Interest Rates, Market Power, and Financial Stability

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Introduction (i)

- Question: **How do interest rates affect financial stability?**

  → Focus on risk-taking by financial intermediaries (banks)

  → Using simple theoretical model

  → Based on “Search for Yield” (ECTA 2017)

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  - → Lower safe rates lead to higher risk-taking

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  - → Risk-taking channel of monetary policy: Borio (BIS 2008)
  - → **What happens when we introduce market power**?

Introduction (ii)

- Why do safe rates affect banks' risk-taking?

  → Safe rates affect banks' funding costs

  → Impact on loan rates and intermediation margins

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  → Impact on loans' probability of default

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- Why is competition relevant?

  → It affects **pass-trough** of funding costs to loan rates

  → It affects margins and monitoring incentives

Introduction (iii)

- Model is silent about what drives changes in safe rates

  → Real factors (savings glut)

  → Monetary policy

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  → Real factors (savings glut)

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- Analyze effect of exogenous changes in (real) safe rates

Model setup

- Banks raise funds from uninsured risk-neutral investors

  → Investors require a given return R_0 (the safe rate)

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  → Monitoring reduces probability of default of loans

  → Monitoring is costly and unobserved by investors

Main result

- Lower safe rates lead to

  → Higher risk-taking in competitive environments (high n)

  → Lower risk-taking in monopolistic environments (low n)

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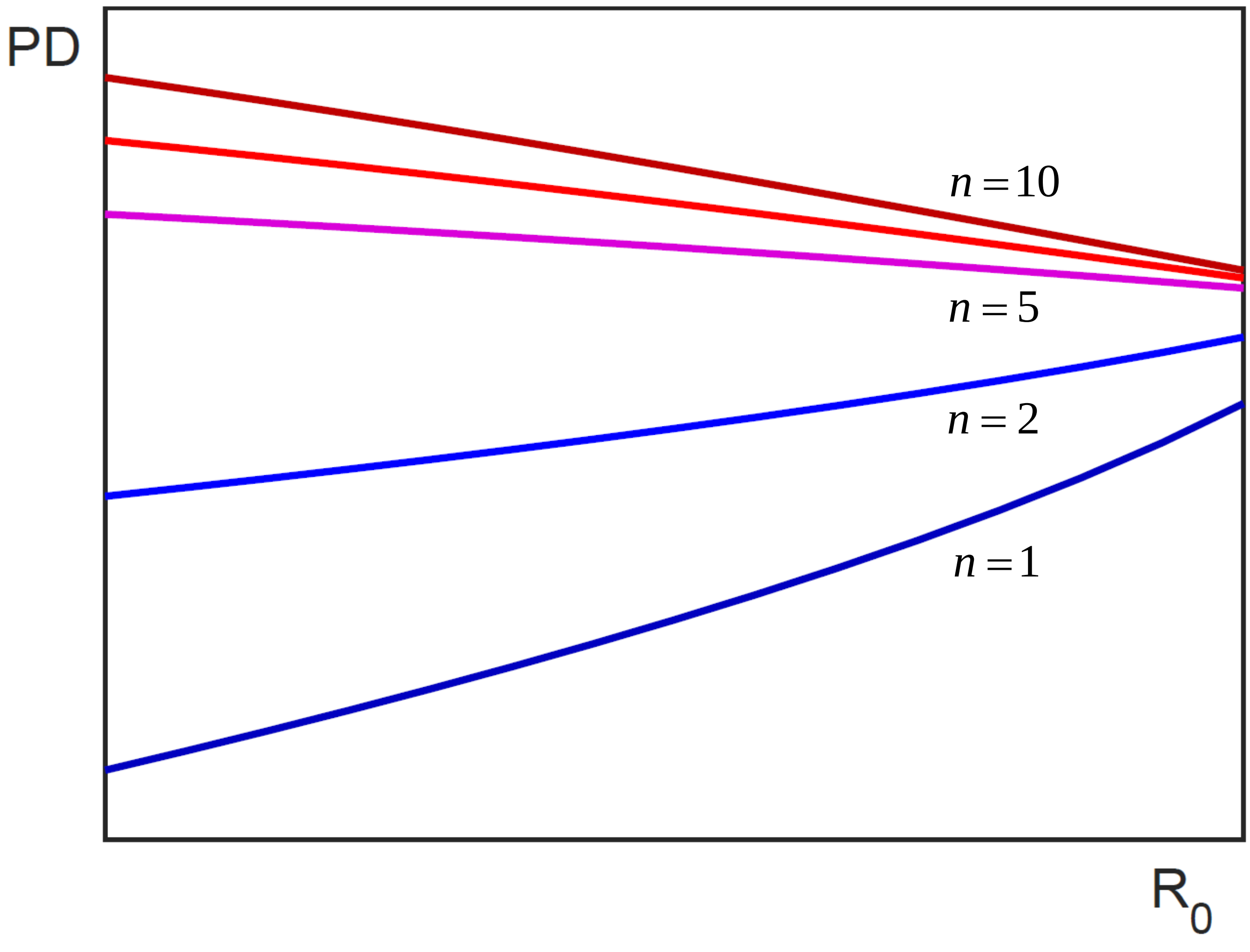
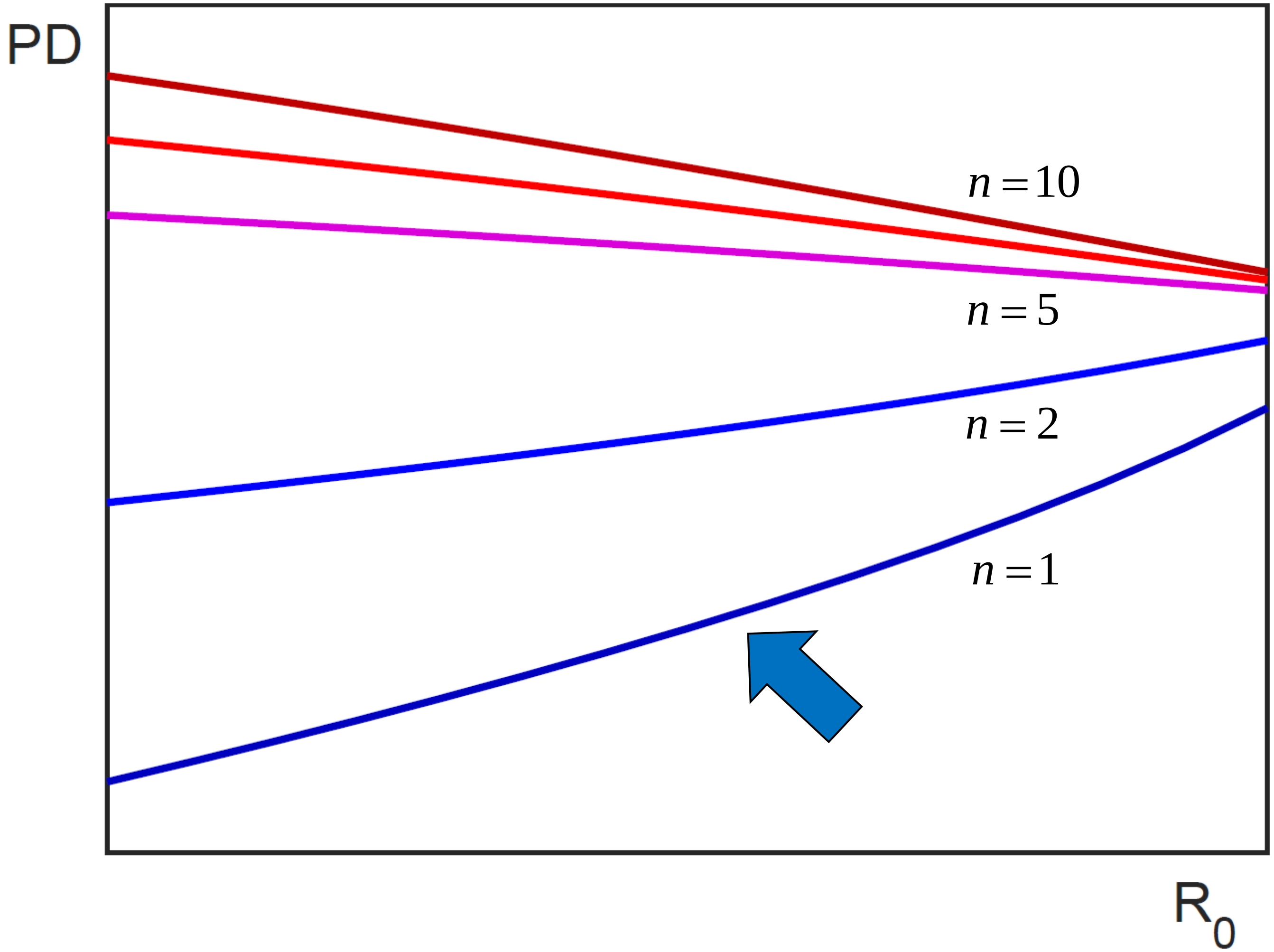
- Risk-taking channel of monetary policy reverses sign

  → When banks have significant market power

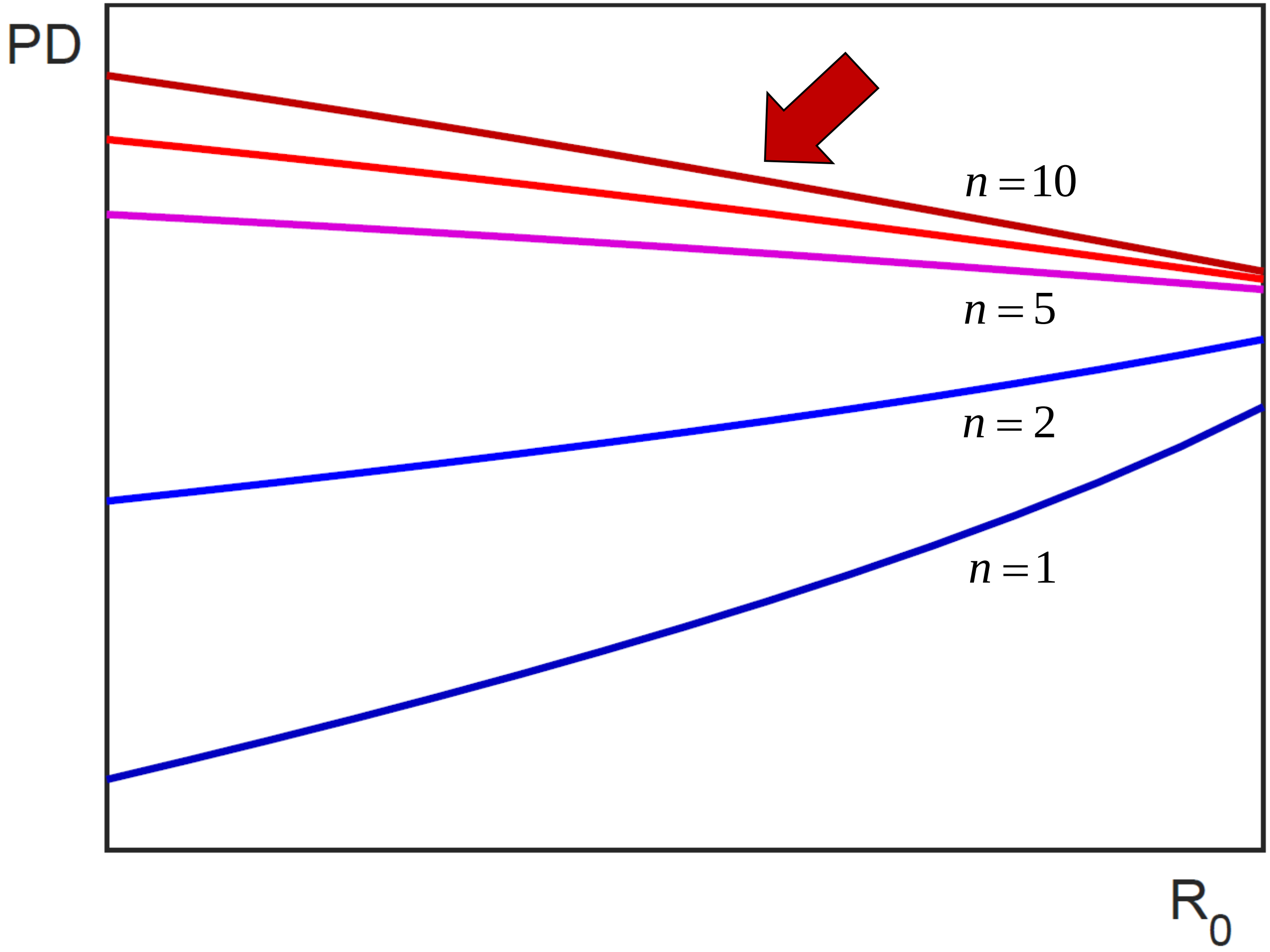
Main result



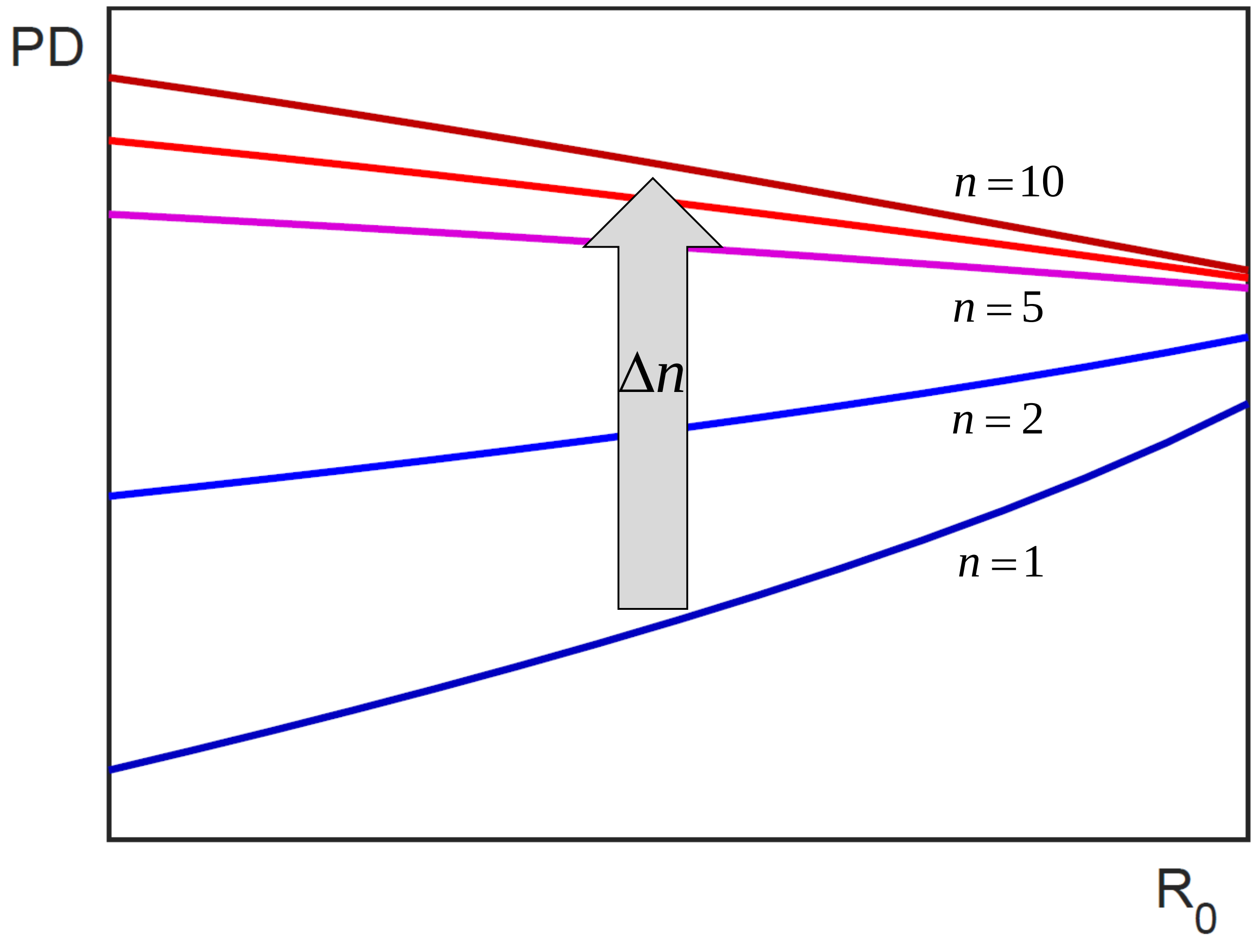
Positive slope in monopolistic environments



Negative slope in competitive environments



Higher risk in competitive environments



Suggestive evidence (i)

- Sensitivity of loan rates and intermediation margins to

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  → For different deciles of banks’ market power

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  → Parameter of interest β_i

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- Data on banks’ market power

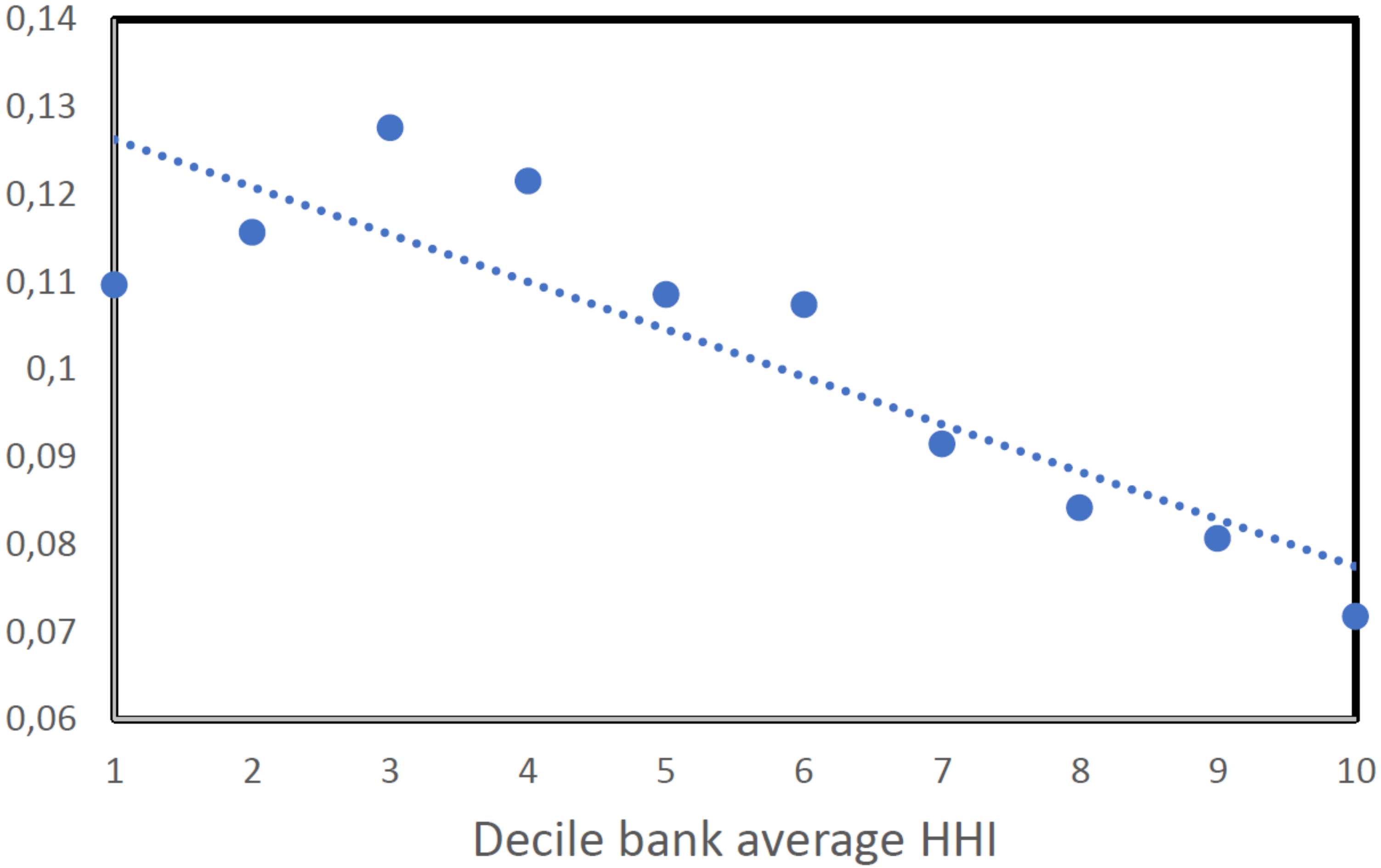
  → New mortgages originated by banks in each county

  → County level HHI for each year

  → Weighted average of county HHIs for each bank

  → Simple average for each bank in all years of the sample

Sensitivity of loan rates to FF rate



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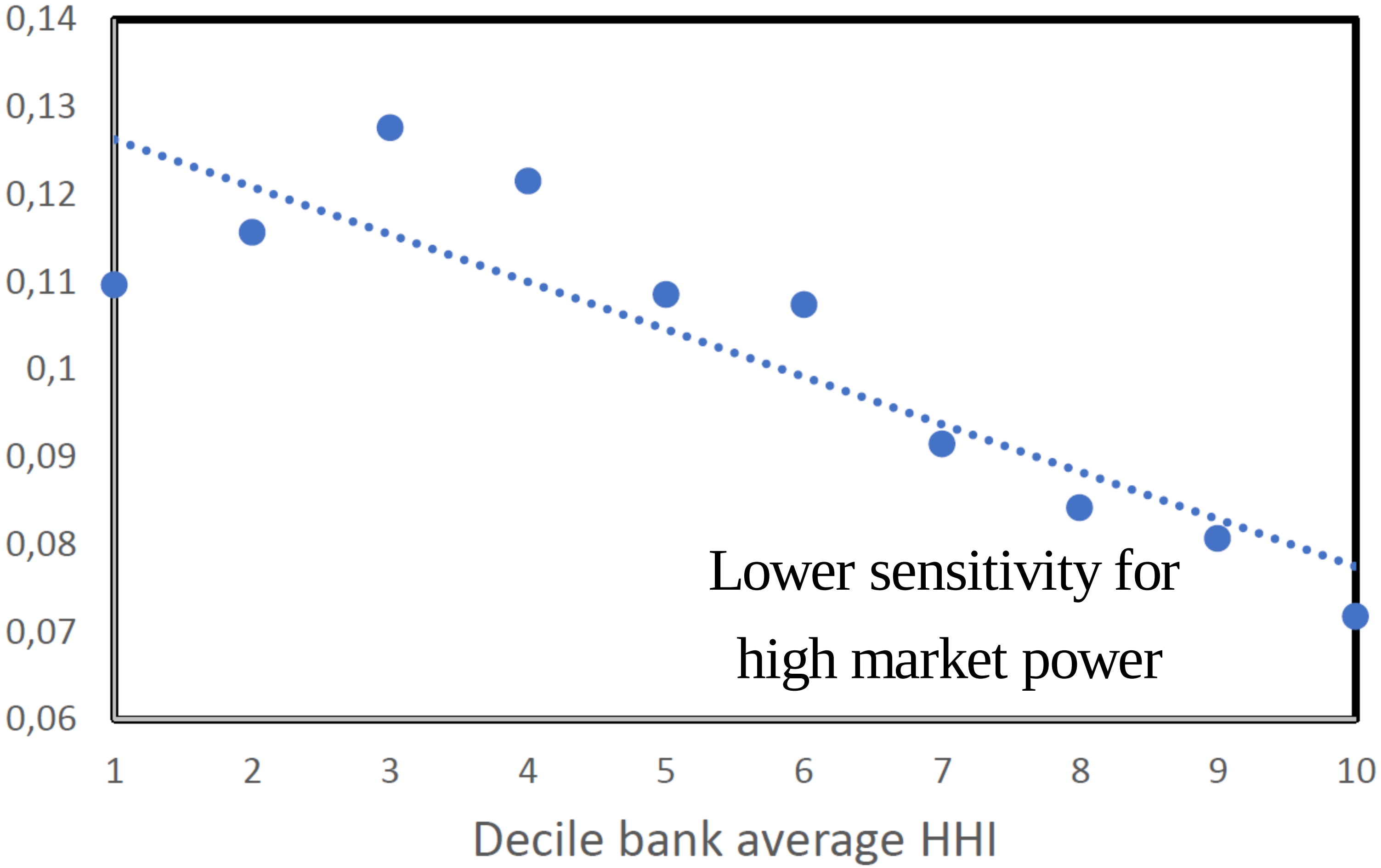
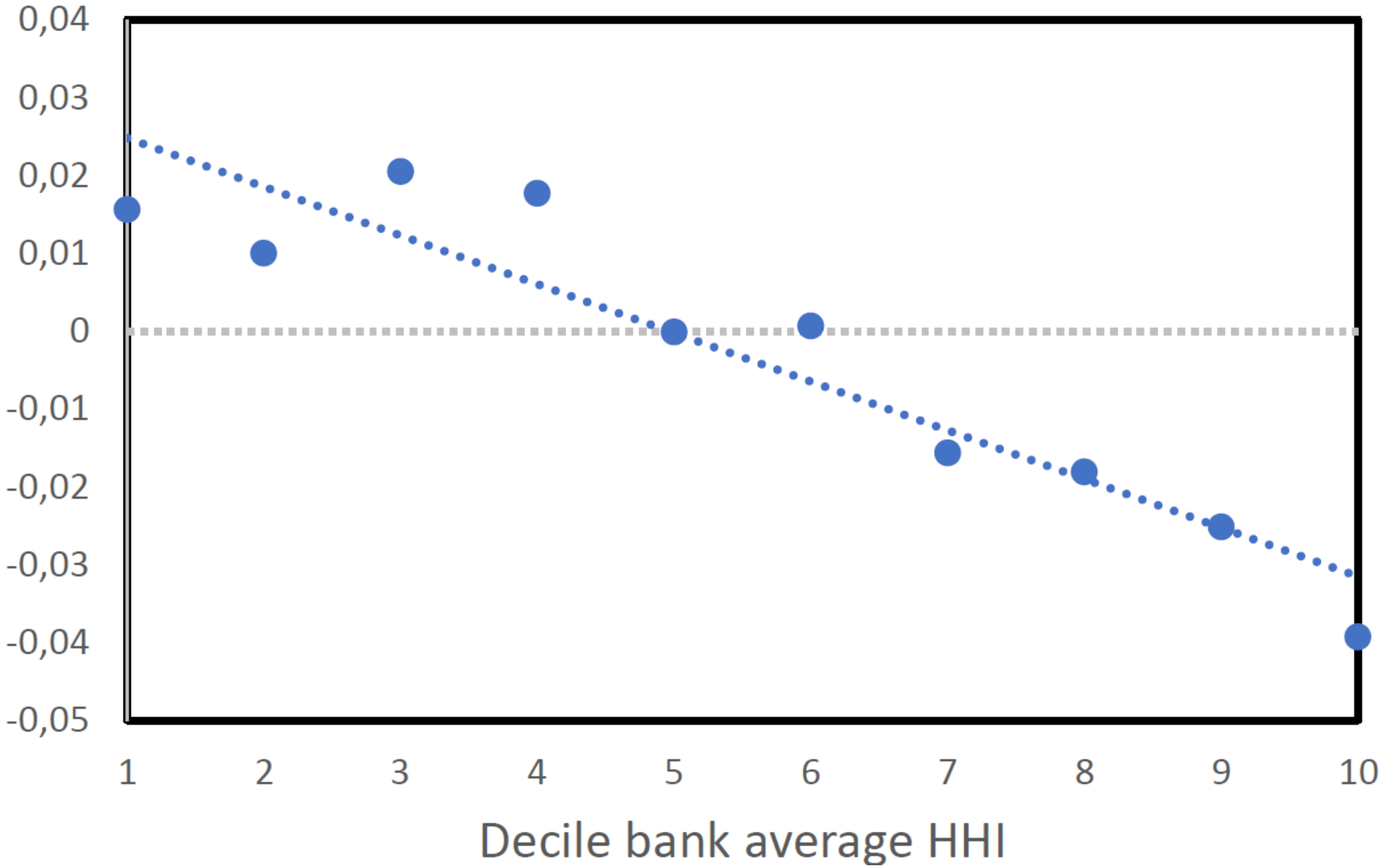


Sensitivity of margins to FF rate



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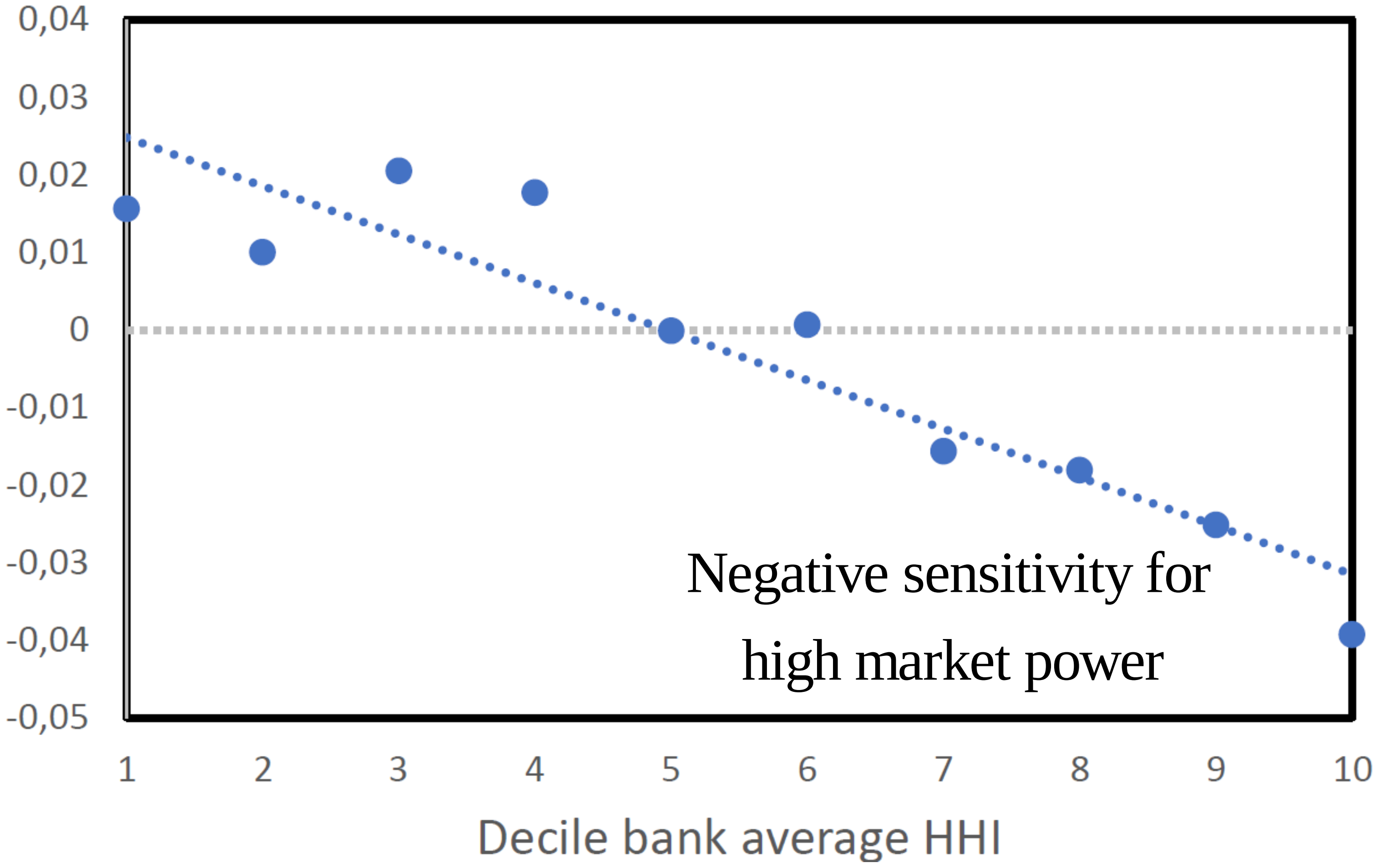

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- Since risk-taking is driven by intermediation margins

  → **Evidence is consistent with our key result**

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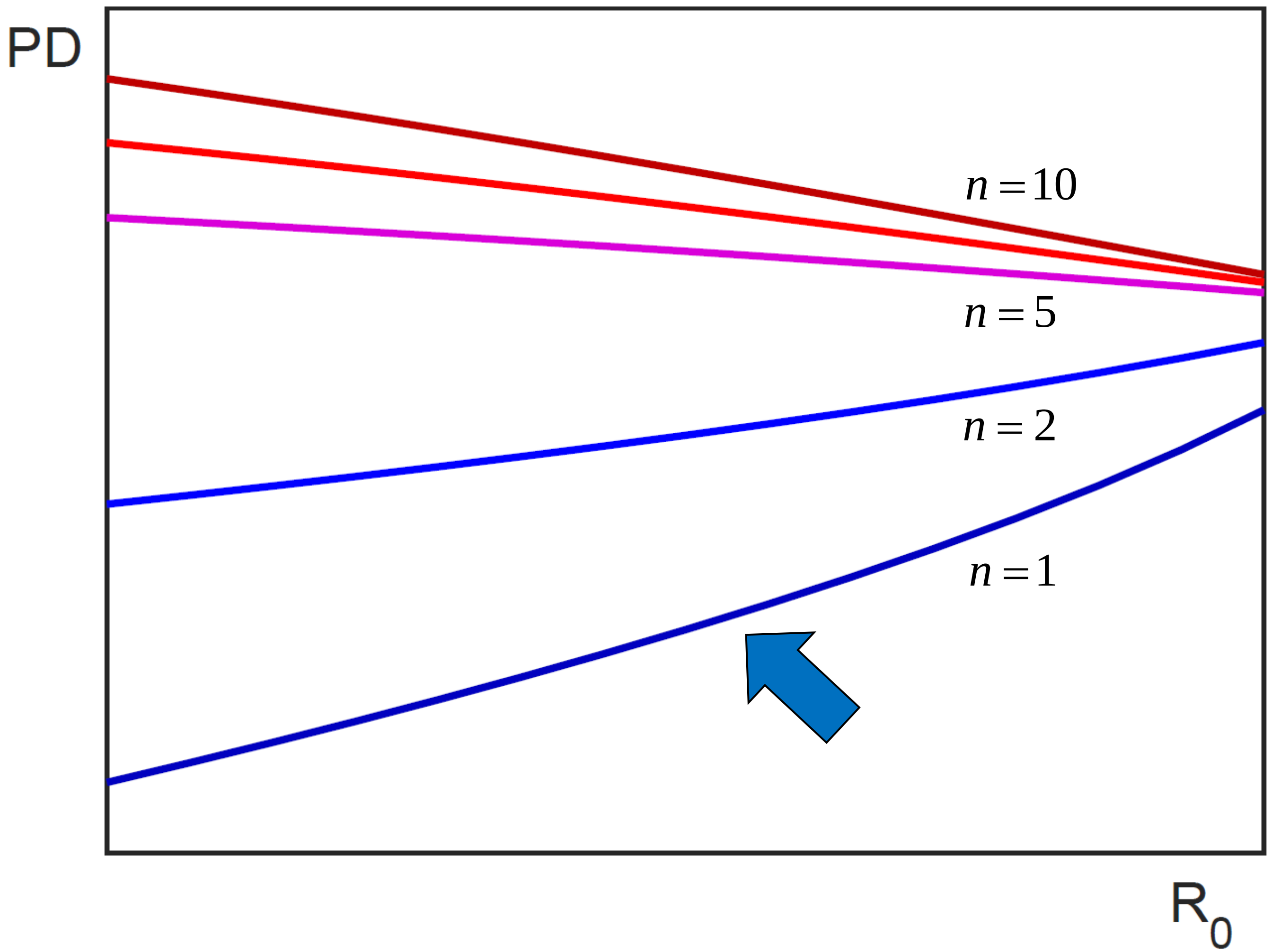

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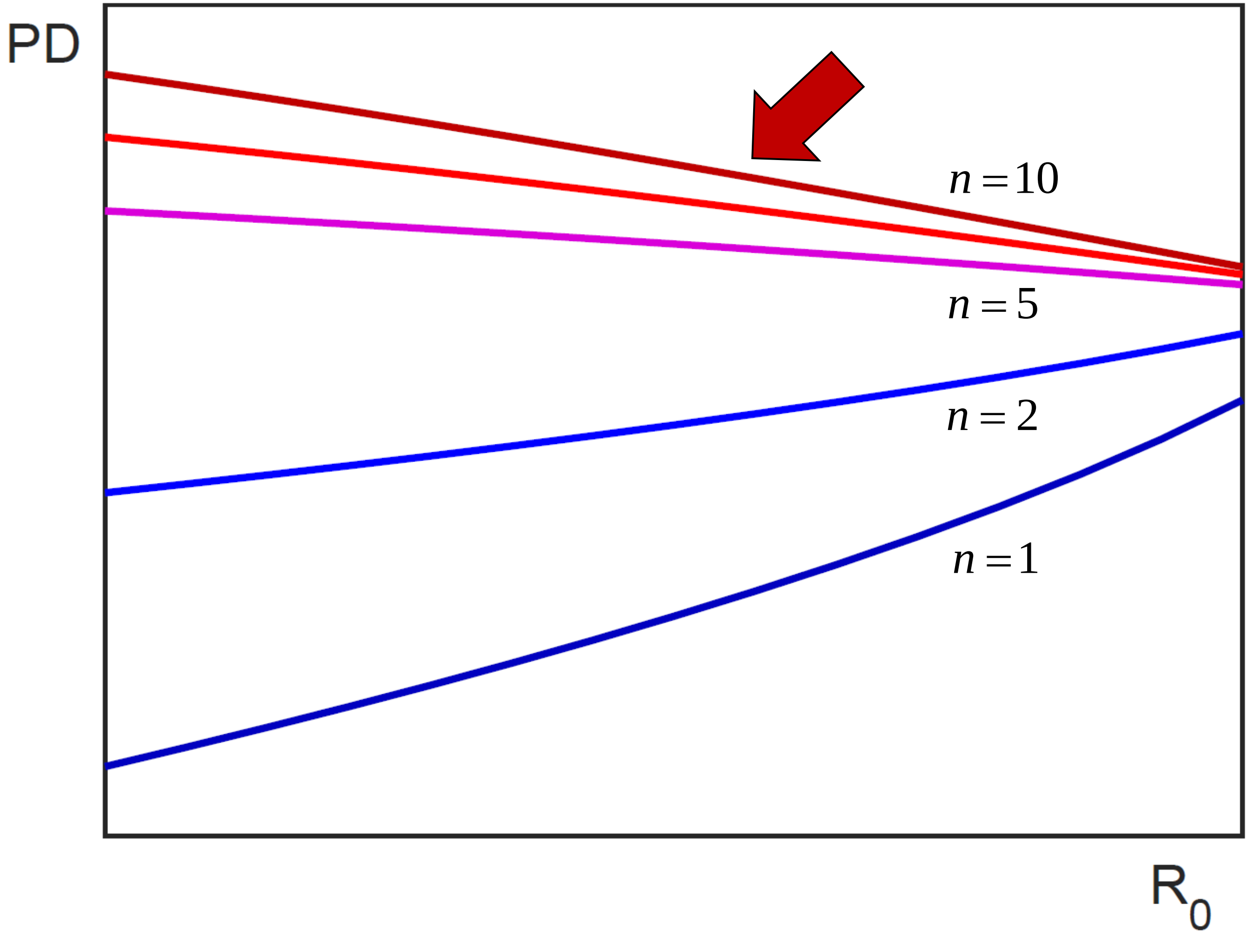

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- Main reference

  → Martinez-Miera and Repullo (ECTA 2017)

Overview

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- Three extensions

  → Heterogeneous monitoring costs

  → Insured deposits

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- Concluding remarks

Part 1

Cournot model of bank competition

Model setup

- Two dates (t = 0, 1)
- Three types of risk-neutral agents

  → **Entrepreneurs** have projects that require bank finance

  → **Banks** have to raise funds from (uninsured) investors

  → **Investors** require expected return R_0 (the safe rate)

Entrepreneurs (i)

- Continuum of penniless entrepreneurs have risky projects

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

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$\rightarrow$ $m \in [0, p]$ is monitoring intensity of lending bank

$\rightarrow$ **Monitoring reduces probability of failure**

Entrepreneurs (ii)

- **Assumption 1**: Decreasing returns to aggregate investment L

$$R(L) = a - bL$$

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  → $R(L)$ is the inverse loan demand function

Banks (i)

- There are *n* identical banks that compete à la Cournot

  → Strategic variable of bank *j* is its lending l_j to entrepreneurs

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$$L = \Sigma_{j=1}^{n} \; l_j$$

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- **Assumption 3**: Bank monitoring is not contractible

  → Moral hazard problem between banks and investors

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- Three stages

1. Each bank j sets supply of loans l_j

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  3. Bank j (privately) chooses monitoring intensity m_j

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- Game solved backwards

    → Stages 2 and 3 first, and then stage 1

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- Problem in stages 2 and 3 is the same for all banks
  - → Depends on lending L in stage 1
  - → Write $B_j = B(L)$ and $m_j = m(L)$

Characterization of equilibrium (i)

- Banks' choice of monitoring (given borrowing rate $B(L)$)

$$m(L) = \arg\max_m \left[(1 - p + m)[R(L) - B(L)] - c(m)\right]$$

Characterization of equilibrium (i)

- Banks' choice of monitoring (given borrowing rate $B(L)$)

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- Two equations with two unknowns

  → Solution gives $B(L)$ and $m(L)$

Proposition 1

- Banks' choice of monitoring

$$m(L) = \frac{1}{2\gamma}\left[R(L) - \gamma(1-p) + \sqrt{[R(L)+\gamma(1-p)]^2 - 4\gamma R_0} \right]$$

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→ Decreasing in safe rate R_0

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→ **Monitoring intensity is proportional to margin**

Characterization of equilibrium (iii)

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→ Equilibrium total lending $L^* = nl^*$

Proposition 2

- A decrease in safe rate R_0 leads to an increase in total lending L^*

  $\rightarrow$ Lower rates are always expansionary

Risk-taking channel of monetary policy (i)

- Effect of changes in safe rate R_0 on equilibrium monitoring m^*

$$\frac{dm^*}{dR_0} = \frac{\partial m^*}{\partial L^*} \frac{\partial L^*}{\partial R_0} + \frac{\partial m^*}{\partial R_0}$$

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  → Higher safe rates reduce lending

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- Second term: ***funding rate effect***

  → Higher safe rates increase borrowing costs

  → Decrease intermediation margin

Risk-taking channel of monetary policy (ii)

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- Under monopoly ($n = 1$) a decrease in safe rate R_0 leads to

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Risk-taking channel of monetary policy (ii)

- The sign of the effect depends on the number of banks n
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  → a decrease in the probability of loan default $PD = p - m^*$
- Under competition ($n \to \infty$) a decrease in safe rate R_0 leads to

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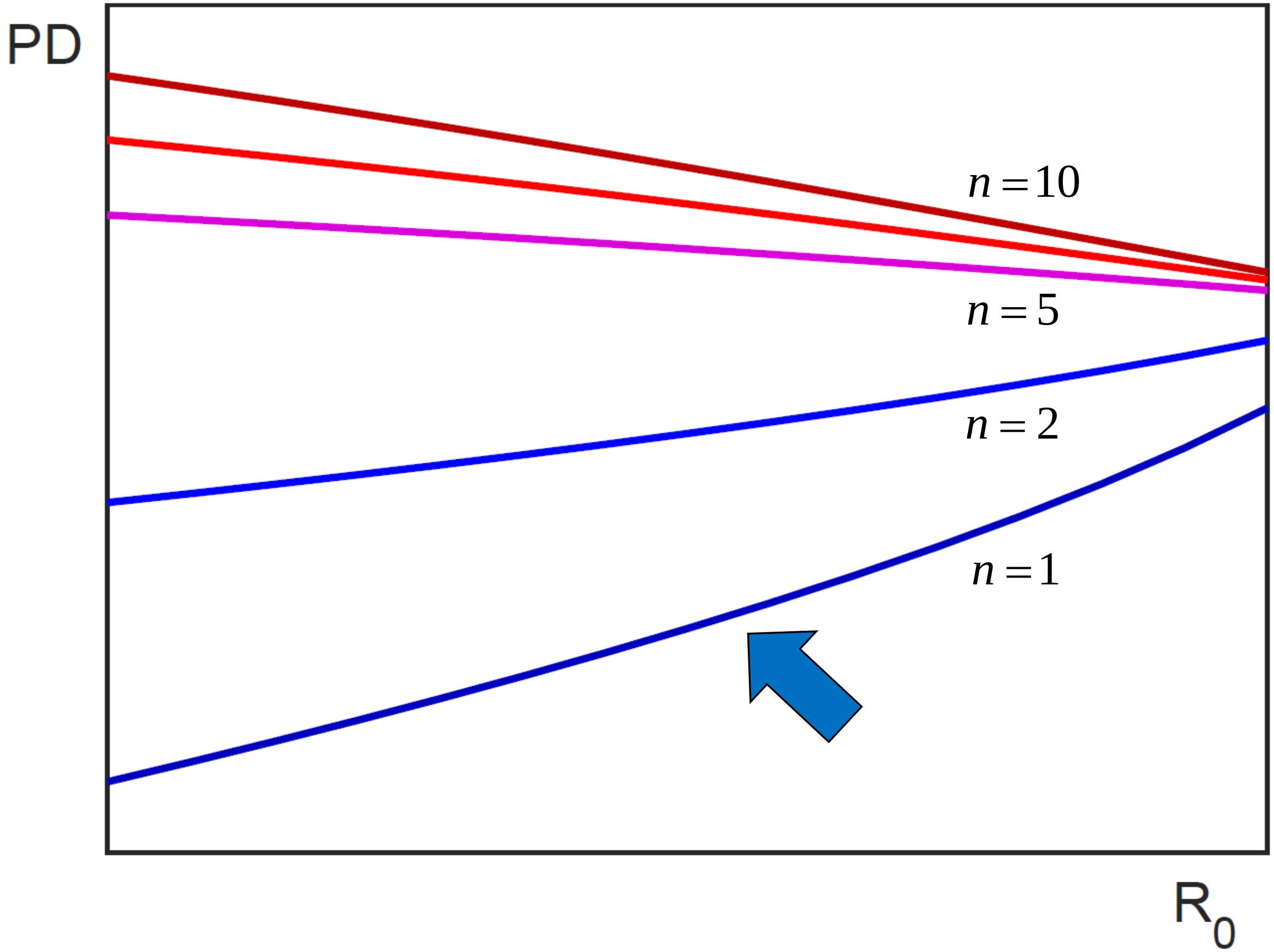
Positive slope in monopolistic environments



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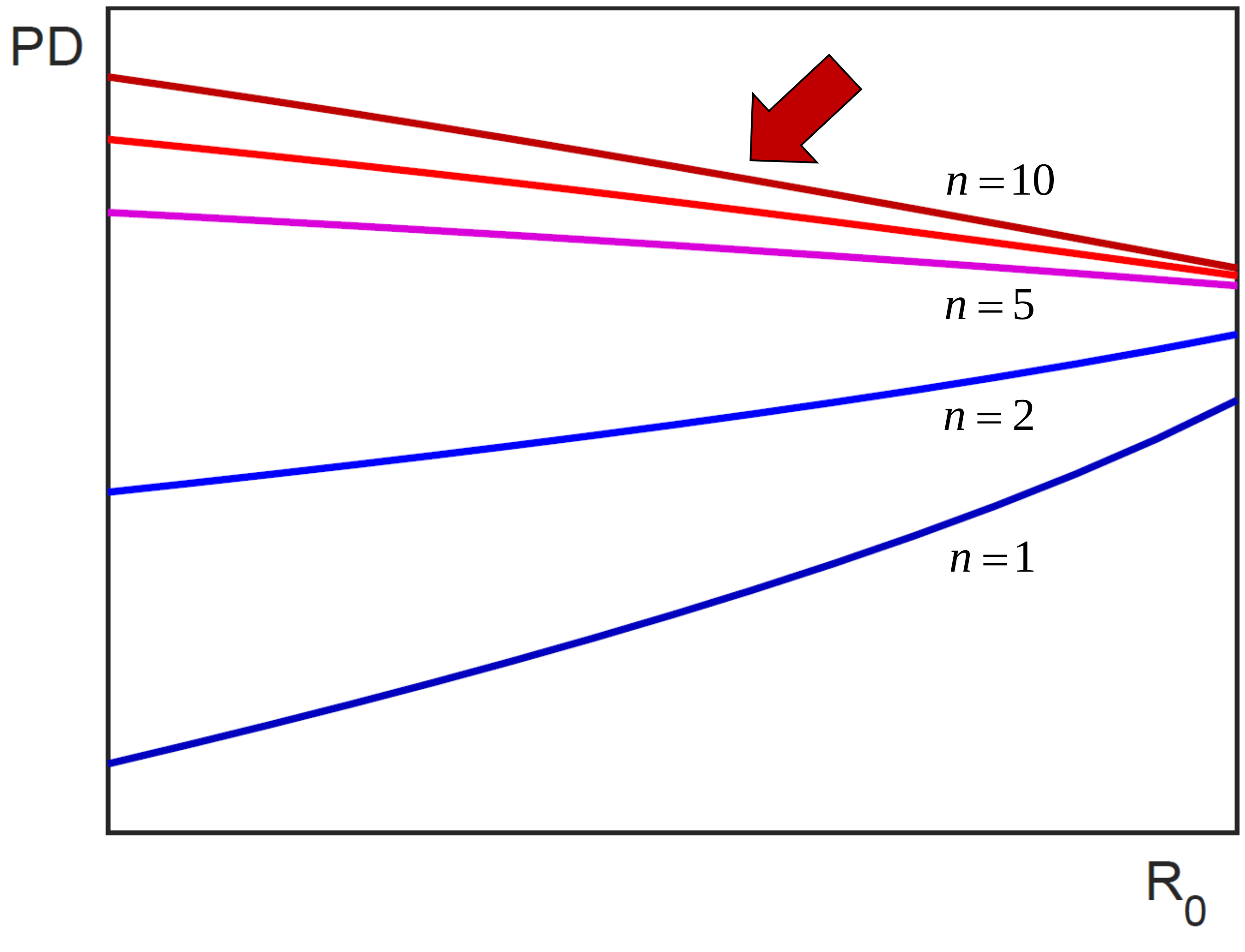

What's the intuition?

- Refer to literature on **pass-through** in Cournot oligopoly
- With competition lower costs have little impact on margins

  → As loan rates are very sensitive to changes in safe rate

  → In our case margins (and monitoring) go down

  → Riskier banks

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- With monopoly lower costs have large impact on margins

  → As loan rates do not react much to changes in safe rate

  → In our case margins (and monitoring) go up

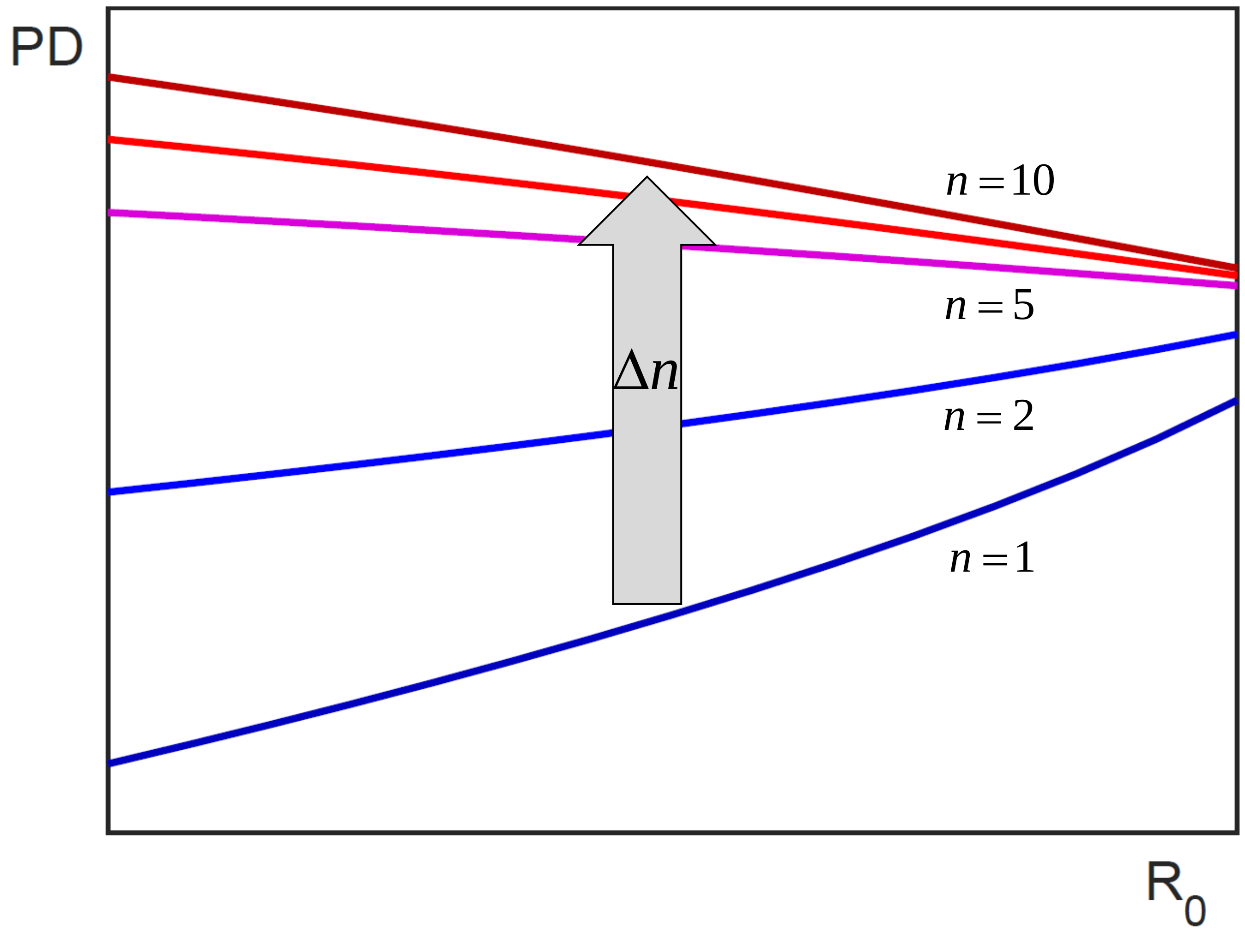
  → Safer banks

Summing up

- Competition increases banks' risk-taking

  → Standard "charter value" result

Higher risk in competitive environments



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  → Standard "charter value" result

- With high competition lower rates **increase** banks' risk-taking

  → "Search for Yield" result

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- Competition increases banks' risk-taking

  → Standard "charter value" result

- With high competition lower rates **increase** banks' risk-taking

  → "Search for Yield" result

- With low competition lower rates **decrease** banks' risk-taking

  → Novel result

Part 2

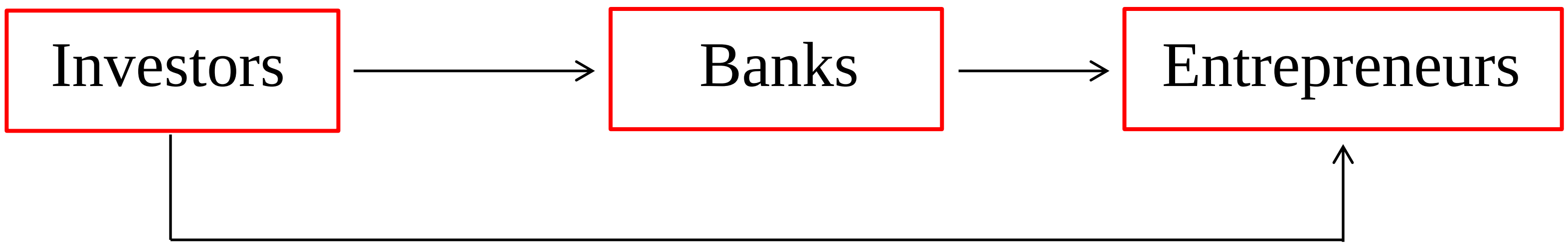
Model with a competitive bond market

Introducing market finance

Intermediated finance

Introducing market finance

Intermediated finance



Direct market finance

Introducing market finance

- Suppose that entrepreneurs can also borrow from the market

  → Bond financing (directly provided by investors)

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- Assume that market finance entails no monitoring

  → Market interest rate R_M satisfies zero profit condition

$$(1-p)R_M = R_0 \quad \to \quad R_M = \frac{R_0}{1-p}$$

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→ Market interest rate R_M satisfies zero profit condition

$$(1-p)R_M = R_0 \quad \rightarrow \quad R_M = \frac{R_0}{1-p}$$

→ Upper bound on the rate that banks can charge

Introducing market finance

- Suppose that entrepreneurs can also borrow from the market

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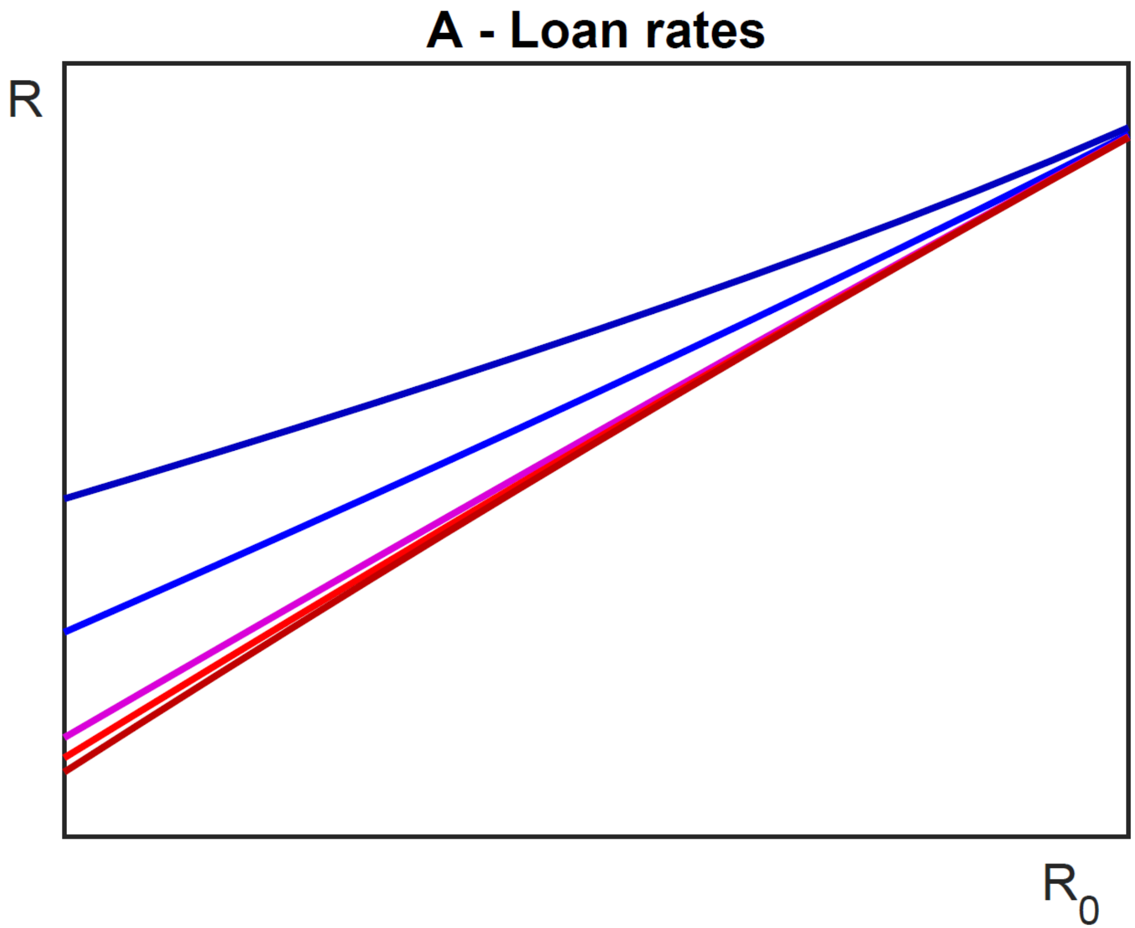
→ Upper bound on the rate that banks can charge

→ **When will the bound be binding?**

Effect of market finance on loan rates



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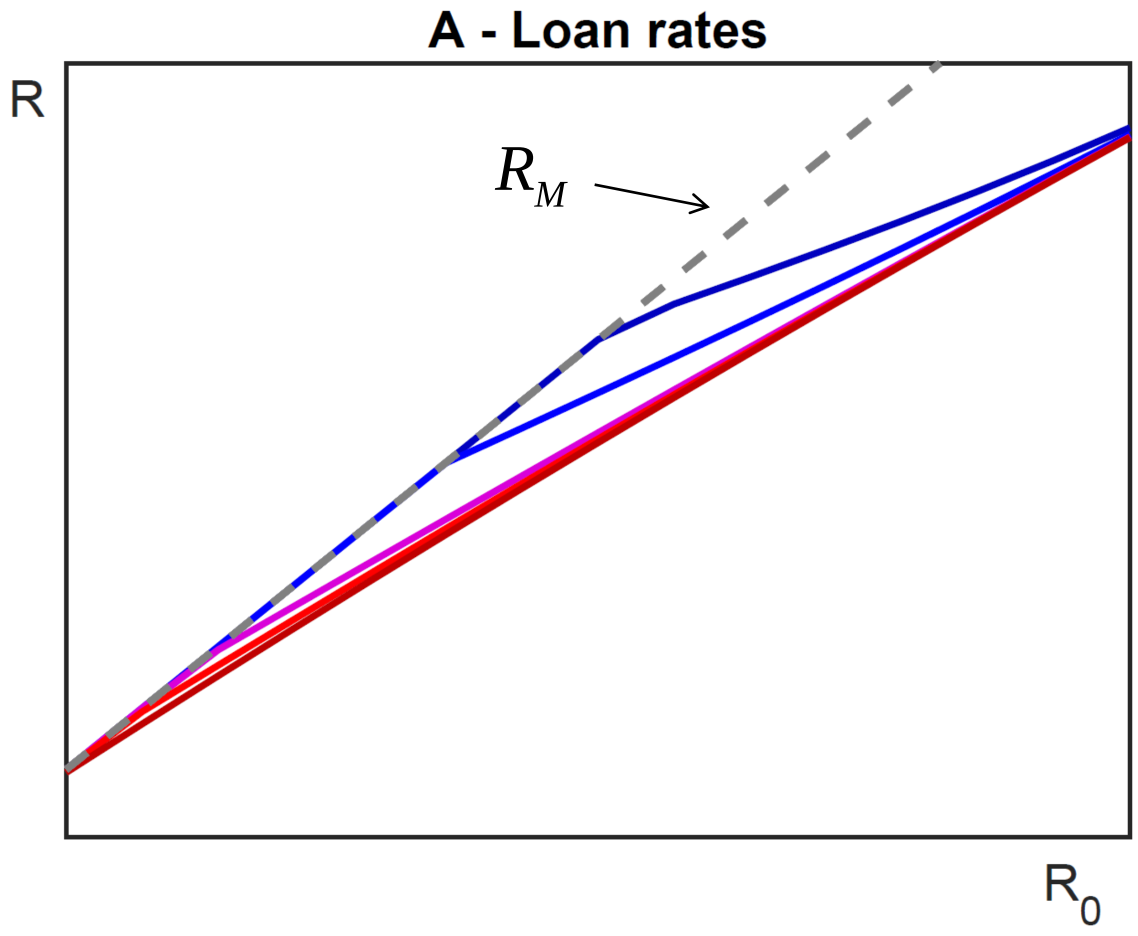

Characterization of binding equilibrium

- When the bound is binding banks will choose L_M such that

$$R_M = R(L_M)$$

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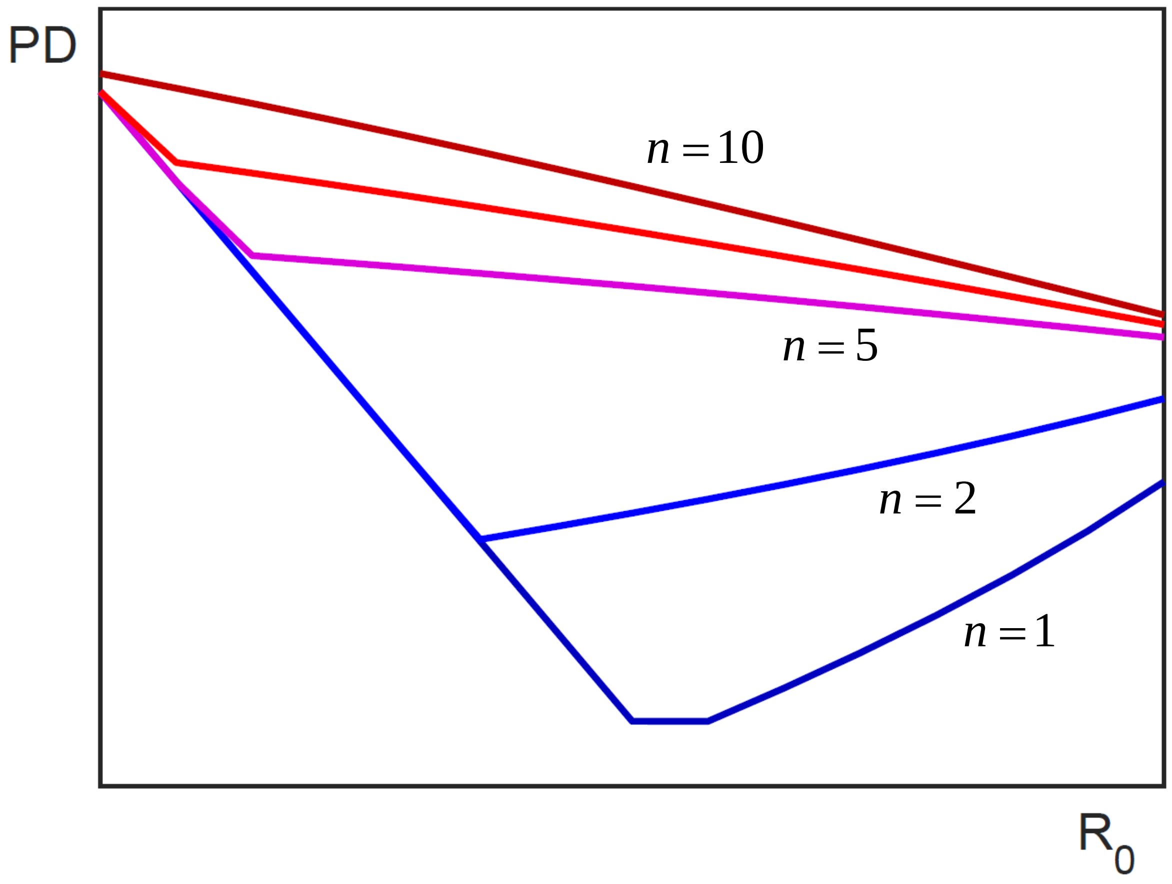
  → Investors' participation constraint

$$[1 - p + m(B)]B = R_0$$

Effect of market finance on risk-taking



Summing up (i)

- Competition with bond market

  → Limits bank's market power

  → Reduces equilibrium loan rates and intermediation margins

  → Reduces monitoring and increases banks' risk-taking

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- Constraint is binding when interest rates are low

  → In such case **lower rates increase banks' risk-taking**

Summing up (ii)

- In monopolistic markets

  → U-shaped relationship between safe rates and risk-taking

  → Decreasing for low rates (when constraint is binding)

  → Increasing for high rates (when constraint is not binding)

Part 3

Dynamic model with bank capital

Endogenous leverage and charter values

- What happens when banks can adjust their leverage?

  → In response to changes in safe rate

  → Dell'Ariccia et al. (2014)

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  → Excess cost of capital $\delta > 0$

Structure of the game (i)

- Four stages at each date t

1. Each bank j sets supply of loans l_j

   → This determines total supply of loans $L = \Sigma_{j=1}^{n} l_j$

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3. Bank j offers interest rate B_j to outside investors

4. Bank j (privately) chooses monitoring intensity m_j

Structure of the game (ii)

- With probability $p - m_j$ bank j fails in which case

  → It loses its charter value

  → A new bank enters the market

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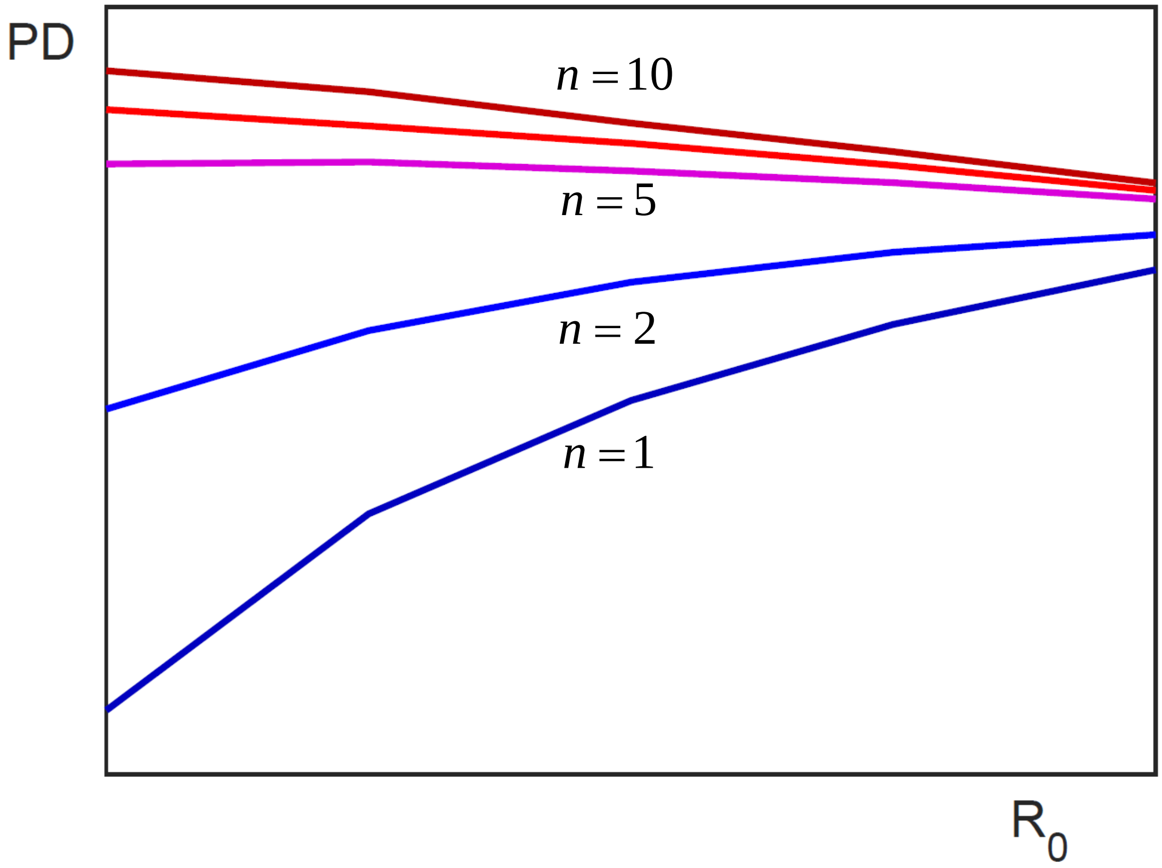
    → Same qualitative results as in benchmark model

Zero excess cost of capital



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- When excess cost of capital $\delta \rightarrow \infty$

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- When excess cost of capital $\delta \to \infty$

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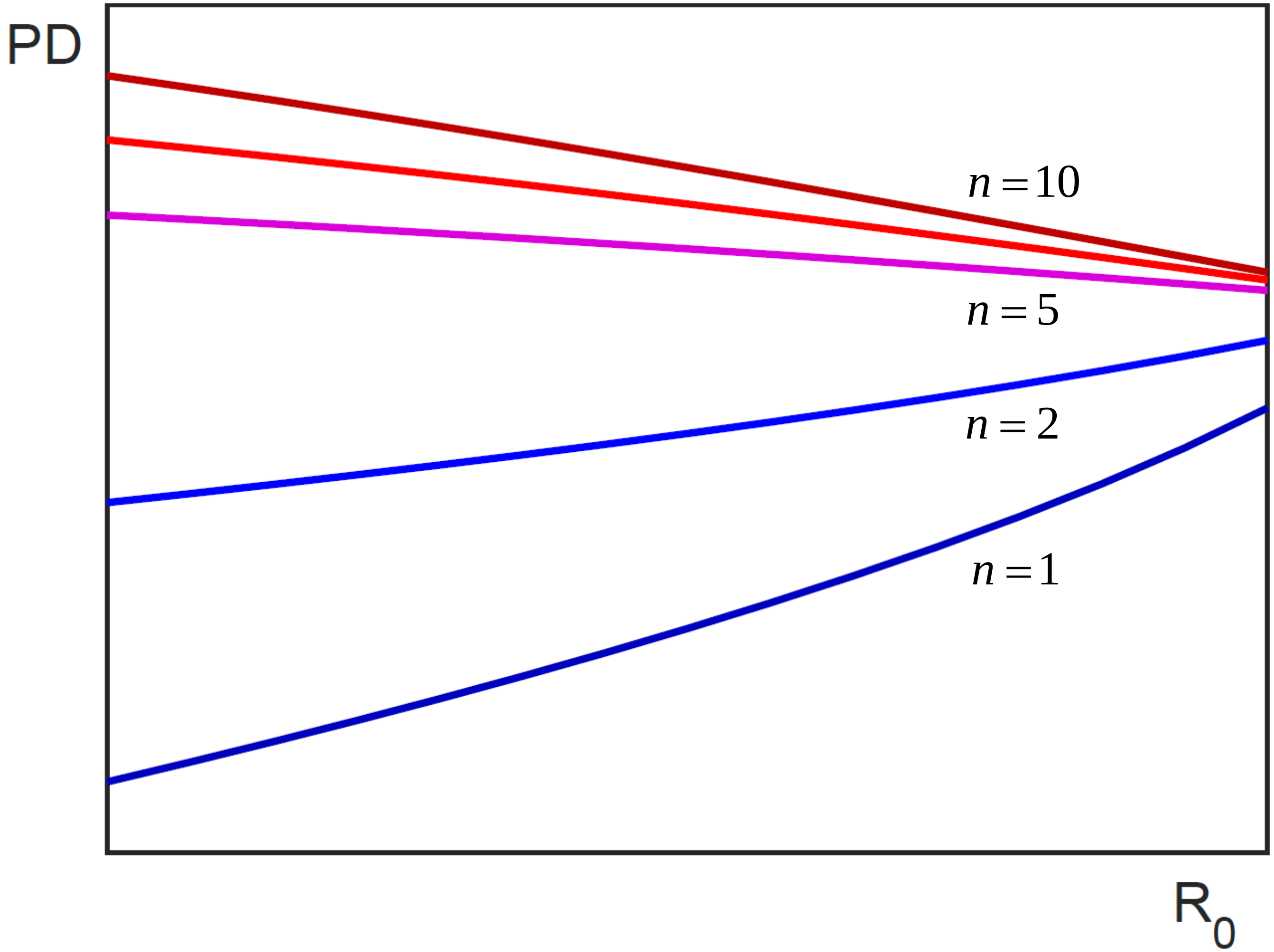
  $\to$ Identical to (static) benchmark model

Infinite excess cost of capital



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  → Solve stage 1 to get Cournot equilibrium lending L

  using Bellman equation for charter value V

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  → Lower capital per unit of loans k – **leverage effect**

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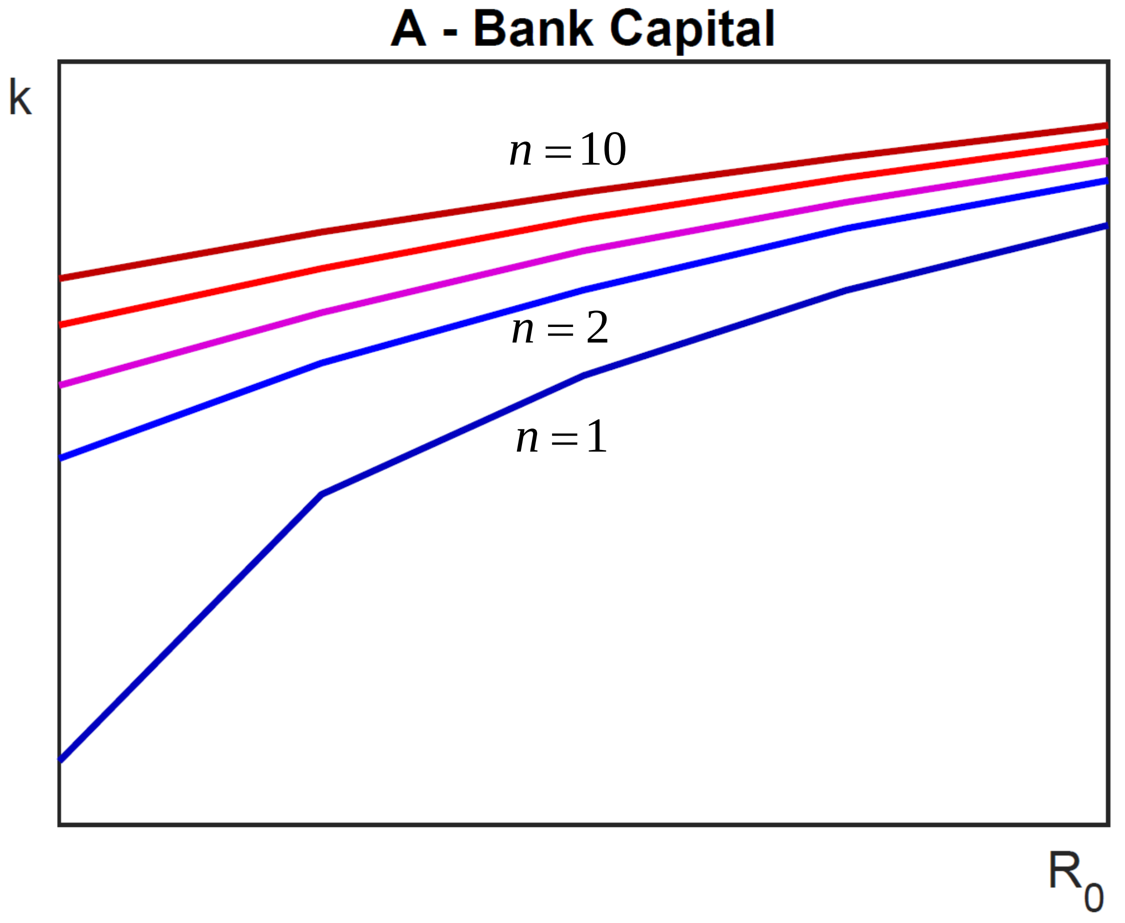
Leverage effect



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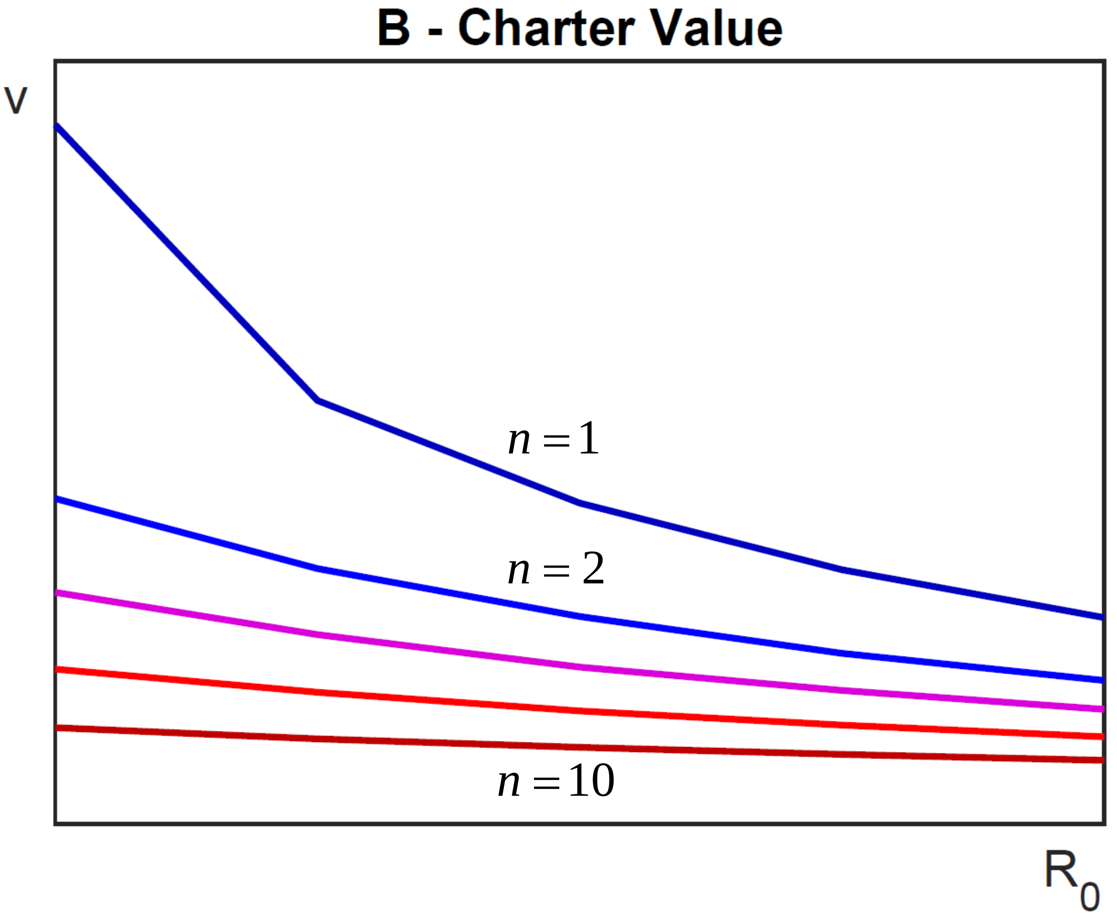
Charter value effect



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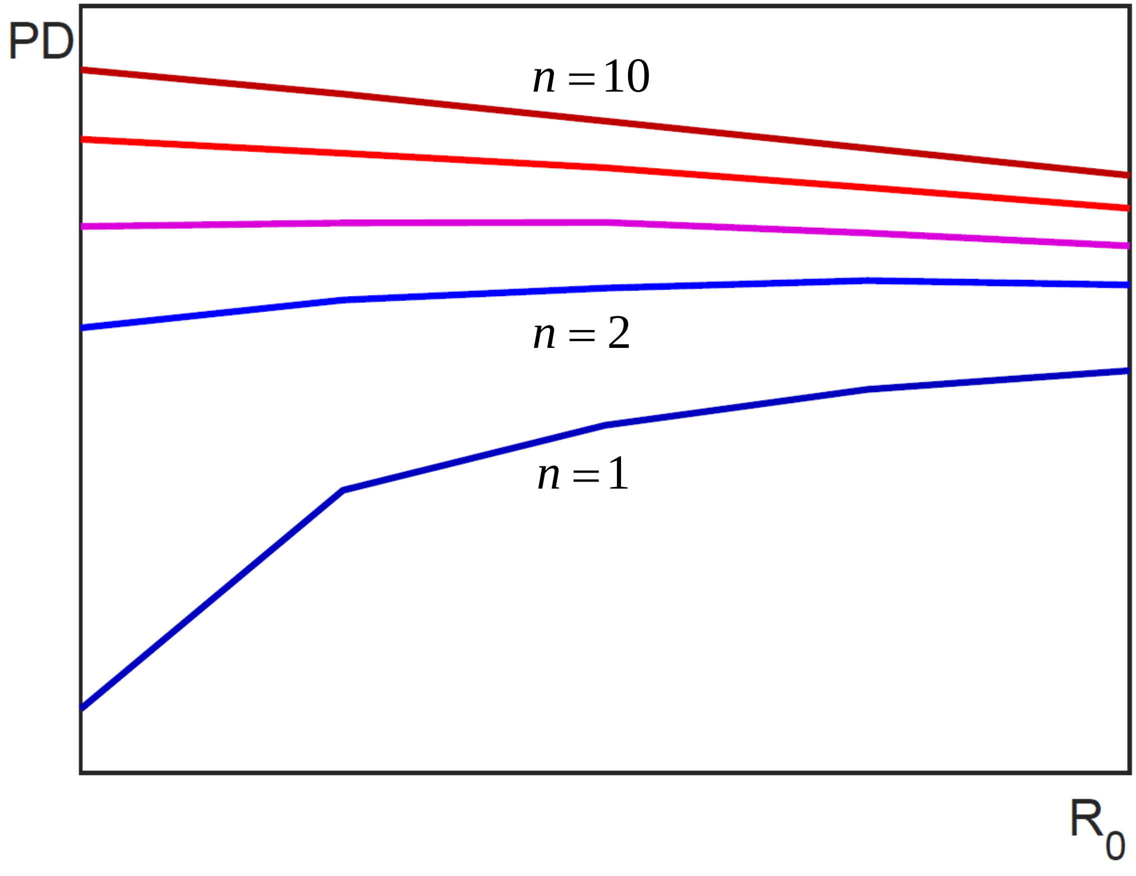
- Which effect dominates?

  → Depends on the number of banks n

Positive excess cost of capital: risk-taking



Summing up

- Dynamic model with costly equity capital

  → Bank failure entails losing charter

  → New bank enters the market upon failure

  → Total number of banks is always n

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- Two effects of lower safe rates

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  → Higher charter values and lower risk-taking

  → Charter value effect dominates when n is small

Part 4

Three extensions

Three extensions

- Back to static benchmark model

  → No inside equity capital and no charter values

- Extensions

  → Heterogeneous monitoring costs

  → Insured deposits

  → Endogenous deposit rates

Part 4a

Heterogeneous monitoring costs

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  → Average PD goes up (because of composition effect)

- Results closer to model with low market power

Part 4b

Insured deposits

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- With insured deposits banks are funded at safe rate: $B(L) = R_0$

  → Simpler model

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- With insured deposits banks are funded at safe rate: $B(L) = R_0$

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- Results similar to model with high market power

Part 4c

Endogenous deposit rates

Cournot competition in deposit market

- Introduce linear inverse supply function of deposits

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- Cournot competition for deposits and loans

  → Balance sheet constraint $l_j = d_j$

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- Introduce linear inverse supply function of deposits
- Cournot competition for deposits and loans

  → Balance sheet constraint $l_j = d_j$

- Similar results as those of the original model

  → With high competition lower rates increase risk-taking

  → With low competition lower rates decrease risk-taking

Concluding remarks

Concluding remarks (i)

- Market structure shapes effect of safe rates on financial stability

  → With high competition: lower rates imply riskier banks

  → With low competition: lower rates imply safer banks

Concluding remarks (i)

- Market structure shapes effect of safe rates on financial stability

  → With high competition: lower rates imply riskier banks

  → With low competition: lower rates imply safer banks

- Results are consistent with "charter value" hypothesis

  → Competition always increases banks' risk-taking

Concluding remarks (ii)

- Results show that you can have higher credit and lower risk

- When banks have significant market power

  → Lower rates increase lending and decrease risk-taking

  → No trade-off between credit and financial stability

Testable implications (i)

- Model yields key testable implication

$$Risk = \alpha + \underset{-}{\beta_0} R_0 + \underset{-}{\beta_1} HHI + \underset{+}{\beta_2} R_0 * HHI + \text{Controls}$$

$\rightarrow$ where HHI = Herfindahl index = $1/n$

Testable implications (ii)

- Other testable implications

  → Nonlinear effect of direct market finance

$$Risk = \alpha + \underset{-}{\beta_0} R_0 + \underset{-}{\beta_1} HHI + \underset{-}{\beta_2} R_0 * HHI + \underset{+}{\beta_3} R_0^2 * HHI + \underset{+}{\beta_4} R_0 * D + \text{Controls}$$

Testable implications (ii)

- Other testable implications

  → Nonlinear effect of direct market finance

  → Effect of proportion D of insured deposits

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Some references

- Dell'Ariccia, L. Laeven, and R. Marquez (2014), "Real Interest Rates, Leverage, and Bank Risk-Taking," *Journal of Economic Theory*.
- Dell'Ariccia, L. Laeven, and G. Suarez (2017), "Bank Leverage and Monetary Policy's Risk-Taking Channel," *Journal of Finance*.
- Drechsler, I., A. Savov, and P. Schnabl (2017), "The Deposits Channel of Monetary Policy," *Quarterly Journal of Economics*.
- Hellmann, T., K. Murdock, and J. Stiglitz (2000), "Liberalization, Moral Hazard in Banking, and Prudential Regulation," *American Economic Review*.
- Jimenez, G., S. Ongena, J.-L. Peydro, and J. Saurina (2014), "Hazardous Times for Monetary Policy," *Econometrica*.
- Martinez-Miera, D., and R. Repullo (2017), "Search for Yield," *Econometrica*.
- Repullo, R. (2004), "Capital Requirements, Market Power, and Risk-Taking in Banking," *Journal of Financial Intermediation*.