Business Complexity and Risk Management: Evidence from Operational Risk Events in U.S. Bank Holding Companies*

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Abstract

Recent regulatory proposals tie a financial institution's systemic importance to its complexity. However, little is known about how complexity affects banks' risk management. Using the 1996–1999 deregulation of banks' nonbanking activities as a natural experiment, we show that U.S. banks' operational risk increased significantly with their business complexity. This trend is stronger for banks that were constrained by regulations beforehand, especially for those with a Section 20 subsidiary, compared to other banks and also to nonbank financial institutions that were never subject to these regulations. We provide evidence that this pattern results from managerial failure rather than strategic risk taking.

Keywords: operational risk, bank holding companies, financial deregulation, Glass-Steagall Act, business complexity.

JEL Classification Numbers: G18, G20, G21, G32, L25.

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"The failure of large, *complex*, and interconnected financial firms can disrupt the broader financial system and the overall economy, and such firms should be regulated with that fact in mind."

Ben S. Bernanke, former Chairman of the Federal Reserve System, June 16, 2010

1 Introduction

The recent financial crisis has catapulted the regulation of large, complex financial institutions to the center of policy debate.[1] The business complexity of U.S. bank holding companies (BHCs) increased significantly since late 1990s due to their aggressive expansion into nonbanking activities. This expansion was primarily driven the Gramm-Leach-Bliley Act (GLBA) of 1999 that removed the restrictions on business activities imposed under the Glass-Steagall Act (GSA) of 1933, including securities underwriting and trading activities. Arguably, the attempts to work around and relax regulatory restrictions on banking activities have contributed to the creation of complex financial systems of today (Gorton and Metrick 2013). Although regulators have recently proposed complexity as one of the main criteria for the designation of a bank as systemically important (BCBS 2014a, BGFRS 2015), there is very little evidence as to how complexity affects risk management in financial institutions. Using the gradual deregulation of banks' nonbanking activities during 1996–1999 as a natural experiment, we show that banks' increased complexity due to expansion into nonbanking activities has led to a deterioration of banks' operational risk management.

The term *complexity* lacks a clear definition in the practitioner and scholarly literature on banking.[2] To address this challenge, we follow the guidelines provided by the Bank for International Settlements (BIS) and the Federal Reserve, which relate complexity to the activities of banks outside of the traditional business of banking and strictly separate it from other measures, such as interconnectedness, geographic activity, and size (BCBS 2014a, BGFRS 2015).

[1]These regulations include the Basel III Capital Accord, the Comprehensive Capital Analysis and Review (CCAR) stress tests under the 2010 Dodd-Frank Wall Street Reform and Consumer Protection Act, additional capital requirements for global systemically important banks (G-SIBs), and enhanced prudential standards for large U.S. bank holding companies. In this paper, we use the terms bank and bank holding company interchangeably.

[2]Business complexity may arise from business diversification (e.g., Neuhann and Saidi 2018; Gorton and Metrick 2013; Brunnermeier, Dong, and Palia 2012; Ashcraft and Schuermann 2008), geographic expansion (e.g., Goetz, Laeven, and Levine 2016; Kroszner and Strahan 2011) or network interconnectedness (e.g., Acemoglu, Ozdaglar, and Tahbaz-Salehi 2015; Caballero and Simsek 2013; Allen and Gale 2000; Gai, Haldane, and Kapadia 2011; Leitner 2005).

Another challenge with identifying the effect of complexity on risk management is the proper measurement of the latter. To address this challenge, we use operational risk events as our metric for five reasons. First, operational risk events generate sizable losses.[3] Second, unlike credit and market risks, where the source of uncertainty lies outside the firm, operational risk is created by sources internal to the firm and is a result of control failures (Jorion 2007). In particular, the operational risk events result from inadequate or failed internal processes, people, or systems and include fraud, flawed business and market practices, failed transaction processing and process management, improper employee and client relations, and system failures (BCBS 2001). Third, a unique feature of our data is that it allows us to use event origination dates, rather than realization dates. This feature prevents the identification problems associated with stale information, such as balance sheet losses for risks taken years earlier.[4] Fourth, these events capture risk management failures without being influenced by confounding factors, such as implicit government guarantees, which can make a more complex bank appear less risky from the investors' perspective while being more risky from the taxpayers' perspective (Acharya, Anginer, and Warburton 2016). Finally, failures in operational risk management indicate deficiencies in other risk management areas (Zeissler and Metrick 2014).

Higher complexity can lead to greater operational risk due to managerial failure or strategic risk taking. Under the *managerial failure* hypothesis, increased complexity can strain managerial oversight and employees' focus, hinder their ability to monitor the bank's subsidiaries, create difficulties in maintaining proper barriers as well as information exchange between different business lines, and reduce the effort of managers due to intensified agency problems.[5]

[3] As an example, in 2005, Bank of America and JP Morgan agreed to settle a lawsuit for $460.5 mln and $2 bln, respectively, because they failed to conduct proper due diligence while underwriting securities for WorldCom. Operational risk events can also cause reputational loss (Perry and de Fontnouvelle 2005) and a significant drop in market values of about 1.5% for each event in the affected BHC (Cummins, Lewis, and Wei 2006; Barakat, Chernobai, and Wahrenburg 2014). A recent example is the cross-selling scandal at Wells Fargo in 2016, which involved its credit cards, insurance, and brokerage businesses, and resulted in about $30 bln drop in equity value, in addition to firing of 5,300 employees, and the resignation of the CEO.

[4] For example, the balance sheet losses due to mortgage-backed securities materialized during the financial crisis can be traced back to the early-to-mid 2000s (Kohn 2009). On average, there are four years between origination and realization of operational risk events. Section 2.1 gives a more detailed background on operational risk.

[5] See, for example, Acharya, Hasan, and Saunders (2006), Staikouras (2006), Laeven and Levine (2007), Berger, Miller, Petersen, Rajan, and Stein (2005), Brickley, Linck, and Smith (2003), Wilmarth (2002), Murray (2001), and Santomero and Eckles (2000). An article in *The Wall Street Journal* (Murray 2001) states that *"dumb moves or stumbles are subject to much greater scrutiny, decisions must be made quickly, with limited information," "vastly expanded operations can make [...] communicating with employees increasingly difficult,"* many CEOs admit that the expanded scope of business *"has become a battle with a new kind of complexity and*

Under the *strategic risk taking* view, higher complexity gives the BHCs more opportunity to load on operational risk with the expectation that they will be rewarded with the resulting increase in performance.[6]

We find that the deregulation-induced complexity does not lead to a large or permanent improvement in BHCs' performance measures as they expand their nonbanking activities, suggesting that BHCs did not reap any long-term rewards and hence contradicting the strategic risk taking view. This finding is consistent with the earlier literature which documents a lack of performance improvement following business diversification post-deregulation.[7] Moreover, we find that greater complexity leads to greater operational risk not only in the nonbanking business lines the BHCs expand into but also in core (banking) business lines, suggesting that the managers' attention and effort in their core business line weakened. Overall, these findings suggest that the increase in operational risk as a result of greater deregulation-induced complexity is more likely to be explained by the managerial failure hypothesis. This argument is also consistent with "managerial action/inaction" and "lack of internal control" being cited as key contributing factors for a large portion of operational risk events in our sample, whereas "strategic risk" or "business risk" are cited for very few events.

A major concern in the identification of the effect of complexity on risk management is reverse causality: a BHC may expand aggressively into previously evaded activities due to a weakening of its risk management. Arguably, a good operational risk example is the highly publicized debacle of Barings Bank in 1995. In 1992, Barings entered the arbitrage trading business through their Singapore office by hiring Nick Leeson, a trader who could not get a broker's license in the U.K. due to fraud in his application. Leeson was put in charge of both the front and the back offices, despite repeated concerns raised by some Barings insiders.[8] This

a new degree of turmoil," thus making the managerial efforts more prone to errors and omissions.

[6]For example, increased complexity enables BHCs to load on systemic tail risks without having to hold regulatory capital (e.g., Clark and Ebrahim 2017; Acharya, Cooley, and Richardson 2010), to benefit from an implicit extension of "too-big-to-fail" guarantees to their nonbank activities (Carow and Heron 2002; Kane 2000; Flannery 1999), to exploit risky growth opportunities by pursuing short-term profit-maximizing behavior (Turbeville 2013; Shleifer and Vishny 2010) and productivity gains (Neuhann and Saidi 2016), and to increase operating cash flow return on assets (Cornett, Ors, and Tehranian 2002).

[7]See, for example, Laeven, Ratnovski, and Tong (2014), Turbeville (2013), Brunnermeier, Dong, and Palia (2012), Shleifer and Vishny (2010), Laeven and Levine (2007), Song and Thakor (2007), Acharya, Hasan, and Saunders (2006), Stiroh (2004), Wilmarth (2002), DeYoung and Roland (2001), Scharfstein and Stein (2000), and Raghuram, Servaes, and Zingales (2000) who document no performance gains, greater information asymmetries, greater idiosyncratic risk, and greater contribution to systemic risk as adverse consequences of increased business diversification post-deregulation.

[8]James Bax, who ran Barings' Asian operations, warned in 1993: *"we are in danger of setting up a structure*

structure allowed him to circumvent typical accounting and internal control/audit safeguards against internal fraud. Instead of hedging his positions as required by the arbitrage strategy, Leeson speculated aggressively without supervision, ultimately accumulating losses in a secret account large enough to bring the bank to its collapse in 1995. This example illustrates how lack of internal controls can contribute to business complexity of a bank through aggressive diversification.

We address this identification concern by using as a natural experiment the deregulation of nonbanking activities between the end of 1996 and the end of 1999, which culminated with the GLBA that enabled banks to diversify deeper into nonbanking activities. Under this identification, prior to 1996, the reason for BHCs to limit their nonbanking activities was not endogenous (strong internal controls) but exogenous (stringent regulatory restrictions). Under the GLBA, these restrictions were abolished for reasons unrelated to the operational risk of banks. Therefore, employing the natural experiment research design alleviates concerns over endogeneity stemming from reverse causality, and is consistent with prior literature (e.g., Rice and Strahan 2010; Krishnan, Nandy, and Puri 2015; Neuhann and Saidi 2018) that argues that banking deregulations during 1990s were exogenous. In particular, it is not plausible that the objective of the GLBA could be to increase operational risk. Therefore, we treat the deregulation as an exogenous shock to complexity to study its causal effect on operational risk.[9]

We observe that the number of operational risk events of BHCs started to increase right after 1996 and more than tripled following the passage of the GLBA in 1999 (Figure 1). However, because the deregulations and their impact were not immediate, this suggestive evidence might still be tainted by confounding effects during this time period that may have weakened the risk management mechanisms and simultaneously led to higher complexity through more aggressive diversification. To address this issue, we note that the BHCs that had already diversified into nonbanking activities before 1996 were more likely to be bound by regulations than the other, not pre-diversified, BHCs. Accordingly, we find that, after deregulation, pre-diversified BHCs

which will prove disastrous and with which we will succeed in losing either a lot of money or client goodwill or probably both" (*The Telegraph*, February 23, 2015).

[9]Barth, Brumbaugh, and Wilcox (2000) offer three arguments for the GLBA in 1999 being of exogenous nature. First, the securities activities have been shown to bear little responsibility for the commercial bank failures around the Great Depression. Second, after Section 20 investment banking subsidiaries were permitted by the Federal Reserve in the late 1980s, there was insufficient evidence that the wider range of permitted activities was to blame for the banking problems in subsequent years. Third, technological advances reduced the costs of sharing data between businesses, raising the expected profitability of cross-selling insurance and securities products.

expanded their nonbanking activities further than did other BHCs.

We use difference-in-differences analysis to study the differential effect of the deregulations on the operational risk of pre-diversified BHCs (treatment group) and other BHCs (control group). Because the pre-1996 diversification decisions were made before the deregulations, these decisions could not have been driven by confounding factors during the deregulation period. Moreover, the difference in operational risk between the two groups does not exhibit a time trend before the deregulations, consistent with the parallel trend assumption. Therefore, it is highly unlikely that the greater increase in operational risk for the pre-diversified BHCs post-GLBA can stem from anything other than the deregulation-induced differential increase in complexity.

We also compare the pre-diversified BHCs with nonbanks. Nonbanks are a suitable alternative control group because they were not directly affected by the GLBA as their activities were not restricted by the GSA. At the same time, nonbanks were active and remained active in the businesses that the pre-diversified BHCs were expanding into. In addition to comparing pre-diversified BHCs with nonbanks, we separate events into banking and nonbanking events following the BIS definition. This allows us to to zoom in on nonbanking events in pre-diversified BHCs and use nonbanks as the control group, as well as by focusing on banking events in pre-diversified BHCs and use other banks as the control group. This separation of banking and nonbanking events also addresses any concern whether our results may be driven by the potentially riskier nature of the nonbanking activities rather than by higher complexity.

Our key result is that the BHCs that experience a greater increase in complexity (the pre-diversified BHCs) suffer a greater increase in their operational risk compared both to other BHCs and to nonbanks. This effect is particularly strong for banks that owned a Section 20 subsidiary prior to the GLBA, which targeted nonbanking activities that these subsidiaries engaged in, such as underwriting and dealing in bank-ineligible securities. In particular, Section 20 owners' annual operational risk losses increased threefold post-deregulation relative to both banks not previously engaged in regulated activities and nonbanks. This result cannot be explained by the potentially riskier nature of the nonbanking activities because, after we separate events into banking and nonbanking events, the treatment effect holds not only for nonbanking events while holding nonbanks as the control group, but also for banking events while holding other banks as the control group.

Our results cannot be explained by a mechanical relationship between the increase in op-

erational risk and the growth of the institutions. In particular, our results are robust after controlling for change in size in various ways – by directly including it as a covariate in our econometric models, by normalizing the dependent variable by size, and by creating growth-matched samples – and also after controlling for other bank-specific attributes shown to be linked to operational risk in previous literature. Moreover, the results still hold after accounting for the M&A activity and media attention. In sum, our findings remain valid under various model specifications and withstand numerous robustness checks. Finally, we find that the effect of complexity on operational risk persists for a long time after the deregulation.

Our study contributes to the recent debate about reinstating the GSA. At the heart of the policy debate lies the tradeoff between potential synergies and diversification benefits arising from a financial institution's involvement in multiple business lines (banking and nonbanking), and potential risk management weaknesses arising from increased complexity that can result in losses for both the financial sector and the taxpayers. While potential benefits of additional risk are likely to manifest themselves rather quickly, the balance sheet losses can take years to materialize. Market-based performance measures, while more timely, may not account for the information asymmetries between investors and managers and can be less sensitive to risk due to implicit government guarantees, especially for systemically important banks.[10] Our approach based on origination dates of operational risk events directly addresses these complications and contributes to the policy debate by highlighting that any apparent performance benefit of diversification may come at the expense of increased risk that is not immediately evident.

Last but not least, some recent empirical literature highlights potential threats coming from operational risk externalities in the form of intra-industry spillover effects (for example, Cummins, Wei, and Xie 2011; Chernobai, Jorion, and Yu 2007), indicating a systematic nature of this risk in the financial sector. Our results suggest that these spillovers are more likely to originate from more complex BHCs. Therefore, such firms may warrant more stringent regulatory requirements for operational risk. Our findings are in agreement with the Basel II Capital Accord's requirement that "banks should implement policies, procedures and practices to manage operational risk commensurate with their size, *complexity*, activities and risk exposure" (BCBS 2014b, p. 4, emphasis added).[11] Our results also support the recent inclusion of operational

[10]Acharya, Anginer, and Warburton (2016) show that bond credit spreads are not sensitive to risk for large financial institutions, and that after TARP, larger financial institutions had greater reduction in credit spreads than smaller institutions. Beliaeva, Khaksari, and Tsafack (2015) found that implicit government guarantees reduce CDS spreads by 76 bps for financial institutions.

[11]The regulatory capital charge for operational risk can exceed those for market and credit risk in many

risk events into the Comprehensive Capital Analysis and Review (CCAR) framework of the Federal Reserve for the stress-testing of systemically important financial institutions.

2 Background, Data, and Preliminary Evidence

2.1 Background on Operational Risk Management

International banking regulatory standards define operational risk as "the risk of loss resulting from inadequate or failed internal processes, people and systems, or from external events" (BCBS 2001, p. 2). The Basel Committee classifies operational risk into seven distinct event types: internal fraud; external fraud; employment practices and workplace safety; clients, products and business practices; damage to physical assets; business disruption and system failures; and execution, delivery, and process management.[12] A distinctive feature of operational risk is its potential for devastating consequences to a firm and the economy, ranging from large monetary losses and shattered reputations to posing a serious threat to financial institutions' stability globally (BCBS 2001; OCC 2007).

Traditionally, the financial industry and scholarly literature held the belief that financial services firms face three primary risks: credit risk (or a risk of a counterparty's default on a debt obligation), market risk (or systematic risk, whose components include interest rate risk, equity risk, and commodity risk), and liquidity risk (or the risk of inability to meet short-term obligations). This belief has been shaken by a sharp increase in the incidence of operational risk.[13] Hoffman (2002) reports that publicly announced large operational losses amounted to over $15 bln annually during 1980s and 1990s, and this figure represents only the tip of the

banks. De Fontnouvelle, DeJesus-Rueff, Jordan, and Rosengren (2006) report that banks allocate on average 15 percent of their risk capital to operational risk. By more recent estimates, Ames, Schuermann, and Scott (2015) find that operational risk represents approximately 10–30 percent of the total risk.

[12]The Internet Appendix A provides a detailed description of these event types. In our data, the relative weights of these events by frequency and severity, respectively, are as follows. Internal fraud: 16.65% and 2.42%; external fraud: 14.21% and 2.5%; employment practices and workplace safety: 7.82% and 0.73%; clients, products, and business practices: 46.17% and 61.04%; damage to physical assets: 1.43% and 2.8%; business disruption and system failures: 2.69% and 0.26%; execution, delivery, and process management: 11.02% and 30.26%. Most of these numbers are similar to those reported in the BIS 2008 Loss Data Collection Exercise (`http://www.bis.org/publ/bcbs160a.pdf`).

[13]Quoting Thomas J. Curry, the Comptroller of the Currency, *"Given the complexity of today's banking markets [...] the OCC deems operational risk to be high and increasing. [...] [OCC supervisors] have seen operational risk eclipse credit risk as a safety and soundness challenge. Rising operational risk concerns them, it concerns me, and it should concern you."* (May 16, 2012, `http://www.occ.gov/news-issuances/speeches/2012/pub-speech-2012-77.pdf`)

iceberg, with the true figure easily being "as high as 10 times this amount," (Hoffman 2002, p. 26) once the losses that are not visible publicly are accounted for. Accordingly, Jorion (2007) refers to operational risk as the most pernicious form of risk because of its contribution to numerous failures in financial institutions.

Evidence suggests that failures in operational risk are indicative of broader weaknesses in other areas. Chernobai, Jorion, and Yu (2011) find that the effects of different internal factors on the incidence of operational risk is similar across different operational risk event types, consistent with the theory that internal control weaknesses are the common root cause for different types of operational risk. Zeissler and Metrick (2014) argue that the $6.2 bln loss of JP Morgan in the 2012 "London Whale" case has revealed significant deficiencies in the bank's overall risk management. According to Kieran Poynter, former U.K. chairman of PriceWaterhouseCoopers, *"Organizations with weak data security are generally also weak in terms of wider risk management and governance."*[14]

The importance of operational risk as a risk management challenge is also recognized by the regulators. The Basel Capital Accords (Basel II and III) of 2004 and 2009 explicitly separate operational risk from credit risk and market risk and lay out a set of specific regulatory standards for banks globally. Regulatory filings (FR Y-9C) show that, in 2015, operational risk regulatory capital accounted for 12.8% of total regulatory capital and varied from 9% to 22% across banks. Operational risk capital amount was $32 bln for JP Morgan, $26 bln for Citi, and $21 bln for Wells Fargo, to name a few. In addition, in the United States, the 2010 Dodd-Frank Wall Street Reform and Consumer Protection Act includes operational risk in stress testing through the Comprehensive Capital Analysis and Review (CCAR) framework. In Europe, operational risk has been a mandatory constituent of the European Banking Authority and United Kingdom's Prudential Regulation Authority stress testing requirements since 2009 and 2013, respectively.[15] Ratings agencies, such as Moody's Investors Service, Morningstar, and Fitch Ratings, recently also began to incorporate operational risk in assigning corporate financial ratings (Moody's Investors Service 2003; Morningstar 2015; Fitch Ratings 2004).[16]

Of the seven operational risk event types, this paper focuses on the four that are most likely to be associated with the risk management failures arising from increased complexity due to

[14] "Good Data Security Is Not Just a Matter of Technology," *Financial Times*, July 16, 2008.

[15] See `http://www.bankofengland.co.uk/pra/Pages/supervision/activities/stresstesting.aspx` and `http://www.eba.europa.eu/risk-analysis-and-data/eu-wide-stress-testing`.

[16] See also `http://businessfinancemag.com/blog/moodys-new-operational-risk-guidelines-will-impact-ratings`.

diversification into nonbanking activities. These four event types have the highest percentage of event counts with "managerial action/inaction" and "lack of internal control" cited as the key contributing factors to operational failure in our operational risk database. Altogether, in our data these events account for 88.05% by frequency and 96.22% by severity.[17] We illustrate these event types with corresponding examples below.

1. Internal fraud: In 1998, a former vice president in Citibank's private-banking section was charged with defrauding the bank out of more than $10 million in 1993 by creating phony bank accounts and using them to obtain loans. In another example, in June 2010, subsidiaries of Fidelity National Financial were ordered to pay $5.7 million in compensation for the role employees played in a $30 million mortgage fraud scam.

2. External fraud: In 1997, the Citibank unit of Citigroup discovered that it had been the victim of loan fraud and had lost between $8 and $9 million. In another example, in 2003, Allied Irish Bank sued Bank of America and Citibank, alleging that they had provided John Rusnak with $200 million through prime brokerage accounts, enabling him to engage in unauthorized trading that surfaced in February 2002.

3. Clients, products, and business practices: In March 2005, Bank of America agreed to pay $460.5 million in settlement of a shareholder lawsuit that claims the third largest bank in the United States failed to conduct proper due diligence when it underwrote securities for WorldCom. In another example, in October 2013, the U.S. Federal Housing Finance Agency reached a $5.1 bln settlement with JP Morgan, which allegedly overstated borrowers' capacity to repay loans underlying more than $33 bln of residential mortgage-backed securities that were sold to Fannie Mae and Freddie Mac between 2005 and 2007.

4. Execution, delivery, and process management: In May 2008, clients of People's United Bank, based in Bridgeport, Connecticut, filed a class action lawsuit in New Haven Superior Court against Bank of New York Mellon, related to a data breach that occurred on February 27, 2008. In a second example, in August 2008, BNY Mellon disclosed in a regulatory filing that it was notifying 12 million customers about the security breach and would set aside $22 million for credit monitoring. In a third example, in June 2005, Bank of America reached a $1.5 million settlement for failing to ensure proper storage of employee email correspondence related to its brokerage business.

[17] Our results remain robust to inclusion of the other three event types, as discussed in Section 5.

In the examples above, not every event occurred within the deregulated nonbanking business lines. However, our goal in this study is to capture the effect of increased complexity on any weakness in risk management that manifests itself as an operational risk event. Since these weaknesses can reveal themselves in any part of the business, we study the events in banking and nonbanking business lines together.[18]

Academic literature on operational risk is growing. First-generation studies on operational risk (around the early 2000s) explore static actuarial-type models for operational risk focusing on the operational risk capital charge estimation under the Basel II Capital Accord (e.g., de Fontnouvelle, DeJesus-Rueff, Jordan, and Rosengren 2006 and Chernobai, Rachev, and Fabozzi 2007). Rosenberg and Schuermann (2006) examine the correlation structure between operational, credit, and market risks and emphasize modeling difficulties arising from the heavy-tailed nature of operational risk. More recent studies examine the internal root causes (Chernobai, Jorion, and Yu 2011; Basak and Buffa 2016), the consequences of such events to the firm (Brown, Goetzmann, Liang, and Schwarz 2008, 2012), and their market-value impact (Cummins, Lewis, and Wei 2006).

2.2 Data on Operational Risk

Strategic business decisions, such as expanding into a nonbanking activity, are made at the parent level instead of the subsidiary level. Therefore, we are interested in the effects of complexity at the high holder (ultimate parent) level. We construct operational risk variables for our sample of high holders using the Financial Institutions Risk Scenario Trends (IBM Algo FIRST) operational risk database marketed by IBM. In this section, we describe our process of cleaning and combining operational risk data with other relevant datasets.

The IBM Algo FIRST database contains several decades of data collected worldwide on over 10,000 public operational risk events, with the bulk of the data after 1980. The majority of data are from the United States, with about three-quarters coming from financial institutions. The database includes information on the dates of the origination of each event, along with its public disclosure and settlement, the dollar impact of loss, event type, business line, contributory factors, and a narrative of event details. The format of the data conforms to BIS definitions of event types and business lines. The availability of the timing of an event's origination date is

[18] In a robustness test (Section 4.3), we distinguish between "banking" and "nonbanking" events, depending on the business line in which the events occurred, and find that increased complexity post-deregulation has impacted operational risk of both types similarly.

a key advantage of using the IBM Algo FIRST database for our analysis.[19]

The database contains events that are made public and is a fair representation of the loss population. As explained in Chernobai, Jorion, and Yu (2011), there is a large variance in loss amounts, with many losses being small in magnitude — some as small as $1, and the loss distribution is similar to that typically observed for losses in banks' internal databases, thus reducing concerns about an upward bias of recorded losses. Moreover, in most cases the source of the data is a third party (for example, a regulatory agency such as the SEC, FINRA, NASD, NYSE, or FDIC, court decisions, affected customers, business partners, and shareholders) rather than the firms themselves, thus mitigating concerns over self-selection bias.

We manually match the firms in the IBM Algo FIRST database with the Compustat identifier (GVKEY). Specifically, we assign the historical GVKEY to each firm-event at the event's origination date in order to capture the actual timing of an operational failure.[20] We begin our sample in 1988 because much of our analysis focuses on BHCs that owned a Section 20 subsidiary. As explained in Section 3.1, establishment of such subsidiaries was allowed beginning in April 1987. The realization date of our operational risk events database ends in 2012.

Next, we construct the operational risk event sample for the U.S. BHCs. We start by linking each GVKEY to the corresponding identifier PERMCO within the Center for Research in Security Prices (CRSP) U.S. Stock Database. We map each PERMCO to the corresponding Federal Reserve identifier, RSSD ID, through the PERMCO–RSSD ID links provided by the Federal Reserve Bank of New York. We then obtain each RSSD ID's high holder RSSD ID through Consolidated Financial Statements for Holding Companies (FR Y-9C) and the Call

[19]The primary clientele of the IBM Algo FIRST database are risk management professionals, auditors, compliance personnel, and senior executives. Currently, around 100 financial institutions subscribe to the database. The data were previously used in Barakat, Chernobai, and Wahrenburg (2014), Chernobai, Jorion, and Yu (2011), Gillet, Hübner, and Plunus (2010), and Wang and Hsu (2013). Other studies (for example, Dutta and Perry 2006) used operational risk data collected from a Loss Data Collection Exercise (LDCE) conducted by the U.S. banking regulatory agencies (the Federal Reserve, the OCC, the FDIC, and the Office of Thrift Supervision); however, the data are limited to very few contributing institutions. Abdymomunov and Mihov (2015) used supervisory operational loss data from FR Y-14-Q filings; however, reporting institutions are limited to BHCs with $50 bln or more in total consolidated assets. Others (for example, Cope, Piche, and Walter 2012) used the ORX Global Loss Database; the data period begins in 2002 and is contributed by around 50 member institutions worldwide.

[20]We start with GVKEYs because the control variables for nonbanks, which we will use as an additional control group in our robustness tests, exist only in Compustat. The IBM Algo FIRST database does not keep track of the ultimate parent firms back in history. It provides information on individual firm names and the names of their current parent firms, which are updated regularly to account for any merger or acquisition activity. This requires us to manually match the firms with their historical parents.

Reports. For the GVKEYs with a missing high holder RSSD ID, we manually go through the IBM Algo FIRST database to match the events with their historical high holder at the event's origination date for our BHC sample. This exercise yields a sample to 1,257 operational risk events.

We merge the operational risk data with our complete BHC sample from FR Y-9C filings which is the source of our control variables. For a bank-quarter observation that does not have a publicly available operational risk event recorded in IBM Algo FIRST, we treat this observation as having a zero event count and loss, following Chernobai, Jorion, and Yu (2011). In the instances with missing loss amounts, we use the median imputation method (Little and Rubin 2002) to fill the missing values with the bank's annual median loss values. In a robustness check (Internet Appendix, Table B11) we also replace all missing values with zero and our results still hold.[21]

Because we are interested in the timing of the event origination, we truncate the last several years of data, following Chernobai, Jorion, and Yu (2011). This truncation accounts for the delays between the time a risk is taken and the time it materializes. In particular, we include only events that originated before the end of 2005, which minimizes concerns over downward bias in event counts during the last several years of our sample period. IBM Algo FIRST codes the origination date of an event as having occurred in the first quarter of a year if the information about the exact origination date is uncertain. Therefore, we consolidate our quarterly data to an annual basis to remove spurious spikes in the data in the first quarter of each year.

Figure 1 describes the evolution of the annual event count using all BHCs available in our data. We observe that a pronounced increase in operational risk frequency overlaps with the deregulation period starting in 1996, with some leveling after 2001. This observation is consistent with our argument that operational risk increases due to the growing complexity enabled by the 1996–1999 deregulations. To ensure that this trend is not driven by the number of BHCs in our sample, Figure 1 also shows the time series of high holder count. While operational risk has been generally increasing over time, the number of BHCs has seen a decline.

[21]Since our analysis of losses is in logarithm form, our "zero" losses are set to 0.01, which is below the minimum annual total loss amount in our sample of $0.016 mln.

2.3 Data on Complexity

The lack of reporting requirements for BHCs with regard to the counts of their subsidiaries and the industries in which they operate creates an empirical challenge with respect to measuring the business diversification of banks over time. To overcome this challenge, we rely on historic merger and acquisitions (M&A) data to recover as much information on the diversification histories of BHCs as possible. To construct our sample, we follow Cetorelli, McAndrews, and Traina (2014).[22] For each of the U.S. publicly traded BHCs identified as an ultimate parent, their method develops a complete family tree by taking an intersection of the market data from four sources: the CRSP database, the regulatory accounting data from the Board of Governors of the Federal Reserve System, the FR Y-9C filings, and financial institutions' M&A activity data from the SNL DataSource compiled by SNL Financial. The family tree is constructed by accounting for the subsidiaries acquired over time among ten financial industries: bank, asset manager, broker-dealer, financial technology, insurance broker, insurance underwriter, investment company, real estate, savings bank/thrift/mutual, and specialty lender.[23]

For our preliminary results in Section 2.5, we use the full 1988–2005 sample. For each bank-year observation we construct three measures that capture the increased complexity due to an expansion of a BHC into nonbanking business lines. The first proxy for increased complexity (*Diversified*) is a dummy variable that equals to 1 if a BHC or its subsidiaries diversified into nonbanking activities in the past year through mergers and acquisitions. In constructing this measure, we ensure that it captures diversification not only when a BHC acquires another nonbank financial firm, but also in the cases where a BHC diversifies into nonbanking industries by acquiring another BHC that itself owns subsidiaries with nonbanking activities.

A disadvantage of this measure is that it does not capture organic growth into nonbanking activities, which can also increase the complexity of a BHC. To address this concern, the second and third proxies for complexity capture BHCs' nonbanking activities using the regulatory filings FR Y-9C and FR Y-9LP. One is the non-interest income ratio (*Non-Interest Income Ratio*), computed as non-interest income divided by the sum of net interest income and non-

[22] We thank Nicola Cetorelli for sharing a summary version of his organizational structure data.

[23] Because the M&A database is necessary to construct a family tree, we narrow down our sample to U.S. publicly traded BHCs that are high holders and that have engaged in at least one M&A activity between 1988:Q1 and 2012:Q4, as recorded in the SNL Financial database. We exclude high holders that have no documented M&A activity in any of the 10 financial industries until the end of our sample period.

interest income, BHCK4079/(BHCK4079 + BHCK4074).[24] Brunnermeier, Dong, and Palia (2012) show that banks with higher non-interest income ratios have higher contributions to systemic risk. The other is nonbank asset ratio (*Nonbank Asset Ratio*), computed as nonbank assets divided by total assets, BHCP4778/BHCK2170. Avraham, Selvaggi, and Vickery (2012) consider nonbank asset ratio as a metric in explaining increased organizational complexity of BHCs since early 1990s.[25]

While these two measures address the weaknesses of the first measure, they suffer from other limitations. First, nonbank assets consist of the total assets of a high holder's nonbanking subsidiaries, and if the subsidiary is absorbed by the parent BHC or by one of the parent's banking subsidiaries, the high holder's *Nonbank Asset Ratio* would decline, although the BHC does not necessarily become less complex. Second, the non-interest income can include certain fees that are well within the banking business, such as transaction fees or service charges. Nonetheless, while each of the three measures has its unique disadvantages, their combination paints a sufficiently complete picture regarding the effects of complexity on operational risk in our preliminary analysis in Section 2.5. We will discuss in more detail how these measures are related to our treatment and control groups in our natural experiment in Section 3.

Table 1 summarizes the definitions and sources of the variables used in this study. Table 2, Panel A summarizes the sample statistics of our data for the period 1988–2005. 14 percent of BHCs in our sample diversified into nonbanking businesses in the past year. On average, BHCs in our sample have a non-interest income ratio of 22 percent and a nonbank asset ratio of 2.5 percent. There is a large variability in these variables. For 98 percent of the data, the non-interest income ratio ranges from 4.3 percent to 73.5 percent and the nonbank asset ratio ranges from 0 percent to 52.2 percent.

2.4 Control Variables

For our control variables, we use market data from CRSP and regulatory accounting data from FR Y-9C to construct bank-specific controls that are deemed to be important determinants of operational risk events, following Chernobai, Jorion, and Yu (2011). These control variables

[24]Non-interest income includes fiduciary income, fees and service charges, trading revenue, and other income from non-interest activities, such as brokerage, advisory services, and underwriting.

[25]Alternatively, one can use business and operating segments as another measure of complexity, but the data in the Compustat Segments database are limited to only a small portion of our banks, potentially creating a sample selection bais.

include bank size (*Ln TA*), the market-to-book ratio (*Market-To-Book*), the cash-to-assets ratio (*Cash-To-TA*), the Tier 1 ratio (*Tier 1 Ratio*), profitability (*ROE*), excessive growth dummy (*Excessive Growth*), and a dummy for a high dividend payout ratio (*High Dividend*).[26] Table 1 details the definitions of these variables.

Keeley (1990) finds that banks with larger market-to-book ratios have a lower default risk; hence, the inverse of the ratio serves as a proxy for distress. Acharya, Davydenko, and Strebulaev (2012) use the ratio of cash and short-term investments to assets as a proxy to identify "problem banks." Ellul and Yerramilli (2013) find that banks with weaker risk management functions tend to have higher Tier 1 capital ratios. Banks with high ROE are less financially constrained and are able to devote more resources to internal control, but at the same time may increase operational risk (Chernobai, Jorion, and Yu 2011) or relax internal controls (Jin and Myers 2006). Excessive growth is measured by excessive growth in liabilities: OCC (2001) and Moody's Investors Service (2002) show that aggressive growth strategies, especially growth in liabilities, often accompany risk management deficiencies and management's inability to effectively sustain exceptional growth. A high dividends payout ratio is used to capture "troubled banks." Dividend payout may be restricted by the Office of the Comptroller of the Currency (OCC) for banks experiencing large losses and identified by regulators as problem banks (OCC 2001; Collier, Forbush, Nuxoll, and O'Keefe 2003).

2.5 Business Complexity and Operational Risk: Preliminary Evidence

In this section we take a first step toward exploring the relationship between business complexity and operational risk. The purpose of this section is two-fold. First, we aim to show that the link between business complexity and operational risk holds in a more general setting — even outside the natural experiment research design that we will present in the following sections. Second, we draw alternative measures of complexity from past literature and explore their link to operational risk.

For each BHC, we estimate the following model:

$$Oprisk_{it} = \alpha + \beta\ Complexity_{i,t-1} + \sum_{k=1}^{K} \delta_k\ Control_{k,i,t-1} + \epsilon_{i,t}, \tag{1}$$

[26] We tried including the natural logarithm of the number of employees as an alternative measure of size with or without *Ln TA* in our models. When both are included, the coefficient of the number of employees loses economic and statistical significance. When only the number of employees is included then all our results remain robust.

where, for each BHC i and year t, *Complexity* is one of the three proxies for complexity described in Section 2.3, *Control* is a set of bank-level control variables described in Section 2.4, and ϵ is the residual term. The dependent variable *Oprisk* is a measure of operational risk — either annual operational risk frequency (*Count*) or the severity amount, captured by either annual total loss (*Ln Total Loss*) or annual average loss per event (*Ln Avg Loss*) (both in logarithmic form). To reduce concerns over look-ahead bias, all explanatory variables have a one year lag. In all models, standard errors are clustered at the BHC and year levels. All monetary values are adjusted for inflation using 2005 CPI.

The results are described in Table 3.[27] We find consistent evidence of a significant positive relation between a BHC's complexity and its operational risk over the period 1988-2005. Panel A of Table 3 shows BHCs that diversified into nonbanking businesses in the past year experience, on average, a 0.10 increase in their annual event frequency, 27 percent higher total loss ($exp(0.238) = 1.27$), and 24 percent higher average loss ($exp(0.213) = 1.24$) of operational risk compared to the other BHCs. Panel B of Table 3 shows that, for one standard deviation increase in the non-interest income ratio (0.143), we observe an expected 0.04 increase in annual operational risk event frequency ($0.281 \times 0.143 = 0.04$) along with a 7 percent increase in annual total loss ($exp(0.469 \times 0.143) = 1.07$) and a 7 percent increase in average operational loss ($exp(0.445 \times 0.143) = 1.07$). Finally, Panel C of Table 3 shows that, for one standard deviation increase in the nonbank asset ratio (0.092), the model predicts a 0.14 increase in the operational risk event count ($1.5 \times 0.092 = 0.14$), a 13 percent higher annual total operational loss ($exp(1.336 \times 0.092) = 1.13$) and a 10 percent higher annual average operational loss ($exp(1.032 \times 0.092) = 1.10$).

Our findings suggest a positive link between operational risk and business complexity that arises from expansion into nonbanking activities. However, the results presented in this section may suffer from endogeneity concerns surrounding the three proxies for complexity. It is possible that a bank expands into previously evaded nonbanking activities due to weakening of its risk management. Using lagged values of our complexity measure would not resolve this problem if weakened risk management post-deregulation takes some time to materialize in the form of operational risk events. Without a formal identification strategy, the lack of a well-defined exogenous complexity measure thus poses an empirical roadblock in establishing the causal

[27]For brevity, these tables do not display the coefficients of the control variables. The full set of results is contained in the Internet Appendix B, Table B1.

link between BHCs' complexity and operational risk. As such, we treat the empirical exercise presented in this section as only a preliminary evidence in support of our study. Our formal research design based on a natural experiment presented next addresses the above concerns and our findings provide compelling evidence of the causal link between complexity and risk management weaknesses.

3 Evidence from a Natural Experiment: The Repeal of the Glass-Steagall Act

We begin our analysis by presenting the institutional background of the gradual repeal of the Glass-Steagall Act of 1933 that led to the Gramm-Leach-Bliley Act in 1999. Our identification strategy exploits the financial deregulation period of the late 1990s as a natural experiment, which triggered an *exogenous* change in complexity. Our econometric framework employs the difference-in-differences estimator to examine the effects of changes in business complexity on changes in operational risk.

3.1 Regulatory Background

The Glass-Steagall Act (GSA) of 1933 prohibited commercial banks from having securities affiliates, thus separating commercial and securities activities. It made it unlawful for commercial banks to be affiliated with any company that is "engaged principally" in underwriting or dealing in securities. The Act also prohibited BHCs from creating interlocks of officers, directors, or employees between a commercial bank and any company "primarily engaged" in securities underwriting or dealing (Lown, Osler, Sufi, and Strahan 2000; Kroszner and Strahan 2014).

Over time, these restrictions were gradually relaxed because the terms "engaged principally" and "primarily engaged" were not clearly defined in the GSA.[28] In April 1987, the Federal Reserve allowed U.S. bank holding companies to establish investment banking subsidiaries that were permitted to underwrite certain "bank-ineligible securities" on a case-by-case basis under Section 20 of the GSA. Such securities affiliates were therefore termed "Section 20 subsidiaries." In the beginning, the revenues from bank-ineligible securities were capped at 5 percent of a Section 20 subsidiary's gross revenue. This cap was raised to 10 percent in September 1989, and then to 25 percent in December 1996. Lown, Osler, Sufi, and Strahan (2000) record that

[28]See Table 2 in Lown, Osler, Sufi, and Strahan (2000) for an overview of the dates of important deregulatory actions between 1987 and 1998.

BHCs, through their Section 20 subsidiaries, increased their share of the securities industry's total revenue from about 17 percent to 27 percent and their share in underwriting business from about 5 percent to about 15 percent between 1996 and 1998, when Section 20 subsidiaries made significant inroads in underwriting, following the loosening of the "ineligible" underwriting revenue restriction at the end of 1996.

On November 12, 1999, the Gramm-Leach-Bliley Act (GLBA) was passed, repealing the GSA and lifting the 25 percent cap. In addition to dissolving the boundaries between commercial banking and investment banking, the GLBA also repealed the parts of the Bank Holding Company Act of 1956 that separated commercial banking from the insurance business. As a result, banks' share of fixed annuity sales increased from about 30 percent in 1999 to 38 percent in 2001 (Kehrer 2006). In sum, since the passage of the GLBA, BHCs have been able to engage in a wide range of activities, including securities underwriting and dealing, and insurance agency and underwriting activities.

3.2 Identification Strategy

The main identification challenge is finding an exogenous variation of bank complexity arising from diversification into nonbanking businesses. To address this challenge, we note that the gradual repeal of Glass-Steagall Act over the period from 1996 to 1999 opened up new possibilities for banks to expand into the previously restricted nonbanking business lines, leading to their increased complexity. As such, we identify those BHCs that are more likely to be affected by the deregulations. We argue that the pre-1996 regulations were more likely to be binding for those BHCs that were already diversified into nonbanking activities before the 1996–1999 deregulations. Based on the investments they had already made after the early deregulations in the late 1980s, these BHCs have, on average, a stronger motivation to expand further into nonbanking business lines than other BHCs, but had been unable to do so under the then-existing restrictions until the end of 1996. Accordingly, Figure 2 shows that the non-interest income ratios and nonbank asset ratios of pre-diversified BHCs have increased more than those of the BHCs that are not pre-diversified, a difference that is significant at the one percent level.

This consideration allows us to sort BHCs into two distinct groups. The treatment group consists of BHCs that have nonbanking subsidiaries prior to the end of 1996.[29] The control

[29] As explained in Section 2.3, we use the full organizational tree as developed by Cetorelli, McAndrews, and Traina (2014) which contains not only the cases of BHCs' acquisitions of nonbanking subsidiaries but also the cases when the acquired entity is another BHC that has a nonbanking subsidiary.

group contains BHCs that do not have nonbanking subsidiaries prior to the end of 1996. As a robustness check, we also use nonbanks as an alternative control group. Nonbanks were not directly affected by the deregulation and they were active in the same businesses that the pre-diversified BHCs were expanding into, both before and after the deregulations.

We first study whether pre-diversified BHCs, i.e., those that were diversified into nonbanking activities prior to 1996, observed a greater increase in their operational risk than BHCs that were not pre-diversified. One potential problem with this specification is that a BHC can be assigned to the treatment group only by having subsidiaries that are not among the business lines affected by the deregulations of 1996–1999. Some of the nonbanking activities, such as savings bank and thrift organizations, were largely allowed in the pre-1997 regulatory environment. Therefore, some of the BHCs in our current treatment group may not be strictly bound by the regulations before the end of 1996, which can potentially bias our estimation results by underestimating the full effect of deregulation.

To address this issue, we augment our treatment group by separating it into two subgroups: a group of BHCs that had a Section 20 subsidiary before the repeal of the Glass-Steagall Act and a group of BHCs that contains the remaining pre-diversified BHCs in our treatment group. Because the deregulations significantly relaxed the restrictions on Section 20 subsidiaries' activities, those BHCs that owned a Section 20 subsidiary should have experienced a much greater increase in their deregulation-driven complexity due to their binding position before and during the 1996–1999 deregulations. Indeed, according to the testimony by the Federal Reserve Governor Susan M. Phillips on March 20, 1997, due to the deregulations, *"existing Section 20 subsidiaries have indicated that they have been able to expand their activities, given the added flexibility with respect to both staffing and revenue."* This statement is also consistent with the significant increase in the market share of the Section 20 subsidiaries in the securities and underwriting business, as discussed in Section 3.1.

We collect information on Section 20 subsidiary owners by first following the Appendix in Cornett, Ors, and Tehranian (2002). We then check the complete merger and acquisition history of these BHCs by manually going through their records at the National Information Center (NIC) to identify whether any of these BHCs had their Section 20 subsidiary acquired by the end of 1999 by another high holder that did not own a Section 20 subsidiary beforehand.

Figure 2 compares the evolution of non-interest income ratios and nonbank asset ratios of the pre-diversified BHCs that owned a Section 20 subsidiary and of those that did not own such

a subsidiary prior to the repeal of the Glass-Steagall Act.[30] The Section 20 group's median non-interest income ratio increases from 35 percent in 1996 to 48 percent in 2000, while for the non-Section 20 group the median of this ratio increases from 17 percent in 1996 to a mere 19 percent in 2000. Similarly, the Section 20 group's median nonbank asset ratio increases from 2.2 percent in 1996 to 7.1 percent in 2000, while for the non-Section 20 group the median of the ratio increases from zero in 1996 to a mere 0.16 percent in 2000. In a formal test, the widening of the gap between Section 20 and non-Section 20 groups is statistically significant at the one percent level. While these measures are noisy proxies for complexity, as discussed in Section 2.3, it is nevertheless reassuring that they move in the direction we expected.

Based on this discussion, we study whether the increase in operational risk post-deregulation is more pronounced for pre-diversified BHCs that owned Section 20 subsidiaries prior to the repeal of the Glass-Steagall Act than for other BHCs, including pre-diversified BHCs with other types of subsidiaries and BHCs that were not pre-diversified.

We also study the channels through which complexity can lead to greater operational risk. Under the *managerial failure* hypothesis, increased complexity can strain managerial oversight and employees' focus, hinder the ability to monitor the bank's subsidiaries (Brickley, Linck, and Smith 2003; Berger, Miller, Petersen, Rajan, and Stein 2005), create difficulties in maintaining proper barriers as well as information exchange between different businesses(Murray 2001; Santomero and Eckles 2000; Walter 1997), and reduce the effort of managers due to intensified agency problems (Acharya, Hasan, and Saunders 2006; Laeven and Levine 2007, Aggarwal and Samwick 2003; Scharfstein and Stein 2000; Rajan, Servaes, and Zingales 2000). Under the *strategic risk taking* hypothesis, higher complexity gives the BHCs more opportunity to load on operational risk and benefit from an implicit extension of "too-big-to-fail" guarantees to their nonbank activities (Kane 2000; Carow and Heron 2002) and to be rewarded with improved performance (Neuhann and Saidi 2016; Turbeville 2013; Shleifer and Vishny 2010; Cornett, Ors, and Tehranian 2002).

3.3 Econometric Framework: Difference-in-Differences Estimator

Our identification strategy exploits the 1996–1999 deregulations as a shock to banks' propensity to diversify into nonbanking activities and thereby grow in complexity. In order to empirically

[30]The Glass-Steagall Act was gradually eliminated between 1996 and 1999. Restricting Section 20 ownership to before 1996 instead of 1999 for the treatment group does not change our results.

assess the impact of the *exogenous* change in organizational complexity on BHCs' operational risk and balance sheet performance, we rely on a difference-in-differences estimator that uses the 1996–1999 deregulations as a natural experiment. Recent studies by Neuhann and Saidi (2016, 2018) also use the deregulations as a natural experiment; they examine the effects of the gradual repeal of the Glass-Steagall Act on banks' idiosyncratic stock-return volatilities and participation in the market for syndicated loans.[31]

For each BHC, we specify our baseline model as follows:

$$\begin{aligned} Oprisk_{it} &= \alpha_i + \beta\ After_{it} + \gamma\ After_{it} \times Pre\text{-}Diversified_i \\ &\quad + \textstyle\sum_{k=1}^{K} \delta_k\ Control_{k,it} + \epsilon_{it}, \end{aligned} \tag{2}$$

where $After$ is a dummy variable taking a value of 1 post-deregulation, $Pre\text{-}Diversified$ is a dummy variable equal to 1 for pre-diversified banks, $Control$ is a set of bank-level control variables, and subscripts i and t refer to bank and time indices. The model does not include the stand-alone $Pre\text{-}Diversified$ dummy variable because it is subsumed by the BHC-specific fixed effect α. The dependent variable $Oprisk$ is a measure of operational risk — either annual operational risk frequency ($Count$) or the severity amount, captured by either annual total loss ($Ln\ Total\ Loss$) or annual average loss per event ($Ln\ Avg\ Loss$) (both in logarithmic form).[32]

Our main difference-in-differences analysis uses sample periods 1994–1996 and 2000–2002 for pre- and post-deregulation periods to capture the impact of deregulations that became effective between the end of 1996 and the end of 1999. To address the bias in standard errors when performing difference-in-differences estimation with time series data of serially correlated outcomes, we follow Bertrand, Duflo, and Mullainathan (2004) and take the averages of the observations in our sample in the before period (1994–1996) and in the after period (2000–2002).[33] We also present various robustness checks and falsification tests, including the use of different time periods, to verify the validity of our results and rule out alternative explanations. One of these robustness checks uses the interim period (1997–1999) as the *"After"* period to

[31]Using the deregulations of 1990s as a natural experiment is a popular technique. Other studies include Rice and Strahan (2010) and Krishnan, Nandy, and Puri (2015).

[32]Following Chernobai, Jorion, and Yu (2007), Cope, Piche, and Walter (2012), and Dahen and Dionne (2010), we control for size by adding it as a covariate in the loss severity models. In our robustness checks, we normalize our losses by total assets, by book equity, and by net income, and remove bank size from the list of controls (Internet Appendix B, Table B2) or match treatment and control groups by asset growth (Section 4.3) and obtain similar results.

[33]Bertrand, Duflo, and Mullainathan (2004) present this approach as the most robust one among the alternatives, including bootstrapping and asymptotic approximation of the variance-covariance matrix.

present the gradual nature of the increase in operational risk, consistent with Figure 1.

We use the same DID framework in order to study the managerial failure and strategic risk taking channels through which complexity can lead to greater operational risk. In our first test, we use as our dependent variables the performance measures based on balance sheet variables and market valuations from previous literature (e.g., Cornett, Ors, and Tehranian 2002 and Laeven and Levine 2009), including return on assets (ROA), volatility of ROA, Z-score, and market-to-book ratio. In our second test, we separate banking and nonbanking operational risk events and use their frequency and severity as our dependent variables.

Table 2, Panel B summarizes sample descriptive statistics of our key variables for the 1994–1996 and 2000–2002 periods. An average BHC in our natural experiment sample has $9.98 bln in total assets with a market-to-book ratio of around 1.7. There is a big variation in the cash-to-assets ratio and Tier 1 ratio, ranging from around 0.02 to 0.28 and from 0.04 to 0.29 for 98 percent of the BHCs. In addition, 39 percent of the banks have excessive growth in liabilities, and 56 percent have an above the industry's median dividend payout ratio relative to other BHCs within the previous year. There is also a big variation in the performance measures, ranging from -0.3 to 1.6 percent for ROA, 0.08 to 0.97 percent for volatility of ROA, and -0.5 to 5.1 for Z-score. The frequency and severity of operational risk events also differ significantly across BHCs with the total annual operational loss of $300 million per institution on average, which is an economically significant figure.

4 Business Complexity and Operational Risk: Evidence from the Natural Experiment

This section presents our empirical findings about the effects of complexity on operational risk. We also explore the managerial failure and strategic risk taking channels through which complexity can lead to greater operational risk and present supporting evidence for the former channel.

4.1 Complexity and Operational Risk

We begin by showing that pre-diversified BHCs experienced a greater increase in their operational risk following the deregulations relative to other, not pre-diversified, BHCs. We then present placebo (falsification) test results showing the absence of a similar effect outside of the

deregulation period. Furthermore, our main result is confirmed by an additional robustness test where we use U.S. nonbank financial firms as the control group.

The results of the frequency and severity models for BHCs are presented in Table 4. Our first frequency model is an unconditional difference-in-differences regression where the treatment group consists of BHCs that were pre-diversified (*Pre-Diversified*) before the end of 1996 (Table 4, Panel A, Model (1)). The coefficient for the treatment effect (*After* × *Pre-Diversified*) is positive and statistically significant at the one percent level. Pre-diversified BHCs experienced, on average, a 0.243 greater increase in their event count than other BHCs which experienced only a modest increase of 0.01 in their event count. This effect is robust to inclusion of the bank size (*Ln TA*) variable in Model (2) and other bank-specific controls in Model (3).

Next, we distinguish between pre-diversified BHCs that own a Section 20 subsidiary from other pre-diversified BHCs. As discussed in Section 3.2, we expect the deregulation-induced complexity to affect the operational risk of Section 20 owners more. As shown in Models (4)–(6) of Table 4, Panel A, the impact of the deregulation is indeed much higher for Section 20 owners, as evidenced by the greater magnitude and statistical significance of the coefficients of the *After* × *Pre-Diversified Sec20* variable than those of the *After* × *Pre-Diversified NonSec20* variable. Specifically, the deregulation-induced increase in annual operational risk frequency for Section 20 owners is on average 1.5 times greater than the increase for the control group of not pre-diversified BHCs. Not surprisingly, this result also implies that the remaining pre-diversified banks, those without a Section 20 subsidiary, experience an increase in their event count relative to the not pre-diversified firms to a much lesser extent than what we observed in Models (1)–(3) for the pre-diversified banks (about 0.24 vs. 0.05), although the effect is still statistically significant. When we add the full set of bank-specific controls (Model (6)), while the relative effect on pre-diversified non-Section 20 BHCs becomes slightly higher (0.06 vs. 0.05), it becomes insignificant. The relative effect on Section 20 owners, however, preserves its magnitude and statistical significance.

For our severity models, we estimate difference-in-differences regressions where the dependent variables are the annual total loss (Table 4, Panel B) and the average loss per event (Table 4, Panel C). These results echo those from our frequency models. In particular, Panel B, Model (3) shows that the pre-diversified banks observe an about 65 percent ($exp(0.5) = 1.65$) greater increase in their annual total loss than not pre-diversified banks. Moreover, Models (4)–(6) show that, as in the frequency models, this result is predominantly driven by Section

20 owners. Table 4, Panel C, confirms these results for the annual average loss per event.

Our results show that the impact of complexity on operational risk cannot be captured by bank size or other bank-specific confounding variables. The coefficient of size is positive and significant at 10 percent or less in all models, consistent with previous findings (Chernobai, Jorion, and Yu 2011; Wang and Hsu 2013). As alternative methods to control for bank size, we normalize losses by total assets, by book equity, and by net income, and exclude bank size from the list of controls (Internet Appendix B, Table B2); or match treatment and control groups by asset growth (Section 4.3). The results are qualitatively the same in all specifications.

Overall, our results are largely consistent with the argument that the deregulation-induced complexity of BHCs has lead to greater operational risk. Following the deregulation, the operational risk of pre-diversified BHCs increased significantly relative to other BHCs. This effect is particularly strong for Section 20 owners, consistent with the fact that their pre-deregulation binding position leads them to experience a greater increase in their organizational complexity by expanding into the deregulated nonbanking activities, as described in Section 3.3 and Figure 2.

For our placebo (falsification) tests, we use the same treatment and control groups but different "before" and "after" sample periods: 1991–1993 vs. 1994–1996 in the first test and 2000–2002 vs. 2003–2005 in the second test. This analysis serves two purposes. First, since there was no similarly-scaled deregulation of BHCs' nonbanking activities before the end of 1996 and after the end of 1999, we should expect to see no treatment effect in placebo tests. Results to the contrary may suggest that omitted time-variant variables drive our treatment effect, which would be in violation of the parallel time trend assumption of a DID regression.[34] Second, the latter placebo test would also inform us whether the effects of the 1996–1999 deregulations were persistent or whether they dissipated in the 2003–2005 period. For the first placebo test (Table 5), we pick up no significant treatment effect, thus putting to rest concerns over a pre-existing non-parallel time trend in our treatment and control groups. For the second placebo test (Table 6), we observe a small decline in operational risk losses for all banks, although this result is statistically insignificant across all model specifications with control variables.[35] This

[34]Of the two placebo tests, the first test is particularly interesting, as the year 1994 coincides with the passage of the Riegle-Neal Interstate Banking and Branching Efficiency Act. We also provide a more detailed analysis of the potential impact of the Riegle-Neal Act on our DID estimation in Section C.4 of the Internet Appendix C. Our results remain robust.

[35]For brevity, Tables 5 and 6 do not show the coefficients of the control variables. Complete results are

decline is likely driven by the Sarbanes-Oxley Act passed in July 2002 and the Basel II Capital Accord issued in June 2004, both of which are geared toward improving risk management. Moreover, we observe only a small and statistically insignificant decline in operational risk for pre-diversified banks and Section 20 owners relative to other banks, suggesting that the effect of the deregulation on operational risk after 1999 was persistent.[36]

In the previous regressions, our control group consisted of BHCs that were not diversified before 1996. In the following, we re-estimate our key equations with U.S. nonbank financial firms as the control group, because they were never subject to banking regulations and hence their complexity should not have been affected by the deregulations.

To address the concern that different nonbanking business lines of BHCs can have different risk levels by nature and that not all of their business lines were affected equally by the deregulations, we use the securities firms (SIC codes 62xx) as our nonbank control group and add a dummy variable for each of the remaining nonbanking financial sectors interacted with the *After* dummy.[37] Since nonbanks do not file FR Y-9C, we construct equivalent firm-specific controls for both BHCs and nonbank financial firms using Compustat. Our treatment group is Section 20 holders because their nonbanking activities are more directly comparable to the control group, the securities firms, and also because we do not have detailed information about the extent to which other BHCs are engaged in other individual nonbanking activities. Nevertheless, we include BHCs that do not have a Section 20 subsidiary in our regressions as a separate group for completeness.

Table 7 summarizes the findings.[38] The main result is that BHCs that are Section 20 subsidiary owners (*BHC Sec20*) experienced a substantially greater increase in operational risk

included in the Internet Appendix B, Tables B3 and B4.

[36]As a third test, we use periods 1994–1996 vs. 2003–2005 to check the persistence of the treatment effect and obtained similar conclusions. The results are included in the Internet Appendix B, Table B5. We also investigate the speed with which banks' operational risk levels adjust to the new complexity levels. In this test, depicted in the Internet Appendix B, Table B6, we use the deregulation period, 1997–1999, as our *"After"* period in the econometric models. We find all treatment effects to be lower in magnitudes but still statistically significant at the five or one percent levels, suggesting that the rise in operational risk as a result of higher complexity was, in fact, gradual, consistent with the gradual nature of the deregulations.

[37]These sectors include non-depository credit institutions (SIC codes 61xx), insurance carriers (SIC codes 63xx), insurance agents, brokers and services (SIC codes 64xx), real estate firms (SIC codes 65xx), and other investment offices (SIC codes 67xx excluding 671x). Uninteracted industry dummy variables are absorbed by the fixed effects.

[38]For brevity, the table does not show the coefficients of the control variables. Complete results are included in the Internet Appendix B, Table B7.

than their nonbank counterparts ($SIC62$, the control group), as evidenced by the coefficient of *After* $\times$ *BHC Sec20* in Models (4)–(6). Moreover, the coefficients of the nonbanks with SIC codes 63xx and above are not significantly different from those of the SIC 62xx control group in Table 7. Overall, the higher complexity due to business diversification of Section 20 holders increased their operational risk significantly relative to all other nonbank institutions. This result lends additional support to our hypothesis that Section 20 owners experienced a greater increase in operational risk due to deregulation-driven complexity.

4.2 Managerial Failure vs. Strategic Risk Taking: Evidence from Performance Measures

Higher complexity can lead to greater operational risk either due to managerial failure or strategic risk taking, as described at the end of Section 3.2. To identify the dominant channel, we examine the changes in performance measures following the deregulation. A performance improvement following increased complexity would support the strategic risk taking hypothesis, whereas the lack thereof would be consistent with the managerial failure hypothesis. We use the same DID framework and replace the dependent variable with several balance-sheet and market-based measures of performance drawing on prior literature (e.g., Cornett, Ors, and Tehranian 2002 and Laeven and Levine 2009): return on assets (ROA), volatility of the ROA, the Z-score, and market-to-book ratio. The control variables are the same as in the operational risk models but we exclude market-to-book ratio as it is now a dependent variable, and ROE as it is highly correlated with ROA.

The findings are presented in Table 8, Panel A. Models (1) and (2) of ROA show that pre-diversified BHCs do not experience a significant increase in their ROA after the deregulation relative to other BHCs. In fact, according to Model (2), Section 20 owners experienced a small and insignificant decline in their ROA relative to not pre-diversified BHCs. Moreover, the results with the standard deviation of ROA and the Z-score suggest that complexity does not bring the benefit of reduced balance sheet riskiness either.

These results offer two important insights. First, they highlight an advantage of using operational risk data over balance-sheet-based performance measures to study risk management. In particular, the timing of the origin of operational risk events is well identified, which prevents the identification problems associated with stale information, whereas balance sheet losses can appear with a significant delay (Kohn 2009), thereby hiding the consequences of poor risk

management. Second, if the strategic risk taking hypothesis were true, then we should observe performance improvement during the "After" period (2000–2002) because this three-year period should allow for sufficient time for the potential benefits of complexity to show up on the balance sheet.[39] We found no evidence that loading on additional risk was compensated with better performance for more complex BHCs, which disagrees with strategic risk taking hypothesis.[40]

Unlike balance-sheet measures of performance, market-based measures do not suffer from the timing problem because asset prices immediately reflect all available information that can materialize in the distant future. However, market valuations may be contaminated by confounding factors, such as implicit government guarantees. This can make a more complex bank appear less risky from the perspective of investors while being in fact more risky from the perspective of taxpayers (Acharya, Anginer, and Warburton 2016) who are the primary focus of regulatory policies. With this in mind, we examine BHCs' market-to-book ratios in the same DID setting.

The market-to-book models in Table 8, Panel A, reveal that pre-diversified BHCs' market-to-book ratios increased following the deregulation (Model (1)) and the increase is stronger especially for Section 20 owners (Model (2)). In particular, Section 20 owners experience a 32 basis points increase in their market-to-book values relative to the not pre-diversified BHCs, all else held equal. Although this suggests that investors value the expansion of BHCs into nonbanking business lines as positive news, this result is not accompanied by a simultaneous increase in ROA, thus pointing to implicit government guarantees as the likely reason for the increase in market valuation. To examine whether this effect persists, in Panel B of Table 8 we perform the DID estimation using 2000–2002 and 2003–2005 sample periods. We observe a negative and statistically significant treatment effect for the market-to-book ratio of the Section 20 subsidiary holders. The magnitude of this negative effect is larger than the positive effect we find in Panel A. Therefore, we conclude that the increase in market-to-book values of the Section 20 owners relative to other BHCs following the deregulation was, at best, temporary. At the same time, we observe no significant treatment effect for the balance sheet measures in Panel B of Table 8. Altogether, these findings disagree with the strategic risk-taking hypothesis

[39]See, for example, Cornett, Ors, and Tehranian (2001) who also use a three year period in their study that focuses on how balance-sheet performance is affected by the establishment of a Section 20 subsidiary.

[40]There may be other benefits of diversification, such as higher market share and political power. However, if these benefits do not manifest themselves as performance improvement it would suggest that the managers are given the wrong incentives to expand their business, which would be consistent with managerial failure hypothesis.

and lend support to the managerial failure hypothesis.[41]

4.3 Managerial Failure vs. Strategic Risk Taking: Evidence from Banking and Nonbanking Events

As an additional test to identify the dominant channel through which complexity leads to greater operational risk, we separate the operational risk events into banking and nonbanking events. Since banking business lines were presumably unaffected by the deregulation, an increased operational risk in core (banking) business lines would suggest that the managers' attention and effort in their core business line weakened due to increased complexity. Such a result would be consistent with the managerial failure hypothesis because strategic risk taking in the newly expanded nonbanking business lines should not have a significant effect on BHCs' core business line.

Separating the operational risk events into banking and nonbanking events has other potential benefits as well. One alternative explanation of the treatment effect in Table 4 is that Section 20 owners, compared to the other BHCs, can experience greater operational risk when they expand into securities activities because these activities are inherently riskier than the traditional commercial banking business (Boyd and Graham 1986; Boyd, Graham, and Hewitt 1993) and not because their complexity goes up. Table 7 partially addressed this concern by using nonbanks (specifically, securities firms) as the alternative control group, where we found a significant increase in the operational risk events for Section 20 owners in comparison with all nonbanks, and in particular with securities firms. Nevertheless, we may capture the risk inherent in nonbanking activities of Section 20 owners more accurately by separating banking and nonbanking events. This separation allows us to study the change in operational risk stemming from banking events by comparing Section 20 owners with other banks and the change in operational risk stemming from nonbanking events by comparing Section 20 owners with nonbanks engaged in similar activities, i.e., securities firms.

Following the BIS business line classification, we define an operational risk event as a banking event if it originated from one of the following business lines: Retail Banking, Commercial Banking, Payment and Settlement, or Agency Services; we define an event as a nonbanking event if it originated from one of the Asset Management, Corporate Finance, Retail Brokerage,

[41]To verify the lack of persistence of the treatment effect even further, we compare 1994–1996 and 2003–2005 periods as summarized in the Internet Appendix B, Table B8. As Table B8 demonstrates, the treatment effect for the market-to-book value is small and statistically insignificant.

Trading and Sales, or Insurance business lines. About 40 percent of the operational risk events in our sample are nonbanking events.

There is another benefit from answering whether the increased operational risk in Section 20 owners is driven by the events from the nonbanking business lines alone or from the banking activities as well. If the increase in operational risk stems solely from the nonbanking activities of the U.S. BHCs, then the elevated complexity caused by the deregulation may be less of a concern for the activities within the core (banking) business lines. If, on the contrary, the additional operational risk is predominantly driven by the events within banking activities, then the negative effects of greater complexity may generate a greater systemic risk, with significant ramifications for the regulation of complexity.

We also simultaneously address the possibility that the true cause of heightened operational risk post-deregulation is the rapid growth of Section 20 owners for reasons unrelated to complexity. While we have addressed this issue by adding size as an additional control (Table 4) and also by normalizing the loss amounts by bank size (total assets, book equity, or net income) in a separate robustness test (Internet Appendix B, Table B2), we tackle any remaining concerns by matching the treatment and control groups by their annual asset growth.

To fully utilize these advantages, we compare banking events of Section 20 owners with those of other BHCs, and nonbanking events of Section 20 owners with those of securities firms. We separate a BHC's assets into the banking and nonbanking parts and compute the asset growth rate for each, measured from the pre-deregulation period (1994–1996) to the post-deregulation period (2000–2002). To study banking events, we match Section 20 owners with the non-Section 20 BHCs by the growth of their average banking assets. Similarly, to study nonbanking events, we match Section 20 owners with securities firms (SIC code 62xx) by their nonbanking asset growth.[42] To improve the matching quality, we perform the growth matching with replacement, i.e., we require that the selection of the non-Section 20 firms for different Section 20 owners is independent of each other. To ensure a sufficiently large sample size for our matched sample, we match each Section 20 owner with top three non-Section 20 firms based on the shortest Mahalanobis distance. The mean and median banking assets' growth rates are 69.77% and 86.3% with a standard deviation of 61.35% for Section 20 owners, and are 81.15%

[42]We compute the banking assets of a Section 20 holder as its total assets minus the assets of its nonbanking subsidiaries (item BHCP4778 from the FR Y-9L filings), and the nonbanking assets as the assets of its nonbanking subsidiaries. We treat total assets of securities firms as their nonbanking assets.

and 95.56% with a standard deviation of 54.93% for non-Section 20 BHCs. The mean and median nonbanking assets' growth rates are 168.20% and 158.29% with a standard deviation of 80.48% for Section 20 owners and are 149.41% and 131.06% with a standard deviation of 91.15% for the securities firms.

We then perform two DID estimations, one using only the BHCs and their banking events and the other using only the Section 20 owners and securities firms and their nonbanking events. The results are presented in Table 9.[43] For banking events (Models (1)–(3)), the treatment effect is similar to our main findings (Table 4). In particular, in Table 4, Models (6), the coefficients for the Section 20 treatment effect for all events were 1.569 for operational risk frequency, 2.102 for total annual operational loss, and 1.822 for annual average operational loss. Comparable coefficients for only banking events (Table 9, Models (3)) are 0.871, 2.325, and 2.131. For nonbanking events (Models (4)–(6)), our results parallel those from the banks vs. nonbanks robustness check (Table 7) and the treatment effect remains highly consistent despite a much smaller sample size. In particular, in Table 7, Models (6), the coefficients for the Section 20 treatment effect were 1.072, 1.647, and 1.462 in the frequency model and the two severity models, respectively. These are close to the numbers obtained for only nonbanking events, 1.159, 1.759, and 1.393 (Table 9, Models (6)). The weaker statistical significance stems from the limited size of our matched sample.[44]

In sum, we find that Section 20 owners experienced a greater increase in operational risk compared to other BHCs not only in the new, nonbanking, business lines but also in their core (banking) business line. Since banking business lines were unaffected by the deregulation, the finding that operational risk increased in banking activities suggests that the managers' attention and monitoring effort in the core business line weakened as the BHCs became more diversified and more complex and is consistent with the managerial failure hypothesis. Additionally, we find that Section 20 owners experienced a greater increase in operational risk from nonbanking activities compared to securities firms, alleviating any remaining concerns that our results might be driven by the potentially riskier nature of nonbanking activities.

[43]For brevity, the table does not show the coefficients of the control variables. Complete results are included in the Internet Appendix B, Table B9.

[44]When we use the full sample instead of the matched samples, the treatment effect due to nonbanking events has a similar magnitude and is statistically more significant and the results for banking events remain statistically significant. See Internet Appendix B, Table B10.

5 Other Robustness Checks

We summarize the results of our further robustness checks in this section and provide the details in the Internet Appendix C. These robustness checks address any remaining concerns regarding whether our results are truly driven by changes in complexity or whether there are alternative explanations. First, we use the full sample of 1988–1996 vs. 1997–2005 to construct the before and after periods and perform a difference-in-differences estimation. Our original results remain largely similar (Internet Appendix C, Section C.1). Second, as we explained in Section 2.1, our focus has been on four of the seven Basel-defined event types that are more likely to be affected by changes in business complexity; we left out events of types employment practices and workplace safety, damage to physical assets, and business disruption and system failures. After including these events, our results remain robust (Internet Appendix C, Section C.2). Third, we examine whether our results for Section 20 owners could be attributed to the insurance deregulations during the same time window. In particular, we limit our sample only to those BHCs that derive less than 1% of their income from insurance activities and confirm that Section 20 owners have experienced significantly greater increase in operational risk as well within this sample (Internet Appendix C, Section C.3).[45] Fourth, we find that our results cannot be explained by the increased M&A activity in the banking sector (Internet Appendix C, Section C.4) following the Riegle-Neal Interstate Banking and Branching Efficiency Act, which was signed in 1994 and became fully effective in June 1997. This result is not surprising given that most of the barriers for interstate branching were lifted by the time the Act became fully effective. Finally, we use the number of news articles from the Factiva business news database as a proxy for media attention to the BHCs in our sample and find that potentially greater media attention for the BHCs in our treatment group cannot explain our results either (Internet Appendix C, Section C.5). To summarize, the results of our comprehensive robustness tests reinforce our main results and help rule out alternative explanations of our findings. We therefore conclude that business complexity is a significant driver of operational risk.

[45] Our choice of the 1 percent threshold is guided by the general disclosure threshold of FR Y-9C in those years, when a BHC was required to report any source of income that made up more than 1 percent of its total annual income under the category of other income for a given year if that income source was not specifically requested elsewhere in that year's FR Y-9C.

6 Conclusion

Using the repeal of the Glass-Steagall Act during 1996–1999 as a natural experiment, we show that the frequency and magnitude of operational risk events have increased significantly with bank complexity. This trend has been particularly strong for bank holding companies that were constrained by the regulations restricting their nonbanking activities, especially those with existing Section 20 subsidiaries, while weaker for the other banks that did not engage in extensive securities underwriting and dealing activities and for nonbank financial institutions that were not subject to the same regulations. Our findings are robust to an extensive array of robustness tests which include using alternative treatment and control groups, extending the sample period, using all operational risk event types, accounting for insurance deregulation, and controlling for the merger and acquisition activity and media coverage. We show that our results are likely to be explained by managerial failure rather than strategic risk taking because complexity does not lead to a large or permanent improvement in BHCs' performance and also because higher complexity generates greater operational risk not only in BHCs' nonbanking business lines but also in their core (banking) business line.

Some recent studies document negative externalities of operational risk events to other financial firms (e.g., Cummins, Wei, and Xie 2011; Chernobai, Jorion, and Yu 2007). These externalities imply that the higher levels of operational risk we observe after the deregulation are not socially optimal. Our results suggest that these spillovers are more likely to originate from more complex BHCs. Moreover, these externalities may be amplified by the aforementioned potential moral hazard problem and they may remain hidden until far too late due to the long gap between origination and realization of operational risk events. Therefore, we hope that our study would jump-start new scholarly research on the interaction between complexity and risk management in the financial sector.

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Figure 1: Frequency of Operational Risk Events

This figure illustrates the annual count of operational risk events by origination year, along with the number of bank holding companies, in our sample period. The dashed lines around 1996 and 1999 indicate the timing of deregulations.

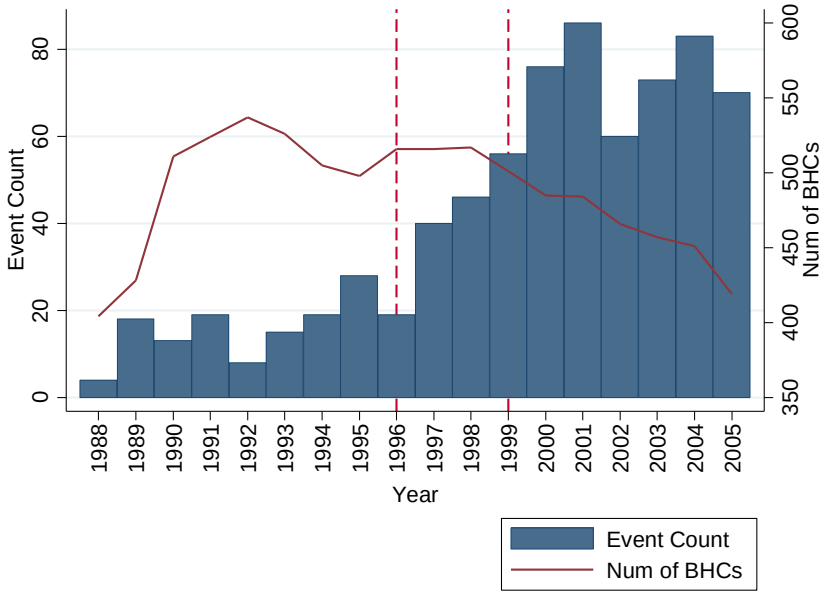
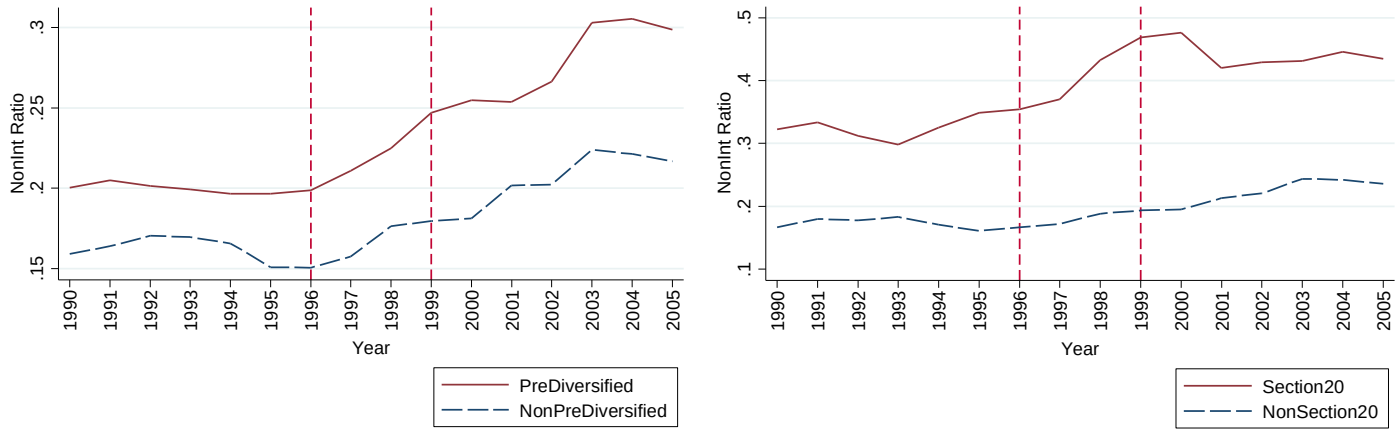


Figure 2: Non-Interest Income Ratios and Nonbank Asset Ratios

This figure illustrates non-interest income ratios (Panel A) and nonbank asset ratios (Panel B) for the bank holding companies in our sample. The "pre-diversified" group refers to bank holding companies that diversified into nonbanking businesses prior to 1996, and the "Section 20" group refers to bank holding companies with a Section 20 subsidiary.

Panel A: Non-Interest Income Ratio



Panel B: Nonbank Asset Ratio

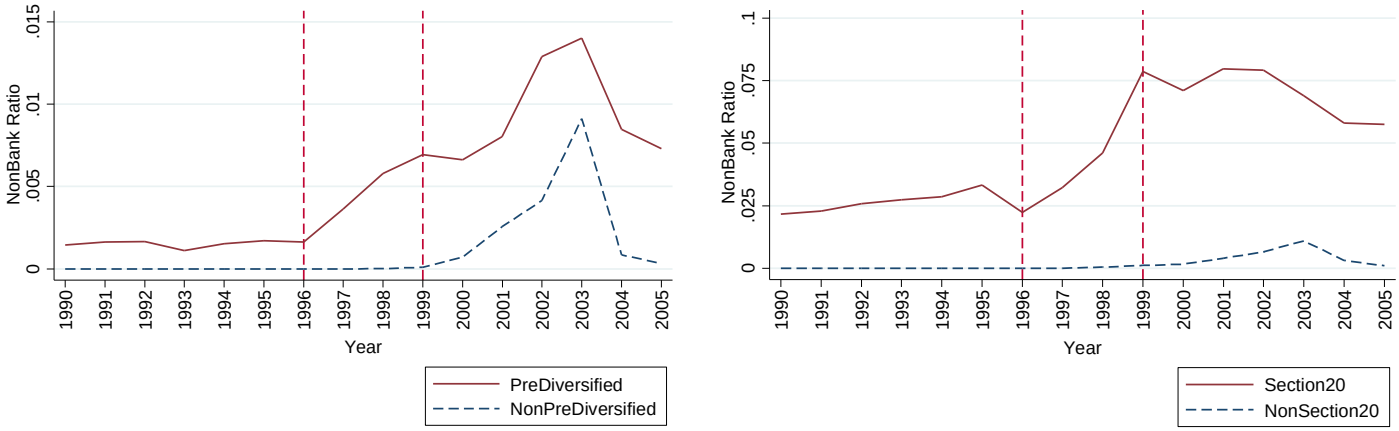


Table 1: Variable Definitions and Sources of Data Used in the Study

This table summarizes the variable definitions and sources of data used in our study.

Variables	Definition
Treatment Group Indicators (1988–2005)	
Pre-Diversified	An indicator variable equal to 1 if the BHC is pre-diversified into nonbanking activities before the end of 1996.
Pre-Diversified Sec20	An indicator variable equal to 1 if a BHC owned a Section 20 subsidiary before the repeal of the Glass-Steagall Act.
Pre-Diversified NonSec20	An indicator variable equal to 1 if a BHC did not own a Section 20 subsidiary before the repeal of the Glass-Steagall Act but is pre-diversified before the end of 1996.
After	An indicator variable equal to 1 for the post-deregulation period (after 1999).
Operational Risk Variables (1988–2005)	
Count	Annual number of operational risk events, from the IBM Algo FIRST database.
Ln Total Loss	Annual total operational loss amount, from the IBM Algo FIRST database. Units: *ln*(USD millions).
Ln Avg Loss	Annual average operational loss amount per event, from the IBM Algo FIRST database. Units: *ln*(USD millions).
Bank Level Characteristics (1988–2005)	
Ln TA	Total assets is a proxy for bank size. It is measured by quarterly BHCK2170 from FR Y-9C or by quarterly ATQ from CRSP and Compustat Merged (CCM). The variable is consolidated to the annual level as a state variable. Units: *ln*(USD millions).
Market-To-Book	Market-to-book ratio is a proxy for bank growth opportunities and is inversely related to default risk. It is estimated as the ratio of MVE to book equity. MVE is estimated by monthly PRC * SHROUT from CRSP and then summed to the quarterly level or by quarterly CSHOQ * PRCCQ from CCM. Book equity is estimated by quarterly BHCK3230 + BHCK3240 + BHCK3247 – BHCK3153 from FR Y-9C or by quarterly CEQQ from CCM. The variable is consolidated to the annual level as a state variable.
ROA%	Return on assets is a proxy for bank profitability. It is estimated as net income divided by total assets: quarterly (BHCK4340/BHCK2170)*100% from FR Y-9C or quarterly (OIBDPQ/ATQ)*100% from CCM. The variable is consolidated to the annual level as a flow variable.
SD ROA%	Standard deviation of return on assets is a proxy for bank riskiness behavior. It is estimated as the standard deviation of the quarterly return on assets in a given year. The variable is calculated at the annual level.
Z-Score	*Z*-score is a proxy for bank stability. It is estimated as return on assets plus equity-to-asset ratio, scaled by the standard deviation of return on assets, where equity-to-asset ratio is estimated by (book equity)/(total assets). The variable is calculated at the annual level, with the return on assets and equity-to-asset ratio consolidated to the annual level as a flow and state variables.
Cash-To-TA	Ratio of cash and short-term investments to assets is a proxy for "problem banks." It is estimated as quarterly (BHCK0081 + BHCK0395 + BHCK0397 + BHCK0383)/BHCK2170 from FR Y-9C or as quarterly CHEQ/ATQ from CCM. The variable is consolidated to the annual level as a state variable.
Tier 1 Ratio	Ratio of regulatory Tier 1 capital to risk-weighted assets. The Basel Accord requires financial institutions to hold regulatory Tier 1 capital as a protection mechanism against financial risks. It is estimated as quarterly (BHCK3210 + BHCK3247)/BHCK2170 from FR Y-9C or as quarterly (TEQQ + REQ)/ATQ from CCM. The variable is consolidated to the annual level as a state variable. To maximize available observations on TEQQ, we replaced the missing TEQQ first by quarterly CEQQ + PSTKQ and then by quarterly ATQ – LTQ from CCM.
ROE (%)	Return on equity is an additional control for bank profitability. It is estimated as net income divided by book equity. The variable is consolidated to the annual level as a flow variable. The variable is winsorized at 2% and 98% for the CCM measure to avoid extreme values from nonbank financial firms.
Excessive Growth	Excessive growth in liabilities is a proxy for bank aggressive growth. It is an indicator equal to 1 if a bank experienced a positive growth of liabilities and assets in the previous year and the growth of liabilities exceeded the growth of assets. Liabilities and assets are measured by quarterly BHCK2948 and BHCK2170 from FR Y-9C or by quarterly LTQ and ATQ from CCM. The variable is calculated at the annual level, with liabilities and assets consolidated to the annual level as state variables.
High Dividend	High dividend payout ratio is used to capture "troubled banks." It is an indicator equal to 1 if a bank's dividend payout ratio during the previous year exceeded the annual median across all sample BHCs. It is measured by quarterly (BHCK4460 + BHCK4598)/BHCK2170 from FR Y-9C or by annual DVT/quarterly ATQ from CCM. The variable is calculated at the annual level, with BHCK4460 and BHCK4598 consolidated to the annual level as flow variables and BHCK2170 and ATQ consolidated to the annual level as state variables.
Other Variables	
Diversified	An indicator variable equal to 1 if the BHC or its subsidiaries diversified into nonbanking activities in the past year.
Non-Interest Income Ratio	Non-interest income divided by the sum of net interest income and non-interest income, BHCK4079/(BHCK4079 +BHCK4074) from FR Y-9C.
Nonbank Asset Ratio	Nonbank assets divided by total assets, BHCP4778/BHCK2170 from FR Y-9LP.
BHC	An indicator variable equal to 1 if the financial institution is a BHC.
BHC Sec20	An indicator variable equal to 1 if a BHC owned a Section 20 subsidiary before the repeal of the Glass-Steagall Act. This variable is the same as *Pre-Diversified Sec20*.
BHC NonSec20	An indicator variable equal to 1 if a BHC did not own a Section 20 subsidiary before the repeal of the Glass-Steagall Act.
SIC61 – SIC65, SIC67	Nonbank indicator variables for each financial sub-industry, according to the SIC two-digit code: non-depository credit institutions (*SIC61*), securities firms (*SIC62*), insurance carriers (*SIC63*), insurance agents, brokers, and services (*SIC64*), real estate firms (*SIC65*), and other investment offices excluding SIC codes 671x (*SIC67*).
Banking M&A	The number of banking sector M&As for each BHC in the previous three years, from the Federal Reserve Bank of Chicago's M&A database.
Banking M&A Target Assets Ratio	Annual target assets ratio for banking sector M&As for each BHC in a given year is the assets of all targets from M&As in the current year divided by the total assets of the high holder in the previous year. Banking M&A Target Assets Ratio is the average of annual target assets ratio over the last three years.
Media	Annual count of news articles for each BHC from the Factiva business news database.

Table 2: Summary Statistics of Key Bank-Level Characteristics

This table summarizes the sample statistics of key bank-level characteristics used in our study, measured at event origination and at the bank-year level. Panel A uses 1988–2005 data and Panel B uses 1994–1996 (pre-deregulation) and 2000–2002 (post-deregulation) data. For the operational risk variables (*Count*, *Ln Total Loss*, and *Ln Avg Loss*), the statistics refer to the cases with existing operational risk events.

Panel A: Complete Sample: 1988–2005

	Percentile							
	1th	25th	50th	75th	99th	Mean	SD	Num Obs
Count	1	1	1	2	17	2.545	3.308	288
Ln Total Loss	-4.605	-0.828	1.964	4.061	9.076	1.443	3.693	288
Ln Avg Loss	-4.605	-0.924	1.829	3.265	6.838	0.943	3.267	288
Diversified	0	0	0	0	1	0.140	0.347	7,751
Non-Interest Income Ratio	0.043	0.141	0.194	0.266	0.735	0.220	0.145	7,751
Nonbank Asset Ratio	0	0	0	0.013	0.522	0.025	0.087	7,751
Ln TA	4.823	5.931	6.679	7.859	12.158	7.091	1.594	7,751
Market-To-Book	0.263	1.174	1.592	2.115	4.840	1.771	5.272	6,222
Cash-To-TA	0.016	0.049	0.077	0.116	0.309	0.090	0.058	7,751
Tier 1 Ratio	-0.001	0.100	0.124	0.151	0.260	0.128	0.066	7,751
ROE (%)	-20.464	5.651	7.603	9.217	16.112	6.522	19.485	7,751
Excessive Growth	0	0	0	1	1	0.417	0.493	6,800
High Dividend	0	0	1	1	1	0.512	0.500	7,743
ROA (%)	-1.112	0.456	0.638	0.797	1.433	0.595	0.506	7,751
SD ROA (%)	0.061	0.252	0.334	0.419	1.281	0.362	0.294	7,624
Z-Score	-1.431	2.083	2.211	2.388	4.486	2.169	1.197	7,624

Panel B: Reduced Sample for DID Models: 1994–1996 (Pre-Deregulation) and 2000–2002 (Post-Deregulation)

	Percentile							
	1th	25th	50th	75th	99th	Mean	SD	Num Obs
Count	1	1	1	2	13	2.152	2.885	105
Ln Total Loss	-4.605	-0.825	1.603	3.745	8.178	1.011	3.456	105
Ln Avg Loss	-4.605	-0.825	1.257	2.712	5.726	0.634	3.086	105
Ln TA	5.064	6.015	6.725	7.953	12.311	7.177	1.613	2,257
Market-To-Book	0.543	1.241	1.558	1.960	4.686	1.699	0.866	1,816
Cash-To-TA	0.020	0.050	0.075	0.108	0.282	0.086	0.053	2,257
Tier 1 Ratio	0.042	0.107	0.132	0.158	0.288	0.137	0.059	2,257
ROE (%)	-4.323	6.445	7.934	9.457	16.058	7.650	4.872	1,762
Excessive Growth	0	0	0	1	1	0.386	0.487	2,075
High Dividend	0	0	1	1	1	0.563	0.496	2,254
ROA (%)	-0.288	0.550	0.691	0.835	1.578	0.690	0.405	2,257
SD ROA (%)	0.079	0.282	0.356	0.428	0.974	0.372	0.222	2,217
Z-Score	-0.531	2.087	2.196	2.347	5.093	2.294	1.822	2,217

Table 3: Business Complexity and Operational Risk: Preliminary Evidence

This table presents the results of the models for our preliminary analysis used in Section 2.5. The dependent variable is annual operational risk event frequency (*Count*), annual total loss (*Ln Total Loss*), and annual average loss per event (*Ln Avg Loss*). The second and third are in logarithmic form. The key explanatory variable is a proxy for business complexity: dummy variable equal to 1 if the BHC diversified into nonbanking activities in the past year (Panel A), non-interest income ratio (Panel B), and nonbank asset ratio (Panel C). For each operational risk measure, Model (1) contains no additional controls and Model (2) contains the full set of controls. All models use annual data for 1988–2005. *t*-statistics reported in parentheses are based on robust standard errors clustered at the bank holding company and year levels. Superscripts ***, **, and * indicate statistical significance at 1%, 5%, and 10% levels. The coefficients of control variables are omitted due to space limitations; complete results can be found in the Internet Appendix B, Table B1.

Panel A: Measure of Complexity: Diversification into Nonbanking Activities

	Count		*Ln Total Loss*		*Ln Avg Loss*	
	(1)	(2)	(1)	(2)	(1)	(2)
Diversified	0.104**	0.102**	0.231***	0.238***	0.207***	0.213***
	(2.161)	(2.177)	(3.120)	(2.913)	(3.202)	(2.957)
Ln TA	0.169***	0.229***	0.312***	0.397***	0.276***	0.348***
	(2.959)	(3.015)	(4.675)	(4.704)	(5.000)	(5.058)
Other Control Variables	No	Yes	No	Yes	No	Yes
Num Observations	7,751	4,735	7,751	4,735	7,751	4,735
R-squared	0.129	0.155	0.163	0.186	0.155	0.175

Panel B: Measure of Complexity: Non-Interest Income Ratio

	Count		*Ln Total Loss*		*Ln Avg Loss*	
	(1)	(2)	(1)	(2)	(1)	(2)
Non-Interest Income Ratio	0.351*	0.281	0.520**	0.469*	0.469**	0.445**
	(1.930)	(1.185)	(2.324)	(1.722)	(2.466)	(1.964)
Ln TA	0.163***	0.225***	0.309***	0.397***	0.273***	0.346***
	(2.887)	(2.931)	(4.491)	(4.488)	(4.794)	(4.797)
Other Control Variables	No	Yes	No	Yes	No	Yes
Num Observations	7,751	4,735	7,751	4,735	7,751	4,735
R-squared	0.130	0.154	0.162	0.184	0.154	0.174

Panel C: Measure of Complexity: Nonbank Asset Ratio

	Count		*Ln Total Loss*		*Ln Avg Loss*	
	(1)	(2)	(1)	(2)	(1)	(2)
Nonbank Asset Ratio	1.168*	1.511*	1.137**	1.336**	0.882**	1.032**
	(1.868)	(1.956)	(2.339)	(2.195)	(2.286)	(2.100)
Ln TA	0.165***	0.221***	0.319***	0.403***	0.283***	0.355***
	(3.050)	(3.100)	(4.757)	(4.866)	(5.084)	(5.231)
Other Control Variables	No	Yes	No	Yes	No	Yes
Num Observations	7,751	4,735	7,751	4,735	7,751	4,735
R-squared	0.146	0.172	0.167	0.188	0.157	0.176

Table 4: Difference-in-Differences Analysis: Evidence from the Natural Experiment

This table presents the results of our difference-in-differences analysis for operational risk. The dependent variables are annual operational risk event frequency (*Count*) in Panel A, annual total loss (*Ln Total Loss*) in Panel B, and annual average loss per event (*Ln Avg Loss*) in Panel C. The second and third are in logarithmic form. All data are averaged over the 1994–1996 (pre-deregulation) and 2000–2002 (post-deregulation) sample periods. All models include bank-level fixed effects, which subsume the effect of the stand-alone treatment and control group dummies. *t*-statistics reported in parentheses are based on robust standard errors clustered at the bank holding company level. Superscripts ***, **, and * indicate statistical significance at 1%, 5%, and 10% levels.

Panel A: Annual Operational Risk Event Frequency

	(1)	(2)	(3)	(4)	(5)	(6)
After	0.010*	-0.125**	-0.224*	0.010*	-0.135**	-0.282**
	(1.950)	(-1.984)	(-1.871)	(1.949)	(-2.322)	(-2.388)
After × Pre-Diversified	0.243***	0.243***	0.282**			
	(2.856)	(2.882)	(2.525)			
After × Pre-Diversified Sec20				1.527***	1.533***	1.569***
				(2.807)	(2.853)	(2.787)
After × Pre-Diversified NonSec20				0.051**	0.050**	0.061
				(2.151)	(2.140)	(1.555)
Ln TA		0.171**	0.316**		0.184**	0.337***
		(2.143)	(2.190)		(2.490)	(2.614)
Market-To-Book			0.012			-0.057
			(0.234)			(-0.875)
Cash-To-TA			-0.082			-1.383
			(-0.086)			(-1.191)
Tier 1 Ratio			3.105**			2.694**
			(2.096)			(2.434)
ROE			-0.010			0.011
			(-0.775)			(0.861)
Excessive Growth			0.011			0.080
			(0.119)			(1.002)
High Dividend			-0.188			-0.141
			(-1.244)			(-1.071)
Constant	0.050***	-1.106**	-2.492**	0.050***	-1.194**	-2.561**
	(2.942)	(-1.999)	(-2.058)	(3.388)	(-2.340)	(-2.432)
Bank Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Num Observations	694	694	412	694	694	412
R-squared	0.061	0.075	0.118	0.293	0.309	0.336

Panel B: Annual Total Operational Loss

	(1)	(2)	(3)	(4)	(5)	(6)
After	0.051	-0.136	-0.283	0.051	-0.149	-0.356**
	(1.279)	(-1.210)	(-1.404)	(1.278)	(-1.466)	(-2.011)
After × Pre-Diversified	0.383***	0.383***	0.501***			
	(3.080)	(3.105)	(3.458)			
After × Pre-Diversified Sec20				1.918***	1.927***	2.102***
				(3.436)	(3.474)	(4.091)
After × Pre-Diversified NonSec20				0.152	0.151	0.227*
				(1.559)	(1.576)	(1.831)
Ln TA		0.237*	0.401*		0.252**	0.426**
		(1.776)	(1.796)		(2.139)	(2.144)
Market-To-Book			-0.124			-0.210
			(-0.688)			(-1.163)
Cash-To-TA			-3.298			-4.916**
			(-1.518)			(-2.478)
Tier 1 Ratio			4.628			4.116
			(1.506)			(1.542)
ROE			0.026			0.052
			(0.734)			(1.579)
Excessive Growth			-0.153			-0.068
			(-0.836)			(-0.419)
High Dividend			-0.304			-0.246
			(-1.490)			(-1.215)
Constant	-4.444***	-6.041***	-7.369***	-4.444***	-6.147***	-7.455***
	(-169.014)	(-6.713)	(-3.916)	(-182.909)	(-7.707)	(-4.404)
Bank Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Num Observations	694	694	412	694	694	412
R-squared	0.074	0.085	0.145	0.211	0.223	0.294

Panel C: Annual Average Operational Loss per Event

	(1)	(2)	(3)	(4)	(5)	(6)
After	0.052	-0.111	-0.236	0.052	-0.121	-0.298*
	(1.315)	(-1.048)	(-1.250)	(1.314)	(-1.253)	(-1.756)
After × Pre-Diversified	0.341***	0.341***	0.452***			
	(2.914)	(2.935)	(3.304)			
After × Pre-Diversified Sec20				1.643***	1.651***	1.822***
				(3.150)	(3.172)	(3.746)
After × Pre-Diversified NonSec20				0.146	0.145	0.217*
				(1.528)	(1.543)	(1.805)
Ln TA		0.206*	0.344*		0.219**	0.365*
		(1.667)	(1.673)		(1.970)	(1.955)
Market-To-Book			-0.131			-0.204
			(-0.738)			(-1.156)
Cash-To-TA			-3.350			-4.735**
			(-1.581)			(-2.430)
Tier 1 Ratio			4.133			3.695
			(1.470)			(1.492)
ROE			0.031			0.053
			(0.903)			(1.645)
Excessive Growth			-0.163			-0.091
			(-0.993)			(-0.600)
High Dividend			-0.276			-0.226
			(-1.430)			(-1.176)
Constant	-4.454***	-5.845***	-6.930***	-4.454***	-5.935***	-7.004***
	(-178.836)	(-7.007)	(-4.010)	(-190.296)	(-7.887)	(-4.404)
Bank Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Num Observations	694	694	412	694	694	412
R-squared	0.068	0.078	0.137	0.179	0.189	0.261

Table 5: First Placebo Test with 1991–1993 and 1994–1996 as Before and After Periods

This table presents the first placebo test results for operational risk. Instead of using the sample of 1994–1996 vs. 2000–2002 (Table 4), we use the sample of 1991–1993 vs. 1994–1996 to construct the before and after periods. The dependent variable is annual operational risk event frequency (*Count*) in Panel A, annual total loss (*Ln Total Loss*) in Panel B, and annual average loss per event (*Ln Avg Loss*) in Panel C. The second and third are in logarithmic form. All data are averaged over the 1991–1993 and 1994–1996 sample periods. All models include bank-level fixed effects, which subsume the effect of the stand-alone treatment and control group dummies. *t*-statistics reported in parentheses are based on robust standard errors clustered at the bank holding company level. Superscripts ***, **, and * indicate statistical significance at 1%, 5%, and 10% levels. The coefficients of control variables are omitted due to space limitations; complete results can be found in the Internet Appendix B, Table B3.

Panel A: Annual Operational Risk Event Frequency

	(1)	(2)	(3)	(4)	(5)	(6)
After	0.011*	0.010	0.000	0.011*	0.012	0.004
	(1.816)	(1.148)	(0.001)	(1.815)	(1.281)	(0.176)
After × Pre-Diversified	0.025	0.025	0.026			
	(0.911)	(0.904)	(0.730)			
After × Pre-Diversified Sec20				0.104	0.105	0.097
				(0.708)	(0.707)	(0.617)
After × Pre-Diversified NonSec20				0.009	0.009	0.008
				(0.732)	(0.720)	(0.381)
Ln TA		0.003	-0.002		-0.003	-0.012
		(0.129)	(-0.032)		(-0.091)	(-0.199)
Other Control Variables	No	No	Yes	No	No	Yes
Bank Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Num Observations	764	764	470	764	764	470
R-squared	0.011	0.011	0.026	0.021	0.021	0.034

Panel B: Annual Total Operational Loss

	(1)	(2)	(3)	(4)	(5)	(6)
After	0.049**	0.077	0.075	0.049**	0.075	0.065
	(1.988)	(1.612)	(0.642)	(1.987)	(1.574)	(0.600)
After × Pre-Diversified	0.008	0.019	0.026			
	(0.125)	(0.267)	(0.247)			
After × Pre-Diversified Sec20				-0.104	-0.089	-0.127
				(-0.350)	(-0.298)	(-0.404)
After × Pre-Diversified NonSec20				0.032	0.041	0.065
				(0.631)	(0.740)	(0.765)
Ln TA		-0.105	-0.238		-0.096	-0.217
		(-0.707)	(-0.797)		(-0.658)	(-0.742)
Other Control Variables	No	No	Yes	No	No	Yes
Bank Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Num Observations	764	764	470	764	764	470
R-squared	0.008	0.009	0.044	0.011	0.012	0.050

Panel C: Annual Average Operational Loss per Event

	(1)	(2)	(3)	(4)	(5)	(6)
After	0.048**	0.078	0.082	0.048**	0.076	0.072
	(1.986)	(1.643)	(0.725)	(1.985)	(1.607)	(0.680)
After × Pre-Diversified	0.005	0.016	0.021			
	(0.076)	(0.238)	(0.213)			
After × Pre-Diversified Sec20				-0.121	-0.106	-0.142
				(-0.436)	(-0.378)	(-0.484)
After × Pre-Diversified NonSec20				0.032	0.041	0.063
				(0.629)	(0.752)	(0.760)
Ln TA		-0.112	-0.243		-0.102	-0.220
		(-0.770)	(-0.826)		(-0.719)	(-0.769)
Other Control Variables	No	No	Yes	No	No	Yes
Bank Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Num Observations	764	764	470	764	764	470
R-squared	0.007	0.010	0.043	0.012	0.014	0.050

Table 6: Second Placebo Test with 2000–2002 and 2003–2005 as Before and After Periods

This table presents the second placebo test results for operational risk. Instead of using the sample of 1994–1996 vs. 2000–2002 (Table 4), we use the sample of 2000–2002 vs. 2003–2005 to construct the before and after periods. The dependent variable is annual operational risk event frequency (*Count*) in Panel A, annual total loss (*Ln Total Loss*) in Panel B, and annual average loss per event (*Ln Avg Loss*) in Panel C. The second and third are in logarithmic form. All data are averaged over the 2000–2002 and 2003–2005 sample periods. All models include bank-level fixed effects, which subsume the effect of the stand-alone treatment and control group dummies. *t*-statistics reported in parentheses are based on robust standard errors clustered at the bank holding company level. Superscripts ***, **, and * indicate statistical significance at 1%, 5%, and 10% levels. The coefficients of control variables are omitted due to space limitations; complete results can be found in the Internet Appendix B, Table B4.

Panel A: Annual Operational Risk Event Frequency

	(1)	(2)	(3)	(4)	(5)	(6)
After	0.008	-0.016	0.002	0.008	-0.016	-0.000
	(0.815)	(-0.715)	(0.068)	(0.814)	(-0.693)	(-0.003)
After × Pre-Diversified	-0.018	-0.015	-0.016			
	(-0.301)	(-0.240)	(-0.260)			
After × Pre-Diversified Sec20				0.051	0.055	0.042
				(0.143)	(0.155)	(0.113)
After × Pre-Diversified NonSec20				-0.031	-0.028	-0.026
				(-0.969)	(-0.855)	(-0.803)
Ln TA		0.080	0.078		0.081	0.080
		(1.193)	(1.196)		(1.133)	(1.097)
Other Control Variables	No	No	Yes	No	No	Yes
Bank Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Num Observations	562	562	500	562	562	500
R-squared	0.000	0.002	0.029	0.003	0.004	0.030

Panel B: Annual Total Operational Loss

	(1)	(2)	(3)	(4)	(5)	(6)
After	-0.021	-0.116*	-0.129	-0.021	-0.114*	-0.111
	(-0.491)	(-1.696)	(-1.414)	(-0.490)	(-1.685)	(-1.204)
After × Pre-Diversified	-0.173	-0.160	-0.141			
	(-1.193)	(-1.101)	(-0.942)			
After × Pre-Diversified Sec20				-0.601	-0.584	-0.587
				(-0.875)	(-0.852)	(-0.841)
After × Pre-Diversified NonSec20				-0.096	-0.083	-0.067
				(-0.843)	(-0.731)	(-0.551)
Ln TA		0.326*	0.373*		0.318*	0.357*
		(1.829)	(1.833)		(1.827)	(1.762)
Other Control Variables	No	No	Yes	No	No	Yes
Bank Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Num Observations	562	562	500	562	562	500
R-squared	0.015	0.020	0.038	0.027	0.032	0.050

Panel C: Annual Average Operational Loss per Event

	(1)	(2)	(3)	(4)	(5)	(6)
After	-0.023	-0.112*	-0.140	-0.023	-0.110*	-0.120
	(-0.555)	(-1.666)	(-1.599)	(-0.554)	(-1.653)	(-1.365)
After × Pre-Diversified	-0.187	-0.174	-0.153			
	(-1.350)	(-1.261)	(-1.065)			
After × Pre-Diversified Sec20				-0.674	-0.658	-0.649
				(-1.065)	(-1.044)	(-1.009)
After × Pre-Diversified NonSec20				-0.099	-0.087	-0.070
				(-0.884)	(-0.777)	(-0.586)
Ln TA		0.304*	0.358*		0.296*	0.341*
		(1.729)	(1.811)		(1.726)	(1.738)
Other Control Variables	No	No	Yes	No	No	Yes
Bank Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Num Observations	562	562	500	562	562	500
R-squared	0.019	0.023	0.040	0.036	0.041	0.057

Table 7: Robustness Test with Nonbanks as the Control Group

This table presents the results of a robustness test for operational risk with nonbanks as the control group. The dependent variable is annual operational risk event frequency (*Count*) in Panel A, annual total loss (*Ln Total Loss*) in Panel B, and annual average loss per event (*Ln Avg Loss*) in Panel C. The second and third are in logarithmic form. All data are averaged over the 1994–1996 (pre-deregulation) and 2000–2002 (post-deregulation) sample periods. All models include bank/firm-level fixed effects, which subsume the effect of the stand-alone treatment and control group dummies. *t*-statistics reported in parentheses are based on robust standard errors clustered at the firm level. Superscripts ***, **, and * indicate statistical significance at 1%, 5%, and 10% levels. The coefficients of control variables are omitted due to space limitations; complete results can be found in the Internet Appendix B, Table B7.

Panel A: Annual Operational Risk Event Frequency

	(1)	(2)	(3)	(4)	(5)	(6)
After	0.223*	0.185	0.298	0.223*	0.184	0.296
	(1.830)	(1.516)	(1.531)	(1.830)	(1.512)	(1.520)
After × BHC	-0.049	-0.062	-0.216			
	(-0.368)	(-0.473)	(-1.064)			
After × BHC Sec20				1.634**	1.622**	1.072*
				(2.390)	(2.396)	(1.934)
After × BHC NonSec20				-0.160	-0.174	-0.316
				(-1.293)	(-1.404)	(-1.593)
After × SIC61	-0.157	-0.157	-0.230	-0.157	-0.157	-0.230
	(-1.216)	(-1.221)	(-1.092)	(-1.216)	(-1.221)	(-1.091)
After × SIC63	-0.153	-0.155	-0.318	-0.153	-0.156	-0.317
	(-1.224)	(-1.247)	(-1.595)	(-1.224)	(-1.247)	(-1.588)
After × SIC64	-0.131	-0.143	-0.267	-0.131	-0.144	-0.271
	(-0.919)	(-1.008)	(-1.237)	(-0.918)	(-1.010)	(-1.251)
After × SIC65	-0.223*	-0.215*	-0.323*	-0.223*	-0.214*	-0.329*
	(-1.830)	(-1.765)	(-1.737)	(-1.830)	(-1.763)	(-1.770)
After × SIC67	-0.223*	-0.241**	-0.334*	-0.223*	-0.241**	-0.339*
	(-1.830)	(-1.967)	(-1.774)	(-1.830)	(-1.971)	(-1.797)
Ln TA		0.063**	0.087***		0.065**	0.092***
		(2.135)	(2.598)		(2.439)	(2.914)
Other Control Variables	No	No	Yes	No	No	Yes
Bank/Firm Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Num Observations	2,576	1,680	986	2,576	1,680	986
R-squared	0.036	0.042	0.064	0.204	0.210	0.233

Panel B: Annual Total Operational Loss

	(1)	(2)	(3)	(4)	(5)	(6)
After	0.148	0.073	0.106	0.148	0.072	0.104
	(0.738)	(0.384)	(0.380)	(0.737)	(0.379)	(0.372)
After × BHC	0.111	0.086	0.037			
	(0.531)	(0.414)	(0.128)			
After × BHC Sec20				1.738***	1.715***	1.647***
				(3.286)	(3.252)	(2.767)
After × BHC NonSec20				0.004	-0.022	-0.088
				(0.018)	(-0.107)	(-0.306)
After × SIC61	-0.073	-0.075	-0.107	-0.073	-0.075	-0.107
	(-0.348)	(-0.364)	(-0.363)	(-0.348)	(-0.364)	(-0.364)
After × SIC63	0.010	0.006	-0.166	0.010	0.006	-0.165
	(0.046)	(0.025)	(-0.522)	(0.046)	(0.024)	(-0.519)
After × SIC64	0.466	0.441	0.524	0.466	0.441	0.519
	(0.916)	(0.873)	(0.796)	(0.916)	(0.873)	(0.789)
After × SIC65	-0.148	-0.132	-0.217	-0.148	-0.131	-0.225
	(-0.738)	(-0.671)	(-0.793)	(-0.737)	(-0.670)	(-0.824)
After × SIC67	-0.152	-0.185	-0.245	-0.152	-0.186	-0.251
	(-0.757)	(-0.922)	(-0.901)	(-0.757)	(-0.924)	(-0.924)
Ln TA		0.123***	0.199***		0.124***	0.205***
		(3.131)	(2.764)		(3.240)	(2.987)
Other Control Variables	No	No	Yes	No	No	Yes
Bank/Firm Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Num Observations	2,576	1,680	986	2,576	1,680	986
R-squared	0.041	0.051	0.063	0.111	0.122	0.142

Panel C: Annual Average Operational Loss per Event

	(1)	(2)	(3)	(4)	(5)	(6)
After	0.104	0.035	0.049	0.104	0.035	0.047
	(0.554)	(0.200)	(0.195)	(0.554)	(0.196)	(0.188)
After × BHC	0.127	0.104	0.084			
	(0.653)	(0.539)	(0.320)			
After × BHC Sec20				1.451***	1.430***	1.462***
				(2.993)	(2.946)	(2.657)
After × BHC NonSec20				0.040	0.016	-0.023
				(0.206)	(0.086)	(-0.089)
After × SIC61	-0.040	-0.042	-0.061	-0.040	-0.042	-0.061
	(-0.205)	(-0.219)	(-0.231)	(-0.205)	(-0.219)	(-0.232)
After × SIC63	0.041	0.037	-0.108	0.041	0.036	-0.107
	(0.191)	(0.172)	(-0.371)	(0.190)	(0.172)	(-0.369)
After × SIC64	0.498	0.475	0.585	0.498	0.475	0.580
	(1.011)	(0.972)	(0.924)	(1.011)	(0.971)	(0.917)
After × SIC65	-0.104	-0.088	-0.156	-0.104	-0.088	-0.163
	(-0.554)	(-0.485)	(-0.631)	(-0.554)	(-0.484)	(-0.660)
After × SIC67	-0.108	-0.137	-0.182	-0.108	-0.138	-0.187
	(-0.574)	(-0.732)	(-0.742)	(-0.574)	(-0.734)	(-0.764)
Ln TA		0.112***	0.180***		0.113***	0.186***
		(2.966)	(2.681)		(3.025)	(2.871)
Other Control Variables	No	No	Yes	No	No	Yes
Bank/Firm Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Num Observations	2,576	1,680	986	2,576	1,680	986
R-squared	0.038	0.047	0.060	0.090	0.100	0.124

Table 8: Difference-in-Differences Analysis: Performance Measures

This table presents our results for performance measures. The dependent variable is a metric of performance: return on assets, standard deviation of return on assets, *Z*-score, and market-to-book ratio. Panel A contains the results from our main regressions that use 1994–1996 (pre-deregulation) and 2000–2002 (post-deregulation) sample periods; all data are averaged over 1994–1996 (pre-deregulation) and 2000–2002 (post-deregulation) sample periods. Panel B presents the estimation results that uses the sample of 2000–2002 vs. 2003–2005 to construct the before and after periods; all data are averaged over the 2000–2002 and 2003–2005 sample periods. All models include bank-level fixed effects, which subsume the effect of the stand-alone treatment and control group dummies. *t*-statistics reported in parentheses are based on robust standard errors clustered at the bank holding company level. Superscripts ***, **, and * indicate statistical significance at 1%, 5%, and 10% levels.

Panel A: Main Regressions with 1994–1996 (Pre-Deregulation) and 2000–2002 (Post-Deregulation) Periods

	Return on Assets		Standard Deviation of Return on Assets		*Z*-Score		Market-to-Book Ratio	
	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)
After	-0.050	-0.048	-0.005	-0.003	0.017	0.001	0.133	0.127
	(-1.194)	(-1.161)	(-0.258)	(-0.154)	(0.158)	(0.011)	(1.169)	(1.125)
After × Pre-Diversified	0.012		0.020		-0.016		0.228***	
	(0.404)		(1.353)		(-0.176)		(2.700)	
After × Pre-Diversified Sec20		-0.018		-0.015		0.223		0.324*
		(-0.324)		(-0.488)		(1.066)		(1.747)
After × Pre-Diversified NonSec20		0.018		0.027*		-0.062		0.210**
		(0.574)		(1.761)		(-0.666)		(2.366)
Ln TA	-0.027	-0.027	-0.022	-0.022	0.021	0.024	0.002	0.003
	(-0.645)	(-0.660)	(-1.145)	(-1.186)	(0.270)	(0.301)	(0.017)	(0.025)
Cash-To-TA	-0.383	-0.348	-0.138	-0.098	-0.720	-1.000	0.579	0.466
	(-1.038)	(-0.961)	(-0.562)	(-0.405)	(-0.574)	(-0.757)	(0.501)	(0.401)
Tier 1 Ratio	2.257***	2.270***	0.859***	0.874***	1.990*	1.891*	-1.756	-1.796
	(3.821)	(3.830)	(2.966)	(3.033)	(1.950)	(1.905)	(-1.074)	(-1.089)
Excessive Growth	0.018	0.016	-0.068***	-0.071***	0.298**	0.314**	-0.006	-0.000
	(0.426)	(0.373)	(-2.935)	(-3.005)	(2.393)	(2.505)	(-0.057)	(-0.001)
High Dividend	0.190***	0.189***	0.073***	0.071***	-0.051	-0.036	0.237*	0.243*
	(3.756)	(3.667)	(3.330)	(3.220)	(-0.416)	(-0.303)	(1.944)	(1.954)
Constant	0.528	0.527	0.411**	0.409**	1.769***	1.780***	1.656*	1.660*
	(1.509)	(1.516)	(2.407)	(2.438)	(2.664)	(2.723)	(1.755)	(1.748)
Bank Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Num Observations	412	412	408	408	408	408	412	412
R-squared	0.245	0.247	0.252	0.260	0.060	0.074	0.186	0.188

Panel B: DID Estimation with 2000–2002 and 2003–2005 Periods

	Return on Assets		Standard Deviation of Return on Assets		*Z*-Score		Market-to-Book Ratio	
	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)
After	-0.064	-0.063	-0.005	-0.005	-0.152	-0.151	0.444***	0.445***
	(-1.529)	(-1.526)	(-0.278)	(-0.282)	(-0.892)	(-0.885)	(5.190)	(5.219)
After × Pre-Diversified	0.005		-0.013		0.091		-0.186**	
	(0.170)		(-0.995)		(0.858)		(-2.099)	
After × Pre-Diversified Sec20		-0.006		0.009		-0.239		-0.558***
		(-0.111)		(0.279)		(-1.186)		(-3.339)
After × Pre-Diversified NonSec20		0.007		-0.017		0.152		-0.118
		(0.245)		(-1.320)		(1.365)		(-1.314)
Ln TA	0.136	0.136	0.005	0.005	0.456	0.452	-0.259	-0.261
	(1.550)	(1.547)	(0.125)	(0.131)	(1.115)	(1.108)	(-1.042)	(-1.065)
Cash-To-TA	0.622	0.625	-0.191	-0.198	1.215	1.315	0.118	0.222
	(0.655)	(0.656)	(-0.478)	(-0.491)	(0.572)	(0.617)	(0.031)	(0.058)
Tier 1 Ratio	5.762***	5.783***	1.804***	1.764***	7.195*	7.797**	-9.933***	-9.258***
	(3.658)	(3.601)	(2.918)	(2.828)	(1.948)	(2.101)	(-3.150)	(-2.925)
Excessive Growth	-0.001	-0.001	-0.014	-0.014	0.193	0.186	-0.215**	-0.223**
	(-0.014)	(-0.019)	(-0.667)	(-0.636)	(1.282)	(1.230)	(-1.974)	(-2.062)
High Dividend	0.112*	0.110*	0.001	0.004	0.421*	0.376*	0.170	0.118
	(1.743)	(1.698)	(0.038)	(0.138)	(1.895)	(1.749)	(1.443)	(0.992)
Constant	-1.264*	-1.265*	0.105	0.107	-2.724	-2.754	5.190***	5.148***
	(-1.747)	(-1.747)	(0.309)	(0.316)	(-0.784)	(-0.794)	(2.728)	(2.727)
Bank Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Num Observations	500	500	498	498	498	498	500	500
R-squared	0.258	0.258	0.133	0.136	0.082	0.094	0.221	0.241

Table 9: Difference-in-Differences Analysis with Banking and Nonbanking Events for Growth-Matched BHCs

This table presents the results for banking and nonbanking operational risk events separately. The dependent variable is annual operational risk event frequency (*Count*) in Panel A, annual total loss (*Ln Total Loss*) in Panel B, and annual average loss per event (*Ln Avg Loss*) in Panel C. We use matched samples where Section 20 subsidiary holders are matched by asset growth with other BHCs for banking events and with nonbanks for nonbanking events. For each operational risk measure, Models (1), (2), and (3) present the results for banking events and Models (4), (5), and (6) present the results for nonbanking events. All data are averaged over the 1994–1996 (pre-deregulation) and 2000–2002 (post-deregulation) sample periods. All models include bank/firm-level fixed effects, which subsume the effect of the stand-alone treatment and control group dummies. *t*-statistics reported in parentheses are based on robust standard errors clustered at the bank holding company or firm level. Superscripts ***, **, and * indicate statistical significance at 1%, 5%, and 10% levels. The coefficients of control variables are omitted due to space limitations; complete results can be found in the Internet Appendix B, Table B9.

Panel A: Annual Operational Risk Event Frequency

	Banking Events			Nonbanking Events		
	(1)	(2)	(3)	(4)	(5)	(6)
After	0.035*	-0.107	-0.341*	0.093**	-0.332	-0.719
	(1.692)	(-1.211)	(-1.853)	(2.052)	(-1.229)	(-1.499)
After × BHC Sec20	0.724***	0.736***	0.871***	0.630*	0.846**	1.159*
	(3.154)	(3.221)	(2.994)	(1.996)	(2.090)	(1.815)
Ln TA		0.173*	0.256**		0.290	0.627*
		(1.700)	(2.078)		(1.454)	(1.724)
Other Control Variables	No	No	Yes	No	No	Yes
Bank/Firm Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Num Observations	130	130	90	72	72	62
R-squared	0.376	0.398	0.482	0.239	0.271	0.332

Panel B: Annual Total Operational Loss

	Banking Events			Nonbanking Events		
	(1)	(2)	(3)	(4)	(5)	(6)
After	0.070	-0.176	-0.624	0.387*	-0.303	-0.855
	(0.489)	(-0.717)	(-1.524)	(1.766)	(-0.486)	(-0.860)
After × BHC Sec20	1.894***	1.915***	2.325***	1.065*	1.416*	1.759
	(4.123)	(4.207)	(5.064)	(1.798)	(1.982)	(1.683)
Ln TA		0.299	0.401		0.472	0.979
		(1.364)	(1.291)		(1.073)	(1.366)
Other Control Variables	No	No	Yes	No	No	Yes
Bank/Firm Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Num Observations	130	130	90	72	72	62
R-squared	0.402	0.413	0.527	0.274	0.297	0.348

Panel C: Annual Average Operational Loss per Event

	Banking Events			Nonbanking Events		
	(1)	(2)	(3)	(4)	(5)	(6)
After	0.075	-0.128	-0.502	0.387*	-0.159	-0.563
	(0.529)	(-0.534)	(-1.244)	(1.804)	(-0.280)	(-0.633)
After × BHC Sec20	1.757***	1.774***	2.131***	0.888	1.165*	1.393
	(4.044)	(4.094)	(4.784)	(1.683)	(1.889)	(1.524)
Ln TA		0.246	0.327		0.373	0.763
		(1.183)	(1.126)		(0.952)	(1.222)
Other Control Variables	No	No	Yes	No	No	Yes
Bank/Firm Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Num Observations	130	130	90	72	72	62
R-squared	0.387	0.395	0.503	0.273	0.291	0.335

Internet Appendix — Not for Publication

APPENDIX A: Definition of Operational Risk Event Types

BIS defines seven operational risk event types (BCBS 2001).

1. Internal fraud: Includes events intended to defraud, misappropriate property, or circumvent regulations or company policy, involving at least one internal party, and are categorized into unauthorized activity and internal theft and fraud.

2. External fraud: Includes events intended to defraud, misappropriate property, or circumvent the law, by a third party, and are categorized into theft, fraud, and breach of system security.

3. Employment practices and workplace safety: Includes events or acts inconsistent with employment, health, or safety laws or agreements, and are categorized into employee relations, safety of the environment, and diversity and discrimination.

4. Clients, products, and business practices: Includes events related to failures to comply with a professional obligation to clients, or arising from the nature or design of a product, including disclosure and fiduciary practices, improper business and market practices, product flaws, and advisory activities.

5. Damage to physical assets: Includes events leading to loss or damage to physical assets from natural disasters, such as hurricanes, earthquakes, and floods, or man-made events, such as terrorism and vandalism.

6. Business disruption and system failures: Includes events causing disruption of business or system failures, including IT system failures and malfunctions.

7. Execution, delivery, and process management: Includes events related to failed transaction processing or process management occurring from relations with vendors and trade counterparties, and are classified into transaction execution and maintenance, customer intake and documentation, and account management.

APPENDIX B: Complete Results for Econometric Models

Some of the tables in the paper did not present the coefficients of the control variables for the sake of brevity. They are Table 3, Table 5, Table 6, Table 7, and Table 9. These tables with the complete set of controls are shown at the end of this Appendix as Table B1, Table B3, Table B4, Table B7, and Table B9, respectively. Additional tables in the end of this Appendix – Table B2, Table B5, Table B6, Table B8, Table B10, and Table B11 – supplement our discussions in Section 4 and are referenced therein.

APPENDIX C: Additional Robustness Tests

In this Appendix, we present the results of additional robustness tests as described in Section 5. The corresponding tables are at the end of this Appendix.

C.1 Results with Extended Sample Period 1988–2005

Our main models use 1994–1996 (pre-deregulation) and 2000–2002 (post-deregulation) periods. In this robustness test, we use extended samples of 1988–1996 and 1997–2005 to construct the before and after periods and perform a similar difference-in-differences estimation. The results are summarized in Table C1. The R-squared has dropped in many models and the key coefficients of the dummy variables and the treatment effect interaction terms have dropped in magnitude and significance, as expected, due to additional noise introduced from extending the sample periods. Nevertheless, the results are largely consistent with our earlier findings.

C.2 Results with All Operational Risk Event Types

As we explained in Section 2.1, our focus has been on four of the seven BIS-defined event types; we left out events of types employment practices and workplace safety, damage to physical assets, and business disruption and system failures, because we believe that they have little relation to complexity-driven weaknesses in risk management. After including these events, our results remain robust (Table C2).

C.3 Diversification of Non-Section 20 BHCs into Securities Activities and Controlling for Insurance Deregulations

In this section, we first examine the effects of non-Section 20 BHCs entering the business of securities underwriting and dealing after the repeal of GSA. If a BHC from the non-Section 20 group entered a deregulated industry during our post-deregulation period (2000–2002), this BHC may experience a sudden increase in its complexity, which could increase its operational risk, thus biasing our primary DID results for Section 20 owners downward.

We also control for the effects of the insurance deregulations that occurred at the same time during our sample period. National banks were permitted by the Office of the Comptroller of the Currency in 1993 to conduct a full range of insurance agency activities in small towns of fewer than 5,000 in population, following a sequence of heated debates since 1986. In 1995, national banks were allowed to sell annuities. In 1996, both national and state-chartered banks were allowed to sell insurance through subsidiaries or directly through bank branches. The insurance regulations differed from those for the securities activities in that they never involved provisions similar to Section 20 subsidiaries. Nevertheless, it might be possible that a portion of the treatment effect may be attributed to the insurance business to the extent that Section 20 owners were more likely to diversify into insurance business than other BHCs after 1999. Although this scenario does not change our conclusion regarding an increase in bank complexity causing an increase in operational risk for Section 20 owners, it still matters to establish whether we reached the conclusion in the way we intended.

In order to test whether and to what extent our main results are affected by these concerns, we take advantage of the fact that BHCs are required to report their income from the investment banking, advisory, brokerage and underwriting, and insurance activities in the FR Y-9C filings since 2001. This enables us to capture a non-Section 20 BHC's expansion into the securities underwriting and dealing business after 1999 and also capture a BHC's active business line in insurance.[1]

To carry out this robustness test, we estimate two new models. In the first model, we drop any non-Section 20 BHC with more than 1 percent of total annual income from securities underwriting and dealing reported in either 2001 or 2002, and then re-estimate our main DID

[1] A BHC's income from investment banking, advisory, brokerage and underwriting commissions and fees is reported in variable BHCKB490. A BHC's income from insurance commissions and fees is reported in BHCKB494. The data for these two variables are not available before 2001.

models. In the second model, we augment both treatment and control groups by dropping any BHC with more than 1 percent of total annual income from insurance commissions and fees reported in either 2001 or 2002, and then re-estimate our main DID models. Our choice of the 1 percent threshold is guided by the general disclosure threshold set in FR Y-9C around those years: a BHC was required to report any source of 'other income' that made up more than 1 percent of its total annual income for a given year if that income source was not already specified elsewhere in FR Y-9C.

The results of this robustness test are reported in Table C3. Compared with the main results from our original analysisin Table 4 (reproduced in Models (1) in Table C3), the impact of the deregulations on both operational risk frequency and severity of Section 20 owners remains similar after controlling for the non-Section 20 BHCs that began to expand into securities underwriting and dealing after deregulation (Models (2)). In turn, the impact of the deregulations on operational risk losses of Section 20 owners relative to the control group somewhat decreases, whereas the effect on operational risk event frequency somewhat increases after controlling for BHCs' insurance activities (Models (3)). Overall, our main results for Section 20 owners do not change significantly.

Moreover, the coefficient of *After*×*Pre-Diversified NonSection20* becomes much smaller in Models (2) and (3). This result is not surprising given that we introduce a downward bias in this coefficient by discarding the BHCs with significant income from deregulated activities following the deregulation not only from the control (not pre-diversified group) but also from the *Pre-Diversified NonSection20* group, making these groups more homogenous. This outcome agrees with our notion that complexity of BHCs increases due to the expansion into the deregulated activities, which in turn increases operational risk. In short, the results of our robustness checks are consistent with those we obtained from the main DID analysis.

C.4 Merger and Acquisition Activities in the Banking Sector

The Riegle-Neal Interstate Banking and Branching Efficiency Act was signed in September 1994 and became fully effective in June 1997. The effective date of the Act overlaps with our main regression period. The purpose of the Act was to relax geographic limits on banks by allowing them to open branches and/or merge with banks across state lines. Merger activity surged in the banking sector following the Act, as BHCs began to consolidate their no-longer-necessary banking subsidiaries across state borders. An increase in banks' efficiency and performance was

observed at the same time, as documented in Jayaratne and Strahan (1997).[2]

Although our first placebo test of 1991–1993 vs. 1994–1996 in Section 4.1 already addressed the potential endogeneity concern associated with the passage of the Riegle-Neal Act, the objective of this robustness test is to address any remaining concerns that Section 20 subsidiary owners, while becoming more complex, also engaged in significantly more and larger M&A activities than the other banks. If this is the case, then the increase in operational risk during the post-deregulation period that we have documented earlier may simply be attributable to the heightened M&A activities in the banking sector allowed by the Riegle-Neal Act, and not to the increased business complexity enabled by the 1996–1999 deregulations, as we have argued.

To address this concern, we examine the M&A activities of our BHCs during 1988–2005 using the Mergers and Acquisitions data provided by the Federal Reserve Bank of Chicago. The Chicago Fed's data set contains the complete banking sector M&A records of our sample high holders since 1976 for all the acquirers existing in the FR Y-9C data or Call Reports. In addition, for each M&A deal, it provides information on the top holding company of the acquirer along with the total assets of the acquiring bank and the target bank. For several cases where the total assets of the target were missing because the target did not report FR Y-9C or Call Report information at the time of the M&A (for example, the target is a savings and loan association), we estimate the total assets by using the change from the previous quarter in the total assets of the acquirer. We then calculate an annual target assets ratio for each of our sample high holders to measure the size of its banking sector M&A activities.[3]

Figure C1 illustrates the banking sector M&A activities for the high holders in our sample. Panel A shows the average number of M&As and Panel B shows the average target assets ratio per high holder. We observe a surge of M&A activities that coincides with the passage and effective dates of the Riegle-Neal Act around 1994 and 1997. However, comparing the post-deregulation period (2000–2002) with the pre-deregulation period (1994–1996) in our main DID analysis, on average, the banking sector M&A activities decrease among the Section 20 BHCs and increase slightly among the non-Section 20 BHCs. Therefore, it is unlikely that the increased operational risk we have captured for the Section 20 owners in the post-deregulation period is solely attributable to the banking sector M&A activities at that time. If anything,

[2]Jayaratne, J., and P.E. Strahan. 1997. The Benefits of Branching Deregulation. *Economic Policy Review* 3(4): 13-39.

[3]The annual target assets ratio is defined as the sum of the assets of all targets from M&As in the current year divided by the total assets of the high holder in the previous year.

the omitted M&A activities would bias our main results downward.

To make sure we do not omit any time-variant characteristics associated with the M&A activities, we include the number of banking sector M&As accumulated in the past three years (*Banking M&A*) as well as the corresponding target assets ratio (*Banking M&A Target Assets Ratio*) as two additional bank-specific controls. The results are summarized in Table C4. For each operational risk measure, Model (1) of Table C4 depicts our original DID results from Table 4, Model (2) presents the results after accounting for all mergers, and Model (3) presents the results after accounting for mergers excluding affiliate mergers. As is evident from the estimation results, our earlier findings hold remarkably well, with the treatment effects maintaining their economic and statistical significance and the coefficients of the M&A controls insignificant in most models.

C.5 Media Coverage

Another likely concern of our study lies in the relation between the media attention, operational risk event disclosure, and the size of the institution. In particular, Section 20 owners, being larger in size and typically deemed as *systemically important* by the regulators, can naturally be greater targets of public scrutiny and thus draw more media attention. This might explain greater number of operational risk events being publicized for these BHCs. If Section 20 owners are more in the public eye after the 1996–1999 deregulations, then an increase in their operational risk might be driven by the disproportional increase in media interest to these institutions, and not an increase in their complexity. We first note that the IBM Algo FIRST database relies heavily on regulatory reports and court resolutions, rather than banks' self-disclosed incidents. In this light, we find it unlikely that our results are biased by potential changes in media attention. Nevertheless, we introduce an additional media attention control variable as a formal robustness check to address any remaining concerns.

We count the number of news articles in the Factiva business news database, where the headline or the first paragraph of the news article mentions the names of our sample high holders. To maximize our data quality, we manually search the Factiva database using the historically accurate entity name (for example, "Bank of America") as well as alternative colloquial names (for example, "BofA" and "BOA") of a BHC in a given year, starting in 1994. Figure C2 illustrates the annual median news count for each of the Section 20 and non-Section 20 groups. We observe that, in general, the Section 20 owners indeed attract more public attention compared

to the non-Section 20 BHCs, as indicated by their consistently higher level of news count. At the same time, the news number of the Section 20 owners does not seem to follow a trend throughout the time compared to the other group, suggesting that media attention is unlikely to explain our findings.

We include the news count as an additional control variable (*Media*) into our models for a formal robustness test. The inclusion of this variable likely introduces a downward bias to our estimates because an increase in the number of public operational risk events can mechanically increase the news count by construction. Therefore, these results should be treated as a lower bound of the effects of complexity on operational risk. To account for the fact that larger institutions tend to attract greater media attention, we restrict the BHCs in our non-Section 20 group to those whose average total assets over the pre-deregulation period (1994–1996) exceeds the minimum average assets of the Section 20 group over the same period.

The econometric results are depicted in Table C5. After inclusion of all relevant control variables, including those related to M&A activity from the previous robustness test, the coefficient of the *Media* variable is economically small and statistically insignificant, while the economic and statistical significance of our key DID estimates remain robust. In sum, these findings reconcile concerns over potential media reporting bias in our DID results.

Table B1: Business Complexity and Operational Risk: Preliminary Evidence

(Complete Results for Table 3)

This table presents complete results of the OLS models for our preliminary analysis used in Section 2.5. The dependent variable is annual operational risk event frequency (*Count*), annual total loss (*Ln Total Loss*), and annual average loss per event (*Ln Avg Loss*). The second and third are in logarithmic form. The key explanatory variable is a proxy for business complexity: dummy variable equal to 1 if the BHC diversified into nonbank activities in the past year (Panel A), non-interest income ratio (Panel B), and nonbank asset ratio (Panel C). For each operational risk measure, Model (1) contains no additional controls and Model (2) contains a full set of controls. All models use annual data for 1988-2005. *t*-statistics reported in parentheses are based on robust standard errors clustered at the bank holding company and year levels. Superscripts ***, **, and * indicate statistical significance at 1%, 5%, and 10% levels.

Panel A: Measure of Complexity: Diversification into Nonbank Activities

	Count		*Ln Total Loss*		*Ln Avg Loss*	
	(1)	(2)	(1)	(2)	(1)	(2)
Diversified	0.104**	0.102**	0.231***	0.238***	0.207***	0.213***
	(2.161)	(2.177)	(3.120)	(2.913)	(3.202)	(2.957)
Ln TA	0.169***	0.229***	0.312***	0.397***	0.276***	0.348***
	(2.959)	(3.015)	(4.675)	(4.704)	(5.000)	(5.058)
Market-To-Book		-0.003		-0.003		-0.002
		(-0.948)		(-0.655)		(-0.482)
Cash-To-TA		-0.515		-0.676		-0.546
		(-1.632)		(-1.184)		(-1.066)
Tier 1 Ratio		0.108		-0.315		-0.304
		(0.563)		(-1.034)		(-1.148)
ROE		-0.002*		-0.002		-0.002
		(-1.688)		(-1.304)		(-1.128)
Excessive Growth		0.050		0.062		0.054
		(1.587)		(1.159)		(1.124)
High Dividend		-0.081**		-0.084		-0.070
		(-2.041)		(-1.545)		(-1.462)
Constant	-1.103***	-1.515***	-6.602***	-7.164***	-6.362***	-6.839***
	(-2.888)	(-3.032)	(-14.967)	(-13.149)	(-17.525)	(-15.498)
Num Observations	7,751	4,735	7,751	4,735	7,751	4,735
R-squared	0.129	0.155	0.163	0.186	0.155	0.175

Panel B: Measure of Complexity: Non-Interest Income Ratio

	Count		*Ln Total Loss*		*Ln Avg Loss*	
	(1)	(2)	(1)	(2)	(1)	(2)
Non-Interest Income Ratio	0.351*	0.281	0.520**	0.469*	0.469**	0.445**
	(1.930)	(1.185)	(2.324)	(1.722)	(2.466)	(1.964)
Ln TA	0.163***	0.225***	0.309***	0.397***	0.273***	0.346***
	(2.887)	(2.931)	(4.491)	(4.488)	(4.794)	(4.797)
Market-To-Book		-0.004		-0.004		-0.003
		(-0.982)		(-0.787)		(-0.655)
Cash-To-TA		-0.619*		-0.866		-0.723
		(-1.829)		(-1.481)		(-1.380)
Tier 1 Ratio		0.002		-0.503		-0.480
		(0.009)		(-1.345)		(-1.482)
ROE		-0.002		-0.002		-0.001
		(-1.583)		(-1.167)		(-0.992)
Excessive Growth		0.049		0.060		0.052
		(1.558)		(1.114)		(1.076)
High Dividend		-0.070*		-0.064		-0.051
		(-1.914)		(-1.200)		(-1.088)
Constant	-1.123***	-1.518***	-6.665***	-7.199***	-6.419***	-6.867***
	(-2.886)	(-2.999)	(-14.645)	(-12.814)	(-17.146)	(-15.073)
Num Observations	7,751	4,735	7,751	4,735	7,751	4,735
R-squared	0.130	0.154	0.162	0.184	0.154	0.174

Panel C: Measure of Complexity: Nonbank Asset Ratio

	Count		*Ln Total Loss*		*Ln Avg Loss*	
	(1)	(2)	(1)	(2)	(1)	(2)
Non-Interest Income Ratio	1.168*	1.511*	1.137**	1.336**	0.882**	1.032**
	(1.868)	(1.956)	(2.339)	(2.195)	(2.286)	(2.100)
Ln TA	0.165***	0.221***	0.319***	0.403***	0.283***	0.355***
	(3.050)	(3.100)	(4.757)	(4.866)	(5.084)	(5.231)
Market-To-Book		-0.003		-0.003		-0.002
		(-0.963)		(-0.631)		(-0.452)
Cash-To-TA		-0.411		-0.617		-0.507
		(-1.478)		(-1.128)		(-1.025)
Tier 1 Ratio		-0.086		-0.511		-0.460
		(-0.372)		(-1.486)		(-1.547)
ROE		-0.002*		-0.002		-0.002
		(-1.676)		(-1.232)		(-1.056)
Excessive Growth		0.037		0.050		0.044
		(1.256)		(0.939)		(0.925)
High Dividend		-0.058*		-0.062		-0.053
		(-1.770)		(-1.206)		(-1.160)
Constant	-1.090***	-1.475***	-6.645***	-7.194***	-6.408***	-6.876***
	(-2.968)	(-3.125)	(-15.005)	(-13.465)	(-17.500)	(-15.804)
Num Observations	7,751	4,735	7,751	4,735	7,751	4,735
R-squared	0.146	0.172	0.167	0.188	0.157	0.176

Table B2: Difference-in-Differences Analysis with Losses Normalized by Bank Size

This table presents the results of a robustness test for operational loss. The dependent variables are annual total loss (Panel A) and annual average loss per event (Panel B) normalized by total assets (Models (1) and (2)), book equity (Models (3) and (4)), and net income (Models (5) and (6)) in the current year and are in logarithmic form. All data are averaged over the 1994–1996 (pre-deregulation) and 2000–2002 (post-deregulation) sample periods. All models include bank-level fixed effects, which subsume the effect of the stand-alone treatment and control group dummies. *t*-statistics reported in parentheses are based on robust standard errors clustered at the bank holding company level. Superscripts ***, **, and * indicate statistical significance at 1%, 5%, and 10% levels.

Panel A: Annual Total Operational Loss

	Normalized by Total Assets		Normalized by Book Equity		Normalized by Net Income	
	(1)	(2)	(3)	(4)	(5)	(6)
After	0.047	-0.001	0.047	-0.002	0.052	-0.002
	(0.372)	(-0.007)	(0.359)	(-0.012)	(0.373)	(-0.017)
After × Pre-Diversified	0.507***		0.518***		0.575***	
	(2.985)		(2.968)		(3.008)	
After × Pre-Diversified Sec20		1.947***		1.964***		2.215***
		(3.536)		(3.522)		(3.583)
After × Pre-Diversified NonSec20		0.261		0.272*		0.296*
		(1.651)		(1.670)		(1.667)
Market-To-Book	-0.212	-0.289	-0.228	-0.306	-0.232	-0.320
	(-1.015)	(-1.392)	(-1.077)	(-1.449)	(-1.004)	(-1.385)
Cash-To-TA	-4.981*	-6.461**	-5.165*	-6.651**	-5.633*	-7.318**
	(-1.806)	(-2.528)	(-1.873)	(-2.590)	(-1.851)	(-2.584)
Tier 1 Ratio	2.704	2.156	2.461	1.911	2.936	2.312
	(0.851)	(0.784)	(0.765)	(0.682)	(0.847)	(0.773)
ROE	0.045	0.068	0.049	0.072	0.046	0.072
	(0.990)	(1.536)	(1.044)	(1.573)	(0.913)	(1.480)
Excessive Growth	-0.249	-0.176	-0.262	-0.189	-0.284	-0.201
	(-1.229)	(-0.902)	(-1.266)	(-0.944)	(-1.231)	(-0.905)
High Dividend	-0.271	-0.220	-0.282	-0.230	-0.298	-0.240
	(-0.987)	(-0.785)	(-1.004)	(-0.806)	(-0.960)	(-0.755)
Constant	-15.454***	-15.346***	-13.084***	-12.976***	-13.026***	-12.903***
	(-22.273)	(-26.090)	(-18.808)	(-21.902)	(-16.925)	(-19.768)
Bank/Firm Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Num Observations	412	412	412	694	412	412
R-squared	0.114	0.208	0.129	0.136	0.116	0.211

Panel B: Annual Average Operational Loss per Event

	Normalized by Total Assets		Normalized by Book Equity		Normalized by Net Income	
	(1)	(2)	(3)	(4)	(5)	(6)
After	0.051	0.011	0.051	0.010	0.057	0.009
	(0.413)	(0.091)	(0.399)	(0.082)	(0.411)	(0.070)
After × Pre-Diversified	0.454***		0.466***		0.522***	
	(2.754)		(2.742)		(2.806)	
After × Pre-Diversified Sec20		1.666***		1.683***		1.933***
		(3.049)		(3.031)		(3.148)
After × Pre-Diversified NonSec20		0.248		0.259		0.282
		(1.596)		(1.617)		(1.618)
Market-To-Book	-0.219	-0.284	-0.236	-0.301	-0.240	-0.315
	(-1.065)	(-1.387)	(-1.127)	(-1.445)	(-1.049)	(-1.382)
Cash-To-TA	-4.970*	-6.215**	-5.154*	-6.405**	-5.622*	-7.072**
	(-1.819)	(-2.427)	(-1.888)	(-2.491)	(-1.865)	(-2.495)
Tier 1 Ratio	2.432	1.971	2.189	1.726	2.664	2.127
	(0.811)	(0.746)	(0.721)	(0.642)	(0.810)	(0.738)
ROE	0.050	0.069	0.054	0.074	0.051	0.074
	(1.136)	(1.594)	(1.186)	(1.629)	(1.045)	(1.533)
Excessive Growth	-0.250	-0.189	-0.263	-0.202	-0.285	-0.214
	(-1.312)	(-1.006)	(-1.347)	(-1.044)	(-1.307)	(-0.998)
High Dividend	-0.240	-0.197	-0.251	-0.208	-0.267	-0.217
	(-0.904)	(-0.730)	(-0.924)	(-0.753)	(-0.886)	(-0.707)
Constant	-15.484***	-15.393***	-13.114***	-13.023***	-13.056***	-12.951***
	(-23.078)	(-26.351)	(-19.507)	(-22.167)	(-17.510)	(-20.007)
Bank/Firm Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Num Observations	412	412	412	412	412	412
R-squared	0.108	0.179	0.108	0.177	0.110	0.186

Table B3: First Placebo Test with 1991–1993 and 1994–1996 Before and After Periods

(Complete Results for Table 5)

This table presents complete results of the first placebo test for operational risk. Instead of using the sample of 1994–1996 vs. 2000–2002 (Table 4), we use the sample of 1991–1993 vs. 1994–1996 to construct the before and after periods. The dependent variable is annual operational risk event frequency (*Count*) in Panel A, annual total loss (*Ln Total Loss*) in Panel B, and annual average loss per event (*Ln Avg Loss*) in Panel C. The second and third are in logarithmic form. All data are averaged over the 1991–1993 and 1994–1996 sample periods. All models include bank-level fixed effects, which subsume the effect of the stand-alone treatment and control group dummies. *t*-statistics reported in parentheses are based on robust standard errors clustered at the bank holding company level. Superscripts ***, **, and * indicate statistical significance at 1%, 5%, and 10% levels.

Panel A: Annual Operational Risk Event Frequency

	(1)	(2)	(3)	(4)	(5)	(6)
After	0.011*	0.010	0.000	0.011*	0.012	0.004
	(1.816)	(1.148)	(0.001)	(1.815)	(1.281)	(0.176)
After × Pre-Diversified	0.025	0.025	0.026			
	(0.911)	(0.904)	(0.730)			
After × Pre-Diversified Sec20				0.104	0.105	0.097
				(0.708)	(0.707)	(0.617)
After × Pre-Diversified NonSec20				0.009	0.009	0.008
				(0.732)	(0.720)	(0.381)
Ln TA		0.003	-0.002		-0.003	-0.012
		(0.129)	(-0.032)		(-0.091)	(-0.199)
Market-To-Book			0.071			0.071
			(0.966)			(0.956)
Cash-To-TA			-0.395			-0.394
			(-1.314)			(-1.314)
Tier 1 Ratio			-0.107			-0.214
			(-0.173)			(-0.310)
ROE			-0.001			-0.001
			(-0.575)			(-0.585)
Excessive Growth			-0.007			-0.019
			(-0.202)			(-0.444)
High Dividend			-0.082			-0.074
			(-0.941)			(-0.755)
Constant	0.032***	0.009	0.095	0.032***	0.050	0.179
	(5.261)	(0.052)	(0.190)	(5.284)	(0.262)	(0.388)
Bank Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Num Observations	764	764	470	764	764	470
R-squared	0.011	0.011	0.026	0.021	0.021	0.034

Panel B: Annual Total Operational Loss

	(1)	(2)	(3)	(4)	(5)	(6)
After	0.049**	0.077	0.075	0.049**	0.075	0.065
	(1.988)	(1.612)	(0.642)	(1.987)	(1.574)	(0.600)
After × Pre-Diversified	0.008	0.019	0.026			
	(0.125)	(0.267)	(0.247)			
After × Pre-Diversified Sec20				-0.104	-0.089	-0.127
				(-0.350)	(-0.298)	(-0.404)
After × Pre-Diversified NonSec20				0.032	0.041	0.065
				(0.631)	(0.740)	(0.765)
Ln TA		-0.105	-0.238		-0.096	-0.217
		(-0.707)	(-0.797)		(-0.658)	(-0.742)
Market-To-Book			0.135			0.135
			(0.548)			(0.545)
Cash-To-TA			-0.823			-0.826
			(-0.833)			(-0.829)
Tier 1 Ratio			0.650			0.884
			(0.277)			(0.397)
ROE			0.008			0.008
			(0.576)			(0.588)
Excessive Growth			0.069			0.095
			(0.548)			(0.803)
High Dividend			-0.395**			-0.412**
			(-2.020)			(-2.065)
Constant	-4.475***	-3.770***	-2.608	-4.475***	-3.825***	-2.792
	(-289.746)	(-3.796)	(-1.148)	(-290.018)	(-3.889)	(-1.283)
Bank Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Num Observations	764	764	470	764	764	470
R-squared	0.008	0.009	0.044	0.011	0.012	0.050

Panel C: Annual Average Operational Loss per Event

	(1)	(2)	(3)	(4)	(5)	(6)
After	0.048**	0.078	0.082	0.048**	0.076	0.072
	(1.986)	(1.643)	(0.725)	(1.985)	(1.607)	(0.680)
After × Pre-Diversified	0.005	0.016	0.021			
	(0.076)	(0.238)	(0.213)			
After × Pre-Diversified Sec20				-0.121	-0.106	-0.142
				(-0.436)	(-0.378)	(-0.484)
After × Pre-Diversified NonSec20				0.032	0.041	0.063
				(0.629)	(0.752)	(0.760)
Ln TA		-0.112	-0.243		-0.102	-0.220
		(-0.770)	(-0.826)		(-0.719)	(-0.769)
Market-To-Book			0.110			0.109
			(0.466)			(0.463)
Cash-To-TA			-0.782			-0.786
			(-0.799)			(-0.795)
Tier 1 Ratio			0.548			0.796
			(0.240)			(0.367)
ROE			0.008			0.009
			(0.644)			(0.658)
Excessive Growth			0.065			0.092
			(0.530)			(0.807)
High Dividend			-0.359*			-0.377**
			(-1.950)			(-2.029)
Constant	-4.483***	-3.731***	-2.572	-4.483***	-3.792***	-2.768
	(-302.492)	(-3.829)	(-1.151)	(-302.956)	(-3.962)	(-1.298)
Bank Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Num Observations	764	764	470	764	764	470
R-squared	0.007	0.010	0.043	0.012	0.014	0.050

Table B4: Second Placebo Test with 2000–2002 and 2003–2005 Before and After Periods (Complete Results for Table 6)

This table presents complete results of the second placebo test for operational risk. Instead of using the sample of 1994–1996 vs. 2000–2002 (Table 4), we use the sample of 2000–2002 vs. 2003–2005 to construct the before and after periods. The dependent variable is annual operational risk event frequency (*Count*) in Panel A, annual total loss (*Ln Total Loss*) in Panel B, and annual average loss per event (*Ln Avg Loss*) in Panel C. The second and third are in logarithmic form. All data are averaged over the 2000–2002 and 2003–2005 sample periods. All models include bank-level fixed effects, which subsume the effect of the stand-alone treatment and control group dummies. *t*-statistics reported in parentheses are based on robust standard errors clustered at the bank holding company level. Superscripts ***, **, and * indicate statistical significance at 1%, 5%, and 10% levels.

Panel A: Annual Operational Risk Event Frequency

	(1)	(2)	(3)	(4)	(5)	(6)
After	0.008	-0.016	0.002	0.008	-0.016	-0.000
	(0.815)	(-0.715)	(0.068)	(0.814)	(-0.693)	(-0.003)
After × Pre-Diversified	-0.018	-0.015	-0.016			
	(-0.301)	(-0.240)	(-0.260)			
After × Pre-Diversified Sec20				0.051	0.055	0.042
				(0.143)	(0.155)	(0.113)
After × Pre-Diversified NonSec20				-0.031	-0.028	-0.026
				(-0.969)	(-0.855)	(-0.803)
Ln TA		0.080	0.078		0.081	0.080
		(1.193)	(1.196)		(1.133)	(1.097)
Market-To-Book			-0.061			-0.057
			(-1.123)			(-1.051)
Cash-To-TA			-1.224			-1.242
			(-1.616)			(-1.649)
Tier 1 Ratio			-1.841			-1.900
			(-1.214)			(-1.202)
ROE			0.007			0.007
			(1.010)			(1.017)
Excessive Growth			-0.164*			-0.162*
			(-1.819)			(-1.795)
High Dividend			0.025			0.032
			(0.684)			(0.528)
Constant	0.192***	-0.419	0.068	0.192***	-0.428	0.050
	(15.678)	(-0.806)	(0.120)	(15.680)	(-0.772)	(0.079)
Bank Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Num Observations	562	562	500	562	562	500
R-squared	0.000	0.002	0.029	0.003	0.004	0.030

Panel B: Annual Total Operational Loss

	(1)	(2)	(3)	(4)	(5)	(6)
After	-0.021	-0.116*	-0.129	-0.021	-0.114*	-0.111
	(-0.491)	(-1.696)	(-1.414)	(-0.490)	(-1.685)	(-1.204)
After × Pre-Diversified	-0.173	-0.160	-0.141			
	(-1.193)	(-1.101)	(-0.942)			
After × Pre-Diversified Sec20				-0.601	-0.584	-0.587
				(-0.875)	(-0.852)	(-0.841)
After × Pre-Diversified NonSec20				-0.096	-0.083	-0.067
				(-0.843)	(-0.731)	(-0.551)
Ln TA		0.326*	0.373*		0.318*	0.357*
		(1.829)	(1.833)		(1.827)	(1.762)
Market-To-Book			-0.056			-0.087
			(-0.558)			(-0.947)
Cash-To-TA			-2.110			-1.978
			(-1.340)			(-1.187)
Tier 1 Ratio			-4.556*			-4.104
			(-1.667)			(-1.479)
ROE			0.004			0.006
			(0.211)			(0.289)
Excessive Growth			-0.364			-0.380*
			(-1.594)			(-1.720)
High Dividend			0.062			0.003
			(0.384)			(0.015)
Constant	-4.173***	-6.657***	-6.030***	-4.173***	-6.598***	-5.893***
	(-137.543)	(-4.903)	(-3.873)	(-138.303)	(-4.964)	(-3.848)
Bank Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Num Observations	562	562	500	562	562	500
R-squared	0.015	0.020	0.038	0.027	0.032	0.050

Panel C: Annual Average Operational Loss per Event

	(1)	(2)	(3)	(4)	(5)	(6)
After	-0.023	-0.112*	-0.140	-0.023	-0.110*	-0.120
	(-0.555)	(-1.666)	(-1.599)	(-0.554)	(-1.653)	(-1.365)
After × Pre-Diversified	-0.187	-0.174	-0.153			
	(-1.350)	(-1.261)	(-1.065)			
After × Pre-Diversified Sec20				-0.674	-0.658	-0.649
				(-1.065)	(-1.044)	(-1.009)
After × Pre-Diversified NonSec20				-0.099	-0.087	-0.070
				(-0.884)	(-0.777)	(-0.586)
Ln TA		0.304*	0.358*		0.296*	0.341*
		(1.729)	(1.811)		(1.726)	(1.738)
Market-To-Book			-0.023			-0.057
			(-0.237)			(-0.637)
Cash-To-TA			-2.028			-1.881
			(-1.387)			(-1.225)
Tier 1 Ratio			-3.959			-3.455
			(-1.488)			(-1.304)
ROE			0.003			0.005
			(0.150)			(0.244)
Excessive Growth			-0.332			-0.350*
			(-1.541)			(-1.681)
High Dividend			0.061			-0.005
			(0.382)			(-0.029)
Constant	-4.205***	-6.525***	-6.108***	-4.205***	-6.458***	-5.956***
	(-145.223)	(-4.867)	(-3.995)	(-146.425)	(-4.941)	(-3.969)
Bank Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Num Observations	562	562	500	562	562	500
R-squared	0.019	0.023	0.040	0.036	0.041	0.057

Table B5: Test for Persistence of the Treatment Effect Using 1994–1996 and 2003–2005 Before and After Periods

This table presents the results of the test for persistence of the treatment effect for operational risk. Instead of using the sample of 1994–1996 vs. 2000–2002 (Table 4), we use the sample of 1994–1996 vs. 2003–2005 to construct the before and after periods. The dependent variable is annual operational risk event frequency (*Count*) in Panel A, annual total loss (*Ln Total Loss*) in Panel B, and annual average loss per event (*Ln Avg Loss*) in Panel C. The second and third are in logarithmic form. All data are averaged over the 1994–1996 and 2003–2005 sample periods. All models include bank-level fixed effects, which subsume the effect of the stand-alone treatment and control group dummies. *t*-statistics reported in parentheses are based on robust standard errors clustered at the bank holding company level. Superscripts ***, **, and * indicate statistical significance at 1%, 5%, and 10% levels.

Panel A: Annual Operational Risk Event Frequency

	(1)	(2)	(3)	(4)	(5)	(6)
After	0.018	-0.209**	-0.250	0.018	-0.223**	-0.375*
	(1.623)	(-2.127)	(-1.490)	(1.622)	(-2.284)	(-1.938)
After × Pre-Diversified	0.284**	0.298**	0.340**			
	(2.524)	(2.560)	(2.510)			
After × Pre-Diversified Sec20				1.575***	1.598***	1.737***
				(2.678)	(2.762)	(2.750)
After × Pre-Diversified NonSec20				0.037	0.050	0.050
				(1.056)	(1.337)	(0.842)
Ln TA		0.200**	0.308**		0.212**	0.321**
		(2.293)	(2.169)		(2.448)	(2.336)
Market-To-Book			-0.138*			-0.094
			(-1.917)			(-1.154)
Cash-To-TA			0.246			-0.865
			(0.264)			(-0.963)
Tier 1 Ratio			1.881*			0.769
			(1.663)			(0.639)
ROE			0.001			0.010
			(0.213)			(1.130)
Excessive Growth			0.089			0.223
			(0.566)			(1.399)
High Dividend			-0.110			0.044
			(-0.942)			(0.383)
Constant	0.062***	-1.303**	-2.206*	0.062***	-1.387**	-2.307*
	(2.732)	(-2.116)	(-1.798)	(3.097)	(-2.290)	(-1.967)
Bank Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Num Observations	560	560	338	560	560	338
R-squared	0.060	0.083	0.127	0.270	0.295	0.339

Panel B: Annual Total Operational Loss

	(1)	(2)	(3)	(4)	(5)	(6)
After	0.012	-0.292***	-0.256	0.012	-0.304***	-0.362*
	(0.306)	(-2.644)	(-1.236)	(0.305)	(-2.797)	(-1.798)
After × Pre-Diversified	0.329**	0.347**	0.552***			
	(2.446)	(2.581)	(2.849)			
After × Pre-Diversified Sec20				1.369**	1.399**	1.731***
				(2.280)	(2.382)	(2.766)
After × Pre-Diversified NonSec20				0.130	0.147	0.307**
				(1.351)	(1.524)	(2.096)
Ln TA		0.269***	0.289*		0.279***	0.300**
		(2.776)	(1.944)		(2.931)	(2.094)
Market-To-Book			-0.240			-0.203
			(-1.401)			(-1.318)
Cash-To-TA			-0.872			-1.810
			(-0.367)			(-0.778)
Tier 1 Ratio			-2.682			-3.620
			(-0.922)			(-1.344)
ROE			0.034			0.041*
			(1.607)			(1.914)
Excessive Growth			-0.110			0.003
			(-0.543)			(0.014)
High Dividend			-0.175			-0.045
			(-1.284)			(-0.332)
Constant	-4.405***	-6.243***	-5.703***	-4.405***	-6.311***	-5.789***
	(-155.078)	(-9.273)	(-4.242)	(-162.622)	(-9.577)	(-4.653)
Bank Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Num Observations	560	560	338	560	560	338
R-squared	0.050	0.075	0.121	0.137	0.165	0.226

Panel C: Annual Average Operational Loss per Event

	(1)	(2)	(3)	(4)	(5)	(6)
After	0.012	-0.245**	-0.204	0.012	-0.253***	-0.282
	(0.298)	(-2.507)	(-1.093)	(0.298)	(-2.647)	(-1.616)
After × Pre-Diversified	0.264**	0.279**	0.461***			
	(2.231)	(2.373)	(2.675)			
After × Pre-Diversified Sec20				1.025*	1.050**	1.331**
				(1.968)	(2.055)	(2.448)
After × Pre-Diversified NonSec20				0.118	0.132	0.280**
				(1.325)	(1.484)	(2.057)
Ln TA		0.227***	0.228*		0.234***	0.236*
		(2.668)	(1.794)		(2.813)	(1.926)
Market-To-Book			-0.218			-0.191
			(-1.394)			(-1.338)
Cash-To-TA			-1.071			-1.763
			(-0.468)			(-0.788)
Tier 1 Ratio			-2.581			-3.274
			(-0.995)			(-1.322)
ROE			0.033			0.039*
			(1.593)			(1.816)
Excessive Growth			-0.128			-0.045
			(-0.720)			(-0.277)
High Dividend			-0.140			-0.044
			(-1.153)			(-0.355)
Constant	-4.418***	-5.966***	-5.310***	-4.418***	-6.016***	-5.373***
	(-175.107)	(-10.171)	(-4.584)	(-180.693)	(-10.491)	(-4.990)
Bank Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Num Observations	560	560	338	560	560	338
R-squared	0.041	0.065	0.111	0.101	0.126	0.184

Table B6: Difference-in-Differences Analysis with 1994–1996 vs. 1997–1999 as Before and After Periods

This table presents the results of our difference-in-differences analysis for operational risk using an alternative after period. Instead of using the sample of 1994–1996 vs. 2000–2002 (Table 4), we use the sample of 1994–1996 vs. 1997–1999 to construct the before and after periods. The dependent variables are annual operational risk event frequency (*Count*) in Panel A, annual total loss (*Ln Total Loss*) in Panel B, and annual average loss per event (*Ln Avg Loss*) in Panel C. The second and third are in logarithmic form. All data are averaged over the 1994–1996 (pre-deregulation) and 1997–1999 (deregulation) sample periods. All models include bank-level fixed effects, which subsume the effect of the stand-alone treatment and control group dummies. *t*-statistics reported in parentheses are based on robust standard errors clustered at the bank holding company level. Superscripts ***, **, and * indicate statistical significance at 1%, 5%, and 10% levels.

Panel A: Annual Operational Risk Event Frequency

	(1)	(2)	(3)	(4)	(5)	(6)
After	-0.001	-0.057*	-0.098**	-0.001	-0.060**	-0.084**
	(-0.114)	(-1.852)	(-1.976)	(-0.114)	(-2.237)	(-2.000)
After × Pre-Diversified	0.125***	0.121***	0.135***			
	(2.910)	(2.922)	(2.718)			
After × Pre-Diversified Sec20				0.745***	0.743***	0.752***
				(2.968)	(3.003)	(2.983)
After × Pre-Diversified NonSec20				0.018	0.013	0.010
				(1.369)	(0.971)	(0.545)
Ln TA		0.147*	0.265**		0.156**	0.263**
		(1.876)	(1.991)		(2.283)	(2.329)
Market-To-Book			0.006			-0.028
			(0.213)			(-0.808)
Cash-To-TA			0.269			-0.182
			(0.752)			(-0.538)
Tier 1 Ratio			1.952*			2.147**
			(1.652)			(2.022)
ROE			0.007			0.005
			(0.890)			(0.644)
Excessive Growth			-0.012			0.005
			(-0.188)			(0.087)
High Dividend			-0.027			0.022
			(-0.698)			(0.513)
Constant	0.044***	-0.952*	-2.193**	0.044***	-1.015**	-2.116**
	(5.135)	(-1.775)	(-2.010)	(5.689)	(-2.167)	(-2.310)
Bank Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Num Observations	954	954	624	954	954	624
R-squared	0.042	0.053	0.075	0.220	0.233	0.250

Panel B: Annual Total Operational Loss

	(1)	(2)	(3)	(4)	(5)	(6)
After	-0.013	-0.093	-0.125	-0.013	-0.100*	-0.097
	(-0.579)	(-1.587)	(-1.092)	(-0.579)	(-1.905)	(-0.931)
After × Pre-Diversified	0.223**	0.217**	0.243**			
	(2.461)	(2.412)	(2.264)			
After × Pre-Diversified Sec20				1.379***	1.376***	1.434***
				(2.861)	(2.866)	(2.965)
After × Pre-Diversified NonSec20				0.023	0.016	0.003
				(0.467)	(0.325)	(0.043)
Ln TA		0.211	0.356		0.228**	0.351*
		(1.583)	(1.610)		(2.016)	(1.894)
Market-To-Book			-0.037			-0.103
			(-0.421)			(-1.062)
Cash-To-TA			-0.492			-1.363
			(-0.404)			(-1.206)
Tier 1 Ratio			3.944*			4.322**
			(1.694)			(2.127)
ROE			0.015			0.011
			(1.094)			(0.800)
Excessive Growth			-0.039			-0.006
			(-0.239)			(-0.039)
High Dividend			0.003			0.097
			(0.028)			(0.991)
Constant	-4.453***	-5.880***	-7.490***	-4.453***	-5.997***	-7.340***
	(-237.028)	(-6.512)	(-4.352)	(-255.039)	(-7.827)	(-5.107)
Bank Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Num Observations	954	954	624	954	954	624
R-squared	0.026	0.031	0.045	0.159	0.165	0.191

Panel C: Annual Average Operational Loss per Event

	(1)	(2)	(3)	(4)	(5)	(6)
After	-0.012	-0.083	-0.101	-0.012	-0.088*	-0.077
	(-0.543)	(-1.518)	(-0.943)	(-0.543)	(-1.781)	(-0.782)
After × Pre-Diversified	0.188**	0.183**	0.204**			
	(2.269)	(2.216)	(2.096)			
After × Pre-Diversified Sec20				1.166***	1.163***	1.221***
				(2.670)	(2.672)	(2.796)
After × Pre-Diversified NonSec20				0.019	0.013	-0.001
				(0.389)	(0.261)	(-0.015)
Ln TA		0.185	0.306		0.199*	0.302*
		(1.545)	(1.555)		(1.923)	(1.790)
Market-To-Book			-0.047			-0.103
			(-0.551)			(-1.115)
Cash-To-TA			-0.647			-1.390
			(-0.563)			(-1.268)
Tier 1 Ratio			3.597*			3.920**
			(1.677)			(2.046)
ROE			0.015			0.011
			(1.136)			(0.878)
Excessive Growth			-0.033			-0.004
			(-0.229)			(-0.034)
High Dividend			0.011			0.092
			(0.115)			(0.988)
Constant	-4.461***	-5.714***	-7.063***	-4.461***	-5.812***	-6.935***
	(-257.971)	(-7.047)	(-4.633)	(-274.212)	(-8.279)	(-5.328)
Bank Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Num Observations	954	954	624	954	954	624
R-squared	0.021	0.026	0.040	0.135	0.140	0.167

Table B7: Robustness Test with Nonbanks as the Control Group
(Complete Results for Table 7)

This table presents complete results of a robustness test for operational risk with Section 20 BHCs and non-Section 20 BHCs as the treatment groups and nonbanks as the control group. The dependent variable is annual operational risk event frequency (*Count*) in Panel A, annual total loss (*Ln Total Loss*) in Panel B, and annual average loss per event (*Ln Avg Loss*) in Panel C. The second and third are in logarithmic form. All data are averaged over the 1994–1996 (pre-deregulation) and 2000–2002 (post-deregulation) sample periods. All models include bank/firm-level fixed effects, which subsume the effect of the stand-alone treatment and control group dummies. *t*-statistics reported in parentheses are based on robust standard errors clustered at the firm level. Superscripts ***, **, and * indicate statistical significance at 1%, 5%, and 10% levels.

Panel A: Annual Operational Risk Event Frequency

	(1)	(2)	(3)	(4)	(5)	(6)
After	0.223*	0.185	0.298	0.223*	0.184	0.296
	(1.830)	(1.516)	(1.531)	(1.830)	(1.512)	(1.520)
After × BHC	-0.049	-0.062	-0.216			
	(-0.368)	(-0.473)	(-1.064)			
After × BHC Sec20				1.634**	1.622**	1.072*
				(2.390)	(2.396)	(1.934)
After × BHC NonSec20				-0.160	-0.174	-0.316
				(-1.293)	(-1.404)	(-1.593)
After × SIC61	-0.157	-0.157	-0.230	-0.157	-0.157	-0.230
	(-1.216)	(-1.221)	(-1.092)	(-1.216)	(-1.221)	(-1.091)
After × SIC63	-0.153	-0.155	-0.318	-0.153	-0.156	-0.317
	(-1.224)	(-1.247)	(-1.595)	(-1.224)	(-1.247)	(-1.588)
After × SIC64	-0.131	-0.143	-0.267	-0.131	-0.144	-0.271
	(-0.919)	(-1.008)	(-1.237)	(-0.918)	(-1.010)	(-1.251)
After × SIC65	-0.223*	-0.215*	-0.323*	-0.223*	-0.214*	-0.329*
	(-1.830)	(-1.765)	(-1.737)	(-1.830)	(-1.763)	(-1.770)
After × SIC67	-0.223*	-0.241**	-0.334*	-0.223*	-0.241**	-0.339*
	(-1.830)	(-1.967)	(-1.774)	(-1.830)	(-1.971)	(-1.797)
Ln TA		0.063**	0.087***		0.065**	0.092***
		(2.135)	(2.598)		(2.439)	(2.914)
Market-To-Book			0.000			0.000
			(0.590)			(0.707)
Cash-To-TA			-0.053			-0.072
			(-0.435)			(-0.582)
Tier 1 Ratio			-0.003			-0.004
			(-0.290)			(-0.355)
ROE			-0.004			-0.003
			(-1.297)			(-1.059)
Excessive Growth			-0.019			-0.020
			(-0.322)			(-0.360)
High Dividend			-0.020			-0.015
			(-0.409)			(-0.334)
Constant	0.030***	-0.342*	-0.439**	0.030***	-0.351**	-0.477**
	(4.080)	(-1.797)	(-2.000)	(4.488)	(-2.067)	(-2.357)
Bank/Firm Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Num Observations	2,576	1,680	986	2,576	1,680	986
R-squared	0.036	0.042	0.064	0.204	0.210	0.233

Panel B: Annual Total Operational Loss

	(1)	(2)	(3)	(4)	(5)	(6)
After	0.148	0.073	0.106	0.148	0.072	0.104
	(0.738)	(0.384)	(0.380)	(0.737)	(0.379)	(0.372)
After × BHC	0.111	0.086	0.037			
	(0.531)	(0.414)	(0.128)			
After × BHC Sec20				1.738***	1.715***	1.647***
				(3.286)	(3.252)	(2.767)
After × BHC NonSec20				0.004	-0.022	-0.088
				(0.018)	(-0.107)	(-0.306)
After × SIC61	-0.073	-0.075	-0.107	-0.073	-0.075	-0.107
	(-0.348)	(-0.364)	(-0.363)	(-0.348)	(-0.364)	(-0.364)
After × SIC63	0.010	0.006	-0.166	0.010	0.006	-0.165
	(0.046)	(0.025)	(-0.522)	(0.046)	(0.024)	(-0.519)
After × SIC64	0.466	0.441	0.524	0.466	0.441	0.519
	(0.916)	(0.873)	(0.796)	(0.916)	(0.873)	(0.789)
After × SIC65	-0.148	-0.132	-0.217	-0.148	-0.131	-0.225
	(-0.738)	(-0.671)	(-0.793)	(-0.737)	(-0.670)	(-0.824)
After × SIC67	-0.152	-0.185	-0.245	-0.152	-0.186	-0.251
	(-0.757)	(-0.922)	(-0.901)	(-0.757)	(-0.924)	(-0.924)
Ln TA		0.123***	0.199***		0.124***	0.205***
		(3.131)	(2.764)		(3.240)	(2.987)
Market-To-Book			0.000*			0.000*
			(1.831)			(1.947)
Cash-To-TA			0.282			0.258
			(0.896)			(0.818)
Tier 1 Ratio			-0.028			-0.029
			(-1.313)			(-1.388)
ROE			-0.002			-0.001
			(-0.623)			(-0.272)
Excessive Growth			-0.118			-0.119
			(-1.165)			(-1.256)
High Dividend			-0.030			-0.023
			(-0.348)			(-0.282)
Constant	-4.492***	-5.188***	-5.604***	-4.492***	-5.197***	-5.652***
	(-405.793)	(-21.087)	(-11.617)	(-421.410)	(-21.605)	(-12.366)
Bank/Firm Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Num Observations	2,576	1,680	986	2,576	1,680	986
R-squared	0.041	0.051	0.063	0.111	0.122	0.142

Panel C: Annual Average Operational Loss per Event

	(1)	(2)	(3)	(4)	(5)	(6)
After	0.104	0.035	0.049	0.104	0.035	0.047
	(0.554)	(0.200)	(0.195)	(0.554)	(0.196)	(0.188)
After × BHC	0.127	0.104	0.084			
	(0.653)	(0.539)	(0.320)			
After × BHC Sec20				1.451***	1.430***	1.462***
				(2.993)	(2.946)	(2.657)
After × BHC NonSec20				0.040	0.016	-0.023
				(0.206)	(0.086)	(-0.089)
After × SIC61	-0.040	-0.042	-0.061	-0.040	-0.042	-0.061
	(-0.205)	(-0.219)	(-0.231)	(-0.205)	(-0.219)	(-0.232)
After × SIC63	0.041	0.037	-0.108	0.041	0.036	-0.107
	(0.191)	(0.172)	(-0.371)	(0.190)	(0.172)	(-0.369)
After × SIC64	0.498	0.475	0.585	0.498	0.475	0.580
	(1.011)	(0.972)	(0.924)	(1.011)	(0.971)	(0.917)
After × SIC65	-0.104	-0.088	-0.156	-0.104	-0.088	-0.163
	(-0.554)	(-0.485)	(-0.631)	(-0.554)	(-0.484)	(-0.660)
After × SIC67	-0.108	-0.137	-0.182	-0.108	-0.138	-0.187
	(-0.574)	(-0.732)	(-0.742)	(-0.574)	(-0.734)	(-0.764)
Ln TA		0.112***	0.180***		0.113***	0.186***
		(2.966)	(2.681)		(3.025)	(2.871)
Market-To-Book			0.000*			0.000**
			(1.934)			(2.037)
Cash-To-TA			0.313			0.293
			(1.005)			(0.937)
Tier 1 Ratio			-0.028			-0.028
			(-1.371)			(-1.434)
ROE			-0.001			0.000
			(-0.334)			(0.033)
Excessive Growth			-0.120			-0.121
			(-1.289)			(-1.373)
High Dividend			-0.023			-0.017
			(-0.282)			(-0.218)
Constant	-4.498***	-5.130***	-5.512***	-4.498***	-5.137***	-5.552***
	(-431.376)	(-21.751)	(-12.189)	(-443.554)	(-21.965)	(-12.839)
Bank/Firm Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Num Observations	2,576	1,680	986	2,576	1,680	986
R-squared	0.038	0.047	0.060	0.090	0.100	0.124

Table B8: Test for Persistence of the Treatment Effect Using 1994–1996 and 2003–2005 Before and After Periods: Performance Measures

This table presents the results of the test for persistence of the treatment effect for performance measures. The dependent variable is a metric of performance: return on assets, standard deviation of return on assets, *Z*-score, and market-to-book ratio. Instead of using the sample of 1994–1996 vs. 2000–2002 (Table 8, Panel A), we use the sample of 1994–1996 vs. 2003–2005 to construct the before and after periods. All data are averaged over the 1994–1996 and 2003–2005 sample periods. All models include bank-level fixed effects, which subsume the effect of the stand-alone treatment and control group dummies. *t*-statistics reported in parentheses are based on robust standard errors clustered at the bank holding company level. Superscripts ***, **, and * indicate statistical significance at 1%, 5%, and 10% levels.

	Return on Assets		Standard Deviation of Return on Assets		*Z*-Score		Market-to-Book Ratio	
	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)
After	-0.161***	-0.156***	-0.040**	-0.040*	-0.014	0.005	0.296*	0.313**
	(-2.844)	(-2.779)	(-2.001)	(-1.953)	(-0.107)	(0.037)	(1.951)	(2.056)
After × Pre-Diversified	0.017		0.045		0.066		-0.002	
	(0.330)		(1.342)		(0.526)		(-0.021)	
After × Pre-Diversified Sec20		-0.037		0.044		-0.121		-0.189
		(-0.520)		(0.945)		(-0.755)		(-1.063)
After × Pre-Diversified NonSec20		0.029		0.045		0.107		0.037
		(0.556)		(1.406)		(0.785)		(0.319)
Ln TA	0.052	0.051	-0.009	-0.009	0.111	0.109	0.013	0.011
	(1.362)	(1.362)	(-0.601)	(-0.604)	(1.296)	(1.313)	(0.128)	(0.103)
Cash-To-TA	-0.963*	-0.912*	-0.481**	-0.480**	0.925	1.106	-2.042*	-1.868
	(-1.790)	(-1.693)	(-2.181)	(-2.219)	(0.624)	(0.749)	(-1.704)	(-1.537)
Tier 1 Ratio	3.682***	3.726***	0.463	0.464	2.493	2.645	-2.785	-2.635
	(3.193)	(3.195)	(0.548)	(0.544)	(1.252)	(1.306)	(-1.215)	(-1.122)
Excessive Growth	-0.039	-0.044	-0.098***	-0.098***	0.132	0.113	-0.079	-0.097
	(-0.639)	(-0.722)	(-3.179)	(-3.183)	(0.991)	(0.838)	(-0.603)	(-0.733)
High Dividend	0.178***	0.171***	0.041*	0.041*	0.124	0.098	0.335**	0.310**
	(3.391)	(3.188)	(1.936)	(1.847)	(1.126)	(0.843)	(2.321)	(2.153)
Constant	-0.168	-0.167	0.439**	0.439**	0.793	0.795	1.965**	1.967**
	(-0.476)	(-0.478)	(2.376)	(2.373)	(1.033)	(1.058)	(2.225)	(2.239)
Bank Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Num Observations	338	338	336	336	336	336	338	338
R-squared	0.288	0.292	0.160	0.160	0.081	0.088	0.343	0.349

Table B9: Difference-in-Differences Analysis with Banking and Nonbanking Events for Growth-Matched BHCs (Complete Results for Table 9)

This table presents complete results for banking and nonbanking operational risk events separately. The dependent variable is annual operational risk event frequency (*Count*) in Panel A, annual total loss (*Ln Total Loss*) in Panel B, and annual average loss per event (*Ln Avg Loss*) in Panel C. The second and third are in logarithmic form. We use paired samples where BHCs in the treatment (Section 20 subsidiary holders) and control groups are matched by asset growth. For each operational risk measure, Models (1), (2), and (3) present the results for banking events and Models (4), (5), and (6) present the for nonbanking events. All data are averaged over the 1994–1996 (pre-deregulation) and 2000–2002 (post-deregulation) sample periods. All models include bank/firm-level fixed effects, which subsume the effect of the stand-alone treatment and control group dummies. *t*-statistics reported in parentheses are based on robust standard errors clustered at the bank holding company or firm level. Superscripts ***, **, and * indicate statistical significance at 1%, 5%, and 10% levels.

Panel A: Annual Operational Risk Event Frequency

	Banking Events			Nonbanking Events		
	(1)	(2)	(3)	(4)	(5)	(6)
After	0.035*	-0.107	-0.341*	0.093**	-0.332	-0.719
	(1.692)	(-1.211)	(-1.853)	(2.052)	(-1.229)	(-1.499)
After × Pre-Diversified Sec20	0.724***	0.736***	0.871***	0.630*	0.846**	1.159*
	(3.154)	(3.221)	(2.994)	(1.996)	(2.090)	(1.815)
Ln TA		0.173*	0.256**		0.290	0.627*
		(1.700)	(2.078)		(1.454)	(1.724)
Market-To-Book			-0.012			-0.097
			(-0.102)			(-0.803)
Cash-To-TA			-4.109			-0.304
			(-1.225)			(-0.476)
Tier 1 Ratio			3.542**			0.634
			(2.304)			(1.350)
ROE			0.010			0.046
			(0.612)			(1.129)
Excessive Growth			0.326			-0.021
			(1.455)			(-0.069)
High Dividend			-0.380			-0.013
			(-1.356)			(-0.026)
Constant	0.108***	-1.218	-2.016*	0.139*	-1.956	-5.070
	(3.310)	(-1.519)	(-1.854)	(1.761)	(-1.309)	(-1.602)
Bank/Firm Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Num Observations	130	130	90	72	72	62
R-squared	0.376	0.398	0.482	0.239	0.271	0.332

Panel B: Annual Total Operational Loss

	Banking Events			Nonbanking Events		
	(1)	(2)	(3)	(4)	(5)	(6)
After	0.070	-0.176	-0.624	0.387*	-0.303	-0.855
	(0.489)	(-0.717)	(-1.524)	(1.766)	(-0.486)	(-0.860)
After × Pre-Diversified Sec20	1.894***	1.915***	2.325***	1.065*	1.416*	1.759
	(4.123)	(4.207)	(5.064)	(1.798)	(1.982)	(1.683)
Ln TA		0.299	0.401		0.472	0.979
		(1.364)	(1.291)		(1.073)	(1.366)
Market-To-Book			-0.059			-0.089
			(-0.175)			(-0.318)
Cash-To-TA			-14.188**			-0.836
			(-2.106)			(-0.517)
Tier 1 Ratio			7.620			1.054
			(1.068)			(0.934)
ROE			0.105			0.039
			(1.372)			(0.430)
Excessive Growth			0.304			0.132
			(0.588)			(0.120)
High Dividend			-0.780*			0.077
			(-1.710)			(0.074)
Constant	-4.241***	-6.533***	-7.559**	-4.095***	-7.497**	-12.102*
	(-53.289)	(-3.866)	(-2.257)	(-27.648)	(-2.323)	(-1.892)
Bank/Firm Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Num Observations	130	130	90	72	72	62
R-squared	0.402	0.413	0.527	0.274	0.297	0.348

Panel C: Annual Average Operational Loss per Event

	Banking Events			Nonbanking Events		
	(1)	(2)	(3)	(4)	(5)	(6)
After	0.075	-0.128	-0.502	0.387*	-0.159	-0.563
	(0.529)	(-0.534)	(-1.244)	(1.804)	(-0.280)	(-0.633)
After × Pre-Diversified Sec20	1.757***	1.774***	2.131***	0.888	1.165*	1.393
	(4.044)	(4.094)	(4.784)	(1.683)	(1.889)	(1.524)
Ln TA		0.246	0.327		0.373	0.763
		(1.183)	(1.126)		(0.952)	(1.222)
Market-To-Book			-0.046			-0.045
			(-0.148)			(-0.178)
Cash-To-TA			-12.823*			-0.556
			(-1.970)			(-0.362)
Tier 1 Ratio			6.869			0.761
			(1.026)			(0.767)
ROE			0.102			0.025
			(1.338)			(0.303)
Excessive Growth			0.177			0.166
			(0.348)			(0.156)
High Dividend			-0.711			0.046
			(-1.632)			(0.050)
Constant	-4.269***	-6.156***	-6.996**	-4.127***	-6.818**	-10.354*
	(-55.789)	(-3.842)	(-2.252)	(-31.306)	(-2.383)	(-1.873)
Bank/Firm Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Num Observations	130	130	90	72	72	62
R-squared	0.387	0.395	0.503	0.273	0.291	0.335

Table B10: Difference-in-Differences Analysis with Banking and Nonbanking Events

This table presents the results for banking and nonbanking operational risk events separately, using our full sample instead of growth-matched samples. The dependent variable is annual operational risk event frequency (*Count*) in Panel A, annual total loss (*Ln Total Loss*) in Panel B, and annual average loss per event (*Ln Avg Loss*) in Panel C. The second and third are in logarithmic form. For each operational risk measure, Models (1), (2), and (3) present the results for banking events and Models (4), (5), and (6) present the for nonbanking events. All data are averaged over the 1994–1996 (pre-deregulation) and 2000–2002 (post-deregulation) sample periods. All models include bank/firm-level fixed effects, which subsume the effect of the stand-alone treatment and control group dummies. *t*-statistics reported in parentheses are based on robust standard errors clustered at the bank holding company or firm level. Superscripts ***, **, and * indicate statistical significance at 1%, 5%, and 10% levels.

Panel A: Annual Operational Risk Event Frequency

	Banking Events			Nonbanking Events		
	(1)	(2)	(3)	(4)	(5)	(6)
After	0.019***	-0.041	-0.102*	0.056	-0.026	-0.098
	(2.714)	(-1.558)	(-1.935)	(1.586)	(-0.533)	(-0.716)
After × BHC Sec20	0.741***	0.743***	0.756***	0.667**	0.652**	0.682*
	(3.280)	(3.331)	(3.301)	(2.150)	(2.159)	(1.780)
Ln TA		0.075**	0.129**		0.134*	0.261*
		(2.287)	(2.345)		(1.920)	(1.734)
Market-To-Book			-0.006			-0.011
			(-0.160)			(-0.215)
Cash-To-TA			-0.943*			-0.489
			(-1.724)			(-1.197)
Tier 1 Ratio			1.191**			-0.039
			(2.506)			(-0.463)
ROE			0.005			0.001
			(0.868)			(0.165)
Excessive Growth			0.021			0.104
			(0.455)			(0.655)
High Dividend			-0.089			-0.035
			(-1.354)			(-0.118)
Constant	0.028***	-0.480**	-0.957**	0.116**	-0.744	-1.516
	(4.154)	(-2.122)	(-2.145)	(2.646)	(-1.563)	(-1.487)
Bank/Firm Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Num Observations	694	694	412	132	132	90
R-squared	0.328	0.340	0.373	0.226	0.245	0.283

Panel B: Annual Total Operational Loss

	Banking Events			Nonbanking Events		
	(1)	(2)	(3)	(4)	(5)	(6)
After	0.075**	-0.075	-0.233*	0.059	-0.113	-0.191
	(2.035)	(-1.011)	(-1.744)	(0.473)	(-0.795)	(-0.703)
After × BHC Sec20	1.890***	1.897***	2.009***	1.393**	1.361**	1.334**
	(4.367)	(4.453)	(4.834)	(2.499)	(2.491)	(2.024)
Ln TA		0.189**	0.285*		0.283	0.550
		(2.105)	(1.898)		(1.636)	(1.638)
Market-To-Book			-0.067			0.003
			(-0.524)			(0.020)
Cash-To-TA			-5.188***			-1.482
			(-2.845)			(-1.091)
Tier 1 Ratio			2.523			-0.126
			(1.152)			(-0.520)
ROE			0.039			-0.000
			(1.366)			(-0.002)
Excessive Growth			-0.137			0.205
			(-1.014)			(0.291)
High Dividend			-0.213			-0.078
			(-1.170)			(-0.133)
Constant	-4.499***	-5.778***	-6.386***	-4.153***	-5.968***	-7.514***
	(-217.706)	(-9.434)	(-4.740)	(-47.825)	(-5.227)	(-3.037)
Bank/Firm Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Num Observations	694	694	412	132	132	90
R-squared	0.258	0.268	0.345	0.230	0.252	0.323

Panel C: Annual Average Operational Loss per Event

	Banking Events			Nonbanking Events		
	(1)	(2)	(3)	(4)	(5)	(6)
After	0.075**	-0.060	-0.199	0.054	-0.096	-0.138
	(2.078)	(-0.831)	(-1.542)	(0.435)	(-0.704)	(-0.550)
After × BHC Sec20	1.756***	1.763***	1.867***	1.220**	1.192**	1.143*
	(4.314)	(4.384)	(4.730)	(2.482)	(2.462)	(1.887)
Ln TA		0.171**	0.250*		0.249	0.475
		(1.972)	(1.749)		(1.563)	(1.571)
Market-To-Book			-0.060			0.012
			(-0.483)			(0.103)
Cash-To-TA			-5.036***			-1.272
			(-2.791)			(-0.960)
Tier 1 Ratio			2.259			-0.126
			(1.097)			(-0.551)
ROE			0.037			0.000
			(1.318)			(0.023)
Excessive Growth			-0.156			0.188
			(-1.202)			(0.271)
High Dividend			-0.200			-0.085
			(-1.138)			(-0.163)
Constant	-4.505***	-5.662***	-6.114***	-4.178***	-5.769***	-7.093***
	(-223.686)	(-9.575)	(-4.768)	(-52.855)	(-5.536)	(-3.146)
Bank/Firm Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Num Observations	694	694	412	132	132	90
R-squared	0.243	0.251	0.328	0.218	0.238	0.313

Table B11: Robustness Test with Zero Loss Amount Adjustment

This table presents the results of a robustness test for operational losses. All missing loss values in the data were set to 0.01, which is below the minimum annual total loss amount in our sample of $0.016 mln. The dependent variables are annual total loss (*Ln Total Loss*) in Panel A and annual average loss per event (*Ln Avg Loss*) in Panel B, in logarithmic form. All data are averaged over the 1994–1996 (pre-deregulation) and 2000–2002 (post-deregulation) sample periods. All models include bank-level fixed effects, which subsume the effect of the stand-alone treatment and control group dummies. *t*-statistics reported in parentheses are based on robust standard errors clustered at the bank holding company level. Superscripts ***, **, and * indicate statistical significance at 1%, 5%, and 10% levels.

Panel A: Annual Total Operational Loss

	(1)	(2)	(3)	(4)	(5)	(6)
After	0.051	-0.131	-0.274	0.051	-0.144	-0.347**
	(1.279)	(-1.176)	(-1.375)	(1.278)	(-1.433)	(-1.986)
After × Pre-Diversified	0.379***	0.380***	0.499***			
	(3.069)	(3.093)	(3.450)			
After × Pre-Diversified Sec20				1.917***	1.926***	2.106***
				(3.460)	(3.497)	(4.141)
After × Pre-Diversified NonSec20				0.149	0.148	0.224*
				(1.531)	(1.546)	(1.810)
Ln TA		0.230*	0.389*		0.246**	0.414**
		(1.748)	(1.765)		(2.114)	(2.118)
Market-To-Book			-0.126			-0.213
			(-0.700)			(-1.177)
Cash-To-TA			-3.396			-5.020**
			(-1.568)			(-2.545)
Tier 1 Ratio			4.595			4.082
			(1.506)			(1.540)
ROE			0.028			0.054
			(0.783)			(1.634)
Excessive Growth			-0.162			-0.076
			(-0.897)			(-0.473)
High Dividend			-0.313			-0.254
			(-1.543)			(-1.270)
Constant	-4.447***	-6.001***	-7.269***	-4.447***	-6.108***	-7.355***
	(-169.933)	(-6.743)	(-3.930)	(-184.117)	(-7.762)	(-4.426)
Bank Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Num Observations	694	694	412	694	694	412
R-squared	0.074	0.084	0.145	0.212	0.224	0.297

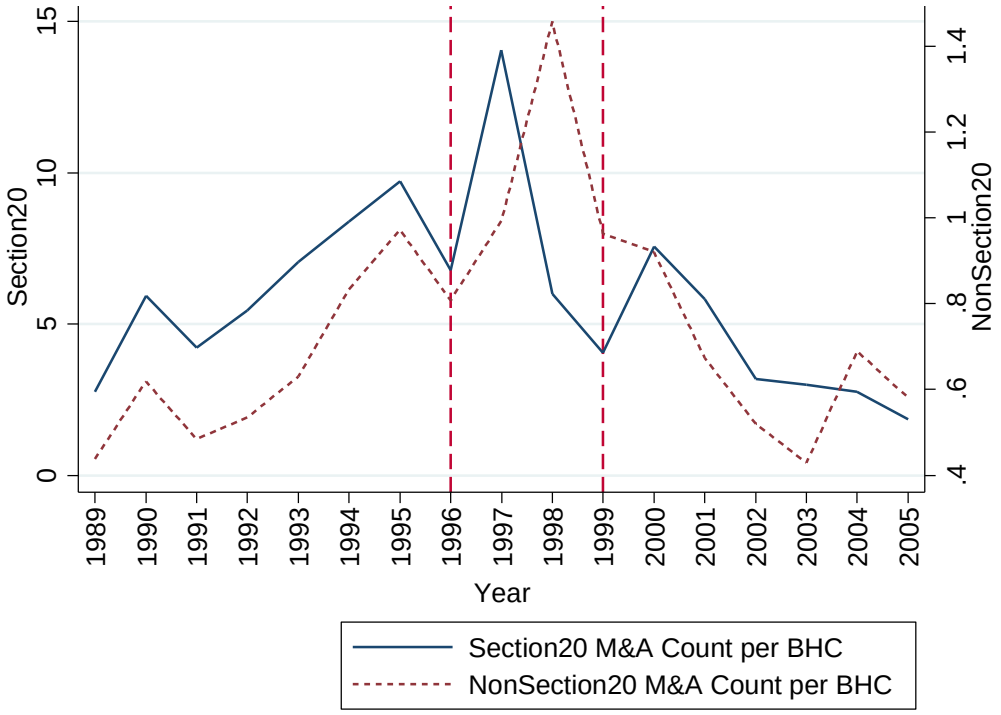
Panel B: Annual Average Operational Loss per Event

	(1)	(2)	(3)	(4)	(5)	(6)
After	0.052	-0.106	-0.228	0.052	-0.117	-0.290*
	(1.315)	(-1.009)	(-1.215)	(1.314)	(-1.214)	(-1.722)
After × Pre-Diversified	0.337***	0.338***	0.449***			
	(2.902)	(2.921)	(3.299)			
After × Pre-Diversified Sec20				1.642***	1.650***	1.825***
				(3.174)	(3.195)	(3.801)
After × Pre-Diversified NonSec20				0.142	0.141	0.213*
				(1.498)	(1.511)	(1.783)
Ln TA		0.200	0.331		0.213*	0.353*
		(1.632)	(1.635)		(1.937)	(1.918)
Market-To-Book			-0.132			-0.207
			(-0.750)			(-1.170)
Cash-To-TA			-3.448			-4.840**
			(-1.633)			(-2.501)
Tier 1 Ratio			4.100			3.661
			(1.468)			(1.488)
ROE			0.032			0.054*
			(0.954)			(1.700)
Excessive Growth			-0.172			-0.099
			(-1.058)			(-0.655)
High Dividend			-0.285			-0.235
			(-1.488)			(-1.236)
Constant	-4.457***	-5.805***	-6.830***	-4.457***	-5.896***	-6.904***
	(-179.835)	(-7.034)	(-4.016)	(-191.543)	(-7.934)	(-4.412)
Bank Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Num Observations	694	694	412	694	694	412
R-squared	0.068	0.077	0.137	0.180	0.190	0.264

Figure C1: Banking Sector M&A Activities

This figure illustrates the banking sector M&A activities for our sample BHCs. Panel A shows the average number of M&As and Panel B shows the average target assets ratio per BHC. The dashed lines around 1996 and 1999 indicate the timing of deregulations.

Panel A: Average Number of M&As per BHC



Panel B: Average Target Assets Ratio per BHC

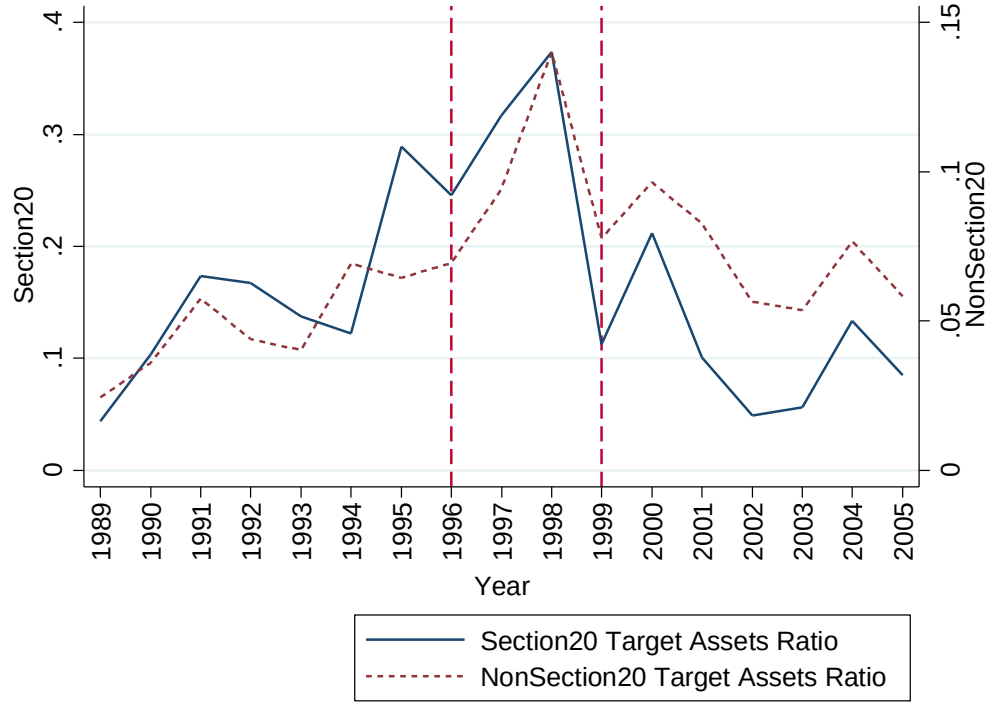


Figure C2: Numbers of News Articles

This figure illustrates the median number of news articles from the Factiva business news database for our sample of Section 20 subsidiary owners and non-Section 20 BHCs. The dashed lines around 1996 and 1999 indicate the timings of deregulations.

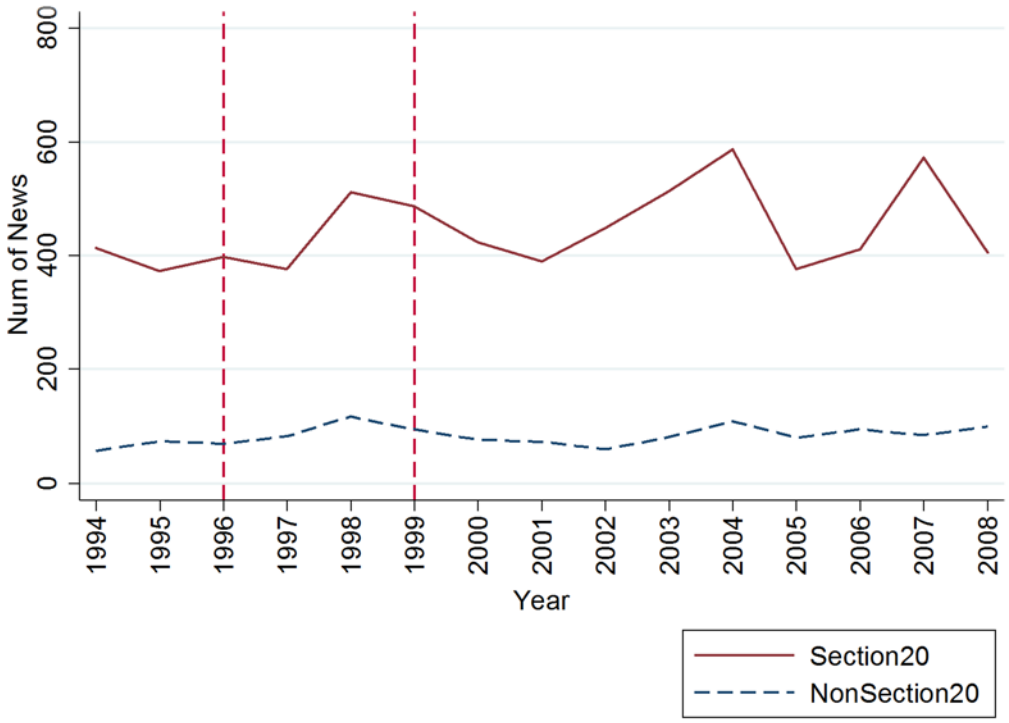


Table C1: Robustness Test with 1988–2005 Data

This table presents the results of the robustness test, in which, instead of using the sample of 1994–1996 vs. 2000–2002 (Table 4), we use the full sample of 1988–1996 vs. 1997–2005 to construct the before (pre-deregulation) and after (post-deregulation) periods. The dependent variable is annual operational risk event frequency (*Count*) in Panel A, annual total loss (*Ln Total Loss*) in Panel B, and annual average loss per event (*Ln Avg Loss*) in Panel C. The second and third are in logarithmic form. All data are averaged over the 1988–1996 (pre-deregulation) and 1997–2005 (post-deregulation) sample periods. All models include bank-level fixed effects, which subsume the effect of the stand-alone treatment and control group dummies. *t*-statistics reported in parentheses are based on robust standard errors clustered at the bank holding company level. Superscripts ***, **, and * indicate statistical significance at 1%, 5%, and 10% levels.

Panel A: Annual Operational Risk Event Frequency

	(1)	(2)	(3)	(4)	(5)	(6)
After	0.008*	-0.142**	-0.247**	0.008*	-0.132**	-0.207**
	(1.893)	(-2.194)	(-2.147)	(1.892)	(-2.391)	(-2.191)
After × Pre-Diversified	0.185***	0.162***	0.177***			
	(2.711)	(2.766)	(2.655)			
After × Pre-Diversified Sec20				1.031**	1.000**	1.010**
				(2.515)	(2.550)	(2.533)
After × Pre-Diversified NonSec20				0.034**	0.015	0.010
				(2.363)	(0.940)	(0.405)
Ln TA		0.194**	0.316**		0.181**	0.278***
		(2.318)	(2.413)		(2.536)	(2.606)
Market-To-Book			-0.008			-0.036
			(-0.321)			(-0.916)
Cash-To-TA			0.802			0.199
			(1.336)			(0.337)
Tier 1 Ratio			3.200**			2.301**
			(2.340)			(2.360)
ROE			0.002			0.004
			(0.497)			(0.904)
Excessive Growth			0.093			0.064
			(1.450)			(1.227)
High Dividend			-0.134			-0.043
			(-1.539)			(-0.563)
Constant	0.032**	-1.243**	-2.605**	0.032**	-1.158**	-2.171**
	(2.348)	(-2.212)	(-2.415)	(2.534)	(-2.417)	(-2.588)
Bank Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Num Observations	968	968	638	968	968	638
R-squared	0.040	0.066	0.100	0.177	0.200	0.224

Panel B: Annual Total Operational Loss

	(1)	(2)	(3)	(4)	(5)	(6)
After	0.022	-0.213***	-0.250**	0.022	-0.202***	-0.205**
	(1.305)	(-3.398)	(-2.251)	(1.304)	(-3.599)	(-1.969)
After × Pre-Diversified	0.265***	0.230***	0.284***			
	(3.338)	(3.077)	(3.187)			
After × Pre-Diversified Sec20				1.210***	1.161***	1.211***
				(2.989)	(2.938)	(3.063)
After × Pre-Diversified NonSec20				0.096**	0.066	0.098*
				(2.017)	(1.492)	(1.773)
Ln TA		0.304***	0.422***		0.290***	0.379***
		(3.854)	(3.755)		(4.138)	(3.841)
Market-To-Book			-0.093			-0.125*
			(-1.609)			(-1.797)
Cash-To-TA			1.049			0.378
			(0.866)			(0.359)
Tier 1 Ratio			3.316**			2.315*
			(2.098)			(1.942)
ROE			0.009			0.011
			(1.316)			(1.648)
Excessive Growth			0.130			0.097
			(0.909)			(0.780)
High Dividend			-0.222**			-0.120
			(-2.569)			(-1.319)
Constant	-4.483***	-6.480***	-7.748***	-4.483***	-6.385***	-7.265***
	(-277.075)	(-12.371)	(-8.350)	(-296.063)	(-13.797)	(-9.231)
Bank Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Num Observations	968	968	638	968	968	638
R-squared	0.061	0.105	0.147	0.179	0.219	0.259

Panel C: Annual Average Operational Loss per Event

	(1)	(2)	(3)	(4)	(5)	(6)
After	0.022	-0.184***	-0.197**	0.022	-0.176***	-0.162*
	(1.312)	(-3.484)	(-2.087)	(1.312)	(-3.600)	(-1.778)
After × Pre-Diversified	0.223***	0.192***	0.241***			
	(3.234)	(2.923)	(3.068)			
After × Pre-Diversified Sec20				0.966***	0.922***	0.966***
				(2.826)	(2.747)	(2.877)
After × Pre-Diversified NonSec20				0.091**	0.064	0.095*
				(1.986)	(1.510)	(1.814)
Ln TA		0.267***	0.359***		0.256***	0.325***
		(4.071)	(3.954)		(4.268)	(3.930)
Market-To-Book			-0.095*			-0.120*
			(-1.728)			(-1.889)
Cash-To-TA			0.808			0.283
			(0.744)			(0.294)
Tier 1 Ratio			2.751**			1.968*
			(2.006)			(1.843)
ROE			0.008			0.010*
			(1.379)			(1.658)
Excessive Growth			0.109			0.083
			(0.863)			(0.747)
High Dividend			-0.197***			-0.118
			(-2.604)			(-1.465)
Constant	-4.490***	-6.241***	-7.219***	-4.490***	-6.166***	-6.841***
	(-316.870)	(-14.388)	(-9.656)	(-333.960)	(-15.629)	(-10.375)
Bank Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Num Observations	968	968	638	968	968	638
R-squared	0.058	0.103	0.144	0.153	0.194	0.236

Table C2: Robustness Test with All Operational Risk Event Types

This table presents the results of the robustness test, in which we use all event types. The Basel Committee classifies operational risk into seven event types: internal fraud, external fraud, employment practices and workplace safety, clients, products and business practices, damage to physical assets, business disruption and system failures, and execution, delivery, and process management. The dependent variable is annual operational risk event frequency (*Count*) in Panel A, annual total loss (*Ln Total Loss*) in Panel B, and annual average loss per event (*Ln Avg Loss*) in Panel C. The second and third are in logarithmic form. All data are averaged over the 1994–1996 (pre-deregulation) and 2000–2002 (post-deregulation) sample periods. All models include bank-level fixed effects, which subsume the effect of the stand-alone treatment and control group dummies. *t*-statistics reported in parentheses are based on robust standard errors clustered at the bank holding company level. Superscripts ***, **, and * indicate statistical significance at 1%, 5%, and 10% levels.

Panel A: Annual Operational Risk Event Frequency

	(1)	(2)	(3)	(4)	(5)	(6)
After	0.015**	-0.148*	-0.248*	0.015**	-0.163**	-0.328**
	(2.244)	(-1.869)	(-1.699)	(2.242)	(-2.176)	(-2.224)
After × Pre-Diversified	0.324***	0.324***	0.384**			
	(2.873)	(2.893)	(2.553)			
After × Pre-Diversified Sec20				2.114***	2.123***	2.165***
				(2.969)	(3.010)	(2.915)
After × Pre-Diversified NonSec20				0.056**	0.055*	0.079
				(1.971)	(1.947)	(1.649)
Ln TA		0.207**	0.382**		0.225**	0.410**
		(2.052)	(2.132)		(2.366)	(2.504)
Market-To-Book			0.023			-0.073
			(0.302)			(-0.807)
Cash-To-TA			0.364			-1.437
			(0.283)			(-0.939)
Tier 1 Ratio			3.723**			3.154**
			(2.018)			(2.285)
ROE			-0.012			0.016
			(-0.742)			(1.012)
Excessive Growth			-0.017			0.077
			(-0.170)			(0.896)
High Dividend			-0.254			-0.189
			(-1.281)			(-1.087)
Constant	0.061***	-1.334*	-3.039**	0.061***	-1.457**	-3.135**
	(2.712)	(-1.911)	(-2.052)	(3.181)	(-2.224)	(-2.350)
Bank Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Num Observations	694	694	412	694	694	412
R-squared	0.062	0.073	0.117	0.319	0.332	0.355

Panel B: Annual Total Operational Loss

	(1)	(2)	(3)	(4)	(5)	(6)
After	0.048	-0.070	-0.181	0.048	-0.087	-0.274
	(1.156)	(-0.575)	(-0.828)	(1.155)	(-0.817)	(-1.480)
After × Pre-Diversified	0.456***	0.457***	0.576***			
	(3.426)	(3.433)	(3.879)			
After × Pre-Diversified Sec20				2.535***	2.541***	2.638***
				(5.083)	(5.076)	(5.410)
After × Pre-Diversified NonSec20				0.145	0.144	0.223*
				(1.371)	(1.379)	(1.764)
Ln TA		0.150	0.262		0.171	0.294
		(1.051)	(1.173)		(1.416)	(1.508)
Market-To-Book			0.102			-0.009
			(0.476)			(-0.046)
Cash-To-TA			-2.107			-4.193*
			(-0.734)			(-1.745)
Tier 1 Ratio			3.984			3.325
			(1.302)			(1.352)
ROE			0.007			0.040
			(0.177)			(1.195)
Excessive Growth			-0.233			-0.124
			(-1.253)			(-0.730)
High Dividend			-0.307			-0.232
			(-1.431)			(-1.051)
Constant	-4.413***	-5.427***	-6.513***	-4.413***	-5.570***	-6.624***
	(-156.879)	(-5.636)	(-3.535)	(-179.339)	(-6.806)	(-3.932)
Bank Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Num Observations	694	694	412	694	694	412
R-squared	0.086	0.090	0.149	0.302	0.307	0.362

Panel C: Annual Average Operational Loss per Event

	(1)	(2)	(3)	(4)	(5)	(6)
After	0.048	-0.047	-0.146	0.048	-0.061	-0.225
	(1.156)	(-0.405)	(-0.699)	(1.155)	(-0.593)	(-1.237)
After × Pre-Diversified	0.400***	0.400***	0.513***			
	(3.214)	(3.219)	(3.672)			
After × Pre-Diversified Sec20				2.161***	2.165***	2.267***
				(4.578)	(4.561)	(4.869)
After × Pre-Diversified NonSec20				0.136	0.135	0.212*
				(1.327)	(1.333)	(1.713)
Ln TA		0.121	0.207		0.139	0.234
		(0.899)	(0.992)		(1.194)	(1.255)
Market-To-Book			0.084			-0.010
			(0.411)			(-0.054)
Cash-To-TA			-2.367			-4.142*
			(-0.843)			(-1.730)
Tier 1 Ratio			3.517			2.956
			(1.225)			(1.244)
ROE			0.013			0.041
			(0.355)			(1.255)
Excessive Growth			-0.233			-0.140
			(-1.372)			(-0.866)
High Dividend			-0.271			-0.207
			(-1.344)			(-0.999)
Constant	-4.426***	-5.241***	-6.081***	-4.426***	-5.362***	-6.176***
	(-167.091)	(-5.801)	(-3.549)	(-185.631)	(-6.832)	(-3.859)
Bank Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Num Observations	694	694	412	694	694	412
R-squared	0.077	0.080	0.137	0.254	0.257	0.314

Table C3: Robustness Test to Control for Expansion into Securities and Insurance Activities

This table presents the results of a robustness test for operational risk after controlling for expansion into securities and insurance activities. The dependent variables are annual operational risk event frequency (*Count*), annual total loss (*Ln Total Loss*), and annual average loss per event (*Ln Avg Loss*). The second and third are in logarithmic form. For each operational risk measure, Model (1) presents the results from our original analysis in Models (6) of Table 4, in Model (2) we drop non-Section 20 subsidiary holders with more than one percent of annual income coming from securities underwriting and dealing activities after 2000, and in Model (3) we drop all BHCs with more than one percent of annual income coming from the insurance activities after 2000. All data are averaged over the 1994–1996 (pre-deregulation) and 2000–2002 (post-deregulation) sample periods. All models include bank-level fixed effects, which subsume the effect of the stand-alone treatment and control group dummies. *t*-statistics reported in parentheses are based on robust standard errors clustered at the bank holding company level. Superscripts ***, **, and * indicate statistical significance at 1%, 5%, and 10% levels.

	Count			*Ln Total Loss*			*Ln Avg Loss*		
	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)
After	-0.282**	-0.340**	-0.325*	-0.356**	-0.341	-0.325*	-0.298*	-0.272	-0.273
	(-2.388)	(-2.197)	(-1.931)	(-2.011)	(-1.648)	(-1.934)	(-1.756)	(-1.386)	(-1.647)
After × Pre-Diversified Sec20	1.569***	1.599***	1.812**	2.102***	2.160***	1.468**	1.822***	1.873***	1.256**
	(2.787)	(2.805)	(2.156)	(4.091)	(4.242)	(2.474)	(3.746)	(3.893)	(2.140)
After × Pre-Diversified NonSec20	0.061	0.032	-0.019	0.227*	0.121	-0.068	0.217*	0.116	-0.068
	(1.555)	(0.724)	(-0.445)	(1.831)	(0.993)	(-0.594)	(1.805)	(0.994)	(-0.617)
Ln TA	0.337***	0.385**	0.456**	0.426**	0.271	0.578***	0.365*	0.202	0.505***
	(2.614)	(2.196)	(2.242)	(2.144)	(1.103)	(3.076)	(1.955)	(0.879)	(2.771)
Market-To-Book	-0.057	-0.078	-0.071	-0.210	-0.227	-0.404**	-0.204	-0.221	-0.393**
	(-0.875)	(-0.894)	(-1.330)	(-1.163)	(-1.337)	(-2.320)	(-1.156)	(-1.365)	(-2.289)
Cash-To-TA	-1.383	-2.090	-1.175	-4.916**	-6.664***	-3.869*	-4.735**	-6.337***	-3.786*
	(-1.191)	(-1.494)	(-0.915)	(-2.478)	(-2.984)	(-1.742)	(-2.430)	(-2.871)	(-1.721)
Tier 1 Ratio	2.694**	2.836**	2.316*	4.116	3.011	4.271	3.695	2.564	3.802
	(2.434)	(2.143)	(1.680)	(1.542)	(1.021)	(1.655)	(1.492)	(0.945)	(1.525)
ROE	0.011	0.015	0.012	0.052	0.028	0.051	0.053	0.028	0.049
	(0.861)	(0.828)	(0.899)	(1.579)	(0.964)	(1.392)	(1.645)	(1.028)	(1.375)
Excessive Growth	0.080	0.115	0.070	-0.068	0.008	0.012	-0.091	-0.025	0.002
	(1.002)	(1.320)	(0.741)	(-0.419)	(0.055)	(0.073)	(-0.600)	(-0.199)	(0.012)
High Dividend	-0.141	-0.113	-0.103	-0.246	-0.071	-0.097	-0.226	-0.057	-0.083
	(-1.071)	(-0.697)	(-0.647)	(-1.215)	(-0.293)	(-0.502)	(-1.176)	(-0.249)	(-0.450)
Constant	-2.561**	-2.865**	-3.348**	-7.455***	-5.864***	-8.391***	-7.004***	-5.362***	-7.842***
	(2.712)	(-2.042)	(-2.123)	(-4.404)	(-2.941)	(-5.581)	(-4.404)	(-2.889)	(-5.408)
Bank Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Num Observations	412	316	300	412	316	300	412	316	300
R-squared	0.336	0.346	0.332	0.294	0.364	0.270	0.261	0.326	0.238

Table C4: Robustness Test to Control for M&A Activities

This table presents the results of a robustness test for operational risk with additional M&A controls. The dependent variables are annual operational risk event frequency (*Count*), annual total loss (*Ln Total Loss*), and annual average loss per event (*Ln Avg Loss*). The second and third are in logarithmic form. For each operational risk measure, Model (1) presents the results from our original analysis in Models (6) of Table 4, in Model (2) we control for the banking M&As that accumulated during the previous 3 years, and in Model (3) we control for the M&As excluding affiliate mergers that accumulated during the previous 3 years. All data are averaged over the 1994–1996 (pre-deregulation) and 2000–2002 (post-deregulation) sample periods. All models include bank-level fixed effects, which subsume the effect of the stand-alone treatment and control group dummies. All models include bank-level fixed effects, which subsume the effect of the stand-alone treatment and control group dummies. *t*-statistics reported in parentheses are based on robust standard errors clustered at the bank holding company level. Superscripts ***, **, and * indicate statistical significance at 1%, 5%, and 10% levels.

	Count			*Ln Total Loss*			*Ln Avg Loss*		
	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)
After	-0.282**	-0.287**	-0.266**	-0.356**	-0.336**	-0.286*	-0.298*	-0.280*	-0.231
	(-2.388)	(-1.973)	(-2.208)	(-2.011)	(-2.028)	(-1.670)	(-1.756)	(-1.764)	(-1.389)
After × Pre-Diversified Sec20	1.569***	1.543***	1.407***	2.102***	2.055***	1.953***	1.822***	1.781***	1.724***
	(2.787)	(2.830)	(2.890)	(4.091)	(3.901)	(3.714)	(3.746)	(3.539)	(3.350)
After × Pre-Diversified NonSec20	0.061	0.078	0.082*	0.227*	0.257**	0.250*	0.217*	0.243*	0.233*
	(1.555)	(1.515)	(1.866)	(1.831)	(1.976)	(1.947)	(1.805)	(1.919)	(1.865)
Ln TA	0.337***	0.326*	0.273**	0.426**	0.349*	0.267	0.365*	0.296*	0.220
	(2.614)	(1.898)	(2.217)	(2.144)	(1.888)	(1.353)	(1.955)	(1.690)	(1.163)
Market-To-Book	-0.057	-0.054	-0.052	-0.210	-0.203	-0.208	-0.204	-0.198	-0.204
	(-0.875)	(-0.853)	(-0.874)	(-1.163)	(-1.128)	(-1.180)	(-1.156)	(-1.122)	(-1.179)
Cash-To-TA	-1.383	-1.567	-1.630	-4.916**	-5.210**	-5.090**	-4.735**	-4.989**	-4.828**
	(-1.191)	(-1.151)	(-1.267)	(-2.478)	(-2.516)	(-2.399)	(-2.430)	(-2.464)	(-2.338)
Tier 1 Ratio	2.694**	2.855**	2.985***	4.116	4.610*	4.592*	3.695	4.129*	4.089
	(2.434)	(2.420)	(2.667)	(1.542)	(1.750)	(1.723)	(1.492)	(1.681)	(1.641)
ROE	0.011	0.013	0.013	0.052	0.059*	0.056*	0.053	0.059*	0.057*
	(0.861)	(1.037)	(1.077)	(1.579)	(1.801)	(1.719)	(1.645)	(1.839)	(1.756)
Excessive Growth	0.080	0.087	0.094	-0.068	-0.063	-0.066	-0.091	-0.086	-0.094
	(1.002)	(1.096)	(1.174)	(-0.419)	(-0.420)	(-0.425)	(-0.600)	(-0.621)	(-0.645)
High Dividend	-0.141	-0.172	-0.193	-0.246	-0.321	-0.323	-0.226	-0.292	-0.289
	(-1.071)	(-1.346)	(-1.461)	(-1.215)	(-1.530)	(-1.546)	(-1.176)	(-1.457)	(-1.441)
Banking M&A		-0.014	-0.040		-0.026	-0.041		-0.022	-0.028
		(-0.841)	(-1.483)		(-1.047)	(-0.906)		(-0.933)	(-0.668)
Banking M&A Target Assets Ratio		0.412	1.122**		1.057	1.844*		0.927	1.531
		(1.199)	(2.069)		(1.399)	(1.804)		(1.244)	(1.532)
Constant	-2.561**	-2.463**	-2.072**	-7.455***	-6.909***	-6.312***	-7.004***	-6.519***	-5.980***
	(-2.432)	(-2.099)	(-2.215)	(-4.404)	(-4.334)	(-3.886)	(-4.404)	(-4.353)	(-3.843)
Bank Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Num Observations	412	412	412	412	412	412	412	412	412
R-squared	0.336	0.348	0.363	0.294	0.315	0.316	0.261	0.279	0.277

Table C5: Robustness Test to Control for Media Attention

This table presents the results of a robustness test for operational risk with an additional control for media attention. Media attention is measured by the number of news articles from the Factiva database. The sample includes the BHCs with asset size greater than the minimum asset size of Section 20 owners before the deregulation. The dependent variables are annual operational risk event frequency (*Count*), annual total loss (*Ln Total Loss*), and annual average loss per event (*Ln Avg Loss*). The second and third are in logarithmic form. For each operational risk measure, Model (1) presents the results without the media attention control. The control variables consist of our firm-level controls included in our main models (Table 4, Models (6)), as well as the variables related to the M&A activity in the past 3 years. Model (2) presents the results with the media attention control included. All data are averaged over the 1994–1996 (pre-deregulation) and 2000–2002 (post-deregulation) sample periods. All models include bank-level fixed effects, which subsume the effect of the stand-alone treatment and control group dummies. *t*-statistics reported in parentheses are based on robust standard errors clustered at the bank holding company level. Superscripts ***, **, and * indicate statistical significance at 1%, 5%, and 10% levels.

	Count		*Ln Total Loss*		*Ln Avg Loss*	
	(1)	(2)	(1)	(2)	(1)	(2)
After	-0.552*	-0.581**	-0.305	-0.303	-0.178	-0.174
	(-1.915)	(-2.174)	(-0.766)	(-0.756)	(-0.475)	(-0.459)
After × BHC Sec20	1.512***	1.260**	1.716***	1.733***	1.439**	1.482**
	(2.700)	(2.625)	(2.761)	(2.686)	(2.413)	(2.408)
Ln TA	0.924*	0.935**	0.761	0.760	0.603	0.601
	(1.940)	(2.424)	(1.545)	(1.547)	(1.278)	(1.294)
Market-To-Book	-0.171	-0.126	-0.277	-0.280	-0.263	-0.271
	(-0.886)	(-0.805)	(-0.685)	(-0.687)	(-0.670)	(-0.684)
Cash-To-TA	-2.594	0.652	-6.250	-6.469	-5.764	-6.313
	(-0.825)	(0.376)	(-1.557)	(-1.573)	(-1.547)	(-1.640)
Tier 1 Ratio	4.162	3.766	9.338	9.365	8.818	8.885
	(1.423)	(1.016)	(1.328)	(1.323)	(1.352)	(1.355)
ROE	0.048	0.056	0.158*	0.157*	0.159**	0.157*
	(1.093)	(1.240)	(1.919)	(1.913)	(2.012)	(1.986)
Excessive Growth	0.260	0.259	-0.139	-0.139	-0.202	-0.202
	(1.086)	(1.068)	(-0.331)	(-0.330)	(-0.522)	(-0.519)
High Dividend	-0.395	-0.228	-0.663*	-0.675*	-0.606	-0.635
	(-1.387)	(-1.451)	(-1.682)	(-1.668)	(-1.612)	(-1.637)
Banking M&A	-0.024	-0.015	-0.039	-0.040	-0.034	-0.035
	(-1.185)	(-1.210)	(-1.369)	(-1.360)	(-1.192)	(-1.236)
Banking M&A Target Assets Ratio	0.498	0.541	2.014	2.011	1.787	1.780
	(0.527)	(0.675)	(1.238)	(1.230)	(1.094)	(1.085)
Media		0.001		-0.000		-0.000
		(1.507)		(-0.220)		(-0.567)
Constant	-8.222**	-9.222**	-11.737**	-11.669**	-10.412**	-10.243**
	(-2.138)	(-2.586)	(-2.506)	(-2.495)	(-2.340)	(-2.319)
Bank Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Num Observations	154	154	154	154	154	154
R-squared	0.422	0.546	0.376	0.376	0.333	0.335