Markets, Banks and Shadow Banks

David Martinez-Miera                  Rafael Repullo
U. Carlos III, Madrid, Spain       CEMFI, Madrid, Spain

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Motivation

“Our higher capital and liquidity requirements on banks will no doubt help to insulate banks from the consequences of large shocks, the danger is that they will also drive a larger share of intermediation into the shadow banking realm.”

Hanson, Kashyap, and Stein (2011)
Introduction

• Main issues to be addressed
  → What is the difference between banks and shadow banks?
  → How regulation affects funding through these channels?
  → How shadow banks affect effectiveness of regulation?
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  → How shadow banks affect effectiveness of regulation?

• Goal is to construct a model to shed light on
  → Effect of regulation on structure & risk of financial system
  → Regulatory tradeoffs
What are shadow banks?

• Broad definition (Financial Stability Board)
  “Credit intermediation involving entities and activities outside of the regular banking system.”
What are shadow banks?

• Broad definition (Financial Stability Board)
  “Credit intermediation involving entities and activities outside of the regular banking system.”

• Narrower definition (Javier Suarez)
  “Banking-like activities developed outside of the perimeter of traditional bank regulation.”
What are banking-like activities?

• Maturity transformation
  → Especially if funding with debt with very short maturities
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• Risk transformation
  → Especially when tranching produces money-like liabilities
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  → Especially if funding with debt with very short maturities

• Risk transformation
  → Especially when tranching produces money-like liabilities

• Credit origination
  → Especially if relationship-based or monitoring-intensive
Our approach

• Focus on two dimensions: monitoring and regulation
  → Whether lenders monitor (or screen) borrowers
  → Whether lenders comply with capital regulation
Our approach

• Focus on two dimensions: monitoring and regulation
  → Whether lenders monitor (or screen) borrowers
  → Whether lenders comply with capital regulation

• Three funding modes
  → When borrowers are not monitored: market finance
  → When borrowers are monitored
     + Lenders comply with regulation: regulated banks
     + Lenders not comply with regulation: shadow banks
Key assumptions on bank capital

• Bank capital is costly but provides “skin in the game”
  → Commitment device for monitoring borrowers
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  → Otherwise shareholders could lever up
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• Complying with regulation implies certification
  → Novel role for banking supervision
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• Complying with regulation implies certification
  → Novel role for banking supervision

• Not complying with regulation requires private certification
  → Additional cost of equity capital
The emergence of shadow banks

• Trade-off between costs and benefits of public certification
  → If bank capital regulation is very tough
  → (Shadow) banks may prefer not to comply with regulation
  → And resort to more expensive private certification
The emergence of shadow banks

• Trade-off between costs and benefits of public certification
  → If bank capital regulation is very tough
  → (Shadow) banks may prefer not to comply with regulation
  → And resort to more expensive private certification

• What if capital could be (privately) certified at zero cost?
  → Alternative setup: regulated banks have insured deposits
  → Similar qualitative results
  → In the paper: not for today
Overview

• Model setup
• Equilibrium
  → Model with no capital requirements
  → Flat capital requirements (Basel I)
  → Value-at-Risk capital requirements (Basel II & III)
• Optimal capital requirements
• Concluding remarks
Part 1
Model setup
Model setup

• Two dates \((t = 0, 1)\)

• Agents: \(\rightarrow\) Set of potential entrepreneurs
  \(\rightarrow\) Set of risk-neutral banks
  \(\rightarrow\) Set of risk-neutral investors
Model setup

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• Entrepreneurs have projects that require outside finance
Model setup

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• Agents:  → Set of potential entrepreneurs
            → Set of risk-neutral banks
            → Set of risk-neutral investors

• Entrepreneurs have projects that require outside finance

• Banks raise funds by issuing uninsured debt and equity capital
            → No deposit insurance
Entrepreneurs

• Continuum of entrepreneurs of observable types $p \in [0,1]$
Entrepreneurs

• Continuum of entrepreneurs of observable types $p \in [0,1]$

• Each entrepreneur of type $p$ has risky project

Unit investment $\rightarrow$ Return $= \begin{cases} A_p, & \text{with prob. } 1-p+m_p \\ 0, & \text{with prob. } p-m_p \end{cases}$

$\rightarrow m_p \in [0, p]$ is the monitoring intensity of lending bank
Bank monitoring

• Monitoring is not observed by debtholders
  → Moral hazard problem

• Monitoring entails cost

\[ c(m_j) = \frac{\gamma}{2} m_j^2, \text{ with } \gamma > 0 \]
Investors

• Two types of risk-neutral investors
  → Debtholders: require expected return normalized to 0
  → Shareholders: require expected return $\delta > 0$ (cost of capital)
Assumptions

- Bank specialization
  
  → Each bank only lends to a single type \( p \) of entrepreneurs
Assumptions

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  \[ \rightarrow \] Each bank only lends to a single type \( p \) of entrepreneurs

• Returns of entrepreneurs of type \( p \) are perfectly correlated
  \[ \rightarrow \] Portfolio return coincides with single project return
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• Large set of potential entrepreneurs for each type \( p \) (free entry)
  → Success return \( A_p \) equals loan rate \( R_p \)
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• Large set of potential entrepreneurs for each type $p$ (free entry)
  → Success return $A_p$ equals loan rate $R_p$

• Loan market is contestable (limit pricing)
  → Equilibrium loan rate is lowest feasible rate
Bank capital certification

• Bank capital has to be certified
  → Otherwise shareholders could lever up

• Certification cost $\eta > 0$
Part 2

Equilibrium
Part 2a

Model with no capital requirements
Banks’ decisions

- Bank lending to entrepreneurs of type $p$ sets
  
  (1) Capital $k_p$ per unit of loans
  
  (2) Borrowing rate $B_p$ offered to debtholders
  
  (3) Lending rate $R_p$ offered to entrepreneurs
Banks’ decisions

• Bank lending to entrepreneurs of type $p$ sets

  (1) Capital $k_p$ per unit of loans
  (2) Borrowing rate $B_p$ offered to debtholders
  (3) Lending rate $R_p$ offered to entrepreneurs

  → Such contract determines monitoring $m_p$
Equilibrium

• An equilibrium is array \((k_p^*, B_p^*, R_p^*, m_p^*)\) that solves

  \[
  \min R_p
  \]
Equilibrium

• An equilibrium is array \((k^*_p, B^*_p, R^*_p, m^*_p)\) that solves
  \[
  \min R_p
  \]
  \[
  \rightarrow \text{subject to incentive compatibility constraint}
  \]
  \[
  m^*_p = \arg \max_m \left\{ (1 - p + m)\left[ R^*_p - (1 - k^*_p)B^*_p \right] - c(m) \right\}
  \]
Equilibrium

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→ debtholders’ participation constraint

\[
(1 - p + m_p^*)B_p^* \geq 1
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Equilibrium

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\(\rightarrow\) debtholders’ participation constraint

\[
(1 - p + m_p^*)B_p^* \geq 1
\]

\(\rightarrow\) and shareholders’ participation constraint

\[
\pi_p^* \geq (1 + \delta + \eta)k_p^*
\]
Proposition 1

• There is a marginal type

\[ \hat{p} = 1 - \sqrt{\frac{1 + \delta + \eta}{c''(0)(\delta + \eta)}} \]
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→ Safer types \( p \leq \hat{p} \) choose market finance: \( m_p^* = k_p^* = 0 \)
Proposition 1

• There is a marginal type

\[ \hat{p} = 1 - \sqrt{\frac{1 + \delta + \eta}{c''(0)(\delta + \eta)}} \]

→ Safer types \( p \leq \hat{p} \) choose market finance: \( m_p^* = k_p^* = 0 \)

→ Riskier types \( p > \hat{p} \) choose bank finance: \( m_p^* > 0 \) and \( k_p^* > 0 \)
Bank capital

$\hat{p}$

Market finance

Bank finance
Probability of default
Comparative statics on certification cost

• Effect of a reduction in certification cost $\eta$ (from $\eta_1$ to $\eta_0$)
  → Expands region where bank finance is optimal
  → Increases banks’ capital and monitoring
  → Reduces entrepreneurs’ probability of default
Bank capital

Low certification cost $\eta_0$

High certification cost $\eta_1$
Probability of default

\[ p - m_p \]

\[ p - m_p^*(\eta_0) \]

\[ \hat{P}_0 \]

\[ \hat{P}_1 \]
Private vs public certification

• Introduce two possible certification agencies
  → Public agency (bank supervisor) with cost $\eta_0$
  → Private agencies with cost $\eta_1 > \eta_0$
Private vs public certification

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• Why is private certification costlier than public certification?
  → Supervisor may have less incentive problems
  → Supervisor may have access to richer information
Private vs public certification

• Introduce two possible certification agencies
  → Public agency (bank supervisor) with cost $\eta_0$
  → Private agencies with cost $\eta_1 > \eta_0$

• Why is private certification costlier than public certification?
  → Supervisor may have less incentive problems
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• What is flip side of public certification?
  → Banks have to comply with regulation
What’s next?

• Two types of capital requirements
  → Risk-insensitive (flat) capital requirements
  → Risk-sensitive (Value-at-Risk) capital requirements
Part 2b

Flat capital requirements
Flat capital requirements

• Flat requirement (Basel I) or leverage ratio (Basel III)

\[ k_p \geq \bar{k} \]
Flat capital requirements

- Flat requirement (Basel I) or leverage ratio (Basel III)
  \[ k_p \geq \bar{k} \]

- Complying with regulation implies certification (with \( \eta_0 = 0 \))
  \[ \rightarrow \text{Role of banking supervision} \]
Shadow banks

• Not complying with regulation implies no public certification
  → Shadow banks resort to private certification
  → Certification cost $\eta_1 > 0$
  → Higher cost of capital for shadow banks
Two cases: low and high flat requirements

• With low flat requirements
  → Only direct market finance and regulated banks
  → No role for shadow banks
Two cases: low and high flat requirements

• With low flat requirements
  → Only direct market finance and regulated banks
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• With high flat requirements
  → Shadow banks can profitably enter the market
  → To fund medium-risk projects
  → Taking over part of the regulated banks’ market
Capital with low flat requirements

$\hat{p}_0$, $p_m$, Regulated banks, Market finance
Capital with high flat requirements

Market finance

Shadow banks

Regulated banks

\( k_p \)

\( \frac{\bar{k}}{k} \)

\( \hat{p}_1 \)

\( p_s \)

\( p \)

\( k^* \)
Effect of tightening flat capital requirements

• Drives safer borrowers away from regulated banks
  → Lower monitoring and higher risk
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• Low-risk regulated banks become safer
  → Higher capital increases monitoring incentives
Effect of tightening flat capital requirements

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• No effect on high-risk regulated banks
  → Capital requirement is not binding
  → These banks maintain capital buffers
Part 2c

Value-at-Risk based capital requirements
VaR capital requirements (i)

- Introducing a VaR-based capital requirement (à la Basel II)
  
  $\Pr(\text{loan losses} > \bar{k}_p) = \alpha$

  where $1 - \alpha$ is confidence level (e.g. 99.9%)
VaR capital requirements (i)

• Introducing a VaR-based capital requirement (à la Basel II)

→ In Basel II

\[ \Pr(\text{loan losses} > \bar{k}_p) = \alpha \]

where \( 1 - \alpha \) is confidence level (e.g. 99.9%)

→ We postulate

\[ \Pr(\text{loan default} \mid \bar{k}_p) = \alpha \]
VaR capital requirements (ii)

• To ensure

\[ \text{Pr(loan default } \mid \bar{k}_p \text{)} = \alpha \]

→ we require \( \bar{k}_p \) to be such that \( p - m_p = \alpha \)
VaR capital requirements (ii)

• To ensure

\[ \Pr(\text{loan default} \mid \bar{k}_p) = \alpha \]

→ we require \( \bar{k}_p \) to be such that \( p - m_p = \alpha \)

• Model then gives closed-form capital requirements formula

\[ \bar{k}_p = f(p, \alpha) \]

→ Increasing in risk \( p \)

→ Increasing in confidence level \( 1 - \alpha \)
VaR capital requirements

$k$ vs $p$

$\bar{k}_p$
Two cases: low and high VaR requirements

- With low VaR requirements
  - Only direct market finance and regulated banks
  - No role for shadow banks
Two cases: low and high VaR requirements

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Capital with low VaR requirements

\( k_p \)

\( \hat{p}_0 \)

Market finance

\( \alpha \)

Regulated banks

\( p \)
Capital with high VaR requirements

- Market finance
- Regulated banks
- Shadow banks

\[ k_p \]

\[ \hat{p}_0 \]

\[ \alpha \]

\[ p_s \]
Effect of tightening VaR requirements

• Drives risky borrowers away from regulated banks
  → Lower monitoring and higher risk
Effect of tightening VaR requirements

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• Very different from the effect of tightening flat requirements
PD with high flat requirements

\[ p - m_p \]

Market finance  \[ \uparrow \uparrow \]  Shadow banks  \[ \downarrow \downarrow \]  Regulated banks
PD with high VaR requirements

\[ p - m_p \]

\[ \hat{p}_0 \]

\[ p_s \]

Market finance

Regulated banks

Shadow banks

\[ \alpha \]
Part 3

Optimal capital requirements
Assumptions (i)

• Representative consumer
  → Utility function over goods produced by entrepreneurs
  → Unit investment produces unit output, if successful
  → Success return $A_p$ is unit price of goods produced by type $p$
Assumptions (ii)

• Utility function of representative consumer

\[ U(q, x) = q + \frac{\sigma}{\sigma - 1} \int_0^1 (x_p)^{\sigma-1} dp \]

→ \( q \) is consumption of composite good
→ \( x_p \) is output of entrepreneurs of type \( p \)
Assumptions (ii)

- Utility function of representative consumer

\[ U(q, x) = q + \frac{\sigma}{\sigma - 1} \int_0^1 (x_p)^{\frac{\sigma - 1}{\sigma}} dp \]

→ \( q \) is consumption of composite good
→ \( x_p \) is output of entrepreneurs of type \( p \)

- Budget constraint

\[ q + \int_0^1 A_p x_p \, dp = I \]

→ \( I \) is consumer’s income
Assumptions (iii)

• Maximizing the utility subject to the budget constraint gives

\[ A_p = (x_p)^{-1/\sigma} \]

→ Success return \( A_p \) is decreasing function of output \( x_p \)
Assumptions (iii)

- Maximizing the utility subject to the budget constraint gives

\[ A_p = (x_p)^{-1/\sigma} \]

→ Success return \( A_p \) is decreasing function of output \( x_p \)

- How is output = investment = \( x_p \) determined?

→ Free entry of entrepreneurs: investment \( x_p \) adjusts

→ Until success return \( A_p \) equals equilibrium loan rate \( R_p \)
Social welfare function

• Investors receive opportunity cost of their funds

→ Participation constraints are satisfied with equality
Social welfare function

• Investors receive opportunity cost of their funds
  → Participation constraints are satisfied with equality

• Entrepreneurs borrow at rates that leaves them no surplus
  → By assumption of free entry
Social welfare function

- Investors receive opportunity cost of their funds
  → Participation constraints are satisfied with equality

- Entrepreneurs borrow at rates that leaves them no surplus
  → By assumption of free entry

- Social welfare comes from output produced by entrepreneurs
  → Social welfare function

\[
W(x) = I + \frac{1}{\sigma - 1} \int_{0}^{1} (1 - p + m_p)(x_p)^{\frac{\sigma - 1}{\sigma}} dp
\]
Optimal capital requirements

• Optimal capital requirements defined by

\[ k^* = \arg \max_k W(x(k)) \]
Optimal capital requirements

- Optimal capital requirements defined by

\[ k^* = \arg \max_k W(x(k)) \]

- Optimal capital requirements are risk-sensitive
  - But do not satisfy VaR condition
  - Lower confidence level for higher risks
  - To avoid emergence of shadow banks for riskier firms
Optimal capital requirements

Market finance $\hat{P}_0$ Regulated banks $P$

$k_p$ $k^*_p$
PD with optimal requirements

\[ p - m_p \]

- Market finance
- \( \hat{p}_0 \)
- Regulated banks
- \( P \)
Concluding remarks
Summing up

• Model of the effects of bank capital regulation on
  → Structure and risk of the financial system
Summing up

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• Key element: distinction between regulated and shadow banks
  → Based on certification of capital by supervisor
  → Alternative: deposit insurance subsidy for regulated banks
Summing up

• Model of the effects of bank capital regulation on
  → Structure and risk of the financial system

• Key element: distinction between regulated and shadow banks
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  → Alternative: deposit insurance subsidy for regulated banks

• Framework for thinking about regulatory trade-offs
  → Also as a building block of more elaborate models
Optimal capital requirements

• Higher capital requirements
  → Ameliorate risk-taking incentives: bright side
  → Drive some borrowers to shadow banks: dark side
  → Flat (VaR) creates medium (high) risk shadow banks
Optimal capital requirements

• Higher capital requirements
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  → Flat (VaR) creates medium (high) risk shadow banks

• Optimal requirements will not be VaR-based
  → Need to bring economics into banking regulation
  → Think in terms of welfare trade-offs
References


Appendix

Model with deposit insurance
Model with deposit insurance

• So far regulated banks have no deposit insurance
  → Advantage (wrt shadow banks): lower certification cost
Model with deposit insurance

• So far regulated banks have no deposit insurance
  → Advantage (wrt shadow banks): lower certification cost

• Alternative setup
  → Capital is certified at zero cost ($\eta_0 = \eta_1 = 0$)
  → Advantage of regulated banks: underpriced insurance
Results with deposit insurance

• With high flat capital requirements
  → Shadow banks can profitably enter the market
  → To fund medium-risk projects
Results with deposit insurance

• With high flat capital requirements
  → Shadow banks can profitably enter the market
  → To fund medium-risk projects

• With high VaR-based capital requirements
  → Shadow banks can profitably enter the market
  → To fund high-risk projects
Flat capital requirements

$k_p$

$\bar{k}$

Market finance  Shadow banks  Regulated banks

$p$
PD with flat requirements
PD with VaR requirements

\[ p - m_p \]

Market finance  Regulated banks  Shadow banks

\[ \alpha \]