Optimal Capital Requirement with Noisy Signals on Banking Risk

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Introduction

- Frequently referred cause of 2008 financial crisis: excessive risk taking
- However, take MBS
  - If risk was known, prices would have taken that into account
  - Problem: were considered safe but risk was higher
- We analyze optimal capital requirements in an environment with various degrees of asymmetric information between financial institutions and investors
- Capital requirements in our model are leverage constraints, λ,

$$\text{Deposits} \leq \lambda \times \text{Banking capital.}$$

Our model

- Banks that borrow from depositors to invest in a risky technology
  - Each bank has access to a single investment project with different level of risk
  - Banks have limited liability
- We consider various degrees of asymmetric information
  - Full information: depositors observe risk of each bank
  - Imperfect information: depositors observe imprecise signal of risk of each bank

Our model

- Leverage constraints don't replace the role of market prices (deposit rates)
  - Leverage constraints supplement market prices when there are market failures, caused by asymmetric information
- Optimal leverage constraints are based on the severity of incomplete information (variance of risk) rather than average risk
  - Noisier signals lead to greater pooling in deposit rates, so a stricter leverage constraint is needed

Mechanism

If depositors observe risk of bank:

- deposit rate incorporates this risk
- riskier banks take less deposits (more expensive for them)

Mechanism

If depositors observe an imprecise signal of risk

- All banks with same signal will be perceived with same risk, so charge the same deposit rate
  - Riskier banks are more leveraged than efficient
  - Safer banks are inefficiently small
- leverage constraint
  - limits leverage of riskier banks
  - aggregate deposits are less risky, so deposit rate is lower
  - safer banks take more deposits
- If signal is noisier, there is more pooling, so a tighter leverage constraint is needed

Related literature

- **Effects of capital requirements**: Begenau and Landvoigt (2016), Diamond and Rajan (2000), Van den Heuvel (2008). We focus on a different dimension for capital requirements: variance of risk
- **Effect of macroprudential capital regulation on banks**: Begenau (2015), Corbae and D'Erasmo (2014), Martinez-Miera and Suarez (2014), Nguyen (2014). We focus on the role that capital requirements play on cross-subsidization across banks
- **Misallocation**: Buera et al (2011); Hsieh and Klenow (2009, 2014); Restuccia and Rogerson (2008). In our model all banks face same expected return, but not lend the same quantity

Our model

- One-period model
- Unit measure of banks
  - Endowed with E capital
  - Each bank has access to a single investment project with common mean return but different level of risk
  - Limited liability
- Deep-pocketed and risk neutral depositors
  - Access to R_f
- Benevolent policymaker that chooses λ

Banks

- Are indexed by $\rho \in [\rho_L, \rho_H]$
- Have access to an investment project with risky return given by

$$R(\rho) = \begin{cases} \frac{1}{\rho} & \text{with prob } \rho \\ 0 & \text{with prob } 1-\rho \end{cases}$$

- Can only invest in their own project
- Use their E and can accept deposits $D(\rho)$ at interest rate $R^D(\rho)$

Banks

- Subject to limited liability
- Cost of $c(I) = \frac{I^2}{2\varphi}$ to manage $I = E + D$ units of investment
- Expected profits

$$\Pi(\rho) = \max_{D} \quad \rho \left[\frac{1}{\rho} \left((E + D) - c\,(E + D) \right) - R^D D \right]$$

First-Best Benchmark

- Benevolent planner perfectly observes the risk of banks and dictates how many deposits they accept
  - Socially efficient allocations

$$\max_{D} \rho \frac{1}{\rho} \left((E + D) - c\left(E + D\right) \right) - R_f D,$$

Optimally deposits don't depend on ρ

$$D^{FB}\left(\rho\right) = \varphi(1 - R_f) - E, \forall \rho.$$

Scenario 1

Competitive equilibrium with perfect information

- Depositors perfectly observe ρ: $R^D(\rho) = \frac{R_f}{\rho}$
- Expected profits

$$\Pi(\rho) = \max_D \rho \left[\frac{1}{\rho} \left((E + D) - c\,(E + D) \right) - R^D(\rho) D \right]$$

- The risk of banks is perfectly priced into deposit rates

$$D(\rho) = \varphi(1 - R_f) - E.$$

Scenario 2

Competitive equilibrium with indistinguishable banks

- Single deposit rate
- Expected profits:

$$D(\rho) = \arg\max_{D} \rho \left[\frac{1}{\rho} \left((E + D) - c\,(E + D) \right) - R^D D \right].$$

- The deposit rate R^D is actuarially fair:

$$R^D = \frac{R_f}{\bar{\rho}}$$

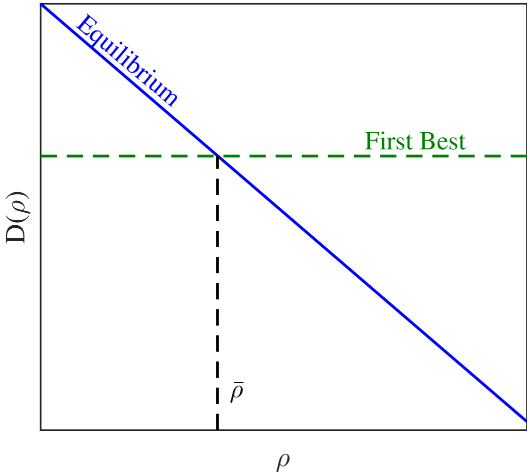
where $\bar{\rho} \equiv \frac{\int \rho D(\rho) dG(\rho)}{\int D(\rho) dG(\rho)}$

- The equilibrium leverage ratio is increasing in the risk of banks

$$D(\rho) = \varphi(1 - \rho R^D) - E.$$

Equilibrium vs first-best investment

Risky banks borrow too much and safer banks borrow too little



Leverage constraints

- Assume policy maker has access to λ such that $\frac{D}{E} \leq \lambda$
- Ramsey problem:

$$\max_{\lambda} \int \left[\rho \frac{1}{\rho} \left(E + D(\rho, \lambda) - c \left(E + D(\rho, \lambda) \right) \right) \right] dG(\rho) - \int R_f D(\rho, \lambda) dG(\rho)$$

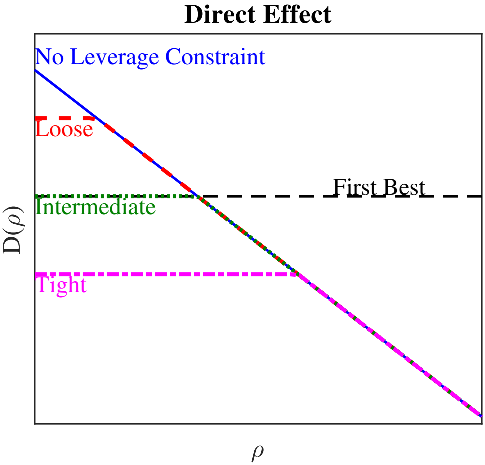
where

$$D(\rho, \lambda) = \min(\lambda E, \varphi(1 - \rho R^D(\lambda)) - E)$$

$$R^D(\lambda) = \frac{R_f}{\bar{\rho}(\lambda)} \quad \bar{\rho}(\lambda) = \frac{\int \rho D(\rho, \lambda) dG(\rho)}{\int D(\rho, \lambda) dG(\rho)}$$

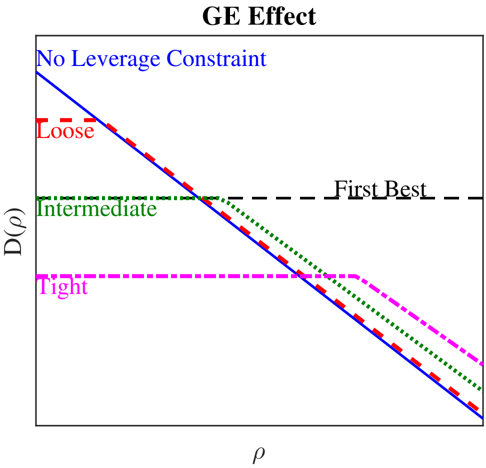
Optimal leverage ratio

Tightening causes risky banks to borrow less
Direct effect is maximized for $\lambda = \frac{D^{FB}}{E}$



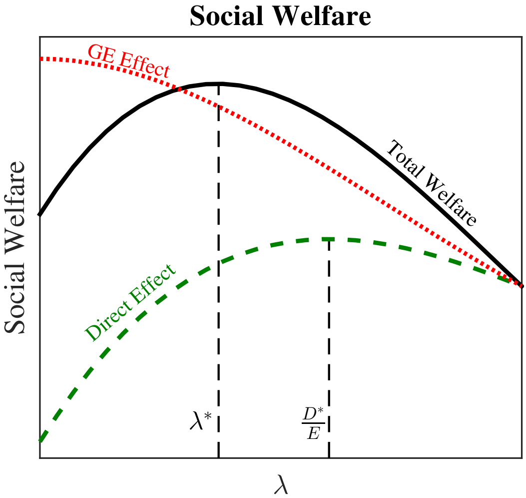
Optimal leverage constraint

Less risky deposits cause a lower R^D, so safe banks accept more deposits



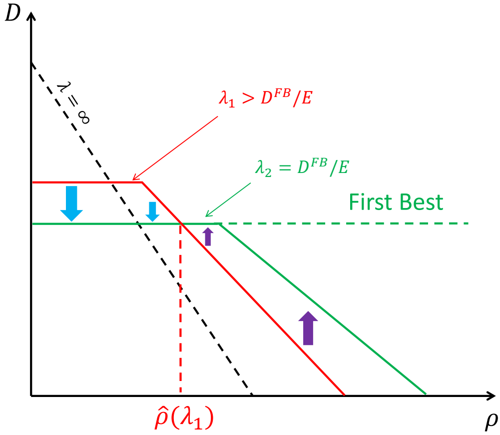
Optimal leverage constraint

$$\lambda^* \in (0, \frac{D^{FB}}{E}]$$



Mechanism

Blue arrows: direct effect
Purple arrows: GE effect



Scenario 3

Partial information: noisy signal

- Depositors and policy-makers observe $\widetilde{\rho} = \rho + \epsilon$, $\epsilon \sim H(\epsilon) \equiv N(0, \sigma^2)$
- Scenario 1 is $\sigma = 0$ and scenario 2 is $\sigma = \infty$
- Ramsey problem

$$\max_{\lambda(\cdot)} \int_\rho \int_\epsilon \left[\frac{1}{\rho} \rho \left(I - c\left(I \right) \right) \right] dH(\epsilon) dG(\rho) - \int_\rho \int_\epsilon R_f D\left(\rho, \tilde{\rho}; \lambda\left(\cdot \right) \right) dH(\epsilon) dG(\rho)$$

$$\text{s.t.} I = E + D\left(\rho, \tilde{\rho}; \lambda\left(\cdot \right) \right)$$

$$\tilde{\rho} = \rho + \epsilon$$

Scenario 3

- Deposits

$$D\left(\rho,\tilde{\rho};\lambda\left(\cdot\right)\right)=\min(\lambda\left(\tilde{\rho}\right)E,\varphi(1-\rho R^{D}\left(\tilde{\rho};\lambda\left(\cdot\right)\right))-E).$$

- Deposit rate

$$R^{D}\left(\tilde{\rho};\lambda\left(\cdot\right)\right)=\frac{R_f}{\bar{\rho}\left(\tilde{\rho};\lambda\left(\cdot\right)\right)}.$$

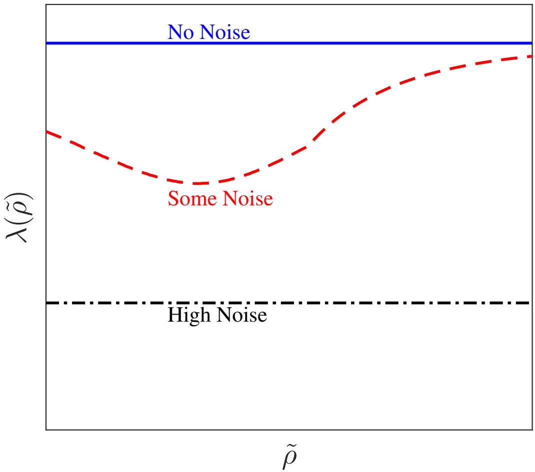
where

$$\bar{\rho}(\tilde{\rho};\lambda\left(\cdot\right))\equiv\frac{E_{\epsilon}\left[\rho D\left(\rho,\tilde{\rho};\lambda(\cdot)\right)|\rho+\epsilon=\tilde{\rho}\right]}{E_{\epsilon}\left[D\left(\rho,\tilde{\rho};\lambda(\cdot)\right|\rho+\epsilon=\tilde{\rho}\right]}$$

- Actual problem is not so cumbersome: decision of banks only affects banks with the same signal

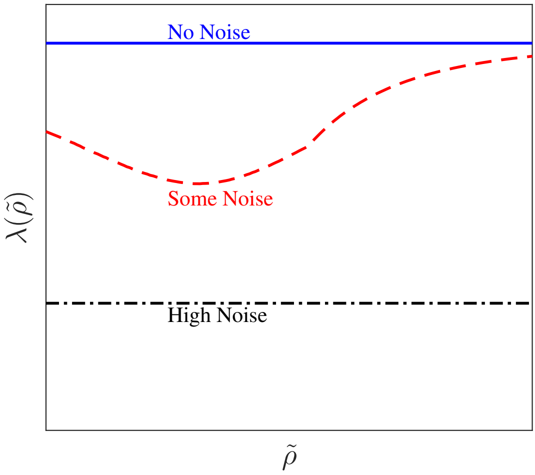
Optimal λ

No noise: any λ high enough works



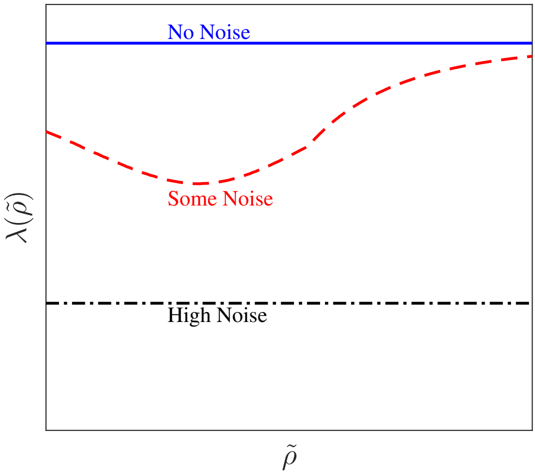
Optimal λ

High noise: tightest λ is needed



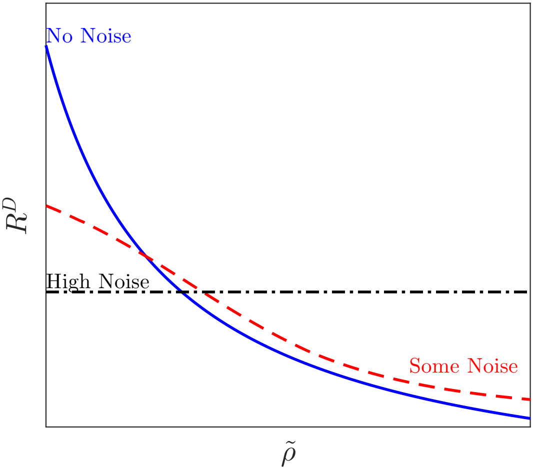
Optimal λ

Some noise: λ is tightest when signal is less informative



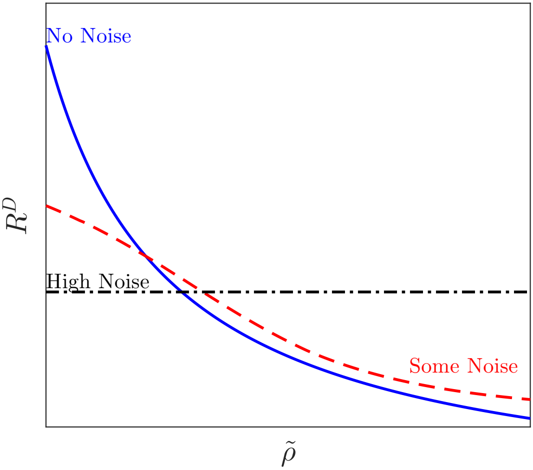
Optimal λ

No noise: R^D perfectly accounts for risk



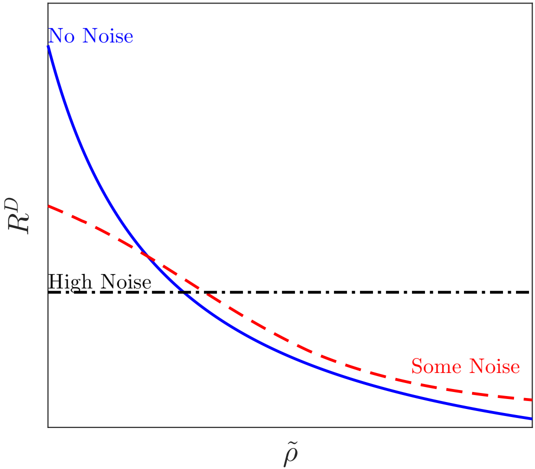
Optimal λ

High noise: R^D gives no info



Optimal λ

Some noise: λ complements role of R^D in accounting for risk



Conclusion

- We characterize the optimal leverage constraint in a model where banks face heterogeneous risk that is partially observable to depositors and policymakers
- With asymmetric information there is cross-subsidization:
  - Risky banks take too many deposits, safe banks too few
- Leverage constraints complement role of R^D in accounting for risk
- When risk signal is less informative it is optimal to have tighter leverage constraints