A Static Capital Buffer is Hard to Beat

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[1]The opinions expressed in this presenation are the authors' and do not reflect the opinions of anyone else in the Federal Reserve System.

Motivation

- Limited liability and (mispriced) deposit insurance create adverse risk-taking incentives in the banking sector.
- A prolonged period of low interest rates heightens the concern that financial intermediaries may reach for yields by taking on excessive risk.
- Capital requirements can correct these incentives by forcing banks to have more skin in the game.
- But high capital requirements hinder liquidity provision by banks as they tilt bank financing away from deposits.
- How should bank regulators manage this tradeoff?

Basel III Guidance

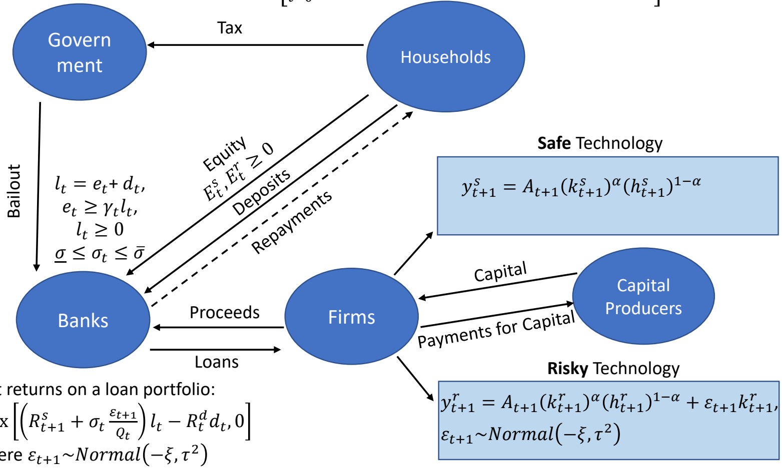
- Counter-cyclical capital buffers.
- Periods of high leverage predict deeper downturns associated with banking crises — this is also the case in our model.
- Raise capital requirements during booms (or periods with high credit/GDP).

We contrast this guidance with the optimal prescriptions for bank capital in our model — an RBC model augmented with financial intermediaries facing a choice over risk-taking:

- Depending on the source of shocks, optimal capital requirements may rise during business-cycle expansions, or contractions, or periods of high volatility.
- We conclude that it is hard to beat a static capital buffer without full knowledge of the underlying shocks.

Our Framework ▸ Details

$$U = E\left[\sum_{t=0}^{\infty} \beta^t \left(\frac{(C_t - \kappa C_{t-1})^{1-\varsigma_c} - 1}{1-\varsigma_c} + \varsigma_0 \frac{D_t^{1-\varsigma_d} - 1}{1-\varsigma_d}\right)\right]$$



Net returns on a loan portfolio:

$$\max\left[\left(R_{t+1}^s + \sigma_t \frac{\varepsilon_{t+1}}{Q_t}\right) l_t - R_t^d d_t, 0\right]$$

where $\varepsilon_{t+1} \sim Normal(-\xi, \tau^2)$

Equilibrium Properties

Proposition 1.

In equilibrium, capital requirements always ***bind****, i.e.* $e_t = \gamma_t l_t$.

Proposition 2.

The ***expected dividends function*** *of banks is* ***convex*** *in the risk parameter,* σ_t*. It holds for arbitrary (not necessarily continuous) distributions of the idiosyncratic shock.*

Corollary.

- *There are* ***no*** *equilibria with* $\underline{\sigma} < \sigma_t < \bar{\sigma}$.

Implications for Bank Optimization

- Which corner is chosen, $\underline{\sigma}$ or $\bar{\sigma}$, depends on a comparison of risk adjusted expected returns (from the perspective of equity holders).
- Risk-taking incentive increases:
  - When expected returns on the safe assets fall (banks may "seek higher yields" when safe returns are low).
  - If the volatility (τ) of the returns on risky assets increases (financial innovations may lead to excessive risk taking).

More Details

Optimal (Ramsey) Policy

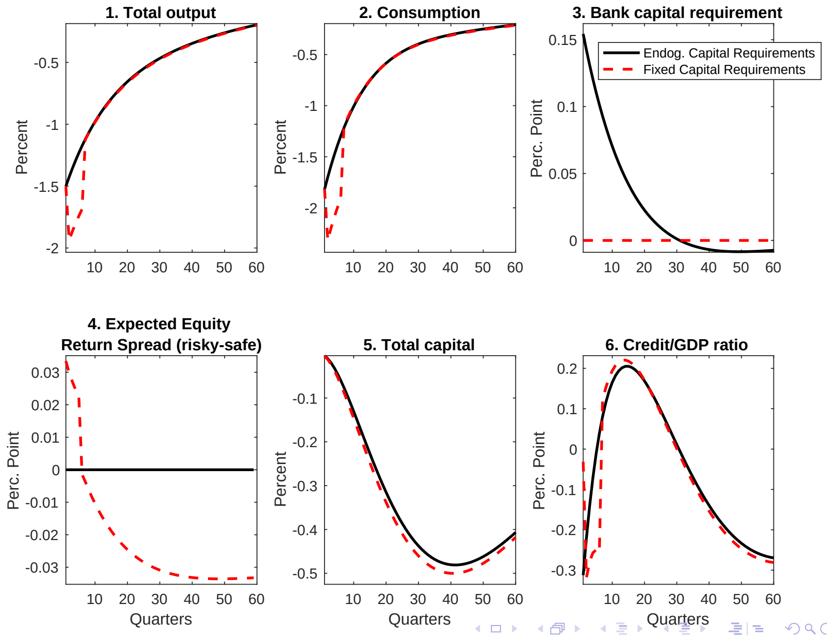
- We focus on the Ramsey problem, conditional on the restrictions of the decentralized equilibrium.
- Define γ_t^* as the lowest capital requirement that keeps banks at the safe corner, at date t.
- The Ramsey problem has a local maximum at $\gamma_t = \gamma_t^*$.
- We compare this (numerically) to alternatives with $\gamma_t = 0$ over various horizons, using a variant of the OccBin algorithm of Guerrieri and Iacoviello (2015). More Details
- Under our calibration, $\gamma_t = \gamma_t^*$ is optimal.

Contractionary TFP Shock

- Consider a contractionary TFP shock (with some persistence)
  1. Under a constant capital requirement.
  2. Under the Ramsey policy.
- The shock reduces expected returns and aggravates risk-taking incentives.
- Ramsey policy raises γ_t.

Contrary to Basel III guidance, the optimal capital requirement rises during a business-cycle contraction (in which the credit/GDP ratio is depressed).

Contractionary TFP Shock



Other Shocks

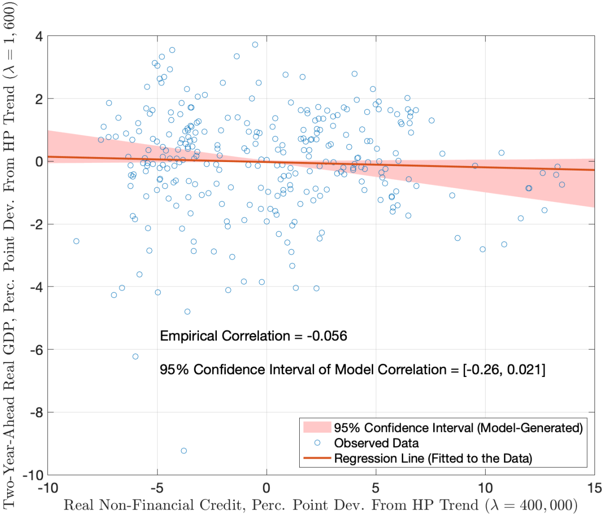
- A positive investment-specific shock (to productivity of capital producers) leads to a boom and also reduces safe returns (by making the capital stock larger next period). This leads the Ramsey policy to raise capital requirements during a boom.
- An increase in the volatility of the idiosyncratic shock to risky technologies increases risk-taking incentives and leads Ramsey policy to raise capital requirements But this may not have major business-cycle consequences (under the Ramsey policy).
- We also show that increases and decreases in capital requirements have asymmetric effects on bank decision making and economic outcomes. Details

Calibration

Use SMM to estimate the shock processes to match variances, correlations, and auto-correlations of GDP, investment, and the price of investment under Ramsey policy.

- We consider two variants of the shock configuration:
  1. Model with two shocks (TFP and investment-specific shocks).
  2. Model that also includes the third (volatility) shock.
- The two alternative calibrations are not statistically discernible given our choice of observed variables.

Credit-GDP (2-year ahead) Correlation: Data and Model



Simple and Implementable Rules

- Implementing the Ramsey rule places an unreasonable information requirement on regulators: it would require full knowledge of any shock hitting the economy.
- Objective: study the ability of simple rules that react to observable variables (asset prices, GDP, credit conditions) to mimic the Ramsey policy.
- To inform the simple rules, we regress the optimal capital requirement on the credit/GDP ratio, the price of investment, other state variables.

More Details

Results

- Simple rules inspired by Basel III do poorly: have a high frequency of risk-taking episodes and low ratio of deposits to output (in both exercises).
- A simple rule reacting negatively to Q_t does well in the exercise with TFP and investment-specific shocks, but not when volatility shocks are added.
- Slightly elevated capital requirements (with a small static buffer) do quite well in the exercise with two shocks (i.e., these shocks do note move γ_t^* much).
- Static buffers need to be larger in the calibration with volatility shocks (i.e., volatility shocks have bigger effects on γ_t^*).

The Performance of Simple Rules

Simple rule	R square	Coef. First variable	Quarters excessive risk-taking (per 100 years)	Average deposit under simple rule
1. Investment price	0.043	-0.066	6.0	15.830
2. Expected banking spread	0.613	0.773	6.8	15.802
3. GDP	0.000	-0.001	6.8	15.805
4. Credit/GDP	0.016	-0.005	7.2	15.788
5. Credit/GDP wih pos.coef	0.000	0.005	6.8	15.805
6. All shock processes, innovations, expected safe return and deposit rate	1.000	Too many to show	0	16.061
7. All shock processes, innovations, and lagged capital requirement	1.000	Too many to show	0	16.061

Including a static buffer of 100 basis points

Static Buffers

Without volatility shocks | With volatility shocks

Static Buffer	Number of quarters with excessive risk-taking (per 100 years)	Average deposit	Number of quarters with excessive risk-taking (per 100 years)	Average deposit
10 bp	149.2	10.261	210.8	7.678
20 bp	66.8	13.526	172.0	9.216
30 bp	10.8	15.785	140.8	10.479
40 bp	0	16.189	108.8	11.784
50 bp	0	16.171	79.2	12.920
100 bp	0	16.081	6.8	15.805
150 bp	0	15.991	0	15.991
Optimal Rule	0	16.251	0	16.241

Conclusion

In our model with endogenous risk taking, optimal capital requirements

- can fall or rise during a boom depending on the underlying shock (TFP or investment-specific shock).
- are more sensitive to volatility shocks (compared to our two business-cycle shocks).
- are not robustly related to capital requirements that follow simple rules.
- are almost matched in performance by a static capital requirement.

Households

Back

- Households maximize utility

$$\max_{C_t, D_t, E_t^s, E_t^r} E \sum_{t=0}^{\infty} \beta^t \left[\frac{(C_t - \kappa C_{t-1})^{1-\varsigma_c} - 1}{1 - \varsigma_c} + \varsigma_0 \frac{D_t^{1-\varsigma_d} - 1}{1 - \varsigma_d} \right],$$

subject to

$$C_t + D_t + E_t^s + E_t^r =$$
$$W_t + R_{t-1}^d D_{t-1} + R_t^{e,s} E_{t-1}^s + R_t^{e,r} E_{t-1}^r - T_t,$$
$$E_t^s \geq 0,$$
$$E_t^r \geq 0.$$

- There are two types of banks specialized in financing safe or risky projects. Equity allocations to each type of bank E_t^s and E_t^r must be non-negative.
- Utility function captures preference for liquidity services offered by deposits (akin to money-in-the-utility specification).

Banks ◂ Back

- Two types of banks:
  1. Safe: lend to firms subject to aggregate shocks only (loans yield R^s_{t+1}).
  2. Risky: lend to risky firms subject to both aggregate and idiosyncratic shocks (loans yield $R^s_{t+1} + \sigma_t \frac{\varepsilon_{t+1}}{Q_t}$).
- The idiosyncratic shock, ε_{t+1} follows a Normal distribution G with a negative mean, $-\xi$, and standard deviation τ,

$$\text{PDF of } \varepsilon_{t+1}, \quad g(\varepsilon_{t+1}) = \frac{1}{\sqrt{2\pi\tau^2}} e^{-\frac{(\varepsilon_{t+1}+\xi)^2}{2\tau^2}},$$

$$\text{CDF of } \varepsilon_{t+1}, \quad G(\varepsilon_{t+1}) = \frac{1}{2}\left[1 + \text{erf}\left(\frac{\varepsilon_{t+1} + \xi}{\tau\sqrt{2}}\right)\right],$$

where $\text{erf}(x) = \frac{1}{\sqrt{\pi}} \int_{-x}^{x} e^{-v^2} dv = \frac{2}{\sqrt{\pi}} \int_0^x e^{-v^2} dv$.

Risky Banks (continued) Back

- Define $np_{t+1} \equiv \left(R^s_{t+1} + \sigma_t \frac{\varepsilon_{t+1}}{Q_t}\right) l_t - R^d_t d_t$.
- An individual bank solves

$$\max_{l_t, d_t, e_t, \sigma_t} E_t \left\{ \beta \frac{\lambda_{ct+1}}{\lambda_{ct}} \left[\int_{\varepsilon^*_{t+1}}^{\infty} np_{t+1} \, \mathrm{d}G(\varepsilon_{t+1}) \right] \right\} - e_t,$$

subject to

$$l_t = e_t + d_t,$$
$$e_t \geq \gamma_t l_t,$$
$$l_t \geq 0,$$
$$\underline{\sigma} \leq \sigma_t \leq \bar{\sigma}.$$

Goods Producing Firms Back

- Operate for two periods:
  1. In the first period, they finance the purchase of capital;
  2. In the second period, they produce and repay the banks.
- Firms write equity contracts with banks (take out loans, with some poetic license) in period t:

$$I_t^f = Q_t k_{t+1},$$

- Safe firms maximize profits

$$\max_{I_t^{f,s}, k_{t+1}^s} E_t \left\{ \max_{h_{t+1}^s} \left[y_{t+1}^s + (1-\delta) Q_{t+1} k_{t+1}^s - W_{t+1} h_{t+1}^s - R_{t+1}^s I_t^{f,s} \right] \right\}.$$

where $y_{t+1}^s = A_{t+1}(k_{t+1}^s)^\alpha (h_{t+1}^s)^{1-\alpha}$.

- From the first-order conditions for this problem, we can show that the expected return to safe loans, used above is

$$E_t R_{t+1}^s = \alpha E_t \left\{ \frac{A_{t+1}}{Q_t} \left(\frac{h_{t+1}^s}{k_{t+1}^s} \right)^{1-\alpha} + (1-\delta) \frac{Q_{t+1}}{Q_t} \right\},$$

Risky Firms Back

- Risky firms maximize profits

$$\max_{I_t^{f,r}, k_{t+1}^r} E_t \left\{ \max_{h_{t+1}^r} \left[y_{t+1}^r + (1-\delta) Q_{t+1} k_{t+1}^r - W_{t+1} h_{t+1}^r - R_{t+1}^r I_t^{f,r} \right] \right\},$$

s.t. $y_{t+1}^r = A_{t+1} \left(k_{t+1}^r\right)^{\alpha} \left(h_{t+1}^r\right)^{1-\alpha} + \varepsilon_{t+1} k_{t+1}^r$ and $Q_t k_{t+1}^r = I_t^r$.

- the first order conditions for labor in period $t+1$ imply the capital labor ratios equalize across sectors:

$$k_{t+1}^r / h_{t+1}^r = k_{t+1}^s / h_{t+1}^s.$$

- Combining the equation with the first order conditions for the maximization and the zero profit condition for firms, it implies

$$E_t R_{t+1}^r = E_t R_{t+1}^s - \frac{\xi}{Q_t}.$$

Capital-Producing Firms

Back

- At the end of period t, competitive capital-producing firms buy capital from firms and then repair depreciated capital and build new capital.
- Capital evolves: $K_{t+1} + K^r_{t+1} = I^n_t + (1-\delta)\left(K_t + K^r_t\right).$
- Supply of investment goods: $I^n_t = isp_t\left[1 - \frac{\phi}{2}\left(\frac{I^g_t}{I^g_{t-1}} - 1\right)^2\right] I^g_t.$
- The production of investment goods is subject to an investment-specific technology shock, isp_t.
- Capital-producing firms solve:

$$\max_{I^g_{t+i}} E_t \sum_{i=0}^{\infty} \psi_{t,t+i}\left[Q_{t+i}\, isp_{t+i}\left[1 - \frac{\phi}{2}\left(\frac{I^g_{t+i}}{I^g_{t+i-1}} - 1\right)^2\right] I^g_{t+i} - I^g_{t+i}\right].$$

The Government ◂ Back

- Deposit insurance requires the government to raise taxes.
- Taxes cover any losses incurred by the government from running the deposit insurance scheme.
- Lump sum taxes, T_t, balance the budget each period.

Interpreting Expected Dividends ▸ Back

- Define $\varepsilon^*_{t+1} = -\frac{Q_t}{\sigma_t}\left[R^s_{t+1} - R^d_t\left(1-\gamma_t\right)\right]$, this is the threshold below which the realization of the idiosyncratic shock triggers the shield of limited liability.
- Expected dividends are given by

$$\Omega(\sigma_t;\ l_t,\ d_t,\ e_t) = E_t\left[\beta\frac{\lambda_{ct+1}}{\lambda_{ct}} l_t\left(\omega_1+\omega_2\right)\right], \quad \text{where}$$

$$[\omega_1+\omega_2] = \left[\underbrace{\left(R^s_{t+1} - R^d_t\left(1-\gamma_t\right) - \frac{\xi\sigma_t}{Q_t}\right)\underbrace{\left(1-G(\varepsilon^*_{t+1})\right)}_{\text{non-defaulted}}}_{\substack{\omega_1 \equiv \text{ returns from a loan} \\ \text{portfolio with riskiness } \sigma_t}} + \underbrace{\left(\frac{\sigma_t}{Q_t}\right)\frac{\tau}{\sqrt{2\pi}}e^{-\left(\frac{\varepsilon^*_{t+1}+\xi}{\tau\sqrt{2}}\right)^2}}_{\substack{\omega_2 \equiv \text{ bonus from} \\ \text{limited liability}}}\right].$$

Comparing Expected Dividends ▸ Back

- Compare the (future) dividends for safe and risky banks

$$\Omega_t^s = E_t\left[\nu_{t+1} l_t \left(R_{t+1}^s - R_t^d(1-\gamma_t)\right)\right] \text{ and}$$

$$\Omega_t^r = E_t\left[\nu_{t+1} l_t \left(\left(R_{t+1}^s - R_t^d(1-\gamma_t) - \frac{\xi}{Q_t}\right)(1 - G(\varepsilon_{t+1}^*)) + \left(\frac{1}{Q_t}\right)\frac{\tau}{\sqrt{2\pi}} e^{-\left(\frac{\varepsilon_{t+1}^*+\xi}{\tau\sqrt{2}}\right)^2}\right)\right],$$

where $\nu_{t+1} \equiv \beta\frac{\lambda_{ct+1}}{\lambda_{ct}}$.

- All else equal, when the interest rate spread $R_{t+1}^s - R_t^d(1-\gamma_t)$ declines and $(1 - G(\varepsilon_{t+1}^*)) < 1$, then Ω^s falls relatively more than Ω^r.
- We cannot have both Ω_t^r and Ω_t^s in equilibrium. We track the expected spread between the returns on risky and safe equity:

$$S_t \equiv E_t\left[R_{t+1}^{e,r} - R_{t+1}^{e,s}\right].$$

Details of the Ramsey Policy

- In response to shocks we check whether setting capital requirements to zero becomes optimal
- We consider a horizon N.
- We check all possible combinations of periods from 1 to N-1 in which capital requirements are imposed to be 0.
- For each case, we record the conditional welfare and compare it against the conditional; welfare of keeping capital requirement at their (postulated optimal) nonzero value. Back

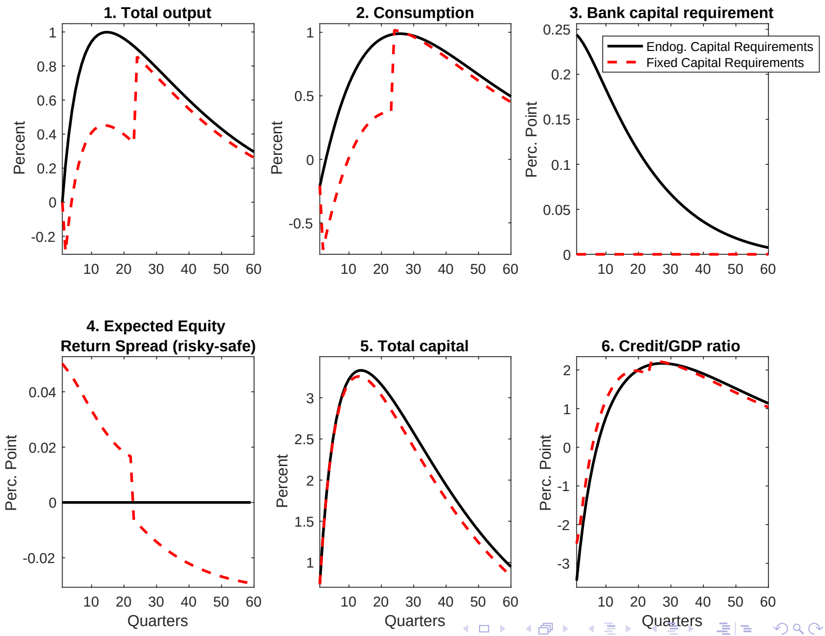
Numerical Methods

- We impose nonnegativity constraints on loans to rule out the short-selling of assets:
  1. In a mixed regime with both safe and risky loans financed, arbitrageurs would force the expected returns on safe and risky loans to align.
  2. In a regime with only safe loans, banks would want to short risky loans.
  3. In a regime with only risky loans, banks would want to short safe loans.
- We solve the model by applying the OccBin toolkit developed in Guerrieri and Iacoviello (2015).
- The short-selling constraints are enforced using complementary slackness conditions.

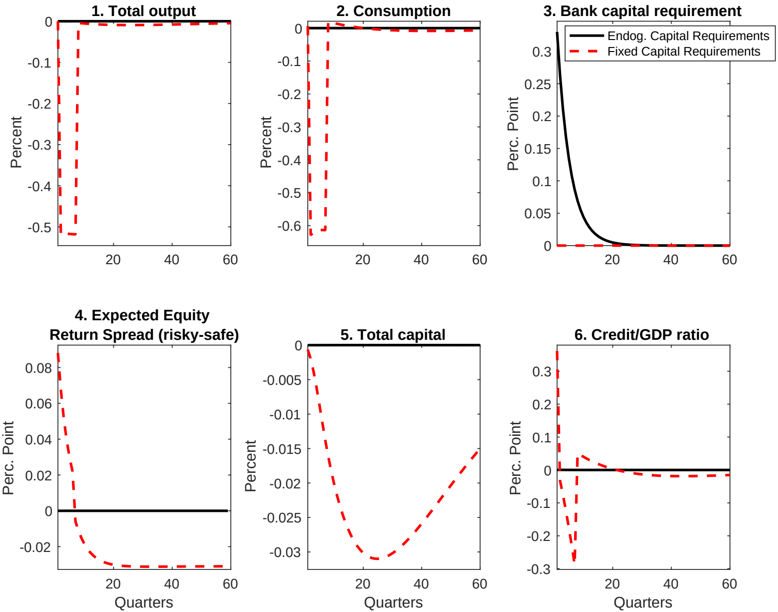
Back

Expansionary Investment Technology Shock

▸ Back



Volatility Shock for Risky Projects ‣ Back



The Effects of Shocks to Capital Requirements

- The Modigliani-Miller theorem does not hold in our model
- Even without regime shifts, increases in capital requirements can have real effects
- An increase in capital requirements acts like a tax hike on banks
- Households, who own the banks, are made poorer and would like to cut back on consumption and increase savings in the form of deposits.
- However, in our model, these effects are negligible for small changes in capital requirements.
- For increases in capital requirements, what happens in the financial sectors effectively stays in the financial sector.

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An Increase in Capital Requirements

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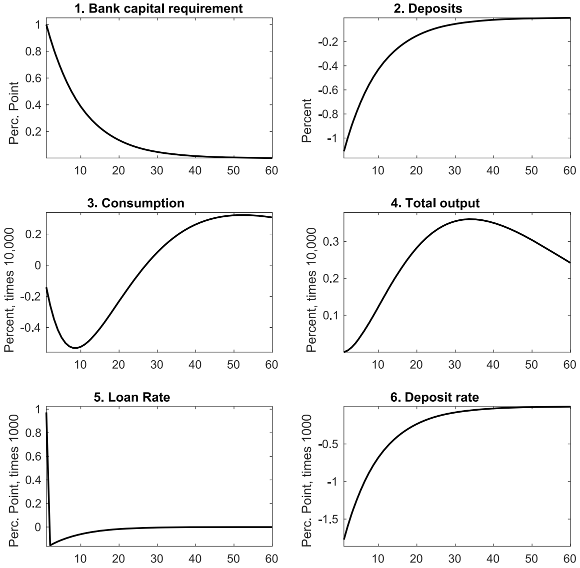

Asymmetric Effects of Capital Requirements

- Decreases in capital requirements immediately tilt the returns towards excessive risk-taking.
- Risky firms produce less on average and production, investment and consumption fall.
- The shift to excessive risk-taking is reversed as the shock dissipates.

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Increases and Decreases in Capital Requirements

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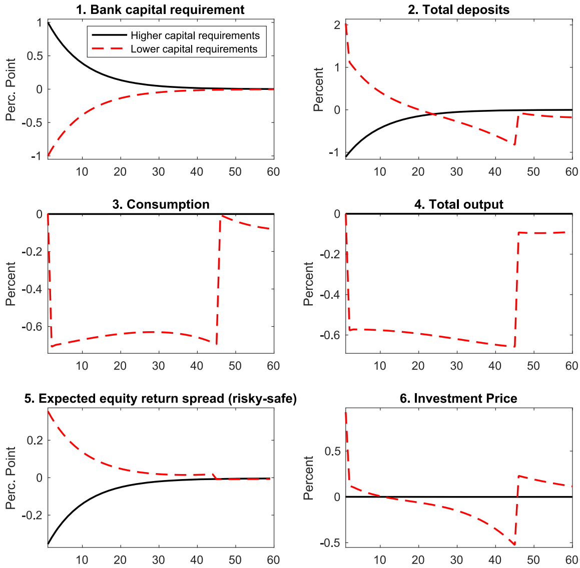
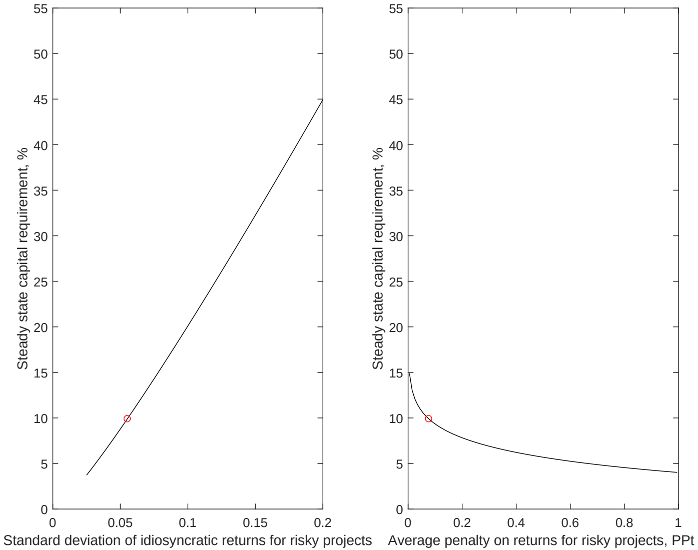


Calibration ▸ Back



Devising simple rules

To explore simple rules systematically we devise this scheme:

- We regress the Ramsey optimal capital requirements from a long sample of simulated data on each state variable (excluding shocks).
- We check the performance of these simple rules allowing for the implied regime shifts (as established the Ramsey policy avoids the risky regime).
- We repeat this method for all possible combinations of two state variables.
- We also consider some interesting candidate rules outside this scheme.

Back

Assessing the simple rules

- We assess the simple rules by focusing on two summary statistics:
  1. Average number of quarters with excessive-risk taking per 100 year period.
  2. The average amount of deposits.
  3. The best rules are able to avoid risk-taking without compressing the liquidity value of deposits.
- Note that in the assessment we also allow for static buffers of various sizes.

Back