Financial Innovation and Risk: Evidence from Operational Losses at U.S. Banking Organizations

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Introduction & Motivation

- Technological advancements in finance are transforming the banking industry.
- There are currently competing narratives about the "bright" (efficiency, growth) and "dark" (risk, instability) sides of innovation.
  - Early literature views financial innovation as a driver of growth and efficiency (Miller, 1986; Merton, 1992).
  - The Global Financial Crisis (GFC), however, led to a reevaluation of its social value.
- This study addresses a gap in our understanding about the firm-level benefits and risks of engaging in financial innovation. We focus on operational risk.

Why Focus on Operational Risk?

- **Nature of Financial Innovation:**
  - The most prominent types of patented innovations (e.g., payments and back-office technologies) are directly tied to processes, systems, and operations.
  - Financial innovation appears more relevant for operational risk compared to "traditional" credit or market risks.
- **Significance in Banking:**
  - Operational risk is a critical issue for banking organizations due to its potential for massive losses and the significant attention it has received from banking regulators (e.g., Curti et al., 2022; Afonso et al., 2019).
- **Challenges for Stability:**
  - Due to the heavy-tailed nature of operational losses, financial innovation poses unique challenges for bank capital management and even financial stability (Berger et al., 2022).

A Priori Unclear Relation

The relation between financial innovation and operational risk at banking organizations is a priori unclear. Potential channels include:

Benign:

- Automation of processes
- Monitoring capabilities
- Improved data analytics and risk modeling
- Digital platforms for risk communication
- Improved technical infrastructure

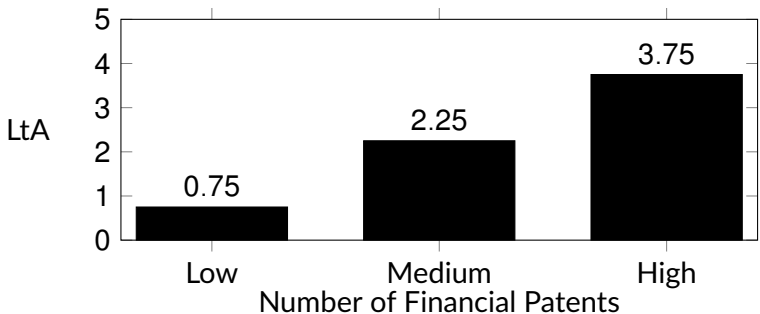
Adverse:

- Implementation challenges
- Cybersecurity threats due to adoption of digital technologies
- Regulatory uncertainty and compliance risks
- Rapid pace of change and skills gaps
- Increased complexity

Preview of Results: Main Finding

- Financial innovation, measured via financial patents, is associated with higher operational losses at U.S. Bank Holding Companies (BHCs).
- One std. dev. increase in our patent-based measure of innovation is associated with a 45.5% increase in operational losses relative to mean.

Figure: Operational Losses (Scaled by Assets) by Innovation Groups



Preview of Results: Additional Findings

- Banks with more financial innovation experience greater frequency of severe tail risk events.
- Institutions with weaker risk management suffer disproportionately more from innovation-induced operational losses.
- The positive relation between financial innovation and op losses is "short-lived". Longer lags of financial innovation patents are not significantly related to op losses.
- While financial innovation is associated with increased market share for banking organizations, financial innovation is not significantly related to their franchise value.

Related Literature

- **(Benefits and Risks of) Financial Innovation:**
  - Early literature emphasizing financial innovation's positive role in economic efficiency and growth (e.g., Miller 1986, 1992; Merton 1992, 1995; Tufano 1995, 2003).
  - Following the GFC, new theories related to security design explaining the creation and collapse of mortgage securities and their derivatives (e.g., Gennaioli et al., 2012; Thakor, 2012; Fostel and Geanakoplos, 2012).
  - Recent empirical research on value, risks and trends in financial innovation (Beck et al. 2016; Chen et al. 2019; Lerner et al. 2023).
- **(Determinants of) Operational Risk at Financial Institutions:**
  - Literature focusing on operational risk in the banking industry due to external factors and internal failures (e.g., Chernobai et al. 2012, 2021; Abdymomunov and Mihov 2019; Abdymomunov et al. 2020; Curti et al. 2022, 2023).
- **This Study:**
  - Bridges the two literatures by exploring the nexus between financial innovation — specifically defined as new financial technologies and business methods in financial services — and operational losses at banking organizations.

Policy Relevance

- In the policy sphere, we add to the ongoing efforts by financial regulators to assess the risks and benefits created by the increasing use of innovative technologies by financial institutions (Board of Governors of the Federal Reserve System, 2022).
  - Our findings confirm that financial innovation should be considered in operational risk assessments because it is significantly related to BHC risk outcomes.
  - Results align with regulators' emphasis on responsible innovation paired with appropriate risk management processes.
  - Findings can inform ongoing efforts to update supervisory training programs and equip examiners to assess risks posed by financial innovations.

Data and Sample

- Supervisory data from FR Y-14Q forms on operational losses of large financial institutions that participate in Dodd-Frank Act Stress Tests.
  - 434,714 individual loss events totalling $298 billion, with information on loss amounts, dates, and classifications.
  - Discard losses below $20,000 due to different loss collection thresholds across BHCs.
- Financial patent data from Lerner et al. (2023).
  - 2,142 patents issued to BHCs in our sample (or 54% of the patents assigned to all banking and financial services firms).
  - Information on application and grant dates, and patent types among other information.
- Financial statement data from FR Y-9C and stock market data from CRSP.

Data and Sample (Cont.)

- Final sample covers 29 large publicly traded U.S. Bank Holding Companies (BHCs) from 2000 to 2018.
  - The 29 BHCs account for 74.5% of U.S. banking industry assets as of year-end 2018.
- All data is aggregated to the BHC-quarter level, using the quarters of operational loss occurrence and patent application.
  - Unbalanced panel of 1,374 BHC-quarter observations.

Operational Loss Measures

- **LtA**: Operational losses that occur at a BHC during a quarter as a proportion of the BHC's total assets (multiplied by 10,000).
- **Loss**: Operational losses that occur at a BHC during a quarter in $ millions.

Operational loss distributions have heavy tails. Few catastrophic risk events account for a large proportion of total dollar losses.

- **N Tail (90, 95, 99)**: The frequency of total assets-scaled tail operational losses at the 90^{th}, 95^{th} or 99^{th} percentiles, respectively, that occur at a BHC during a quarter.

Financial Innovation Measure

- **N Patents**: The quarterly number of successful financial patent applications by a BHC, averaged over quarters [t-3,t].
  - Lerner et al. (2023) contend that patents are a reasonable measure of financial innovation (e.g., patentability of business methods on an equal footing with traditional technologies; major finance innovations are patented).
  - On the other hand, most non-patent metrics of innovative activity in financial services are problematic. For instance, R&D reporting for financial firms is likely distorted due to tax rule ambiguity (National Research Council, 2005).

Descriptive Statistics of Major Variables

	Mean	SD	P10	P50	P90	N
Loss ($M)	235.22	1375.31	2.14	18.61	372.56	1,374
LtA	3.14	9.55	0.26	1.01	5.71	1,374
N Evts Tail 90	25.05	21.47	9.00	20.00	46.00	1,374
N Evts Tail 95	12.67	10.73	4.00	10.00	23.00	1,374
N Evts Tail 99	2.55	2.73	0.00	2.00	6.00	1,374
N Patents	1.24	3.18	0.00	0.00	3.75	1,374

- On average, BHCs lose $235 million (0.03% of total assets) each quarter to operational risk. Standard deviations indicate substantial time-series and cross-sectional variation.
- On average, BHCs (successfully) apply for 1.2 patents per quarter, although they certainly do not do so every quarter.

Empirical Specification

OLS regression with standard errors clustered at the BHC and quarter levels:

$$LtA_{i,t} = \beta_t + \beta_1 Ln(N\ Patents)_{i,t-1} + \beta_2 Controls_{i,t-1} + \epsilon_{i,t}$$

where:

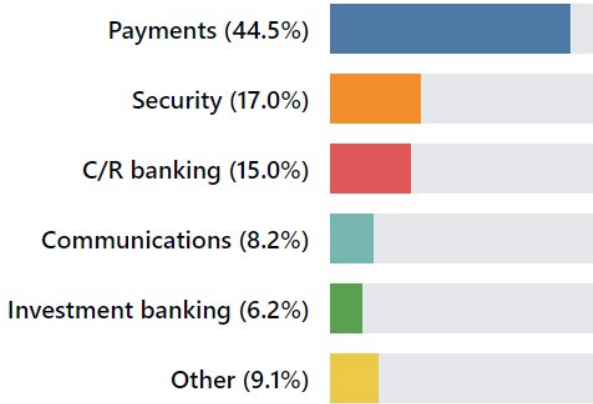
- *LtA*: Operational losses that occur at a BHC during a quarter as a proportion of the BHC's total assets ($\times$10,000).
- β_t denotes quarter fixed effects
  - Robust to including BHC fixed effects
- *Controls* include: *Ln(Assets)*, *II-to-NII*, *Deposits-to-Assets*, *Loans-to-Assets*, *ROE*, *Leverage*, *Maturity Gap*, *Loan Losses*

Operational Loss and Financial Innovation

	(1) LtA	(2) Ln(Loss)	(3) N Evts	(4) Ln(Avg Sev)
Ln(N Patents)	1.985***	0.323**	0.268***	0.089
	(0.001)	(0.012)	(0.000)	(0.145)
Controls	Yes	Yes	Yes	Yes
Observations	1,374	1,374	1,374	1,374
Adjusted R^2	0.146	0.712		0.282

- Based on Column (1), a one standard deviation increase in *Ln(N Patents)* is associated with a $142,920 increase in quarterly operational losses per $1 billion of BHC assets, which is a 45.5% increase in *LtA* relative to its mean.
- Instrumental variable regressions, using the proportion of "high science, engineering, and technology" (HSET) businesses in neighboring states, confirm this result.

Patent Types



Financial patents can be classified according to their specific functions in financial services (Lerner et al. 2023).

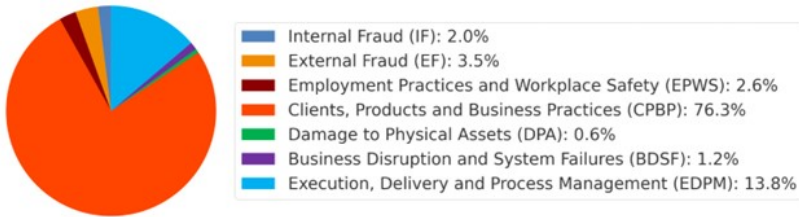
Patent Types

	(1) LtA	(2) LtA	(3) LtA	(4) LtA	(5) LtA	(6) LtA
Ln(N Payments Patents)	2.780***					
Ln(N Security Patents)		3.764**				
Ln(N Communications Patents)			1.629			
Ln(N C&R Banking Patents)				4.159***		
Ln(N Investment Banking Patents)					2.944	
Ln(N Other Patents)						5.015**
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1,374	1,374	1,374	1,374	1,374	1,374
Adjusted R^2	0.147	0.144	0.136	0.144	0.137	0.143

While the coefficient estimates are positive across all columns, patents in communications and investment banking are not significantly related to operational losses.

Operational Loss Types

Operational risk is an amalgamation of various types of sub-component risks:



Operational Loss Types

	(1) LtA (IF)	(2) LtA (EF)	(3) LtA (EPWS)	(4) LtA (CPBP)	(5) LtA (DPA)	(6) LtA (BDSF)	(7) LtA (EDPM)
Ln(N Patents)	-0.086	0.186*	0.016	1.649***	-0.005	0.012	0.213
	(0.159)	(0.058)	(0.255)	(0.010)	(0.795)	(0.787)	(0.127)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1,374	1,374	1,374	1,374	1,374	1,374	1,374
Adjusted R^2	0.048	0.203	0.163	0.142	0.196	0.059	0.088

More innovation at banking organizations increases the institutions' losses from external fraud (e.g., cyber losses) and failures to meet obligations to clients, faulty products, and improper practices (e.g., regulatory, compliance and other legal losses).

Tail Operational Losses

As previously mentioned, operational loss distributions have heavy tails...

	(1) N Evts Tail 90	(2) N Evts Tail 95	(3) N Evts Tail 99
Ln(N Patents)	0.144***	0.206***	0.328***
	(0.000)	(0.000)	(0.000)
Controls	Yes	Yes	Yes
Observations	1,374	1,374	1,374

- More innovative BHCs suffer more frequent tail operational loss events.
- Depending on the tail threshold used, a 10% increase in the number of patents filed is associated with a 1.38-3.18% increase in the frequency of tail operational losses.

The Role of Risk Management

Weak BHC risk controls are associated with more operational losses (e.g. Abdymomunov and Mihov, 2019).

	(1) LtA
Ln(N Patents)	4.464***
	(0.004)
Ln(N Patents) × RMI (0/1)	-4.174***
	(0.007)
RMI (0/1)	-0.387
	(0.530)
Controls	Yes
Observations	797
Adjusted R^2	0.189

Strong risk management helps BHCs to reign in innovation-induced operational risks.

Lag Structure of the Effect

To get at the longer-term effect of financial innovation on operational losses, we study the lagged effect of financial patent applications.

	(1) LtA	(2) LtA	(3) LtA
Ln(N Patents [t-4, t-1])			4.646**
			(0.047)
Ln(N Patents [t-8, t-5])	0.597		-3.320
	(0.364)		(0.176)
Ln(N Patents [t-12, t-9])		0.926*	0.202
		(0.082)	(0.711)
Controls	Yes	Yes	Yes
Observations	1,355	1,333	1,333
Adjusted R^2	0.136	0.118	0.139

While lagged innovation measures are positively related to future operational losses, their effect is economically and statistically weak.

BHC Value and Financial Innovation

- Schumpeterian growth models predict that firms grow through successful innovation.
- We next examine the effect of financial innovation on BHC market share and franchise value.

	(1) Asset Share	(2) Deposit Share	(3) Market-to-Book	(4) Tobin's Q
Ln(N Patents)	0.009**	0.012***	0.721	0.019
	(0.017)	(0.002)	(0.130)	(0.249)
Controls	Yes	Yes	Yes	Yes
Observations	1,374	1,374	1,374	1,373
Adjusted R^2	0.880	0.852	0.087	0.523

- Banking organizations with higher intensity of innovation tend to have larger market shares both in terms of assets and deposits.
- However, the market share gains resulting from financial innovation do not translate into higher franchise values for those BHCs engaging in financial innovation.

Conclusion

- **Key Finding**: Financial innovation at (large) U.S. banking organizations is associated with higher operational losses, especially for organizations with weak risk management.
- **Potential Policy Implication**: Regulators should consider financial innovation when evaluating banking organization operational risk profiles in an era of rapid innovation and technological change.
- **Balanced View**: While financial innovation is related to bigger market share, increased operational losses undermine benefits. A robust risk management framework is crucial for harnessing the benefits of innovation while mitigating risks.