# Regulation, Supervision, and Bank Risk-Taking

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#### **Introduction (i)**

- Until the Global Financial Crisis academics paid little attention to bank regulation and supervision
  - → Bank regulation was isolated from mainstream economics
  - → Bank supervision was even more isolated
- In fact, many (mainly US) academics confused regulation with supervision
  - → Agarwal et al. (QJE 2014), "Inconsistent regulators"
  - → The paper was about federal and state <u>supervisors</u>

#### **Introduction (ii)**

- Supervisors had little interest in interacting with researchers (inside or outside central banks)
  - → Reluctance to share supervisory information
- Drivers of change
  - → Use of stress testing in banking supervision
  - → Arrival of macroprudential supervision
  - → Appointment of researchers to top positions in supervision

#### **Introduction (iii)**

- Situation has changed in recent years
  - → Many academic papers on bank supervision
  - → Some research conferences like this one
- Almost all the research on bank supervision is empirical
  - → Number of facts that lack a theoretical explanation
- Purpose of this paper
  - → Understanding the mechanisms behind some of these facts

#### Some research with US data (i)

- Agarwal, Lucca, Seru, and Trebbi (QJE 2014)
  - → Federal supervisors are tougher than state supervisors
  - → Leniency of state supervisors leads to higher failure rates
- Hirtle, Kovner, and Plosser (JF 2020)
  - → Compare "district top" banks to similar institutions in other districts that are not ranked largest
  - → Bank supervision lowers risk-taking

#### Some research with US data (ii)

- Costello, Granja, and Weber (JAR 2019)
  - → Role of supervisors in enforcing reporting transparency
  - → Restatements of banks' call reports
- Kandrac and Schlusche (*RFS* 2021)
  - → Natural experiment of a decline in supervisory oversight
  - → Causal effect on higher risk-taking

#### Some research with US data (iii)

- Eisenbach, Lucca, and Townsend (JF 2022)
  - → Structural model of allocation of supervisory hours
  - → Significant effect of supervision on bank risk
  - → Importantly, they note:

"In estimating the effect of supervision on bank risk, we do <u>not</u> explicitly specify the channel through which supervision operates"

### Some research with European data

- Abbassi, Iyer, Peydró, and Soto (2023)
  - → Banks reduced their riskier loans and securities following the 2013 announcement of the Asset Quality Review
- Kok, Müller, Ongena, and Pancaro (*JFI* 2023)
  - → Banks that participated in the 2016 EU-wide stress test reduced their credit risk
- Bonfim, Cerqueiro, Degryse, and Ongena (MS 2023)
  - → On-site inspections in Portugal reduced zombie lending

### Two papers in this conference

- Altavilla, Boucinha, Jasova, Peydró, and Smets (2024)
  - → Supranational supervision in Europe reduces credit supply to riskier firms
- Degryse, Huylebroek, and Van Doornik (2024)
  - → Supervisory actions arising from SupTech application in Brazil reduce bank risk-taking

### This paper

- Understanding mechanisms behind these empirical results
  - → Effect of supervision on bank risk-taking
  - → Interaction with bank regulation
  - → Are they complements or substitutes?

#### Overview of model

- Two agents (bank and supervisor) and three dates (t = 0, 1, 2)
- At t = 0 the bank raises one unit of insured deposits
  - → Chooses the (unobservable) risk of its investment
- At t = 1 the supervisor gets a signal on the return of investment
  - → Assesses whether the bank is "failing or likely to fail"
  - $\rightarrow$  If so, supervisor closes the bank
  - → Or equivalently sends it to the resolution authority
- At t = 2 final return is realized (if bank is not closed at t = 1)

#### Main results

- In laissez-faire (without regulation or supervision)
  - → Bank has an incentive to take excessive risk
- Regulation (capital requirements) reduces risk-taking
- Supervision also reduces risk-taking (in addition to regulation)
  - → Disciplining effects of supervision come from the fact that supervisory information is noisy

#### **Outline**

- Model setup
- Laissez-faire
- Bank capital regulation
- Bank supervision
- Regulation and supervision
- Discussion
- Concluding remarks

# Part 1 Model setup

# **Model setup**

- Three dates (t = 0, 1, 2)
- Two agents: risk-neutral bank and supervisor
- Bank raises one unit of deposits at t = 0
  - $\rightarrow$  Invest these funds in an asset with returns at t = 1 or t = 2

## **Assumptions**

- Deposits are insured and deposit rate is normalized to zero
- Asset returns are normally distributed (for tractability) with

$$\begin{bmatrix} L \\ R \end{bmatrix} \sim N \begin{pmatrix} \begin{bmatrix} a\overline{R} \\ \overline{R} \end{bmatrix}, \sigma^2 \begin{bmatrix} b & c \\ c & 1 \end{bmatrix} \end{pmatrix}$$

 $\rightarrow$  where  $\overline{R} > 1$ , 0 < a < 1, 0 < c < 1, and  $c^2 < b < 1$ 

## Comments on the assumptions (i)

$$\begin{bmatrix} L \\ R \end{bmatrix} \sim N \begin{pmatrix} \begin{bmatrix} a\overline{R} \\ \overline{R} \end{bmatrix}, \sigma^2 \begin{bmatrix} b & c \\ c & 1 \end{bmatrix} \end{pmatrix}$$

- $E(R) = \overline{R} > 1$ 
  - → Expected final return > Face value of deposits
  - → Positive NPV investment

### Comments on the assumptions (ii)

$$\begin{bmatrix} L \\ R \end{bmatrix} \sim N \begin{pmatrix} \begin{bmatrix} a\overline{R} \\ \overline{R} \end{bmatrix}, \sigma^2 \begin{bmatrix} b & c \\ c & 1 \end{bmatrix} \end{pmatrix}$$

- $E(L) = a\overline{R} < \overline{R} = E(R)$ 
  - → Expected liquidation return < Expected final return
  - → Inefficient liquidation in the absence of information
  - → Possible role for supervisory information

### Comments on the assumptions (iii)

$$\begin{bmatrix} L \\ R \end{bmatrix} \sim N \begin{pmatrix} \begin{bmatrix} a\overline{R} \\ \overline{R} \end{bmatrix}, \sigma^2 \begin{bmatrix} b & c \\ c & 1 \end{bmatrix} \end{pmatrix}$$

- Cov(L, R) = c > 0
  - → Liquidation return and final return are positively correlated
  - $\rightarrow$  Bank invests in financial assets, not real assets that could be redeployed to other sectors at price independent of R

## Comments on the assumptions (iv)

$$\begin{bmatrix} L \\ R \end{bmatrix} \sim N \begin{pmatrix} \begin{bmatrix} a\overline{R} \\ \overline{R} \end{bmatrix}, \sigma^2 \begin{bmatrix} b & c \\ c & 1 \end{bmatrix} \end{pmatrix}$$

- $Var(L) = b\sigma^2 < \sigma^2 = Var(R)$ 
  - → Liquidation return is less volatile than final return
  - → Not strictly needed, but realistic (passage of time)
- Since  $Cov(L,R)^2 < Var(L)Var(R)$ 
  - $\rightarrow$  This implies c < 1

# Bank risk-taking

- Bank chooses risk of its investment  $\sigma$  at t=0
- Deviating from reference value  $\bar{\sigma} > 0$  entails nonpecuniary cost

$$c(\sigma) = \frac{\gamma}{2} (\sigma - \overline{\sigma})^2$$

- $\rightarrow \bar{\sigma}$  characterizes business model of the bank
- → Deviating from it (in either direction) is costly
- → Key assumption of model: concavify objective function

# Part 2 Laissez-faire

# Bank's objective function

- In the absence of regulation and/or supervision
  - $\rightarrow$  Bank maximizes expected payoff at t=2, denoted  $\pi(\sigma)$ , net of the cost of risk-taking  $c(\sigma)$
- Bank's choice of risk

$$\sigma^* = \arg\max_{\sigma} v(\sigma) = \pi(\sigma) - c(\sigma)$$

# Bank's expected payoff (i)

• Bank's expected payoff at t = 2

$$\pi(\sigma) = E\left[\max\left\{R - 1, 0\right\}\right] \Pr(R \ge 1)$$

→ By the properties of normal distributions

$$E\left[\max\left\{R-1,0\right\}\right] = E[R-1|R \ge 1]$$

$$= \overline{R} - 1 + \sigma\phi\left(\frac{\overline{R} - 1}{\sigma}\right) \left[\Phi\left(\frac{\overline{R} - 1}{\sigma}\right)\right]^{-1}$$

$$\Pr(R \ge 1) = \Phi\left(\frac{\overline{R} - 1}{\sigma}\right)$$

 $\rightarrow$  where  $\phi(\cdot)$  and  $\Phi(\cdot)$  are pdf and cdf of standard normal

# Bank's expected payoff (ii)

• Bank's expected payoff at t = 2

$$\pi(\sigma) = (\overline{R} - 1)\Phi\left(\frac{\overline{R} - 1}{\sigma}\right) + \sigma\phi\left(\frac{\overline{R} - 1}{\sigma}\right)$$

- Since the function  $\max\{R-1,0\}$  is convex
  - → By second-order stochastic dominance, the bank would like to choose an infinite amount of risk

$$\pi'(\sigma) = \phi\left(\frac{\overline{R}-1}{\sigma}\right) > 0$$

 $\rightarrow$  Cost of risk-taking  $c(\sigma)$  ensures an interior solution

#### Bank's choice of risk

• Bank's choice of risk characterized by first-order condition

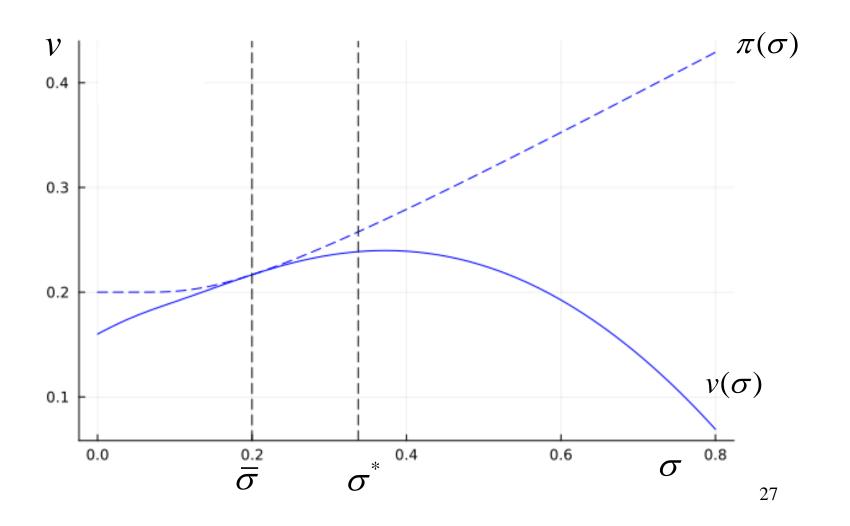
$$v'(\sigma) = \pi'(\sigma) - c'(\sigma) = \phi\left(\frac{\overline{R} - 1}{\sigma}\right) - \gamma(\sigma - \overline{\sigma}) = 0$$

 $\rightarrow$  which implies

$$\sigma^* > \overline{\sigma}$$

- Summing up: Under laissez-faire the bank will increase the asset risk above the reference value  $\bar{\sigma}$ 
  - $\rightarrow$  Positive cost of excess risk-taking  $c(\sigma^*) > 0$

# Risk-taking in laissez-faire



#### Parameter values (i)

• The following parameter values are used in all the figures

$$\overline{R} = 1.2$$
,  $a = 0.8$ ,  $c = 0.2$ ,  $\overline{\sigma} = 0.2$ , and  $\gamma = 2$ 

• These values are not intended to provide a calibration of the model, since they are chosen to facilitate the graphical representation of the qualitative results

## Effect of market power on risk-taking

• Differentiating the first-order condition gives

$$\frac{d\sigma^*}{d\overline{R}} = -\frac{\frac{1}{\sigma}\phi'\left(\frac{\overline{R}-1}{\sigma}\right)}{\frac{\partial}{\partial\sigma}\left[\phi\left(\frac{\overline{R}-1}{\sigma}\right) - \gamma(\sigma-\overline{\sigma})\right]}$$

- → By second-order condition the denominator is negative
- $\rightarrow \overline{R} 1 > 0$  implies that numerator is negative
- Hence, higher market power reduces bank risk-taking
  - → In line with the classical "charter value view"

# Part 3 Bank capital regulation

# Bank capital regulation

- Examine the effect of a regulation that requires the bank to fund a fraction  $\overline{k} > 0$  of its unit investment with equity capital
- Assume that capital is more expensive than insured deposits
  - $\rightarrow$  Let  $\delta > 0$  denote the excess cost of capital

# Bank's expected payoff (i)

• Bank's expected payoff at t = 2

$$\pi(\sigma;k) = E\left[\max\left\{R - (1-k), 0\right\}\right] \Pr(R \ge 1-k) - (1+\delta)k$$

- $\rightarrow$  where  $k \ge \overline{k}$  denotes the bank's capital
- In principle, the bank could have more capital than  $\overline{k}$ 
  - → but this will be suboptimal (see below)

# Bank's expected payoff (ii)

• Note that the expected payoff could also be written as of t = 0

$$\frac{\pi(\sigma;k)}{1+\delta} = -k + \frac{1}{1+\delta} E\left[\max\left\{R - (1-k), 0\right\}\right] \Pr(R \ge 1-k)$$

- $\rightarrow$  First term: Contribution of bank shareholders at t = 0
- $\rightarrow$  Second term: Discounted expected payoff at t = 2

# Capital requirement is binding

• By our previous results we can write

$$\pi(\sigma;k) = [\overline{R} - (1-k)]\Phi\left(\frac{\overline{R} - (1-k)}{\sigma}\right) + \sigma\phi\left(\frac{\overline{R} - (1-k)}{\sigma}\right) - (1+\delta)k$$

 $\rightarrow$  which implies

$$\frac{\partial}{\partial k}\pi(\sigma;k) = \Phi\left(\frac{\overline{R} - (1-k)}{\sigma}\right) - (1+\delta) < 0$$

 $\rightarrow$  Constraint  $k \ge \overline{k}$  will always be binding

#### Bank's choice of risk

Bank's objective function

$$v(\sigma; \overline{k}) = \pi(\sigma; \overline{k}) - c(\sigma)$$

• Bank's choice of risk

$$\sigma^*(\overline{k}) = \arg\max_{\sigma} \left[ \pi(\sigma; \overline{k}) - c(\sigma) \right]$$

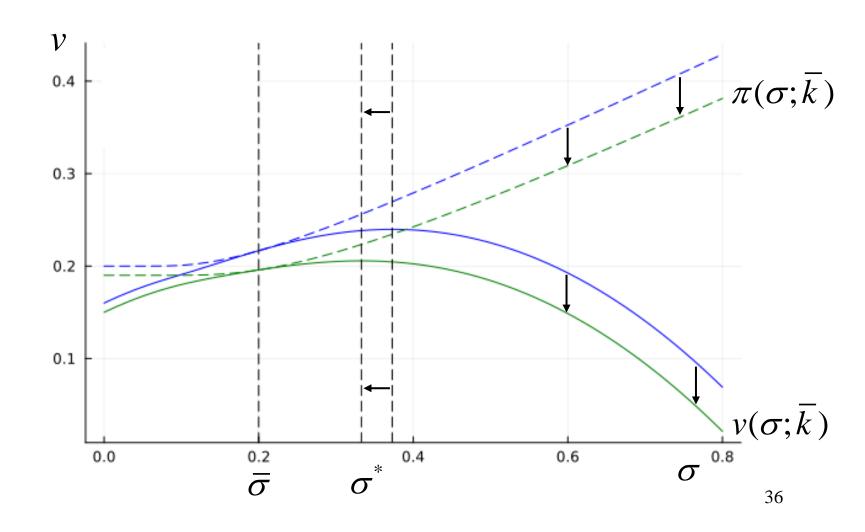
→ First-order condition

$$\frac{\partial}{\partial \sigma} \pi(\sigma; \overline{k}) - c'(\sigma) = \phi \left( \frac{\overline{R} - (1 - \overline{k})}{\sigma} \right) - \gamma(\sigma - \overline{\sigma}) = 0$$

 $\rightarrow$  which implies

$$\sigma^*(\bar{k}) > \bar{\sigma}$$

# Risk-taking with capital requirements



#### Parameter values (ii)

- The excess cost of capital is assumed to be  $\delta = 0.1$
- All other parameters are as in the laissez-faire section

$$\overline{R} = 1.2$$
,  $a = 0.8$ ,  $c = 0.2$ ,  $\overline{\sigma} = 0.2$ , and  $\gamma = 2$ 

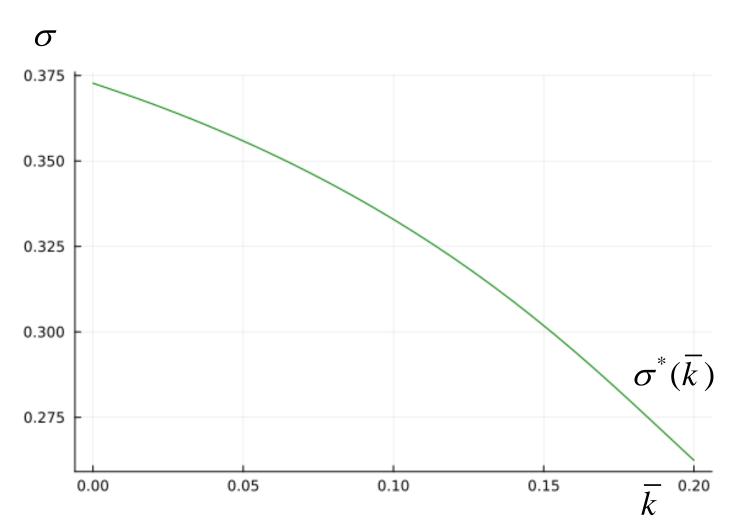
## Effect of regulation on risk-taking

• Differentiating the first-order condition gives

$$\frac{d\sigma^{*}(\bar{k})}{d\bar{k}} = -\frac{\frac{1}{\sigma}\phi'\left(\frac{\bar{R} - (1 - \bar{k})}{\sigma}\right)}{\frac{\partial}{\partial \sigma}\left[\phi\left(\frac{\bar{R} - (1 - \bar{k})}{\sigma}\right) - \gamma(\sigma - \bar{\sigma})\right]}$$

- → By second-order condition the denominator is negative
- $\rightarrow \bar{R} (1 \bar{k}) \ge 0$  implies that numerator is negative
- Hence, higher capital requirements reduce bank risk-taking

# Effect of regulation on risk-taking



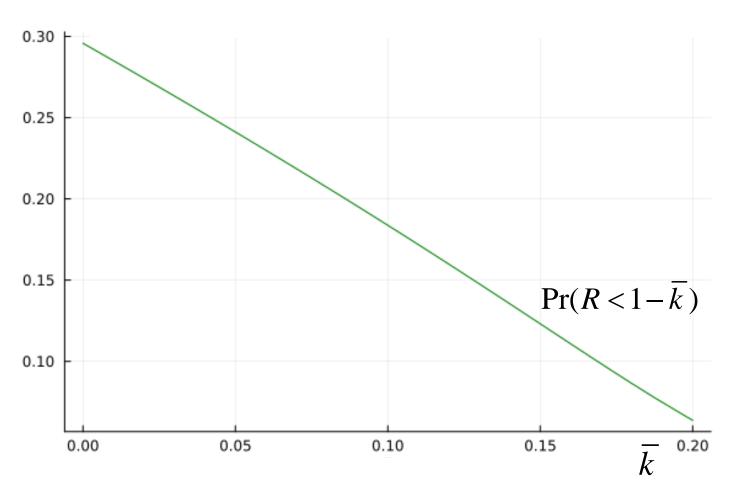
## Effect of regulation on bank failure

• Probability of bank failure under regulation given by

$$\Pr[R < 1 - \overline{k}] = \Phi\left(\frac{(1 - \overline{k}) - \overline{R}}{\sigma^*(\overline{k})}\right)$$

- Higher capital requirements
  - $\rightarrow$  Decrease numerator  $(1-\bar{k})-\bar{R}$  (which is negative)
  - $\rightarrow$  Decrease denominator  $\sigma^*(\overline{k})$
  - → Both effects reduce the value of the ratio (more negative)
  - → Lower probability of bank failure

# Effect of regulation on bank failure



# Part 4 Bank supervision

• Supervisor observes at t = 1 non-verifiable signal

$$s = R + \varepsilon$$

on the final return of the bank's investment R

- $\rightarrow$  where  $\varepsilon \sim N(0, \tau \sigma^2)$  and independent of L and R
- Note that
  - $\rightarrow \tau$  characterizes the noise in the supervisory information
  - $\rightarrow 1/\tau$  measures the quality of the supervisory information

Joint distribution of signal and returns

$$\begin{bmatrix} L \\ R \\ s \end{bmatrix} \sim N \begin{bmatrix} a \\ 1 \\ 1 \end{bmatrix}, \sigma^2 \begin{bmatrix} b & c & c \\ c & 1 & 1 \\ c & 1 & 1+\tau \end{bmatrix}$$

Joint distribution of signal and returns

$$\begin{bmatrix} L \\ R \\ s \end{bmatrix} \sim N \begin{pmatrix} \overline{R} \begin{bmatrix} a \\ 1 \\ 1 \end{bmatrix}, \sigma^2 \begin{bmatrix} b & c & c \\ c & 1 & 1 \\ c & 1 & 1+\tau \end{bmatrix} \end{pmatrix}$$

Note that

$$E(s) = E(R + \varepsilon) = \overline{R}$$

Joint distribution of signal and returns

$$\begin{bmatrix} L \\ R \\ s \end{bmatrix} \sim N \begin{pmatrix} \overline{R} \begin{bmatrix} a \\ 1 \\ 1 \end{bmatrix}, \sigma^2 \begin{bmatrix} b & c & c \\ c & 1 & 1 \\ c & 1 & 1+\tau \end{bmatrix} \end{pmatrix}$$

• Note that

$$Var(s) = Var(R + \varepsilon) = Var(R) + Var(\varepsilon) = (1 + \tau)\sigma^{2}$$

Joint distribution of signal and returns

$$\begin{bmatrix} L \\ R \\ s \end{bmatrix} \sim N \begin{pmatrix} \overline{R} \begin{bmatrix} a \\ 1 \\ 1 \end{bmatrix}, \sigma^2 \begin{bmatrix} b & c & c \\ c & 1 & 1 \\ c & 1 & 1+\tau \end{bmatrix} \end{pmatrix}$$

• Note that

$$Cov(R, s) = Cov(R, R + \varepsilon) = Var(R) = \sigma^2$$

Joint distribution of signal and returns

$$\begin{bmatrix} L \\ R \\ s \end{bmatrix} \sim N \begin{pmatrix} \overline{R} \begin{bmatrix} a \\ 1 \\ 1 \end{bmatrix}, \sigma^2 \begin{bmatrix} b & c & c \\ c & 1 & 1 \\ c & 1 & 1+\tau \end{bmatrix} \end{pmatrix}$$

• Note that

$$Cov(L, s) = Cov(L, R + \varepsilon) = Cov(L, R) = c\sigma^{2}$$

• By the properties of normal distributions

$$E(L|s) = a\overline{R} + \frac{c(s - \overline{R})}{1 + \tau}$$

$$E(R|s) = \overline{R} + \frac{s - \overline{R}}{1 + \tau}$$

• Note that these conditional expectations do not depend on the risk  $\sigma$  chosen by the bank

• Since c < 1, slope of E(L|s) is lower than slope of E(R|s), so

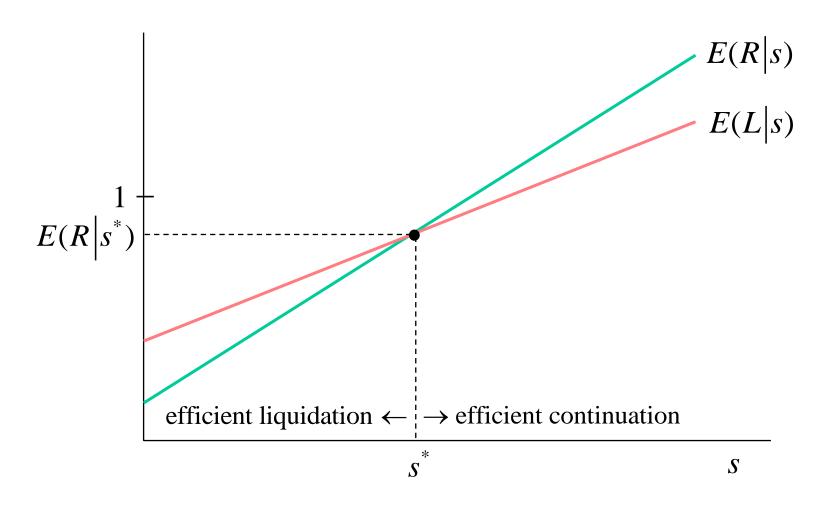
$$E(L|s) > E(R|s)$$
 if and only if  $s < s^* = \overline{R} - \frac{(1+\tau)(1-a)}{1-c}\overline{R}$ 

- $\rightarrow$  where  $s^*$  is the efficient liquidation threshold (given  $\tau$ )
- I will assume that parameter values are such that

$$E(L|s^*) = E(R|s^*) = \frac{a-c}{1-c}\overline{R} < 1$$

- $\rightarrow$  Expected final return at  $s^*$  is smaller than value of deposits
- → Efficient liquidation only if bank has negative equity

## Efficient liquidation threshold



## Supervisor's closure decision (i)

- I do <u>not</u> assume that the supervisor uses the efficient liquidation threshold  $s^*$  to decide on closure
  - → This will be discussed below
- Instead, we assume that the supervisor uses the **failing or** likely to fail criterion

# ECB Banking Supervision guidelines

- There are four reasons why a bank can be declared failing or likely to fail:
  - → It no longer fulfils the requirements for authorisation by the supervisor
  - → It has more liabilities than assets
  - → It is unable to pay its debts as they fall due
  - → It requires extraordinary financial public support
- At the time of declaring a bank as failing or likely to fail, one of the above conditions must be met or be likely to be met 53

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- At the time of declaring a bank as failing or likely to fail, one of the above conditions must be met or be likely to be met 54

## Supervisor's closure decision (ii)

• Supervisor assesses that bank has more liabilities than assets if

• By our previous results

$$E(R|s) = \overline{R} + \frac{s - \overline{R}}{1 + \tau} < 1$$
 if and only if  $s < \hat{s} = 1 - \tau(\overline{R} - 1)$ 

- $\rightarrow$  Supervisor's closure threshold is  $\hat{s}$
- Note that closure threshold does <u>not</u> depend on the risk  $\sigma$  chosen by the bank
  - → Key (nice) feature of model

# **Terminology**

- Supervisor that uses the failing or likely to fail rule  $s < \hat{s}$  will be called an **F** supervisor
- Supervisor that uses the efficient liquidation rule  $s < s^*$  will be called an **E supervisor**

# Comparison of two types of supervisor

• By our previous assumption we have

$$\hat{s} - s^* = (1 + \tau) \left( 1 - \frac{a - c}{1 - c} \, \overline{R} \right) > 0$$

- $\rightarrow$  Range of signals  $s \in (s^*, \hat{s})$  for which closure is inefficient
- F supervisor is tougher than E supervisor

## Some questions to be addressed

- Does supervision reduce bank risk-taking  $\sigma$ ?
- If so, what are the channels for this effect?
- Is a lower noise  $\tau$  (or a higher quality  $1/\tau$ ) of supervisory information conducive to lower risk-taking?
- Is an F supervisor more effective in reducing risk-taking than an E supervisor?
- How does supervision interact with regulation?

# Bank's objective function

- I assume that supervisor uses liquidation proceed to cover deposit insurance payouts
  - $\rightarrow$  Bank gets zero payoff when  $s < \hat{s}$
- Bank's choice of risk

$$\sigma^*(\tau) = \arg\max_{\sigma} v(\sigma; \hat{s}) = \pi(\sigma; \hat{s}) - c(\sigma)$$

$$\rightarrow$$
 where  $\hat{s} = 1 - \tau(\overline{R} - 1)$ 

# Bank's expected payoff

• Bank's expected payoff at t = 2

$$\pi(\sigma; \hat{s}) = E \lceil R - 1 \mid R \ge 1, s \ge \hat{s} \rceil \Pr(R \ge 1, s \ge \hat{s})$$

→ By the properties of truncated normal distributions

$$\pi(\sigma; \hat{s}) = (\overline{R} - 1)\Phi\left(\frac{\overline{R} - 1}{\sigma}, \frac{\sqrt{1 + \tau}(\overline{R} - 1)}{\sigma}; \frac{1}{\sqrt{1 + \tau}}\right) + \sigma\phi\left(\frac{\overline{R} - 1}{\sigma}\right)\Phi\left(\frac{\sqrt{\tau}(\overline{R} - 1)}{\sigma}\right) + \frac{\sigma}{2\sqrt{1 + \tau}}\phi\left(\frac{\sqrt{1 + \tau}(\overline{R} - 1)}{\sigma}\right)$$

 $\rightarrow$  where  $\Phi(\cdot,\cdot;\rho)$  is the cdf of standard bivariate normal distribution with correlation coefficient  $\rho$ 

60

## Effect of noise $\tau$ (i)

• Recall that supervisor observes at t = 1 non-verifiable signal

$$s = R + \varepsilon$$

where  $\varepsilon \sim N(0, \tau \sigma^2)$  and independent of L and R

• When  $\tau = 0$  the supervisor observes final return *R*. Since

$$\lim_{\tau \to 0} \hat{s} = 1 - \tau(\overline{R} - 1) = 1 \implies s < \hat{s} \iff R < 1$$

- $\rightarrow$  Bank will be closed by supervisor at t = 1 if and only if it would fail at t = 2
- → Equivalent to laissez-faire

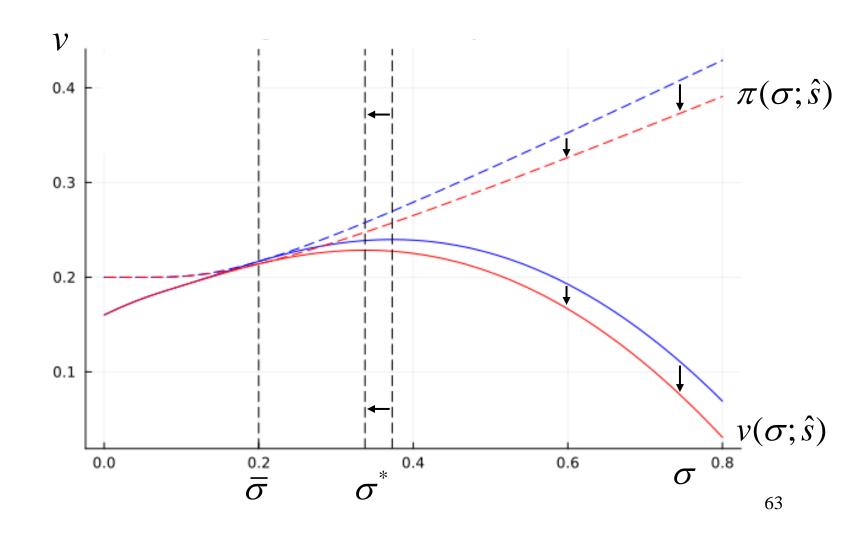
## Effect of noise $\tau$ (ii)

• When  $\tau \to \infty$ 

$$\lim_{\tau \to \infty} \hat{s} = 1 - \tau(\overline{R} - 1) = -\infty \implies \Pr(s < \hat{s}) = 0$$

- → Bank will never be closed by the supervisor
- → Equivalent to laissez-faire
- What happens when  $0 < \tau < \infty$ ?
  - → Supervision reduces bank's risk-taking (compared to laissez-faire)

# **Risk-taking with supervision**



#### Parameter values (iii)

- Noise in supervisory information is assumed to be  $\tau = 1$
- All other parameters are as in the laissez-faire section

$$\bar{R} = 1.2$$
,  $a = 0.8$ ,  $c = 0.2$ ,  $\bar{\sigma} = 0.2$ , and  $\gamma = 2$ 

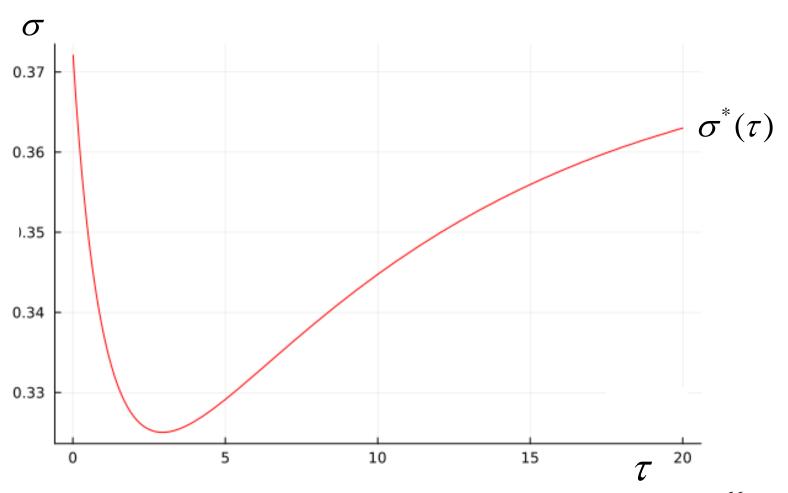
## Effect of noise on risk-taking (i)

• Since

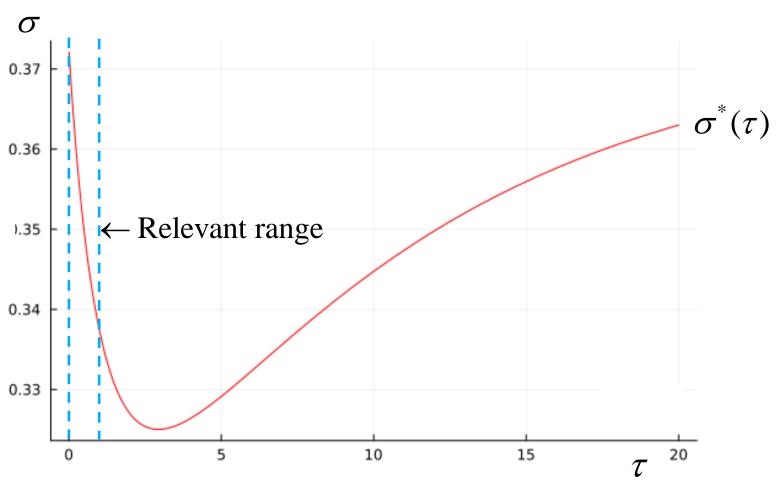
$$\lim_{\tau \to 0} \sigma^*(\tau) = \lim_{\tau \to \infty} \sigma^*(\tau) = \sigma^*$$

- $\rightarrow$  relationship between  $\tau$  and  $\sigma^*(\tau)$  cannot be monotonic
- → first decreasing and then increasing

# Effect of noise on risk-taking

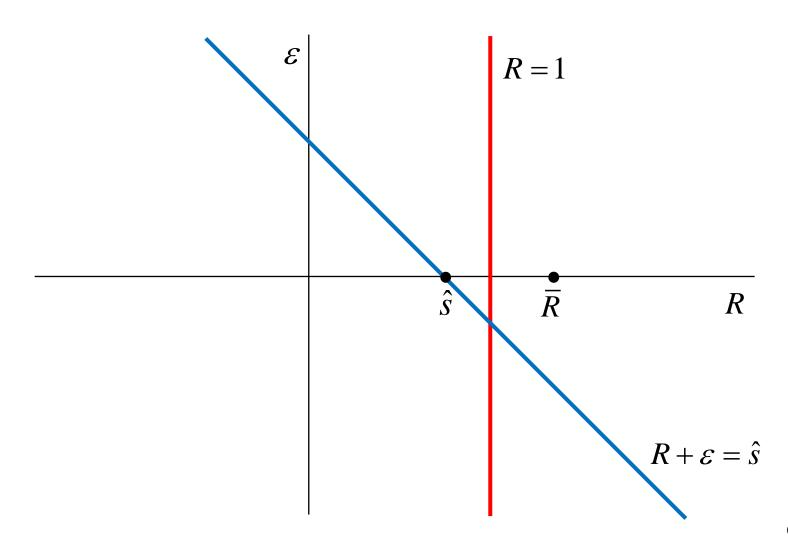


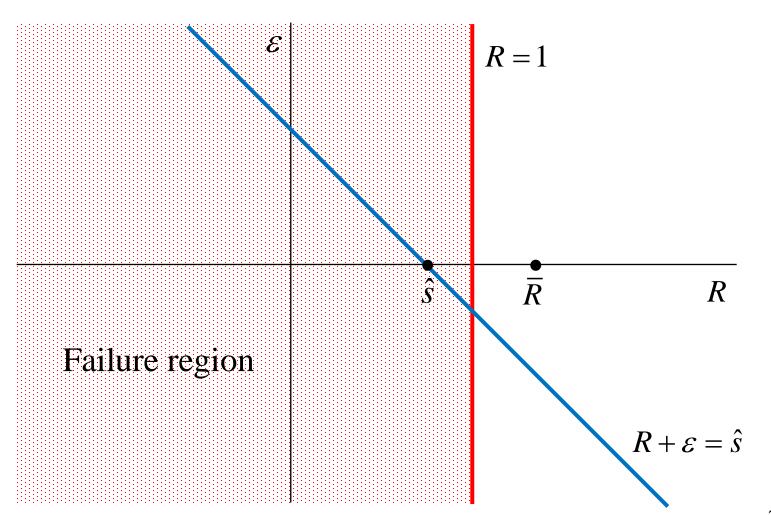
# Effect of noise on risk-taking

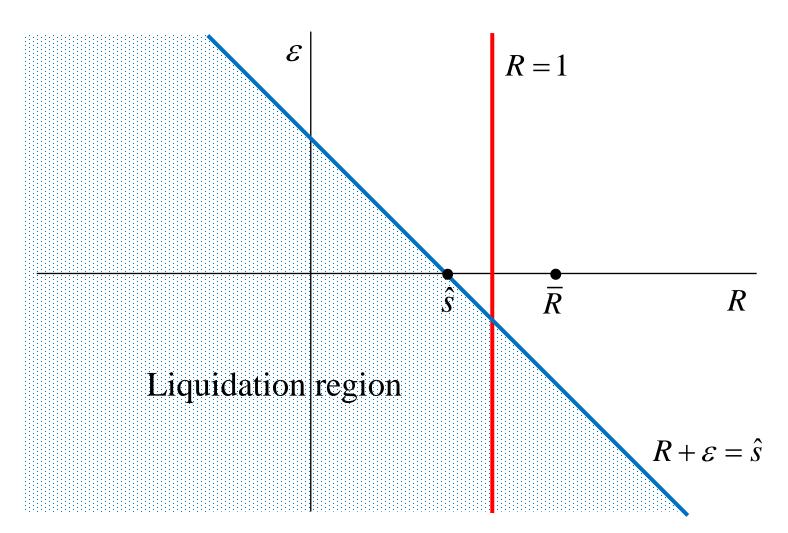


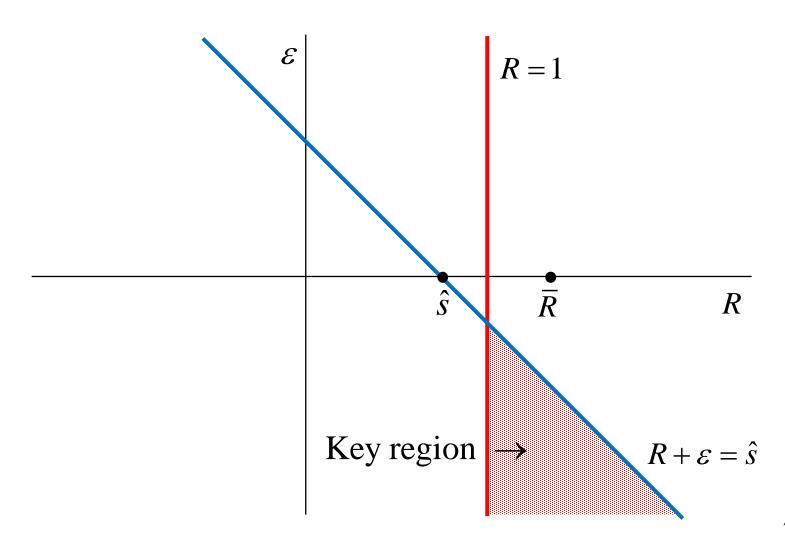
# Effect of noise on risk-taking (ii)

- In the relevant (low  $\tau$ ) range, better quality of information (lower  $\tau$ ) increases bank risk-taking
  - $\rightarrow$  In the limit  $\tau \rightarrow 0$  we go back to laissez-faire
  - $\rightarrow$  How can this be explained?









#### Effect of noise on risk-taking (iii)

- In the key region
  - $\rightarrow$  Bank is liquidated at t = 1 (since  $s < \hat{s}$ )
  - $\rightarrow$  But would have not failed at t = 2 (since  $R \ge 1$ )
- Moreover, if  $\tau > 0$  we have

$$\Pr(s < \hat{s} \text{ and } R \ge 1) > 0$$

- $\rightarrow$  To reduce this probability the bank chooses a smaller  $\sigma^*$
- Hence, the disciplining effects of supervision come from the fact that supervisory information is noisy

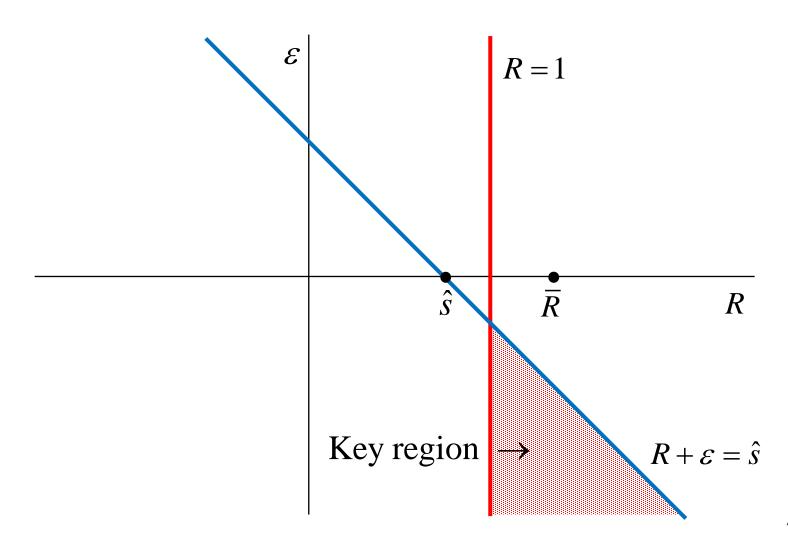
#### Effect of noise on risk-taking (iv)

- An increase in  $\tau$  has two effects
  - → Moves boundary of liquidation region to the left

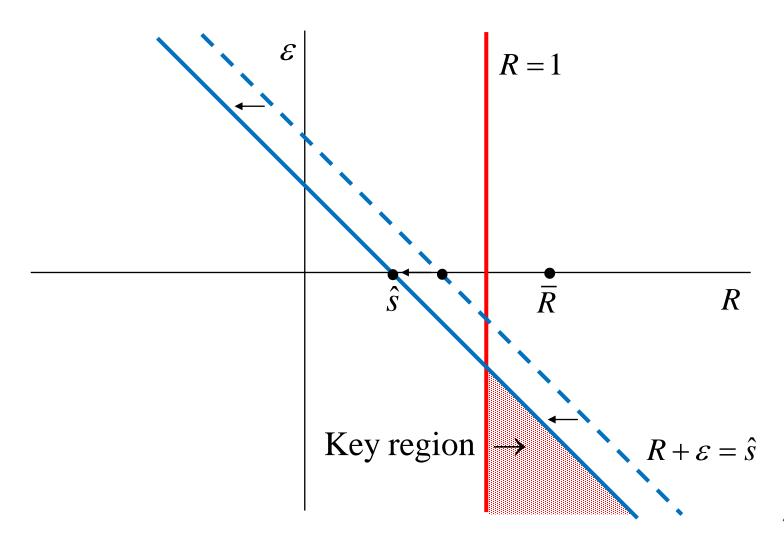
$$\hat{s} = 1 - \tau(\overline{R} - 1)$$

 $\rightarrow$  Increases the variance of the noise  $\varepsilon$ 

#### Effect on boundary of an increase in noise $\tau$



#### Effect on boundary of an increase in noise $\tau$



#### Effect of noise on risk-taking (v)

- The first effect reduces size of key region
  - $\rightarrow$  Leads to an increase in  $\sigma^*$
- The second effect increases likelihood of falling into key region
  - $\rightarrow$  Leads to a reduction in  $\sigma^*$
- For low values of  $\tau$  the second effect dominates
  - → This explains why a lower quality of the supervisory information leads to lower risk-taking

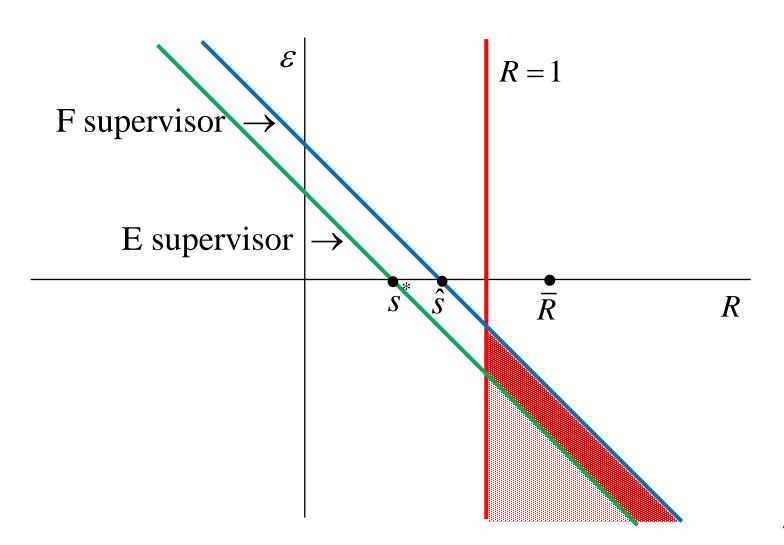
#### F and E supervisors (i)

- Question: Is an F supervisor (using the failing or likely to fail rule) more effective than an E supervisor (using the efficient liquidation rule) in controlling risk-taking incentives?
  - $\rightarrow$  Answer: Yes
- Why is this the case?
  - → Recall our previous result

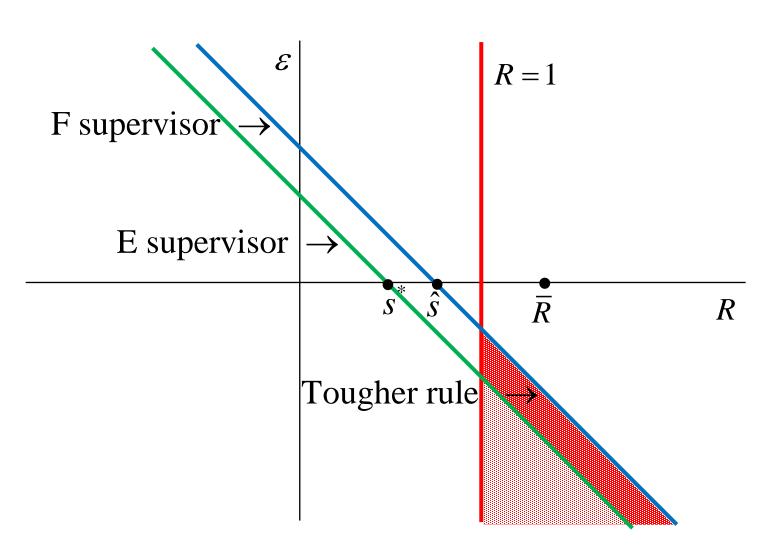
$$\hat{s} = s^* + (1+\tau) \left( 1 - \frac{a-c}{1-c} \overline{R} \right) > s^*$$

 $\rightarrow$  Higher threshold for F supervisor (for the same  $\tau$ )

### F and E supervisors



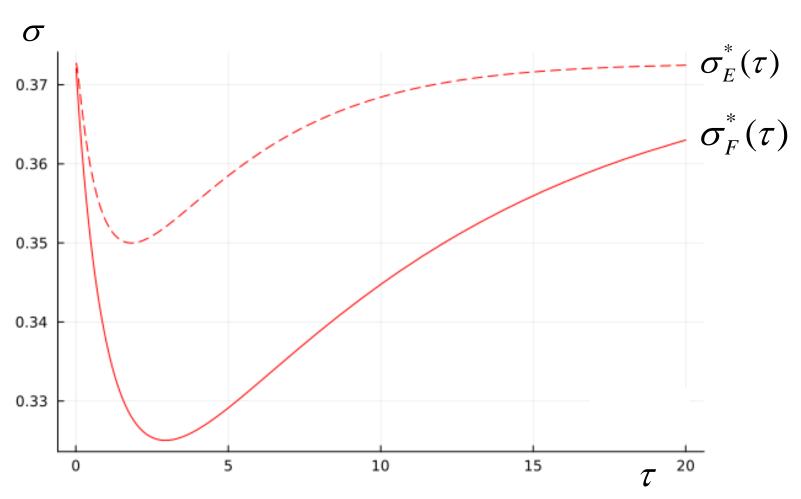
#### F and E supervisors



#### F and E supervisors (ii)

- Higher threshold of F supervisor
  - $\rightarrow$  With no change in the variance of the noise  $\varepsilon$
  - $\rightarrow$  Leads the bank to choose a smaller  $\sigma^*$
  - → To reduce probability of falling into the key region

### F and E supervisors



# Part 5 Regulation and supervision

#### Regulation and Supervision

- Question: What is the effect of introducing an F supervisor in a setup where the bank is subject to a capital requirement  $\overline{k}$ ?
- Closure rule of F supervisor has to be modified
  - → Bank is failing or likely to fail when

$$E(R|s) = \overline{R} + \frac{s - \overline{R}}{1 + \tau} < 1 - \overline{k}$$

 $\rightarrow$  Threshold is decreasing in the capital requirement  $\bar{k}$ 

$$\hat{s}(\overline{k}) = \hat{s} - (1+\tau)\overline{k}$$

#### Bank's expected payoff

• Bank's expected payoff at t = 2

$$\pi(\sigma; \hat{s}(\overline{k}), \overline{k})$$

$$= E\left[R - (1 - \overline{k}) \middle| R \ge 1 - \overline{k}, s \ge \hat{s}(\overline{k})\right] \Pr[R \ge 1 - \overline{k}, s \ge \hat{s}(\overline{k})] - (1 + \delta)\overline{k}$$

→ By the properties of truncated normal distributions

$$\pi(\sigma; \hat{s}(\overline{k}), \overline{k}) = [\overline{R} - (1 - \overline{k})] \Phi\left(\frac{\overline{R} - (1 - \overline{k})}{\sigma}, \frac{\sqrt{1 + \tau} [\overline{R} - (1 - \overline{k})]}{\sigma}; \frac{1}{\sqrt{1 + \tau}}\right) + \sigma \phi\left(\frac{\overline{R} - (1 - \overline{k})}{\sigma}\right) \Phi\left(\frac{\sqrt{\tau} [\overline{R} - (1 - \overline{k})]}{\sigma}\right) + \frac{\sigma}{2\sqrt{1 + \tau}} \phi\left(\frac{\sqrt{1 + \tau} [\overline{R} - (1 - \overline{k})]}{\sigma}\right)$$
85

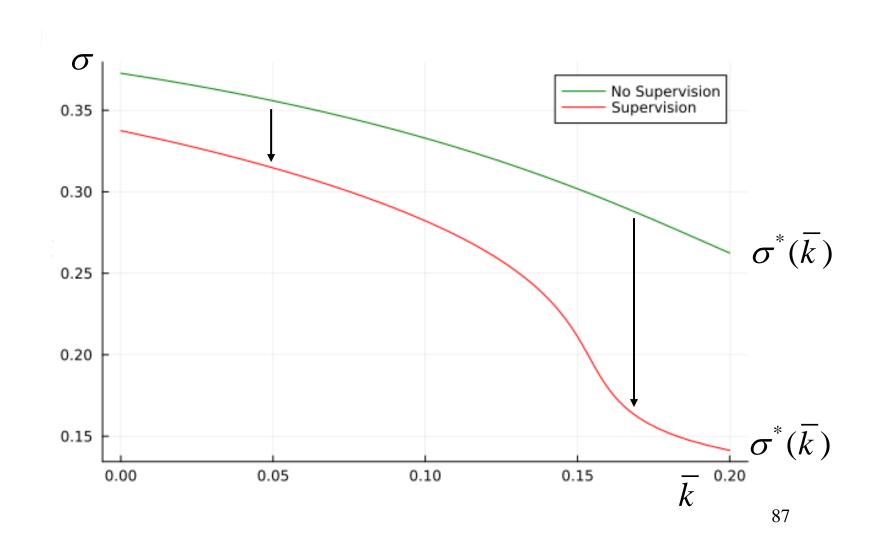
#### Bank's choice of risk

• Bank's choice of risk

$$\sigma^*(\tau, \overline{k}) = \arg\max_{\sigma} v(\sigma; \hat{s}(\overline{k}), \overline{k}) = \pi(\sigma; \hat{s}(\overline{k}), \overline{k}) - c(\sigma)$$

- $\rightarrow$  where  $\hat{s}(\overline{k}) = \hat{s} (1+\tau)\overline{k}$
- The following figure plots  $\sigma^*(\tau, \overline{k})$ 
  - $\rightarrow$  For a range of values of  $\overline{k}$
  - $\rightarrow$  and two values of  $\tau$ :  $\tau \rightarrow \infty$  (laissez-faire) and  $\tau = 1$

### **Effect on risk-taking**



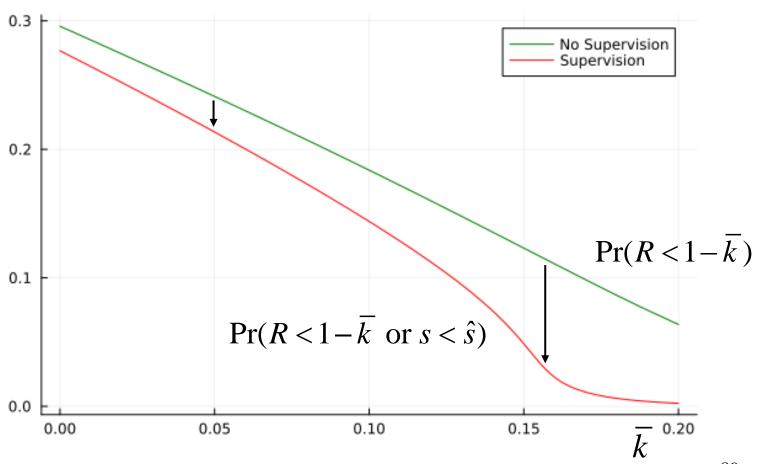
#### Probability of bank failure

• The following figure plots

$$\Pr[R < 1 - \overline{k} \text{ or } s < \hat{s}(\overline{k})]$$

- $\rightarrow$  For a range of values of  $\bar{k}$
- $\rightarrow$  and two values of  $\tau$ :  $\tau \rightarrow \infty$  (laissez-faire) and  $\tau = 1$

#### Effect on bank failure



#### **Summing up**

- Regulation and supervision are complements
  - → Supervision is more effective for high capital requirements

# Part 6 Discussion

#### **Discussion**

- Comments on three features of model with bank supervision
  - → Beneficial effects of tough supervisor
  - → Beneficial effects of noisy supervisory information
  - → Supervisory "closure" need not imply liquidation

#### Effects of tough supervisor

- Beneficial effects of tough supervisor are reminiscent of the old literature on central bank independence
  - → Delegation of monetary policy to an agent with preferences biased toward price stability delivers better outcomes in terms of employment and inflation
  - → Here delegation of supervision to an agent with preferences biased towards closure delivers better outcomes in terms of risk-taking

#### Effects of noisy supervisory information

- It may be surprising that higher noise (in relevant range) leads lower risk-taking
  - → But this is the result in recent empirical paper by Agarwal, Morais, Seru, and Shue (2024) entitled "Noisy experts?"

"Some amount of uncertainty around bank supervisory models such as stress tests may be desirable in that it could limit opportunistic gaming by banks and encourage conservative actions"

#### Closure need not imply liquidation

- Closure by supervisor that uses the failing or likely to fail rule need not imply liquidation
  - → Rather, transfer to another authority (say the SRB) that would decide between resolution and liquidation
- In our setup, resolution could be applied whenever

- → Bank would <u>not</u> be inefficiently liquidated
- → Management will be fired: key for risk-taking incentives

## **Concluding remarks**

#### **Concluding remarks (i)**

- Bank supervision involves
  - 1. Assessment of compliance with regulation
  - 2. Assessment of liquidity and solvency through monitoring
  - 3. Use of this information to request corrective actions

#### **Concluding remarks (i)**

- Bank supervision involves
  - 1. Assessment of compliance with regulation
  - 2. Assessment of liquidity and solvency through monitoring
  - 3. Use of this information to request corrective actions
- This paper focuses on the second and third tasks, but the first one is crucial
  - → Regulation has large effects on risk-taking but only if it is properly enforced (e.g. preventing the manipulation of risk-weights)

    98

#### **Concluding remarks (ii)**

- Paper focuses of effects of regulation and supervision on bank risk-taking, but what about welfare?
  - → Liquidation may be efficient but the bank may prefer to gamble for resurrection
  - → Lower risk-taking may be welfare improving if deposit insurance payouts are funded with distortionary taxation
  - → But one should also consider that both bank regulation and supervision are costly

# Happy 10th anniversary!

