Optimal Bank Reserve Remuneration and Capital Control Policy

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Motivation

The financial stress faced by households and firms during the Global Financial Crisis and the Covid-19 pandemic reopened fundamental questions for macroprudential policymaking in open economies:

- Do financial frictions cause economies to over- or underborrow?

- Should macroprudential policy curb external borrowing?

- Should central banks inject bank reserves countercyclically?

- How should interest on reserves and capital controls behave over the business cycle?

Starting Point

Existing models of overborrowing:

- assume that domestic agents borrow directly from foreign lenders, subject to a collateral constraint.

- the collateral constraint creates a pecuniary externality.

- As a result:
—— the economy overborrows from the rest of the world.
—— the optimal macroprudential policy is a capital control tax that discourages borrowing, especially when the economy is close to a binding collateral constraint.

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

Question: Does this simplification have consequences for the main predictions of this class of models?

This Paper studies an open economy with:

(1) a collateral constraint, as in the standard model (Mendoza, 2002; Korinek, 2011; Uribe, 2006; Bianchi, 2011; Benigno et al., 2013; Schmitt-Grohé and Uribe, 2021). Specifically,
— household debt is limited by a fraction of income.

(2) bank intermediation (Cúrdia and Woodford, 2011; Eggertsson et al., 2019)
— 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.

Preview of Results: (1) Optimal Policy with Costless Bank-Reserve Provision

Suppose the central bank can supply bank reserves at no operating cost. Then, we show that:

• The optimal interest-on-reserve policy can completely circumvent the banking channel. This result extends to an open economy one derived by Cúrdia and Woodford (2011) for a closed economy.
• But the optimal interest-on-reserve policy can also completely circumvent the household's collateral constraint.

⇒ The optimal interest-on-reserve policy achieves the **first-best allocation.** Further, **capital controls are unnecessary**.

⇒ **Underborrowing:** In the first-best equilibrium, external borrowing is limited only by the natural debt limit. So, with impatient households, external debt is higher than in the unregulated economy, in which debt is limited by the collateral constraint.

Preview of Results: (2) Optimal Policy with Costly Bank-Reserve Provision

Suppose the central bank can supply bank reserves, but that operating such facility is costly (administration, monitoring, etc.).

• Now, a social planner with access to capital controls and interest on reserves can achieve only a constrained optimal allocation:
— The social planner can no longer fully circumvent either the banking friction or the household's collateral constraint.

• However, under plausible calibrations, as in the case of costless reserve provision, the economy **underborrows.**
— That is, the economy without government intervention has too little external debt relative to the economy in which the interest rate on reserves and capital controls are set optimally.

Intuition for the Underborrowing Result

- bank reserves act as a cushion between household debt and the country's external debt (=foreign deposits).

- balance sheet of the bank:

    bank reserves + domestic loans = foreign deposits

- By manipulating interest on reserves, the government can uncouple episodes of household deleveraging (fall in loans) from episodes of economy-wide deleveraging (fall in foreign deposits).

- When the economy suffers a negative shock that causes the household's collateral constraint to bind (household deleveraging), the government steps in and provides liquidity in the form of bank reserves.

- 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

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

where

$d_t, l_t, r_t =$ deposits, loans, and bank reserves, respectively.
$i^d_t, i^l_t, i^r_t =$ interest rates on deposits, loans, and reserves, respectively.
$\pi_t =$ 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 $d_t \geq 0$, $l_t \geq 0$, and $r_t \geq 0$ to maximize π_{t+1} taking as given i^d_t, i^r_t, i^l_t.

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* There is a reserve satiation level $\bar{r}$, such that $\Gamma_r(l, r) = 0$ for all $r \geq \bar{r}$.

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. These conditions hold with inequality ($\leq$) when $l_t = 0$ or $r_t = 0$, respectively.

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 = endowment 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

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

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

Quantitative Analysis

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 that in Bianchi (2011), $\beta^B(1 + i^*)$, where $\beta^B = 0.91$ is the subjective discount factor used by Bianchi. This yields

$$\beta = 0.8677$$

Functional Forms and Calibration (cont.)

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 are set by SMM to $\kappa = 0.3205$, $A = 0.0089$, $\alpha = 1.8104$, $\phi = 6.7983$, $\bar{r} = 0.5848$, $B = 2.6852$, to match 6 empirical first moments in emerging countries:

(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.

Calibration of Financial Parameters: Fit of SMM Conditions

	Moment	Formula	Observed	Predicted
(1)	Lending spread	$\frac{i^l - i^d}{1 + i^d}$	0.0499	0.0509
(2)	Reserve-to-deposit ratio	$\frac{r}{d}$	0.0644	0.0712
(3)	Debt-to-output ratio	$\frac{d}{y^T + py^N}$	0.2900	0.2992
(4)	Intermediation-cost-to-deposit ratio	$\frac{\Gamma(l,r)}{d}$	0.0175	0.0165
(5)	Central-bank-operating-cost-to-reserve ratio	$\frac{\Gamma^r(r)}{r}$	0.0205	0.0228
(6)	Frequency of binding collateral constraint		0.0500	0.0530

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).

Optimal Policy versus Laissez Faire

We will compare two equilibria:

− the **constrained optimal allocation,** i.e., the best competitive equilibrium attainable with interest on reserve and capital control policy (i_t^r, τ_t^c)

− the **unregulated economy,** i.e., 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
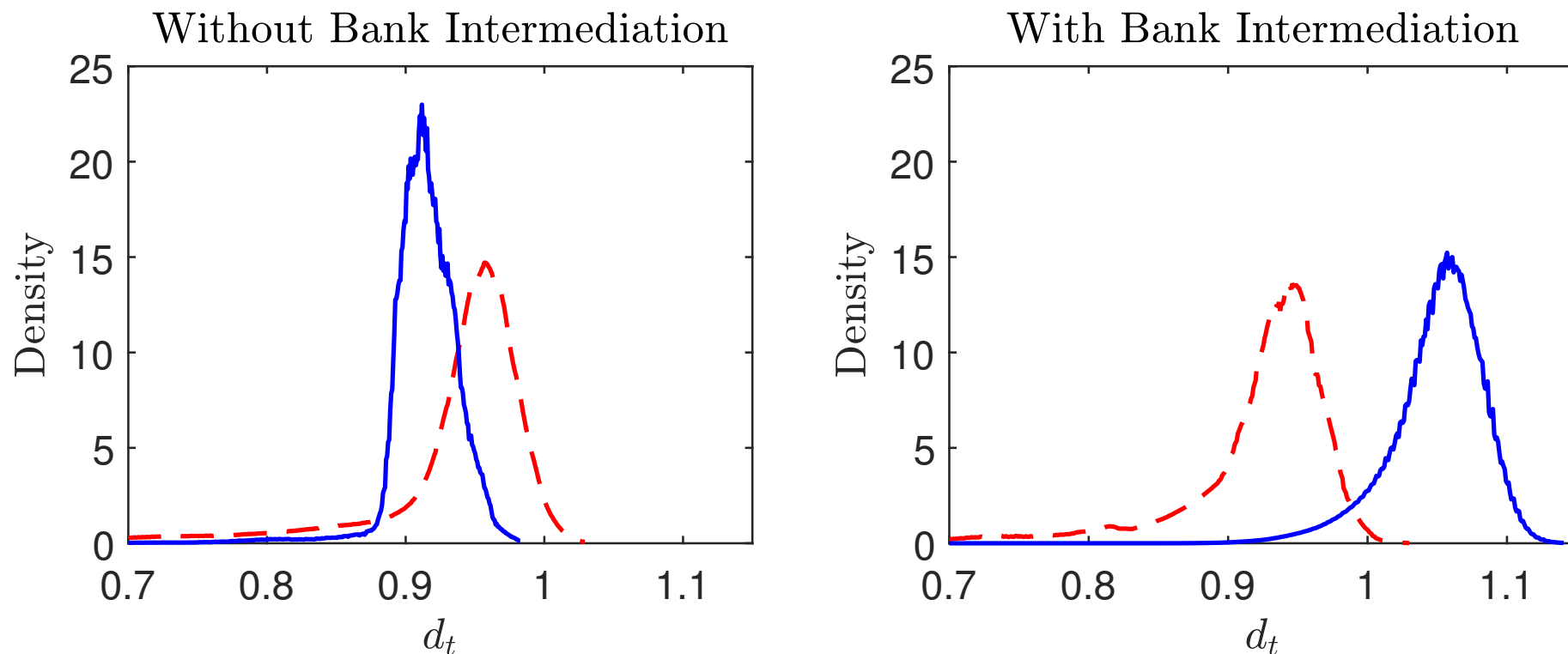
Solid lines: constrained optimal allocation
Broken lines: unregulated economy.
The figure shows that in the absence of a banking channel there is overborrowing, whereas in the presence of the bank intermediation friction there is underborrowing.

Unconditional Distributions of Loans and Reserves

Loans, l_t Reserves, r_t
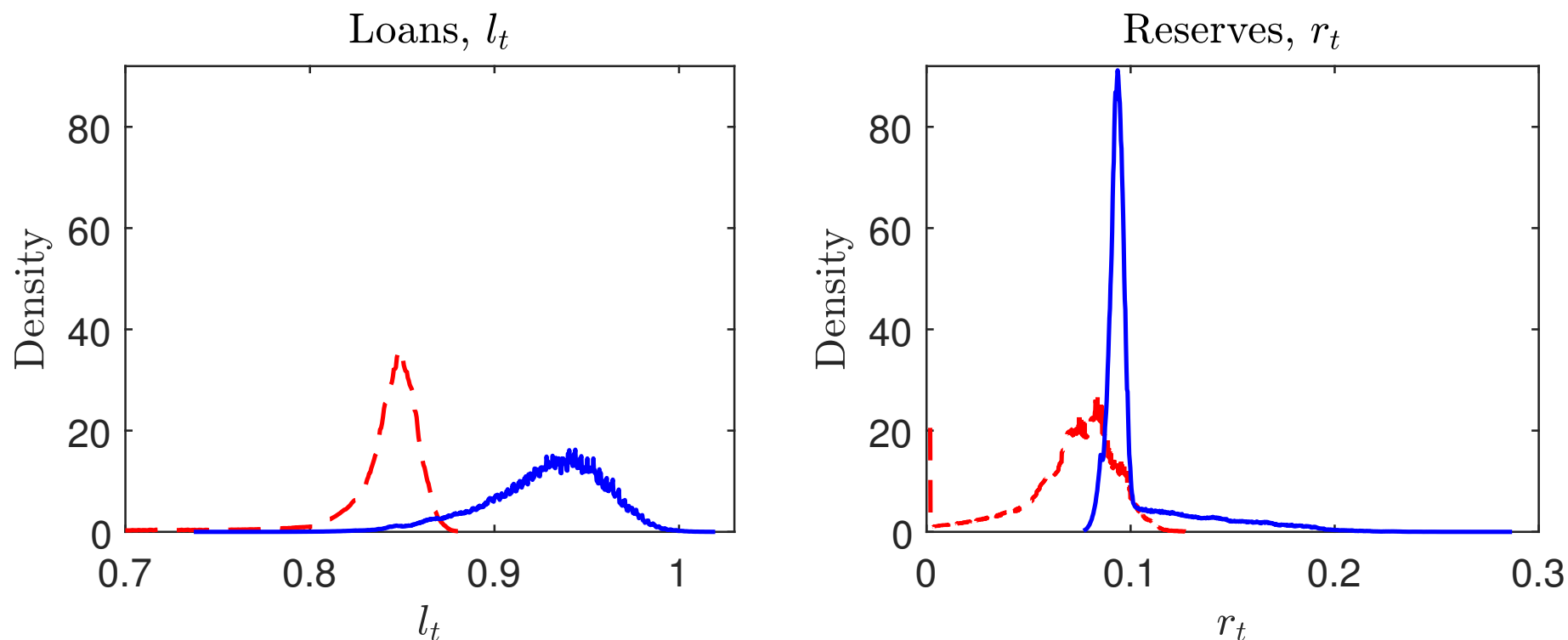
Note. The densities associated with the constrained optimal allocation are shown with a solid line and the densities of the unregulated economy with a broken line.

The Typical Sudden Stop

The Typical Sudden Stop Episode
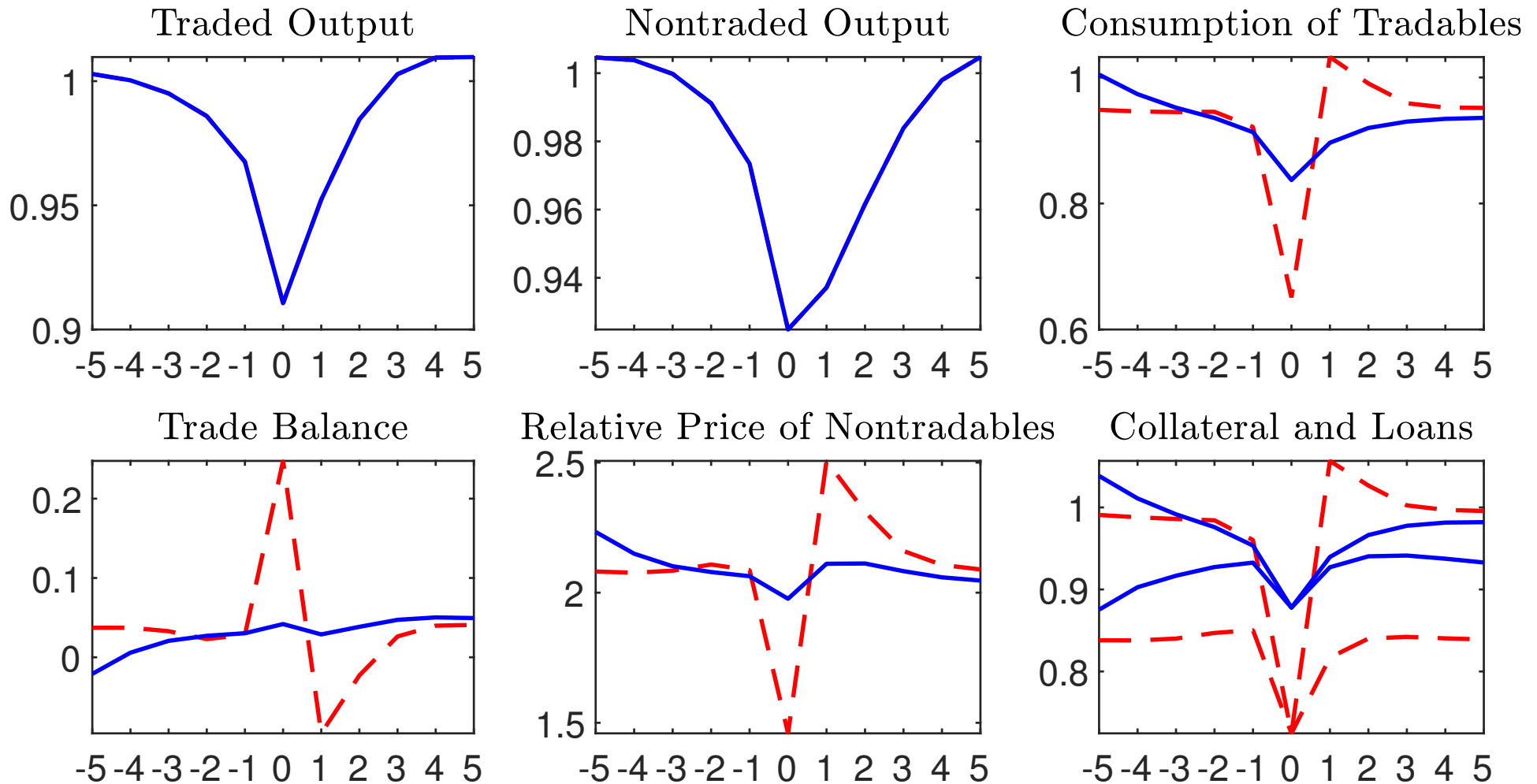
Solid lines: constrained optimal allocation.
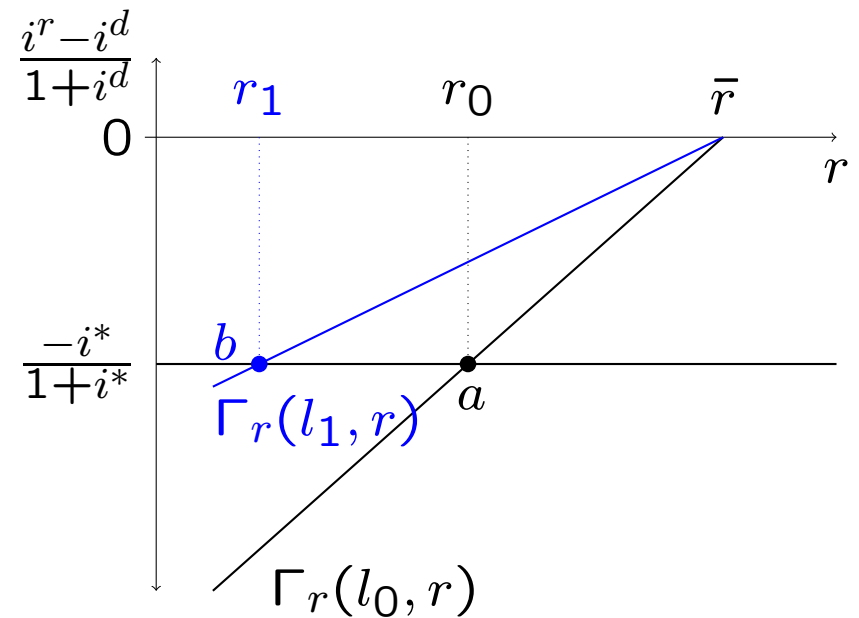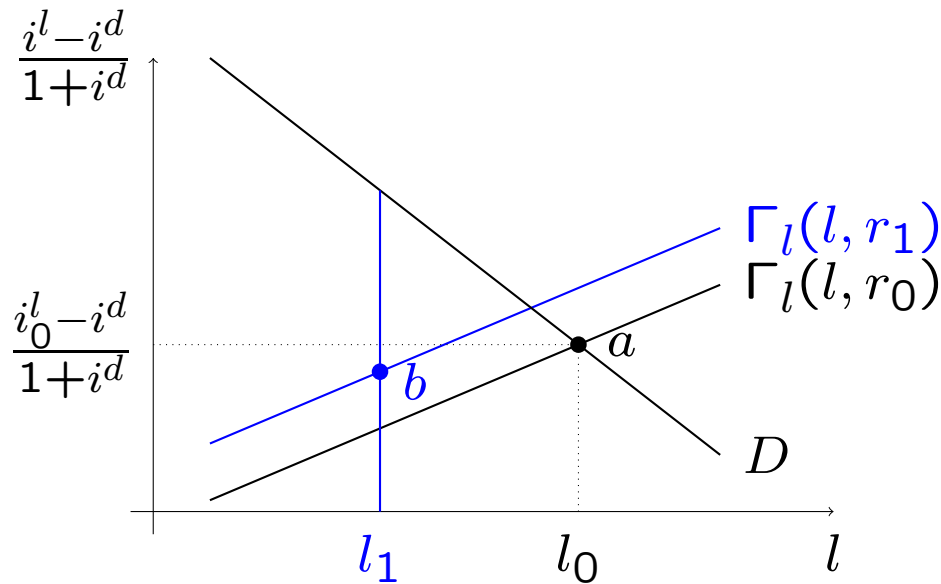Broken lines: unregulated economy.
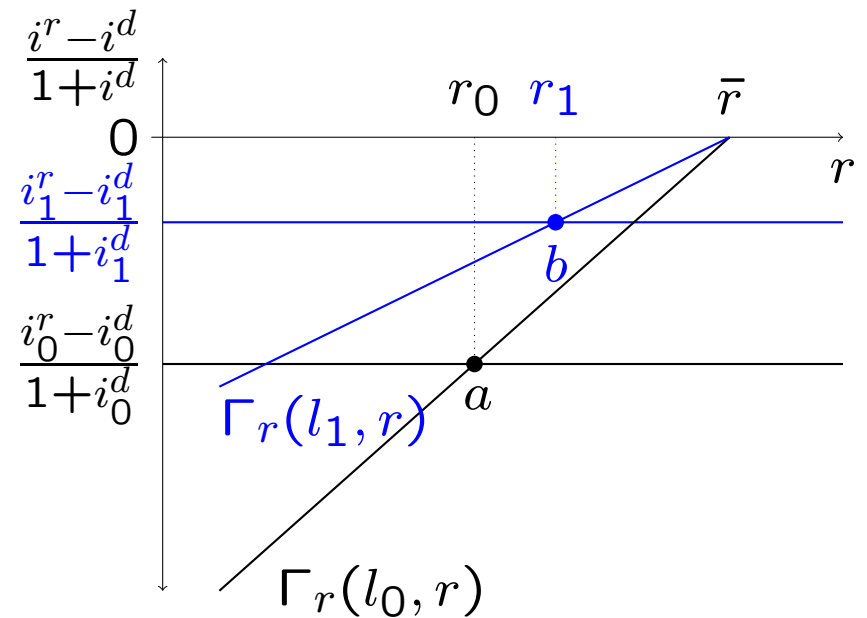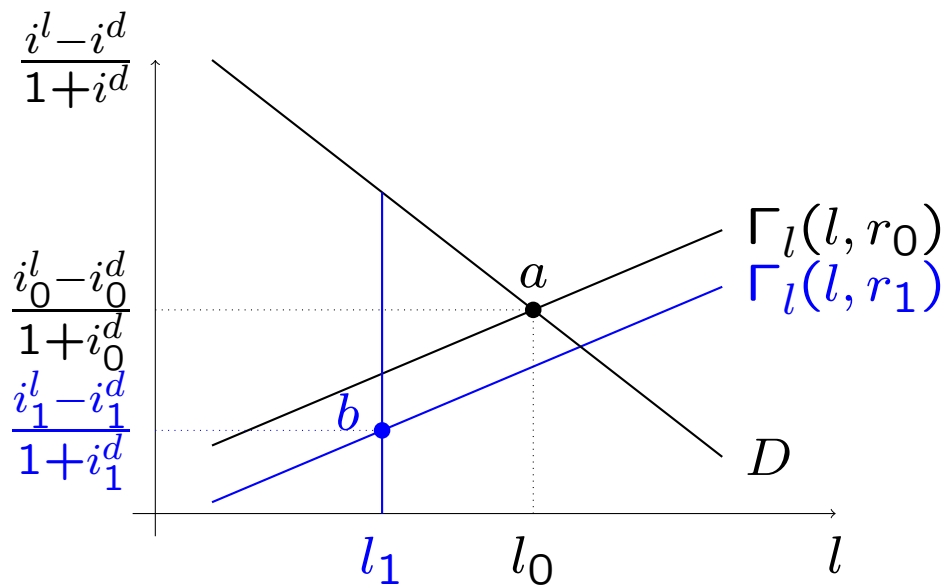
The Typical Sudden Stop Episode (ctd.)
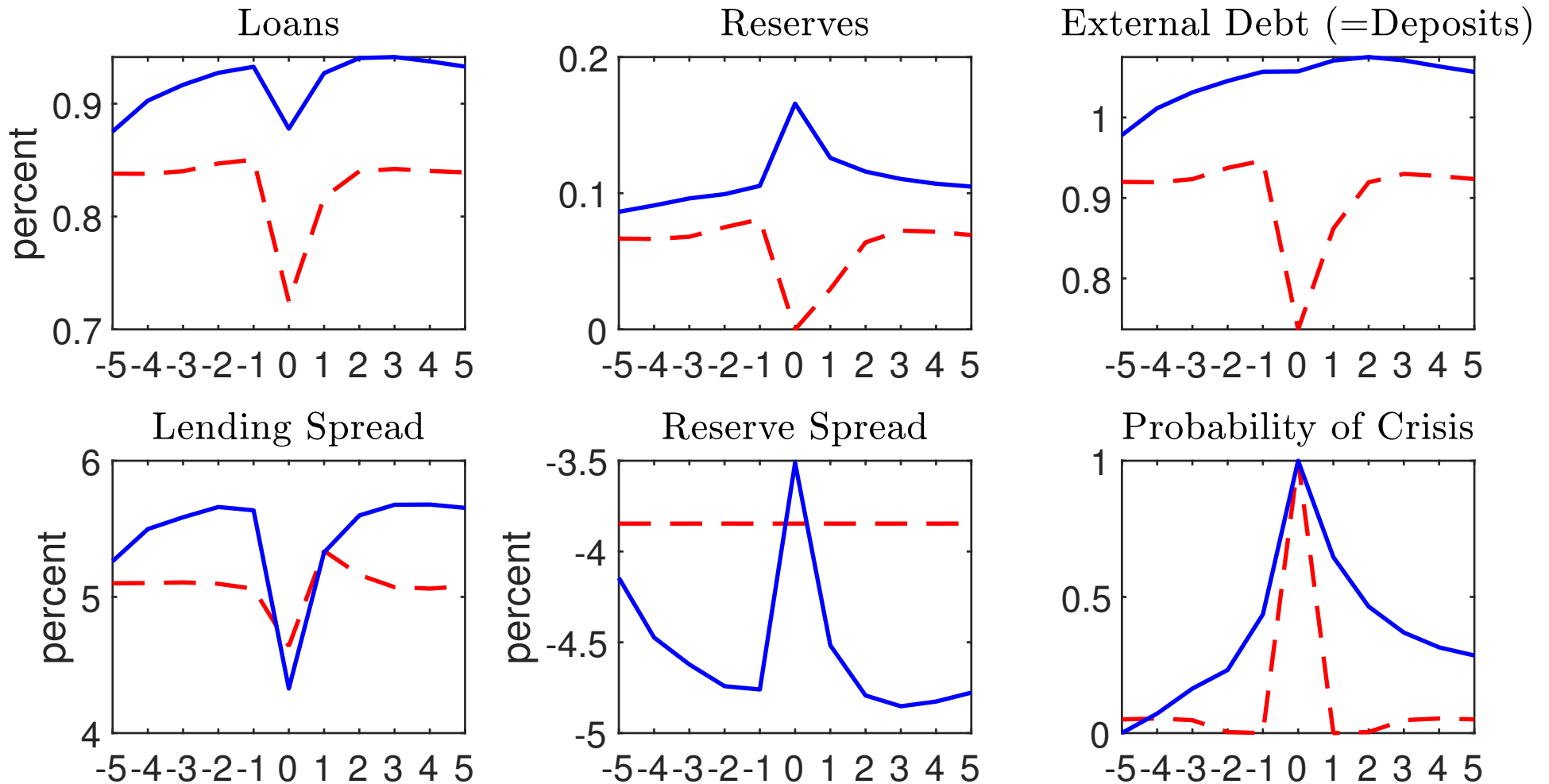
Solid lines: constrained optimal allocation.
Broken lines: unregulated economy.
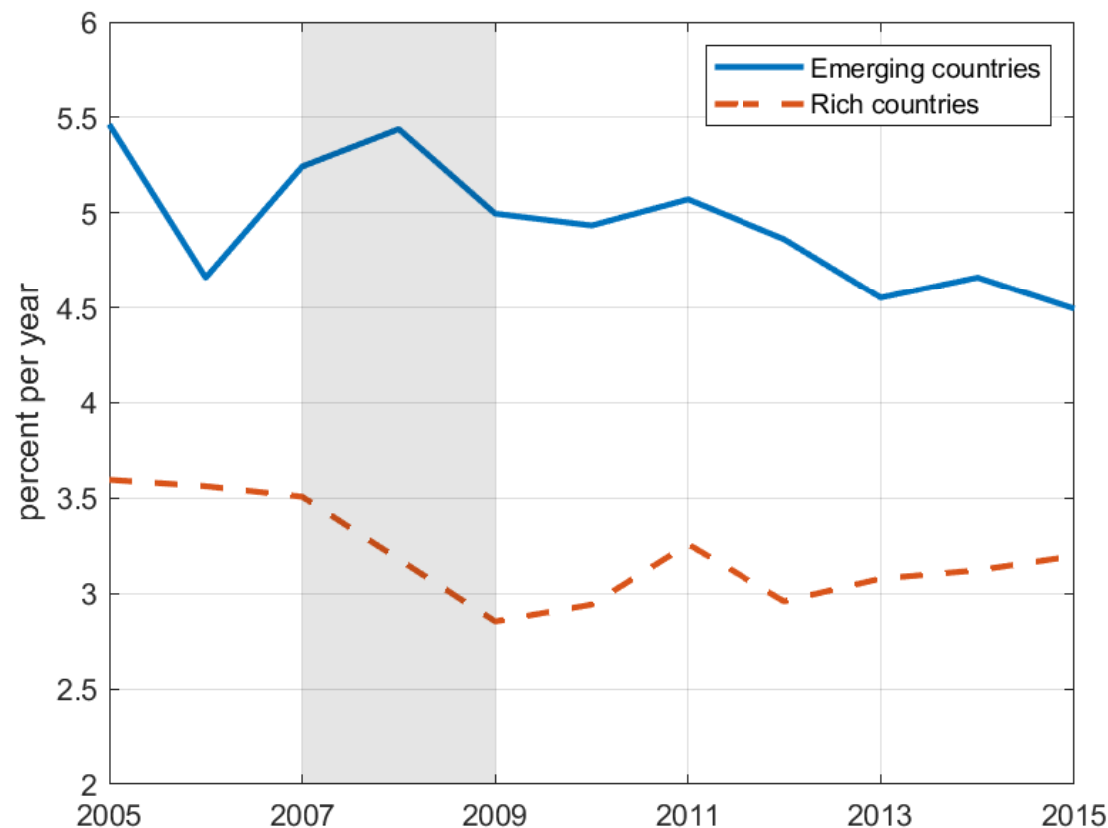
Graphical Interpretation

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

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

Notes. The lending spread, $(i^l_t - i^d_t)/(1 + i^d_t)$, 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^l_t, is the series FILR_PA and the measure for the deposit rate, i^d_t, is the series FIDR_PA. Shading indicates the global financial crisis of 2007 to 2009.

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.

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 under the optimal reserve remuneration and capital control policy, the external debt is higher than in the absence of government intervention.

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

- Under the optimal policy regime, bank reserves are countercyclical. Bank reserves act as a cushion between external debt and household debt.

- By pumping bank reserves during episodes in which the household collateral constraint binds, the government allows the economy to continue to have access to external funding in spite of the fact that households are being forced to deleverage.

EXTRAS

Behavior of i_t^r and τ_t^c around sudden stops conditional on a slack collateral constraint in the regulated economy

Reserve Rate

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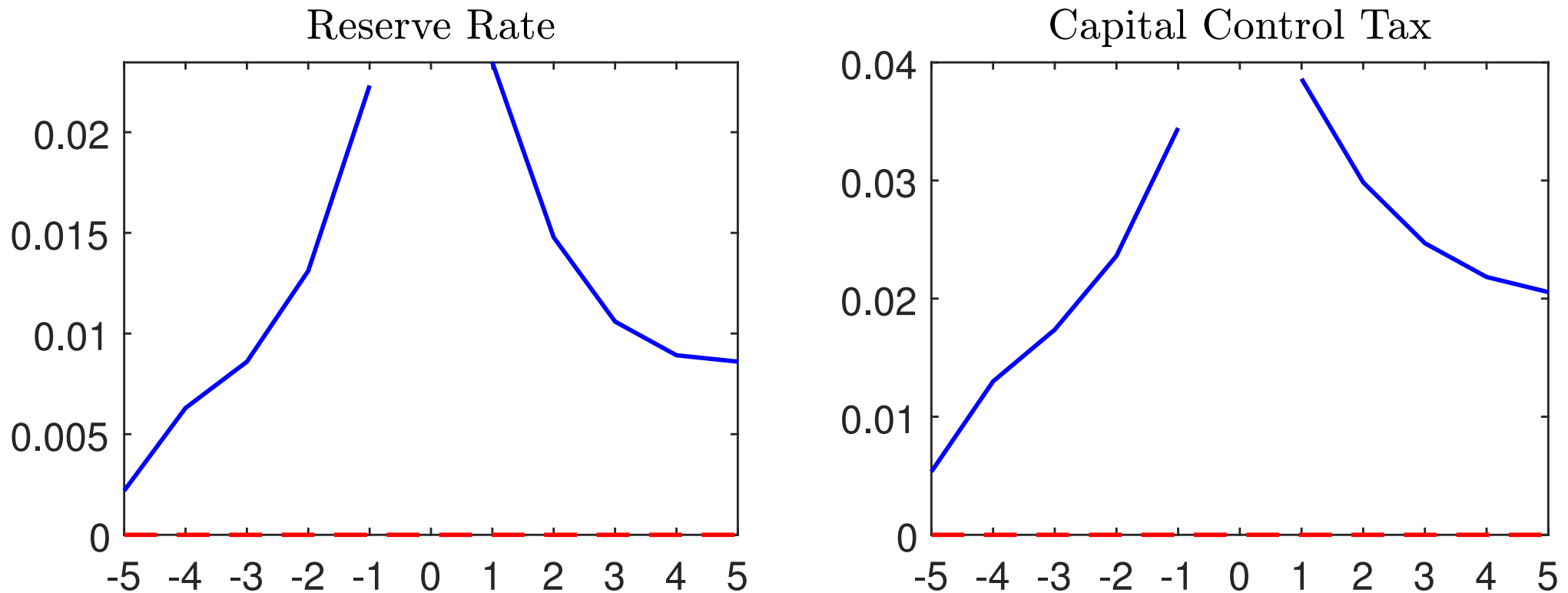
Note. The dynamics associated with the constrained optimal allocation are shown with a solid blue line and the dynamics associated with the unregulated economy with a broken red line.

Behavior of i_t^l around sudden stops in the unregulated economy for alternative specification of the model

Lending Rate, i_t^l
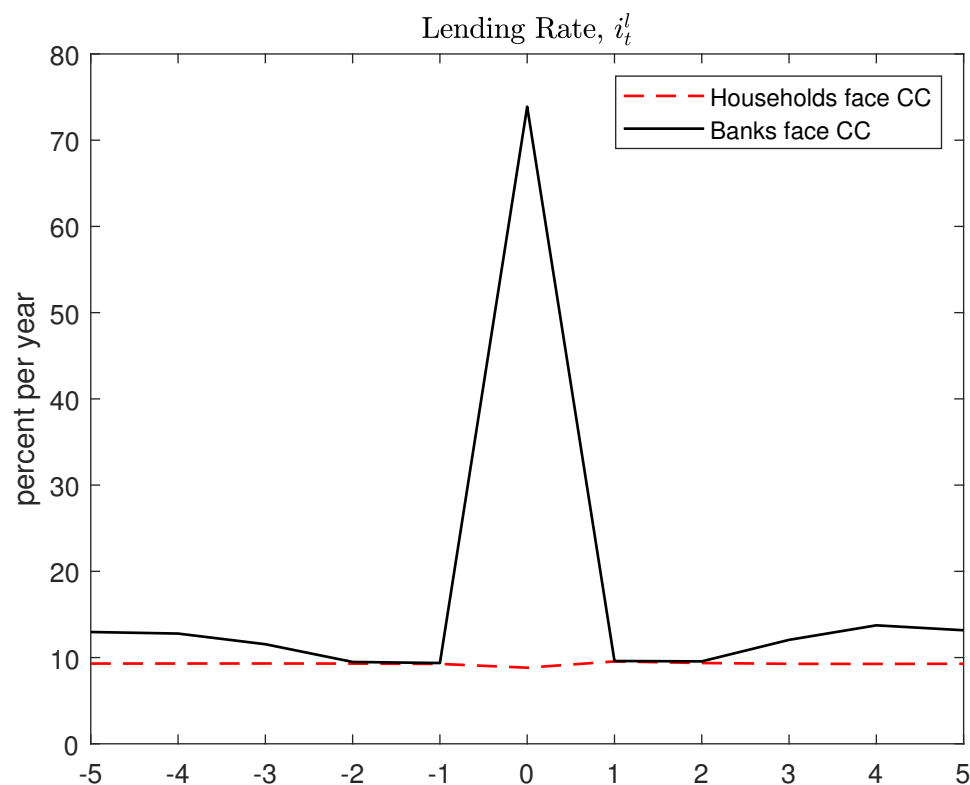
Note. The horizontal axis measures time. The collateral constraint binds in period 0.

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.