

Interest Rate Risk and Bank Equity Valuations

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Management and Regulatory Implications**
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INTRODUCTION

- What are the effects of changes in interest rates on bank profitability?
- **Conventional Wisdom:** Banks benefit from a steep yield curve because they engage in **maturity transformation**.
 - ▶ But rising longer-term rates can cause immediate capital losses on longer-term assets.
 - ▶ Banks may hedge interest rate risk.
 - ▶ Noninterest income/expense may change in response to changes in interest rates.
- Empirical literature offers mixed evidence regarding the effects of changes in interest rates on profitability of banks.

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EXISTING EVIDENCE

- Analysis based on equity valuations:
 - ▶ Generally finds that bank stock returns—controlling for the market return—react **negatively** to increases in interest rates. (Flannery & James [1984]; Aharony et al. [1986]; Saunders & Yourougou [1990]; Yourougou [1990]; Kwan [1991]; Akella & Greenbaum [1992]; Lumpkin & O'Brien [1997]; Choi & Elyasiani [1997]; Schuermann & Stiroh [2006])
- Analysis based on accounting measures of profitability:
 - ▶ Mixed evidence that bank net interest margins respond to changes in short-term rates or in the slope of the yield curve. (Flannery [1981,1983]; Hancock [1985]; English [2002]; Hanweck & Ryu [2005]; Den Haan et al. [2007]; Memmel [2011]; Begenau, Piazzesi & Schneider [2012])

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OUR PAPER

- Measure the response of bank stock returns to **interest rate surprises** associated with **monetary policy actions**:
 - ▶ These surprises are uncorrelated with other economic news.
- Examine how the reaction of bank stock returns to interest rate surprises varies with:
 - ▶ Degree of maturity mismatch between assets and liabilities.
 - ▶ Reliance on “core deposits.”
 - ▶ Usage of interest rate derivatives.
 - ▶ Bank size and other characteristics.
- Examine the mechanisms behind the reaction by looking at the accounting measures of profitability and the size and composition of bank balance sheets.

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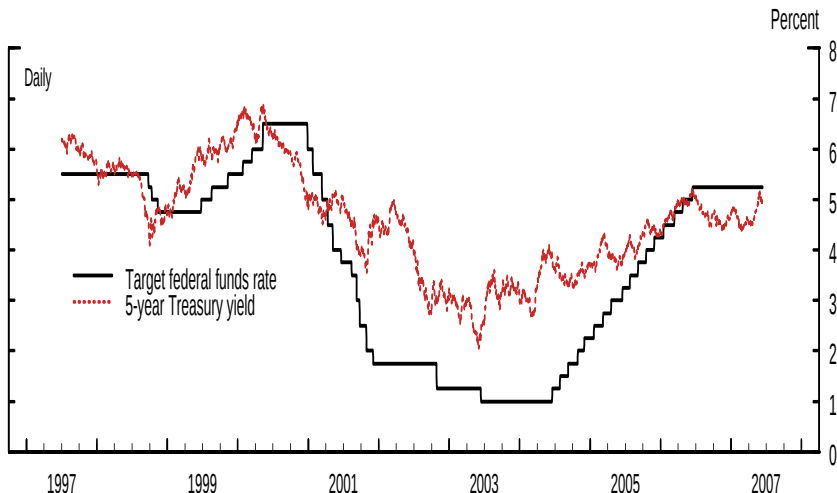
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KEY RESULTS

- Bank equity values **decline** in response to **unanticipated increases** in the level of interest rates:
 - ▶ Greater reliance on core deposits $\Rightarrow$ greater decline.
 - ▶ Larger bank $\Rightarrow$ greater decline.
- Bank equity values **decline** in response to an **unanticipated steepening** of the yield curve.
 - ▶ Larger repricing/maturity gap $\Rightarrow$ smaller decline.
- Results are robust to controlling for the usage of interest rate derivatives using available Call Report data.
- Adjustments in quantities and interest margins are important for understanding the reaction of bank equity values to interest rate changes.

SAMPLE PERIOD



- 84 FOMC announcements between 7/2/97 and 6/28/07:
 - Four intermeeting moves (10/15/98, 1/3/01, 4/18/01, 9/17/01).

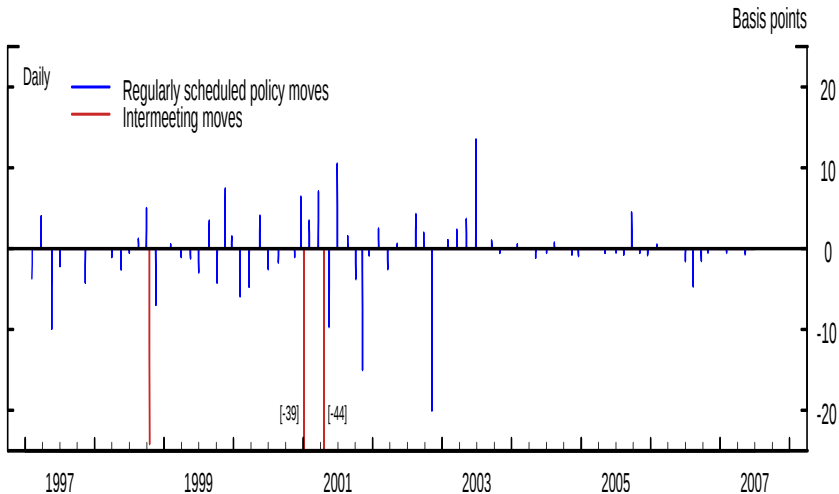
TARGET SURPRISE

- For each FOMC announcement, decompose the change in the **target** federal funds rate:

$$\underbrace{\Delta ff_t}_{\text{actual}} \equiv \underbrace{\Delta ff_t^e}_{\text{expected}} + \underbrace{\Delta ff_t^u}_{\text{surprise}}$$

- ▶ Δff_t^e measured using federal funds futures quotes over the 30-minute window around the FOMC announcement ([Kuttner \[2001\]](#))
- ▶ **Target Surprise:** $\Delta ff_t^u = \Delta ff_t - \Delta ff_t^e$
 - Unexpected change in the federal funds target rate associated with a specific FOMC announcement.

TARGET SURPRISES

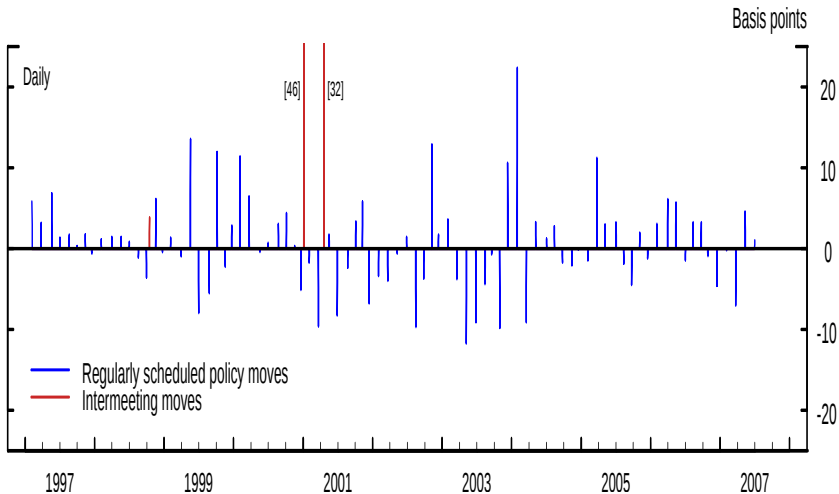


NOTE: Excludes the 9/17/2001 intermeeting policy action.

SLOPE SURPRISE

- Unexpected steepening or flattening of the yield curve.
- **Slope Surprise:** $(\Delta y_t^m - \Delta f f_t^u)$
 - ▶ Δy_t^m = change in the m -year Treasury yield over a 30-minute window around the FOMC announcement
 - ▶ $m = 2, 5, \text{ and } 10 \text{ years}$
- Slope surprises can occur when FOMC communication alters the expected path of future short-term interest rates.

5-YEAR SLOPE SURPRISES



NOTE: Excludes the 9/17/2001 intermeeting policy action.

STOCK RETURNS AND INTEREST RATE SURPRISES

- **Intraday** stock price quotes for 355 BHCs (Obs. = 11,026).
- R_{it} = (simple) return for bank i over the 2-hour window around the FOMC announcement on day t .
- Baseline specification:

$$R_{it} = \beta_0 + \beta_1 \Delta ff_t^u + \beta_2 (\Delta y_t^m - \Delta ff_t^u) + \beta_3 \Delta ff_t^e + \epsilon_{it}$$

- ▶ Estimated by OLS.
- ▶ Driscoll & Kraay [1998] robust standard errors.
- ▶ Coefficient interpretation:

$$\beta_1 = \left. \frac{\partial R}{\partial \Delta ff^u} \right|_{(\Delta y^m = \Delta ff^u)} \quad (\text{level surprise})$$

$$\beta_2 = \left. \frac{\partial R}{\partial (\Delta y^m - \Delta ff^u)} \right|_{(\Delta ff^u = 0)} \quad (\text{slope surprise})$$

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REACTION OF BANK STOCK RETURNS

All FOMC Announcements

Explanatory Variable	$m = 2\text{-year}$	$m = 5\text{-year}$	$m = 10\text{-year}$
Level surprise: Δff^u	-8.166*** (1.458)	-8.627*** (1.584)	-10.20*** (1.962)
Slope surprise: $(\Delta y^m - \Delta ff^u)$	-4.913*** (1.694)	-4.819*** (1.446)	-5.807*** (1.854)
Expected change: Δff^e	0.617 (0.478)	0.560 (0.422)	0.525 (0.426)
Constant	0.065 (0.080)	0.085 (0.082)	0.078 (0.083)
Adj. R^2	0.103	0.102	0.099

NOTE: Robust standard errors in parentheses; *, **, *** denotes significance at the 10%, 5%, and 1% level, respectively.

MEASURING THE MATURITY MISMATCH

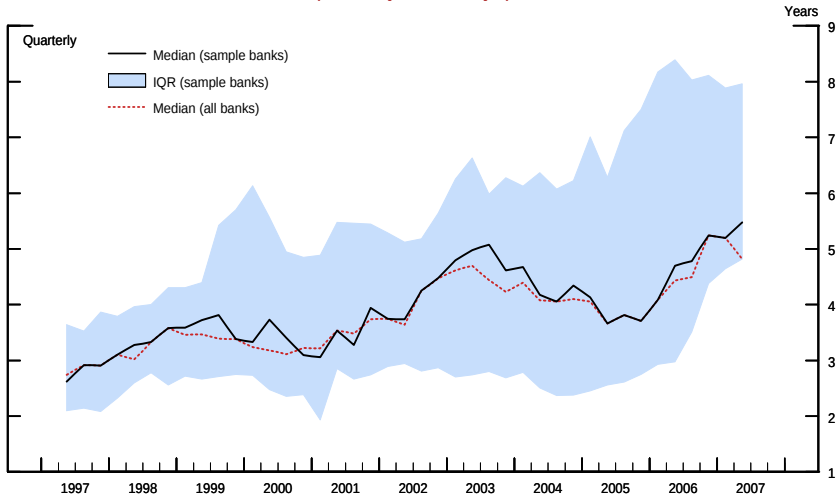
- Call Reports contain information on the repricing time and/or maturity of selected assets and liabilities:

$$GAP_{it}^{RP} = \left[\begin{array}{c} \text{average} \\ \text{repricing/maturity} \\ \text{of assets} \end{array} \right] - \left[\begin{array}{c} \text{average} \\ \text{repricing/maturity} \\ \text{of liabilities} \end{array} \right]$$

- ▶ Based on 26 asset and 11 liability categories
- Large GAP_{it}^{RP} implies more maturity transformation in the traditional sense.
- Demand, transactions, and savings deposits are included at their contractual maturity (i.e., zero years)
- GAP_{it}^{RP} is not a measure of duration.

REPRICING/MATURITY GAP

(1997:Q2–2007:Q2)



NOTE: All percentiles are weighted by interest-earning assets.

MEDIAN BANK BALANCE SHEET CHARACTERISTICS

By Repricing/Maturity Gap Quintile

Variable	Q1	Q2	Q3	Q4	Q5
Total loans (shr. of assets)	0.71	0.69	0.69	0.67	0.61
C&I loans (shr. of total loans)	0.20	0.19	0.18	0.14	0.13
CRE loans (shr. of total loans)	0.42	0.36	0.34	0.31	0.30
RRE loans (shr. of total loans)	0.17	0.25	0.26	0.32	0.37
Consumer loans (shr. of total loans)	0.05	0.07	0.10	0.10	0.09
Interest-bearing liabilities (shr. of liabilities)	0.83	0.83	0.85	0.86	0.86
Savings deposits (shr. of liabilities)	0.29	0.31	0.33	0.31	0.33
Demand & trans. deposits (shr. of liabilities)	0.17	0.15	0.16	0.13	0.13
Total assets (\$ billions)	1.43	1.54	2.26	2.45	1.98

CORE DEPOSITS

- Core (demand, transactions, and savings) deposits are “special:”
 - ▶ Evidence of sticky rates and quantities.
([Hannan & Berger \[1991\]](#); [Neumark & Sharpe \[1992\]](#))
 - ▶ Interest rates on core deposits are typically below short-term market rates.
- Core deposits are a source of “rents:”
 - ▶ Banks can benefit from an increase in short-term market rates.
([Samuelson \[1945\]](#))
 - ▶ But if withdrawals are even moderately interest-sensitive, rents can also decline, implying negative duration.
- We control separately for demand & transaction deposits (DTD) and savings deposits (SD).

STOCK RETURNS AND INTEREST RATE SURPRISES

By Bank Characteristics

- Regression specification:

$$R_{it} = \beta_1 \Delta ff_t^u + \beta_2 (\Delta y_t^m - \Delta ff_t^u) + \\ \gamma_1 [GAP_{it}^{R/M} \times \Delta ff_t^u] + \gamma_2 [GAP_{it}^{R/M} \times (\Delta y_t^m - \Delta ff_t^u)] + \\ \theta'_1 [\mathbf{X}_{it} \times \Delta ff_t^u] + \theta'_2 [\mathbf{X}_{it} \times (\Delta y_t^m - \Delta ff_t^u)] + \eta_i + \epsilon_{it}$$

- $\mathbf{X}_{it}$ = vector of bank-specific characteristics
 - ▶ A_{it}^{OTH} = other assets (as a share of interest-earning assets) (mean = 9%)
 - ▶ L_{it}^{OTH} = other liabilities (as a share of liabilities) (mean = 17%)
 - ▶ DTD_{it} = demand + transaction deposits (as a share of liabilities)
 - ▶ SD_{it} = saving deposits (as a share of liabilities)
 - ▶ LNS_{it} = loans & leases (as a share of total assets)
 - ▶ $\log A_{it}$ = log of (real) total assets

REACTION OF BANK STOCK RETURNS

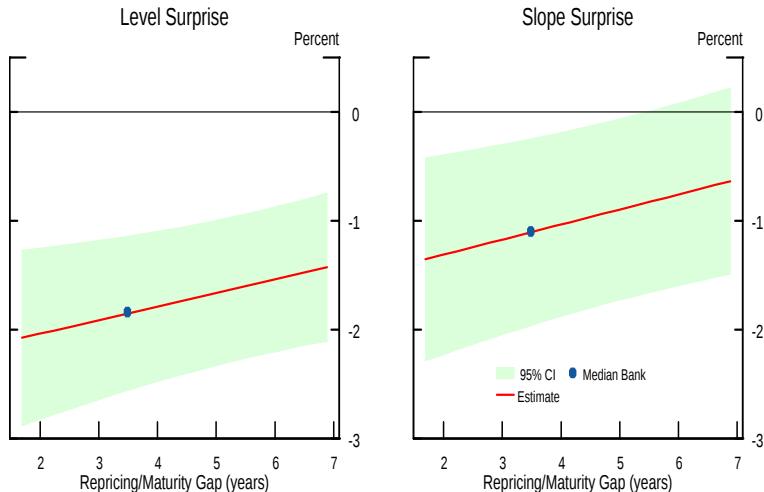
By Repricing/Maturity Gap

Variable $\times$ Interest Rate Surprise	$m = 2\text{-year}$	$m = 5\text{-year}$	$m = 10\text{-year}$
$GAP^{R/M} \times \Delta ff^u$	0.500** (0.238)	0.453* (0.237)	0.598** (0.256)
$GAP^{R/M} \times (\Delta y^m - \Delta ff^u)$	0.553** (0.244)	0.426** (0.217)	0.521** (0.246)

NOTE: Robust standard errors in parentheses; *, **, *** denotes significance at the 10%, 5%, and 1% level, respectively.

REACTION OF BANK STOCK RETURNS

By Repricing/Maturity Gap



NOTE: Slope surprise is measured using a 2-year Treasury yield.

REACTION OF BANK STOCK RETURNS

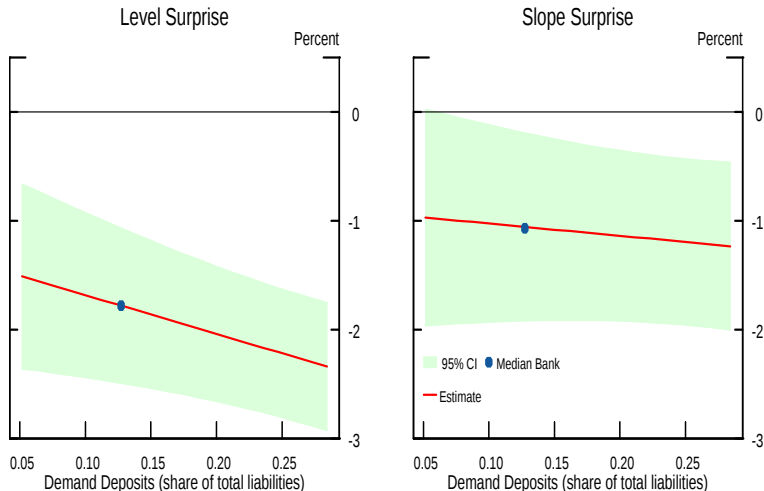
By Reliance on Demand/Transactions Deposits

Variable $\times$ Interest Rate Surprise	$m = 2\text{-year}$	$m = 5\text{-year}$	$m = 10\text{-year}$
$DTD \times \Delta ff^u$	-14.27** (5.644)	-17.80*** (5.522)	-18.58*** (6.928)
$DTD \times (\Delta y^m - \Delta ff^u)$	-4.516 (6.349)	-8.046 (5.882)	-8.002 (6.863)

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REACTION OF BANK STOCK RETURNS

By Reliance on Demand/Transactions Deposits



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REACTION OF BANK STOCK RETURNS

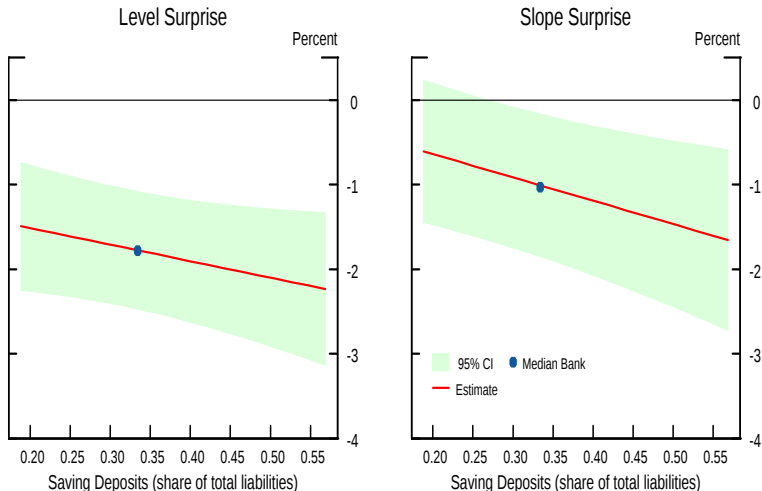
By Reliance on Savings Deposits

Variable $\times$ Interest Rate Surprise	$m = 2\text{-year}$	$m = 5\text{-year}$	$m = 10\text{-year}$
$SD \times \Delta ff^u$	-7.793* (4.637)	-8.750 (5.467)	-7.937 (6.309)
$SD \times (\Delta y^m - \Delta ff^u)$	-11.02** (4.437)	-11.32** (4.401)	-9.004* (5.366)

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REACTION OF BANK STOCK RETURNS

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REACTION OF BANK STOCK RETURNS

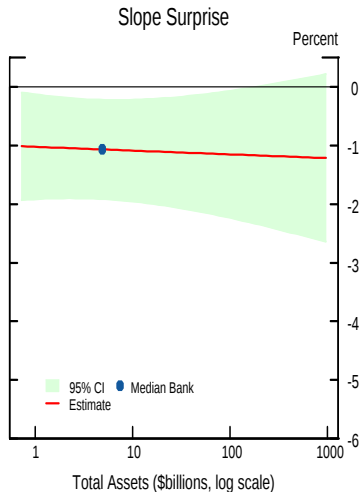
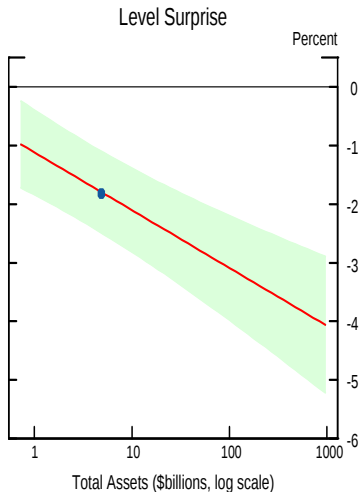
By Bank Size

Variable $\times$ Interest Rate Surprise	$m = 2\text{-year}$	$m = 5\text{-year}$	$m = 10\text{-year}$
$\log A \times \Delta ff^u$	-1.714*** (0.340)	-1.766*** (0.347)	-2.035*** (0.460)
$\log A \times (\Delta y^m - \Delta ff^u)$	-0.111 (0.429)	-0.123 (0.390)	-0.394 (0.447)

NOTE: Robust standard errors in parentheses; *, **, *** denotes significance at the 10%, 5%, and 1% level, respectively.

REACTION OF BANK STOCK RETURNS

By Bank Size



NOTE: Slope surprise is measured using a 2-year Treasury yield.

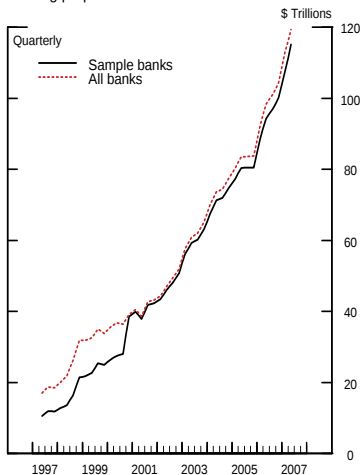
INTEREST RATE DERIVATIVES

- Banks may hedge interest rate risk using derivatives.
- Call Report information on interest rate derivatives:
 - ▶ By type of purpose: trading vs. non-trading (i.e., hedging)
 - Notional outstanding amounts.
 - Positive and negative fair (i.e., market) values.
 - ▶ Notional amounts by contract type (i.e., swaps, futures, etc.)

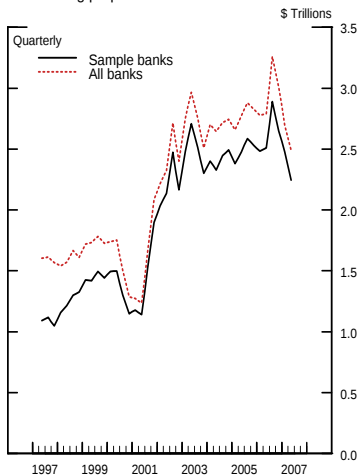
NOTIONAL AMOUNT OF INTEREST RATE DERIVATIVES

By Type of Purpose

Trading purposes



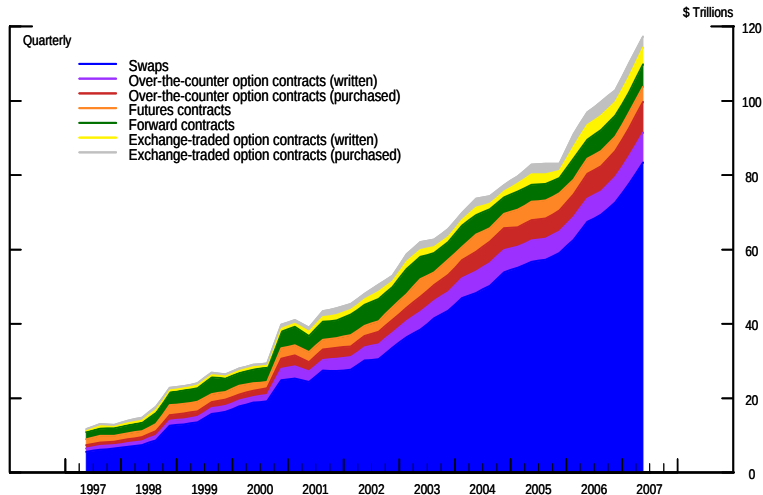
Non-trading purposes



NOTE: Deflated by the GDP price deflator (2005 = 100).

NOTIONAL AMOUNT OF INTEREST RATE DERIVATIVES

By Contract Type

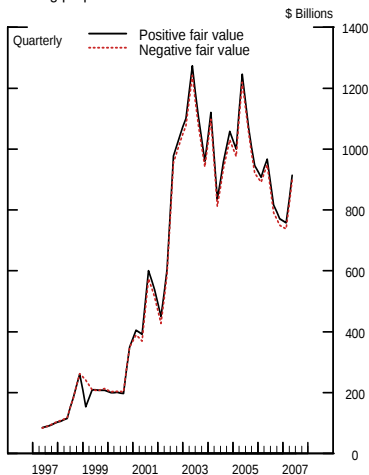


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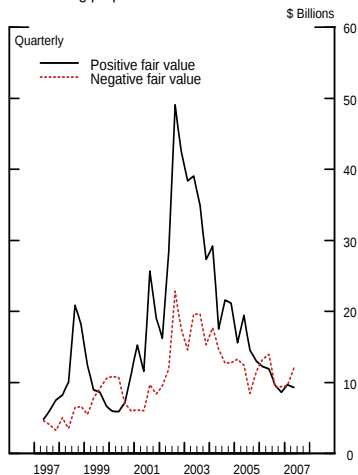
FAIR VALUE OF INTEREST RATE DERIVATIVES

By Type of Purpose

Trading purposes



Non-trading purposes



NOTE: Deflated by the GDP price deflator (2005 = 100).

INTEREST RATE DERIVATIVES

By Size Quintile

Trading Purposes (percent of assets)					
Valuation	Q1	Q2	Q3	Q4	Q5
<i>Notional Value</i>					
Mean	0.09	0.01	0.06	0.32	133.1
Median	0.00	0.00	0.00	0.00	1.37
Max	72.2	14.8	10.5	29.6	4608
<i>Net Fair Value</i>					
Mean	-0.00	0.00	0.00	0.00	0.03
Min	-0.05	-0.03	-0.07	-0.05	-21.6
Median	0.00	0.00	0.00	0.00	0.00
Max	0.08	0.03	0.70	0.09	2.00

INTEREST RATE DERIVATIVES

By Size Quintile

Non-Trading Purposes (percent of assets)

Valuation	Q1	Q2	Q3	Q4	Q5
<i>Notional Value</i>					
Mean	1.87	0.79	2.11	6.53	19.8
Median	0.00	0.00	0.00	0.21	8.54
Max	146.8	20.1	94.8	760.9	430.2
<i>Net Fair Value</i>					
Mean	0.00	0.00	0.00	0.00	0.07
Min	-0.66	-0.63	-1.14	-0.94	-1.22
Median	0.00	0.00	0.00	0.00	0.01
Max	2.46	0.53	0.99	1.23	2.69

STOCK RETURNS AND INTEREST RATE SURPRISES

Controlling for the Usage of Interest Rate Derivatives

- Regression specification:

$$\begin{aligned}
 R_{it} = & \beta_1 \Delta ff_t^u + \beta_2 (\Delta y_t^m - \Delta ff_t^u) + \\
 & \gamma_1 [GAP_{it}^{R/M} \times \Delta ff_t^u] + \gamma_2 [GAP_{it}^{R/M} \times (\Delta y_t^m - \Delta ff_t^u)] + \\
 & \theta'_1 [\mathbf{X}_{it} \times \Delta ff_t^u] + \theta'_2 [\mathbf{X}_{it} \times (\Delta y_t^m - \Delta ff_t^u)] + \\
 & \lambda'_1 [\mathbf{Z}_{it} \times \Delta ff_t^u] + \lambda'_2 [\mathbf{Z}_{it} \times (\Delta y_t^m - \Delta ff_t^u)] + \eta_i + \epsilon_{it}
 \end{aligned}$$

- ▶ $\mathbf{Z}_{it}$ = vector of interest rate derivative controls (all available contract types).
- ▶ Use $\log \left(1 + \frac{\text{Notional Amount}}{\text{Total Assets}} \right)$ transformation.

REACTION OF BANK STOCK RETURNS

By Usage of Interest Rate Derivatives

Median Bank	Interest Rate Surprise	
	Level	Slope
With median interest rate derivatives position	-7.234*** (1.407)	-4.279** (1.717)
With large interest rate derivatives position	-6.278** (3.169)	-2.480 (3.518)

NOTE: Robust standard errors in parentheses; *, **, *** denotes significance at the 10%, 5%, and 1% level, respectively.

- Estimated effects of all other bank characteristics are the same.

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INSPECTING THE MECHANISM

Interest Rates and Accounting Measures of Profitability

- Use accounting measures of profitability and balance sheets to further understand the mechanisms behind the reaction of equity values to interest rate shocks.
- Using merger-adjusted Call Report data, construct a panel of 4,776 of U.S. commercial banks over the 1997:Q2–2007:Q2 period.

INSPECTING THE MECHANISM

Interest Rates and Accounting Measures of Profitability

- Dynamic fixed effects specification:

$$\pi_{it} = \sum_{k=1}^4 \rho_k \pi_{i,t-k} + \beta_1 y_t^{3m} + \beta_2 (y_t^{10y} - y_t^{3m}) + \gamma_0' \mathbf{X}_{i,t-1} + \gamma_1' [\mathbf{X}_{i,t-1} \times y_t^{3m}] + \gamma_2' [\mathbf{X}_{i,t-1} \times (y_t^{10y} - y_t^{3m})] + \lambda' \mathbf{m}_t + \eta_i + \epsilon_{it}$$

- ▶ π_{it} = accounting measure of profitability
- ▶ $\mathbf{X}_{it}$ = vector of bank-specific characteristics
- ▶ $\mathbf{m}_t$ = vector of macroeconomic controls
(real GDP growth, unemployment gap, inflation, S&P 500 return, 10-year BBB credit spread, VIX)
- Estimated by OLS with Driscoll-Kraay robust standard errors.

INTEREST RATES, PROFITABILITY, AND ASSET GROWTH

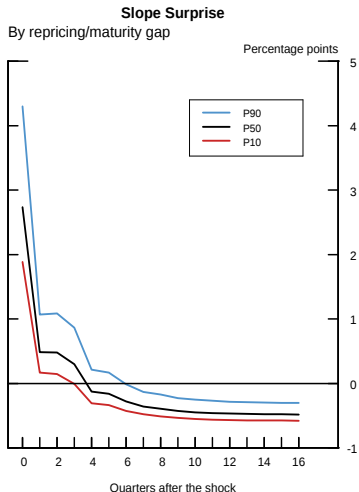
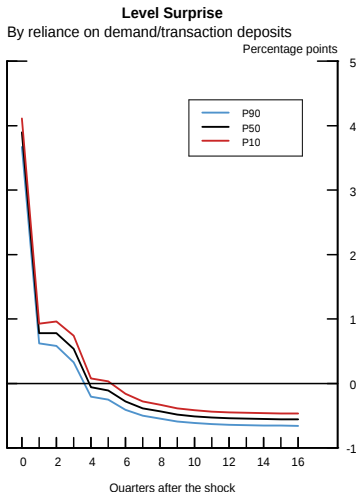
By Selected Bank Characteristics

Variable $\times$ Interest Rate	<i>NII</i>	<i>NNI</i>	<i>ROA</i>	$\Delta \log A$
Level effect (median)	0.088*** (0.014)	-0.015 (0.011)	0.051*** (0.010)	-2.139** (0.879)
Slope effect (median)	0.071*** (0.011)	-0.005 (0.008)	0.037*** (0.008)	-1.830*** (0.618)
$GAP^{R/M} \times y^{3m}$	-0.001 (0.002)	0.000 (0.001)	-0.000 (0.002)	0.105* (0.060)
$GAP^{R/M} \times (y^{10y} - y^{3m})$	0.007*** (0.002)	-0.001 (0.002)	0.007*** (0.002)	0.291*** (0.059)
$DTD \times y^{3m}$	0.110*** (0.035)	-0.144*** (0.024)	0.015 (0.022)	-2.883*** (0.920)
$DTD \times (y^{10y} - y^{3m})$	-0.020 (0.045)	-0.126*** (0.032)	-0.106*** (0.030)	-2.670** (1.365)
R^2 (within)	0.690	0.321	0.258	0.104

NOTE: Robust standard errors in parentheses; *, **, *** denotes significance at the 10%, 5%, and 1% level, respectively.

NET INCOME AND INTEREST RATE SHOCKS

By Type of Shock and Selected Bank Characteristics



INTEREST RATES AND BALANCE SHEET COMPOSITION

Growth Contribution	Level	Slope	R^2	Share
$(\Delta LNS)/A$	0.973*	-0.836**	0.116	0.637
	(0.514)	(0.384)	-	-
$(\Delta SEC)/A$	0.823	0.464	0.110	0.234
	(1.267)	(0.899)	-	-
$(\Delta FFSRRP)/A$	-3.646***	-3.540***	0.215	0.033
	(1.019)	(0.560)	-	-
$(\Delta BALDEP)/A$	-0.556***	-0.499***	0.118	0.012
	(0.149)	(0.099)	-	-
$(\Delta COREDEP)/A$	-2.152**	-0.729	0.116	0.432
	(1.045)	(0.748)	-	-
$(\Delta TIMEDEP)/A$	0.037	-0.721***	0.121	0.281
	(0.321)	(0.192)	-	-
$(\Delta MNGLIAB)/A$	0.465	0.447*	0.085	0.167
	(0.366)	(1.717)	-	-

NOTE: Robust standard errors in parentheses; *, **, *** denotes significance at the 10%, 5%, and 1% level, respectively.

CONCLUSION

- Bank stock returns react **negatively** to
 - ▶ Unexpected increase in the **level** of interest rates.
 - ▶ Unexpected steepening of the **slope** of the yield curve.
- A large maturity mismatch between assets and liabilities mitigates the negative reaction of stock returns to slope surprises.
- Reliance on core deposits is associated with greater sensitivity.
- The reaction of stock returns is consistent with the adjustments of interest margins *and* the size and composition of banks' balance sheets in response to interest rate changes.

AN ASSET PRICING PERSPECTIVE

- Interest rate surprises induced by monetary policy actions have large effects on the aggregate stock market.
([Bernanke & Kuttner \[2005\]](#))
- Do our results represent a departure from standard empirical asset pricing models?

OUR APPROACH: STEP I

- Estimate a dynamic CAPM using daily data:

$$(R_{i\tau} - r_{\tau}^f) = \alpha_{i\tau} + \beta_{i\tau}(R_{\tau}^M - r_{\tau}^f) + \epsilon_{i\tau},$$

- Idiosyncratic return for FOMC announcement day t :

$$(R_{it} - r_t^f) - \left[0.31\hat{\alpha}_{i,t-1} + \hat{\beta}_{i,t-1}(R_t^M - r_t^f) \right]$$

- **Result:** Level and slope surprise have **no effect** of idiosyncratic returns.
- **Implication:** Reaction of bank stock returns to changes in interest rates induced by FOMC announcements is in line with their usual comovement with the market.

OUR APPROACH: STEP II

- Bank-specific characteristics determining the magnitude and direction of the reaction to policy-induced interest rate surprises should be correlated with the market beta.
- Estimate:

$$\hat{\beta}_{it} = \boldsymbol{\theta}' \mathbf{X}_{i,t-1} + \eta_i + \epsilon_{it},$$

- ▶ $\hat{\beta}_{it}$ = estimate of market beta for bank i in quarter t
- ▶ $\mathbf{X}_{i,t-1}$ = vector of “fundamental” bank characteristics

BANK CHARACTERISTICS ON THE MARKET BETA

Explanatory Variable	Coef.	S.E.
Maturity gap: $GAP^{R/M}$	-0.067***	0.012
Other assets: A^{OTH}	-0.589***	0.208
Other liabilities: L^{OTH}	1.242***	0.310
Savings deposits: SD	2.090***	0.408
Demand deposits: DTD	1.930***	0.410
Loans/Assets: LNS/A	-0.014	0.177
Size: $\log A$	0.561***	0.052
Swaps	-0.752***	0.090
OTC options (written)	-0.295*	0.163
OTC options (purchased)	0.207	0.133
ET options (written)	0.217	0.178
ET options (purchased)	-0.123	0.147
Futures	0.027	0.099
Forwards	0.168**	0.073
Memo: R^2 (within) = 0.175		