Capital Regulation and Credit Fluctuations

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Content

1 Motivation (1)

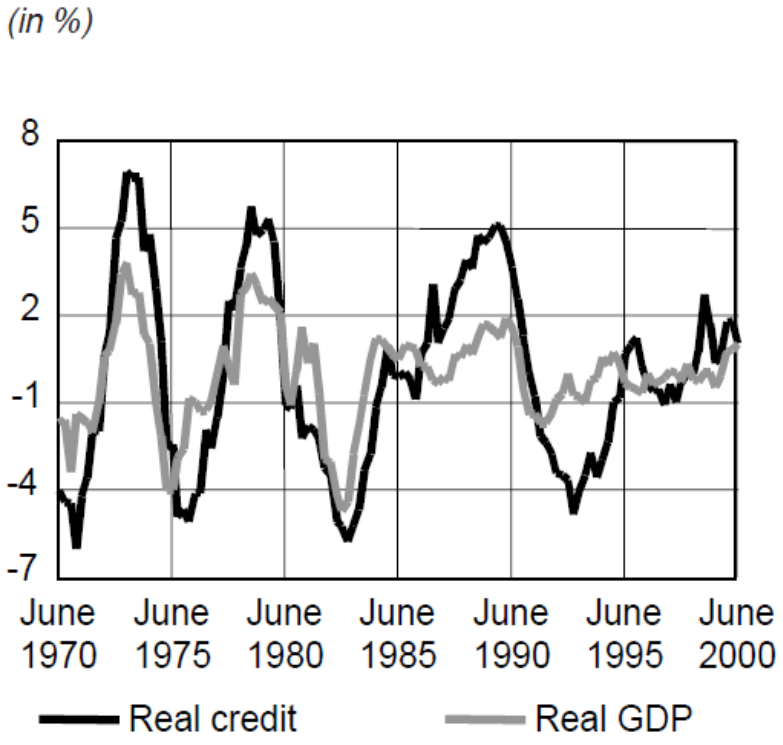
- The newly-established **macro-prudential regulators** are considering the implementation of **counter-cyclical capital ratios**, i.e. imposing tighter capital requirements in booms.
- Yet, the conceptional foundations for such a regulation are not totally clear.
- The presumption is that **banks tend to lend too much during booms and too little during downturns**, generating excessive fluctuations of credit, output and asset prices.

1 Motivation (2)

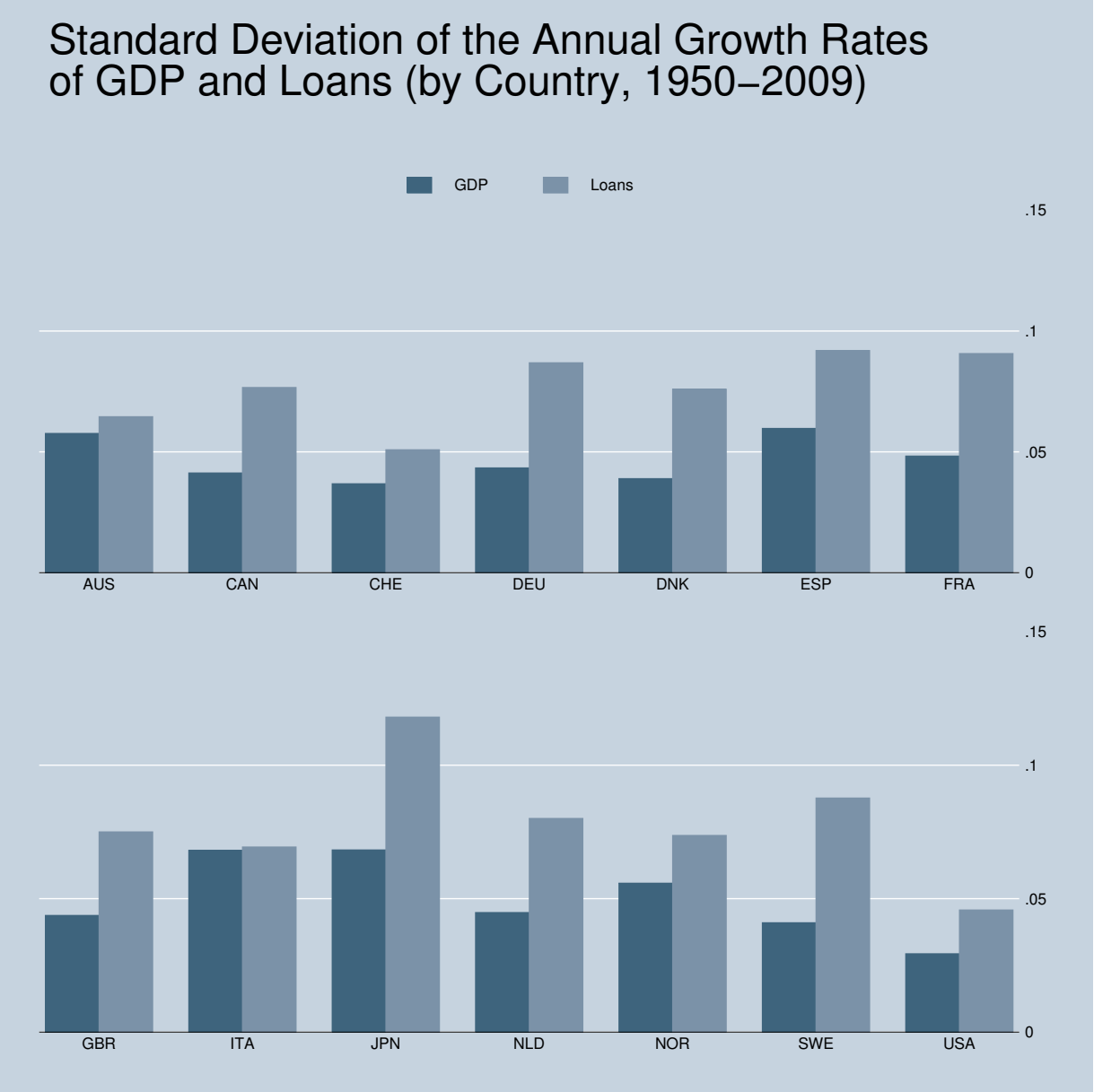
Over the period 1970-2000, **credit growth** in the USA was highly correlated with GDP growth, but **more volatile** (source: IMF International Statistics, 2000).

Similarly, Meh and Moran (2010) find that from 1990 to 2005, the **standard deviation of bank lending** in the USA was 4.52 times that of GDP

Real credit and GDP cycles
(% deviation from trend)
United States



1 Motivation (3)



2 Contribution (1)

- Simple model of credit fluctuations.
- Conceptional foundation of counter-cyclical capital ratios.
- It results from the **interplay of 3 ingredients** characterizing modern banks:
  - Endogenous leverage constraints in booms and downturns, due to financial frictions,
  - High exposure to aggregate shocks,
  - Access to (complete) financial markets.

2 Contribution (2)

The interplay of these 3 ingredients has interesting consequences:

(1) Misallocation of borrowing capacity across good and bad states (too much in booms, too little in downturns).

(2) Excessive volatility of bank-lending, capital prices and wages.

(3) (1) and (2) can be corrected by imposing a (stricter) capital ratio **during booms**.

(4) Such regulation corrects the misallocation of borrowing capacity, and is an effective stabilization tool.

(5) Classical capital ratios can be bypassed (and ex ante capital has to be used).

2 Contribution (3)

Broader regulatory context

- Our paper shows that **credit cycles can be detrimental to welfare even if there are no banking crises**.
  - Broader mandate for macroprudential authorities.
  - Good news for supervisors: credit growth is easier to measure than the probability of a banking crisis!
- Complement to the literature on endogenous banking crises, based on investors' irrationality (over-optimism à la Minsky) or on the expectation of future bail-outs (Farhi and Tirole, 2011).

3 Related Literature (1)

- Bernanke and Gertler (1989): Amplification and persistence of real shocks are due to financial frictions.
- Kiyotaki and Moore (1997): When entrepreneurs cannot fully insure (Krishnamurthy, 2003), credit constraints based on collateral value generate endogenous fluctuations.

  Entrepreneurs borrow too much (Bianchi, 2011), due to pecuniary externalities (Korinek, 2011).

3 Related Literature (2)

The most closely-related papers are

- Holmström and Tirole (1997): bank capital (and firms' net work) impact the equilibrium values of credit, investment and output.

  Difference: macro model, macro shocks, **trading of borrowing capacity**.

- Lorenzoni (2008)'s model of "inefficient credit booms".

  Difference: **trading of borrowing capacity**, banks, and simplifying the modeling of financial frictions.

- Gersbach and Rochet (2011) model of investment externalities.

  Difference: **trading of borrowing capacity** and assuming zero adjustment costs.

3 Related Literature (3)

DSGE models with a banking sector:

- Gertler-Karadi (2009), Gertler-Kiyotaki (2009): Bankers may steal a fraction of the assets they manage. This imposes an Incentive Compatibility constraint: a bank's equity must always be a sufficient fraction of its assets value.
- Christensen-Meh-Moran (2011): Double moral hazard model of HolmstrÃ¶m-Tirole (1997) + probability of systemic crisis.
- Angeloni-Faia (2011) use the model of Diamond-Rajan (2000-2001): Bankers must be financed by a sufficient fraction of short-term debt/deposits, otherwise they steal the assets' returns. This creates a probability of a bank run.

VERY COMPLEX MODELS, TARGETED FOR MONETARY POLICY: HARD TO USE THEM FOR FINANCIAL STABILITY POLICY.

4 The Model (1)

We start with the **simplest possible model in which bank capital matters**: Small scale static macro model.

- One period: dates $t = 1, 2$.
- Two goods, capital and consumption: capital good (total endowment normalized to 1) invested at $t = 1$ to produce consumption at $t = 2$.
- All agents are risk-neutral, consume at $t = 2$.

  Social surplus: aggregate output $Y = \mathbb{E}[C_2]$.
- Three types of agents:
  - Continuum of bankers, aggregate wealth E (individual wealth e)
  - Continuum of investors, aggregate wealth $1 - E$
  - Continuum of entrepreneurs (play passive role).

4 The Model (2)

Two sectors:

- Large/established firms, borrow from financial (F) markets: aggregate size X. Aggregate production function $F(X)$.
- Small/new firms, financed by banks (must be monitored by banks. Banks alleviate moral hazard).

Typical bank lends k, aggregate credit K. Expected return on loans: R.

Note that $X + K = 1$.

- Financial friction: banker must get payment of at least bk.

  Income that can be pledged to investors: only $(R - b)k$.
- Friction can be due to moral hazard at banks (Holmström and Tirole, 1997), limited commitment (Hart and Moore, 1995), asset diversion (Gertler and Kiyotaki, 2009), ...

4 The Model (3)

So to wrap up:

- Large/transparent firms in sector F:
  Can be financed directly by investors.
- By contrast small/opaque firms in sector B:
  Must be monitored by banks. Banks themselves must be given incentives to monitor them. (Chained moral hazard.)
- This moral hazard problem limits the lending capacity of each bank to a multiple of its own wealth w.

5 Equilibrium Without Macro Shocks (1)

credit	k	e	equity
		$k-e$	deposits

typical bank's balance sheet

Expected pay-offs:

- for bankers: bk (because of moral hazard)
- for depositors: $(R-b)k$

- Investors can also sell (rent) their capital at price $p = F'(1-K)$
- Return on deposits must be at least p:

$$p \geq \frac{(R-b)k}{k-e}.$$

5 Equilibrium Without Macro Shocks (2)

- Bankers maximize leverage under participation constraint of investors:

$$p(k-e) \leq (R-b)k,$$

$$\Rightarrow \frac{e}{k} \geq 1 - \frac{R-b}{p},$$

can be interpreted as a **market imposed capital ratio**.

- Capital ratio is binding at aggregate level:

$$K = \frac{E}{1 - \frac{R-b}{p}} \equiv D(p),$$

where $D(p)$ is the demand of capital by banks, which increases in E and R, decreases in b.

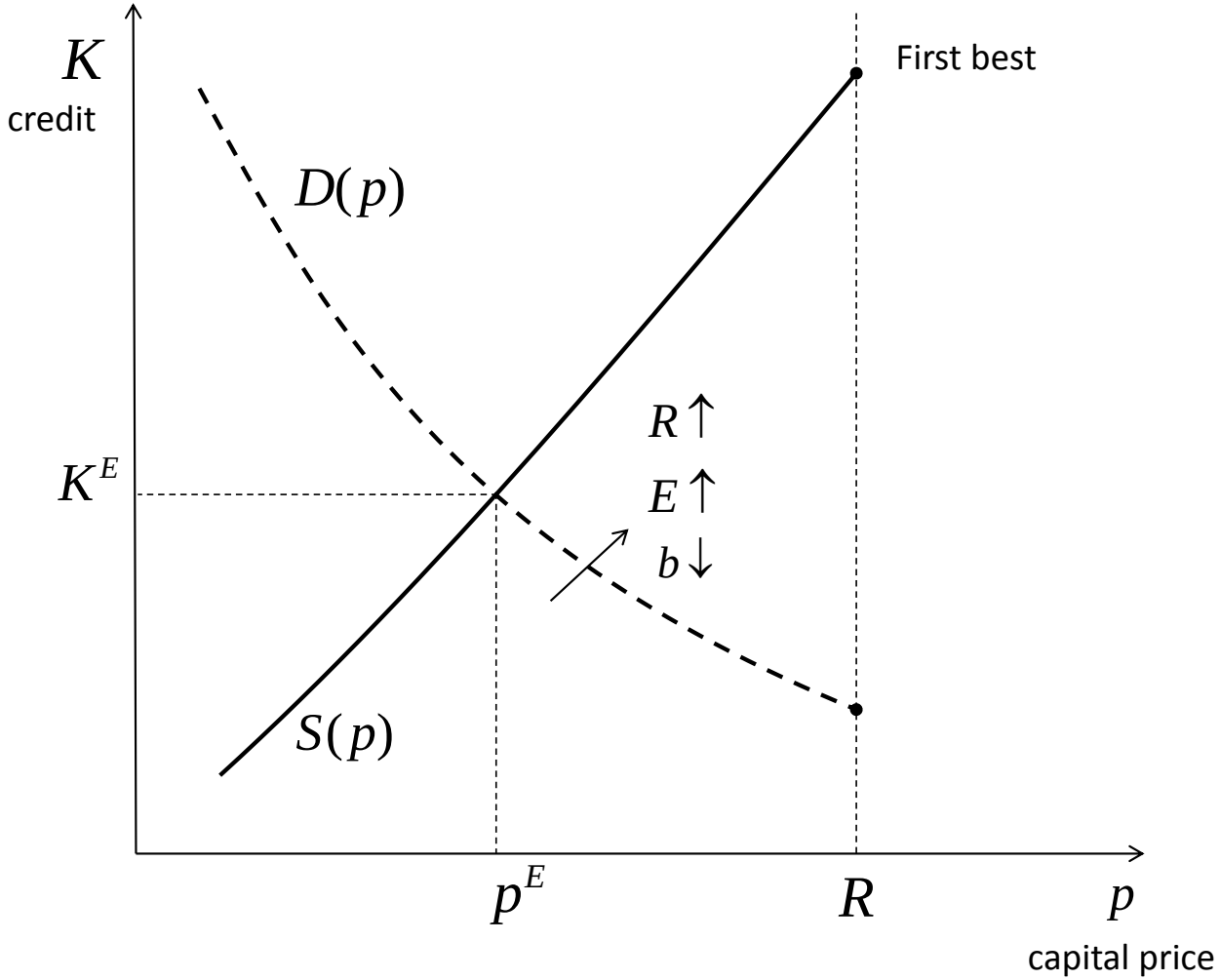
5 Equilibrium Without Macro Shocks (3)

Supply of capital to banks:

$$p = F^{'}(1 - K) \Leftrightarrow K = S(p).$$

- **Unique Competitive Equilibrium**: $S(p) = D(p)$.
- Volume of credit decreases with b (intensity of Moral Hazard), increases with E (bank capital) and R (return on banks' assets).
- Bank-lending K increases with R (pro-cyclical).
- Thus market-imposed capital ratio $\frac{E}{K}$ decreases with R.

Equilibrium Without Macro Shocks (4)



Note that $R - p^E$ can be interpreted as the **credit spread**.

6 Equilibrium With Macro Shocks (1)

- We now introduce sectoral productivity shocks:

  Return on banks' assets (loans) R_s,

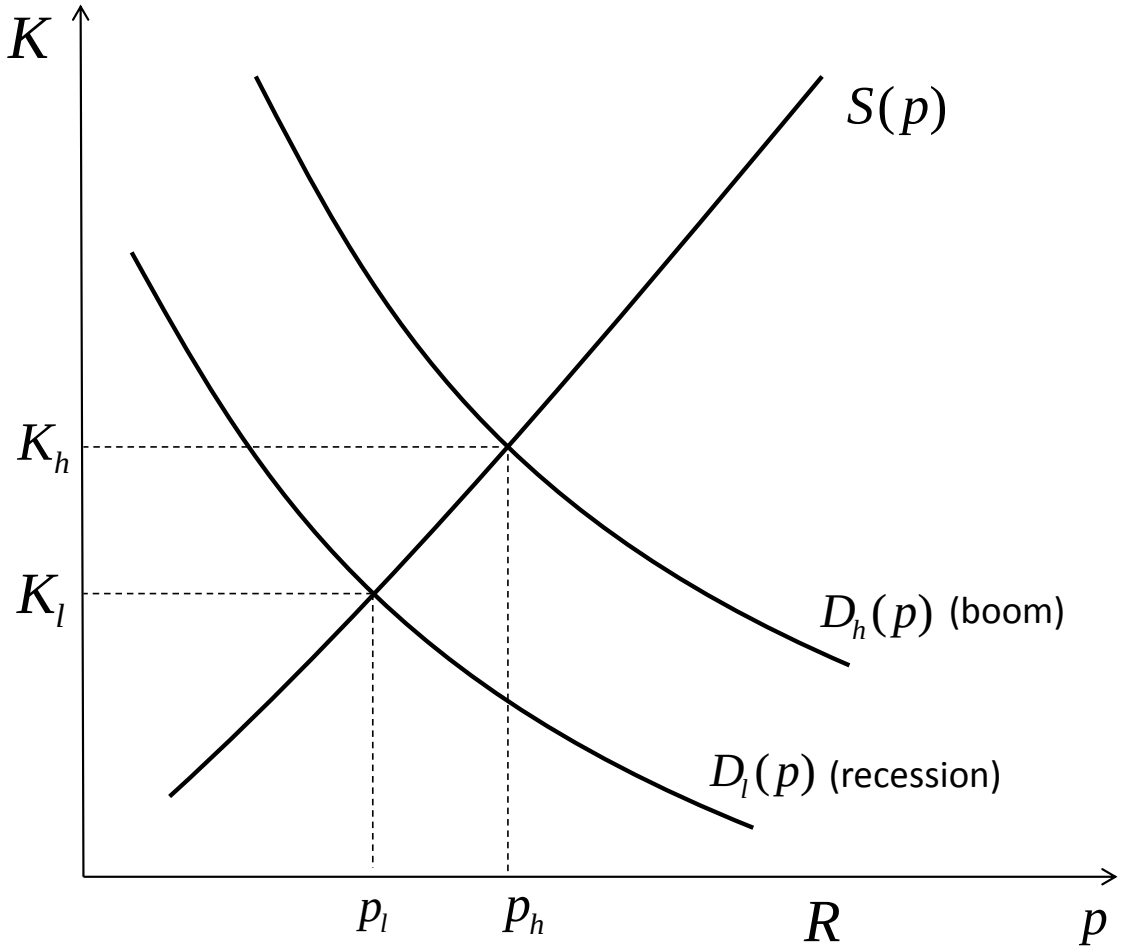
  where $s = \begin{cases} h \text{ (boom)}, \\ l \text{ (recession)} . \end{cases}$ $\quad R_h > R_l$, $\mathbb{E}[R_s] = R$

- If banks only finance themselves by (spot) deposits, productivity shocks generate high volatility of interest rates and output

$$S(p) = \frac{E}{1 - \frac{R_s - b}{p}} \equiv D_s(p).$$

$$p = p^E(R_s, E).$$

6 Equilibrium with Macro Shocks (2)



"Large" fluctuations of capital prices (horizontal axis) and credit volumes (vertical axis).

7 The Case of Complete Markets (1)

In practice banks have access to financial markets (derivatives, swaps, etc.):

- We introduce date 0 where banks and investors can trade on contingent capital markets, prior to realization of macro shock.
- Typical bank swaps $(e_h - e)$ in state h for $(e - e_l)$ in state l. (Allocates borrowing capacity across booms and downturns.)
- Risk neutrality of investors $\Rightarrow \mathbb{E}[p_s(e_s - e)] = 0$. "budget constraint" of the bank.
- Bank forms contingent plans (k_l, k_h) :

  capital needs $e_s = k_s \left(1 - \frac{R_s - b}{p_s}\right)$.

7 The Case of Complete Markets (2)

Allocation of Borrowing Capacity in t=0	Lending in t=1	Aggregate Consumption in t=2	Rents of Bankers (return on equity) in t=2
$E \rightarrow E_h$	$K_h = \dfrac{p_h E_h}{p_h R_h - b}$	$\Longrightarrow F'(1-K_h) + R_h K_h$	bK_h
$E \rightarrow E_l$	$K_l = \dfrac{p_l E_l}{p_l R_l - b}$	$\Longrightarrow F'(1-K_l) + R_l K_l$	bK_l

$$\Updownarrow \qquad\qquad \Downarrow$$

$$p_h(E_h - E) + p_l(E_l - E) = 0 \qquad \boxed{\begin{aligned} p_h &= F'(1-K_h) \\ p_l &= F'(1-K_l) \end{aligned}}$$

7 The Case of Complete Markets (3)

COMPARATIVE STATICS:

- Average credit volume $\mathbb{E}[K_s]$ and capital price p increase with banks' capital E, decrease with b (size of frictions).
- **Volatility of capital prices:** $\sigma_p \equiv \frac{p_h - p_l}{p} = \frac{R_h - R_l}{p} > \sigma_R = \frac{R_h - R_l}{R}$ decreases in E and increases in b. So does credit spread $R - p$.
- More bank capital (higher E) or more transparency (lower b) stabilizes the economy (even in the absence of banking crises).
- However ex post capital ratio $\frac{e_s}{k_s} = 1 - \frac{R_s - b}{p_s} = \frac{p - R + b}{p_s}$ is higher during recessions.
- If elasticity of capital supply is less than 1, contingent markets stabilize the economy.

8 A Role for Macro-prudential Regulation (1)

Definition: *A capital allocation* $K = (K_l, K_h)$ *is constrained efficient if it maximizes social surplus under the participation constraint of investors* $p_s \geq \frac{(R_s - b)K_s}{K_s - E_s}$ *with* $\mathbb{E}[p_s(E_s - E)] = 0$, which is equivalent to

$\mathbb{E}[p_s(R_s - b + K_s)] = \mathbb{E}[p_s]E$, where $p_s = F'(1 - K_s),\ s = l, h.$

NB: We assume that the social planner cannot tax banks assets separately from securities: same financing constraint as private banks

8 A Role for Macro-prudential Regulation (2)

Theorem

(1) *The competitive allocation K^c is (generically) constrained inefficient.*

(2) *If capital supply S is log-concave, social surplus can be increased by $\Delta K_h < 0 < \Delta K_l$.*

8 A Role for Macro-prudential Regulation (3)

- The **equilibrium volatility of credit growth rates is excessive** because **banks maximize their expected rents and take capital prices (p_h and p_l) as given** (two-dimensional pecuniary externalities).
- Even if banks are small, they all take the same decisions (same exposure to macro shocks) and therefore have an impact on prices.
- Capital prices are too high in the good state and too low in the bad state.
- This can be corrected by **imposing a capital ratio in the good state.**

8 A Role for Macro-prudential Regulation (4)

Objective: Reduce K_h, increase K_l

Forms of capital regulation

- Classical: $e_h \geq \hat{\rho} k_h, \ \hat{\rho} = \frac{E_h^*}{K_h^*}$.
  Fails as banks increase e_h and lower e_l.
- Initial/ex ante: $e \geq \rho^* k_h, \ \rho^* = \frac{E}{K_h^*}$.

9 Complement 1

- Traditional sector: $\tilde{F}(1-K, L)$, L endowment of labor, supplied inelastically.
- Standard assumptions on $\tilde{F}(\cdot, \cdot)$.

Proposition

Capital requirements $k_h \rho^* \leq e$, $\rho^* = \frac{E}{K_h^*}$ reduce wage fluctuations.

9 Complement 2: Distribution of Gains from Macro-prudential Policies

Ways to distribute output gains

- Taxing of bankers' income (monetary version).
- Taxing complementary consumption goods (cannot be substituted by non-pledgeable output in banking).
- Households with workers and bankers.

9 Complement 3: Liquidity Regulation

Companion paper Gersbach & Rochet (2011): Banks invest already at $t = 0$, but they can adjust these investments at $t = 1$, after observing macro shock. **Assumption:** bank managers **control reallocation decisions**, while shareholders **only control financing decisions**.

Then, the privately optimal contract can only be implemented if banks issue **short-term debt:**

- Bankers do not want to sell assets in a bad state, because their bonuses increase with their bank's size.
- To force them to sell assets in the bad state this, the contract must specify some debt repayment at the interim date (close to Jensen's free cash flow theory).
- Investors want banks to **downsize a lot** during recessions, thus they impose **a lot of short-term financing.**
- Our result that banks **downsize too much** during recessions implies **too much short-term financing**.

9 Complement 4 (1): Dynamic Extension (Preliminary)

- Embedding static model in dynamic macroeconomic system
- Intertemporal linkages
  - Equity in t $\underset{\substack{\uparrow \\ \text{Aggregate shocks,} \\ \text{reallocations,} \\ \text{payments}}}{\Longrightarrow}$ Equity in $t+1$ $\underset{\substack{\uparrow \\ \text{Aggregate shocks,} \\ \text{reallocations,} \\ \text{payments}}}{\Longrightarrow}$ $\cdots$
  - Saving/Investment decisions
- Equity: $W_{t+1} = bk_{t,s_t}$

9 Complement 4 (2): Dynamic Extension (Preliminary)

- Volatility of asset returns in frictionless sector is inversely-related to the bank's inside equity
  (related to the characteristics of the banking sector in general)
- Volatility cycles of bank-lending
  (intertemporal linkage of inside equity using Proposition 3)

  Negative shock $\longrightarrow$ inside equity $\Downarrow$ $\longrightarrow$ volatility of bank-lending $\Uparrow$

  If further negative shock $\longrightarrow$ volatility of bank-lending increases further, etc.

10 Conclusions (1)

- We have developed a simple model of the financial sector, where banks are characterized by three features:
  1. limited pledgeability of the banks' future returns,
  2. a common exposure to aggregate shocks,
  3. markets to reallocate borrowing capacity.
- The combination of these three features generates a misallocation of borrowing capacity across good and bad states
  - Limited pledgeability of the banks' future returns generates a leverage constraint that depends on capital prices.
  - Since banks are all exposed to the same macro shocks, they all allocate too much borrowing capacity to the good state.

10 Conclusions (2)

- Misallocation of borrowing capacity by all banks leads to boom-busts cycles and excessive volatility of credit, output and capital prices.
- Counter-cyclical capital ratios can correct this market failure.
- Note that the relevant measure of bank capital for macro-prudential purposes is **inside equity** (skin in the game of banks' insiders). This is quite different from capital to be used to absorb losses (they include long-term debt and outside equity).
- Pigouvian taxation is a theoretical alternative instrument for internalizing externalities (price vs. quantities), but we find it much more difficult to implement in practice.

10 Conclusions (3): Comparison with Collateral-based Models

Debt deflation models that build upon Bernanke and Gertler (1983) and Kiyotaki and Moore (1997) **depict the relation between small borrowers and banks well**:

- small borrowers are typically **credit-constrained only in bad times** (crisis periods)
- their credit limit only depends **on the value of their collateral** (their future income is not pledgeable)
- they **cannot access derivatives markets** to hedge against fluctuations of collateral prices.

10 Conclusions (4): Comparison With Collateral-based Models

By contrast, we look at the **impact of bank capital** on macro variables.

Thus our model focuses on the **banks-investors relation**:

- banks are **always credit-constrained**. They maximize leverage.
- their **credit limits depend** on their level of their own wealth and **on their future income** (they can pledge some fraction of it)
- **banks can access derivatives markets** to reallocate their borrowing capacity (we assume complete markets; only friction: moral hazard).

Moreover, our model also explains credit booms (symmetric externality) and the **role of macro-prudential regulation even in the absence of banking crises.**

THANK YOU FOR YOUR ATTENTION

Backup

Backup (1): The Case of Complete Markets

- Budget constraint of the bank becomes:

$$\mathbb{E}[k_s(p_s - R_s + b)] = pe,$$

where $p \equiv \mathbb{E}(p_s)$ is the future price of capital

- Banks choose (k_h, k_l) that maximize their expected return on inside equity $b\mathbb{E}[k_s]$ under this constraint. In any interior solution, it must be that:

$$p_s - R_s + b = p - R + b; \quad s = h, l.$$

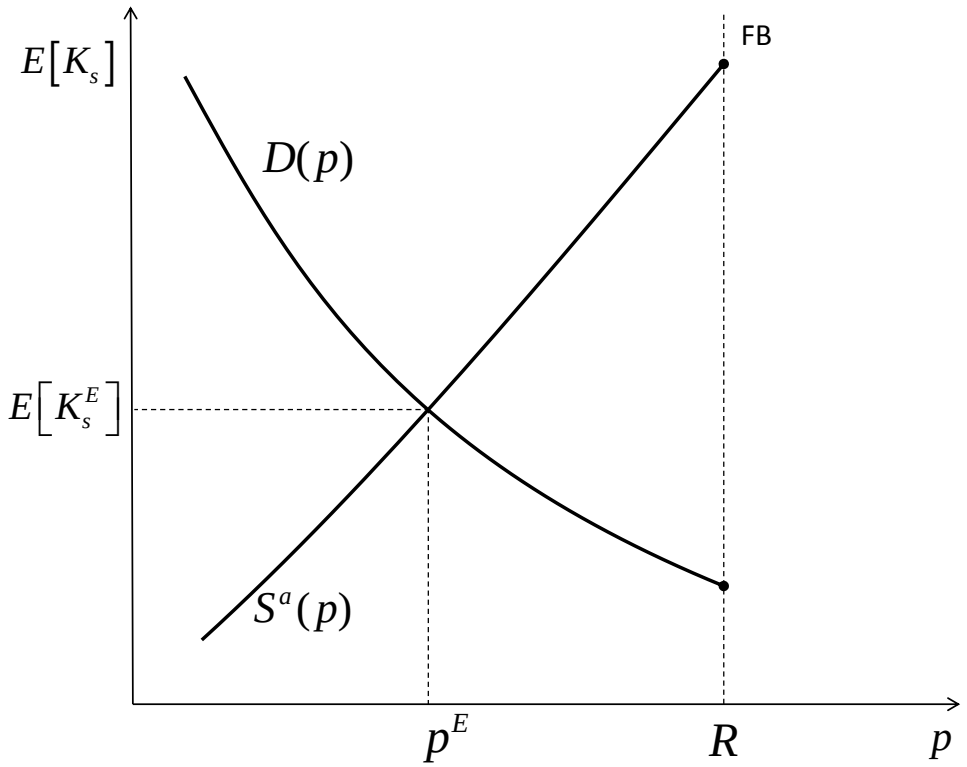
- By aggregation of budget constraints, we obtain an equilibrium condition on p:

$$(p - R + b)\mathbb{E}[K_s] = pE.$$

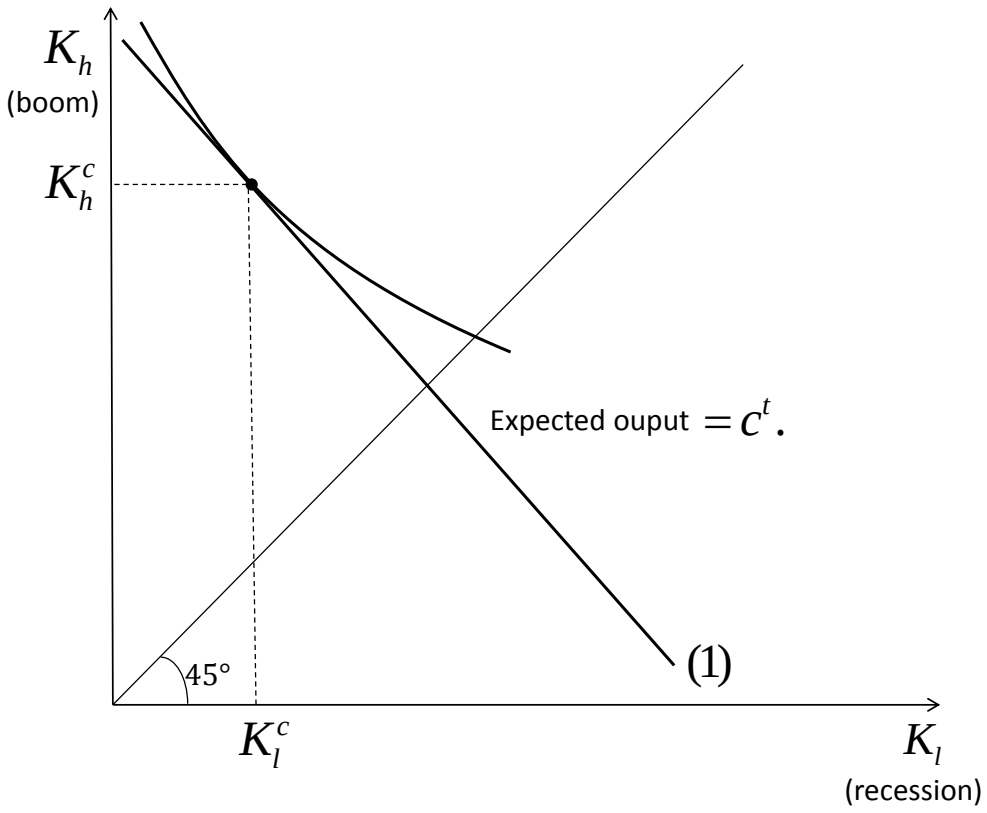
Backup (2): The Case of Complete Markets

Equilibrium capital prices fluctuate one to one with productivity shocks: $p_s = R_s - R + p$. Futures price of capital p determined by:

$$S^a(p) \equiv \mathbb{E}[S(R_s - R + p)] = \frac{E}{1 - \frac{R-b}{p}} \equiv D(p).$$



Backup (3): A Role for Macro-prudential Regulation



Aggregate leverage constraint faced by banks, **capital prices being taken as given**

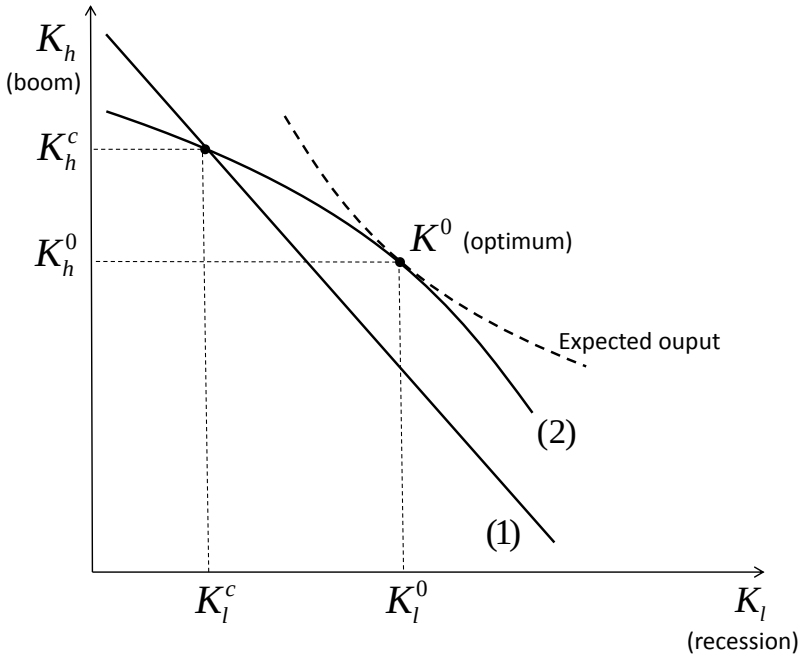
$$\mathbb{E}[(K_s - E)p_s] = \mathbb{E}[(R_s - b)K_s]. \tag{1}$$

Backup (4): A Role for Macro-prudential Regulation

A Central Planner maximizes output under

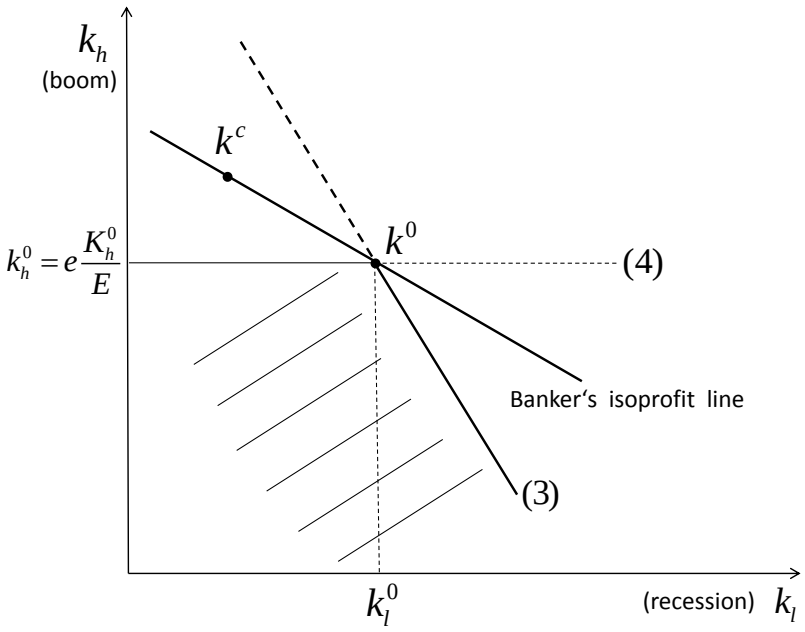
$$G(K) \equiv \mathbb{E}[(K_s - E)F'(1 - K_s) - (R_s - b)K_s] = 0. \tag{2}$$

Constraints (1) and (2) intersect at K_l^c, K_h^c, but the second has a smaller slope.



Intuition: $\Delta G = \mathbb{E}[\Delta K_s(p_s - R_s + b - F''(1 - K_s)(K_s - E))]$. When S is log-concave, $-K(F''(1 - K))$ is increasing in K and additional term $-F''(1 - K_s)(K_s - E)$ bigger for $s = h$.

Backup (5): A Role for Macro-prudential Regulation



Max $b\mathbb{E}[k_s]$ under the constraints

$$\mathbb{E}[(k_s - e)p_s^0] \leq \mathbb{E}[(R_s - b)k_s] \tag{3}$$

$$k_h \leq e\frac{K_h^0}{E}. \tag{4}$$

By imposing an upper bound on credit in the good state h (minimum capital ratio) the regulator can restore optimality.

Backup (6): Complement 4: Dynamic Extension (Preliminary)

- Our model could provide a useful building block for a DSGE model in which bank capital matters.
- To see this, we have started investigating a dynamic extension of our model:

$$E_{t+1} = bK_{t,s_t}$$

E_{t+1}: aggregate bank capital at $t+1$
bK_t^s: profit from period t in state s (reinvested in the banks)

$$K_{t+1} = S(p_{t+1}) = S(p^E(R_t, E_{t+1})),$$

where $p^E(R, E)$ is the equilibrium price of capital in the static model.

- This generates **persistence for credit volumes and capital prices, both in levels and volatilities**.

Back-Up (7): Motivation

- Conceptional foundations for **macro-prudential regulations** are still vague. Possible directions:
  - **Resilience of the financial system**
    Limiting probability and cost of systemic crises, avoiding contagious failures, protecting financial infrastructures...
  - **Moderating credit cycles**
    Banks may lend too much during booms and too little during downturns (excessive fluctuations of credit, output and asset prices)

    This paper:
    Excessive fluctuations of bank-lending?
    How can credit cycles be moderated?

Back-Up (8): The Dynamic Model

Proposition

(i) *There exist volatility cycles of bank-lending.*

(ii) *Economy may grow out of financial frictions.*

(iii) *Economy may deviate from frictionless allocation by a wide margin (large welfare losses).*

(iv) *Financial intermediation becomes arbitrarily small with positive probability in finite time.*

Remarks: constant, possibly small productivity risk

Implications: Moderating lending cycles yields “large” expected welfare gains.

Back-Up (9): The Dynamic Model – Illustration

$$
\begin{aligned}
\text{Negative shock in } t &\rightarrow \text{Equity } \Downarrow \text{ in } t+1, \text{ bank-lending in } t+1 \Downarrow \\
&\rightarrow \text{Volatility of bank-lending in } t+2 \Uparrow \\
\text{Negative shock in } t+1 &\rightarrow \text{Equity } \Downarrow \text{ in } t+2, \text{ bank-lending in } t+2 \Downarrow\Downarrow \\
&\rightarrow \text{Volatility of bank-lending in } t+3 \Uparrow \\
&\vdots \\
&\rightarrow \text{Bank-lending may become arbitrarily small}
\end{aligned}
$$