Bank Complexity, Governance, and Risk

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Outline

Motivation

- Large and complex banking organizations under scrutiny after the GFC
  - Risk management
  - Systemic risks
  - Difficult to resolve
- Regulatory actions aimed at curtailing complexity (Dodd-Frank Act)
- Important to understand the relationship between complexity, regulatory changes, and risk
  1. Depends on type of complexity [organizational, business, geographic]
  2. Weaker bank governance likely enhances scope for adverse outcomes.

Literature review

- Bank risk:
  - Governance: Gorton and Rosen (1995), DeYoung, Peng, and Yan (2013)
  - Diversification: Buch, Koch and Koetter (2013), Laeven and Levine (2007), Goetz, Laeven, Levine (2016), Barth and Wihlborg (2017)

- Bank complexity:
  - Carmassi and Herring (2016), Cetorelli and Goldberg (2014, 2016), Cetorelli, Jacobides, and Stern (2017), Goldberg and Meehl (2019)
  - Complexity and risk: Freixas, Loranth and Morrison (2007), Luciano and Wihlborg (2014), Berger et al. (2017), Chernobai, Ozdagli, Wang (2018), Laeven and Levine (2007), Cetorelli and Traina (2018)

Outline

Tradeoffs of complexity: Our conjectures

- Positive:
  - Diversified income
  - Synergies across businesses and countries
  - Liquidity risk reduction across affiliated entities
- Negative:
  - Agency problems may lead to "empire building"
  - Complexity may make it more difficult to contain risks
- Balance of outcomes should
  - Vary across organizational, business and geographic complexity
  - Vary by type of risk considered
  - Be more negative for BHCs with weaker governance

Hypothesis 1: Role of regulatory changes

More stringent regulatory frameworks, including recovery and resolution regimes, should lower complexity and risk profiles for BHCs, especially for those with weaker corporate governance.

- The DFA targeted reducing the complexity of BHCs and improving ultimate ease of resolution by requiring Living Wills.
  - Staggered Implementation: Assets above $250 billion (July 2012); Assets above $100 billion (July 2013); Assets between $50 and $100 billion (December 2013)
- Well governed BHCs should reduce complexity and risk by less, and should not lose diversification benefits of complexity.
- Allow for differential level of treatment ($> $750 bil)

Hypothesis 1: Role of regulatory changes

Difference-in-difference analysis using BHCs reporting living wills (2012) as treated. Sample 2009Q2-2018Q2.

$$C^i_{b,t} = \alpha + \beta \cdot LW_t + \theta \cdot G_{b,2009} + \phi \cdot (LW_t \cdot G_{b,2009}) + \gamma \cdot X_t + \psi \cdot Z_{b,t-1} + \epsilon_{b,t} \quad (1)$$

$$Y^i_{b,t} = \alpha + \beta \cdot LW_t + \theta \cdot G_{b,2009} + \phi \cdot (LW_t \cdot G_{b,2009}) + \gamma \cdot X_t + \psi \cdot Z_{b,t-1} + \epsilon_{b,t} \quad (2)$$

$C_b \equiv$ complexity, $G_b \equiv$ governance in 2009, $Y_b \equiv$ risk or diversification, $LW_t \equiv$ Post Living Wills, $X \equiv$ macro controls, $Z_b \equiv$ bank controls
Allow for differential level of treatment ($>$ \$750 bil)

Hypothesis 2: Longer run average relationship between complexity, risk and governance

2a: BHC complexity reduces the risk profile of banks if it is accompanied by an increase in the diversification of banks' income streams.

2b: Higher BHC complexity should reduce risks more for BHCs with stronger corporate governance

Estimate equations separately, and as a system using IV approach which recognizes the co-determination of BHC risk and complexity choices:

$$Y_{b,t} = \alpha^1 + \theta^1 \cdot C_{b,t-1} + \beta^1 \cdot G_{b,t-1} + \gamma^1 \cdot X_t + \psi^1 \cdot Z_{b,t-1} + \delta_b + \epsilon_{b,t} \quad (3)$$

$$C^i_{b,t} = \alpha^2 + \theta^2 \cdot Y_{b,t-1} + \beta^2 \cdot G_{b,t-1} + \gamma^2 \cdot X_t + \psi^2 \cdot Z_{b,t-1} + \kappa_b + \omega_{b,t} \quad (4)$$

$C_b \equiv$ complexity, $G_b \equiv$ governance, $Y_b \equiv$ risk or diversification,
$X \equiv$ macro controls, $Z_b \equiv$ bank controls
Sample 1996Q1-2018Q2

Outline

US large BHCs

- Sample of US Bank Holding Companies (BHC)
  - File reports Y-6 describing the BHC structure
  - Publicly traded, determined by mapping Compustat CRSP codes and RSSD ID
  - Above $25 billion in 2012 assets
- Sample period 1996Q1-2018Q4
- BHCs per quarter: min 23, max 49

BHC Complexity Concepts

Entities within BHCs: NIC reporting as in Cetorelli and Stern (2015)
Complexity measures: Goldberg and Meehl(2019), Cetorelli and Goldberg(2014) ▸ Complexity table
Organizational Complexity: *Log affiliate count*
Business Complexity: Business Scope

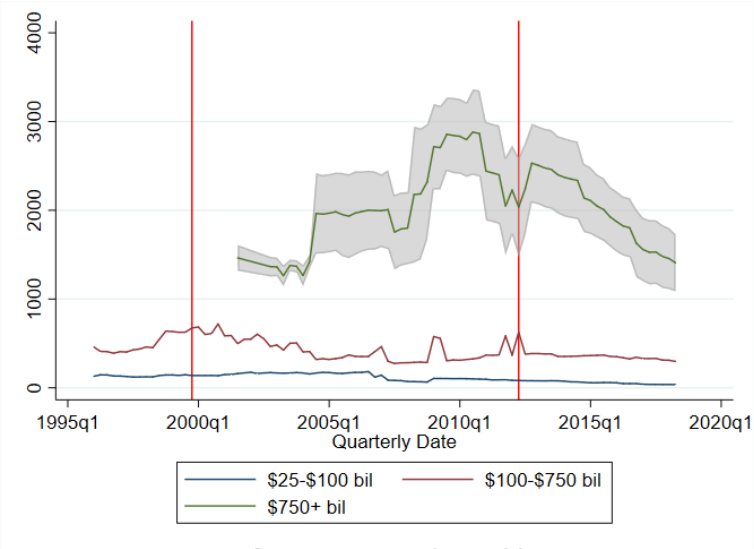
- *First principle component from: Non-financial Count Share, CountB, BHHI, CountN*

Geographical Complexity: Geographic Scope

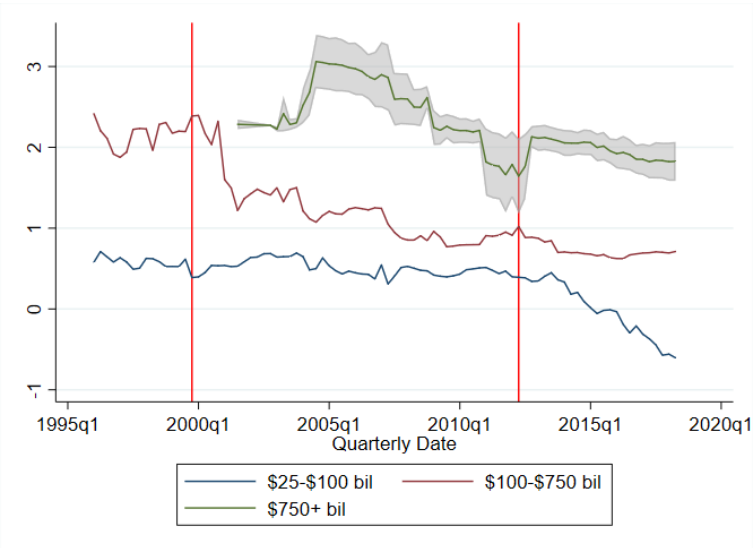
- *First principle component from: CountC, CHHI, Share of Foreign Office claims in total assets, CountNDT*

▸ PCA table

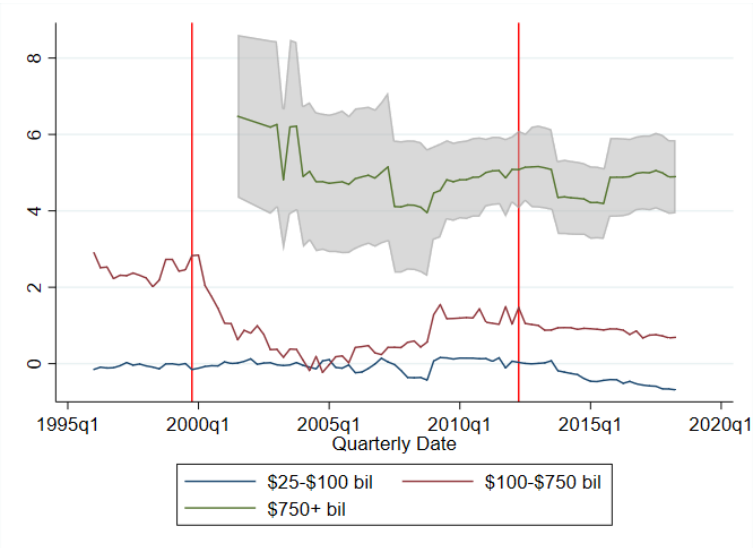
BHC complexity



Total Count of Affiliates



BPC1: Business Scope

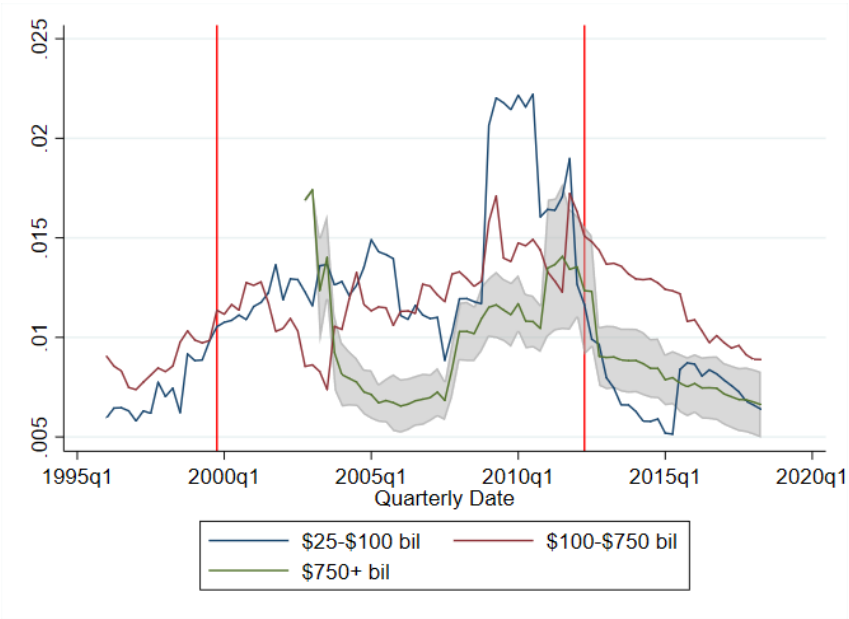


GPC1: Geographic Scope

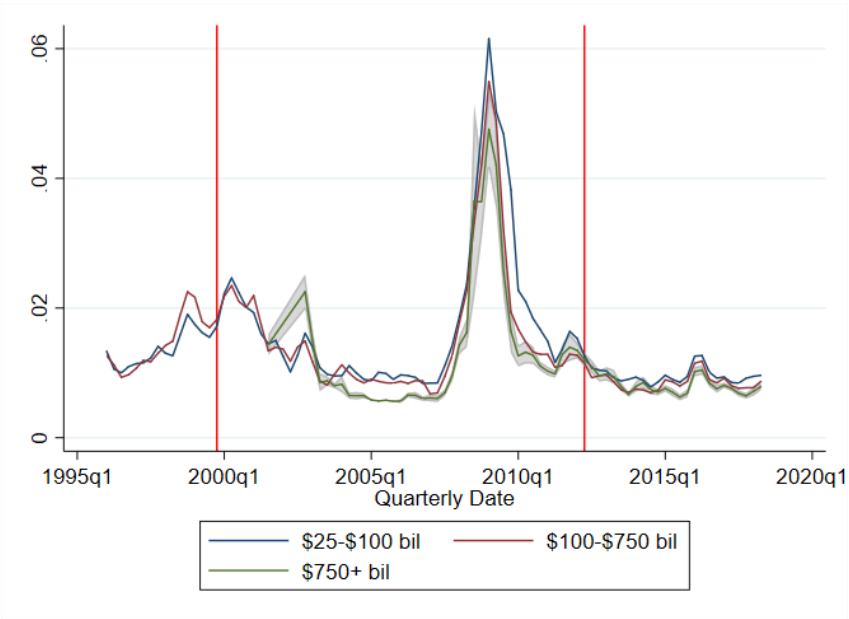
BHC Diversification and Risk Concepts

- Diversification:
  - Std. dev. of ROA, Std. dev. of idiosyncratic returns
- Idiosyncratic risk [enter with negative sign]:
  - Log z-score (balance sheet) $= \frac{Avg.ROA + Avg.(Equity/Assets)}{Std.ROA}$
  - Log of market z-score $= \frac{EquityReturns+1}{SDofStockReturns}$
- Systematic risk: Dynamic Beta
  - GARCH MA(1) process of returns of firm vs returns of market (Engle, 2014)
- Liquidity risk: LIBOR-OIS Beta
  - Regression of returns of firm vs LIBOR-OIS spread
- Systemic risk: SRISK
  - Expected Capital Shortfall given Crisis Period (Acharya et. al., 2012)

BHC Diversification Measures



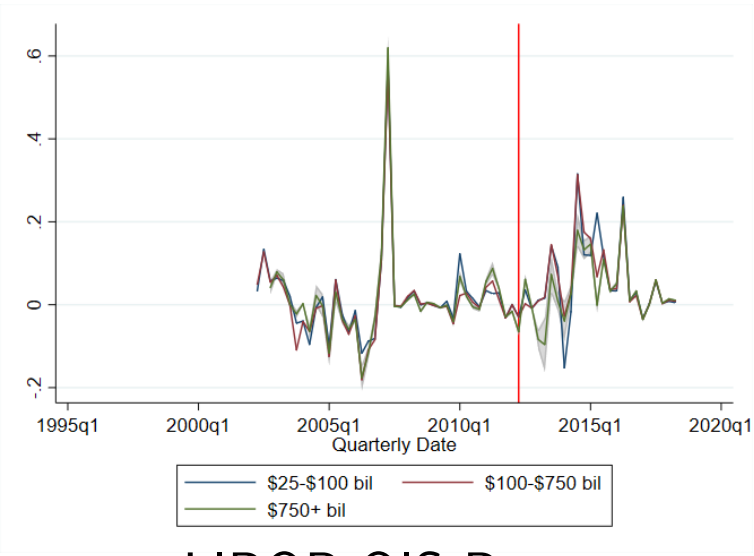
SD RoA (12 qtrs)



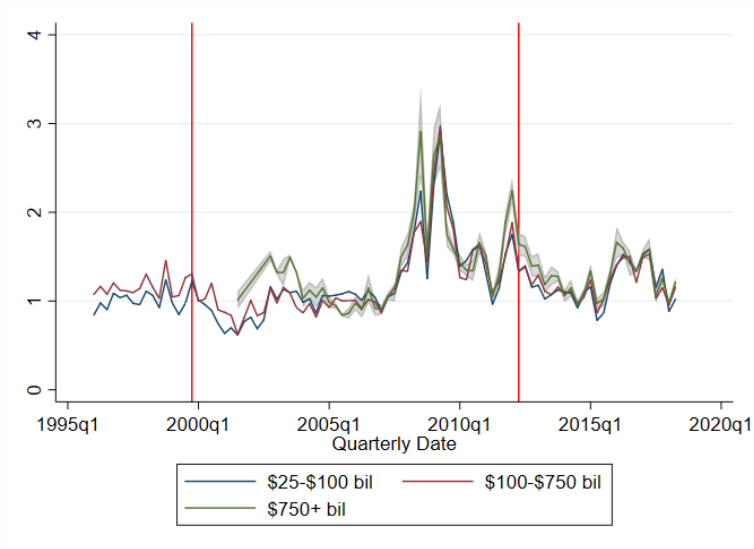
SD Idiosyncratic Returns

SD lower, BHC diversification higher, for largest US BHCs

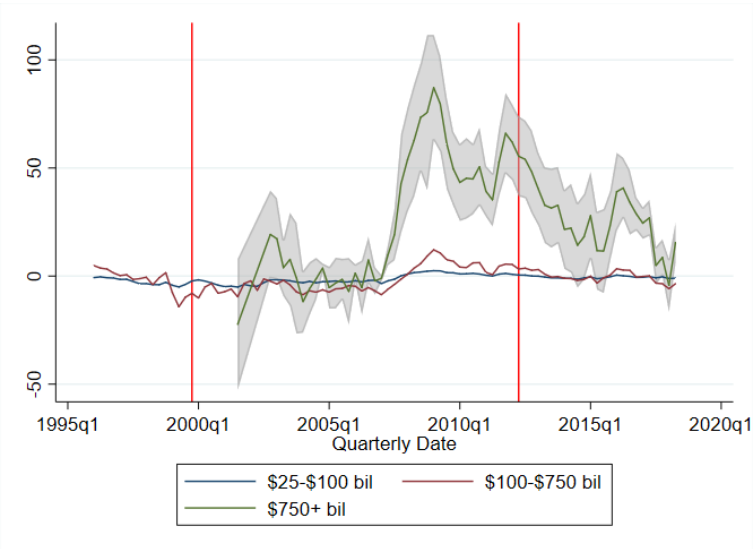
BHC Risk Measures



LIBOR-OIS Beta

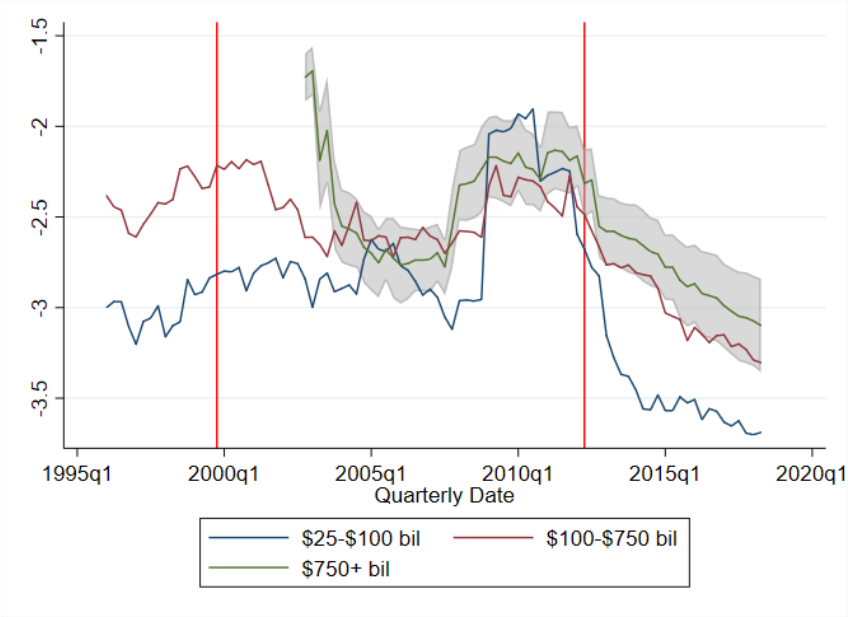


Dynamic Beta

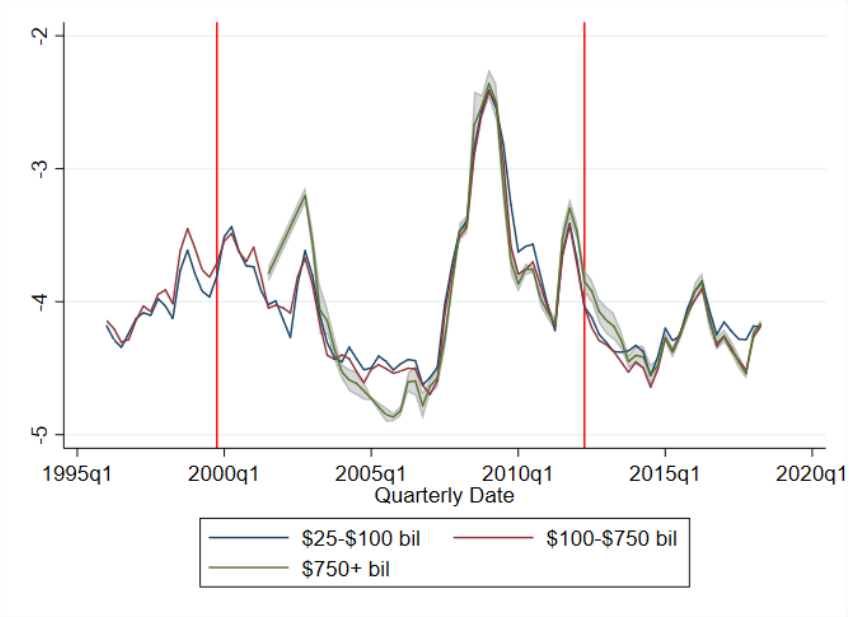


SRISK

BHC Risk Measures

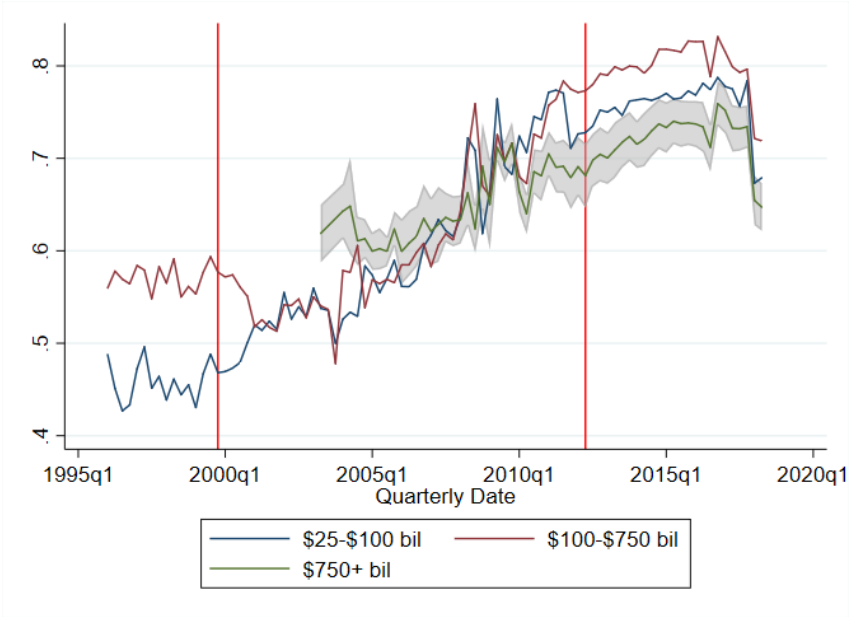


-Log Z-score

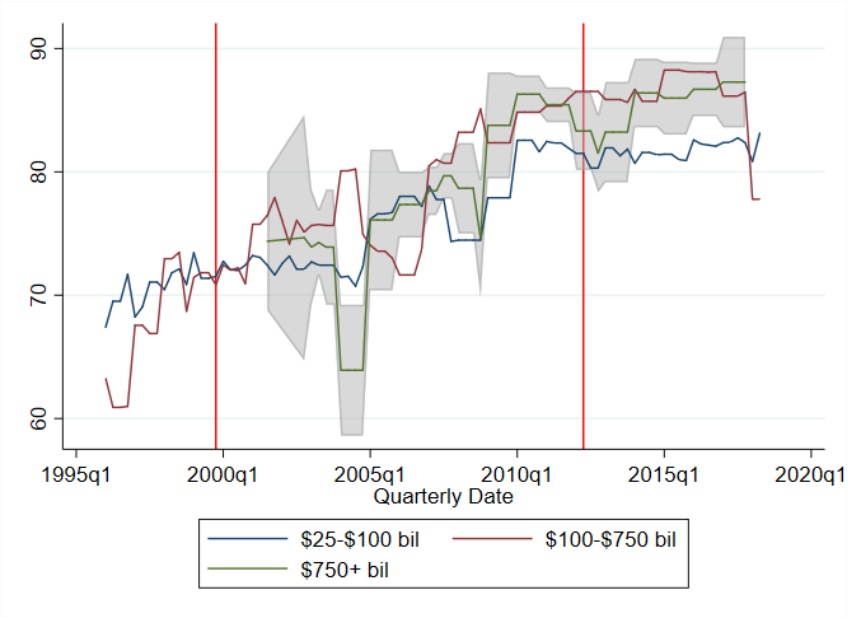


-Log Market Z-score

BHC Governance Measures



Institutional Ownership
(Share of stocks owned by institutional investors)



Percent Independent Directors *

Data Source: Capital IQ, Refinitiv, ExecuComp

Outline

Hypothesis 1: Changes in complexity after introduction of living wills, with role of governance

Treated Group Effects

	Org. Complexity			Bus. Scope			Geo. Scope		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Post LW	-0.16***	-0.11*	-0.72	-0.12	-0.09	-0.67	-0.08	-0.10	0.23
Post LW X 750+ bil_{2009}		-0.24**	-0.22*		-0.12	-0.11		0.09	0.07
Post LW X Inst. $ownership_{2009}$			-0.05			-0.06			0.44
Post LW X Perc. Ind. $Directors_{2009}$			0.01			0.01			-0.02
N	1183	1183	1183	1183	1183	1183	1183	1183	1183
Adj. within-R2	0.27	0.30	0.30	0.05	0.06	0.06	0.24	0.24	0.25
Bank FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Banks	47	47	47	47	47	47	47	47	47

Living Will Regulation most impactful for organizational complexity, with largest declines in the largest BHCs. Effects not differentiated by BHC governance.

Hypothesis 1: Changes in diversification after introduction of living wills, with role of governance

Treated Group Effects

	SD of ROA			SD of Idiosyncratic returns		
	(1)	(2)	(3)	(4)	(5)	(6)
Post LW	-0.004***	-0.004***	-0.017	0.001	-0.000	0.006
Post LW X 750+ bil_{2009}		0.002	0.002		0.004**	0.004**
Post LW X Inst. $ownership_{2009}$			0.014			0.007
Post LW X Perc. Ind. $Directors_{2009}$			0.000			-0.000
N	1120	1120	1120	1143	1143	1143
Adj. within-R2	0.24	0.25	0.26	0.62	0.63	0.63
Bank FE	Yes	Yes	Yes	Yes	Yes	Yes
Banks	48	48	48	48	48	48

Post LW reduction in treated BHC return variation, interpreted as improved diversification.

Hypothesis 1: Changes in idiosyncratic risk after introduction of living wills, with role of governance

Treated Group Effects

	z-score			Market z-score		
	(1)	(2)	(3)	(4)	(5)	(6)
Post LW	-0.487***	-0.507***	-1.808	-0.046**	-0.055***	0.219
Post LW X 750+ bil_{2009}		0.110	0.133		0.044	0.030
Post LW X Inst. $ownership_{2009}$			0.003			0.198
Post LW X Perc. Ind. $Directors_{2009}$			0.016			-0.005**
N	1120	1120	1120	1143	1143	1143
Adj. within-R2	0.39	0.39	0.39	0.82	0.82	0.82
Bank FE	Yes	Yes	Yes	Yes	Yes	Yes
Banks	48	48	48	48	48	48

Treated group had larger declines in idiosyncratic risks, similar for the very largest BHCs with even greater organizational complexity declines. Possibly concentrated in better governed BHCs.

Hypothesis 1: Changes in liquidity, systematic, and systemic risk after introduction of living wills, with role of governance

Treated Group Effects

	Dynamic Beta			SRISK			LIBOR-OIS Beta		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Post LW	0.02	-0.00	0.29	-4.40**	0.35	9.61	0.05***	0.06***	0.08
Post LW X 750+ bil_{2009}		0.11	0.09		-21***	-21***		-0.03*	-0.02
Post LW X Inst. $ownership_{2009}$			0.23			-5.93			-0.12**
Post LW X Perc. Ind. $Directors_{2009}$			-0.01			-0.07			0.00
N	1082	1082	1082	1082	1082	1082	1143	1143	1143
Adj. within-R2	0.55	0.55	0.55	0.24	0.35	0.35	0.10	0.10	0.10
Bank FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Banks	44	44	44	44	44	44	48	48	48

While treated group registered more organizational complexity declines and more of a reduction in idiosyncratic risk, some relative increases in liquidity risk. (effect moderated in largest and better governed BHCs)

Hypotheses 1: Takeaways

- The introduction of living wills, a regulatory tightening, significantly reduced on the organizational complexity of treated BHCs relative to other large BHCs, consistent with Hypothesis 1a.
- BHCs governance was not important for the relative scale of changes in organizational complexity, rejecting Hypothesis 1b.

Hypothesis 1 - Relation between complexity, regulations, and risk

- Balance sheet income diversification improved after the introduction of living wills, which contributed to a reduction of idiosyncratic risk.
- Systemic risk decreased more for living will reporters.
- Liquidity risk exposures were relatively higher (or declined by less) for the treated group, relative to other large BHCs.
- Treated BHCs with stronger governance tended to have more reductions in risks, but these are not robust across governance or risk metrics, rejecting part of Hypothesis 1.

Hypothesis 2 - Long run average relation between complexity, diversification, risk, and governance

- Estimate each individual equations using each of the alternative complexity and risk measures.
- Estimate systems of equations using ivreg.
  - Complexity is instrumented by using the log of real assets, an indicator variable for the regulatory regime, and the average complexity of competitors in the same size category.
  - Diversification and risk measures are instrumented by using the market to book ratio and NPL ratio for each bank and the VIX.

$$Y_{b,t} = \alpha^1 + \theta^1 \cdot C_{b,t-1} + \beta^1 \cdot G_{b,t-1} + \gamma^1 \cdot X_t + \psi^1 \cdot Z_{b,t-1} + \delta_b + \epsilon_{b,t}$$

$$C^i_{b,t} = \alpha^2 + \theta^2 \cdot Y_{b,t-1} + \beta^2 \cdot G_{b,t-1} + \gamma^2 \cdot X_t + \psi^2 \cdot Z_{b,t-1} + \kappa_b + \omega_{b,t}$$

Long run relation between Complexity and Diversification, controlling for governance and size

	Single Equation Estimates			**IV System Estimates**		
Diversification as Dependent Variable	Org.	Bus. Scope	Geo. Scope	Org.	Bus. Scope	Geo. Scope
SD ROA	+	−	−**	−**	−	−***
SD Idiosyncratic Returns	−***	−**	+	−	+	−
Complexity as Dependent Variable	Org.	Bus Scope	Geo. Scope	Org.	Bus Scope	Geo. Scope
SD ROA	+	+	−	+	−	+*
SD Idiosyncratic Returns	−**	−**	−	−	−**	+

More organizational and geographic complexity tend to reduce the variance of returns, improve diversification.

Economic Significance: Complexity and Diversification

- Impact of one standard deviation change in organizational complexity (670 legal entities) on:
  - SD ROA: -0.014 (equivalent to -1.4 x std. dev. of SD ROA)
- Impact of one standard deviation change in geographic complexity (2.2) on:
  - SD ROA: -0.013 (equivalent to -1.3 x std. dev. of SD ROA)
- Effect of income diversification on complexity small, only significant for std. dev. of idiosyncratic returns

Long run relation between complexity and risk, controlling for governance and size

	Single Equation Estimates			**IV System Estimates**		
Risk as Dependent Variable	Org.	Bus. Scope	Geo. Scope	Org.	Bus. Scope	Geo. Scope
Z-score[-1]	+	+	−	−**	+	−***
Market Z-score[-1]	−***	−***	+	−	−*	+
LIBOR-OIS Beta	+*	+	+*	+	+	+**
Dynamic Beta	+	−	+***	+**	−	+***
SRISK	+**	+	+**			
Complexity as Dependent Variable	Org.	Bus Scope	Geo. Scope	Org.	Bus Scope	Geo. Scope
Z-score	−	−	+	+	−	+**
Market Z-score	+***	+**	−	−	−**	+
LIBOR-OIS Beta	+***	+	+	+***	−	+***
Dynamic Beta	+	−	+***	+*	−	+***
SRISK	+***	+	+**			

Economic Significance: Complexity and Risk

- Impact of one standard deviation change in organizational complexity (670 legal entities) on:
  - z-score[-1]: -1.37 (equivalent to -1.63 x std. dev. of the z-score[-1])
  - Dynamic beta: 0.6 (equivalent to -1.4 x std. dev. of the dynamic beta)
- Impact of one standard deviation change in geographic complexity (2.2) on:
  - z-score[-1]: -1.27 (equivalent to -1.52 x std. dev. of the z-score)
  - Dynamic beta: 0.8 (equivalent to -1.9 x std. dev. of the dynamic beta)
  - Liquidity risk: 0.09 (equivalent to -0.81 x std. dev. of the liquidity risk measure)
- Effect of risk on complexity most significant for liquidity risk, systematic risk and systemic risks. Consequences are for higher organizational complexity and geographic scope. Economic size of this adverse reinforcement is small (a one std. dev. change in liquidity risk exposure changes geographic complexity by of 0.2 std. dev.)

Hypothesis 2 - Takeaways

- Organizational complexity and geographic scope are associated with income diversification and lower idiosyncratic risks.
- But organizational complexity and geographic scope tend to raise liquidity risk exposures of BHCs, systematic risks, and systemic risk contributions.
- More organizationally complex and geographically dispersed BHCs are associated with larger systematic and liquidity risk exposures, making them vulnerable to correlated events. Effects are not fully mitigated by better governance in US BHCs.

Outline

Conclusions

- Living wills reduced treated BHCs organizational complexity: business scope and geographic scope were less impacted.
- Living wills generated a relative increase in income diversification, a reduction in both idiosyncratic risks and systemic risk, and a relative increase in liquidity risk.
- Governance plays a less important role.
- Organization complexity and geographic scope tend to reduce idiosyncratic risk while increasing exposures to liquidity risk and market risk, and enhancing systemic risk contributions.
- Complexity entails tradeoffs across types of risks. Spillbacks of risks on complexity tend to be smaller in economic importance.

Thank You

Complexity Variables

Variable	Definition
Organizational	
$Count_{b,t}$	Total Count of subsidiaries held by BHC
Business	
$BPC1_{b,t}$	Business scope; 1st principle component over variables below
Non-fin Count $Share_{b,t}$	Share of non-financial affiliates
$CountB_{b,t}$	Total count of business types (commercial banks, mutual/pension funds, insurance, other financial, non-fin management firms, other nonfinancial)
$CountBHHI_{b,t}$	$\frac{CountB}{CountB-1}\left(1-\sum_{j=1}^{B}\left(\frac{count_j}{\sum_{j=1}^{B} count_j}\right)^2\right)$ where B are business types and $count_j$ is the number of BHC's subsidiares that are classified in accordance with each business type j.
$CountN_{b,t}$	Number of 4-digit NAICS industries
Geographic	
$GPC1_{b,t}$	Geographic scope; 1st principle component over variables below
$CountC_{b,t}$	Count of countries spanned by BHC's affiliates
$CountCHHI_{b,t}$	$CountCHHI = \frac{CountC}{CountC-1}\left(1-\sum_{c=1}^{C}\left(\frac{count_c}{\sum_{c=1}^{C} count_c}\right)^2\right)$ where C is the set of countries and $count_c$ is the count of subsidiaries in each country c.
Share of foreign office $claims_{b,t}$	Share of foreign office claims in total assets, by bank
$CountNDT_{b,t}$	Count Net Due to Positions, countries, by bank

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PCA Results

	Comp1	Comp2
Business Complexity (BPC)		
Non-Financial Count Share	0.45	-0.16
CountB	0.60	0.28
HHI Business Types	-0.17	0.94
CountN	0.64	0.10
% Variation Explained	0.44	0.25
Geographic Complexity (GPC)		
CountC	0.53	-0.23
CountCHHI	0.45	0.81
Share of foreign office claims in total assets	0.51	0.07
Count NDT	0.51	-0.54
% Variation Explained	0.79	0.13

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Summary Statistics

	mean	sd	min	p25	p50	p75	max	count
BHC Sample								
Assets ($2012 billions)	258.283	457.92	23.014	48.366	90.709	202.368	2541.892	3659
Loans to Assets Ratio	0.582	0.19	0.022	0.519	0.648	0.706	0.870	3658
Deposits to assets ratio	0.625	0.18	0.000	0.576	0.664	0.735	0.935	3538
Liquid assets ratio	0.256	0.15	0.002	0.155	0.215	0.308	0.824	3652
Equity to assets ratio	0.092	0.03	0.030	0.074	0.088	0.108	0.217	3659
Number of BHCs	32.917	5.55	23.000	29.000	32.000	34.000	49.000	3659
BHC Complexity								
Total affiliate count	382.352	672.69	4.000	58.000	115.000	388.000	4494.000	3601
Non-Financial Count Share	0.452	0.18	0.053	0.322	0.418	0.547	0.973	3601
CountB	5.216	0.55	3.000	5.000	5.000	6.000	6.000	3601
HHI Business Types	0.745	0.16	0.076	0.678	0.785	0.852	1.000	3601
CountN	17.192	8.16	4.000	12.000	14.000	20.000	53.000	3601
CountC	14.775	18.10	1.000	2.000	6.000	22.000	87.000	3601
HHI Countries	0.311	0.29	0.000	0.038	0.214	0.596	0.935	3601
Share of foreign office claims in total assets	0.080	0.12	0.000	0.001	0.014	0.125	0.518	3659
Count Net due to positions	11.657	18.07	1.000	1.000	3.000	16.000	100.000	3659
Business Scope	0.810	1.14	-2.041	-0.053	0.651	1.609	4.395	3601
Geographic Scope	0.798	2.17	-1.050	-0.837	-0.129	2.220	9.034	3601
BHC Diversification								
SD. RoA (12 qtr)	0.010	0.01	0.000	0.004	0.007	0.011	0.078	3467
Idiosyncratic Returns	0.014	0.01	0.004	0.009	0.011	0.016	0.159	3564
BHC Risk								
-Log Z-Score (12 qtr)	-2.811	0.84	-5.885	-3.372	-2.770	-2.216	-0.565	3467
-Market Z-score	-4.043	0.47	-5.141	-4.358	-4.118	-3.796	-1.791	3565
Beta	1.160	0.43	0.173	0.903	1.087	1.336	4.381	3111
SRISK	1.794	16.44	-68.088	-2.340	-0.158	1.898	142.643	3111
LIBOR-OIS Beta	-0.030	0.11	-0.873	-0.054	-0.009	0.015	0.402	2151
BHC Governance								
Total Inst. Ownership, Pct. Shares Outstanding	0.635	0.17	0.002	0.517	0.632	0.764	1.935	2960
Share of independent directors	78.207	11.83	28.571	71.429	80.000	87.500	100.000	2619
Macro Controls								
VIX	19.35	7.24	10.31	13.72	17.40	23.17	58.59	114
Credit to GDP Gap (BIS)	-0.50	8.41	-16.10	-6.90	1.45	7.20	12.20	134
Annualized real GDP Growth	2.66	2.32	-8.40	1.50	2.95	4.00	7.50	134

Governance Patterns Across BHCs, by size

	Institutional Ownership		Independent Percent	
Asset Bin	High	Low	High	Low
25-100 bil	4	9	3	10
100-750 bil	5	7	6	6
750+ bil	0	5	0	5