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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.
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.
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.
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).
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).
Bernanke and Gertler (1989): Amplification and persistence of real shocks are due to financial frictions.

The most closely-related papers are


- Lorenzoni (2008)’s model of “inefficient credit booms”. Difference: trading of borrowing capacity, banks, and simplifying the modeling of financial frictions.

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.


- 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.**
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 $Y = E[C_2]$.
- **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).
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 $w$. 
Equilibrium Without Macro Shocks (1)

A typical bank's balance sheet:

- **Credit**
- **Equity**
- **Deposits**

**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 $p$:

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

- Thus market-imposed capital ratio \( \frac{E}{K} \) decreases with \( R \).
Note that $R - p^E$ can be interpreted as the **credit spread**.
We now introduce sectoral productivity shocks:

Return on banks’ assets (loans) $R_s$,

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

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

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

$$p = p^E(R_s, E).$$
“Large” fluctuations of capital prices (horizontal axis) and credit volumes (vertical axis).
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 \(e_s = k_s \left(1 - \frac{R_s - b}{p_s}\right)\).
Allocation of Borrowing Capacity in t=0

\[ E \xrightarrow{} E_h \xrightarrow{} K_h = \frac{p_h E_h}{p_h R_h - b} \xrightarrow{} F'(1 - K_h) + R_h K_h \]

\[ E \xrightarrow{} E_l \xrightarrow{} K_l = \frac{p_l E_l}{p_l R_l - b} \xrightarrow{} F'(1 - K_l) + R_l K_l \]

\[ p_h (E_h - E) + p_l (E_l - E) = 0 \]

\[ p_h = F'(1 - K_h) \]
\[ p_l = F'(1 - K_l) \]

Lending in t=1

Aggregate Consumption in t=2

Rents of Bankers (return on equity) in t=2
**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.
Definition: A capital allocation \( K = (K_l, K_h) \) is constrained efficient if it maximizes social surplus under the participation constraint of investors

\[ p_s \geq \frac{(R_s-b)K_s}{K_s-E_s} \quad \text{with} \quad \mathbb{E}[p_s(E_s - E)] = 0, \]

which is equivalent to

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

NB: We assume that the social planner cannot tax banks assets separately from securities: same financing constraint as private banks.
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 $\Delta K_h < 0 < \Delta K_l$. 
The equilibrium volatility of credit growth rates is excessive because banks maximize their expected rents and take capital prices \((p_h \text{ and } p_l)\) as given \(\text{two-dimensional pecuniary externalities)}\).

Even if banks are small, they all take the same decisions \(\text{same exposure to macro shocks)}\) 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.
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**: $e \geq \rho^* k_h$, $\rho^* = \frac{E}{K^*_{h}}$. 
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.
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**.
Embedding static model in dynamic macroeconomic system

Intertemporal linkages

- Equity in $t$ $\implies$ Equity in $t+1$ $\implies$ ... \\
  Aggregate shocks, reallocations, payments \\
  Aggregate shocks, reallocations, payments

- Saving/Investment decisions

Equity: $W_{t+1} = bk_{t,s_t}$
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 $\rightarrow$ inside equity $\downarrow$ $\rightarrow$ volatility of bank-lending $\uparrow$

If further negative shock $\rightarrow$ volatility of bank-lending increases further, etc.
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.
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.
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.
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 (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 \( p \):

\[ (p - R + b)\mathbb{E}[K_s] = pE. \]
Equilibrium capital prices fluctuate one to one with productivity shocks: \( p_s = R_s - R + p \). Futures price of capital \( p \) determined by:

\[
S^a(p) \equiv \mathbb{E}[S(R_s - R + p)] = \frac{E}{1 - \frac{R - b}{p}} \equiv D(p).
\]
Aggregate leverage constraint faced by banks, capital prices being taken as given

\[ E[(K_s - E)p_s] = E[(R_s - b)K_s]. \]
A Central Planner maximizes output under

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

(2)

Constraints (1) and (2) intersect at \( K^c_l, K^c_h \), but the second has a smaller slope.

\[ \Delta G = \mathbb{E}[\Delta K_s(p_s - R_s + b - F''(1 - K_s)(K_s - E))]. \]  

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 \( s = h \).
Max \( b\mathbb{E}[k_s] \) under the constraints

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

\[
k_h \leq e \frac{K^0_h}{E}. \quad (4)
\]

By imposing an upper bound on credit in the good state \( h \) (minimum capital ratio) the regulator can restore optimality.
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.**
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?
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.
Negative shock in $t$ $\rightarrow$ Equity $\downarrow$ in $t + 1$, bank-lending in $t + 1$ $\downarrow$
$\rightarrow$ Volatility of bank-lending in $t + 2$ $\uparrow$

Negative shock in $t + 1$ $\rightarrow$ Equity $\downarrow$ in $t + 2$, bank-lending in $t + 2$ $\downarrow\downarrow$
$\rightarrow$ Volatility of bank-lending in $t + 3$ $\uparrow$

$\vdots$

$\rightarrow$ Bank-lending may become arbitrarily small