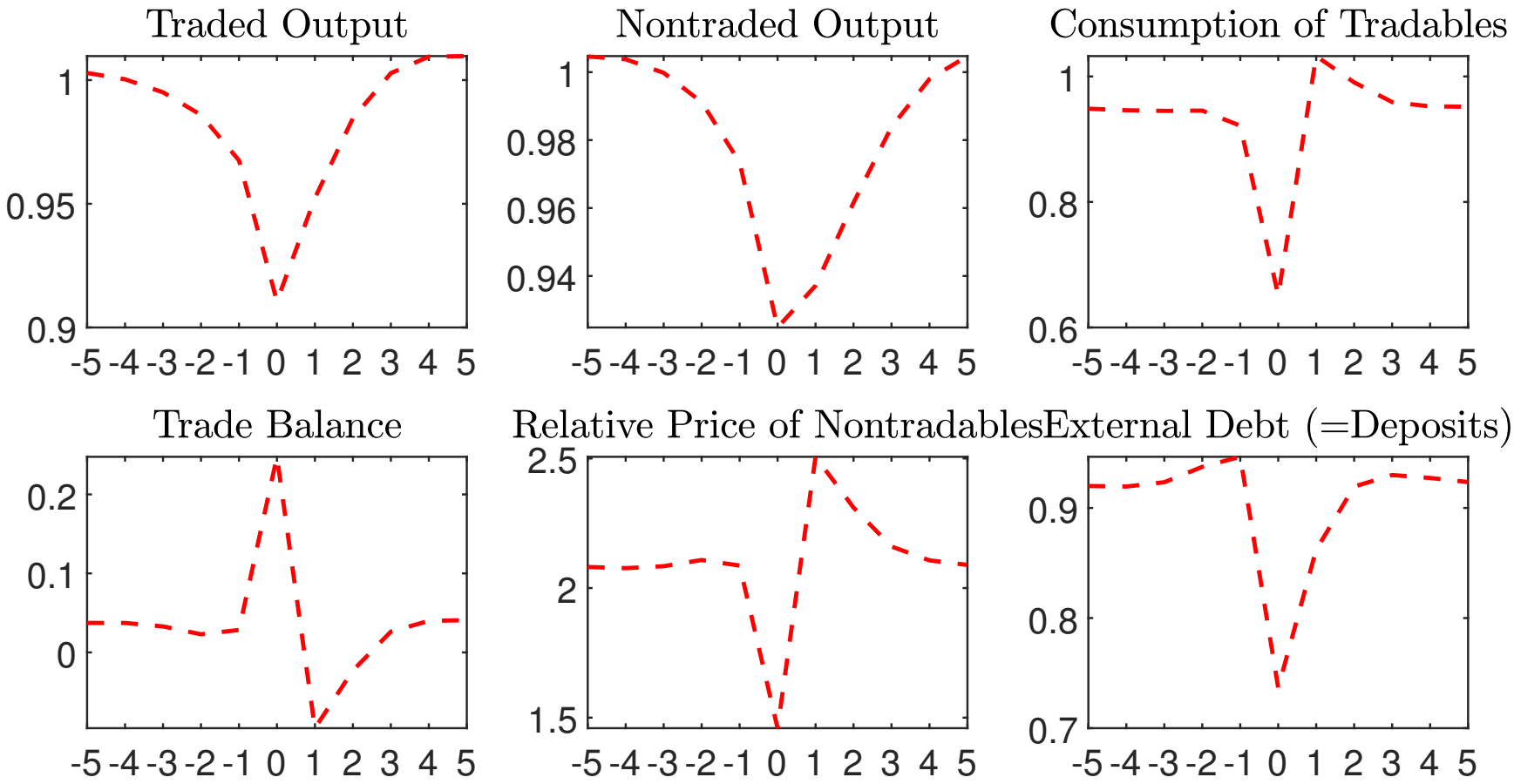
Unconditional Correlations of Reserves with Loans and Output

	Laissez-faire	Constrained optimal
corr(r_t, l_t)	0.81	-0.38
corr$(r_t, y_t^T + p_t y_t^N)$	0.30	-0.75

Note. The column labeled laissez-faire corresponds to the competitive equilibrium with $i_t^r = \tau_t^c = 0$ and the column labeled constrained optimal to the competitive equilibrium with i_t^r and τ_t^c chosen optimally.

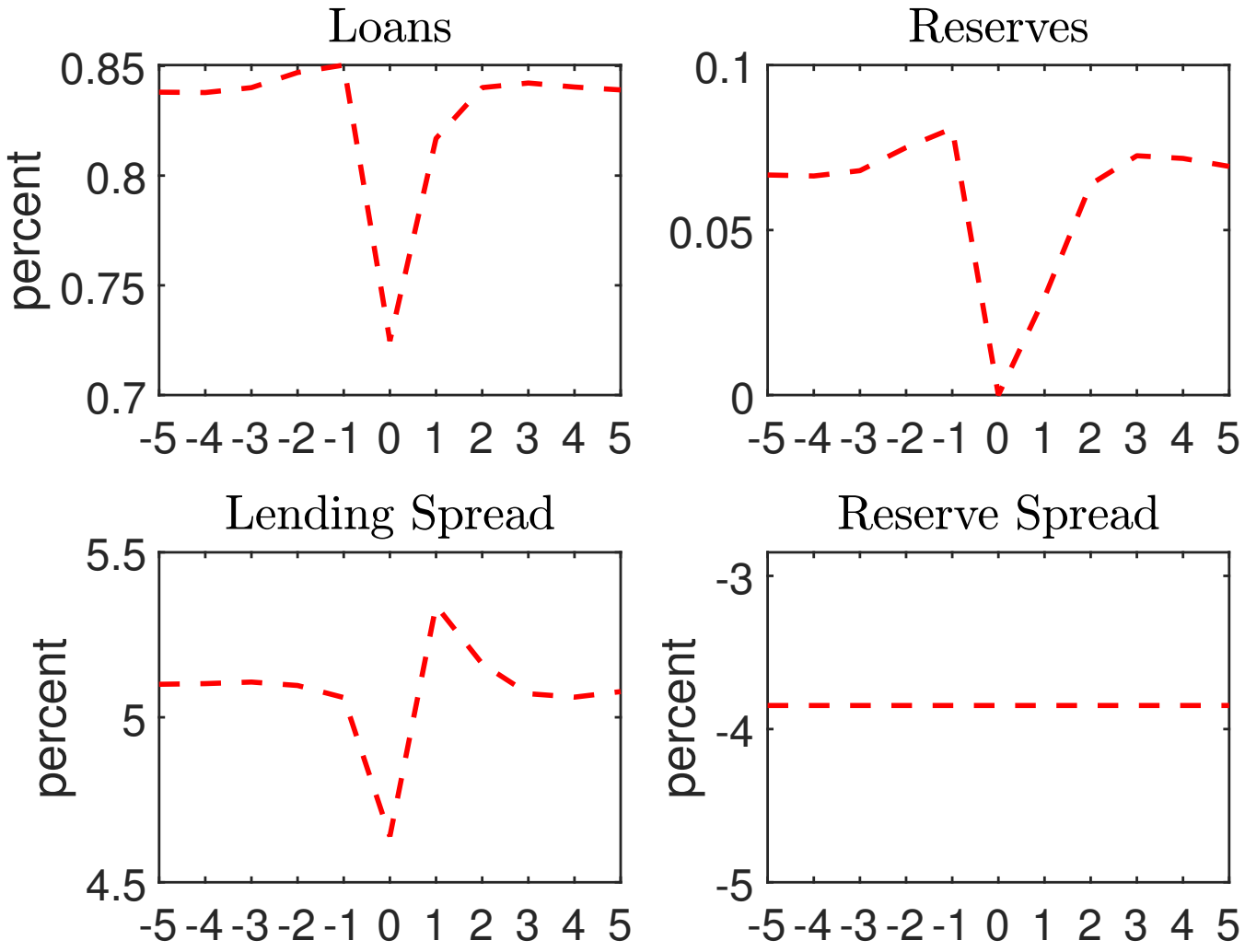
The Typical Sudden Stop

The Typical Sudden Stop in the Unregulated Economy



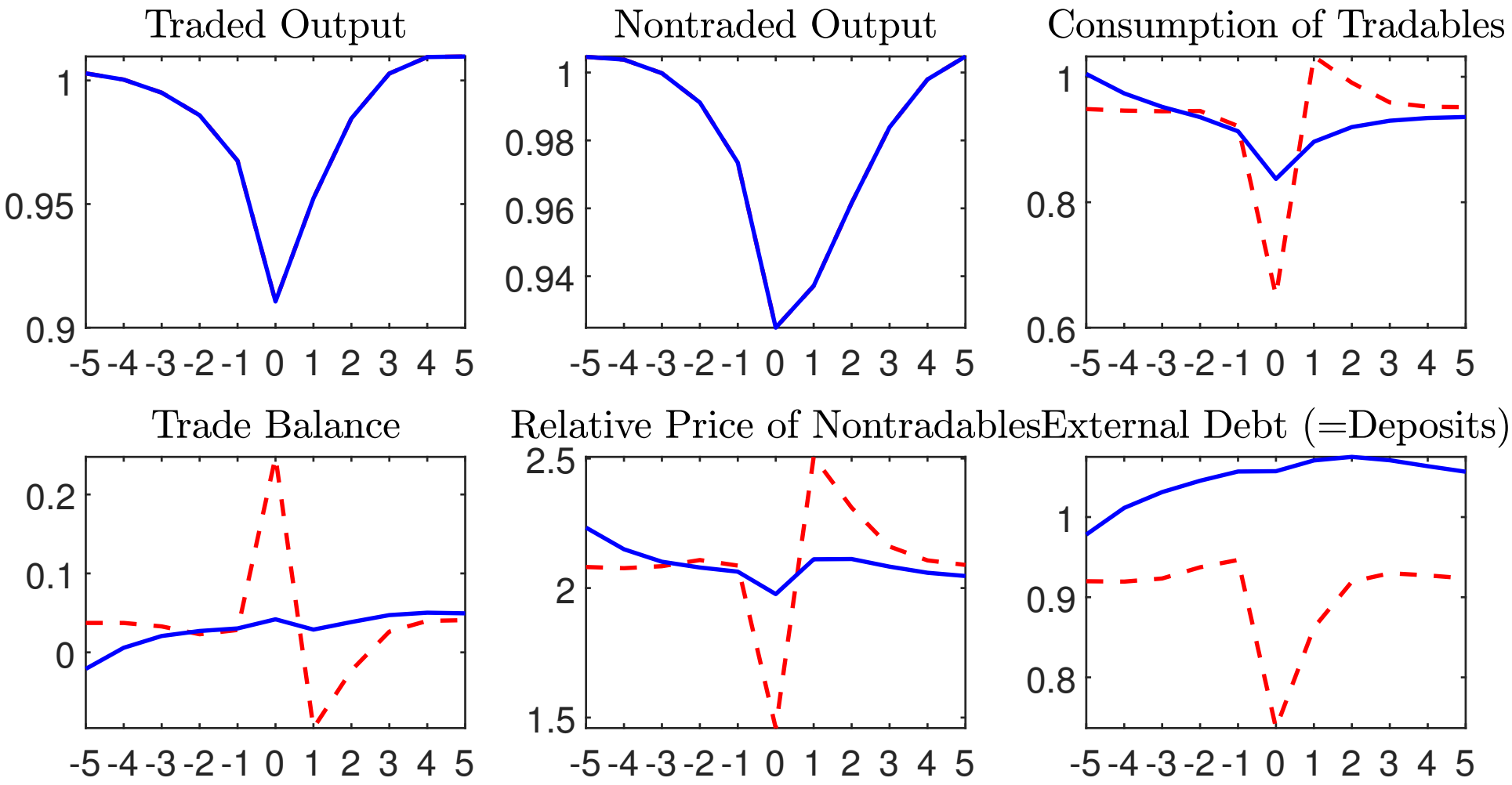
Broken lines: unregulated economy

The Typical Sudden Stop in the Unregulated Economy (ctd.)



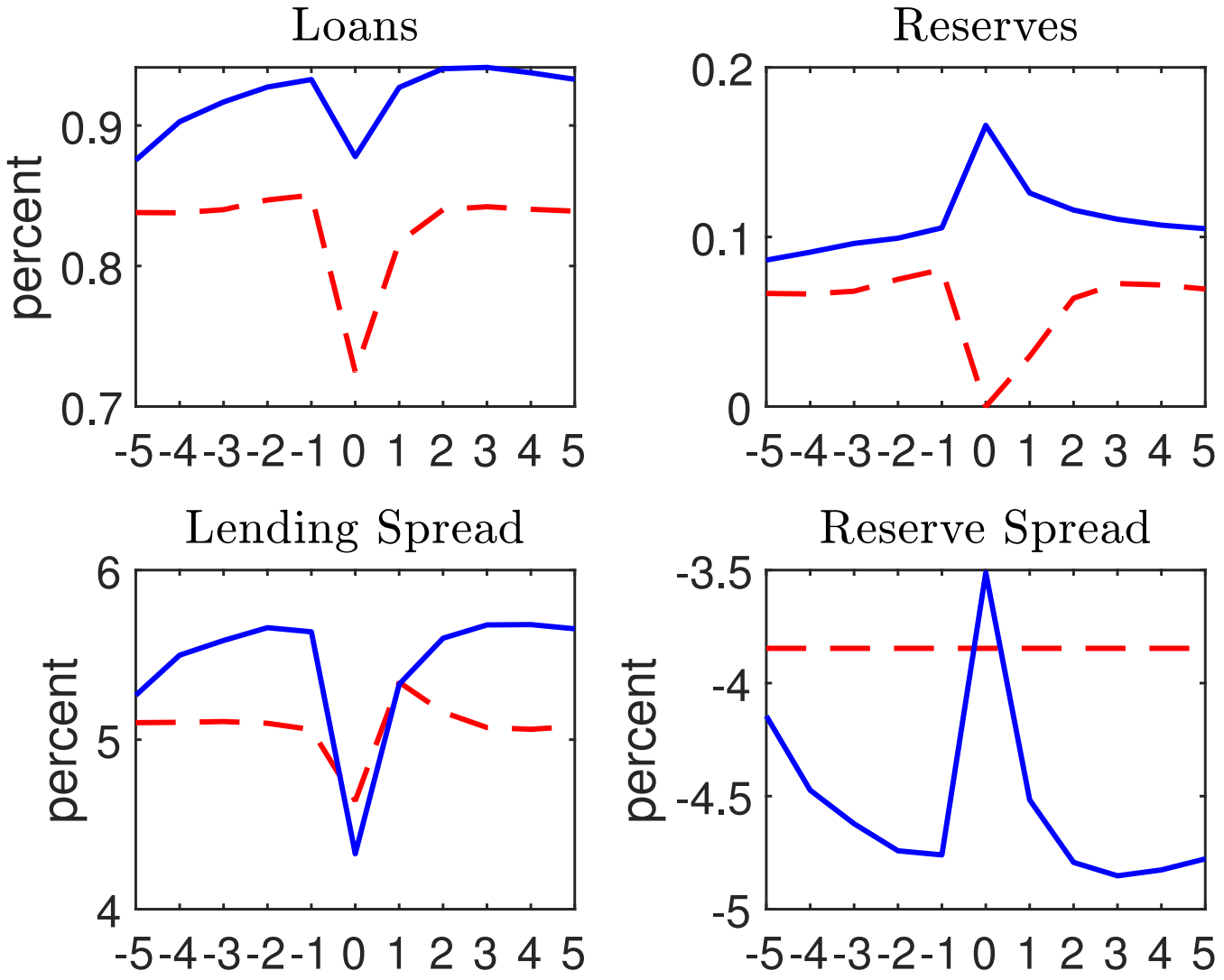
Broken lines: unregulated economy

The Typical Sudden Stop with Optimal Policy



Broken lines: unregulated economy **Solid lines: constrained optimal allocation**

The Typical Sudden Stop with Optimal Policy (ctd.)



Broken lines: unregulated economy

Solid lines: constrained optimal allocation

Conclusion

• How should central banks conduct bank reserve remuneration policy in open economies?

• This paper addresses this question in the context of a model with a banking channel and a collateral constraint that limits household debt by a fraction of income.

• The central result of the paper is that the unregulated economy underborrows, that is, its external debt is lower than in the economy with optimal reserve remuneration and capital control policy.

• This result overturns the standard overborrowing result obtained in the absence of a banking channel.

• Under the optimal policy regime, bank reserves are countercyclical.

• By raising bank reserves during episodes in which the household collateral constraint binds, the government acts as a lender of last resort to households allowing the economy to continue to have access to external funding in spite of the fact that households are being forced to deleverage.

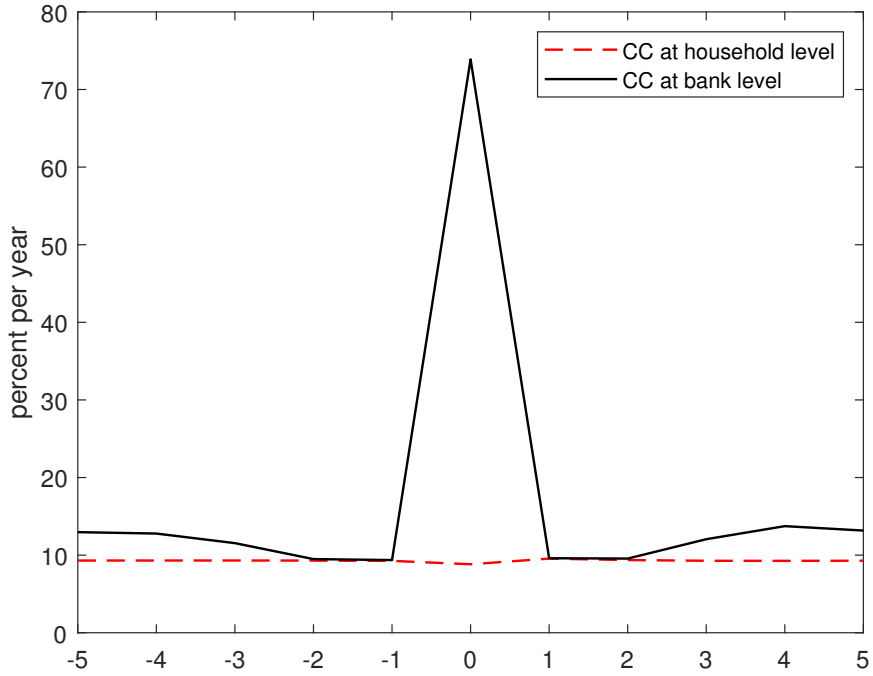
EXTRAS

- The model predicts that lendings spreads fail to rise during a crisis.

- This is so because the borrowing constraint is placed at the household level.

- What if the borrowing constraint is placed at the level of the bank?

Behavior of i_t^l around sudden stops in the unregulated economy when collateral constraint is at the bank level



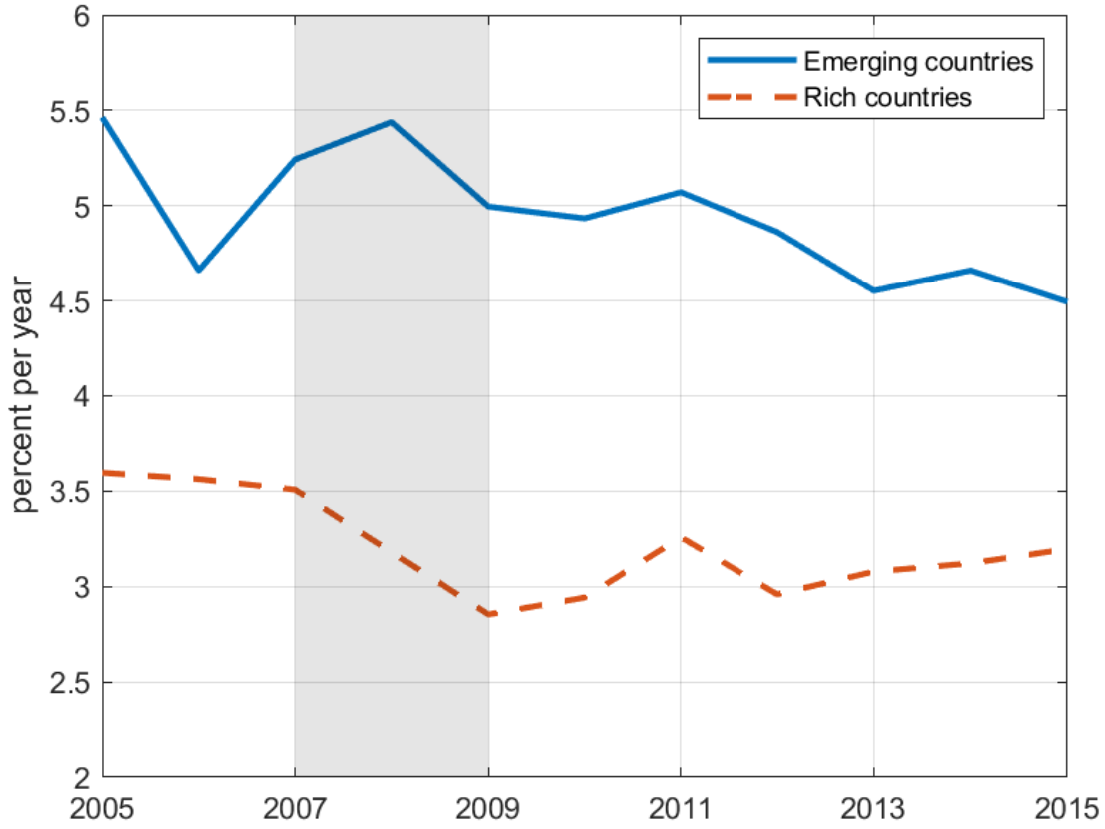
Note. The horizontal axis measures time. The collateral constraint binds in period 0.

• When the collateral constraint is placed at the level of the bank, the model predicts that in the period of a binding collateral constraint the loan rate spikes at over 70 percent. By constrast, when the collateral constraint is placed at the level of the household, then the loan rate does not spike; in fact, it declines by 45 bp.

- Rockoff (2021):

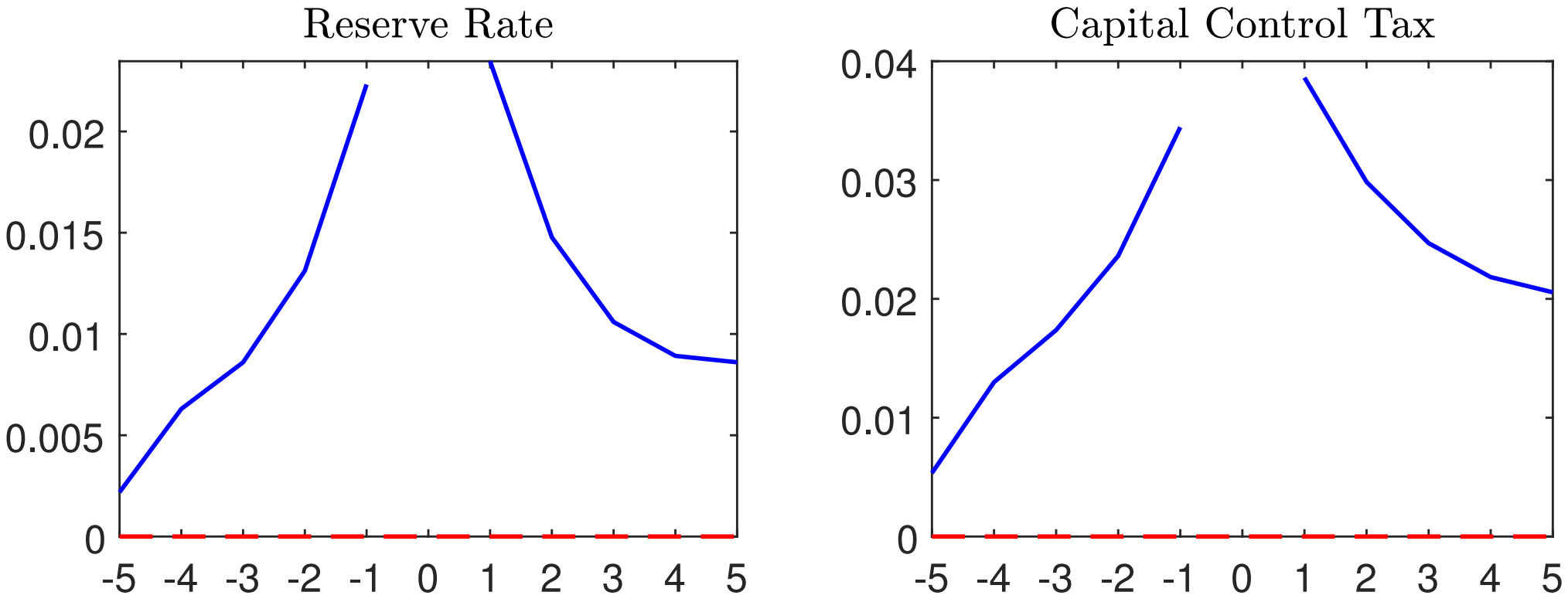
  Historically, the presumption that a key symptom of a financial crisis is a sharp increase in the lending rate has led to the misdiagnosis of major financial crises. Oliver M. W. Sprague (*the* expert on financial crises at the time) failed to recognize the 1929-1932 financial crisis for lack of an increase in lending spreads.

Lending Spreads around the Global Financial Crisis in Emerging and Rich Countries



Notes. The lending spread, $(i_t^l - i_t^d)/(1 + i_t^d)$, is computed as the median of the annual lending spread across a group of emerging and rich countries, respectively. The classification of countries follows Uribe and Schmitt-Grohé (2017). Countries with populations smaller than 1 million or with missing data over the period 2005-2015 were excluded. The 32 emerging countries included are: Albania, Algeria, Argentina, Bahrain, Bolivia, Botswana, Brazil, Bulgaria, Chile, Colombia, Costa Rica, Dominican Republic, Egypt, Greece, Guatemala, Hungary, Iran, Jordan, South Korea, Malaysia, Mexico, Namibia, New Zealand, Panama, Paraguay, Peru, Portugal, Spain, Thailand, Trinidad and Tobago, Uruguay, and Venezuela. The 9 rich countries included are: Australia, Canada, Hong Kong, Ireland, Italy, Japan, Singapore, Switzerland, and United States. The data source is IMF, International Financial Statistics, the measure for the loan rate, i_t^l, is the series FILR_PA and the measure for the deposit rate, i_t^d, is the series FIDR_PA. Shading indicates the global financial crisis of 2007 to 2009.

Optimal i_t^r and τ_t^c around sudden stops



Note. The dynamics associated with the constrained optimal allocation are shown with a solid blue line and the dynamics associated with the unregulated economy with a broken red line.

Functional Forms and Calibration

CRRA period utility function

$$u(c_t) = \frac{c_t^{1-\sigma} - 1}{1-\sigma},$$

CES aggregator function

$$c_t = \left[a {c_t^T}^{1-1/\xi} + (1-a) {c_t^N}^{1-1/\xi} \right]^{1/(1-1/\xi)},$$

Calibration: use standard values in the related literature:

$$\sigma = 2$$
$$\xi = 0.83$$
$$a = 0.31$$

Functional Forms and Calibration (cont.)

- **The world interest rate:**

$$i^* = 0.04$$

This is a standard value in business-cycle analysis.

- **The subjective discount factor,** β, is set to match the average relative impatience factor, $\beta(1+i^l)$, to
(a) be consiste with that in Bianchi (2011), $\beta^B(1+i^*)$, where $\beta^B = 0.91$ is the subjective discount factor used by Bianchi; and
(b) be consistent with an observed lending spread$(1+i^l)/(1+r^*)-1$ of 0.0499.
This yields

$$\beta = 0.8667$$

Sources of Uncertainty

• The driving forces are the exogenous endowments, y_t^T and y_t^N, which are assumed to follow a bivariate AR(1) process.

• The stochastic process for (y_t^T, y_t^N) is taken from Bianchi (2011).

Calibration

Parameter	Value	Description
		Structural Parameters
σ	2	Inverse of intertemporal elasticity of consumption
a	0.31	Parameter of CES aggregator
ξ	0.83	Elasticity of substitution between tradables and nontradables
i^*	0.04	World interest rate
β	0.8667	Subjective discount factor
κ	0.3205	Parameter of collateral constraint
A	0.0089	Parameter of intermediation cost function $\Gamma(l,r)$
α	1.8104	Parameter of the intermediation cost functions $\Gamma(l,r)$ and $\Gamma^r(r)$
ϕ	6.7983	Parameter of intermediation cost function $\Gamma(l,r)$
$\overline{r}$	0.5848	Parameter of intermediation cost function $\Gamma(l,r)$
B	2.6852	Parameter of intermediation cost function $\Gamma^r(r)$
		Discretization of State Space
n_{y^T}	13	Number of grid points for $\ln y_t^T$, equally spaced
n_{y^N}	13	Number of grid points for $\ln y_t^N$, equally spaced
n_d	800	Number of grid points for d_t, equally spaced
$\left[\ln \underline{y}^T, \ln \overline{y}^T\right]$	[-0.1093, 0.1093]	Range for logarithm of tradable output
$\left[\ln \underline{y}^N, \ln \overline{y}^N\right]$	[-0.1328, 0.1328]	Range for logarithm of nontradable output
$[\underline{d}, \overline{d}]$	[0.4, 1.05]	Debt range unregulated economy

Note. The time unit is a year.

Non-Equivalence of Reserve Remuneration and Reserve Requirements

• In many emerging markets central banks do not remunerate reserves but instead impose reserve requirements.

• Model with reserve requirements and capital controls:

– $i_t^r = 0$

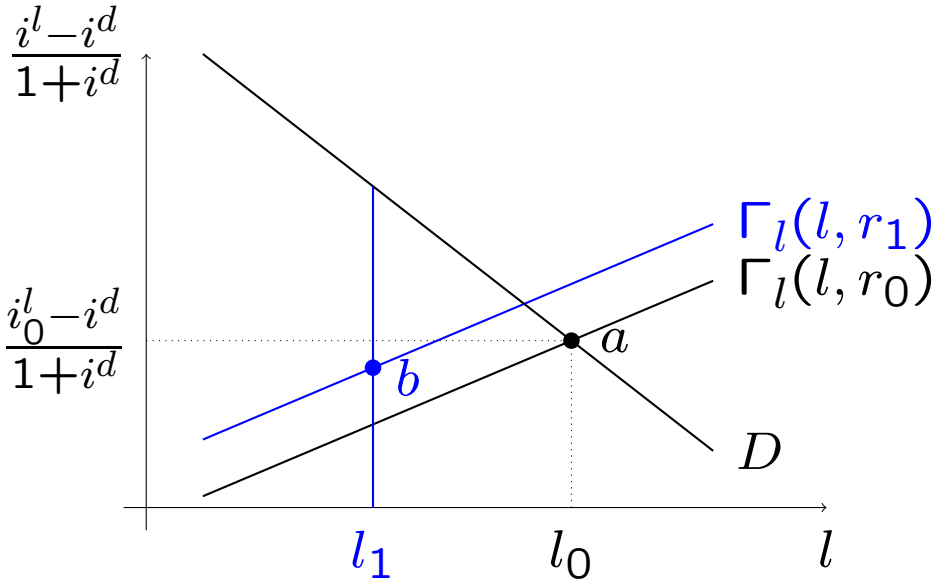
– $r_t \geq \delta_t d_t$, with $\delta_t \in [0, 1)$

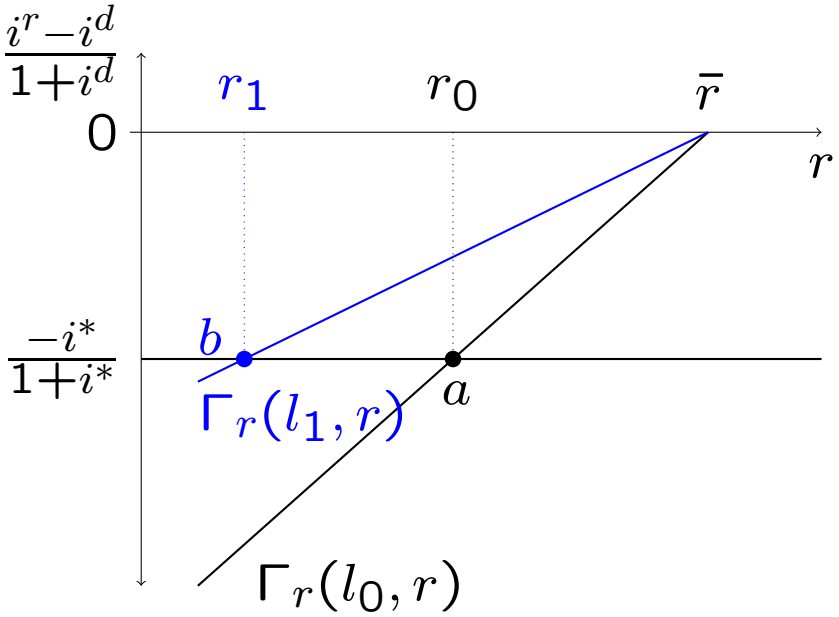
– τ_t^c

• Does reserve remuneration welfare dominate reserve requirements as a macroprudential tool? In the present environment the answer is YES.

Graphical Interpretation

The Loan and Reserve Markets During a Sudden Stop in the Unregulated Economy





The Loan and Reserve Markets During a Sudden Stop in the Regulated Economy