

Risk Management in Financial Institutions

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Determinants of Risk Management in Financial Institutions

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 - Since financial crisis, much debate of risk management failures
 - Yet basic patterns and determinants are not known
 - Essential for monetary and macro-prudential policy

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■ Identification

- Drop in net income due to loan losses and local house price drops
- IV and difference-in-difference estimation

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 - Risk management requires net worth
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 - Hedging demand varies in sign in cross section

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- **Evidence on risk management and risk exposures** ▶ Empirical literature

Hypothesis and Preview of Results

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- **No evidence for alternative hypotheses**

Data and Measurement

- **Data sources**

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- **Bank holding companies (BHCs):** 22,723 BHC-quarter obs.
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- **Banks:** 603,894 bank-quarter observations
 - Advantage: More detailed hedging data from Call reports

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■ Sample

- Exclude main dealers, results robust to their inclusion

Data and Measurement: Gross Hedging

- **Definition: Gross hedging**

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■ Distribution of gross hedging – BHC level

	Mean	Med.	75th	90th	95th	98th	Max.
Gross hedging	0.038	0.006	0.036	0.103	0.194	0.354	0.571
Gross trading	0.071	0	0	0.017	0.075	0.589	8.801

- Large number of zeros
- Most BHCs use derivatives for hedging not trading

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- **Relation between gross hedging and net hedging**

- Average ratio of (absolute) net hedging to gross hedging: 90.9%

Data and Measurement: Interest Rate Exposure

- **Definition: Maturity gap** ▶ Descriptive statistics

$$\text{Maturity gap}_{it} = \frac{A_{it}^{IR} - L_{it}^{IR}}{\text{Total assets}_{it}}$$

- A_{it}^{IR} : Assets maturing or repricing within 1 year
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 - Δ cash flows \approx maturity gap \times Δ short rate

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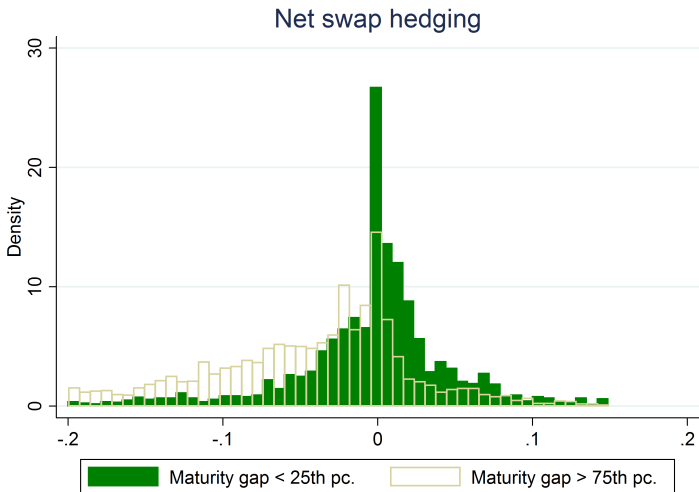
- (New) **Definition: Duration gap** ▶ Descriptive statistics

$$D_{gap} \equiv D_A - \frac{L}{A} D_L.$$

- D_A (D_L): Measure of duration of assets A (liabilities L)
- Rescaled version of duration of equity E : $D_E = \frac{A}{E} D_{gap}$

Data and Measurement: Interest Rate Exposure

- **Institutions with lots of floating-rate liabilities pay fixed**
 - Consistent with hedging



Data and Measurement: Financial Institutions' Net Worth

- **Key state variable: Net worth**
 - Net worth determines tightness of financial constraints

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- **Key state variable: Net worth**

- Net worth determines tightness of financial constraints

- **Measurement: Net worth – financial constraints**

▶ Descriptive statistics

- Size (log Total book assets) (1)
- Market value of equity (log)
- Market value of equity / Market value of assets (2)
- Net income / Total assets (3)
- Cash dividends / Total assets (4)
- Credit rating from S&P
- Net worth index
 - First principal component of (1) through (4)
 - Weights: 0.149, 0.307, 0.272 and 0.272

Hedging and Net Worth: Cross-Section Evidence

- **Between variation and pooled sample: OLS** ▶ OLS estimation
 - BHC-mean and pooled OLS regressions
 - Strong correlation between hedging and net worth in cross section

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- **Within variation** – institution fixed effects ▶ FE estimation
 - Institutions hedge more when their net worth is higher

Hedging Before Distress

- **Definition: Distress**

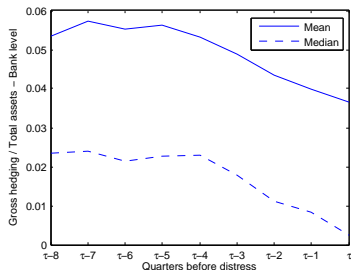
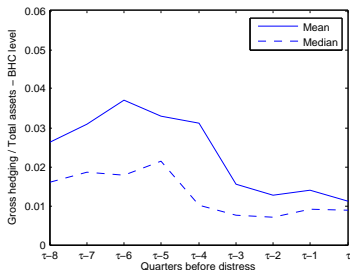
- Exit with market capitalization (or equity) to total assets below 4%

Hedging Before Distress

■ Definition: Distress

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■ Both BHCs and banks cut hedging before distress ▶ Estimation



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- **Instrument for net income: lagged house price changes**
 - **Identifying assumption**
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 - Focus on 2005-2013
 - Focus on institutions with above-median loans secured by real estate
 - Construct deposit-weighted average house price change by institution

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- **Validity of instrument**
 - Changes in provisions (not interest income) explain changes in net income ▸ Variance decomposition
 - Loan losses arise from loans backed by real estate ▸ Composition of nonaccrual loans
 - Drop in house prices (not interest rates) key determinant of mortgage defaults (see Mayer/Pence/Sherlund (2009) and others)

Instrumenting Net Worth with House Prices

■ Construction of instrument

- Data – ZIP-code level: Zillow (house prices); FDIC (deposits)
- Compute deposit-weighted avg. house price change over past 2 years
- Assumption: loans proportional to deposits at ZIP-code level

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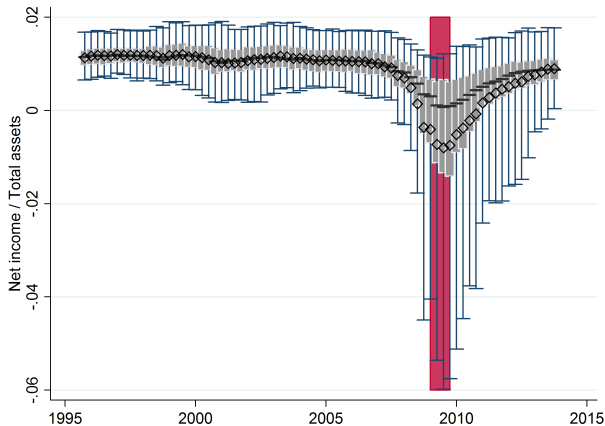
■ IV estimation

	BHC level		Bank level	
	OLS	IV	OLS	IV
First stage		0.251*** (0.009)		0.113*** (0.001)
R^2		0.096		0.053
Net income	0.185** (0.011)	0.254*** (0.003)	0.049** (0.031)	0.086*** (0.000)
R^2	0.008	0.003	0.003	0.001

Distribution of Net Income over Sample Period

- Large losses mostly concentrated in 2009

- 50% BHCs with negative net income in 2009Q4



Identification: Losses on Loans Secured by Real Estate

- **Difference-in-difference (DD) specification**
 - Large changes in net income occur mostly in 2009
 - Exploit heterogeneity across institutions for treatment and control
 - Focus on institutions with above-median loans secured by real estate

Identification: Losses on Loans Secured by Real Estate

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- **Treatment and control group**

- **Treatment: bottom 30% in net income in 2009**
- Control: top 30% in net income in 2009

- Focus on 2005-2013; treatment year plus/minus 4 years

Gross Hedging by BHCs – Treatment and Control Group

- **Treated BHCs cut hedging relative to control group**

Gross Hedging by BHCs and Banks – DD Estimates

■ Treated BHCs and banks cut hedging significantly

- ... both with and without institution fixed effects

	BHC level			Bank level		
	Post-event dummy	Year dummies	Year dummies	Post-event dummy	Year dummies	Year dummies
2009 and after	-0.029*** (0.003)			-0.015*** (0.009)		
2009		-0.020 (0.136)	-0.022*** (0.007)		-0.019** (0.042)	-0.017** (0.031)
2010		-0.039*** (0.004)	-0.042*** (0.000)		-0.010 (0.181)	-0.017** (0.019)
2011		-0.038*** (0.005)	-0.035*** (0.000)		0.001 (0.910)	0.006 (0.390)
2012		-0.019 (0.153)	-0.020** (0.010)		-0.021*** (0.008)	-0.027*** (0.000)
2013		-0.031** (0.024)	-0.033*** (0.000)		-0.028*** (0.000)	-0.018** (0.017)
BHC FE	No	No	Yes	No	No	Yes
Time FE	Yes	Yes	Yes	Yes	Yes	Yes

Alternative Treatments

- **Alternative treatment I: house prices**
 - Exploit heterogeneity in local house price changes across institutions
 - Treatment: bottom 30% in house prices changes in 2007Q1-2008Q4
 - Control: top 30% in house prices changes in 2007Q1-2008Q4

Alternative Treatments

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■ **Alternative treatment II: housing supply elasticity**

- Use Saiz (2010)'s measure of housing supply elasticity at MSA level
- Compute deposit-weighted avg. housing supply elasticity by institution
- Treatment: bottom 30% in weighted-avg. housing supply elasticity
- Control: top 30% in weighted-avg. housing supply elasticity

DD Estimates with Alternative Treatments

■ Alternative treatments yield rather similar results

Treatment	House price change			Housing supply elasticity		
	Post-event dummy	Year dummies	Year dummies	Post-event dummy	Year dummies	Year dummies
2009 and after	-0.040** (0.011)			-0.042*** (0.003)		
2009		-0.020* (0.099)	-0.022* (0.079)		-0.023*** (0.000)	-0.085*** (0.000)
2010		-0.022* (0.099)	-0.026* (0.079)		-0.027*** (0.000)	-0.096*** (0.000)
2011		-0.044** (0.031)	-0.051** (0.023)		-0.026** (0.011)	-0.059** (0.014)
2012		-0.042** (0.035)	-0.039* (0.054)		-0.021** (0.037)	-0.055** (0.023)
2013		-0.025* (0.078)	-0.016 (0.115)		-0.019** (0.045)	-0.047** (0.053)
BHC FE	No	No	Yes	No	No	Yes
Time FE	Yes	Yes	Yes	Yes	Yes	Yes

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■ Similar results at bank level

Robustness: Parallel Trends Assumption

■ Testing parallel trends assumption

- Include year-treatment dummies in pre-treatment period

Treatment	Net income			
	Year dummies		Year dummies	
2005	-0.014	(0.331)	-0.003	(0.784)
2006	-0.010	(0.499)	0.008	(0.444)
2007	-0.007	(0.626)	-0.000	(0.989)
2008	-		-	
2009	-0.028*	(0.085)	-0.017	(0.134)
2010	-0.047***	(0.004)	-0.029**	(0.010)
2011	-0.046***	(0.005)	-0.028**	(0.015)
2012	-0.027*	(0.095)	-0.030***	(0.009)
2013	-0.039**	(0.019)	-0.036***	(0.002)
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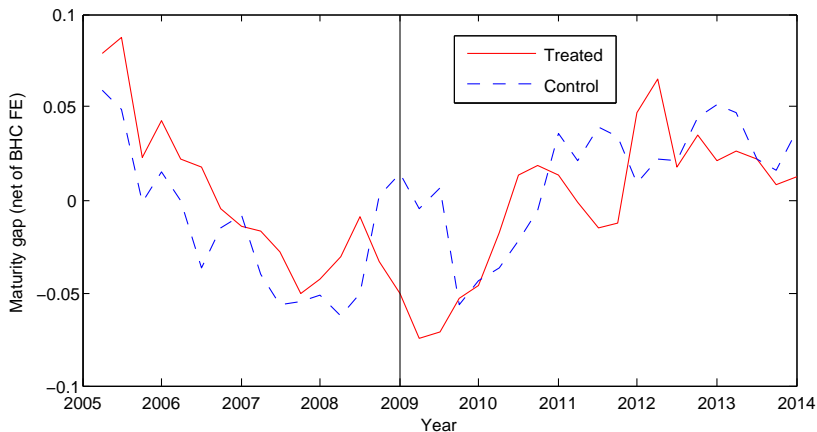
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- No significant pre-treatment differences in trends

Robustness: Maturity Gap in Treatment and Control Group

- **No differences in maturity gap** ▶ DD estimation – maturity and duration gap
 - Treated BHCs do not seem to reduce interest rate exposure

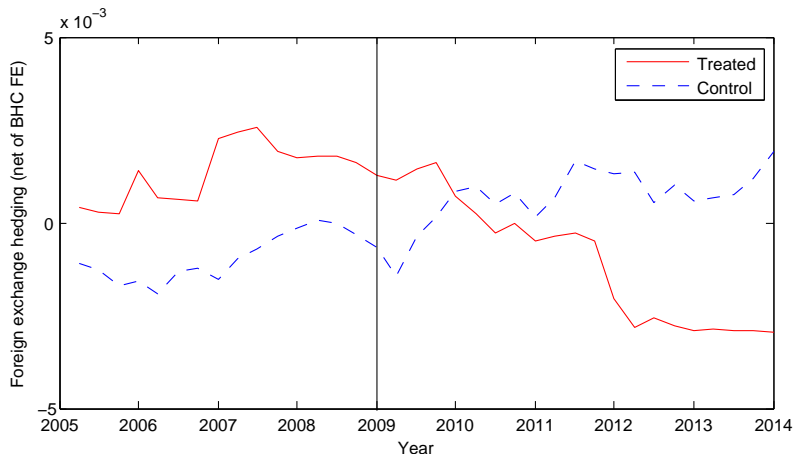


Robustness: Foreign Exchange Hedging by BHCs

■ Treated BHCs cut forex hedging relative to control group

▶ Descriptive statistics – forex

▶ DD estimation – forex



Alternative Hypothesis 1: Risk Shifting?

■ Evidence from trading

- Idea: risk shifting should involve more trading
- **Significantly positive relation between trading and net worth**
 - ... both in cross-section and within institutions

▶ Estimation – trading

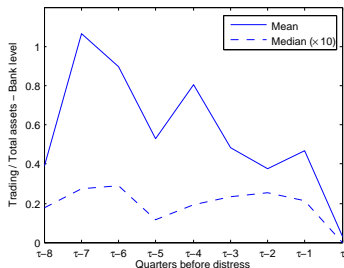
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► Estimation – trading

■ Banks cut derivatives trading before distress



- However, corresponding estimates not statistically significant

Alternative Hypothesis 2: Operational Risk Management?

■ Cross-sectional evidence using maturity gap

- Idea: operational hedging should involve higher maturity gap
- **Significant, positive correlation between maturity gap and net worth** ▸ Estimation – maturity gap
- Poorly capitalized institutions do less operational risk management

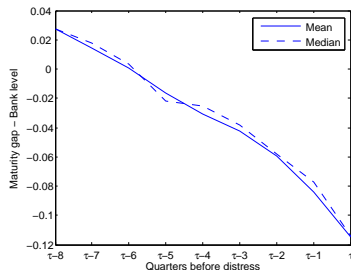
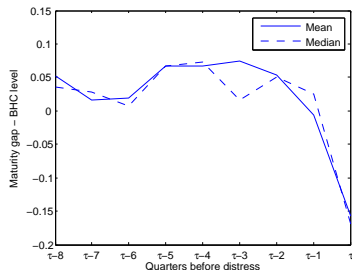
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■ Maturity gap drops before distress

- Institutions engage in less, not more, operational risk management



Alternative Hypothesis 3: Regulatory Capital?

- **Measurement**

- Total regulatory capital / Risk-weighted assets
- Tier 1 regulatory capital / Risk-weighted assets

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■ No significant relation between hedging and regulatory capital

- Most coefficients insignificant and several change signs
- Both *across* (pooled OLS and pooled Tobit) and *within* institutions

▶ Estimation – regulatory capital

▶ Distribution – regulatory capital

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■ Davidson-Mackinnon (1981)'s J -test of model nestedness

- Market net worth, not regulatory capital, explains hedging

Conclusion

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Conclusion

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 - Net worth explains basic patterns in cross section and time series
 - Novel identification strategy allows causal interpretation
- **Financing needs associated with hedging substantial barrier to risk management**
- **No evidence for alternative hypothesis**
 - Risk shifting (from trading)
 - Operational risk management
 - Importance of regulatory capital

Empirical Literature

- Risk exposures and risk management by financial institutions
 - Effect on lending policies
 - Purnanadam (2007), Landier/Sraer/Thesmar (2013)
 - **Begenau/Piazzesi/Schneider (2015)**
 - New methodology to measure interest rate risk
 - Trading positions increase interest rate risk exposures
 - Monetary policy and risk exposures
 - Drechsler/Savov/Schnabl (2016), Di Tella/Kurlat (2016)

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 - Drechsler/Savov/Schnabl (2016), Di Tella/Kurlat (2016)
- Corporate hedging – mostly: single cross-section; user dummies
 - Tufano (1996)
 - Hedging by gold mining firms; focus on executives' incentives
 - **Rampini/Sufi/Viswanathan (2014)**
 - Empirical laboratory: airlines' fuel price risk management
 - Advantage: measurement – fraction expected fuel expenses hedged
 - Panel data at intensive and extensive margin
 - Financial constraints impede risk management

Maturity gap – Descriptive Statistics

	Min.	10th	25th	Mean	Med.	75th	90th	Max.	S.D.
Maturity									
Gap (BHC)	-0.59	-0.09	-0.00	0.09	0.08	0.17	0.28	0.77	0.15
Gap (bank)	-0.63	-0.19	-0.12	-0.02	-0.03	0.06	0.16	0.98	0.15
Duration									
Assets (D_A)	1.27	3.40	4.11	5.52	5.16	6.52	8.15	15.15	2.00
Liabilities (D_L)	0.16	0.58	0.72	0.96	0.90	1.10	1.32	2.11	0.63
Gap (D_{gap})	0.02	2.56	3.30	4.69	4.33	5.69	7.27	14.51	1.97
Equity (D_E)	7.36	23.10	31.82	50.36	44.20	62.10	87.76	151.7	22.23

Net Worth – Descriptive Statistics

■ Market-based measures of net worth – BHC level

	Min.	10th	25th	Mean	Med.	75th	90th	Max.	S.D.	Obs.
Size	13.12	13.35	13.70	14.75	14.38	15.48	16.70	20.48	1.36	22,723
Mkt. cap.	7.63	10.91	11.55	12.67	12.39	13.60	14.86	18.56	1.62	22,723
Mkt. cap./A.	0.00	0.06	0.10	0.14	0.14	0.17	0.20	0.33	0.06	22,723
Net inc./ A.	-0.194	0.001	0.006	0.008	0.010	0.012	0.015	0.103	0.012	20,704
Payout/ A.	-0.000	0.000	0.001	0.001	0.001	0.001	0.002	0.019	0.001	5,813
Div./ A.	-0.001	0	0.000	0.001	0.001	0.001	0.002	0.040	0.001	22,426
Rating	CCC-	BBB-	BBB	BBB+	BBB+	A	A+	AA	2.06	3,579

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Cross-Sectional Regressions – BHC-mean and Pooled OLS

■ Positive relation between hedging and net worth

■ Cross-sectional evidence

Model	Size	Mkt. cap.	Mkt. cap./ Assets	Net income	Net payout	Div.	Rating
BHC-mean OLS	0.034*** (0.000)	0.025*** (0.000)	0.060 (0.313)	0.962*** (0.000)	11.014** (0.024)	15.884*** (0.004)	0.014** (0.033)
Pooled OLS w/ time FE	0.031*** (0.000)	0.023*** (0.000)	0.017 (0.143)	0.344*** (0.000)	8.115*** (0.000)	3.304*** (0.000)	0.013*** (0.000)

Hedging and Net Worth: Cross-Section Evidence

■ Cross-Section – BHC level

Model	Size	Mkt. cap.	Mkt. cap./ Assets	Net income	Div.	Rating	Net worth index
BHC mean Tobit	0.052*** (0.000)	0.040*** (0.000)	-0.059 (0.426)	0.681* (0.098)	17.631*** (0.005)	0.013** (0.010)	0.018*** (0.000)
Tobit w time FE	0.055*** (0.000)	0.043*** (0.000)	0.130*** (0.000)	0.695*** (0.000)	11.958*** (0.000)	0.014*** (0.000)	0.022*** (0.000)
Quantile 75th pctile	0.031*** (0.000)	0.019*** (0.000)	0.112*** (0.000)	0.338*** (0.000)	16.142*** (0.000)	0.016*** (0.000)	0.008*** (0.000)
Quantile 85th pctile	0.049*** (0.000)	0.029*** (0.000)	0.131*** (0.000)	0.599*** (0.000)	22.791*** (0.000)	0.021*** (0.000)	0.014*** (0.000)
Heckman model							0.005*** (0.000)

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Hedging and Net Worth: Time-Series Evidence

■ Within variation – institution fixed effects

Model	Size	Mkt. cap.	Mkt. cap./ Assets	Net income	Div.	Rating	Net worth index
BHC Gross	0.034*** (0.000)	0.006*** (0.000)	-0.009 (0.358)	0.182*** (0.000)	0.661*** (0.003)	-0.001 (0.642)	0.002*** (0.000)
Obs.	22,723	22,723	22,723	20,839	20,568	3,657	20,568
Bank Gross	0.003*** (0.000)			0.052*** (0.000)	0.032*** (0.003)		
Obs.	627,219			581,207	418,225		
Bank Net	0.008*** (0.000)			0.006 (0.773)	0.105* (0.080)		
Obs.	95,650			94,118	78,091		

Hedging and Net Worth: Time-Series Evidence

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Obs.	22,723	22,723	22,723	20,839	20,568	3,657	20,568
Bank Gross	0.003*** (0.000)			0.052*** (0.000)	0.032*** (0.003)		
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Bank Net	0.008*** (0.000)			0.006 (0.773)	0.105* (0.080)		
Obs.	95,650			94,118	78,091		

■ Institutions hedge more when their net worth is higher

◀ Back

Hedging Before Distress

- **Econometric specification**

$$H_{it} = FE_i + FE_t + \sum_{j=0}^8 \gamma_j \cdot D_{\tau-j} + \varepsilon_{it}$$

Hedging Before Distress

■ Econometric specification

$$H_{it} = FE_i + FE_t + \sum_{j=0}^8 \gamma_j \cdot D_{\tau-j} + \varepsilon_{it}$$

■ Regression results

Event time	BHC level	Bank level	
	Gross hedging	Gross hedging	Net hedging
$t - 8$	-0.007	-0.002	-0.003
$t - 7$	-0.011	-0.000	-0.002
$t - 6$	-0.013	-0.006	-0.007
$t - 5$	-0.020**	-0.013**	-0.006
$t - 4$	-0.020**	-0.014**	-0.007
$t - 3$	-0.021**	-0.013*	-0.011*
$t - 2$	-0.020**	-0.012*	-0.010
$t - 1$	-0.026***	-0.018**	-0.019***
t	-0.026***	-0.023***	-0.019***
Obs.	16,056	51,520	8,489
No. distressed	49	636	358
Within- R^2	0.013	0.036	0.011

Variance Decomposition of Net Income

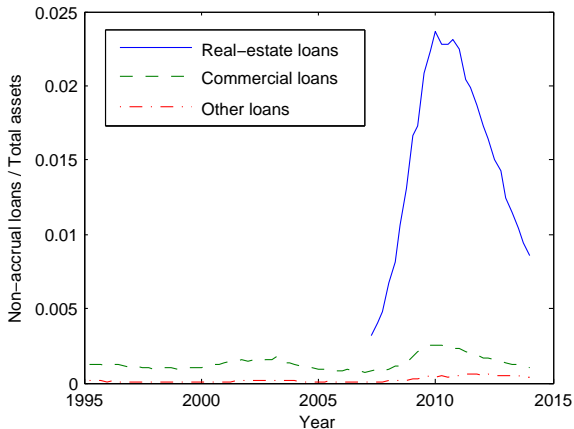
- **Changes in provisions explain changes in net income**

- Changes in net interest income less important

	(1)	(2)	(3)	(4)	(5)
Δ Net interest income	0.736 (37.15)	0.091 (2.09)			0.760 (38.09)
Δ Net noninterest income	0.904 (157.45)		0.967 (123.09)		
Δ Noninterest income					0.807 (62.46)
Δ Noninterest expense					0.918 (154.07)
Δ Provisions	-0.793 (-92.54)			-1.045 (-66.14)	-0.790 (-92.37)
R^2	0.803	0.000	0.605	0.307	0.804

Nonaccrual Loans by Loan Type

- Most nonaccrual loans are loans secured by real estate



Robustness: Gaps in Treatment and Control Group

- DD estimates – dependent variable: maturity/duration gap
 - Treated BHCs increase interest rate exposure in treatment year

	BHC level		Bank level	
	Maturity gap		Maturity gap	Duration gap
2009 and after	-0.025 (0.352)		-0.038 (0.232)	-0.037 (0.920)
2009		-0.087** (0.021)		-0.094*** (0.012)
2010		-0.019 (0.609)		-0.036 (0.303)
2011		-0.021 (0.569)		-0.041 (0.204)
2012		0.008 (0.817)		-0.006 (0.862)
2013		-0.008 (0.815)		-0.014 (0.663)
				0.025 (0.965)
				0.039 (0.946)
				0.034 (0.958)
				0.042 (0.924)

◀ Back

Foreign exchange hedging – Descriptive Statistics

	Mean	Med.	90th	95th	98th	Max.	S.D.	Obs.
Gross hedging – BHC level	0.001	0	0.000	0.003	0.015	0.225	0.011	22,723
Gross hedging – bank level	0.000	0	0	0	0.000	0.693	0.009	627,219

◀ Back

Robustness – Foreign exchange hedging

■ Treated BHCs and banks cut forex hedging significantly

- ... both with and without institution fixed effects

	Post-event dummy	BHC level Year dummies	Year dummies	Post-event dummy	Bank level Year dummies	Year dummies
2009 and after	-0.005*** (0.000)			-0.003*** (0.006)		
2009		-0.001 (0.666)	-0.002 (0.169)		-0.003 (0.382)	-0.003 (0.318)
2010		-0.004** (0.017)	-0.003* (0.099)		-0.003* (0.098)	-0.003* (0.099)
2011		-0.005*** (0.001)	-0.006*** (0.001)		-0.007** (0.024)	-0.006** (0.044)
2012		-0.006*** (0.000)	-0.006*** (0.001)		-0.006** (0.032)	-0.006** (0.029)
2013		-0.006*** (0.000)	-0.007*** (0.000)		-0.006** (0.019)	-0.006** (0.025)
Bank FE	No	No	Yes	No	No	Yes
Time FE	Yes	Yes	Yes	Yes	Yes	Yes

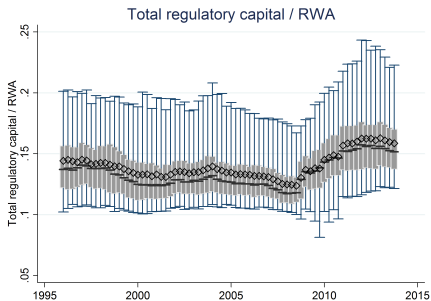
Regression of Hedging on Regulatory Capital

- **No significant relation between hedging and regulatory capital**
 - ... both in cross-section and within institution
 - ... both for Tier 1 and total regulatory capital

	BHC-mean OLS	Pooled OLS	Pooled Tobit	BHC FE
Reg. Cap. / Assets	-0.224	0.260	0.192	0.113
	(0.280)	(0.114)	(0.619)	(0.318)
R^2	0.000	0.008	0.036	0.009
Tier 1 Cap. / Assets	0.193	0.086	-0.337	0.247*
	(0.529)	(0.472)	(0.259)	(0.060)
R^2	-0.000	0.008	0.036	0.009

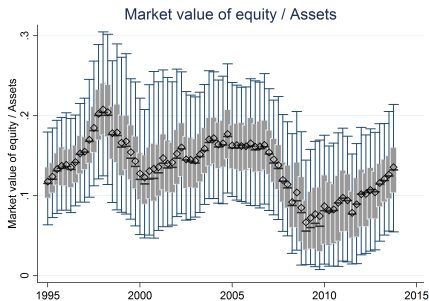
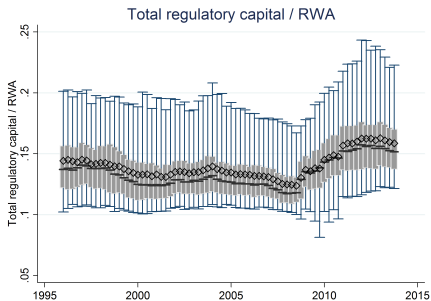
Regulatory Capital During the Financial Crisis

■ Distribution of regulatory capital/risk-weighted assets



Regulatory Capital During the Financial Crisis

■ Distribution of regulatory capital/risk-weighted assets



Regression of Trading on Net Worth

■ Positive and significant relation between trading and net worth

■ ... both in cross-section and time dimension

Model	Size	Mkt. cap.	Mkt. cap./ Assets	Net income	Net payout	Div.	Rating
BHC-mean	0.579***	0.484***	0.600	9.361*	330.525***	374.661***	0.872***
Tobit	(0.000)	(0.000)	(0.509)	(0.089)	(0.001)	(0.000)	(0.000)
R^2	0.267	0.215	0.000	0.001	0.013	0.011	0.036
Tobit with time FE	0.590***	0.511***	3.300***	11.459***	214.900***	164.830***	0.809***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
R^2	0.318	0.279	0.014	0.009	0.029	0.012	0.045
BHC FE	0.082***	0.020***	0.692***	1.172***	20.334**	5.965	0.040
	(0.000)	(0.010)	(0.000)	(0.001)	(0.039)	(0.471)	(0.127)
R^2	0.009	0.042	0.049	0.044	0.089	0.042	0.096

Regression of Maturity Gap on Net Worth

- **Positive correlation between maturity gap and net worth**

- Better capitalized institutions do more operational hedging

Model	Size	Mkt. cap.	Mkt. cap. / Assets	Net income	Net payout	Div.	Rating
Pooled OLS with time FE	0.042*** (0.000)	0.037*** (0.000)	0.626*** (0.000)	1.277*** (0.032)	-0.433 (0.960)	2.449 (0.599)	0.078*** (0.000)
R^2	0.124	0.131	0.061	0.032	0.031	0.034	0.149