Banker Compensation and Bank Risk Taking: The Organizational Economics View

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Indices of Riskiness: Management and Regulatory Implications
Atlanta, GA

1 The views expressed in this discussion do not necessarily reflect the views of the Federal Reserve Bank of Richmond or the Federal Reserve System.
Bannker compensation is being regulated under belief that compensation practices contributed to the financial crisis.

- Financial Stability Board (2009)
- U.S. regulators’ supervisory guidance (2010)
- Dodd-Frank Law
- EU - bonus caps
Regulation of Banker Compensation

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Idea: regulating compensation indirectly limits risk taking.
My Goals

Use organizational/contract theory to see if:

1. Does regulating banker pay make any sense?
2. If so, what compensation arrangements create risk?
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Two relevant groups of employees

- CEO or top managers who alone influence bank risk
- Employees who together influence bank risk
  - e.g., loan officers

J.P. Morgan compensation expenses in 2012
- $31 billion to employees, $18.7 million to CEO
- 248,633 employees (FTE)
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Paper about latter group. They are important

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Take an Organizational Economics View

Model a bank as:

- Lots of people, each acting in own interest
- Private information
- Use of monitoring and controls
- Separation of duties

Implications

- Results can differ from single-agent model
- Compensation good for CEO need not be good for lower employees
- Correlation of employee returns key issue
- Evaluating control/monitoring important
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Organizational Hierarchy

Lots of studies
SEC data disclosures

Very few studies
Data Proprietary
Theoretical Literature

Banking - mostly about CEO

  - Build on Jensen and Murphy (1990)
  - Most of theoretical bank risk taking literature has equity owners choose risk
  - Kareken and Wallace (1978)
- Thanassouli (2012) - not about incentives
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**Organizational Economics/Contract Theory**

- Huge literature
- We’ll use relative performance (Holmstrom (1982))
- Also, add monitoring
Empirical Literature in Banking

Looks for connection between form of CEO pay and bank risk

Studies of the 1980s and 1990s

- Houston and James (1995) - No effect
- Bensten and Evans (2006) - Some effect

Studies of the 2000s

- Some evidence of effect, not conclusive
Empirical Literature - Bank Employees

Very few studies - data proprietary

- Agarwal and Ben-David (2011) - Natural experiment at a bank
- Berg, Puri, and Rocholl (2012) - Another natural experiment
- Cole, Kanz, and Klapper (2011) - laboratory experiments
- Hertzberg, Liberti, and Paravisini (2011) - loan officer rotation and reporting incentives
Strategy

Set up principal-multi-agent problem

- Bank with limited liability and insured deposits
- Bank risk determined by loan officers
- Equity is principal
- Loan officers are risk-averse agents
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Regulator not formally modeled
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Regulator not formally modeled

Will solve problem as if bank implements safe and risky loans. Then characterize these contracts and compare them.
Notation

Agents (Loan Officers)

Continuum, measure one, ex ante identical
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\(a\) - action (in equilibrium all take same \(a\)), finite
\(c\) - compensation
\(r\) - loan officer return, finite
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\( \theta \) - common shock after \( a \), finite, public (more on this later)
\( h(\theta) \) - probability of \( \theta \)
\( f(r|\theta, a) \) - each agent’s stochastic production technology
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$U(c) - V(a)$ - Agent’s utility function.
$U(0) \geq 0, \ U' > 0, \ U'' < 0, \ V' > 0, \ V'' > 0$
$\bar{U}$ - Reservation Utility
Notation

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\( U(0) \geq 0, U' > 0, U'' < 0, V' > 0, V'' > 0 \)
\( \bar{U} \) - Reservation Utility

\( c(r,\theta) \) - compensation schedule for agents
Notation (cont.)

Principal (owners of bank equity)

*Investment funded*

\textit{D} - govt insured deposits (given), interest rate zero

1 – \textit{D} - Equity
Notation (cont.)

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*\(\bar{r}\) - Total return produced by agents

*\(\bar{c}\) - Total compensation payments to agents*
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*Profits*

$max\{\bar{r} - \bar{c} - D, 0\}$ - Limited liability
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Profits

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Lim liab and insured deposits - taxpayers bear downside risk
A major distortion in banking models
Bank’s Program

\[
\max_{a, c(r, \theta) \geq 0, \tilde{c}(\theta) \geq 0, \tilde{r}(\theta)} \sum_{\theta} h(\theta) \max\{\tilde{r}(\theta) - \tilde{c}(\theta) - D, 0\}
\]
Bank’s Program

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\max_{a, c(r, \theta) \geq 0, \bar{c}(\theta) \geq 0, \bar{r}(\theta)} \sum_{\theta} h(\theta) \max\{\bar{r}(\theta) - \bar{c}(\theta) - D, 0\}
\]

subject to

\[\forall \theta, \quad \bar{r}(\theta) = \sum_{r} f(r|\theta, a)r \quad (RC)\]

\[\forall \theta, \quad \bar{c}(\theta) = \sum_{r} f(r|\theta, a)c(r, \theta) \quad (CC)\]
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\forall \theta, \quad \bar{c}(\theta) \leq \max\{\bar{r}(\theta) - D, 0\} \quad (BC)
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\[\forall \theta, \bar{c}(\theta) \leq \max\{\bar{r}(\theta) - D, 0\} \quad (BC)\]

\[\sum_{\theta} h(\theta) \sum_r f(r|\theta, a)U(c(r, \theta)) - V(a) \geq \bar{U} \quad (PC)\]
Bank’s Program

\[
\max_{a, c(r, \theta) \geq 0, \bar{c}(\theta) \geq 0, \bar{r}(\theta)} \sum_{\theta} h(\theta) \max\{\bar{r}(\theta) - \bar{c}(\theta) - D, 0\}
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\[
\sum_{\theta} h(\theta) \sum_{r} f(r|\theta, a)U(c(r, \theta)) - V(a) \geq \bar{U} \quad \text{(PC)}
\]

\[
\sum_{\theta} h(\theta) \sum_{r} f(r|\theta, \hat{a})U(c(r, \theta)) - V(\hat{a}) \geq \sum_{\theta} h(\theta) \sum_{r} f(r|\theta, a)U(c(r, \theta)) - V(a), \forall \hat{a} \quad \text{(IC)}
\]
How to Solve

**Complication:** Objective function and \( (BC) \) are non-differentiable

But, for each \( a \), know states where firm is bankrupt.

Fix consumption in bankrupt states at zero.

Problem of implementing \( a \) is then differentiable and can get FOC.

Can find optimal \( a \) by solving the subproblems of implementing each \( a \) (like Grossman and Hart (1983)).
FOC: Interior solution

\[
\frac{1}{U'(c(r, \theta))} = \lambda + \sum_{\hat{a}} \mu(\hat{a}) \left( 1 - \frac{f(r|\theta, \hat{a})}{f(r|\theta, a)} \right)
\]

Likelihood Ratio is key for compensation

\[
LR(r, \theta, \hat{a}; a) \equiv \frac{f(r|\theta, \hat{a})}{f(r|\theta, a)}
\]

\[LR \uparrow \iff c \downarrow\]

Optimal compensation will depend on specification of \( f(r|\theta, a) \).
The Importance of Correlation

Correlation in $f(r|\theta, a)$ critical for determining bank risk.

Evaluate compensation contracts when:

- Correlation Exogenous
- Correlation Endogenous
No Correlation

If no correlation,

$$\forall \theta, \quad \bar{r} = \bar{r}(\theta) = \sum_r f(r|a,\theta)r$$

No variation in bank’s gross return
No Correlation

If no correlation,

\[ \forall \theta, \; \bar{r} = \bar{r}(\theta) = \sum_r f(r|a, \theta)r \]

No variation in bank’s gross return

\[ \Rightarrow \text{Lim. liab. does not distort bank’s choice of } a \text{ (no chance of bankruptcy)} \]
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No variation in bank’s gross return
\[ \Rightarrow \lim \text{ liab. does not distort bank’s choice of } a \text{ (no chance of bankruptcy)} \]

Proposition

When loan officer returns are uncorrelated, there is no connection between the form of loan officer compensation and bank risk.
No Correlation

If no correlation,

$$\forall \theta, \bar{r} = \bar{r}(\theta) = \sum_r f(r|a, \theta)r$$

No variation in bank’s gross return
⇒ Lim. liab. does not distort bank’s choice of a (no chance of bankruptcy)

Proposition

When loan officer returns are uncorrelated, there is no connection between the form of loan officer compensation and bank risk.

No need to regulate pay.
Perfect Correlation

Compensation
LR undefined for most $r$. (Deviation detected with prob. 1.)
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A relative performance implementation
Compare $r$ with $\bar{r}$. 
Perfect Correlation

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Compare $r$ with $\bar{r}$.
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Compare $r$ with $\bar{r}$.
If differ, pay 0. If same, pay a wage.
Perfect Correlation

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Compare $r$ with $\bar{r}$.
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Can infer $\theta$ from $\bar{r}(\theta)$, so as if $\theta$ observed.
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Compare $r$ with $\bar{r}$.
If differ, pay 0. If same, pay a wage.

Can infer $\theta$ from $\bar{r}(\theta)$, so as if $\theta$ observed.

(Logic behind assuming $\theta$ public.)
Bank’s Profits

Proposition

When loan officer returns are perfectly correlated, if $E(\bar{c}|a)$ is increasing and convex in $a$, then the bank chooses an $a$ that is less than the social optimum.

Idea: Lower $a \rightarrow$ lower wage $\rightarrow$ higher profits when solvent.

A low wage can be risky!!!
Example of Low Wage Increasing Risk (to govt.)

Not classic risk-shifting story where bank chooses high-variance, low-mean return. Here, by lowering $a$ (the mean) the bank pays less and keeps more when successful, but fails more often.
Intermediate Correlation

Simplify technology: Two actions, two returns
\( r = 0 \) (loan defaults) or \( r = 1 \) (loan repaid), \( \bar{\theta} = \sum_{\theta} h(\theta) \)

\[
f(r = 1|\theta, a) = a(\alpha \bar{\theta} + (1 - \alpha)\theta)
\]
Intermediate Correlation

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Fix \( a \)

If \( \alpha = 1 \) only risk is to loan officer

\( \bar{r}(\theta) = a \bar{\theta}, \forall \theta \)
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Fix \( a \)

If \( \alpha = 1 \) only risk is to loan officer
\[
\bar{r}(\theta) = a\bar{\theta}, \forall \theta
\]

If \( \alpha = 0 \) risk to loan officer and to bank
\[
\bar{r}(\theta) = a\theta, \forall \theta
\]
Likelihood Ratios

\[ LR(r = 1, \theta) = \frac{\hat{a}}{a}, \quad LR(r = 0, \theta) = \frac{1 - \hat{a}(\alpha \bar{\theta} + (1 - \alpha)\theta)}{1 - a(\alpha \bar{\theta} + (1 - \alpha)\theta)} \]
Likelihood Ratios

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\[ \frac{\partial LR(r = 1, \theta)}{\partial \theta} = 0 \Rightarrow \frac{\partial c(r = 1, \theta)}{\partial \theta} = 0 \]

\[ \frac{\partial LR(r = 0, \theta)}{\partial \theta} > 0 \Rightarrow \frac{\partial c(r = 0, \theta)}{\partial \theta} < 0 \]

NOTE: Assumes interior solution.
Consumption Sharing Rules

Assume interiority for simplicity

Spread goes up with bank performance

Note: Qualitative properties do not depend on $\alpha$. 
Other Implications

Worker’s Share of Total Revenue

\[ r(\theta) = a(\alpha\bar{\theta} + (1 - \alpha)\theta) \]

For interior range

\[ WS(\theta) = \frac{r(\theta)c(r = 1, \theta) + (1 - r(\theta))c(r = 0, \theta)}{r(\theta)} \]

Can show that

\[ \frac{\partial WS(\theta)}{\partial r(\theta)} < 0 \]

Worker’s share declines (in the interior range)
Endogenous Correlation Example

\[ r = 0 \text{ (loan defaults) or } r = 1 \text{ (loan repaid)} \]

\[ f(r = 1|\theta, a) = a\bar{\theta} + (1 - a)\theta \]

\[ \bar{\theta} = \sum_{\theta} h(\theta), \quad 0 < \theta < 1, \quad 0 < a < 1 \]

\( a \) determines correlation, mean preserving
Endogenous Correlation Example

\( r = 0 \) (loan defaults) or \( r = 1 \) (loan repaid)

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f(r = 1|\theta, a) = a\bar{\theta} + (1 - a)\theta
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\( a \) determines correlation, mean preserving

If \( a = 1 \) only risk is to loan officer

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Endogenous Correlation Example

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f(r = 1|\theta, a) = a\bar{\theta} + (1-a)\theta
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\( a \) determines correlation, mean preserving

If \( a = 1 \) only risk is to loan officer

\[ \bar{r}(\theta) = \bar{\theta}, \ \forall \theta \]

If \( a = 0 \) risk is to loan officer and bank

\[ \bar{r}(\theta) = \theta \]
Endogenous Correlation Example (cont.)

Two actions $a_l$ (risky) and $a_h$ (safe) with $a_l < a_h$

$$LR(r = 1, \theta) = \frac{\hat{a} \bar{\theta} + (1 - \hat{a})\theta}{a \bar{\theta} + (1 - a)\theta}$$

If bank wants $a_h$ then $\frac{\partial LR(r=1,\theta)}{\partial \theta} > 0 \Rightarrow \frac{\partial c(r=1,\theta)}{\partial \theta} < 0$

Similarly, $\frac{\partial c(r=1,\theta)}{\partial \theta} > 0$

If bank wants $a_l$ then pays a wage.
Compensation to Implement Low Correlation Action

Assume interiority for simplicity

Note: Can use Innes (1990) to get rid of non-monotonicity in $r$ for $\theta > \bar{\theta}$. 
A Sufficient Condition: Two-Action Case

Good action - $a_h$
Bad action - $a_l$

A *sufficient* condition for bad action to be taken

$$\sum_{\theta} h(\theta) \sum_{r} f(r, \theta | a_l) U(c(r, \theta)) \geq \sum_{\theta} h(\theta) \sum_{r} f(r, \theta | a_h) U(c(r, \theta)).$$

If expected value of compensation weighted by utility is bigger for bad action than safe action, then bad action taken.
Relative Performance and Bank Risk in General

Compensation that discourages correlation
  - Reward when agent does differently than the bank
  - Punish when agent does the same as the bank
Relative Performance and Bank Risk in General

Compensation that discourages correlation
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Compensation that encourages correlation
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Relative Performance and Bank Risk in General

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Compensation that encourages correlation

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- Punish when agent does differently than the bank

Follows from likelihood ratios
Monitoring

All banks use processes and controls

- Traders receive risk limits. Risk management monitors them.
- Loan officers generate loans. Loan review committee assesses.
- Consumer credit applications. Must fit within a set of parameters.

Udell (1989) study of loan review at Midwestern banks.
- The higher the portfolio risk the more the bank invested in loan review.
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Monitoring and control environment affect compensation-risk connection
Subprime: Role of Originator Channel

Cumulative Subprime Foreclosure Rate
Adjustable Rate Mortgages with FICO between 600 and 650 and LTV between 85 and 95
Loans Originated between April and July 2005 in the Fifth Federal Reserve District

Source: Calculations based on data provided by LPS Applied Analytics
Prime: Role of Originator Channel

Cumulative Prime Foreclosure Rate
Fixed Rate Mortgages with FICO between 700 and 750
and LTV between 70 and 80
Loans originated between April and July 2005
in the 5th Federal Reserve District

Source: Calculations based on data provided by LPS Applied Analytics
Monitoring

Variety of ways to model - audits, collusion

Paper - writes out a general problem with a loan review
Monitoring

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Loan reviewer effort, private information
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Add a loan reviewer. One per loan officer.
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Gives team production
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Add a loan reviewer. One per loan officer.
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Gives team production
Like earlier program, but with the team production and additional incentive and participation constraints for the loan reviewers
**Monitoring**

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Paper - writes out a general problem with a loan review
Loan officer just like before
Add a loan reviewer. One per loan officer.
Loan reviewer effort, private information
Gives **team** production
Like earlier program, but with the team production and additional incentive and participation constraints for the loan reviewers
One implication: Want to pay loan reviewer on loan performance.
Specific Formulation

Loan officer effort the same as before
Specific Formulation

Loan officer effort the same as before
Loan reviewer’s only accepts/rejects a loan
Specific Formulation

Loan officer effort the same as before
Loan reviewer’s only accepts/rejects a loan
Loan reviewer’s effort

- Increases probability of rejecting a bad loan
- Reduces probability of rejecting a good loan.
Specific Formulation

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Loan reviewer’s effort
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Loan officer compensation similar to earlier analysis

Loan reviewer - paid depending on whether accepts or rejects loan.
Specific Formulation

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Loan reviewer’s effort
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Loan officer compensation similar to earlier analysis

Loan reviewer - paid depending on whether accepts or rejects loan.

Alternative to regulating compensation - Could just assess quality of loan review to determine if bank is taking risk. In practice - this is equivalent to assessing bank’s internal processes.
Summary of Results

• No correlation - don’t care about compensation
• Perfect correlation - low wages create risk
• Pay that generates correlation should be main concern
  • Described good and bad relative performance contracts
• Organizational structure important
  • Affects compensation
  • Provides alternative tools to compensation for controlling risk
Extensions: Applications of Organizational Economics

Other important features of bank activities that are relevant for compensation

- Persistence (Jarque and Prescott (2010))
  - Many lending decisions have long-term effects.
- Team production
- Heavy use of discretion in management pay
  - Soft information?
- Separation of duties
  - To deal with collusion
- Use of audits
- Career concerns
A Concluding Comment

One big lesson of contract theory/organization economics literature.

- Optimal contracts are highly sensitive to features of the environment, e.g., technology, likelihood ratios, info assumptions, monitoring, etc.
- Need field work and empirical studies to determine the right model