Bank Regulatory Reforms and Institutional Equity Holdings

Michael Bowe, Olga Kolokolova, Marcin Michalski†

This version: 5th March 2019

Abstract

This paper examines the effects of changes in bank regulatory environment on the risk, return, and liquidity characteristics of equity portfolios of U.S. bank holding companies between 1997 and 2016. Using a comprehensive sample of bank and hedge fund holdings data we examine the impact of the repeal of the Glass-Steagall Act, the introduction of the second and third Basel Capital Accords, and the implementation of the Dodd-Frank legislation on institutional portfolios. We document a significant increase in both the idiosyncratic volatility and illiquidity of banks' portfolios during the period of financial deregulation initiated by the formal removal of restrictions prohibiting banks from engaging in securities trading. In contrast, the subsequent reforms of the bank capital requirements system and the prohibition of banks from proprietary trading activities lead to reductions in those metrics. Our results suggest that banks' restricted ability to engage in market-making can be offset by the activities of hedge funds, although the consequences of this substitution for long-term market stability remain unclear.

JEL classification: G18, G21, G23, G28.

Keywords: Bank Regulation, Bank Equity Holdings, Portfolio Disclosure, Portfolio Characteristics, Hedge Funds.

We would like to thank the participants of presentations at the University of Manchester for their helpful comments on an earlier version of the paper. The authors gratefully acknowledge the financial support of the University of Manchester, the Centre for the Analysis of Investment Risk (CAIR), and the Economic and Social Research Council (ESRC).

† Michael Bowe is affiliated with Alliance Manchester Business School, the University of Manchester and the Department of Accounting and Finance, the University of Vaasa. Olga Kolokolova is affiliated with Alliance Manchester Business School, the University of Manchester. Marcin Michalski is affiliated with the University of Liverpool Management School. Please direct all enquiries and comments about this paper to Marcin Michalski (m.michalski@liverpool.ac.uk).

1 Introduction

Modern banking institutions are large, complex organisations which combine the traditional services of granting loans and maintaining deposits with a range of advisory services, private wealth management, and securities trading. During the past two decades, both the business models of banks and the regulatory environment within which they operate have undergone a substantial transformation. The regulatory policy developments which took place in the aftermath of the 2007 - 2009 Financial Crisis have not only led to a significant reform of the bank capital requirements system, but also introduced laws resembling those passed during the Great Depression of the 1930's, prohibiting banks from engaging in proprietary trading and certain other market activities.

In this paper, we examine the relationship between regulatory policy innovations and changes in the return, risk, and illiquidity characteristics of the equity portfolios held by U.S. bank holding companies. Our analysis focuses on the changes that occur between 1997 and 2016, a period incorporating the repeal of the Glass-Steagall Act, the introduction of the second Basel Capital Accord, the passage of the Dodd-Frank Act, and the implementation of the third Basel Accord. Our study formally evaluates whether bank equity holdings are affected by the removal of legal restrictions preventing banking institutions from active participation in securities trading in the late 1990's, the reform of the regulatory market risk capital requirements system in 2004, the reinstatement of the laws prohibiting bank proprietary trading, and the increase in bank capital requirements and introduction of liquidity requirements in 2010.

To that end, we utilise difference-in-differences analysis assessing the significance of changes in the characteristics of the bank equity portfolio relative to those exhibited by the market portfolio and a portfolio comprising equity holding of a large sample of hedge funds. Our results indicate that financial deregulation initiated by the repeal of the Glass-Steagall Act results in an increase of both idiosyncratic volatility and illiquidity of banks' equity portfolios, while the subsequent policies aimed at improving banks' risk management, preventing them from engaging in proprietary trading, and increasing their reserves of liquid capital, lead to reductions in the two metrics. While our findings suggest that the reduction in risk and illiquidity of banks' portfolios is in line with the broad objectives of macroprudential policies, they also indicate that the reduced scope of banking institutions involvement in financial markets may result in some of those responsibilities being taken over by firms operating outside of the regulators' direct oversight.

2 Regulatory background and related literature

To the best of our knowledge, the question of the relation between changes in the regulatory environment in which banks operate and the risk and liquidity characteristics of the equity portfolios they hold is not extensively explored in prior studies. Nonetheless, our paper is closely related to the existing literature assessing the efficacy of universal banking, exploring the role of banks as market-makers, and carrying out a cost-benefit analysis of the bank regulatory reforms proposed by policymakers.

In a number of seminal theories of financial intermediation, such as Diamond and Dybvig (1983), Diamond (1984), or Kashyap, et al. (2002), the function of a bank within an economic system is typically limited to taking deposits from households and originating loans to firms pursuing risky investment projects. While useful for analytical purposes, such assumption simplifies the market activities universal banks are involved in. Motivated by the onset of the originate-to-distribute model of bank lending and the rapid growth of the market for securitised loans in the 1980's, Gorton and Penacchi (1995) develop a theoretical framework by relaxing a key assumption of Diamond's (1984) model, namely that loans are not marketable (as in the originate-to-hold model). This allows banks to maximise their expected profits by optimally selling part of their loan portfolio while still providing valuable credit screening services. More recently, Schleifer and Vishny (2010) develop a model of financial intermediation in which banks respond to investor sentiment in the markets in which they operate. They use their capital to securitise new loans when asset prices are high, accessing short-term borrowing to expand their balance sheets and maximise profits. The model demonstrates how profit-oriented loan securitisation serves as a channel of transmission of security market fluctuations into the real economy, resulting in investment cyclicality and increased systemic risk.

From a historical perspective, the emergence of the market for securitised debt and banks' involvement in this matter is a relatively recent phenomenon. U.S. national banks began establishing securities affiliates as early as 1903 in an effort to sidestep regulations banning them from engaging in trading of bonds and stocks. In the 1920's, many banks which went on to fail during the ensuing economic crisis used such affiliated firms to underwrite the equity and debt securities of their borrowers, who in turn used the proceeds from the securities offering to pay off the debt owed to the bank. The 1933 Banking Act (the Glass-Steagall Act) sought to rectify this perceived weakness of the banking system's architecture and to address such conflicts of interest by prohibiting any deposit-taking institutions from engaging in any form of dealing in corporate securities. This resulted in a *de jure* break-up of universal banks into separate commercial and investment banks. Although the proponents of the Act claimed that banks deliberately underwrote low-

quality securities to avoid incurring losses on their loan portfolios, Kroszner and Rajan (1994) find no empirical evidence to support such arguments.

The Glass-Steagall Act remained in place until 1999 when its provisions were repealed under the Financial Modernization Act (the Gramm-Leach-Bliley Act), although the rapidly growing use of loan securitisation by commercial banks made it appear increasingly obsolete from the early 1980's onwards. Furthermore, in 1987, some commercial banks were authorised by the Federal Reserve Board to engage in trading of bank-ineligible debt and equity securities through Section 20 subsidiaries. Evidence presented by Bhargava and Fraser (1998) shows that large commercial banks, such as J.P. Morgan and Citicorp, captured over 20% of the market for asset-backed securities within the first year of operations of their Section 20 subsidiaries. Although such subsidiaries were initially not allowed to derive more than 5% of their gross revenue from bank-ineligible market activities over any two-year period, the volume of their activity prompted the Federal Reserve to raise this limit to 10% in 1989 and to 25% in 1996 (Cornett, et al., 2002). In effect, those regulatory developments allowed commercial and investment banks to merge and form universal banks once again. Together with the growing interconnectedness of global financial markets and the rapid technological advances, this has led to a profound change in banks' business models and the functions they serve within the financial system and the wider economy. Indeed, some of the largest U.S. banking institutions have since become the most important market-makers for a wide variety of securities, ranging from government and corporate bonds, through over-the-counter derivatives, to equities.

The potential benefits stemming from the diversification of bank business activities are examined in several studies, but there is no clear consensus on whether expanding the range of services offered by a banking institution enhances its value and its resilience to economic shocks. Cornett, et al. (2002) show that banks which establish Section 20 subsidiaries improve their pre-tax cashflow performance relative to other commercial and investment banks, while, at the same time, not exhibiting any significant changes in their risk measures. In contrast, Bhargava and Fraser (1998) note that while stocks of the affected banks earn positive abnormal returns after the initial authorisation of Section 20 activities, the subsequent relaxation of the trading limits is associated with negative abnormal returns and results in an increase in firm-specific risk. Studies by Stiroh (2004) and Stiroh and Rumble (2006) find that while raising fees, trading revenue, and other forms of non-interest income as a proportion of a bank's net operating income reduces the volatility of its profit and revenue, it also leads to an increase in an institution's exposure to insolvency risk. Furthermore, the formation of diversified financial conglomerates typically results in a discounted valuation relative to the value of the individual business units (Schmid and Walter, 2009), even though such mergers and acquisitions generate significant

positive cumulative abnormal returns (Filson and Olfati, 2014). Importantly, however, despite the increases in total and firm-specific risks (Geyfman and Yeager, 2009), greater business diversification and reliance on non-interest income does not have adverse effects on the quality and pricing of loans issued by banks (Abedifar, et al., 2018).

A key point raised by Wagner (2010) is that while diversification of business activities undertaken at a financial institution makes it less likely to fail, it also results in an increase in systemic risk, as *ex ante* unique banks become more exposed to the same risks. The relation between bank asset commonality and systemic risk is further examined in a model developed by Allen, et al. (2012), in which banks' exposure to a common asset and reliance on short-term debt result in failures when creditors receive an adverse signal about the quality of the asset. More importantly, the systemic nature of universal banks' activities allows them to transmit shocks originating in the banking sector to other financial markets, as concerns about the liquidity and solvency of key banking institutions can result in fire sales of tradable securities that they hold (Diamond and Rajan, 2011), or even in a complete impairment of the functioning of the securities markets in which they actively participate (Brunnermeier and Pedersen, 2009). Recent examples of such adverse links between the health of the banking sector and the functioning of financial markets include the runs on short-term debt securities, such as asset-backed commercial paper or repo agreements which occur in July and August 2007, sparked by the deterioration of the quality of mortgages held on banks' balance sheets (Brunnermeier, 2009, Gorton and Metrick, 2012). Additionally, using a unique set of data on German banks, Abbassi, et al. (2016) demonstrate that fire sales in securities markets can generate further negative externalities, as banks with greater trading expertise reduce their credit supply during a crisis in order to increase their investment in low-rated long-term securities.

The severity of the 2007 - 2009 Financial Crisis prompted policymakers to once again review the regulatory framework within which banking institutions operate. Among other objectives, they sought to safeguard the stable provision of traditional banking services against the risks arising due to banks' active participation in capital markets. In the United States, the new policies were introduced in July 2010 when the Dodd-Frank Wall Street Reform and Consumer Protection Act (the Dodd-Frank Act) was signed into federal law. The Act established a number of new government agencies tasked with increasing the transparency of the U.S. financial markets and their resilience to systemic risk, with additional provisions included under §619, known as the Volcker Rule, banning banks from engaging in any proprietary trading of securities or sponsoring any type of privately offered investment funds. In effect, the implementation of the Dodd-Frank Act has brought some of the regulatory restrictions first placed on the banking sector's participation in broader financial markets by the Glass-Steagall Act full circle.

The analyses of the Act's provisions undertaken by Duffie (2012) and Thakor (2012) highlight the practical difficulties involved in distinguishing which activities should be classified as proprietary trading and which as market-making. The authors claim that this shortcoming of the Volcker Rule will have negative consequences for liquidity provision for many securities. This prediction has since been empirically confirmed by Bao, et al. (2018) who examine the trading behaviour of Volcker Rule-affected dealers in one particular asset class, namely stressed bonds. Additionally, both reports suggest that the implementation of the Volcker Rule may have adverse effects on the long-term stability of the financial system, as financial institutions subject to considerable regulatory oversight reduce the scope of their activities in the market, and will eventually be replaced by firms operating outside the policymaker's supervision. A number of studies highlight the role of hedge funds in the supply of market liquidity. Aragon and Strahan (2012) demonstrate that the stocks held by hedge funds operated by Lehman Brothers experience greater declines in liquidity following the bank's bankruptcy relative to stocks held by hedge funds which did not experience a funding shock. Furthermore, Jylhä, et al. (2014) provide evidence demonstrating that hedge funds supply liquidity to the market when market liquidity is poor, and that the extent of this process is positively related to the fund's size and the strictness of its redemption restrictions.

Unlike other institutional investors, however, banks are required to comply with the strict capital requirements regulations outlined in the Basel Accords. The first Basel Accord, announced in 1988, included no provisions for market risk faced by banks, and while this was rectified by the 1996 Market Risk Amendment (Basel Committee on Banking Supervision, 1996), its provisions only applied to banking institutions with trading accounts in excess of $1 trillion (Holod, et al., 2017). Although the second Basel Accord announced in 2004 sought to introduce a more comprehensive regulatory framework and to enhance the risk management practices of banks (Basel Committee on Banking Supervision, 2004), its implementation was never completed as a result of the 2007 - 2009 Financial Crisis. Instead, the Committee announced the Third Accord in 2010, which addresses systemic and liquidity risks in the banking system, and replaces Value-at-Risk with stressed Conditional Value at Risk as the basis of calculation of regulatory capital for market risk (Basel Committee on Banking Supervision, 2010). Importantly, under the Liquidity Coverage Ratio regulations, bank equity holdings are eligible for inclusion as a source of highly-liquid short-term financing (Basel Committee on Banking Supervision, 2013). More recently, the Committee announced the final details of the Fundamental Review of the Trading Book, set to be implemented by January 2019, which aims to revise the market risk framework and reduce the extent of regulatory arbitrage by restricting the eligibility criteria for reclassification of assets held on the trading and banking books (Basel Committee on Banking Supervision, 2016).

The validity of Value-at-Risk estimates reported by banks has been challenged by several studies. The regulators reliance on Value-at-Risk is criticised as early as 2002, with Danìelsson (2002) suggesting that the model's reliance on historical data does not allow it to provide any useful information about banks' riskiness in times of crisis. Furthermore, the model of Alexander and Baptista (2006) demonstrates that mean-variance efficient portfolios that are constructed in the presence of a Value-at-Risk constraint, are riskier than those constructed in its absence. In a follow-up study, they find that although the stressed conditional Value-at-Risk approach advocated by Basel III leads to a better outcome than a Value-at-Risk constraint, it still results in suboptimal portfolio allocation (Alexander and Baptista, 2017). Finally, Begley, et al. (2017) report that banks strategically report lower levels of risk in their trading books when they face a shortfall of equity capital, and that such behaviour is particularly pertinent during periods of high systemic risk.

Our study most closely relates to the analysis by Trebbi and Xiao (2017), who examine the combined effects of the Dodd-Frank Act and Basel III on liquidity in the U.S. fixed income market. The authors attempt to identify structural breaks in bond liquidity measures and carry out a difference-in-differences analysis for matched bonds underwritten by institutions affected by the Volcker Rule and by those that are exempt from it. The study fails to identify any structural breaks and to uncover evidence of deterioration of liquidity of the bond market. In contrast, our study focuses on the equity holdings of U.S. bank holding companies, and examines the relation between regulatory policy developments and changes in the portfolio return, risk, and illiquidity metrics over a longer period, including the repeal of the Glass-Steagall Act, the introduction of Basel II, and their subsequent replacement by the Dodd-Frank Act and Basel III.

3 Data and methodology

Our analysis centres on the stock holdings of the entire banking sector, rather than on holdings of individual firms. Such an approach allows us to better capture the systemic nature of banking institutions' exposure to the stock market, and to consider the regulatory reforms' impact on the operation of the banking system as a whole.

To construct the banking sector's equity portfolio, we first collect the 13F filings data[1] from Thomson Reuters for systemically important U.S. banks selected for assessment by the Federal Reserve as part of the Comprehensive Capital Analysis and Review frame-

[1] All institutions managing investments in securities of $100 million or more must submit form 13F to the Securities and Exchange Commission every quarter, disclosing the details of their equity holdings. See https://www.sec.gov/fast-answers/answers-form13fhtm.html for further details.

work,[2] and for the key broker-dealer banks which failed during the 2007 - 2009 Financial Crisis (listed in Appendix A). We then combine the firm-level holdings information by aggregating the number of shares in each individual stock held by banks in a given quarter.

This data is supplemented with daily price and trading volume information from the Center for Research in Security Prices (CRSP) database for all stocks traded on the New York Stock Exchange, the American Stock Exchange, and on NASDAQ. All security holdings reported in the 13F filings associated with CUSIP identifiers which cannot be matched with those of the stocks obtained from CRSP are removed from the dataset.[3] We then assign portfolio weights to each equity position by calculating the end-of-quarter dollar value of the position[4] and dividing it by the corresponding end-of-quarter dollar value of the entire bank portfolio. The portfolio is rebalanced every quarter to reflect the changes in equity positions reported by banks. As with all studies utilising data derived from 13F filings, one caveat of our analysis is that we are unable to account for the short positions in stocks taken by banks, as such information is not publicly available.

We next form two additional equity portfolios, which serve as benchmarks in the subsequent analysis of changes in the risk and liquidity characteristics of bank equity holdings. First, we form a value-weighted market portfolio comprising all the stocks obtained from the CRSP database. Second, we form another institutional stock portfolio based on equity holdings reported in 13F filings submitted by hedge funds. The two benchmark portfolios allow us to control for changes in the overall market conditions during the sample period, and to directly compare changes in the characteristics of equity portfolios held by financial institutions subject to increasing regulatory oversight (banks) and by institutions which operate on a largely unregulated basis (hedge funds).

To construct the hedge fund portfolio we first identify all investment funds which report to the Securities and Exchange Commission listed in Eurekahedge and Lipper Hedge Fund (TASS) databases, and then manually verify the company descriptions to confirm that a selected institution operates solely as a hedge fund. This ensures that hedge funds affiliated with, or directly sponsored by, banks are not included in the sample. This prevents the inclusion of overlapping positions in the two portfolios we form. We then match the manager identification numbers of the independent hedge funds with their 13F filings, and repeat the previous process to construct the bank equity portfolio.

[2]See https://www.federalreserve.gov/supervisionreg/ccar.htm for the details of the Comprehensive Capital Analysis and Review framework, including lists of institutions selected for participation each year.

[3]This ensures that the sample does not include holdings of non-equity securities or certain derivative instruments also disclosed in 13F filings.

[4]A small number of stock-quarter observations is removed at this stage due to, most likely, a reporting error, which results in implausibly large values of the respective positions.

The information on institutional equity holdings derived from 13F filings is available from the first quarter of 1980 to the last quarter of 2017 (at the time of writing of this paper). However, due to concerns about the quality of the data reported in the early 1990's and the possibility of revisions to the 13F filings submitted more recently, we restrict our data sample to the period beginning with the first quarter of 1997 and ending in the first quarter of 2016.

Table 1 shows the number of unique banks and hedge funds in the data sample, the number of stocks in each of the three portfolios we form, and the dollar values of the portfolios at the beginning, the mid-point, and the end of the sample period. Note that although the number of hedge funds in the sample is considerably greater than the number of banks, their aggregate portfolios are of comparable size and dollar value across time. Furthermore, as indicated in Bowe, et al. (2018), bank holding companies included in this study control more than 80% of the total assets of the entire U.S. banking system, making our bank portfolio highly representative of the entire banking sector.

Table 1: Sample overview

Variable	Market portfolio	Bank portfolio	Hedge fund portfolio
No. of unique financial institutions	–	27	835
No. of unique stocks in the portfolio	27,840	16,130	14,663
No. of stock-quarter observations	547,355	385,712	340,025
Portfolio value (1997:Q1)	$8,347,500,000,000	$334,610,000,000	$255,730,000,000
Portfolio value (2006:Q3)	$19,741,000,000,000	$1,413,900,000,000	$1,194,600,000,000
Portfolio value (2016:Q1)	$28,611,000,000,000	$1,126,400,000,000	$1,958,800,000,000

The table reports the number of unique banks and hedge funds in the data sample, the numbers of unique stocks included in their aggregate equity portfolios and in the market portfolio, the number of stock-quarter observations associated with each portfolio, as well as their respective dollar values at the beginning, the mid-point, and the end of the sample period.

For each of the three portfolios, we calculate daily close-to-close returns for all constituent stocks and compute their value-weighted sum based on the 13F filings data. We then determine the mean daily return, total risk, and the 5% Value-at-Risk of the portfolio by calculating the average, standard deviation and the 5th percentile of daily portfolio returns within each quarter. The resulting return and total risk measures are next used to compute the Sharpe ratios of the portfolios. Additionally, we use the Carhart (1997)

four-factor model to obtain the mean daily risk-adjusted portfolio returns, their idiosyncratic volatility, and loadings on the four risk factors in each quarter T by estimating the following regression:

$$r_{i,t} = \alpha_{i,T} + b_{i,T}MKT_t + s_{i,T}SMB_t + h_{i,T}HML_t + m_{i,T}MOM_t + e_{i,t} \tag{1}$$

where $r_{i,t}$ is the daily return on portfolio i in excess of the risk-free rate; $\alpha_{i,T}$ is the mean daily risk-adjusted return on portfolio i in quarter T; $b_{i,T}$, $s_{i,T}$, $h_{i,T}$, and $m_{i,T}$ are the portfolio loadings on the daily market, size, value, and momentum risk factors; and $e_{i,t}$ is the residual.[5]

Finally, we calculate the mean portfolio Amihud (2002) illiquidity measure for each quarter T, by computing the average of the following metric:

$$A_{i,t} = \sum_{j=1}^{n} w_{j,T} \times \frac{|r_{j,t}|}{DVOL_{j,t}} \tag{2}$$

where $A_{i,t}$ is the illiquidity measure of portfolio i on day t, $w_{j,T}$ is the weight of stock j in portfolio i during quarter T, $r_{j,t}$ is the return earned by stock j on day t, and $DVOL_{j,t}$ is the dollar volume of trading in stock j on day t.

All measures of return, risk, and illiquidity are winsorised at the 1st and the 99th percentile in order to minimise the adverse impact of observations with extreme values on the precision of the estimates we obtain.

Our examination of the effects of changes in the regulatory environment on the characteristics of banks' equity portfolio is based on a difference-in-differences approach. To that end, we first divide our data into four subsamples using the policy change announcement dates to identify the most likely point in time when a switch to a new regulatory regime occurs. Specifically, we use July 1999, when the Gramm-Leach-Bliley Act is signed into law, June 2004, when Basel II is announced, and July 2010, when the Dodd-Frank Act becomes federal law, as the cut-off dates when forming the four subsamples. Importantly, due to close proximity between the passage of the Dodd-Frank Act and the announcement of Basel III regulations in December 2010, we treat those events as a single regulatory innovation in our analysis. Table 2 summarises the timeline of the reforms we study and provides information on the duration of each of the four regulatory regimes.

[5] We obtain the data on daily risk factors from Kenneth R. French's website, available at http://mba.tuck.dartmouth.edu/pages/faculty/ken.french/data_library.html.

Table 2: Timeline of regulatory developments

Regulatory regime	First quarter	Last quarter	Duration
Glass-Steagall Act and Basel I	1997:Q1	1999:Q2	10 quarters
Gramm-Leach-Bliley Act and Basel I	1999:Q3	2004:Q1	19 quarters
Gramm-Leach-Bliley Act and Basel II	2004:Q2	2010:Q2	25 quarters
Dodd-Frank Act and Basel III	2010:Q3	2016:Q1	23 quarters

The table provides an outline timeline of the regulatory developments examined in this study, along with the start and end quarters and the duration of the regulatory regime subsamples used in the difference-in-differences analysis we carry out.

Based on the discussion of the regulatory reforms presented above, our analysis assumes that the passage of the Gramm-Leach-Bliley Act corresponds to a reduction in the regulatory burden faced by banks, whereas the subsequent introduction of Basel II, the Dodd-Frank Act and Basel III represents a move towards establishing a more restrictive environment within which banking institutions operate. While we form no *ex ante* expectations about the impact of the Gramm-Leach-Bliley Act and Basel II on the risk and return characteristics of banks' equity portfolio, we anticipate that the implementation of the Dodd-Frank Act and Basel III should result in a reduction of risk and illiquidity metrics of the portfolio.

To assess if the regulatory developments affect the properties of the banks' equity portfolios, we first calculate the difference between the risk and liquidity metrics for three portfolio pairs: the bank portfolio and the market portfolio, the hedge fund portfolio and the market portfolio, and, finally, the bank portfolio and the hedge fund portfolio. We then test if the change in the mean and variance of the differences between the metrics of the three portfolio pairs in the period following a new policy announcement relative to the preceding period is statistically significant.

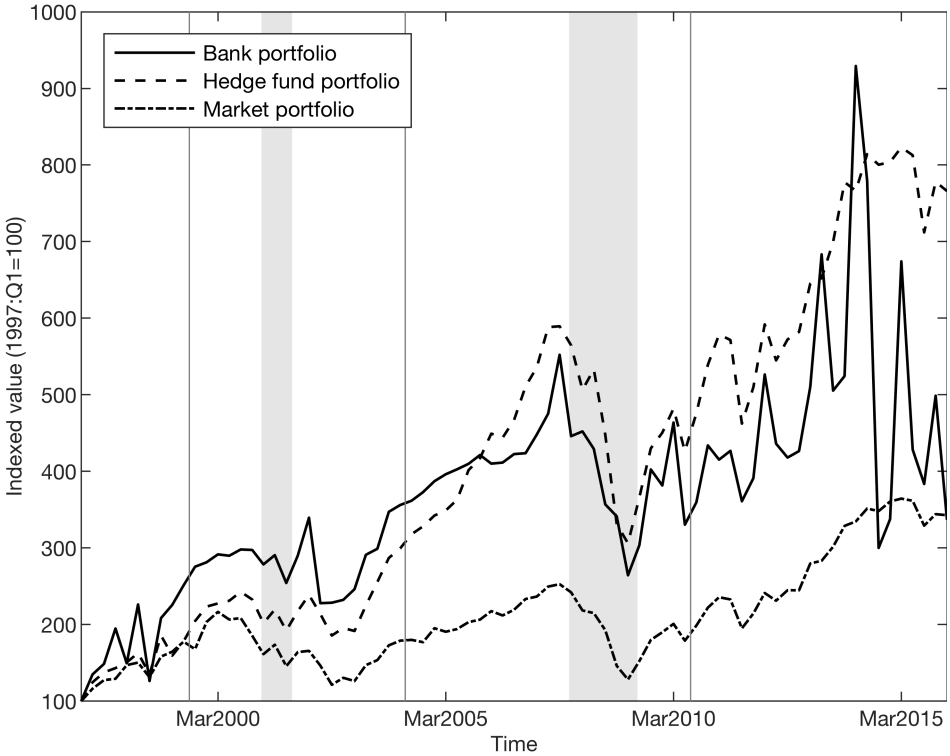
Such approach allows us to establish whether the variation in the characteristics of bank and hedge fund portfolios is merely a reflection of the developments in the broader stock market, and, if not, whether the changes in the regulatory burden faced by banks affect their equity holdings vis-à-vis the stock holdings of unregulated hedge funds. Furthermore, as new policy compliance deadlines are frequently extended by the regulators to give financial institutions more time to adjust their balance sheets and business models, employing a difference-in-differences approach based on the full duration of a regulatory regime allows us to capture the full impact of regulatory change on bank portfolio characteristics, which could potentially be more challenging using a traditional event study methodology which requires precise identification of policy implementation dates.

4 Empirical results

4.1 Overview of changes in portfolio characteristics

The dollar values of the market, bank, and hedge fund portfolios have all increased substantially during the period we study. As shown in Figure 1, the value of the market portfolio increased by a factor of 3.6 relative to its 1997:Q1 value during the sample period. The values of the bank portfolio and the hedge fund portfolio both exhibit much faster growth rates than the market portfolio, with the value of the former increasing by a factor of 9.3 by 2014:Q1 and the latter growing by a factor of 8.14 during the same period. The growth rates of the gross domestic product of the United States and the total assets held by U.S. bank holding companies between 1997:Q1 and 2015Q:4 (increasing by a factor of 2.1 and 4, respectively) reported by Bowe, et al. (2018), provide a useful comparison, demonstrating how rapidly the bank equity portfolio has grown during the sample period.

Figure 1: Indexed values of the market, bank, and hedge fund portfolios 1997:Q1 - 2016:Q1

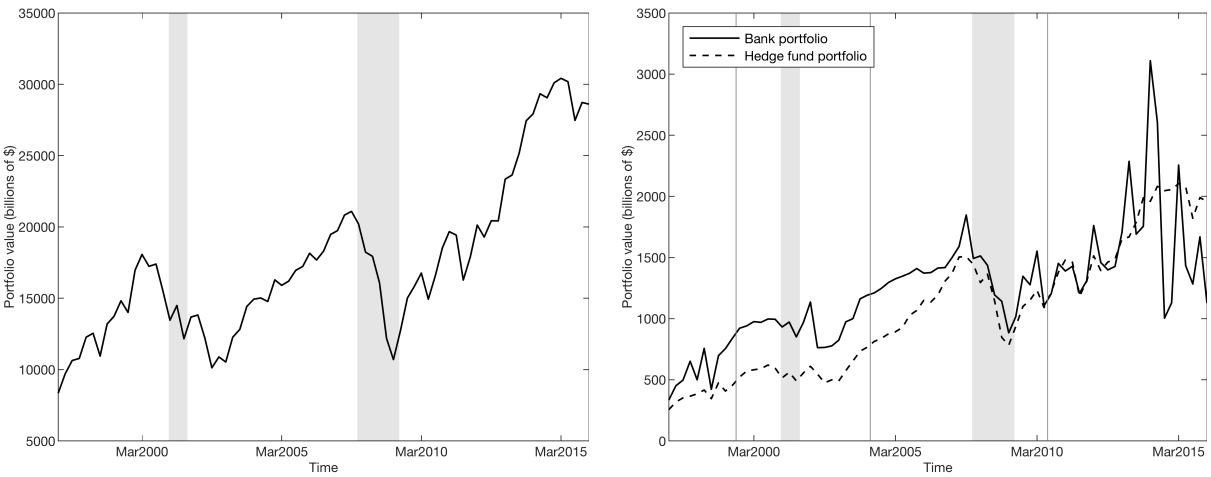


The figure plots total dollar values of the market portfolio, the bank portfolio, and the hedge fund portfolio relative to their 1997:Q1 dollar values, scaled to 100. The vertical lines represent the bank regulatory policy change announcement dates. The shaded areas correspond to recession periods as reported by the National Bureau of Economic Research.

Figure 2a demonstrates that the value of the market portfolio increases from approximately \$8.35 trillion dollars in 1997:Q1 to more than \$28.5 trillion in 2016:Q1. As indi-

cated in Figure 2b, the values of bank and hedge fund equity portfolios have grown from \$335 billion and \$256 billion at the beginning of the sample period to more than \$1.1 trillion and \$1.9 trillion, respectively, by its end. Additionally, Figures 1 and 2 demonstrate the extent of damage inflicted on U.S. equity markets by the 2007 - 2009 Financial Crisis. During the five quarters between the peak in the business cycle in December 2007 and its trough in June 2009, the value of the market portfolio declined by approximately \$10 trillion, whereas the valuation of bank and hedge funds equity portfolios was reduced by \$1 trillion and \$500 billion, respectively. The effects of the Federal Reserve's decision to pursue unconventional monetary policies in the aftermath of the crisis, aimed at providing economic stimulus by lowering the long-term yields on a broad range of assets, are reflected by the quick recovery of equity portfolio values beginning in 2009:Q1 and their continued rapid growth until early 2015. In contrast, the impact of the bursting of the Dot-com bubble and the recession in the early 2000's is considerably less pronounced for all three portfolios.

Figure 2: Dollar values of the market, bank, and hedge fund portfolios 1997:Q1 - 2016:Q1



(a) Market portfolio (b) Bank and hedge fund portfolios

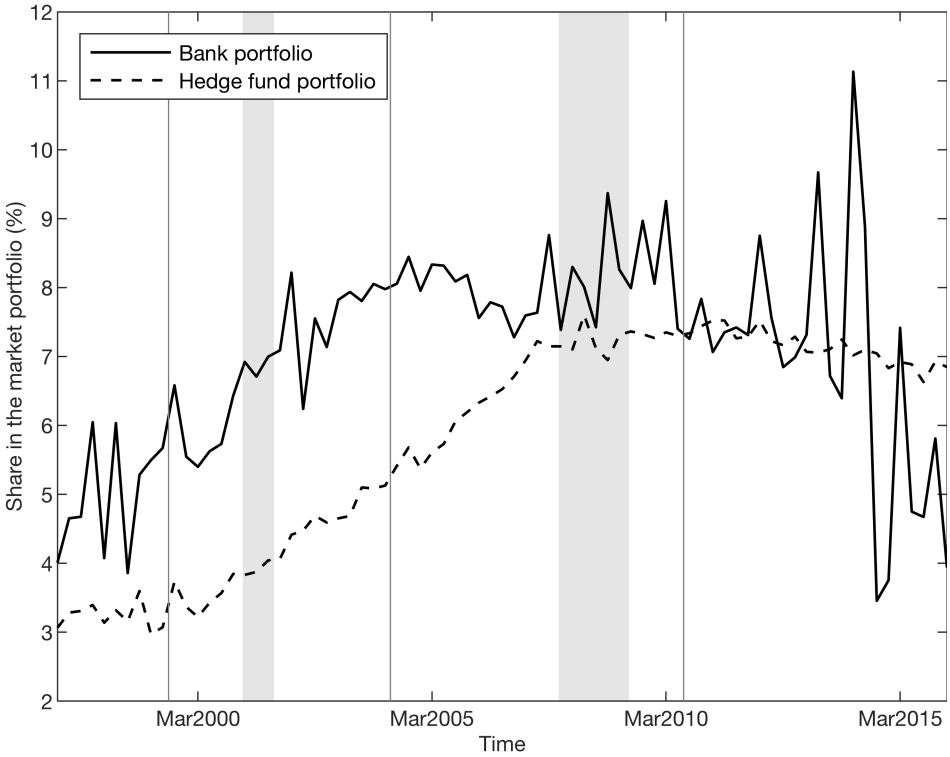
Sub-figures (a) and (b) plot the total dollar values of the market portfolio, the bank portfolio and the hedge fund portfolio, respectively. The vertical lines in sub-figure (b) represent the bank regulatory policy change announcement dates. The shaded areas correspond to recession periods as reported by the National Bureau of Economic Research.

Note, that relative to the hedge fund portfolio, the value of the bank equity portfolio exhibits considerably greater volatility following the 2007 - 2009 Financial Crisis. Although the number of banks in our sample decreases following the crisis, due to failures or acquisitions of distressed institutions, it remains quite stable in its aftermath. Consequently, the higher volatility could be a reflection of the adjustment of banks' business models undertaken as a result of post-crisis regulatory developments.

Figure 3 reports the shares of the bank and hedge fund equity portfolios in the market

portfolio. In 1997:Q1, the banks in our sample held positions accounting for approximately 4% of the entire market portfolio, increasing their share to 8% by 2008. During the same period, the share of hedge funds' holdings also increases by 4 percentage points, from 3% to 7%. While hedge funds' share has remained stable at 7% during and after the 2007 - 2009 Financial Crisis, the share of banks has first increased to more than 9% by 2010 and has subsequently become more volatile. That notwithstanding, Figure 3 demonstrates that bank holding companies remain an important class of institutional investors, and that their participation in equity markets is of sufficient volume for changes in bank regulations to generate spill-over effects affecting other financial markets.

Figure 3: Shares of the bank and hedge funds portfolios in the market portfolio 1997:Q1 - 2016:Q1



The figure plots the total dollar values of the the bank portfolio and the hedge fund portfolio as a fraction of the dollar value of the market portfolio. The vertical lines represent the bank regulatory policy change announcement dates. The shaded areas correspond to recession periods as reported by the National Bureau of Economic Research.

We report the average annualised daily risk, return, and illiquidity metrics for the three portfolios across the four regulatory regimes in Table 3. The results reveal that the bank portfolio consistently generates returns that are lower than those produced by the market portfolio, as measured by their average raw return r_p. Furthermore, despite evidencing lower total risk, σ_r, during the first three regulatory periods, the equity portfolio held by banks is also associated with lower Sharpe Ratios throughout the sample period. The average returns and total risk of the hedge fund portfolio exhibit patterns similar to the

bank portfolio, with the exception of the period during which the Gramm-Leach-Bliley Act and Basel I are in place, when it produces higher return and lower total risk than the market portfolio.

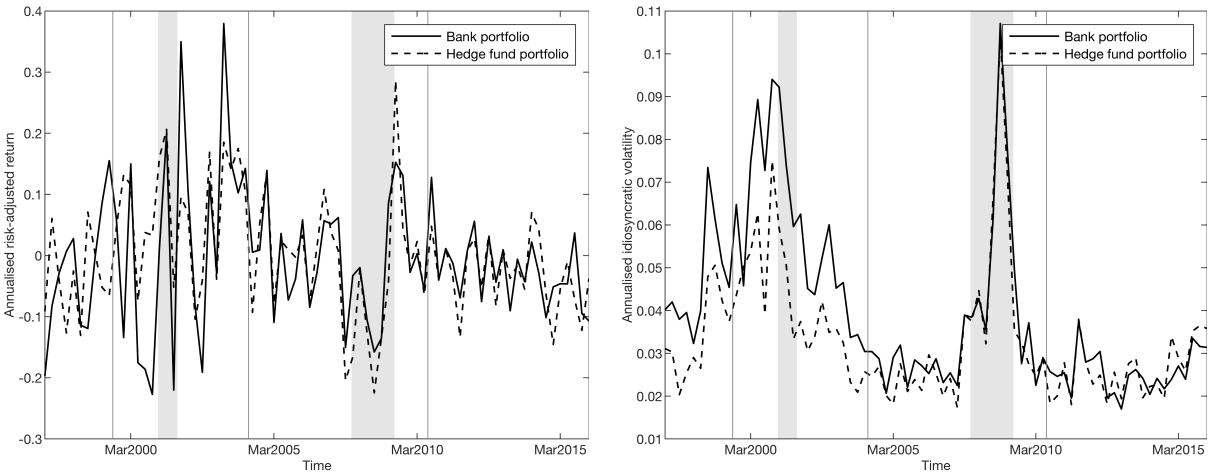
Table 3: Average portfolio return, risk, and liquidity characteristics

Market portfolio											
Regulatory regime	r_p	σ_r	α_p	σ_e	β_{MKT}	β_{SMB}	β_{HML}	β_{MOM}	$VaR_{5\%}$	A_p	SR_p
GSA and Basel I	0.3076	0.1705	0.0416	0.0105	0.9982	0.0263	0.0173	−0.0160	−0.0161	0.0282	1.7727
GLBA and Basel I	0.1442	0.1969	0.1177	0.0130	0.9628	0.0104	0.0235	0.0071	−0.0185	0.0203	0.8658
GLBA and Basel II	0.0894	0.1872	0.0527	0.0131	0.9837	0.0087	0.0379	0.0367	−0.0200	0.0093	0.7972
DFA and Basel III	0.1523	0.1452	0.0096	0.0102	0.9691	−0.0044	0.0092	−0.0203	−0.0151	0.0056	1.3324
Bank portfolio											
Regulatory regime	r_p	σ_r	α_p	σ_e	β_{MKT}	β_{SMB}	β_{HML}	β_{MOM}	$VaR_{5\%}$	A_p	SR_p
GSA and Basel I	0.0861	0.1257	−0.0269	0.0463	0.8976	0.7292	0.3009	−0.1085	−0.0129	0.5272	1.0684
GLBA and Basel I	0.1069	0.1595	0.0278	0.0590	0.7625	0.6040	0.4432	−0.1030	−0.0160	1.1778	1.0297
GLBA and Basel II	0.0421	0.1820	−0.0092	0.0364	0.7718	0.4842	0.1370	−0.0121	−0.0196	0.3642	0.4960
DFA and Basel III	0.0791	0.1506	−0.0242	0.0257	0.8331	0.5070	0.0849	−0.0671	−0.0156	0.1659	0.7797
Hedge fund portfolio											
Regulatory regime	r_p	σ_r	α_p	σ_e	β_{MKT}	β_{SMB}	β_{HML}	β_{MOM}	$VaR_{5\%}$	A_p	SR_p
GSA and Basel I	0.0967	0.1300	−0.0398	0.0341	0.9233	0.6809	0.2851	−0.1363	−0.0132	0.3672	1.2601
GLBA and Basel I	0.1524	0.1726	0.0716	0.0413	0.8543	0.6127	0.3740	−0.0882	−0.0167	0.3431	1.1070
GLBA and Basel II	0.0265	0.1876	−0.0191	0.0338	0.7867	0.5004	0.1095	0.0012	−0.0203	0.3071	0.4197
DFA and Basel III	0.0741	0.1483	−0.0307	0.0260	0.8185	0.5081	0.0693	−0.0964	−0.0155	0.2404	0.7433

The table reports the means of the estimated return, risk, and Amihud illiquidity metrics for the market portfolio, the bank equity portfolio, and the hedge fund equity portfolio across the four regulatory regimes.

The underperformance of the institutional portfolios relative to the market portfolio is further reflected by their risk-adjusted returns, α_p, which in all four instances are lower than those of the market portfolio, and with the exception of one period, negative. Figure 4a plots the risk-adjusted returns of the bank and the hedge fund portfolios. It demonstrates that the risk-adjusted returns of the bank portfolio exhibit considerably higher volatility than the returns of the hedge fund portfolio during the period of deregulation following the passage of the Gramm-Leach-Bliley Act. Following the announcement of Basel II, however, the risk-adjusted returns of the two portfolios display comparable patterns of behaviour. This convergence is further illustrated by Figure 4b, plotting the idiosyncratic volatilities of the two portfolios, which shows that while initially the firm-specific volatility of the bank portfolio is greater than that of the hedge fund portfolio, the two become nearly identical in the period after Basel II is introduced. Additionally, the mean loadings on the four risk factors used in the Carhart model indicate that both banks and hedge funds exhibit similar patterns of changes in preferences for growth and value stocks, with the coefficient on the size premium steadily declining over time, and the coefficient on the value premium increasing during the second period in our sample and then steadily declining.

Figure 4: Risk-adjusted returns and idiosyncratic volatilities of the bank and hedge fund portfolios 1997:Q1 - 2016:Q1



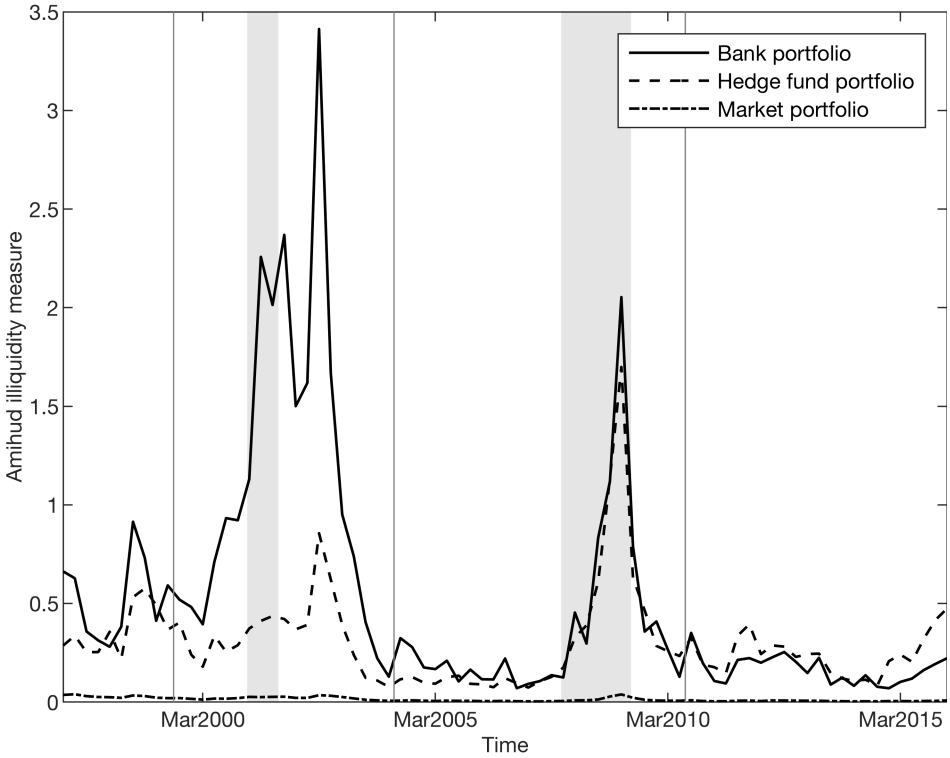
(a) Annualised risk-adjusted returns (b) Annualised idiosyncratic volatilities

Sub-figures (a) and (b) plot the annualised mean daily risk-adjusted returns and idiosyncratic volatilities of the bank portfolio and the hedge fund portfolio, respectively. The vertical lines represent the bank regulatory policy change announcement dates. The shaded areas correspond to recession periods as reported by the National Bureau of Economic Research.

The Amihud illiquidity measure is the metric which demonstrates the highest degree of dissimilarity between the three portfolios, as shown in Figure 5. Unsurprisingly, the market portfolio is the least illiquid portfolio in our sample throughout the entire period we

examine. In stark contrast, the bank portfolio is the most illiquid one during the first three periods, exhibiting considerably greater illiquidity than the hedge fund portfolio during the period when the Gramm-Leach-Bliley Act and Basel I are in place. The bank portfolio then becomes less illiquid than the hedge fund portfolio following the implementation of the Dodd-Frank Act and Basel III. Note that unlike in the case of the market or the hedge fund portfolios, the illiquidity of the bank equity portfolio is the highest in the aftermath of the Dot-com bubble and the early 2000's recession, and not during the 2007 - 2009 Financial Crisis.

Figure 5: Illiquidity of the market, bank, and hedge fund portfolios 1997:Q1 - 2016:Q1



The figure plots the Amihud illiquidity measure of the market, bank, and hedge fund portfolios. The vertical lines represent the bank regulatory policy change announcement dates. The shaded areas correspond to recession periods as reported by the National Bureau of Economic Research.

To establish whether the changes in portfolio performance metrics reported in Table 3 are statistically significant, we carry out a test of mean and variance equality between the quarterly estimates for the periods before and after a regulatory development takes place. We report the test results in Table 4.

Table 4: Changes in average portfolio return, risk, and liquidity characteristics

Market portfolio											
Policy development	r_p	σ_r	α_p	σ_e	β_{MKT}	β_{SMB}	β_{HML}	β_{MOM}	$VaR_{5\%}$	A_p	SR_p
GLBA	−0.1633	0.0264	0.0761***	0.0025	−0.0353***	−0.0160	0.0062	−0.0232	−0.0024	−0.0079***	−0.9069
	(−1.03)	(1.18)	(3.23)	(1.16)	(−4.36)	(−1.65)	(0.29)	(1.54)	(−1.13)	(−2.79)	(−1.02)
Basel II	−0.0549	−0.0097	−0.0650***	0.0000	0.0209**	−0.0016	0.0144	0.0295*	−0.0015	−0.0110***	−0.0686
	(−0.51)	(−0.29)	(−3.63)	(0.02)	(2.59)	(−0.17)	(0.74)	(1.72)	(−0.44)	(−4.54)	(−0.12)
DFA and Basel III	0.0629	−0.0420	−0.0431***	−0.0028**	−0.0146*	−0.0131*	−0.0287*	−0.0570***	0.0050	−0.0037**	0.5353
	(0.76)	(−1.37)	(−3.64)	(−2.11)	(−1.80)	(−1.70)	(−1.84)	(−3.03)	(1.48)	(−2.09)	(1.15)
Bank portfolio											
Policy development	r_p	σ_r	α_p	σ_e	β_{MKT}	β_{SMB}	β_{HML}	β_{MOM}	$VaR_{5\%}$	A_p	SR_p
GLBA	0.0209	0.0338	0.0547	0.0127*	−0.1351**	−0.1252**	0.1423*	0.0055	−0.0031	0.6506**	−0.0387
	(0.10)	(1.70)	(0.85)	(1.84)	(−2.68)	(−2.10)	(1.99)	(0.10)	(−1.32)	(2.32)	(−0.03)
Basel II	−0.0648	0.0225	−0.0369	−0.0225***	0.0092	−0.1198***	−0.3063***	0.0909**	−0.0036	−0.8136***	−0.5336
	(−0.46)	(0.73)	(−0.87)	(−3.75)	(0.28)	(−3.04)	(−5.91)	(2.06)	(−1.12)	(−4.07)	(−0.64)
DFA and Basel III	0.0370	−0.0314	−0.0150	−0.0108**	0.0613***	0.0228	−0.0521	−0.0550	0.0040	−0.1983**	0.2837
	(0.36)	(−1.07)	(−0.69)	(−2.55)	(3.33)	(0.81)	(−1.28)	(−1.38)	(1.30)	(−2.15)	(0.48)
Hedge fund portfolio											
Policy development	r_p	σ_r	α_p	σ_e	β_{MKT}	β_{SMB}	β_{HML}	β_{MOM}	$VaR_{5\%}$	A_p	SR_p
GLBA	0.0557	0.0426*	0.1113***	0.0072	−0.0698*	−0.0682	0.0889	0.0481	−0.0035	−0.0240	−0.0387
	(0.28)	(2.04)	(3.23)	(1.42)	(−1.85)	(−1.55)	(1.52)	(1.10)	(−1.60)	(−0.37)	(−0.11)
Basel II	−0.1258	0.0150	−0.0906***	−0.0075	−0.0667***	−0.1123***	−0.2645***	0.0894**	−0.0037	−0.0360	−0.5336
	(−0.91)	(0.47)	(−2.84)	(−1.40)	(−2.78)	(−3.86)	(−6.67)	(2.13)	(−1.09)	(−0.38)	(−0.87)
DFA and Basel III	0.0476	−0.0393	−0.0117	−0.0078*	0.0318*	0.0077	−0.0402	−0.0976**	0.0049	−0.0667	0.2837
	(0.44)	(−1.32)	(−0.45)	(−1.80)	(1.90)	(0.32)	(−1.36)	(−2.53)	(1.51)	(−0.82)	(0.55)

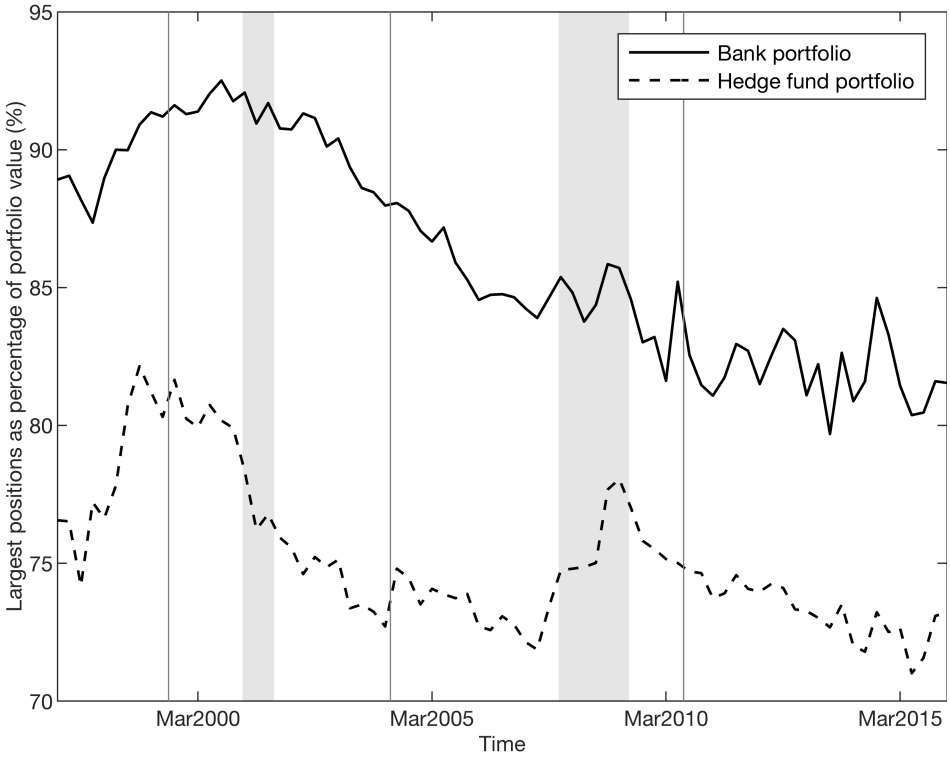
The table reports changes in the mean of the estimated return, risk, and Amihud illiquidity metrics for the market portfolio, the bank equity portfolio, and the hedge fund equity portfolio, calculated as the difference between the portfolio statistics computed for the new regulatory regime and the previous regime. t-statistics in parenthesis. *, **, *** denote 10%, 5% and 1$ level of significance.

The results for the bank portfolio indicate that none of the reported changes in returns, total risk, risk-adjusted returns, or Value-at-Risk metrics are statistically significant. We find, however, that the reduction in idiosyncratic volatility of the portfolio during the periods when Basel II, the Dodd-Frank Act and Basel III are in place are all statistically significant. This potentially indicates that the increases in bank capital requirements brought by the consecutive Basel Accords prompts banks to reduce the firm-specific riskiness of their investments in equities. Additionally, the changes in risk factor loadings which occur in the period associated with Basel II are statistically significant for both banks and hedge funds, and are also of a similar order of magnitude. This suggests that the shift in the composition of the bank portfolio occurring during that time is likely a reflection of broader changes in institutional investors' stock characteristics preferences.

Most importantly, the results presented in Table 4 demonstrate that the changes in the Amihud illiquidity measure of the bank portfolio are statistically significant throughout the entire sample period. Although the increase in the liquidity of the market portfolio is also statistically significant, the changes in illiquidity of the hedge fund portfolio taking place across the four regulatory regimes are statistically indistinguishable from one another.

Both the bank and the hedge fund portfolios are well-diversified, as they comprise more than half of all of the unique stocks included in the market portfolio. They are not, however, uniformly distributed in terms of the weights attached to the individual stocks. Indeed, we establish that a substantial proportion of the portfolios' value is allocated to approximately 10% of all the unique stocks held by banks and by hedge funds. Figure 6 plots the value of the positions with weights above the 90th percentile of the distribution in each quarter relative to the value of the entire bank and hedge fund portfolios. It demonstrates that the two portfolios are highly concentrated, as the largest positions therein comprise between 85% and 92% of the bank equity portfolio, and between 71% and 82% of the hedge fund portfolio.

Figure 6: Value of the largest positions as a proportion of the portfolio value 1997:Q1 - 2016:Q1



The figure plots the cumulative value of the positions with weights above the 90th percentile relative to the value of the entire bank and hedge fund portfolios, respectively. The vertical lines represent the bank regulatory policy change announcement dates. The shaded areas correspond to recession periods as reported by the National Bureau of Economic Research.

To establish whether the regulatory developments we analyse have homogenous effects on all positions within the bank equity portfolio, regardless of their relative size, we form additional small and large position portfolios by partitioning the sample around the 90th percentile of portfolio weights in each quarter. We repeat this process for the hedge fund portfolio to establish additional size-based benchmark portfolios. The weights of the stocks included in the resulting portfolios are re-scaled so that they sum to 100% in order to ensure comparability of their return, risk, and illiquidity metrics. Table 5 reports the annualised daily return, risk, and illiquidity statistics for size-based bank and hedge fund portfolios across the four regulatory regimes.

Table 5: Average portfolio return, risk, and liquidity characteristics by position size

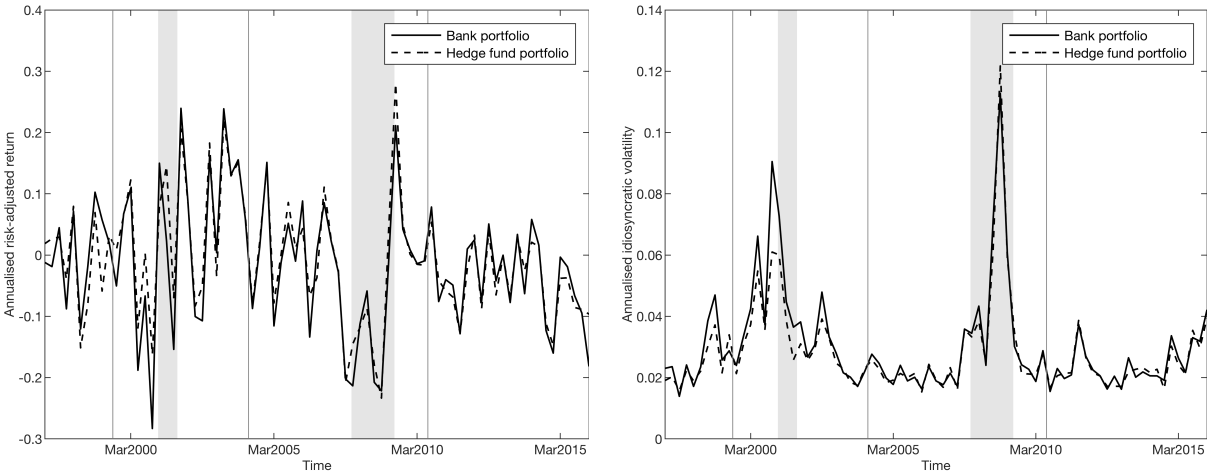
Smallest positions in the bank portfolio											
Regulatory regime	r_p	σ_r	α_p	σ_e	β_{MKT}	β_{SMB}	β_{HML}	β_{MOM}	$VaR_{5\%}$	A_p	SR_p
GSA and Basel I	0.1093	0.1175	0.0039	0.0265	0.8622	0.7407	0.2924	−0.1244	−0.0120	0.5645	1.6078
GLBA and Basel I	0.1134	0.1482	0.0248	0.0386	0.7088	0.6302	0.4222	−0.1297	−0.0147	1.2698	1.0581
GLBA and Basel II	0.0150	0.1796	−0.0305	0.0310	0.7376	0.5104	0.1281	−0.0072	−0.0195	0.4071	0.3959
DFA and Basel III	0.0612	0.1498	−0.0404	0.0242	0.8084	0.5579	0.0809	−0.0837	−0.0156	0.1938	0.6700
Largest positions in the bank portfolio											
Regulatory regime	r_p	σ_r	α_p	σ_e	β_{MKT}	β_{SMB}	β_{HML}	β_{MOM}	$VaR_{5\%}$	A_p	SR_p
GSA and Basel I	0.2829	0.1592	0.0744	0.0300	0.9978	0.0647	0.2096	−0.1236	−0.0149	0.0017	1.8736
GLBA and Basel I	0.1981	0.1936	0.1356	0.0408	1.0331	0.1302	0.2266	−0.0053	−0.0181	0.0007	1.0711
GLBA and Basel II	0.0801	0.1984	0.0508	0.0247	1.0145	0.0453	0.0584	0.0152	−0.0213	0.0002	0.7073
DFA and Basel III	0.1520	0.1496	0.0031	0.0179	0.9866	−0.0214	−0.0027	−0.0163	−0.0155	0.0001	1.2842
Smallest positions in the hedge fund portfolio											
Regulatory regime	r_p	σ_r	α_p	σ_e	β_{MKT}	β_{SMB}	β_{HML}	β_{MOM}	$VaR_{5\%}$	A_p	SR_p
GSA and Basel I	0.1236	0.1217	−0.0074	0.0241	0.9011	0.7618	0.2961	−0.1196	−0.0123	0.4046	1.6162
GLBA and Basel I	0.1353	0.1661	0.0495	0.0331	0.8122	0.6747	0.4205	−0.1356	−0.0163	0.3956	1.0787
GLBA and Basel II	0.0235	0.1855	−0.0191	0.0306	0.7691	0.5469	0.1463	−0.0135	−0.0202	0.4284	0.4297
DFA and Basel III	0.0564	0.1495	−0.0427	0.0238	0.8033	0.5764	0.0880	−0.0845	−0.0158	0.3022	0.6367
Largest positions in the hedge fund portfolio											
Regulatory regime	r_p	σ_r	α_p	σ_e	β_{MKT}	β_{SMB}	β_{HML}	β_{MOM}	$VaR_{5\%}$	A_p	SR_p
GSA and Basel I	0.3030	0.1700	0.0747	0.0305	1.0498	0.1780	0.1329	−0.0746	−0.0158	0.0013	1.7650
GLBA and Basel I	0.2300	0.2065	0.1736	0.0409	1.0637	0.1627	0.1771	0.0026	−0.0191	0.0006	1.1801
GLBA and Basel II	0.1287	0.2004	0.0776	0.0271	1.0133	0.0621	−0.0215	0.0989	−0.213	0.0002	1.0286
DFA and Basel III	0.1728	0.1558	0.0215	0.0194	1.0106	−0.0022	−0.0553	−0.0023	−0.0163	0.0001	1.4255

The table reports the means of the estimated return, risk, and Amihud illiquidity metrics for the smallest and the largest positions in the bank equity portfolio and the hedge fund equity portfolio, respectively, across the four regulatory regimes.

A comparison of the return, risk, and illiquidity metrics of the small and large position portfolios reveals a number of stark differences between the two, which occur in both types of institutional portfolios. First and foremost, the portfolios comprising the positions with the largest weights are more profitable, both in terms of raw and risk-adjusted returns, than their small position counterparts. Although total risk of the small position portfolios is generally lower across the four regulatory regimes, their idiosyncratic volatilities are higher than those of the large position portfolios in the two periods following the introduction of Basel II. Finally, the large position portfolios are significantly less illiquid than the small position portfolios.

Figures 7 and 8 show the risk-adjusted returns and idiosyncratic volatilities of the small positions portfolios and the large positions portfolios, respectively. Although the risk-adjusted returns of the two small position portfolios (Figure 7a) and their idiosyncratic volatilities (Figure 7b) are nearly identical, the differences between the patterns of changes for the large positions portfolios are more discernible, as demonstrated by Figures 8a and 8b. That notwithstanding, the two metrics are highly correlated across time for all four portfolios, with correlation coefficients of 0.93 and 0.87 for risk-adjusted returns, and 0.96 and 0.93 for idiosyncratic volatilities of the small and the large positions, respectively. However, the firm-specific risks of the size-based portfolios reach their maximum values at different points in time during the sample period. For small positions, similarly to the complete portfolios, idiosyncratic volatility reaches its highest value during the 2007 - 2009 Financial Crisis. In contrast, the firm-specific risk of the largest position portfolios attain their highest levels in 2000:Q1, when the Dot-com bubble collapses.

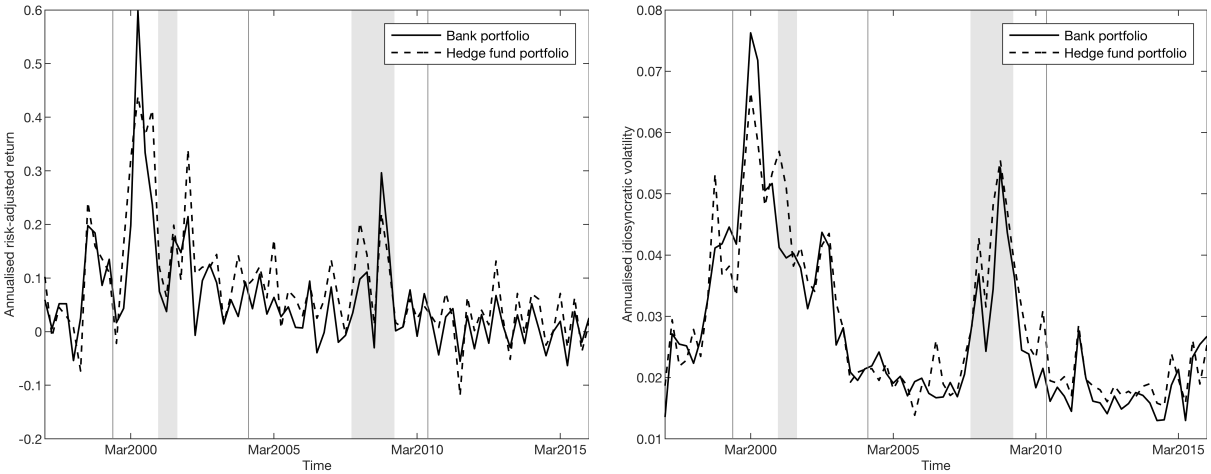
Figure 7: Risk-adjusted returns and idiosyncratic volatilities of the smallest positions in bank and hedge fund portfolios 1997:Q1 - 2016:Q1



(a) Annualised risk-adjusted returns (b) Annualised idiosyncratic volatilities

Sub-figures (a) and (b) plot the annualised mean daily risk-adjusted returns and idiosyncratic volatilities of the portfolios comprising the positions with weights below the 90th percentile each quarter in the bank and hedge fund portfolios, respectively. The vertical lines represent the bank regulatory policy change announcement dates. The shaded areas correspond to recession periods as reported by the National Bureau of Economic Research.

Figure 8: Risk-adjusted returns and idiosyncratic volatilities of the largest positions in bank and hedge fund portfolios 1997:Q1 - 2016:Q1

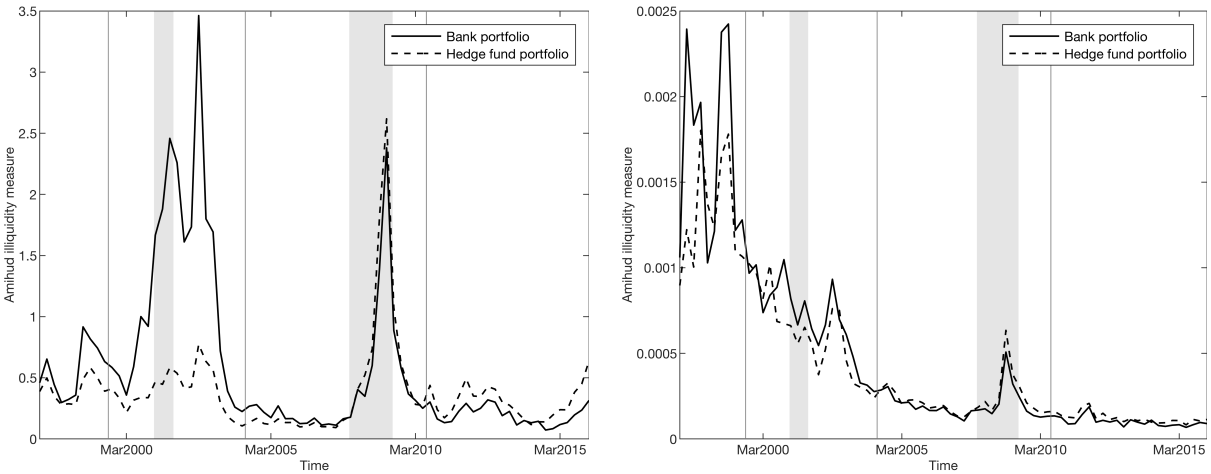


(a) Annualised risk-adjusted returns (b) Annualised idiosyncratic volatilities

Sub-figures (a) and (b) plot the annualised mean daily risk-adjusted returns and idiosyncratic volatilities of the portfolios comprising the positions with weights above the 90th percentile each quarter in the bank and hedge fund portfolios, respectively. The vertical lines represent the bank regulatory policy change announcement dates. The shaded areas correspond to recession periods as reported by the National Bureau of Economic Research.

The changes in the Amihud illiquidity measure of the two small positions portfolios, shown in Figure 9a, closely resemble those reported for the entire bank and hedge fund portfolios. The portfolio of smallest positions held by banks is more illiquid than the benchmark hedge fund portfolio, with its illiquidity peaking following the early 2000's recession, but becomes less illiquid in the period following the introduction of the Dodd-Frank Act and Basel III. In stark contrast, the portfolios of largest positions not only display highly comparable patterns of changes in illiquidity, becoming considerably less illiquid during the sample period, but also exhibit lower illiquidity than the market portfolio.

Figure 9: Illiquidity of the size-based bank and hedge fund portfolios 1997:Q1 - 2016:Q1



(a) Illiquidity of the small positions bank and hedge fund portfolios

(b) Illiquidity of the large positions bank and hedge fund portfolios

Sub-figures (a) and (b) plot the Amihud illiquidity measure of the portfolios comprising the positions with weights below the 90th percentile each quarter in the bank and hedge fund portfolios, respectively. The vertical lines represent the bank regulatory policy change announcement dates. The shaded areas correspond to recession periods as reported by the National Bureau of Economic Research.

The results of t-tests comparing the mean and variance of the return, risk, and illiquidity statistics of the four size-based portfolios in the periods before and after a regulatory intervention are reported in Table 6. Comparing the results of tests based on the size-based portfolios with those reported in Table 4, allows us to determine whether any of the changes observed in the complete portfolios can be attributed to the changes exhibited by either the small positions or the large positions portfolios.

The changes in the loadings on the size and value risk factors occurring following the introduction of Basel II are statistically significant across all four size-based portfolios, and of orders of magnitude comparable to those identified for the complete portfolios. In contrast, although the changes in idiosyncratic volatility of the entire bank equity portfolio, and of its large positions, are statistically significant following each of the three regulatory developments, only the portfolio of small positions exhibits a statistically sig-

nificant increase after the passage of the Gramm-Leach-Bliley Act, and no significant changes afterwards. Although we identify a similar pattern of changes in the idiosyncratic volatilities of the small and large position hedge fund portfolios, only the reduction in firm-specific volatility of the entire hedge fund portfolio in the period following the announcement of the Dodd-Frank Act and Basel III is statistically significant. Similarly, while we find that the decrease in the Amihud illiquidity measure of the two large position portfolios are statistically significant, only the changes manifest by the bank portfolio of small positions are statistically significant and conform with our results for the entire bank portfolio.

This leads us to conclude that the changes in the idiosyncratic volatilities and Amihud illiquidity measures of the complete institutional portfolios are driven by the developments occurring within the large positions portfolio in the former case, and within the small positions portfolio in the latter case.

Table 6: Changes in average portfolio characteristics of the smallest and largest positions

Smallest positions in the bank portfolio											
Policy development	r_p	σ_r	α_p	σ_e	β_{MKT}	β_{SMB}	β_{HML}	β_{MOM}	$VaR_{5\%}$	A_p	SR_p
GLBA	0.0042	0.0307	0.0210	0.0121*	−0.1534***	−0.1105**	0.1298**	−0.0053	−0.0027	0.7052**	−0.5498
	(0.02)	(1.51)	(0.42)	(1.85)	(−3.58)	(−2.39)	(2.30)	(−0.12)	(−1.25)	(2.45)	(−0.35)
Basel II	−0.0984	0.0314	−0.0553	−0.0076	0.0288	−0.1198***	−0.2941***	0.1226***	−0.0049	−0.8627***	−0.6622
	(−0.71)	(1.02)	(−1.42)	(−1.21)	(1.11)	(−3.96)	(−6.76)	(2.98)	(−1.47)	(−4.08)	(−0.73)
DFA and Basel III	0.0462	−0.0298	−0.0099	−0.0068	0.0708***	0.0475*	−0.0472	−0.0765*	0.0039	−0.2132**	0.2740
	(0.43)	(−1.02)	(−0.36)	(−1.44)	(4.01)	(1.87)	(−1.33)	(−1.92)	(1.25)	(−2.02)	(1.15)
Largest positions in the bank portfolio											
Policy development	r_p	σ_r	α_p	σ_e	β_{MKT}	β_{SMB}	β_{HML}	β_{MOM}	$VaR_{5\%}$	A_p	SR_p
GLBA	−0.0848	0.0344	0.0613	0.0108*	0.0353	0.0655	0.0170	0.1183**	−0.0032	−0.0010***	−0.8025
	(−0.56)	(1.60)	(1.25)	(1.96)	(0.94)	(1.47)	(0.27)	(2.63)	(−1.58)	(−6.49)	(−0.92)
Basel II	−0.1180	0.0048	−0.0848**	−0.0161***	−0.0185	−0.0849***	−0.1682***	0.0205	−0.0032	−0.0005***	−0.3638
	(−1.13)	(0.14)	(−2.57)	(−4.22)	(−0.81)	(−3.61)	(−3.89)	(0.65)	(−0.84)	(−9.90)	(−0.66)
DFA and Basel III	0.0719	−0.0489	−0.0477***	−0.0067***	−0.0279***	−0.0667***	−0.0611**	−0.0315	0.0058	−0.0001***	0.5769
	(0.86)	(−1.51)	(−2.85)	(−3.12)	(−2.69)	(−5.73)	(−2.03)	(−1.25)	(1.60)	(−5.39)	(1.29)

Table continued overleaf.

Table 6 (continued): Changes in average portfolio characteristics of the smallest and largest positions

Smallest positions in the hedge fund portfolio											
Policy development	r_p	σ_r	α_p	σ_e	β_{MKT}	β_{SMB}	β_{HML}	β_{MOM}	$VaR_{5\%}$	A_p	SR_p
GLBA	0.0117	0.0444**	0.0570	0.0090*	−0.0889**	−0.0870**	0.1244***	−0.0160	−0.0040*	−0.0090	−0.5375
	(0.06)	(2.13)	(1.43)	(2.02)	(−2.43)	(−2.11)	(2.91)	(−0.37)	(−1.86)	(−0.15)	(−0.35)
Basel II	−0.1117	0.0193	−0.0686*	−0.0026	−0.0431*	−0.1278***	−0.2742***	0.1221***	−0.0040	−0.0328	−0.6490
	(−0.78)	(0.61)	(−1.99)	(−0.45)	(−1.92)	(−4.83)	(−7.54)	(3.04)	(−1.15)	(0.23)	(−0.76)
DFA and Basel III	0.0329	−0.0359	−0.0236	−0.0068	0.0341**	0.0295	−0.0583*	−0.0710*	0.0044	−0.1262	0.2070
	(0.30)	(−1.20)	(−0.90)	(−1.39)	(2.15)	(1.28)	(−1.85)	(−1.90)	(1.36)	(−0.98)	(0.34)
Largest positions in the hedge fund portfolio											
Policy development	r_p	σ_r	α_p	σ_e	β_{MKT}	β_{SMB}	β_{HML}	β_{MOM}	$VaR_{5\%}$	A_p	SR_p
GLBA	−0.0729	0.0364	0.0988**	0.0103**	0.0139	−0.0152	0.0442	0.0773	−0.0033	−0.0007***	−0.5848
	(−0.44)	(1.65)	(2.06)	(2.11)	(0.39)	(−0.29)	(0.78)	(1.24)	(−1.66)	(−6.50)	(−0.66)
Basel II	−0.1013	−0.0060	−0.0960***	−0.0138***	−0.0505**	−0.1007***	−0.1987***	0.0962*	−0.0022	−0.0004***	−0.1515
	(−0.91)	(−0.17)	(−3.14)	(−3.70)	(−2.17)	(−3.45)	(−5.02)	(1.91)	(−0.64)	(−7.05)	(−0.27)
DFA and Basel III	0.0441	−0.0446	−0.0561***	−0.0077***	−0.0026	−0.0643***	−0.0338	−0.1012**	0.0049	−0.0001***	0.3968
	(0.49)	(−1.39)	(−3.33)	(−3.16)	(−0.21)	(−5.41)	(−1.09)	(−2.43)	(1.45)	(−4.73)	(0.86)

The table reports changes in the mean of the estimated return, risk, and Amihud illiquidity metrics for the portfolios comprising the smallest and the largest positions in the bank and hedge fund portfolios, respectively. t-statistics in parenthesis. *, **, *** denote 10%, 5% and 1$ level of significance.

4.2 Difference-in-differences analysis

We now present the results of difference-in-differences analysis. This is undertaken in order to establish whether the changes in the return, risk, and illiquidity characteristics of the bank equity portfolio we have identified are driven by regulatory policy developments. To this end, we base our tests on the differences between the bank portfolio and the market portfolio, the hedge fund portfolio and the market portfolio, and the bank portfolio and the hedge fund portfolio. We posit that for each portfolio metric, if the tests indicate that the differences between the bank portfolio and the market portfolio, and the bank portfolio and the hedge fund portfolio are statistically significant, while those between the hedge fund portfolio and the market portfolio are not, then the changes in the metric of interest can be attributed to a particular bank regulatory policy development and not to a change in market conditions. We report the results of the test based on the complete bank and hedge fund portfolios in Table 7.

Table 7: Difference-in-differences results

Bank portfolio − Market portfolio											
Policy development	r_p	σ_r	α_p	σ_e	β_{MKT}	β_{SMB}	β_{HML}	β_{MOM}	$VaR_{5\%}$	A_p	SR_p
GLBA	0.1842	0.0074	−0.0214	0.0101*	−0.0997*	−0.1092*	0.1361	−0.0177	−0.0006	0.6585**	0.8682
	(1.65)	(0.56)	(−0.29)	(1.90)	(−2.00)	(−1.78)	(1.63)	(−0.33)	(−0.38)	(2.36)	(0.94)
Basel II	−0.0099	0.0321***	0.0281	−0.0226***	−0.0117	−0.1182***	−0.3206***	0.0614	−0.0021*	−0.8026***	−0.4651
	(−0.15)	(3.49)	(0.56)	(−5.04)	(−0.36)	(−2.97)	(−6.03)	(1.57)	(−1.92)	(−4.05)	(−1.06)
DFA and Basel III	−0.0259	0.0106*	0.0281	−0.0080**	0.0759***	0.0359	−0.0233	0.0020	−0.0009	−0.1947**	−0.2516
	(−0.82)	(1.95)	(1.13)	(−2.53)	(4.38)	(1.38)	(−0.67)	(0.06)	(−1.46)	(−2.14)	(−1.11)
Hedge fund portfolio − Market portfolio											
Policy development	r_p	σ_r	α_p	σ_e	β_{MKT}	β_{SMB}	β_{HML}	β_{MOM}	$VaR_{5\%}$	A_p	SR_p
GLBA	0.2190**	0.0162	0.0353	0.0047	−0.0345	−0.0522	0.0827	0.0249	−0.0011	−0.0161	0.7538
	(2.43)	(1.44)	(0.84)	(1.36)	(−0.93)	(−1.20)	(1.16)	(0.57)	(−0.81)	(−0.26)	(0.99)
Basel II	−0.0710	0.0247***	−0.0256	−0.0075	−0.0876***	−0.1108***	−0.2789***	0.0599	−0.0021**	−0.0250	−0.6187*
	(−1.24)	(2.91)	(−0.67)	(−1.47)	(−4.04)	(−3.92)	(−6.38)	(1.66)	(−2.32)	(−0.27)	(−1.87)
DFA and Basel III	−0.0153	0.0027	0.0315	−0.0050	0.0464***	0.0208	−0.0115	−0.0406	−0.0001	−0.0631	−0.2116
	(−0.42)	(0.45)	(1.09)	(−1.55)	(3.15)	(0.91)	(−0.46)	(−1.32)	(−0.14)	(−0.79)	(−0.98)
Bank portfolio − Hedge fund portfolio											
Policy development	r_p	σ_r	α_p	σ_e	β_{MKT}	β_{SMB}	β_{HML}	β_{MOM}	$VaR_{5\%}$	A_p	SR_p
GLBA	−0.0348	−0.0087	−0.0566	0.0055	−0.0653*	−0.0570	0.0534	−0.0426	0.0004	0.6746***	0.1144
	(−0.86)	(−1.31)	(−1.06)	(1.59)	(−1.74)	(−1.06)	(0.90)	(−0.85)	(0.49)	(2.92)	(0.36)
Basel II	0.0610**	0.0075	0.0537*	−0.0150***	0.0759***	−0.0075	−0.0418	0.0015	0.0000	−0.7776***	0.1536
	(2.19)	(1.63)	(1.71)	(−6.72)	(3.10)	(−0.22)	(−1.09)	(0.05)	(0.07)	(−5.37)	(0.89)
DFA and Basel III	−0.0106	0.0079***	−0.0034	−0.0030**	0.0295*	0.0151	−0.0119	0.0426**	−0.0008**	−0.1316***	−0.0400
	(−0.65)	(3.03)	(−0.21)	(−2.33)	(1.98)	(0.82)	(−0.43)	(2.05)	(−2.44)	(−4.77)	(−0.41)

The table reports the results of difference-in-differences tests. The first difference is between the return, risk, and illiquidity metrics of either the bank or the hedge fund portfolio and the benchmark portfolio. The second difference is between the period following a policy change and the preceding period. t-statistics in parenthesis. *, **, *** denote 10%, 5% and 1$ level of significance.

Our analysis so far identifies the idiosyncratic volatility and the Amihud illiquidity measure of the bank portfolio as the two metrics which exhibit statistically significant differences following the three regulatory innovations during the sample period. Accordingly, they are the main focus of our discussion.

Although the increase in idiosyncratic volatility of the bank portfolio during the period of deregulation initiated by the Gramm-Leach-Bliley Act relative to the market portfolio is statistically significant, it is statistically indistinguishable from the increase in firm-specific risk of the hedge fund portfolio. However, the results for the periods following the introduction of Basel II, as well as the passage of the Dodd-Frank Act and the announcement of Basel III, show that the reduction in the idiosyncratic volatility of the bank portfolio, relative to both the market portfolio and the hedge fund portfolio, is highly statistically significant. At the same time, the changes in idiosyncratic volatility of the hedge fund portfolio relative to the market portfolio are statistically insignificant. This allows us to conclude that introduction of higher bank capital requirements and prohibiting banks from engaging in proprietary trading both lead to a significant reduction in the overall firm-specific risk of the equity positions they hold.

In terms of the Amihud illiquidity measure, the test results indicate a robust relation between the illiquidity of banks' equity holdings and changes in the regulatory environment within which they operate. The removal of any formal restrictions preventing banks from engaging in securities trading brought about by the Gramm-Leach-Bliley Act, has led to a statistically and economically significant increase in the illiquidity of bank portfolios, relative to both the market and the hedge fund portfolios. In contrast, the subsequent announcement initiating Basel II regulations, and the Dodd-Frank Act and Basel III all result in significant increases of the bank portfolio's liquidity in relation to the market portfolio and the hedge fund portfolio. This evidence suggests that financial deregulation prompts banking institutions to invest in more illiquid stocks, while policies aimed at either increasing bank capital requirements or reducing the scope of their activities in financial markets force banks to rebalance their portfolio towards more liquid positions.

To ensure the robustness of our main results, we repeat the tests using the small positions and the large positions bank and hedge fund portfolios. The results are reported in Tables 8 and 9. In contrast to the results discussed so far, we find that the introduction of Basel II appears as the sole regulatory development which results in a statistically significant reduction in idiosyncratic volatility of the small positions bank portfolio relative to both the market and the hedge fund portfolios. However, as shown in Table 6, the mean and variance of firm-specific risk of the small positions portfolio held by banks during that period is not statistically different from the preceding regulatory regime. Fur-

thermore, while the changes in the idiosyncratic volatility of the large positions portfolio conform to our previous findings when assessed in relation to the market portfolio, they are not statistically different relative to changes exhibited by the large positions portfolio of hedge funds. Additionally, although the difference-in-differences analysis of changes in the Amihud illiquidity metrics of the small positions portfolios fully supports the results documented for the entire portfolio, the results of the tests carried out on the large positions portfolio are not conclusive. We attribute this to the considerably greater illiquidity of the market portfolio, which results in difference-in-differences estimates that predominantly reflect the effects of changes in the liquidity of the market portfolio, rather than either of the two institutional portfolios.

Table 8: Difference-in-differences results for the small positions portfolios

Bank portfolio − Market portfolio											
Policy development	r_p	σ_r	α_p	σ_e	β_{MKT}	β_{SMB}	β_{HML}	β_{MOM}	$VaR_{5\%}$	A_p	SR_p
GLBA	0.1675	0.0043	−0.0551	0.0095*	−0.1181***	−0.0945**	0.1236*	−0.0285	−0.0003	0.7132**	0.3572
	(1.63)	(0.32)	(−0.92)	(1.92)	(−2.84)	(−2.06)	(1.93)	(−0.68)	(−0.20)	(2.50)	(0.36)
Basel II	−0.0436	0.0410***	0.0097	−0.0076***	0.0079	−0.1182***	−0.3085***	0.0930***	−0.0033***	−0.8517***	−0.5936
	(−0.67)	(4.89)	(0.20)	(−1.60)	(0.34)	(−4.07)	(−7.25)	(2.74)	(−3.55)	(−4.07)	(−1.30)
DFA and Basel III	−0.0167	0.0122**	0.0332	−0.0040	0.0854***	0.0606**	−0.0184	−0.0195	−0.0010	−0.2096**	−0.2612
	(−0.44)	(2.48)	(1.08)	(−1.09)	(6.11)	(2.63)	(−0.64)	(−0.64)	(−1.60)	(−2.01)	(−1.00)
Hedge fund portfolio − Market portfolio											
Policy development	r_p	σ_r	α_p	σ_e	β_{MKT}	β_{SMB}	β_{HML}	β_{MOM}	$VaR_{5\%}$	A_p	SR_p
GLBA	0.1750	0.0180	−0.0191	0.0065**	−0.0536	−0.0710*	0.1182**	−0.0392	−0.0016	−0.0011	0.3695
	(1.68)	(1.51)	(−0.37)	(2.18)	(−1.50)	(−1.75)	(2.27)	(−0.95)	(−1.18)	(−0.02)	(0.39)
Basel II	−0.0569	0.0290***	−0.0036	−0.0026	−0.0639***	−0.1263***	−0.2886***	0.0926***	−0.0024***	0.0438	−0.5804
	(−0.88)	(3.62)	(−0.09)	(−0.60)	(−3.19)	(−4.94)	(−8.25)	(2.75)	(−2.74)	(0.31)	(−1.49)
DFA and Basel III	−0.0300	0.0061	0.0195	−0.0040	0.0487***	0.0426**	−0.0296	−0.0140	−0.0005	−0.1225	−0.3283
	(−0.75)	(1.17)	(0.65)	(−1.04)	(3.70)	(2.01)	(−1.23)	(−0.48)	(−0.79)	(−0.97)	(−1.33)
Bank portfolio − Hedge fund portfolio											
Policy development	r_p	σ_r	α_p	σ_e	β_{MKT}	β_{SMB}	β_{HML}	β_{MOM}	$VaR_{5\%}$	A_p	SR_p
GLBA	−0.0075	−0.0137***	−0.0360*	0.0031	−0.0645***	−0.0235	0.0054	0.0107	0.0013***	0.7143***	−0.0123
	(−0.26)	(−3.49)	(−1.76)	(1.21)	(−3.23)	(−1.01)	(0.19)	(0.50)	(3.23)	(3.04)	(−0.07)
Basel II	0.0133	0.0121***	0.0133	−0.0050***	0.0718***	0.0080	−0.0199	0.0004	−0.0009***	−0.8955***	−0.0131
	(0.72)	(4.43)	(1.05)	(−3.08)	(5.54)	(0.51)	(−1.25)	(0.03)	(−2.75)	(−6.02)	(−0.12)
DFA and Basel III	0.0134	0.0061***	0.0137	−0.0000	0.0367***	0.0180	0.0111	−0.0055	−0.0005*	−0.0871***	0.0670
	(1.38)	(3.73)	(1.61)	(−0.04)	(4.38)	(1.61)	(1.04)	(−0.53)	(−1.73)	(−2.89)	(1.09)

The table reports the results of difference-in-differences tests. The first difference is between the return, risk, and illiquidity metrics for the smallest positions in either the bank or the hedge fund portfolio and the benchmark portfolio. The second difference is between the period following a policy change and the preceding period. t-statistics in parenthesis. *, **, *** denote 10%, 5% and 1$ level of significance.

Table 9: Difference-in-differences results for the large positions portfolios

Bank portfolio − Market portfolio											
Policy development	r_p	σ_r	α_p	σ_e	β_{MKT}	β_{SMB}	β_{HML}	β_{MOM}	$VaR_{5\%}$	A_p	SR_p
GLBA	0.0785	0.0080	−0.0148	0.0082**	0.0706*	0.0815*	0.0108	0.0951**	−0.0008	0.0069**	0.1044
	(1.54)	(1.56)	(−0.37)	(2.07)	(1.84)	(1.77)	(0.18)	(2.10)	(−0.97)	(2.51)	(0.34)
Basel II	−0.0631**	0.0145***	−0.0198	−0.0162***	−0.0394*	−0.0833***	−0.1826***	−0.0090	−0.0016**	0.0105***	−0.2952*
	(−2.12)	(4.18)	(−0.74)	(−6.35)	(−1.71)	(−3.37)	(−4.61)	(−0.34)	(−2.57)	(4.38)	(−1.74)
DFA and Basel III	0.0090	−0.0069***	−0.0046	−0.0039***	−0.0133	−0.0536***	−0.0324	0.0255	0.0008	0.0036**	0.0416
	(0.86)	(−3.01)	(−0.36)	(−3.23)	(−1.41)	(−3.96)	(−1.21)	(1.36)	(1.93)	(2.05)	(0.55)
Hedge fund portfolio − Market portfolio											
Policy development	r_p	σ_r	α_p	σ_e	β_{MKT}	β_{SMB}	β_{HML}	β_{MOM}	$VaR_{5\%}$	A_p	SR_p
GLBA	0.0904**	0.0100**	0.0228	0.0078**	0.0492	0.0008	0.0380	0.0541	−0.0008	0.0072**	0.3221
	(2.52)	(2.18)	(0.68)	(2.41)	(1.35)	(0.01)	(0.64)	(0.90)	(−1.08)	(2.56)	(1.43)
Basel II	−0.0465*	0.0036	−0.0310	−0.0138***	−0.0713***	−0.0991***	−0.2131***	0.0667	−0.0007	0.0106***	−0.0829
	(−1.91)	(1.06)	(−1.35)	(−6.36)	(−3.19)	(−3.40)	(−6.01)	(1.63)	(−1.38)	(4.43)	(−0.57)
DFA and Basel III	−0.0188	−0.0026	−0.0130	−0.0049***	0.0119	−0.0512***	−0.0050	−0.0442	−0.0000	0.0035**	−0.1385
	(−1.03)	(−0.95)	(−0.87)	(−6.36)	(1.14)	(−4.78)	(−0.20)	(−1.53)	(−0.03)	(2.05)	(−1.26)
Bank portfolio − Hedge fund portfolio											
Policy development	r_p	σ_r	α_p	σ_e	β_{MKT}	β_{SMB}	β_{HML}	β_{MOM}	$VaR_{5\%}$	A_p	SR_p
GLBA	−0.0119	−0.0020	−0.0376	0.0004	0.0214	0.0808*	−0.0272	0.0410	0.0000	−0.0003**	−0.2177
	(−0.40)	(−0.43)	(−1.36)	(0.16)	(0.99)	(1.97)	(−0.59)	(1.10)	(0.06)	(−2.53)	(−1.46)
Basel II	−0.0167	0.0109***	0.0112	−0.0023	0.0319**	0.0158	0.0305	−0.0757**	−0.0009*	−0.0001***	−0.2123*
	(−0.78)	(3.03)	(0.60)	(−1.38)	(2.22)	(0.78)	(0.74)	(−2.68)	(−1.71)	(−4.49)	(−1.84)
DFA and Basel III	0.0278*	−0.0043	0.0084	0.0010	−0.0253*	−0.0025	−0.0273	0.0697**	0.0008*	0.0000	0.1801**
	(1.79)	(−1.47)	(0.77)	(0.93)	(−1.95)	(−0.19)	(−0.81)	(2.63)	(1.79)	(1.18)	(2.05)

The table reports the results of difference-in-differences tests. The first difference is between the return, risk, and illiquidity metrics for the largest positions in either the bank or the hedge fund portfolio and the benchmark portfolio. The second difference is between the period following a policy change and the preceding period. t-statistics in parenthesis. *, **, *** denote 10%, 5% and 1$ level of significance.

4.3 Discussion and policy implications

Collectively, our results indicate the existence of a statistically significant negative relation between the regulatory burden faced by banking institutions and the idiosyncratic volatilities and illiquidity measures of their equity portfolios. While our tests show that the illiquidity of the entire portfolio is driven by the small positions in the portfolio, we are unable to fully confirm that the changes in the firm-specific risk of the portfolio are predominantly a reflection of changes in the positions with the largest weights in the portfolio. That notwithstanding, our study offers a number of important implications for the design of regulatory frameworks applied to institutional investors.

The significant reductions in idiosyncratic volatility and illiquidity of bank equity portfolios following the inclusion of provisions for market risk in bank regulatory capital frameworks, the increases in regulatory capital requirements and the introduction of specific liquidity targets for banks all contribute to the achievement of the objectives of macroprudential policies. A more liquid equity portfolio serves as an additional asset which banks can quickly and efficiently convert into cash, allowing them to appropriately respond to potential liquidity shortfalls.

Furthermore, our results suggest that the decrease in the overall illiquidity of banks' equity holdings is a result of a transition towards more liquid positions with the smallest weights in the portfolio. As such, this indicates that regulatory interventions may reduce banks' willingness to hold inventories of illiquid equities. This may adversely affect their ability to act as market-makers. We find that the illiquidity of the smallest positions held by hedge funds remains largely unchanged during the period we study, and exceeds the illiquidity of the bank portfolio following the latest regulatory policy developments.

One consequence of this development is that it could allow hedge funds to maintain a steady provision of market-making services even when banking institutions reduce the extent of their participation in this process. However, this also means that the policymakers face the possibility that the essential service of market-making will increasingly be provided by financial institutions which do not have to comply with any capital requirements and are less transparent than banks.

5 Conclusions

This paper contributes to the growing body of literature evaluating the effects of regulatory policy developments on banks' trading activities in a number of financial markets. Specifically, it examines the relation between policy innovations occurring between 1997

and 2016 and the changes in return, risk, and illiquidity characteristics of the equity portfolio held by the banking sector.

Our analysis is based on a comprehensive sample of equity holdings reported by U.S. bank holding companies and by independent hedge funds. It utilises multiple difference-in-differences tests to ascertain whether the repeal of the Glass-Steagall Act in 1999, the 2004 and 2010 reforms of the Basel capital requirements, and the passage of the Dodd-Frank Act in 2010 lead to statistically significant changes in the portfolio characteristics of bank equity holdings.

We establish that both the idiosyncratic volatility and the illiquidity of banks' equity portfolio increase significantly during the period of deregulation initiated by the repeal of the Glass-Steagall Act. Those changes, however, are subsequently reversed by the consecutive Basel reforms and the Dodd-Frank Act. Importantly, we demonstrate that the changes in the illiquidity of the bank portfolio are driven by the positions with the smallest portfolio weights.

The results we document in this paper demonstrate that the changes in the characteristics of bank equity holdings conform with the broad objectives of macroprudential policies, due to the reductions in their idiosyncratic volatility and illiquidity. However, they also indicate that banks' ability to act as market-makers in equities may have been adversely affected by the recent policy developments, increasing the likelihood that this role will be fulfilled by hedge funds or other institutional investors operating outside the regulator's purview. The consequences of this effect for the long-term stability of the financial system need to be monitored.

Bibliography

1. Abbassi, P., Iyer, R., Peydró, J.-L., Tous, F. R. (2016), "Securities Trading by Banks and Credit Supply: Micro-evidence From the Crisis", *Journal of Financial Economics*, Vol. 121, No. 3, pp. 569 - 594;

2. Abedifar, P., Molyneux, P., Tarazi, A. (2018), "Non-interest Income and Bank Lending", *Journal of Banking & Finance*, Vol. 87, pp. 411 - 426;

3. Alexander, G. J., Baptista, A. M. (2006), "Does the Basle Capital Accord Reduce Bank Fragility? An Assessment of the Value-at-Risk Approach", *Journal of Monetary Economics*, Vol. 57, No. 7, pp. 1631 - 1660;

4. Alexander, G. J., Baptista, A. M. (2017), "Bank Capital Regulation of Trading Portfolios: An Assessment of the Basel Framework", *Journal of Money, Credit, and Banking*, Vol. 49, No. 4, pp. 603 - 634;

5. Allen, F., Babus, A., Carletti, E. (2012), "Asset Commonality, Debt Maturity and Systemic Risk", *Journal of Financial Economics*, Vol. 104, No. 3, pp. 519 - 534;

6. Amihud, Y. (2002), "Illiquidity and Stock Returns: Cross-Section and Time-Series Effects", *Journal of Financial Markets*, Vol. 5, No. 1, pp. 31 - 56;

7. Aragon, G. O., Strahan, P. E. (2012), "Hedge Funds as Liquidity Providers: Evidence from the Lehman Bankruptcy", *Journal of Financial Economics*, Vol. 103, No. 3, pp. 570 - 587;

8. Bao, J., O'Hara, M., Zhou, X. (A.) (2018), "The Volcker Rule and Corporate Bond Market Making in Times of Stress", *Journal of Financial Economics*, In Press;

9. Basel Committee on Banking Supervision (1996), *Amendment to the Capital Accord to Incorporate Market Risks*;

10. Basel Committee on Banking Supervision (2004), *International Convergence of Capital Measurement and Capital Standards*;

11. Basel Committee on Banking Supervision (2010), *Basel III: A Global Regulatory Framework for More Resilient Banks and Banking Systems*;

12. Basel Committee on Banking Supervision (2013), *Basel III: The Liquidity Coverage Ratio and Liquidity Risk Monitoring Tools*;

13. Basel Committee on Banking Supervision (2016), *Minimum Capital Requirements for Market Risk*;

14. Begley, T. A., Purnanandam, A., Zheng, K. (2017), "The Startegic Underreporting of Bank Risk", *The Review of Financial Studies*, Vol. 30, No. 10, pp. 3376 - 3415;

15. Bhargava, R., Fraser, D. R. (1998), "On the Wealth and Risk Effects of Commercial Bank Expansion Into Securities Underwriting: An Analysis of Section 20 Subsidiaries", *Journal of Banking & Finance*, Vol. 22, No. 4, pp. 447 - 465;

16. Bowe, M., Kolokolova, O., Michalski, M. (2018), *Too Big to Care, Too Small to Matter: Macrofinancial Policy and Bank Liquidity Creation*, Working Paper, available online at: https://ssrn.com/abstract=2933461;

17. Brunnermeier, M. K. (2009), "Deciphering the Liquidity and Credit Crunch 2007–2008", *Journal of Economic Perspectives*, Vol. 23, No. 1, pp. 77 - 100;

18. Brunnermeier, M. K., Pedersen, L. H. (2009), "Market Liquidity and Funding Liquidity", *The Review of Financial Studies*, Vol. 22, No. 6, pp. 2201 - 2238;

19. Carhart, M. M. (1997), "On Persistence in Mutual Fund Performance", *The Journal of Finance*, Vol. 52, No. 1, pp. 57 - 82;

20. Cornett, M. M., Ors, E., Tehranian, H. (2002), "Bank Performance around the Introduction of a Section 20 Subsidiary", *The Journal of Finance*, Vol. 57, No. 1, pp. 501 - 521;

21. Danìelsson, J. (2002), "The Emperor Has No Clothes: Limits to Risk Modelling", *Journal of Banking & Finance*, Vol. 26, No. 7, pp. 1273 - 1296;

22. Diamond, D. W. (1984), "Financial Intermediation and Delegated Monitoring", *The Review of Economic Studies*, Vol. 51, No. 3, pp. 393 - 414;

23. Diamond, D. W., Dybvig, P. H. (1983), "Bank Runds, Deposit Insurance, and Liquidity", *The Journal of Political Economy*, Vol. 91, No. 3, pp. 401 - 419;

24. Diamond, D. W., Rajan, R. G. (2011), "Fear of Fire Sales, Illiquidity Seeking, and Credit Freezes", *The Quarterly Journal of Economics*, Vol. 126, No. 2, pp. 557 - 591;

25. Duffie, D. (2012), *Market Making Under the Proposed Volcker Rule*, Working Paper, Rock Center for Corporate Governance, No. 106;

26. Filson, D., Olfati, S. (2014), "The Impacts of Gramm-Leach-Bliley Bank Diversification on Value and Risk", *Journal of Banking & Finance*, Vol. 41, pp. 209 - 221;

27. Geyfman, V., Yeager, T. J. (2009), "On the Riskiness of Universal Banking: Evidence from Banks in the Investment Banking Business Pre- and Post-GLBA", *Jour-*

nal of Money, Credit, and Banking, Vol. 41, No. 8, pp. 1649 - 1669;

28. Gorton, G. B., Metrick, A. (2012), "Securitized Banking and the Run on Repo", *Journal of Financial Economics*, Vol. 104, No. 3, pp. 425 - 451;

29. Gorton, G. B., Pennacchi, G. G. (1995), "Banks and Loan Sales. Marketing Nonmarketable Assets", *Journal of Monetary Economics*, Vol. 35, No. 3, pp. 389 - 411;

30. Holod, D., Kitsul, Y., Torna, G. (2017), "Market Risk-based Capital Requirements, Trading Activity, and Bank Risk", *Journal of Banking & Finance*, In Press;

31. Jylhä, P., Rinne, K., Suominen, M. (2014), "Do Hedge Funds Supply or Demand Liquidity?", *Review of Finance*, Vol. 18, No. 4, pp. 1259 - 1298;

32. Kashyap, A. K., Rajan, R., Stein, J. C. (2002), "Banks as Liquidity Providers: An Explanation for the Coexistence of Lending and Deposit-taking", *The Journal of Finance*, Vol. 57, No. 1, pp. 33 - 73;

33. Kroszner, R. S., Rajan, R. G. (1994), "Is the Glass-Steagall Act Justified? A Study of the U.S. Experience with Universal Banking Before 1933", *The American Economic Review*, Vol. 84, No. 4, pp. 810 - 832;

34. Schleifer, A., Vishny, R. W. (2010), "Unstable Banking", *Journal of Financial Economics*, Vol. 97, No. 3, pp. 306 - 318;

35. Schmid, M. M., Walter, I. (2009), "Do Financial Conglomerates Create or Destroy Economic Value?", *Journal of Financial Intermediation*, Vol. 18, No. 2, pp. 193 - 216;

36. Stiroh, K. J. (2004), "Diversification in Banking: Is Noninterest Income the Answer?", *Journal of Money, Credit, and Banking*, Vol. 36, No. 5, pp. 853 - 882;

37. Stiroh, K. J., Rumble, A. (2006), "The Dark Side of Diversification: The Case of US Financial Holding Companies", *Journal of Banking & Finance*, Vol. 30, No. 8, pp. 2131 - 2161;

38. Thakor, A. J. (2012), *The Economic Consequences of the Volcker Rule*, Working Paper, Center for Capital Markets Competitiveness, Olin Business School, Washington University in St. Louis, St. Louis;

39. Trebbi, F., Xiao, K. (2017), "Regulation and Market Liquidity", *Management Science*, In Press;

40. Wagner, W. (2010), "Diversification at Financial Institutions and Systemic Crises", *Journal of Financial Intermediation*, Vol. 19, No. 3, pp. 373 - 386;

Appendix A: Banking institutions included in the data sample

The sample of banks used in this study includes the following financial institutions:

1. **Bank of America Corporation;**
2. **The Bank of New York Mellon Corporation;**
3. **BB&T Corporation;**
4. The Bear Stearns Companies, Inc.†;
5. **Capital One Financial Corporation;**
6. **Citigroup, Inc., including Citicorp and Travelers Group;**
7. **Comerica, Inc.;**
8. **Fifth Third Bancorp;**
9. **The Goldman Sachs Group, Inc.;**
10. **Huntington Bancshares, Inc.;**
11. **JPMorgan Chase & Co.;**
12. **KeyCorp;**
13. Lehman Brothers Holdings, Inc.†;
14. **M&T Bank Corporation;**
15. Merill Lynch & Co., Inc.†;
16. **Morgan Stanley;**
17. **Northern Trust Corporation;**
18. **PNC Financial Services Group, Inc.;**
19. **Regions Financial Corporation;**
20. **State Street Corporation;**
21. **SunTrust Banks, Inc.;**
22. **U.S. Bancorp;**
23. Wachovia†;
24. **Wells Fargo & Company;**

25. **Zions Bancorporation.**

The institutions marked in bold are among the 38 firms selected by the Federal Reserve to participate in the annual Comprehensive Capital Analysis and Reviews. The firms marked by † either fail or are acquired by other bank holding companies during the 2007 - 2009 Financial Crisis.