Banker Compensation and Bank Risk Taking: The Organizational Economics View

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January 2, 2014
Federal Reserve Day Ahead Conference
Philadelphia, PA

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.
Regulation of Banker Compensation

Banker 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
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Idea: regulate compensation to indirectly limit 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
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Paper about latter group. They are important

- J.P. Morgan compensation expenses in 2012
- $31 billion to employees, $18.7 million to CEO
- 248,633 employees (FTE)
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
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Implications

- Correlation of employee returns is key
- Evaluating controls/internal monitoring important
- Results can differ from single-agent model
  - Compensation regs good for CEO need not be good for lower employees
Introduction

Loan Officer Compensation

Exogenous Correlation

Endogenous Correlation

Monitoring

Conclusion

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)
- Thanasssaoulis (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 funded with equity and insured deposits
- Equity is principal and has limited liability
- Loan officers make loans
- Loan officers are risk-averse agents
- Bank risk depends on portfolio of loans made
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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*

*\( D \) - govt insured deposits (given), interest rate zero*

*\( 1 - D \) - 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*

\[
\text{max}\{\bar{r} - \bar{c} - D, 0\} - \text{Limited liability}
\]
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Notation (cont.)

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1 – *D* - Equity

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

*Profits*

\[ \max\{\bar{r} - \bar{c} - D, 0\} \] - Limited liability

Lim liab and insured deposits - taxpayers bear downside risk

A major distortion in banking models
Bank’s Program

\[
\max_{a, c(r, \theta) \geq 0, \bar{c}(\theta) \geq 0, \bar{r}(\theta)} \sum_{\theta} h(\theta) \max\{\bar{r}(\theta) - \bar{c}(\theta) - D, 0\}
\]
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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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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$$\forall \theta, \quad \bar{c}(\theta) \leq \max\{\bar{r}(\theta) - D, 0\} \quad (\text{BC})$$
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\forall \theta, \quad \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

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

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

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

\[LR \uparrow \Leftrightarrow c \downarrow\]

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

$$\Rightarrow$$ Lim. liab. does not distort bank’s choice of $a$ (no chance of bankruptcy)
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
\[ \Rightarrow \text{Lim. liab. does not distort bank’s choice of } a \text{ (no chance of bankruptcy)} \]

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

Proposition

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

No need to regulate pay.
Perfect Correlation

Compensation
LR undefined for most $r$. (Deviation detected with prob. 1.)
Perfect Correlation

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A relative performance implementation
Compare $r$ with $\bar{r}$. 
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A relative performance implementation
Compare $r$ with $\bar{r}$.
If differ, pay 0. If same, pay a wage.
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A *relative performance* implementation
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.
Perfect Correlation

Compensation
LR undefined for most $r$. (Deviation detected with prob. 1.)

A relative performance implementation
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 $E(\tilde{c}|a)$ 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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\( r = 0 \) (loan defaults) or \( r = 1 \) (loan repaid), \( \bar{\theta} = \sum_\theta h(\theta) \)

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Fix \( \alpha \)

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

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

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

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

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

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

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

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

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

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

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

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\( a \) determines correlation, mean preserving

If \( a = 1 \) only risk is to loan officer, no bank risk

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

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

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

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

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

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
  • Reward when agent does differently than the bank
  • Punish when agent does the same as the bank

Compensation that encourages correlation
  • Reward when agent does the same as the bank
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Relative Performance and Bank Risk in General

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Compensation that encourages correlation

- Reward when agent does the same as the bank
- 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
Monitoring

Variety of ways to model

Paper - writes out one way
Monitoring

Variety of ways to model

Paper - writes out one way
  - Loan officers just like before

Pay loan reviewers (and risk managers) on loan performance
Evaluate quality of controls to limit risk
Monitoring

Variety of ways to model

Paper - writes out one way

- Loan officers just like before
- Add loan reviewers with an effort incentive problem
Monitoring

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- Gives team production
Monitoring

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Implications

- Pay loan reviewers (and risk managers) on loan performance
- Evaluate quality of controls to limit risk
Summary of Results

Correlation is key

• Exogenous correlation benchmarks
  • No correlation - don’t care about compensation
  • Perfect correlation - low wages create risk

• Endogenous correlation
  • Pay that generates correlation should be main concern
  • How relative performance structured matters

• Monitoring and controls also important for correlation
  • And thus compensation
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
  - Can look at deferred compensation

- 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 and be able to evaluate compensation.