Competition, Stability, and Efficiency in the Banking Industry

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Number of banks fell in half (from 11,000 in 1984 to 5000 in 2018)

Share of banking industry assets held by the top 4 more than doubled (rose from 15% in 1984 to 44% in 2018)
• 6 out of the 10 largest economies had *5 Bank Concentration* greater than 70% in 2015.

• *5 Bank Concentration* grew by over 50% in Brazil, GB, and US and shrunk by over 10% in China and Italy from 2000 to 2015.
What we do

- Building on the literature addressing the possible tradeoff between competition and stability, we provide a dynamic model of an imperfectly competitive banking industry where policies can trigger endogenous changes in the long run competitiveness of the industry.
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We find:

• An intensification of competition increases measures of market efficiency at the cost of bank fragility.

• Economies can avoid the fragility costs of competition by enhancing bank governance and tightening leverage requirements.

• Risk taking and the bank lending channel of monetary policy depends on the degree of bank competition.

• Policy affects market structure and market structure affects policy.
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  • Economies can avoid the fragility costs of competition by enhancing bank governance and tightening leverage requirements.
  • Risk taking and the bank lending channel of monetary policy depends on the degree of bank competition.
  • Policy affects market structure and market structure affects policy.

• We provide empirical evidence consistent with the model predictions.
1. Model (based on C-D):
   • Bank managers Cournot compete for insured deposits and choose the riskiness of their loan portfolio (competition affects the cost of bank finance).
   • The riskiness of the loan portfolio determines the likelihood of bank failure.
   • Shareholders inject initial equity to cover bank entry costs.
   • Free entry endogenously determines the number \( N \) of banks.
OUTLINE

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2. Short ($N$ fixed) and Long ($N$ endogenous) Run Policy Predictions:
   • Governance to align manager and shareholder agency conflicts raise bank charter values, inducing entry (and less concentration).
   • While tighter leverage requirements decrease short run bank profits, less risk raises charter value (inducing less concentration).
   • Contractionary monetary policy lowers lending more in less concentrated industries.
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   - Use a novel data construction to identify individual bank, state, and time contingent competition measures.
   - Regression analysis confirms the causal impact of increasing competition on bank risk taking, one of the model’s key predictions.
Physical Environment

• There is a risky technology indexed by $S \in [0, 1]$.

• For each unit input, the technology yields $A \cdot S$ with probability $p(S)$ and yields 0 otherwise.

• The technology exhibits a risk-return tradeoff (i.e., higher return projects are less likely to succeed) since $p'(S) < 0$. We make the following parametric assumption $p(S) = 1 - S^\eta$, where $\eta \geq 1$.

• If $Z \geq 0$ units are invested in the technology, then expected output is $p(S) \cdot S \cdot A \cdot Z$.

• The (opportunity) cost of the input is given by $\tilde{\gamma} \cdot Z^2$, sufficient to generate an interior solution.
• $N$ banks Cournot compete for insured deposits (free entry gives $N$).

• Initial equity injection, $E_i$, finances the fixed entry costs $\kappa$ of bank $i$.

• Seasoned equity is prohibitively costly, so $D_i = L_i$.

• Inverse deposit supply function is $r_D(Z) = \gamma Z$ where $Z = \sum_{i=1}^{N} D_i$.

• Bank managers choose the riskiness of the loan portfolio $S_i$ and its scale $D_i$ to maximize discounted (at rate $\beta$) bank profits s.t. a leverage constraint that $\frac{D_i}{E_i} \leq \lambda$.

• Limited liability (funds must be injected if a bank is insolvent).

• Parameter $\alpha$ captures both deposit insurance costs and other marginal costs (e.g. fed funds) of external funding.

• Shareholders with linear preferences and discount factor $\delta \geq \beta$ make the initial equity injection (possible agency conflicts)
BANK DECISION PROBLEM

• Bank $i$’s static profit function is given by

$$
\pi_i(S_i, D_i; N) = p(S_i) [A \cdot S_i - (r_D(Z) + \alpha)] D_i.
$$

where $r_D(Z)$ is the inverse deposit supply function with $Z = \sum_{i=1}^{N} D_i$, $r'(Z) > 0$ (so costly external finance depends on competition), and interest margin is $R_i = A \cdot S_i - (r_D(Z) + \alpha)$. 

**Bank Decision Problem**

- Bank $i$’s static profit function is given by

$$\pi_i(S_i, D_i; N) = p(S_i) [A \cdot S_i - (r_D(Z) + \alpha)] \cdot D_i.$$  \hfill (1)

where $r_D(Z)$ is the inverse deposit supply function with $Z = \sum_{i=1}^{N} D_i$, $r'(Z) > 0$ (so costly external finance depends on competition), and interest margin is $R_i = A \cdot S_i - (r_D(Z) + \alpha)$.

- An incumbent manager maximizes the present value of the solvent bank at discount rate $\beta$, the dynamic problem of bank $i$ is given by

$$V_i(N) = \max_{S_i, D_i} \pi_i(S_i, D_i; N) + \beta p(S_i)V_i(N'),$$ \hfill (2)

subject to

$$\frac{D_i}{E_i} \leq \lambda,$$ \hfill (3)

where $N'$ denotes the number of banks next period.
**Free Entry Condition**

- Shareholders with discount rate $\delta$ will inject equity to fund bank $i$ entry provided

$$E_i(N) \equiv \frac{\pi_i^C(N)}{1 - \delta p(SC)} \geq \kappa.$$  \hspace{1cm} (4)

- Free entry ((4) with equality) endogenously determines the number of banks $N^C$ in a symmetric equilibrium.
Free Entry Condition

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- Free entry ((4) with equality) endogenously determines the number of banks $N^C$ in a symmetric equilibrium.

- (2) and (4) imply an “agency” wedge between managerial and shareholder value of the bank:

$$V(N^C) = w(SC) \cdot E(N^C), \quad (5)$$

where

$$w(SC) \equiv \frac{[1 - \delta p(SC)]}{[1 - \beta p(SC)]} \quad (6)$$

- Manager and Shareholder incentives are only aligned if $\beta = \delta$. 
**Equilibrium Risk Taking and Lending**

- The two first order conditions in an equilibrium where the leverage requirement is non-binding can be written

\[
p(S^C_n) = -\frac{p'(S^C_n)}{A} \cdot \left[ R^C_n + \beta \cdot \frac{E(N^C_n)}{D^C_n} \cdot w(S^C_n) \right], \tag{7}
\]

\[
R^C_n = \frac{r'_D(Z^C_n)}{N^C_n} \cdot Z^C_n, \tag{8}
\]

- (7) implies that the probability of success \( p(S) \) is:
  - Positively related to interest margins (since \(-p'(S^C_n) > 0,\)).
  - Inversely related to leverage and agency conflicts.
  - There is an interaction between leverage and agency.

- (8) implies that the interest margin \( R \) is declining in competition (since \( \frac{r'_D(Z)}{N} = \frac{\gamma}{N} \)).
**Policy**

Government Budget Constraint:

- Expected inflows to deposit insurance equals expected outflows:

\[ F + \hat{\alpha} \cdot p(S^C) \cdot Z^C = (1 - p(S^C)) \cdot r_D(Z^C) \cdot Z^C. \] (9)
Policy

Government Budget Constraint:

• Expected inflows to deposit insurance equals expected outflows:

\[ F + \hat{\alpha} \cdot p(S^C) \cdot Z^C = (1 - p(S^C)) \cdot r_D(Z^C) \cdot Z^C. \]  

(9)

Policy Problem:

• The policymaker chooses policy parameters:
  - Entry barriers \( \kappa \)
  - Governance \( \beta \)
  - Leverage \( \lambda \)
  - Monetary \( \alpha \)

to minimize the weighted distance between the decentralized level of risk taking from the efficient level (with weight \( 1 - \phi \)) as well as deviations in expected output (with weight \( \phi \)):

\[ \min_{\{\kappa, \beta, \alpha, \lambda\}} (1 - \phi) \cdot |S^C - S^*| + \phi \cdot |Y^C - Y^*| \]  

(10)

where \( Y = p(S) \cdot A \cdot S \cdot Z \).
Cournot Equilibrium

Taking policy parameters as given, a symmetric steady state Cournot equilibrium is simply 3 equations in 3 unknowns:

- F.O.C. w.r.t. Risk Taking $S$ (→ loan portfolio success probability $p(S)$).
- F.O.C. w.r.t. Deposit Funding $D$ (→ aggregate lending $Z = N \cdot D$).
- Free entry condition $N$ (→ bank market concentration $\frac{1}{N}$).
Cournot Equilibrium

Taking policy parameters as given, a symmetric steady state Cournot equilibrium is simply 3 equations in 3 unknowns:

- F.O.C. w.r.t. Risk Taking $S$ ($\rightarrow$ loan portfolio success probability $p(S)$).
- F.O.C. w.r.t. Deposit Funding $D$ ($\rightarrow$ aggregate lending $Z = N \cdot D$).
- Free entry condition $N$ ($\rightarrow$ bank market concentration $\frac{1}{N}$).

Our experiments (unanticipated policy shocks) consider two cases:

- Short Run: Taking market structure $N$ as given by our benchmark calibration, how do $S$ and $Z$ change transitioning with expected duration to a new long run in $\frac{1}{\zeta}$ years?

\[
V_{\Theta'}(N) = \max_{S,D} \pi_{\Theta'}(N) + \beta p(S_{\Theta'}) [(1 - \zeta)V_{\Theta'}(N) + \zeta V_{\Theta'}(N')] 
\]

- Long Run: Market structure $N$ changes since policy affects the charter value of the bank (and hence entry).
Calibration

Figure: Data and Benchmark Model
Moments

<table>
<thead>
<tr>
<th></th>
<th>Data</th>
<th>Model</th>
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</thead>
<tbody>
<tr>
<td>Concentration</td>
<td>0.330</td>
<td>0.333</td>
</tr>
<tr>
<td>ROA</td>
<td>0.040</td>
<td>0.021</td>
</tr>
<tr>
<td>cv(ROA)</td>
<td>0.067</td>
<td>0.013</td>
</tr>
<tr>
<td>D/E</td>
<td>14.830</td>
<td>14.888</td>
</tr>
<tr>
<td>log( Deposits)</td>
<td>22.466</td>
<td>22.489</td>
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</table>

Figure: Benchmark Parameters

<table>
<thead>
<tr>
<th></th>
<th>values</th>
</tr>
</thead>
<tbody>
<tr>
<td>δ</td>
<td>0.975</td>
</tr>
<tr>
<td>α</td>
<td>0.030</td>
</tr>
<tr>
<td>β</td>
<td>0.950</td>
</tr>
<tr>
<td>A</td>
<td>0.200</td>
</tr>
<tr>
<td>η</td>
<td>4.000</td>
</tr>
<tr>
<td>˜γ</td>
<td>4 \times 10^{-12}</td>
</tr>
<tr>
<td>κ*</td>
<td>392.473</td>
</tr>
</tbody>
</table>

Left Table: * In millions. Right Table: Parameters above the line are chosen outside the model. Parameters below are chosen inside the model.
Risk Taking and Lending FOCs Across Market Structure

- An increase in competition (raising $N$) shifts foc rightward, increasing $S$ and decreasing $D$. 
Too little competition may generate inefficiently low risk taking. Too much may generate inefficiently high risk taking.

Since the choices of the decentralized bank differ from the social planner’s choice, there is a role for regulatory policy.
Regulatory Policy Counterfactuals

% deviations from benchmark. No agency ($\delta = \beta = .975$), Tight Leverage ($\lambda = 5$).

- Better governance lowers risk and raises efficiency ($R$ drops 4%).
- Tighter leverage lowers risk but reduces efficiency ($R$ rises 19%).
- There are interaction effects between the two policies.
Monetary Policy Counterfactuals

- Contractionary policy ($\alpha$ rises from 3% to 5%) increases risk taking and decreases lending in the short run.
- Contractionary policy amplifies decrease in aggregate bank lending in more competitive mkt. structures (analogous to Kashyap and Stein).
**Robustness**

- **Too-Big-To-Fail**
  - Introduce a probability of a bailout $b$ with deadweight loss $1 - \theta$.  
    ▶️ Details

- **Rise of Shadow Banking**
  - Competition from nonbank finance raises elasticity $\gamma$ of inverse deposit supply function $r_D(Z) = \gamma Z$.  
    ▶️ Details

- **Regulatory Arbitrage**
  - Tighter Leverage Requirements (lower $\lambda$) coupled with rise in $\gamma$.  
    ▶️ Details

- **Fintech**
  - Monitoring improvements raise the parameter $\eta$ in $p(S) = 1 - S^\eta$.  
    ▶️ Details

- **Business Cycles**
  - A business cycle boom raises parameter $A$ in production technology $A \cdot S$.  
    ▶️ Details

- **Contagion**
  - Contagion modelled as an externality captured in $p(S, \overline{S})$.  
    ▶️ Details
Model Predictions Summary

- More competition leads to lower bank profit margins and more risk-taking (more fragility).

- Too little (much) competition leads to socially inefficient levels of risk taking and lending.

- Better governance and tighter leverage constraints lead to less risk taking. There is a positive *interaction* between better governance and tighter leverage.

- Contractionary monetary policy leads to more risk-taking and less bank lending in more competitive market structures.
Empirical Results

There are two key building blocks to JLL’s construction of bank-state-time-varying measures of the regulation-induced competitive pressures in the US from 1982-1995:

- **Time and State Level Variation:** Starting in 1982, individual states began removing cross-state branching restrictions ending with the Riegle-Neal Act in 1995.
- **Bank Level Variation:** Use a gravity model to generate geographic costs of BHC expansion to nearby markets (consistent with empirical evidence by Goetz, Laeven, and Levine that BHCs are more likely to expand into geographically close markets).

Assess the impact of competition on bank franchise (charter) value and bank risk using the following regression specification:

\[
Y_{bst} = \gamma_C \cdot Competition_{bst} + \gamma_X' \cdot X_{bst-1} + \theta_b + \theta_{st} + \varepsilon_{bst}, \quad (11)
\]
## Empirical Results

**Figure:** Competition, Charter Value, and Risk

<table>
<thead>
<tr>
<th></th>
<th>Charter Value</th>
<th>Bank Risk</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(1)</td>
<td>(2)</td>
</tr>
<tr>
<td>Bank Competition</td>
<td>-0.6146***</td>
<td>-0.6076**</td>
</tr>
<tr>
<td></td>
<td>(0.2242)</td>
<td>(0.2471)</td>
</tr>
<tr>
<td>Leverage-Lagged</td>
<td>-0.0320***</td>
<td>-0.0307***</td>
</tr>
<tr>
<td></td>
<td>(0.0077)</td>
<td>(0.0072)</td>
</tr>
<tr>
<td>Ln(Bank Assets)-Lagged</td>
<td>-0.3172***</td>
<td>-0.3235***</td>
</tr>
<tr>
<td></td>
<td>(0.1117)</td>
<td>(0.1117)</td>
</tr>
<tr>
<td>% Institutional Ownership</td>
<td>0.6926***</td>
<td>-0.4530***</td>
</tr>
<tr>
<td></td>
<td>(0.1895)</td>
<td>(0.0837)</td>
</tr>
<tr>
<td>Blockholders Top 10</td>
<td></td>
<td>0.4673**</td>
</tr>
<tr>
<td></td>
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<td>(0.2065)</td>
</tr>
<tr>
<td>Leverage*Institutional Ownership</td>
<td></td>
<td>0.0497***</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(0.0129)</td>
</tr>
<tr>
<td>Leverage*Blockholders-Top 10</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>R-squared</td>
<td>0.8496</td>
<td>0.8527</td>
</tr>
</tbody>
</table>
Empirical Results

An intensification of competition reduces charter value and increases bank risk.

- As shown in column (1), Competition enters negatively, statistically significantly, and economically large in the Charter Value regression.

- As shown in column (4), a regulatory-induced intensification of competition increases the riskiness of the bank (Bank Risk), is statistically significant, and economically large.

- Increased leverage decreases charter value and increases equity volatility, the coefficient on leverage-lagged is negative and positive in columns (1)-(3) and (4)-(8) respectively.

- Better governance decreases equity volatility, the coefficient on institutional ownership and blockholders Top 10 enter negatively in columns (5)-(6) respectively.

- Fluctuations in leverage have a bigger impact on risk when governance is better, the coefficient on the interaction term is positive in columns (7) and (8) respectively.
## Empirical Results - Contractionary Monetary Policy

**Bank Risk**

<table>
<thead>
<tr>
<th></th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
<th>(4)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Bank Competition</strong></td>
<td>0.6221**</td>
<td>0.6988**</td>
<td>0.5963**</td>
<td>0.7011**</td>
</tr>
<tr>
<td></td>
<td>(0.2623)</td>
<td>(0.2934)</td>
<td>(0.2716)</td>
<td>(0.2847)</td>
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<tr>
<td><strong>Leverage-Lagged</strong></td>
<td>0.0300***</td>
<td>0.0307***</td>
<td>0.0297***</td>
<td>0.0308***</td>
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<tr>
<td></td>
<td>(0.0051)</td>
<td>(0.0050)</td>
<td>(0.0049)</td>
<td>(0.0049)</td>
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<tr>
<td><strong>Ln(Bank Assets)-Lagged</strong></td>
<td>-0.1645*</td>
<td>-0.1615*</td>
<td>-0.1580*</td>
<td>-0.1619*</td>
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<tr>
<td></td>
<td>(0.0900)</td>
<td>(0.0899)</td>
<td>(0.0897)</td>
<td>(0.0867)</td>
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<tr>
<td><strong>FFR_1</strong></td>
<td>1.0835**</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.4301)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>FFR_1*Bank Competition</strong></td>
<td>-0.4177*</td>
<td></td>
<td></td>
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</tr>
<tr>
<td></td>
<td>(0.2136)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>FFR_2</strong></td>
<td></td>
<td>2.2895***</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>(0.5305)</td>
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<tr>
<td><strong>FFR_2*Bank Competition</strong></td>
<td>-0.9277***</td>
<td></td>
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<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>(0.3384)</td>
<td></td>
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</tr>
<tr>
<td><strong>FFR_3</strong></td>
<td></td>
<td></td>
<td>1.3956***</td>
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<td>(0.4059)</td>
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<td><strong>FFR_3*Bank Competition</strong></td>
<td>-0.4701***</td>
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<td>(0.1614)</td>
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<td><strong>FFR_4</strong></td>
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<td>2.0084***</td>
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<td>(0.7139)</td>
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<tr>
<td><strong>FFR_4*Bank Competition</strong></td>
<td></td>
<td>-0.6102**</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td>(0.2777)</td>
</tr>
</tbody>
</table>

**Observations** 1518  1518  1518  1518

**R-squared** 0.8183  0.8182  0.8188  0.8175
Empirical Results - Contractionary Monetary Policy

• Consistent with the predictions of the model, as shown in column (1),

  • $FFR_b$ enters positively and significantly in the Bank Risk regression.

  • The interaction term $FFR_b \times Comp$ enters negatively and significantly.

• That is, tighter monetary policy increases bank risk and the increased bank risk with contractionary policy is lower in more competitive environments.
CONCLUSION

- A simple analytical framework to understand the interaction between competition, stability, and efficiency.

- Can be used for counterfactual regulatory and monetary policy analysis and design in imperfectly competitive banking markets.

- The framework makes endogenous predictions for such endogenous variables as:
  - Concentration
  - Bank Entry and Exit
  - Leverage
  - Interest Margins
  - Bank Equity Value and its Volatility
  - Expected FDIC costs

- The framework is consistent with empirical work on competition and stability in the U.S. and can easily be calibrated to other economies. Toolkit at:

  https://sites.google.com/a/wisc.edu/deancorbae/research/CorbaeLevineCode_191212.zip
Social Planner’s Problem

• To obtain the “socially efficient” level of risk taking and aggregate investment for our model economy, we solve the social planner’s problem in a frictionless economy given by:

\[
\max_{S,Z} p(S) \cdot A \cdot S \cdot Z - \tilde{\gamma}Z^2
\]  

(12)

where \(\tilde{\gamma}Z^2\) is the opportunity cost of investment.

• It is evident from (1) that if \(\gamma = \frac{\tilde{\gamma}}{p(S^*)}\) and \(\alpha = 0\), then the aggregate costs of funds in a symmetric decentralized equilibrium is the same as the planner’s cost.
## Competition and Stability

**Figure:** Variation in Market Structure

<table>
<thead>
<tr>
<th>Planner</th>
<th>Less Competitive</th>
<th>Benchmark (levels)</th>
<th>More Competitive</th>
<th>Optimal Entry Barriers</th>
</tr>
</thead>
<tbody>
<tr>
<td>N</td>
<td>NA</td>
<td>1</td>
<td>3</td>
<td>5</td>
</tr>
<tr>
<td>S</td>
<td>-9%</td>
<td>-27%</td>
<td>0.73</td>
<td>13%</td>
</tr>
<tr>
<td>D</td>
<td>NA</td>
<td>31%</td>
<td>5843.22</td>
<td>-22%</td>
</tr>
<tr>
<td>Z</td>
<td>-24%</td>
<td>-56%</td>
<td>17529.65</td>
<td>30%</td>
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<tr>
<td>D/E</td>
<td>NA</td>
<td>-80%</td>
<td>14.89</td>
<td>181%</td>
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<tr>
<td>p</td>
<td>13%</td>
<td>30%</td>
<td>0.71</td>
<td>-27%</td>
</tr>
<tr>
<td>R</td>
<td>NA</td>
<td>31%</td>
<td>0.03</td>
<td>-22%</td>
</tr>
<tr>
<td>$\pi^*$</td>
<td>NA</td>
<td>124%</td>
<td>121.08</td>
<td>-56%</td>
</tr>
<tr>
<td>$\kappa^*$</td>
<td>NA</td>
<td>562%</td>
<td>392.47</td>
<td>-72%</td>
</tr>
<tr>
<td>V</td>
<td>NA</td>
<td>474%</td>
<td>371.14</td>
<td>-71%</td>
</tr>
<tr>
<td>F/Y</td>
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<td>-135%</td>
<td>0.18</td>
<td>225%</td>
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<tr>
<td>$Y^*$</td>
<td>-22%</td>
<td>-59%</td>
<td>1825.91</td>
<td>8%</td>
</tr>
<tr>
<td>cv(Y)</td>
<td>-52%</td>
<td>-91%</td>
<td>748.57</td>
<td>144%</td>
</tr>
<tr>
<td>cv(E)</td>
<td>NA</td>
<td>-54%</td>
<td>0.64</td>
<td>50%</td>
</tr>
</tbody>
</table>

Except for benchmark, all columns are percent deviations from benchmark. In millions. $Y = p(S) \cdot A \cdot S \cdot Z$. 
**Competition and Stability Details**

- Leverage is monotonically increasing in the degree of competition (i.e. \( \frac{D}{E} \) is 80% lower (181% higher) in the less (more) competitive economy than in the benchmark).

- Interest margins are monotonically decreasing in the level of competition (i.e. \( R \) is 31% higher (22% lower) in the less (more) competitive economy than in the benchmark).

- Intermediated output and FDIC expenses (relative to output) are increasing in the level of competition.

- The economy is more volatile in competitive environments (the coefficient of variation of both output and equity value are increasing in the degree of competition).
### Regulatory Policy Counterfactuals

**Figure:** Regulatory Policy Counterfactuals: Short-Run versus Long-Run

<table>
<thead>
<tr>
<th></th>
<th>Eliminating agency SR</th>
<th>Eliminating agency LR</th>
<th>Tightening Leverage SR</th>
<th>Tightening leverage LR</th>
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<td>3.0</td>
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<td>S</td>
<td>-2%</td>
<td>-2%</td>
<td>-19%</td>
<td>-18%</td>
</tr>
<tr>
<td>D</td>
<td>-3%</td>
<td>-4%</td>
<td>-47%</td>
<td>-66%</td>
</tr>
<tr>
<td>Z</td>
<td>-3%</td>
<td>-1%</td>
<td>-47%</td>
<td>-37%</td>
</tr>
<tr>
<td>D/E</td>
<td>-8%</td>
<td>-4%</td>
<td>-66%</td>
<td>-66%</td>
</tr>
<tr>
<td>P</td>
<td>3%</td>
<td>3%</td>
<td>23%</td>
<td>23%</td>
</tr>
<tr>
<td>R</td>
<td>-3%</td>
<td>-4%</td>
<td>47%</td>
<td>19%</td>
</tr>
<tr>
<td>$\pi^*$</td>
<td>-2%</td>
<td>-6%</td>
<td>-4%</td>
<td>-51%</td>
</tr>
<tr>
<td>$E^*$</td>
<td>6%</td>
<td>0%</td>
<td>58%</td>
<td>0%</td>
</tr>
<tr>
<td>V</td>
<td>11%</td>
<td>6%</td>
<td>58%</td>
<td>-8%</td>
</tr>
<tr>
<td>$F/Y$</td>
<td>-17%</td>
<td>-12%</td>
<td>-115%</td>
<td>-108%</td>
</tr>
<tr>
<td>$Y^*$</td>
<td>-1%</td>
<td>0%</td>
<td>-47%</td>
<td>-37%</td>
</tr>
<tr>
<td>$\text{cv}(Y)$</td>
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<td>-81%</td>
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<tr>
<td>$\text{cv}(E)$</td>
<td>-6%</td>
<td>-4%</td>
<td>-40%</td>
<td>-40%</td>
</tr>
</tbody>
</table>

Percent deviations from benchmark. * In millions. $Y = p(S) \cdot A \cdot S \cdot Z$. Note here the entry cost $\kappa$ is held fixed and so in the short-run equity $E^* \neq \kappa$. 

Return to the main menu.
REGULATORY POLICY COUNTERFACTUALS

Better Governance

• **Short Run (fixed $N$):**
  - Less risk taking ($S$ drops by 2%) and less leverage ($D/E$ drops by 8%).
  - Volatility of bank equity drops by 6%.
  - Expected cost of funding bank failures falls by 17%.

• **Long Run:** Higher long run profits induces entry ($N$ rises by 3%) mitigating some short run effects.
**Regulatory Policy Counterfactuals**

**Better Governance**
- **Short Run (fixed $N$):**
  - Less risk taking ($S$ drops by 2%) and less leverage (D/E drops by 8%).
  - Volatility of bank equity drops by 6%.
  - Expected cost of funding bank failures falls by 17%.
- **Long Run:** Higher long run profits induces entry ($N$ rises by 3%) mitigating some short run effects.

**Tighter Lverage Constraints**
- **Short Run:**
  - Less risk taking ($S$ falls by 19%) and less leverage (D/E falls by 66%).
  - While interest margins rise the drop in lending leads to lower short run profitability. The increase in success probability however leads to higher long run profitability.
  - Volatility of bank equity drops by 47%.
  - Expected cost of funding bank failures falls by 115%.
- **Long Run:** Higher long run profits induces entry ($N$ rises by 87%).
Interaction Effects

- The interaction of tightening leverage (reducing $\lambda$) and governance policies aimed at decreasing agency conflicts (increasing $\beta$) can magnify the reduction in risk-taking.

- Under our benchmark calibration, we find that the percentage change in risk-taking from tighter leverage requirements is $-18.6\%$ while in an environment where there is no agency conflict the percentage change in risk-taking induced by the tightening of leverage requirements is $-19.2\%$.

- That is, we find a $0.6\%$ higher interaction effect when governance to deal with agency conflicts is combined with policies to curtail leverage relative to the benchmark.

- This finding motivates the interaction terms in our empirical analysis.
Regression Variables

• For BHC $b$, headquartered in state $s$, in year $t$, $Y_{bst}$ is either Charter Value, which equals the natural logarithm of the market value of the bank divided by the book value of assets or Bank Risk, which equals the natural logarithm of the standard deviation of daily stock returns.

• $Competition_{bst}$ is the measure of regulatory-induced competitive pressures facing BHC $b$ in state $s$, in year $t$.

• $X_{bst-1}$ represents a vector of time-varying BHC traits, measured in period $t-1$, where Log(Total Assets)–Lagged equals the natural logarithm of the BHC’s total assets one-year lagged, and Leverage – Lagged equals the BHC’s debt to equity ratio one-year lagged.

• Bank ($\theta_b$) and state-year ($\theta_{st}$) fixed effects.

• We report heteroskedasticity-consistent standard errors, clustered at the state level.
### Monetary Policy Counterfactuals

**Figure:** Monetary Transmission Mechanism Across Market Structures

<table>
<thead>
<tr>
<th></th>
<th>Benchmark (levels)</th>
<th>Contractionary Monetary Policy Benchmark (N=3)</th>
<th>Contractionary Monetary Policy Benchmark LR</th>
<th>Competitive Benchmark (levels) (N = 5 )</th>
<th>Contractionary Monetary Policy More Competitive (N=5)</th>
<th>Contractionary Monetary Policy More Competitive LR</th>
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<tr>
<td>N</td>
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<td>0.73</td>
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<tr>
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<td>F/Y</td>
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<td>35%</td>
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<td>0.57</td>
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<td>-19%</td>
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<tr>
<td>Y*</td>
<td>1825.91</td>
<td>-14%</td>
<td>-23%</td>
<td>1966.93</td>
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<tr>
<td>cv(Y)</td>
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<td>1825.36</td>
<td>5%</td>
<td>-18%</td>
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<td>cv(E)</td>
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<td>0%</td>
<td>0.96</td>
<td>14%</td>
<td>0%</td>
</tr>
</tbody>
</table>

Percent deviations of monetary policy contraction from $\alpha = 0.03$ to $\alpha = 0.05$ holding market size fixed at $N = 3$ and $N = 5$ levels respectively.
Monetary Policy Counterfactuals

Contractionary Policy

- **Short Run (fixed $N$):**
  - More risk taking ($S$ rises by 6%) and more leverage (D/E rises by 57%).
  - Volatility of bank equity jumps by 20%.
  - Expected cost of funding bank failures rises by 35%.

- **Long Run:** Lower long run profits reduces entry ($N$ drops by 23%) mitigating some short run effects ($S$ unchanged) while aggregate lending drops greatly through entry ($Z$ drops by 23%).
Monetary Policy Counterfactuals

Contractionary Policy

- **Short Run (fixed \( N \)):**
  - More risk taking (\( S \) rises by 6%) and more leverage (D/E rises by 57%).
  - Volatility of bank equity jumps by 20%.
  - Expected cost of funding bank failures rises by 35%.

- **Long Run:** Lower long run profits reduces entry (\( N \) drops by 23%) mitigating some short run effects (\( S \) unchanged) while aggregate lending drops greatly through entry (\( Z \) drops by 23%).

Contractionary Policy across Market Structure

- Consistent with the bank lending channel in Kashyap and Stein (2000), we find that an increase in \( \alpha \) from 3% to 5% drops lending by smaller banks more than larger banks (i.e. \( D \) is 24% smaller when \( N = 5 \) than when \( N = 3 \)).
ROBUSTNESS

Percent Deviation from Benchmark

variable
Lending
Risk-taking

Percent Deviations
variable
Lending
Risk-taking

Return

35 / 55
**ROBUSTNESS**

**Figure:** Robustness Table 1

<table>
<thead>
<tr>
<th></th>
<th>Shadow Banking SR ($\gamma$)</th>
<th>Shadow Banking LR ($\gamma$)</th>
<th>Regulatory Arbitrage SR ($\lambda + \gamma$)</th>
<th>Regulatory Arbitrage LR ($\lambda + \gamma$)</th>
<th>Fintech SR ($\eta$)</th>
<th>Fintech LR ($\eta$)</th>
<th>Non-Interest Income LR ($\varepsilon$)</th>
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<td>104%</td>
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<td>-18%</td>
<td>6%</td>
<td>11%</td>
<td>-1%</td>
</tr>
<tr>
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<td>8%</td>
<td>-36%</td>
<td>-1%</td>
</tr>
<tr>
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<td>8%</td>
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<td>29%</td>
<td>22%</td>
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<td>-36%</td>
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<td>-37%</td>
<td>-51%</td>
<td>51%</td>
<td>-50%</td>
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<td>-40%</td>
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<td>-39%</td>
<td>-3%</td>
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</tbody>
</table>

In the first two experiments, $\gamma$ and $\lambda$ are both increased by 50% respectively. The Fintech experiment corresponds to $\eta$ being increased from 4 to 10,
# Robustness

**Figure:** Robustness Table 2

<table>
<thead>
<tr>
<th></th>
<th>Business Cycle SR (A)</th>
<th>Business Cycle LR (A)</th>
<th>Too Big To Fail SR (b = 1)</th>
<th>Too Big To Fail LR (b = 1)</th>
<th>Contagion SR (ψ = 0.5)</th>
<th>Contagion LR (ψ = 0.5)</th>
</tr>
</thead>
<tbody>
<tr>
<td>N</td>
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<td>0%</td>
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<td>0%</td>
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</tr>
<tr>
<td>S</td>
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<td>9%</td>
<td>14%</td>
<td>4%</td>
<td>3%</td>
</tr>
<tr>
<td>D</td>
<td>65%</td>
<td>29%</td>
<td>11%</td>
<td>-15%</td>
<td>5%</td>
<td>9%</td>
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<tr>
<td>Z</td>
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<td>29%</td>
<td>5%</td>
<td>2%</td>
</tr>
<tr>
<td>D/E</td>
<td>-36%</td>
<td>29%</td>
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<td>-15%</td>
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<td>9%</td>
</tr>
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<td>-17%</td>
<td>-16%</td>
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<tr>
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<td>9%</td>
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<tr>
<td>π*</td>
<td>167%</td>
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<td>13%</td>
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<tr>
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<td>28%</td>
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<tr>
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<td>167%</td>
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<td>0%</td>
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<td>358%</td>
<td>68%</td>
<td>148%</td>
<td>31%</td>
<td>20%</td>
</tr>
<tr>
<td>cv(E)</td>
<td>3%</td>
<td>31%</td>
<td>29%</td>
<td>54%</td>
<td>13%</td>
<td>10%</td>
</tr>
</tbody>
</table>

The TBTF experiment moves bailout probability from 0 to \( b = .8 \) with \( \theta = .72 \). The contagion experiment moves the externality of other banks risk-taking on a given individual banks success probability from \( \psi = 0 \) to \( \psi = .5 \).
**Too-Big-To-Fail** \((b = 0 \text{ to } b = 0.8 \text{ with } \theta = 0.72)\)

The problem of an incumbent manager is now

\[
V_i(N) = \max_{S_i,D_i} \pi_i(N) + \beta \left\{ p(S_i)V_i(N') + (1 - p(S_i)) \left[ b_i\theta V(N') + (1 - b_i) \cdot 0 \right] \right\}
\]

**Short Run (fixed \(N\)):**

- Increases risk taking \((S)\) rises by 9\%\) as well as bank lending \((D)\) rises by 11\%\).
- Average output rises by 1\%.
- Volatility of bank equity rises by 29\%.
- Expected cost of funding bank failures rises by 100\%.

**Long Run (endogenous \(N\)):**

- Higher expected long run profits from government support induces entry \((N)\) rises by 52\%\) which generates even more risk taking and “over” lending \((S)\) rises by 14\% and \(Z\) rises by 29\%).
Shadow Banking (γ rises 50%)

Short Run (fixed $N$):

- Competition from other nonbank sources for funding decreases individual and aggregate bank lending (i.e. $D$ and $Z$ decrease by 36%), lowers risk taking by 3%, and interest margins by 4%.
- The drop in lending induces lower short run profits and equity value.

Long Run (endogenous $N$):

- Decreased profitability leads to less entry ($N$ drops by 16%).
- Less competition induces less risk taking and lower leverage ($S$ drops by 5% and $D/E$ drops by 29%).
- Smaller banking industry implies expected cost of funding bank failures falls by 45%.
Regulatory Arbitrage ($\lambda$ drops by 66% and $\gamma$ rises 50%)

Short Run (fixed $N$):

• Competition from other nonbank sources for funding and tighter regulation decreases individual and aggregate bank lending further. Risk taking however drops and interest margins rise.

• The drop in lending induces lower short run profits but higher equity value.

Long Run (endogenous $N$):

• Increased profitability leads to more entry ($N$ rises by 25%).

• More competition offsets less risk taking from tighter leverage constraints.

• Expected cost of funding bank failures falls by over 100%.
Fintech ($\eta = 4$ to $\eta = 10$)

Short Run (fixed $N$):

- Risk taking increases and a large increase in lending ($S$ rises 6% and $D$ rises by 8%).
- The drop in failure rates to 3% induces a large rise in long run profitability.

Long Run (endogenous $N$):

- Increased profitability leads to a large increase in entry ($N$ roughly doubles).
- Expected cost of funding bank failures falls by 73%.
Business Cycle \((A = 0.2 \text{ to } A = 0.3)\)

Short Run (fixed \(N\)):

- Risk taking drops and lending rises along with intermediated output. Thus, we get countercyclical risk/failure and procyclical lending.
- Interest margins, short run profits, and equity values are all procyclical.
- The expected cost of deposit insurance falls.
- While variability of output is procyclical, variability of equity is countercyclical.

Long Run (endogenous \(N\)):

- In the long run, entry rises (i.e. procyclical entry).
- While short run leverage was countercyclical, long run leverage is procyclical.
Contagion ($\theta = 0$ to $\theta = 0.5$)

- Contagion modeled in reduced form as $p(S_i, \bar{S}) = 1 - S_i^\phi S^{\psi}$ where $\phi + \psi = \eta$ (e.g. network externality).

- That is, bank $i$’s choice of risk depends explicitly on what all other banks’ choice of risk ($\bar{S}$) is, similar to how we model the funding technology $r_D(Z)$.

- This specification nests our benchmark when $\psi = 0$.

- The best response function exhibits strategic complementarity.

- Stronger externality generates more risk taking and lending.
Contagion Results ($\psi = 0$ to $\psi = 0.5$)

Short Run (fixed $N$):
- Risk taking and lending rise (strategic complementarities).
- While interest margins and short run profits rise, equity values fall due to the decrease in success probability.
- Output marginally higher, but expected costs of deposit insurance rise tremendously.
- More variability in output and equity values.

Long Run (endogenous $N$):
- In the long run, entry falls due to the decrease in charter value.
- Decreasing competition weakens the risk taking effect, but lending rises even further.
- No long run effect on output.
Strategic Complementarity

**Figure:** Best Response Function $S(\bar{S})$ with Contagion

![Graph showing the best response function with a slope approximately equal to 0.8. The graph compares the best-response function against a 45-degree line.](image)


**CONTAGION COMPARATIVE STATICS**

**FIGURE:** Contagion Comparative Statics

![Contagion Comparative Statics](image-url)
U.S. Banking Industry Concentration

![Graph showing the concentration of U.S. banking industry from 1983 to 2015. The graph plots the number of banks and the top 10 asset share against years. The number of banks decreases over time, while the top 10 asset share increases. The x-axis represents the years (1983, 1987, 1991, 1995, 1999, 2003, 2007, 2011, 2015), and the y-axis represents the number of banks and the top 10 asset share.]}
First Order Conditions

- At the time the \((S_i, D_i)\) choice is taken, entry has already occurred so \(E_i = \kappa\) and \(N\) is taken as given.

- Attaching a multiplier \(\mu\) to constraint (3), the first order conditions from problem (2)-(3) are given by

\[
S_i : p(S_i) \cdot A \cdot D_i + p'(S_i) \cdot R_i \cdot D_i + p'(S_i) \cdot \beta \cdot V_i(N') = 0, \tag{13}
\]

\[
D_i : p(S_i) \cdot R_i - p(S_i) \cdot r'_D(Z) \cdot D_i - \frac{\mu_i}{\kappa_i} = 0. \tag{14}
\]
LITERATURE

• Builds on the applied theory papers by:
  
  • Allen and Gale (2000)
  • Boyd and DeNicolo (2005)
  • Martinez-Miera and Repullo (2010)

• Adds dynamics and free entry condition which endogenizes market structure.

• Importantly policy affects market structure and market structure affects policy.
There are a large number of managers who take compensation as given.

Managers receive a constant fraction $f$ of the earnings of the bank while equity holders receive a fraction $1 - f$.

Static preferences of the manager are given by $u(c_M) = \psi_M c_M$ while preferences of equity holders are given by $u(c_E) = \psi_E c_E$.

For simplicity we take $\psi_M = f^{-1}$ and $\psi_E = (1 - f)^{-1}$. 

Compensation
Leverage Unconstrained versus Constrained FOCs

- Tightening leverage (lowering $\lambda$) shifts foc for $D$ not $S$, decreasing $S$ and $D$. 
Mitigating agency conflicts (raising $\beta = \delta$) shifts foc for $S$ (not $D$) leftward, decreasing $S$ and $D$. 
Contractionary Policy Effects on FOCs

- Contractionary monetary policy (raising $\alpha$) shifts foc for $S$ and $D$ rightward, increasing $S$ and decreasing $D$. 
Empirical Results

An intensification of competition reduces charter value and increases bank risk.

- As shown in column (1), *Competition* enters negatively and significantly in the *Charter Value* regression.
- The estimated economic impact of competition on BHC profits and franchise value is large.
  - A BHC that experiences a change in *Competition* from the $25^{th}$ percentile to the $75^{th}$ percentile of the sample distribution finds its *Charter Value* would fall by about $50\%$.

- As shown in column (4), a regulatory-induced intensification of competition increases the riskiness of the bank (*Bank Risk*).
- The estimated impact is economically large.
  - A BHC that experiences a change in *Competition* from the $25^{th}$ percentile to the $75^{th}$ percentile of the sample distribution finds its *Bank Risk* would be about $50\%$ higher in the more highly competitive environment.
**Policy Shock Definitions**

Four time-varying, BHC-specific measures of monetary policy based on the assumption that banks that rely more on deposits are more sensitive to changes in the FFR, because they have less access to elastic financing sources if, for example, the FFR increases.

1. **FFR\(_1\)** is the FFR averaged over the year interacted with the degree to which the BHC relies on non-wholesale deposits, lagged one year:
   \[
   FFR_t = \frac{(\text{total deposits} - \text{wholesale deposits})}{\text{bank liabilities}}_{t-1}.
   \]

2. **FFR\(_2\)** is defined similarly, except rather than measuring the FFR over the year, it is measured during the first quarter of the year.

3. **FFR\(_3\)** is the FFR averaged over the year interacted with the degree to which the BHC funds itself with deposits, lagged one year:
   \[
   FFR_t = \frac{(\text{bank liabilities} - \text{non-deposit liabilities})}{\text{bank liabilities}}_{t-1}.
   \]

4. **FFR\(_4\)** is defined similarly to **FFR\(_3\)**, except that rather than measuring the FFR over the year, it is measured during the first quarter of the year.