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The Volcker Rule and the hedge fund liquidity circle

Michael Bowe*[1,2], Olga Kolokolova†[1], and Lijie Yu‡[1]

[1] *Alliance Manchester Business School, the University of Manchester, UK*
[2] *The University of Vaasa, Finland*

Abstract

The implementation of the Volcker Rule (section 619 of the 2010 Dodd-Frank Act) impacts funding liquidity of hedge funds, their liquidity risk exposure and liquidity provision to the market. Analysing a sample of 5,558 hedge funds, we find that following the legislation, capital flows to hedge funds decline, and their flow-performance sensitivity increases. Hedge funds reduce their market liquidity exposure and realign their market-making activities towards highly liquid stocks. These effects are mitigated for funds with low operational risks and those connected to the largest US-based prime brokers.

Keywords: Volcker Rule; Hedge funds; Liquidity risk; Liquidity provision; Fund flows.

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*michael.bowe@manchester.ac.uk

†olga.kolokolova@manchester.ac.uk. Corresponding author. Alliance Manchester Business School, the University of Manchester, Booth street West, Manchester, M15 6PB UK, tel.(+44) 01613062081.

‡lijie.yu@manchester.ac.uk

1 Introduction

A key component of the US government's response to the 2008 financial crisis is the enactment of the 2010 Dodd-Frank Wall Street Reform and Consumer Protection Act, among the most all-encompassing financial regulations of the current millennium. Section 619 of this Act incorporates one of its core regulatory directives, known as the Volcker Rule, which aims to reduce banks' overall risk profile. This key provision restricts banking entities from proprietary trading, as well as either sponsoring or maintaining an ownership interest in covered funds, a class of entities which includes both hedge funds and private equity funds. The Act became law in July 2010, granting banks a five-year time-frame to achieve full regulatory compliance.

This paper examines two key questions. First, do Volcker Rule regulations, targeted at the banking sector, also influence the risk profile and liquidity transmission channels in the hedge fund industry? Second, is the nature of any influence mediated by prime broker's connections to funds?[1] Figure 1 illustrates the hedge funds 'circle of liquidity' (henceforth, liquidity circle), clarifying the interconnected relationships most likely to be affected by the Volcker Rule. The ban on proprietary trading by banks and the reduction in their market-making activity potentially creates liquidity shortages in certain financial instruments, adversely affecting overall market liquidity and hedge funds' trading environment. Moreover, following the prohibition of bank investment, funds that customarily attract such investment may experience negative liquidity shocks. Indeed, the period encompassing implementation of the Volcker Rule sees hedge fund industry performance deteriorating, and in 2016 the sector experiences a significant net outflow of $102 billion, with market-leading investment banks in particular relinquishing their investments.[2]

[1]For the direct effects of the Volcker Rule on banking sector see, among others, Chung et al. (2016); Elayan et al. (2018); Keppo and Korte (2016); Schäfer et al. (2015).

[2]In 2015, Morgan Stanley sells its 19% stake in the $17.5 billion London-based Lansdowne Partners

Cumming et al. (2017) show that relative to non-US hedge funds, US hedge funds impacted by Dodd-Frank regulations experience stronger outflows following its enactment. While investor redemptions are important determinants of hedge funds' exposure to funding risk (Klaus and Rzepkowski, 2009), financing and leverage channelled through affiliated prime brokers also contributes to their funding liquidity. Consequently, strong relations with their prime brokers may help hedge funds to mitigate the negative effects of any deterioration in funding liquidity after the Volcker Rule. Indeed, Boyarchenko et al. (2020) show that after the introduction of key Basel III banking regulations that constrain bank leverage, hedge funds both increase the number of prime brokers they use and reduce their dependence on regulatory constrained prime brokers. These twin channels of market liquidity and funding liquidity both impact the trading decisions of hedge funds and their liquidity provision to the market, thereby completing the liquidity circle.[3]

[Figure 1 in here]

We find that following the Volcker Rule's enactment, which constitutes an exogenous shock to the financial system, the funding liquidity of hedge fund's deteriorates. Average hedge fund flows declines while their flow-performance sensitivity increases. The effect is especially discernible in funds with high operational risks. Such an environment of tighter funding liquidity leads to a reduction in hedge funds' exposure to market liquidity risk, inducing a drift towards more liquid investments and a further reduction in hedge funds'

LLP in 2015 (J. Chung and E. Glazer, Morgan Stanley Aims to Sell Stake in Lansdowne Partners. The Wall Street Journal, February 8, 2015). Over the five year period up to 2016, Goldman Sachs has sold its hedge fund holdings (N. Popper, Goldman Sachs Sells $285 Million in Hedge Fund Holdings, The New York Times, November 5, 2014) cutting its exposure to non-Volcker-compliant investments by 60% (R. Tracy, Big Banks Could Get More Time to Sell Funds Banned by Volcker Rule, The Wall Street Journal, December 12, 2016).

[3] Aragon and Strahan (2012) use Lehman's bankruptcy as an exogenous funding liquidity shock and document a funding-to-market liquidity spillover, consistent with Brunnermeier and Pedersen (2008) liquidity spiral theory.

liquidity provision to illiquid market segments. One implication of this finding is that overall market efficiency may be adversely affected by the collective response of hedge funds to the changing trading environment after the Volcker Rule.[4] These effects are mitigated for funds with low operational risks and prime brokerage connections to large and complex financial institutions (LCFIs) in the US.[5] US LCFIs appear to facilitate trading by funds with low operational risks, enabling them to retain their pre-Volcker levels of exposure to market liquidity and to maintain their liquidity provision to more illiquid segments of the equity market. The results are robust when we use: direct hedge fund holdings as reported to 13f, matched sample analysis, as well as within-fund changes in funding liquidity, liquidity risk exposure and comparing liquidity provision in periods before and after the Rule.

Our analysis contributes to two strands of literature. The first relates to the nexus of relationships between hedge funds and other major financial institutions. The second analyses hedge funds' contribution to the operational efficiency and liquidity of financial markets. Hedge funds affiliated with financial conglomerates access more stable funding, enabling them to provide liquidity during periods of financial turmoil (Franzoni and Giannetti, 2019). Reductions in funding costs and enhanced bank returns predict an increase in fund-of-funds leverage (Ang et al., 2011). Prime brokers are among the widely studied hedge fund affiliates. Hedge funds that share prime brokers exhibit a strong co-movement in returns, often attributable to information flows initiated by the common broker (Chung and Kang, 2016). Similarly, information regarding corporate client loans disseminates from prime brokers to hedge funds (Kumar et al., 2018). Prime brokerage relations also expose hedge funds to significant counterparty risk. The probability of

[4]Related to this, Bao et al. (2018) document deterioration in the liquidity of stressed bonds following the Volcker Rule, as banks retrench from market-making activity.

[5]We adopt the term 'large and complex financial institutions' (LCFIs), in reference to the largest, systemically important global commercial and investment banks, as in King and Maier (2009).

hedge fund contagion increases significantly following adverse shocks to their prime broker's share price (Boyson et al., 2010). Hedge funds using Lehman Brothers as their prime broker experience a decline in funding liquidity subsequent to that institution's bankruptcy in 2008 (Aragon and Strahan, 2012). Stocks traded by Lehman-connected funds experience a greater decrease in liquidity compared to other stocks following its bankruptcy, supporting an interaction between funding liquidity and market liquidity (Brunnermeier and Pedersen, 2008). Kruttli et al. (2018) analyse the credit exposures between Deutsche Bank, acting as a prime broker, and its affiliated hedge funds, concluding that liquidity shocks are transmitted to these connected funds and result in a reduction in their aggregate borrowing. Boyarchenko et al. (2020) explore the link between hedge funds and their regulated prime brokers. The authors find that post-2014, regulated prime brokers affiliated with LCFIs reduce their leverage below the maximum permitted level. In turn, hedge funds diversify away from these prime brokers, tending to employ a larger number of brokers. Our study builds on this literature, examining whether prime brokerage relationships contribute to the documented changes in hedge fund liquidity exposure and liquidity provision following Volcker Rule implementation. The evidence indicates that such relationships with LCFIs significantly influence the measurable effects of the Volcker Rule.

Our paper also extends the literature on hedge fund liquidity and funds' contribution to the operational efficiency of financial markets. Market liquidity risk plays an important role in determining hedge fund performance. Evidence reveals that hedge funds that load up on liquidity risk outperform low-loading funds by about 6% per year during non-crisis periods (Sadka, 2010). Funds with stricter share restrictions hold more illiquid assets and earn an illiquidity premium (Aragon, 2007). Motivated by these high rewards, hedge funds that offer favorable redemption terms to investors also take on excessive liquidity risk, thereby exacerbating the subsequent risk of fire sales (Teo, 2011). Brandon

and Wang (2013) analyse the impact of liquidity risk on equity hedge fund performance, documenting that liquidity risk betas are significantly positive, and any superior performance of particular hedge funds becomes insignificant after accounting for liquidity risk. Hedge fund managers appear to time market liquidity, increasing their exposure to market liquidity risk when market liquidity is high, with top liquidity timing funds subsequently outperforming poor timers (Cao et al., 2013).

Funding liquidity risk is also shown to be relevant for hedge fund performance. Funds with lower funding risk generate higher returns, an effect driven by the increased exposure of such funds to various equity-mispricing anomalies (Aiken et al., 2019). Hedge funds play an important role in the provision of market liquidity. Kolokolova et al. (2017) focus on the impact of hedge fund flows in the bond market, finding that an increase in fund flows predicts a future decline in corporate bond yields. This effect is amplified when market liquidity is low. Jylhä et al. (2014) show that hedge funds, especially large funds and those that offer less frequent redemptions, typically supply liquidity to the stock market and earn positive returns from such liquidity provision. However, during liquidity-related crises, hedge funds demand liquidity. Using data on institutional transactions, Franzoni and Plazzi (2013) find that hedge funds' liquidity provision is positively associated with aggregate funding conditions, and that its sensitivity to funding liquidity is stronger than that of other institutional investors. A decrease in liquidity provision by hedge funds often precedes a reduction in market liquidity, while such an effect is absent for other institutions. Our study finds that following implementation of the Volcker Rule, hedge funds in general experience outflows, take on less liquidity risk, and reorientate their market-making activities from less to more liquid segments of the equity market. Overall, our analysis of the indirect effects of banking regulation on an important class of unregulated market players, hedge funds, contributes to a better understanding of the complex network of relationships and dependencies between a variety of financial

market participants.

The significance of hedge funds in global financial markets is becoming increasingly noteworthy. According to BarclayHedge,[6] global hedge fund assets under management increased 75-fold within 30 years, from $40 billion in 1990 to nearly $3 trillion in 2017. Hedge fund trades account for at least one-third of the total daily trading volume on the New York Stock Exchange (NYSE) (Cao et al., 2017), acting as crucial providers of liquidity and drivers of price formation (Mügge, 2014), thereby attenuating aggregate equity market mispricing (Akbas et al., 2015). At the same time, their relatively high use of leverage leaves hedge funds particularly vulnerable to market and funding liquidity risk, while their close relationships with LCFIs potentially enhances financial instability risks, as became evident following the collapse of Long-Term Capital Management L.P. (Dardanelli, 2011; King and Maier, 2009). This network of institutional connectivity has initiated increasing calls for the imposition of controls on hedge fund activity, with indirect regulation of their counterparties often considered to be the most effective mechanism for restraining funds' operations (King and Maier, 2009; Dardanelli, 2011; Nabilou and Pacces, 2015). Our results provide empirical evidence to inform such policy debates.

2 Research Design

This section develops testable hypotheses relating to the Volcker Rule's impact on the relationships depicted in the hedge fund liquidity circle in figure 1. To provide context, we begin by discussing the time line for the Volcker Rule's implementation, then proceed to analyse its effect on the funding liquidity of hedge funds. Finally, we discuss patterns in hedge funds' exposure to market liquidity and changes in their liquidity provision.

[6]The data is available at https://www.barclayhedge.com/solutions/assets-under-management/hedge-fund-assets-under-management/hedge-fund-industry/.

2.1 The Volcker Rule: Implementation time line

The Volcker Rule received the public endorsement of President Obama on January 21, 2010 and is enacted as part of the Dodd-Frank Wall Street Reform and Consumer Protection Act on July 21, 2010, codified in Section 13 of the Bank Holding Company Act of 1956. Following public consultations and recommendations from the Financial Stability Oversight Council, the Board of Governors of the Federal Reserve System Board (Board), the Federal Deposit Insurance Corporation (FDIC), the Office of the Comptroller of the Currency (OCC), the Securities and Exchange Commission (SEC), and the Commodity Futures Trading Commission (CFTC) then collectively formulate a proposal for implementing the Volcker Rule, which is released on October 11, 2011. The revised Rule incorporates provisions for a two-year conformance period for banks to re-orientate their activities and investments to satisfy its requirements, and is scheduled to become operational on July 21, 2012. However, implementation is delayed subsequent to statements by the Federal Reserve Chairman in his report to Congress on February 29, 2012, warning that regulators could not satisfy this deadline. On December 10, 2013, the Volcker Rule's regulations are endorsed by the above five financial regulatory agencies, and are published in the Federal Register on January 31, 2014, becoming effective on April 1, 2014.

The Volcker Rule regulations require the largest US banking entities (with at least $50 billion in trading assets) to report the quantitative information it stipulates from July 1, 2014, and to become fully compliant by July 21, 2015. However, a number of subsequent extensions arise to enable banks to exit illiquid investments. On December 18, 2014, the Federal Reserve extends the Volcker Rule's conformance period until July 21, 2016 for 'legacy covered funds'. It subsequently extends this period further to July 21, 2017, the last of the three one-year extensions that the Board is legally authorized to

grant. On deadline day, July 21, 2017, the Board, the FDIC and the CFTC, announce that no enforcement action will be taken with respect to qualifying foreign funds until after July 21, 2018. This no-action position is further extended in 2018 to July 21, 2019 and once again in 2019 to July 21, 2021.

Figure 2 depicts this timeline of events. Despite the series of extensions granted to enable banks to achieve full compliance with the Rule, they must still endeavour to implement the legislation from April 1, 2014. Importantly, from July that year their compliance efforts are monitored through a formal reporting channel. Thus, we expect that any major adjustments in bank-hedge fund relations and any resulting changes in hedge fund trading decisions will manifest after April 2014. This informs our decision throughout the main analysis to concentrate on two sub-periods: denoted the "Before the Rule" period ending in March 2014, and the "After the Rule" period beginning in April 2014.

At the same time, we are conscious of the evolution of events during the implementation phase. As information concerning the eventual need to comply with the regulations becomes available as early as 2010, and the compliance period for all institutions (except qualifying foreign funds) ends on July 21, 2017, in the later part of the paper we additionally consider any changes to hedge fund liquidity exposure and provision during three different phases: an implementation phase, from July 2010 to March 2014; a compliance phase, from April 2014 to July 2017; and a post-Volcker Rule full compliance phase, from August 2017 to December 2018.

[Figure 2 in here]

2.2 The Volcker Rule and hedge fund funding liquidity

In addition to the ban on proprietary trading, another key constituent of the Volcker Rule consists of the prohibitions it imposes on banks in relation to either sponsoring or investing in hedge funds. It follows that hedge funds receiving bank investment may subsequently face outflows following the Dodd-Frank Act. Cumming et al. (2017) show that, relative to non-US hedge funds, the alpha of the US domiciled hedge funds declines and their outflows increase following Dodd-Frank's implementation. The Volcker Rule explicitly limits hedge funds' relationships with banking entities. Its prolonged implementation period and various extensions also contributes to enhancing legal uncertainty. Therefore, it is likely to impact not only the level of flows, but also flow-performance sensitivity.[7]

The Rule's negative effect on funding liquidity is likely, however, to be distributed heterogeneously across hedge funds. Hedge funds with lower operational risks may be better equipped than others to adapt to new regulatory environment, as operational risk often underpins financial risk and it is an important determinant of fund failure (Brown et al., 2009). General legal uncertainly is amplified for funds with higher operational risk. It follows that Volcker Rule implementation may lead to a greater dispersion in funding outcomes across hedge funds, with funds characterised by high operational risk exhibiting stronger outflows and greater flow-performance sensitivity. This analysis informs our first set of hypotheses:

Following implementation of the Volcker Rule:

H1(a) flows to hedge funds decline and flow-performance sensitivity increases,

H1(b) these effects are enhanced in funds with higher operational risk.

[7]For mutual funds, for example, higher uncertainty and defused believes about their quality lead to higher sensitivity of flows to past performance (Artavanis et al., 2018; Bollen, 2007; Chevalier and Ellison, 1997; De Andrade Jr, 2009).

To test these hypotheses, initially we estimate Equation (1) using all hedge funds and then separate funds into sub-samples with higher and lower operational risk.

$$Flow^i_{t:t+11} = \alpha + (\beta_0 + \beta_1 Volcker_t) \cdot \overline{Ret^i}_{t-12} + \gamma_0 Volcker_t + \delta Controls^i_t + \varepsilon^i_t \quad (1)$$

where $Flow^i_{t:t+11}$ is the percentage flow for hedge fund i over the year between month t and $t+11$, and $\overline{Ret^i}_{t-12}$ is the average return of fund i over the previous 12 months. We measure the monthly flow using Equation (2), where AUM^i_t denotes the assets under management of fund i at the end of month t, and Ret^i_t is the reported return for fund i during month t.

$$Flow^i_t = \frac{AUM^i_t - AUM^i_{t-1}(1 + Ret^i_t)}{AUM^i_{t-1}} \quad (2)$$

We capture the pre- and post-Volcker Rule phases with a dummy variable $Volcker$, taking a value of 1 after April 2014, and 0 otherwise, following the sample division we outline in Section 2.1. In the robustness test, we employ three variables which capture the different phases of the regulation's implementation in place of the single variable $Volcker$. We report the results in Section 5.2 and they are all consistent with those obtained from the more parsimonious specification we discuss here.

To measure operational risk, we follow Brown et al. (2009) and Bollen and Pool (2012) and use four categories of red performance flags to indicate a higher regulatory risk exposure: *Repeat* is the percentage of reported returns that are repeated at least once; $Negative$ is the percentage of returns below zero; $kink1$ is the average number of return observations that are between 0 and 2% and -4% to -2% minus the number of return observations that are between -2% and 0; $kink2$ is the value of the test statistic

in Equation (3) measuring the discontinuity at zero in the distribution of a hedge fund's returns.

$$kink2 = \frac{x - np}{\sqrt{np(1-p)}} \tag{3}$$

Here x is the number of return observations between -2% and 0, n is the total number of observations, and p is the probability that a normally distributed variable with the same mean and standard deviation as the hedge fund lies in this bin. We use returns before April 2014 to measure operational risk, assigning a fund an additional risk point for each measure of *Repeat* and $kink1$ which lies above the median, and of $Negative$ and $kink2$ which is below the median. A hedge fund is designated to be of high operational risk if the sum of its risk points equals either three or four. On this basis, we classify 1,956 funds in our sample as high risk funds.

In choosing the remaining control variables for the flow regressions, we closely follow Ding et al. (2008) and Kolokolova and Mattes (2018). STD^i_{t-12} is the standard deviation of monthly returns over the past 12 months; $lnAUM^i_{t-1}$ is the natural logarithm of hedge fund dollar assets in month $t-1$; Age^i_{t-1} is the age in months of a hedge fund at month $t-1$; HWM^i equals 1 if a high-water mark provision is present, and 0 otherwise; $MgtFee^i$ is the management fee a fund charges; $IncFee^i$ is the incentive fee; $Leverage^i$ equals 1 if a fund uses leverage, and 0 otherwise; $Redemption^i$ is the fund's redemption period (measured in days); $LockUp^i$ is the fund's lockup period (measured in months). Finally, the variable $StyleFlow^i_t$ is the average flow into funds in the same style category as fund i, whose inclusion enables us to generally capture the influence of time-varying effects arising from the macroeconomic environment which may systematically affect hedge fund flows. Table 1 summarizes all the variable definitions we use in the paper.

Our analysis predicts β_1 to be positive and γ_0 to be negative in Equations (1), indicating that following the Volcker Rule, hedge fund flow-performance sensitivity increases

and they experience outflows. These coefficients are expected to be larger in absolute values for the sub-sample of funds with high operational risk.

[Table 1 in here]

2.3 The Volcker Rule, hedge fund liquidity exposure and market liquidity provision

According to Cao et al. (2013), hedge fund managers reduce their funds' exposure to market liquidity risk when facing deteriorating market liquidity. It follows that we should observe all hedge funds decreasing their exposure to market liquidity factors after the Volcker Rule's implementation. Conversely, Jylhä et al. (2014) argue that when periods of reduced market liquidity coincide with favourable funding conditions, hedge funds' propensity to supply liquidity increases. The deterioration in market liquidity which occurs as banks reduce their market-making activity subsequent to the Volcker Rule should enhance hedge funds' propensity to supply liquidity, ceteris paribus. Indeed, Duffie (2012) shows that non-bank broker-dealers play a more important role in both market-making and market liquidity provision after the Volcker Rule. However, hedge funds also experience outflows after the Volcker Rule. Such funding shocks reduce their incentives to trade illiquid assets. Therefore, facing conflicting incentives, hedge funds may choose not to uniformly adjust their liquidity provision across all assets, but optimally select to increase their market-marking activities in market segments which include more liquid stocks, and reduce their liquidity provision in illiquid assets as a result of the uncertain funding conditions. As suggested above, the net effect is a reduction in their overall exposure to market liquidity factors.

If our intuition underlying Hypothesis *H1(b)* is valid, hedge funds with lower operational

risk encounter relatively lower funding liquidity risk after the Volcker Rule. It follows that the need to adjust their investment liquidity should also be mitigated for these funds.

Reliable support from a prime broker can also supplement loss of funding liquidity from investors. The US LCFI prime brokers, institutions that previously undertook but are now retrenching from market-making activities, may facilitate their connected hedge funds' access to the requisite information and advice. Prior to the Volcker Rule, LCFIs are less likely to share their relevant expertise with connected hedge funds, as such proprietary knowledge benefits the banks' own trading. After the Rule, they may be more like to share this information with hedge funds (while collecting fees from them), since proprietary trading has been prohibited. However, not all connected hedge funds are likely to receive similar level of service and support from prime brokers. In a tighter regulatory environment, prime brokers reduce the leverage they provide to hedge funds (Boyarchenko et al., 2020) and increase their fees, especially for those funds running more illiquid and highly leveraged strategies.[8] Being more tightly regulated themselves, US LCFIs are more likely to scale down their relationships with hedge funds that have higher operational risk, while preserving interactions with lower-risk hedge funds. Hence, compared to high-operational risk funds, low-operational risk funds are more likely to to both encounter milder increases in funding liquidity risk from the investor side, and to benefit from information sharing from their connections with US LCFI prime brokers. This leads to our next set of hypotheses:

Following implementation of the Volcker Rule:

H2(a) hedge funds reduce their exposure to market liquidity,

H2(b) hedge funds realign their liquidity provision towards more liquid segments of the stock market,

[8]Global Custodian, "Hedge fund prime brokerage fees on the up", November 11, 2015, https://www.globalcustodian.com/hedge-fund-prime-brokerage-fees-on-the-up/.

H2(c) any liquidity provision realignment effect is less pronounced for funds with low operational risks and a prime brokerage connection to US-based LCFIs.

To tests these hypotheses, we estimate Equation (4) using the entire sample, and then separately for funds with higher and lower operational risk,

$$Ret_t^i = \alpha + \sum_{k=1}^{7} \beta_k F_{k,t} + (\gamma_0 + \gamma_1 Volcker_t + \gamma_2 Connect^i + \gamma_3 Volcker_t \cdot Connect^i) \cdot L_t + \varepsilon_t^i \quad (4)$$

where Ret_t^i is hedge fund i's return in month t, $Connect^i$ captures if fund i has connections to US LCFI prime brokers, and L_t measures different liquidity-related factors. $F_{k,t}$ are the seven Fung and Hsieh factors consisting of: two equity-oriented risk factors, namely the Standard & Poors (S&P) 500 index total return (MKT) and the difference between the Russell 2000 index total return and the S&P 500 total return (SMB); two bond-oriented risk factors, namely the change in the 10-year Treasury constant maturity yield ($TERM$) and the change in Moody's Baa yield over the 10-year Treasury constant maturity yield ($CREDIT$); and three trend-following momentum risk factors, namely, $PTFSBD$ (bond), $PTFSFX$ (currency) and $PTFSCOM$ (commodity).[9] We also include fund strategy fixed effects to capture systematic differences in returns across different hedge fund investment styles. We cluster standard errors at the fund level to account for any potential correlation within fund return residuals, as documented in Boyson et al. (2010) and Brown et al. (2019).

A dummy variable *Connect* measures a hedge fund's prime brokerage connection to US-based LCFIs, the main institutional targets of the Volcker Rule. The variable takes a value of 1 if a US-based LCFI is a prime broker of a hedge fund and zero otherwise. Typically, hedge fund databases provide static information (such as information identifying a fund's prime brokers and custodians) which is accurate on the date the database is most

[9]These factors may be downloaded from http://faculty.fuqua.duke.edu/ dah7/DataLibrary/TF-FAC.xls.

recently updated. However, hedge funds may strategically realign their relationship with LCFIs over time, and connections measured in December 2018 (the end of our sample period, see Section 3) may be an inaccurate proxy for pre-Volcker Rule connections.[10] To address this issue, we use a December 2013 snapshot of the data to enable us to more precisely capture the pre-Volcker Rule LCFI-fund connections. We identify the US-based LCFIs as the eight US banks in the list of Systemically Important Financial Institutions (SIFI) namely: the Bank of America Corporation, JP Morgan Chase & Co., Citigroup Inc., Wells Fargo & Company, Goldman Sachs Group, Morgan Stanley, Bank of New York Mellon Corporation, and State Street Corporation (Financial Stability Board, 2011). We focus exclusively on hedge funds' connections to these SIFIs since, according to Paul Volcker himself, the Volcker Rule will only affect banks that are involved in highly-speculative trading, particularly, those banks deemed too-big-to-fail.[11]

We use liquidity-related factors, L_t, to measure the liquidity exposure and liquidity provision of hedge funds. Specifically, to capture the liquidity exposure of hedge funds, we employ two variables, the monthly innovations in aggregate market liquidity (LIQ) and the traded liquidity factor ($TradedLiq$) of Pástor and Stambaugh (2003),[12] both widely used measures in the literature (see, for example, Teo, 2011; Jylhä et al., 2014). To estimate hedge fund returns from liquidity provision, we employ the liquidity provision factor (Rlp_t) as L_t in Equation (4). We construct this factor following Jylhä et al. (2014), utilising short-term return reversal to capture the returns to a zero-investment contrarian

[10] Indeed, Boyarchenko et al. (2020) show that post 2014 after various regulatory changes, hedge funds use more prime brokers and diversify away from the more heavily regulated LCFIs-affiliated prime brokers.

[11] At the time of this statement, Volcker is Chairman of President Obama's Economic Advisory Board.

[12] This data is available at https://faculty.chicagobooth.edu/lubos.pastor/research/. Using the aggregate market-wide liquidity measure reflects the idea that in periods of reduced liquidity, increases in trading volume initiate more pronounced price changes and subsequent price reversals. Intuitively, it reflects the average strength of individual stock price reversions following large trades. The traded liquidity measure is the return on a long-short equity portfolio position, which buys (sells) stocks with the highest (lowest) exposure to innovations in aggregate market liquidity.

long-short trading strategy. Specifically, for each day we estimate a cross-sectional regression relating 5-day returns to twenty daily lagged returns and a set of controls, and estimate future expected 5-day returns. Jylhä et al. (2014) show that the average loadings on the lagged returns are negative, indicating price reversals. Every day, a long (short) position is opened in stocks with a positive (negative) expected 5-day return. The position is held for five days and then closed. We calculate daily returns as the average return of all positions opened on any given day, and then employ monthly averages to obtain the final value of Rlp_t. Khandani and Lo (2011) and Nagel (2012) adopt a similar approach and methodology.

Initially we run the regression using the above general Rlp factor. Subsequently, to capture liquidity realignment by hedge funds, we use two sub-factors: returns from providing liquidity to more liquid stocks Rlp^{Liquid}, and to less liquid stocks $Rlp^{Illiquid}$. To construct these sub-factors, we follow the same procedure as in Jylhä et al. (2014) using two sub-samples of stocks, liquid and illiquid. Liquid (illiquid) stocks are defined as those for which the Amihud illiquidity measure is below (above) the median value on the sorting date.[13]

We expect γ_1 to be positive when using the Rlp^{Liquid} factor and negative when using either the $Rlp^{Illiiquid}$, LIQ, or $TradedeLiq$ factors in Equation (4), indicating that hedge funds increase their liquidity provision to more liquid market segments but decrease it in less liquid segments, reducing their overall exposure. We expect γ_3 to take the opposite sign to γ_1 when using sub-sample of funds with lower operational risk, indicating an attenuated effect on liquidity provision for connected funds with lower operational risk.

[13]Alternatively, one could directly examine the changes in liquidity of hedge fund holdings across different periods to identify the effect of the Volcker Rule. However, due to the confidentiality surrounding hedge fund investment strategies, only large long positions in US equity of investors, aggregated at the company level, are available through 13f filings to the Security and Exchange Commission. This information is insufficient to capture the liquidity supply/demand of hedge funds, which often entails short selling.

3 Data

We collect hedge fund data from the Eurekahedge database, which includes a history of returns and information on hedge fund characteristics and their affiliated companies. We use a 2013 data snapshot to capture LCFI-fund connections before the Volcker Rule. We exclude duplicate funds and multiple share classes of the same fund, and restrict our sample to funds with at least 36 return observations reporting their returns in US dollars. To address a potential backfilling bias, we exclude the first 12 months of returns for each fund, filter out any observations before 1994 to control for survivorship bias, and exclude Funds of Funds. The final sample includes 5,558 live and defunct funds and the sample period extends from January 1994 to December 2018.

Following Ilerisoy et al. (2017), we divide hedge funds into three broad investment style categories: directional funds, non-directional funds, and semi-directional funds. We further classify funds into eight strategies: Long/Short Equities, Fixed Income, Relative Value, Event Driven, Global Macro, Managed Futures, Multi-Strategy and Others (Table 2). Tables 3 and 4 report summary statistics for hedge fund monthly returns and annual flows, respectively. Panel A reports the statistics for the full sample, and Panel B presents the statistics by investment style. The statistics within a style are equally weighted averages across all funds in the same style category. The average return over the complete sample is 0.501% per month. Event Driven category funds are the most profitable with an average return of 0.603%, followed by Other funds with an average return of 0.537%. Global Macro funds exhibit the lowest average returns of 0.398% per month, followed by Managed Futures funds whose average return is 0.459%. Fixed Income funds exhibit the smallest return volatility of 2.031% per month and the highest mean-to-standard deviation ratio of 0.23. Overall, flows seem to reflect the pattern of returns, with Event Driven funds on average receiving the highest inflow, albeit Fixed Income funds experience

the lowest inflow during our sample period.

[Tables 2 to 4 in here]

Table 5 reports the descriptive statistics relating to other hedge fund characteristics. Average fund size is approximately $158 million, and an average fund is less than 3 years old (excluding the first 12 months). Just over half of the funds report using leverage. The average management and performance fees are 1.51% and 17%, respectively. Representative lock-up, redemption and subscription periods are around 3, 1.5 and 1 month, respectively.

In our sample, 7.7% of hedge funds (427 of 5558) are connected to US-based LCFIs in 2013. Comparing the characteristics of connected and unconnected funds (Panels B and C), the two groups of funds exhibit statistically significant differences in terms of age, fees, lock-up, redemption, and subscription periods. On average, the life span of connected funds is 13 months longer, they are less likely to use leverage (0.45% versus 0.52%), they charge lower management fees (1.43% versus 1.52%) but higher incentive fees (18.728% versus 17.014%), and their lock-up, redemption, and subscription periods are two months, three weeks, and one week longer, respectively.

[Table 5 in here]

Table 6 reports summary statistics for this paper's three market liquidity related measures, namely the innovations in aggregate market liquidity (LIQ) and traded liquidity ($TradedLiq$) factors of Pástor and Stambaugh (2003), and the returns from liquidity provision of Jylhä et al. (2014). We calculate the latter using stock market data from the Center for Research in Security Prices (CRSP) over the sample period from January 1994

to December 2015. When comparing the pre-Volcker to later periods the distributions of LIQ and $TradedLiq$ differ significantly, as indicated by the values of the Kolmogorov-Smirnov and Cramer-von Mises statistics. Notably, the average traded liquidity factor becomes negative during the implementation and compliance phases, before again turning positive in the post-Volcker Rule full compliance period. The average returns from liquidity provision also turn negative during the compliance and the post-Volcker Rule full compliance periods. This indicates that the 5-day contrarian strategy that works successfully before the Volcker Rules' implementation, fails to deliver positive returns in subsequent periods. The fact it appears to take longer than five trading days for price reversals to be fully realised in the second sub-period suggests a trading environment characterised by reduced market liquidity and a paucity of arbitrage capital.[14]

[Table 6 in here]

4 Empirical Results

4.1 Hedge fund funding liquidity

Table 7 reports the estimation results from Equation (1), capturing the impact of Volcker Rule implementation on investor flows to hedge funds. The first column presents

[14]While the Volcker Rule prohibits banks from engaging in proprietary trading, their underwriting and market-making activities are exempt from the restrictions. As in reality it is difficult to disentangle proprietary trading from market-making (Chow and Surti, 2011), the affected banks greatly reduce their trading activities. This adversely impacts both the scale and quality of market-making services that banks provide to investors, resulting in a deterioration in market liquidity (Duffie, 2012) with the declining size of banks' trading books (Keppo and Korte, 2016). However, the changes in market liquidity cannot be solely attributed to the Volcker Rule given other relevant overlapping events. One such prominent event is the US debt ceiling crisis which began in January 2013 and led to the enactment of a legal mandate to increase limits on US Government debt. This crisis is curtailed in October 2013, following the Continuing Appropriations Act and in February 2014 the debt ceiling is suspended until March 2015.

the results for the compete sample, while the second and third columns use funds with higher and lower operational risk, respectively. Consistent with hypothesis $H1(a)$ the average fund flow decreases after the Volcker Rule, as captured by the significantly negative coefficient on $Volcker$ (γ_0) in column (1). Annual flows to hedge funds decline by around 4.38 percentage points, while flow-performance sensitivity increases significantly subsequent to the Rule (positive β_1 in column (1)). These effects are much stronger for funds with high operational risk. The γ_0 coefficient of -8.23 is significant in column (2) for funds with higher operational risk while it is four times smaller in absolute value (-2.12) and statistically insignificant in column (3) for lower operational risk funds. The β_1 coefficients are positive and significant in both columns, but the effect for funds with higher operational risk is three times larger than for funds with low operational risk (6.17 vs. 1.86, respectively). Overall, our results indicate a deterioration in hedge fund funding liquidity conditions after the Volcker Rule, which is more pronounced for funds with higher operational risk. We note the effects of control variables on flows are all consistent with previous literature. Hedge funds with high return volatility, larger size, a longer history, higher incentive fees, and longer subscription periods experience lower inflows, while funds with a high-water mark provision attract more inflows. Capital flows into the same-style category positively impact individual fund flows.

[Table 7 in here]

4.2 Hedge funds' liquidity exposure and market liquidity provision

Table 8 reports the estimation results for Equation (4) which captures changes in hedge funds' exposure to market liquidity in response to the Volcker Rule's implementation. Columns (1) and (4) present the findings for all funds, while (2) and (5) document

those for funds with higher, and (3) and (6) those for funds with lower operational risk, respectively. Positive and significant coefficients γ_0 for the liquidity measures in all columns indicate that hedge funds customarily take on liquidity risk, consistent with findings in prior literature (Sadka, 2010; Teo, 2011). Negative and highly significant coefficients γ_1 in all columns confirm that hedge funds decrease their exposure to market liquidity subsequent to the Volcker Rule, supporting hypothesis $H2(a)$. Our measured impact of the effect of operational risk reveals that before the Volcker Rule, hedge funds with lower operational risk are more exposed to the market liquidity factors. After the Rule, the lower operational risk funds exhibit a more pronounced reduction in exposure to liquidity factors as compared to higher risk funds.

Responding to tightening funding liquidity constraints after the Volcker Rule, all hedge funds reduce their liquidity exposure. The effect is alleviated for lower operational risk funds funds connected to US LCFI prime brokers, as captured by a positive and significant coefficient γ_3 in columns (3) and (6). US LCFI prime brokers appear to be ensuring that their hedge fund clients with lower operational risk possess sufficient resources to undertake their investment strategies. These LCFI-connected funds exhibit a milder reduction in their exposure to the LIQ factor: the average negative effect of the Volcker Rule ($\gamma_1 = -9.78$) is ameliorated for such connected funds ($\gamma_3 = 3.82$). For the $TradedLiq$ measure, any negative effect of the Volcker Rule is more than offset for lower operational risk funds with connections to US LCFI prime brokers ($\gamma_1 = -12.94$, $\gamma_3 = 16.99$). Collectively, these findings support hypothesis $H2(c)$.[15]

Table 9 reports the results for the impact of Volcker Rule on hedge funds' provision of liquidity to different equity market segments. The significantly positive coefficient γ_0 on

[15]In the supplementary online appendix, we report the results for individual fund strategies. they indicate a more pronounced effect of connections to LCFI prime broker for directional and semi-directional funds, in particular the Long/Short Equities and Managed Futures funds.

Rlp in columns (1) to (3) indicates that hedge funds customarily supply liquidity overall, a finding which is consistent with Jylhä et al. (2014) and Franzoni and Plazzi (2013).

Disaggregating the *Rlp* factor across liquid and illiquid stocks reveals certain subtle nuances to the results. Hedge funds demand liquidity when trading liquid stocks, but supply it to illiquid assets, as revealed by a negative and significant γ_0 for Rlp^{Liquid} and positive significant γ_0 for $Rlp^{Iliquid}$. Before the Volcker Rule, in comparison to funds with lower operational risk, funds with higher operational risk demand more liquidity when trading liquid stocks and supply less liquidity to illiquid assets.

When considering the impact of the Volcker Rule on liquidity provision, the estimated effects for liquid and illiquid stocks once again point in opposing directions. The coefficient γ_1 on the interaction term $Rlp^{Liquid} \cdot Volcker$ is significantly positive, while it is negative for $Rlp^{Illiquid} \cdot Volcker$, a finding which supports hypothesis $H2(b)$. Following the Rule's implementation, hedge funds increase their liquidity provision to more liquid segments of the equity market but withdraw it from less liquid stocks.[16] Reflecting the previous results, hedge funds with lower operational risk seem to benefit from their connections to LFCI prime brokers and they are less affected by the tightening funding liquidity conditions. Most importantly, they do not reduce their liquidity provision to illiquid stocks: as evident in column (9), the negative effect of the Volcker Rule on exposure to *Rlp* ($\gamma_1 = -34.42$) is offset for funds with lower operational risk and connections to US LCFI prime brokers ($\gamma_3 = 43.44$).

[Tables 8 and 9 in here]

[16] In the supplementary online appendix we report results for individual fund strategies. The largest reduction in liquidity provision to illiquid stocks is associated with directional funds, while semi-directional funds enhance their liquidity provision in liquid stocks the most.

5 Extensions and robustness

5.1 Holding-based liquidity measures

A more direct evaluation of changing hedge fund strategies in relation to their liquidity exposure may be obtained from measuring changes in the liquidity of the reported holdings of a sub-sample of hedge funds that submit 13F filings. Hedge fund investment companies registered in the U.S. managing over $100 million are required by the Securities and Exchange Commission (SEC) to file quarterly reports of their security holdings. We aggregate individual hedge funds managed by the same hedge fund companies and obtain their holdings from the CDA database (Thomson Reuters, 13f filings). In total, we identify 388 hedge fund companies holding 5,709 stocks, comprising 5,713,269 unique data points of holdings (a hedge fund company-quarter-security data point).

For every stock. each quarter we calculate fractional hedge fund holdings as the total value of the holdings by hedge funds in this stock divided by its market capitalization at the end of the reporting quarter. Then we calculate the average fractional holdings of every stock during the pre-Volcker period (January 2010 to March 2014) and post-Volcker period (April 2014 to December 2018) as the simple averages of quarterly fractional holdings within each period. We compute changes in the average fractional holdings from pre- to post-Volcker periods, and split stocks into two groups according to the changes in holdings. Stocks bought (sold) by hedge funds are those evidencing a change in the average fractional holdings above (below) the median. Finally, we compare the liquidity-related characteristics of the stocks bought and sold by hedge funds. In particular, we consider their market capitalization, Amihud illiquidity measure, and bid-ask spread. Table 10 reports the results. Stocks in which hedge funds increase holdings have significantly larger average market capitalization, lower value of the Amihud illiquidity measure, and a

smaller bid-ask spread, in comparison to stocks sold by hedge funds. These results provide further direct holding-based evidence that hedge funds reallocate their investments from less to more liquid assets after the Volcker Rule.

[Table 10 in here]

5.2 The Volcker Rule: Implementation vs full compliance periods

Our main analysis focuses on the impact of the Volcker Rule subsequent to the date it became operative, namely from April 1, 2014 to the end of the sample period. However, the Rule forms part of the Dodd-Frank Act, and is written into law on July 21, 2010, with banks initially required to be fully compliant by July 21, 2017. In this section we analyse if hedge funds begin to adjust their liquidity provision strategies subsequent to information about the Rule being released in 2010 and whether the Rule induces permanent changes to the hedge fund operating environment with the effects still evident after full compliance is enforced.

We expect to observe gradual adjustments of liquidity exposure and liquidity provision during the initial implementation period, but not to the full extent witnessed after April 2014. These effects may become more or less pronounced after the compliance period, depending on the extent to which hedge funds adapt to the new operating environment and discover alternative sources of capital.

We repeat our prior analysis of liquidity exposure and provision by hedge funds employing three new dummy variables in place of a single $Volcker$ dummy: $Phase1$, $Phase2$, and $Phase3$. These three new variables capture the implementation, compliance, and post-Volcker Rule full compliance periods, respectively. $Phase1$ equals one from July

2010 to March 2014, and zero otherwise. $Phase2$ equals one from April 2014 to July 2017, and zero otherwise. $Phase3$ equals one from August 2017 to December 2018, and zero otherwise.

Tables 11 and 12 report the results. It is noteworthy that hedge funds increase their market liquidity exposure during the implementation phase, as reflected in the positive and highly significant value of γ_1^{Phase1} for both LIQ and $TradedLiq$ evident for all types of fund (Table 11), while a significant reduction in liquidity exposure is observed only after the Volcker Rule becomes operative and enforced from April 2014 (captured by negative and highly significant values of γ_1^{Phase2} again for all types of funds). The negative effect persists throughout the post-Volcker Rule full compliance period, with γ_1^{Phase3} being negative and significant in all specifications, apart from LIQ exposure, for hedge funds with higher operational risk. Similar to our main results, hedge funds with lower operational risk benefit from prime brokerage connections to large US banks and are able to further increase their exposure to the $TradedLiq$ factor during the implementation period, and do not reduce it during the compliance period. The reduction of the average exposure to $TradedLiq$ by funds with lower operational risk ($\gamma_1^{Phase2} = -16.27$ in column (6)) is more than offset for funds with prime brokerage connections ($\gamma_3^{Phase2} = 19.03$). Their prime brokerage connections, however, do not allow hedge funds with lower operational risk to avoid a reduction in their exposure to market liquidity factors during the post-Volcker period (γ_3^{Phase3} is not statistically significant). Hence, even though large prime brokers are able to ameliorate funding liquidity constraints for their "good" clients, this does not completely outweigh the effect of long-term changes in the investment environment.

With respect to liquidity provision (Table 12), it appears that hedge funds immediately relocate their liquidity provision from illiquid to liquid stock segments after the Volcker

Rule became law in July 2010, further reducing it to illiquid stocks during the compliance period (γ_1^{Phase1} and γ_1^{Phase2} are positive when liquid stocks are considered and negative for illiquid stocks). After the compliance period, hedge funds return to offering liquidity provision to both liquid and illiquid stock segments, with the effect more pronounced for liquid stocks.

[Tables 11 and 12 in here]

5.3 Matched sample analysis

As a robustness test, we seek to ensure that the documented differences between connected and unconnected funds are not driven by observed (and potentially unobserved) characteristics of hedge funds by repeating the analysis using propensity score matching (PSM). We implement PSM in three steps. In the first step, within each hedge fund style we estimate a probit regression for the probability of a fund being connected to any US-based LCFI. As determinants, we include a number of fund characteristics, namely the initial size of the fund, its management and incentive fees and its use of HWM and leverage, redemption, subscription, and lockup periods. In the second step, we obtain each fund's propensity score as the probability that a fund with given characteristics is a connected fund. In the third step, we match connected funds and non-connected funds using one-to-one matching without replacement. We keep only those matches for which the difference in the score is smaller than 0.05. We obtain 327 pairs of matched funds and repeat our analysis on this matched sample of 654 total funds. The results in Table 13 and 14 confirm that our main findings remain qualitatively unaltered using matched funds.

[Tables 13 and 14 in here]

5.4 Within-fund analysis

Our sample covers a period of significant structural change in the asset management industry resulting from the sweeping regulations incorporated into the Dodd-Frank Act. As this other related legislation is also implemented around the same period as the Volcker Rule, it may exert an independent effect on hedge funds' investment strategies and investor flows. For example, the Dodd-Frank Act imposes registration requirements and requires significantly higher disclosure of proprietary information. Anecdotal evidence suggests that many hedge funds, especially the more established ones, responded to these disclosure rules by returning their capital to investors and converting to a family office structure to avoid the new regulations.[17] This could alter the relative composition of the sample of funds reporting to commercial databases, with a greater proportion of less established funds reporting after the Volcker Rule, which may lead to the observed decline in hedge fund flows and greater measured flow-performance sensitivity.

To ensure that our results are not driven by the changes in the cross-section of hedge funds present in our database before and after the Rule, we further restrict the sample to those funds in existence both prior and subsequent to the Volcker Rule. We use funds with at least 36 return observations during the pre-Volcker period (January 2010 to March 2014) and at least 36 observation during the post-Volcker (April 2014 to December 2018) period. This sub-sample includes 1,288 funds.

For each fund i we estimate separate regressions during the pre- and post-Volcker periods. The flow regression is based on Equation (5) and the return regression on Equation (6), with the latter using different liquidity measures in turn. We then evaluate

[17] Robert Frank, Gregory Zuckerman and Steve Eder. Soros Fund All in the Family. The Wall Street Journal, July 27, 2011.

the average within-fund changes in the coefficients β_0^R and β_0^L.

$$Flow^i_{t:1+11} = \alpha + \beta_0^R \cdot \overline{Ret^i}_{t-12} + \delta Controls^i_t + \varepsilon^i_t \tag{5}$$

$$Ret^i_t = \alpha + \sum_{k=1}^{7} \beta_k F_{k,t} + \beta_0^L \cdot L_t + \varepsilon^i_t \tag{6}$$

A positive average change in β_0^R for funds that report before and after the Rule would suggest that on average these funds experience increases in their flow-performance sensitivity. A negative average change in β_0^L would suggest that the exposure to the corresponding liquidity factor declines.

Table 15 reports the mean values of the coefficients for the two periods, t-test statistics or the difference in means, as well as Kolmogorov-Smirnov and Cramer-von Mises statistics for the changes in the (cross-sectional) distributions of coefficients across the two periods. The results are consistent with our main findings. Flow-performance sensitivity of hedge funds increases in the later period, but it is mainly driven by hedge funds with higher operational risk. At the same time, all funds reduce their exposure to market liquidity factors after the Volcker Rule.

[Table 15 in here]

5.5 Connection endogeneity

The possibility exists that funds with lower operational risk may purposely choose LCFI prime brokers, enabling them to retain their pre-Volcker levels of exposure to market liquidity and not reduce their liquidity provision to the illiquid segments of the equity market. To address this endogeneity problem, we specify and estimate a profit regression

model by regressing the probability of a hedge fund choosing a LCFI prime broker on fund size, operational risk, and domicile. We compute the Inverse Mills Ratio (IMR) from this first-stage probit and incorporate it as an additional factor in Equation (4). The results are shown in Tables 16 to 18. The first stage estimates reveal that hedge funds with more assets, higher operational risk, or domiciled in Bermuda, British Virgin Islands, Cayman Islands, Isle of Man, Malta, the United Kingdom, and the United States are more likely to choose a LCFI prime broker. Furthermore, the coefficients for the IMR in Tables 17 to 18 are negative but statistically insignificant for hedge funds with lower operational risk, and our main findings remain qualitatively unchanged after including IMR.

[Tables 16 to 18 in here]

6 Conclusion

The evolving nature of the complex relationship between hedge funds and LCFIs is attracting increasing attention from both academics and policy-makers subsequent to the 2008 financial crisis, amid growing financial stability concerns. In this paper, we examine the impact of the implementation of a post-crisis banking regulation, the Volcker Rule, on the hedge fund circle of liquidity. Volcker Rule provisions prohibit LCFIs from proprietary trading and constrains their ability to invest in hedge funds. To the best of our knowledge, the indirect regulatory effects of these Rule provisions on hedge funds, a critical policy outcome, have not been extensively explored in the literature. Our key findings relate to two components of the liquidity circle impacted by the Volcker Rule. The first documents decreased funding liquidity of hedge funds, arising from increased regulatory risk; the second reveals a decrease in hedge funds' willingness to assume liquidity risk and a

reorientation of their market-making activities away from illiquid towards liquid stocks. The Volcker Rule creates favourable conditions for market liquidity and funding liquidity to become mutually reinforcing, contributing to the potential creation of illiquidity spirals in the spirit of Brunnermeier and Pedersen (2008).

Specifically, we find that following implementation of the Volcker Rule, hedge funds experience a reduction in capital flows and an enhancement in their flow-performance sensitivity. The decline in flows and increase in the flow-performance sensitivity are more pronounced for hedge funds with higher operational risk. Facing a deterioration in funding liquidity, hedge funds appear to re-balance their portfolios towards more liquid assets, reducing their exposure to market liquidity factors. Prior to the Volcker Rule, hedge funds undertake an important market service by re-distributing liquidity. They can be characterised as demanding liquidity when trading in more liquid equity market segments and as liquidity suppliers for the less liquid segments, thereby balancing the market. Subsequent to the Rule's implementation, hedge funds appear to step into a market-making role, one previously undertaken by the LCFIs, but only in the liquid stock segment of the market. Funds retreat from trading in relatively illiquid stocks.

The effect is ameliorated for hedge funds with lower operational risk that are connected to the US-based LCFI prime brokers. Facing tighter regulations themselves, these prime brokers seem to be fostering business relations with reliable clients, namely hedge funds with lower operational risk, by providing them with the means to sustain their operations even in a less liquid market environment with tighter funding constraints. This duration of this support provided by prime brokers is relatively short lived, and it is no longer pronounced after August 2017, when full compliance with the Volcker Rule is required by law. Overall, following implementation of the Volcker Rule, liquidity re-distribution in the equity market is disrupted, potentially leading to a further dispersion in liquidity across

individual stocks . This retreat of hedge funds from undertaking investment in relatively illiquid assets after the Volcker Rule may have contributed to a further deterioration in both market liquidity and market efficiency in those sectors which are already less liquid and less efficient.

Viewed from a policy perspective, our findings contribute to an understanding of the far reaching effects of the Volcker Rule, beyond its direct aim of stimulating prudent investment from LCFIs. They provide a prescient warning of the possible unintended consequences of future financial market and banking regulations.

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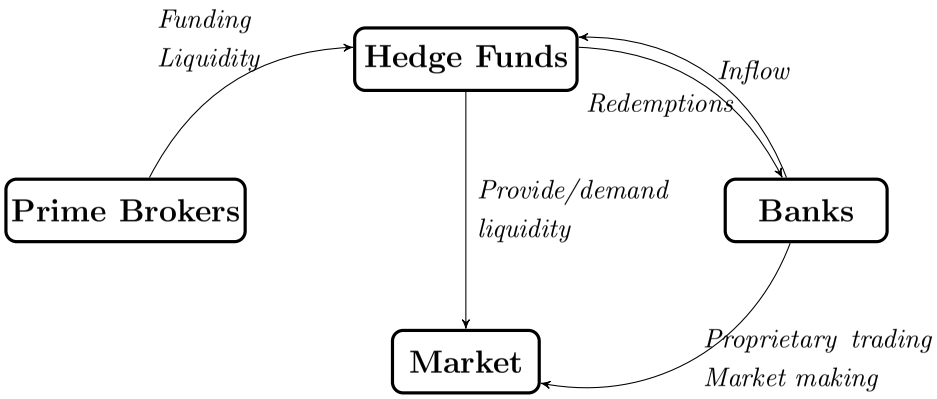
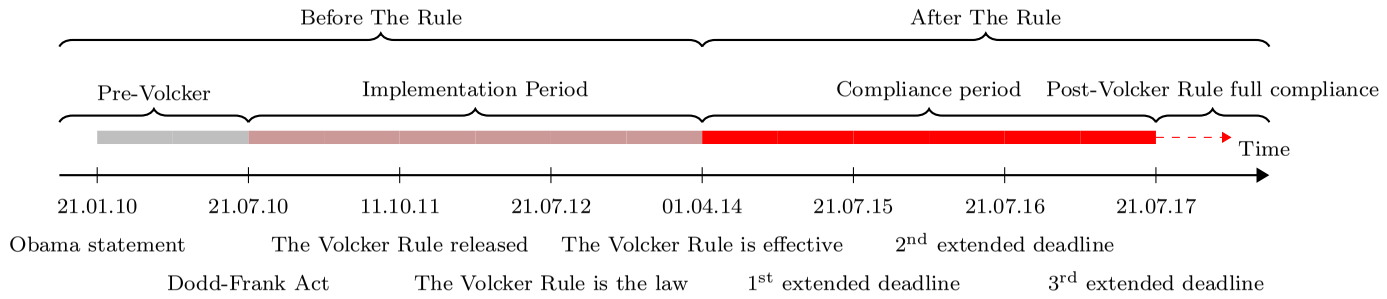


The figure depicts the direction of liquidity flows constituting the 'circle of liquidity' of hedge funds.

Figure 1: The hedge fund 'circle of liquidity'.



The figure depicts the timeline for implementation of the Volcker Rule.

Figure 2: The Volcker Rule implementation period.

Tables

Table 1: Variable Description

This table describes the variables used in this paper in alphabetical order.

Variables	Description
Age	The age of a hedge fund.
AUM	The asset under management of a hedge fund.
Connect	A dummy variable equals 1 if a US-based LCFI is a prime broker of a hedge fund.
CREDIT	The change in Moody's Baa yield over the 10-year Treasury constant maturity yield.
Flow	The flows to a hedge fund derived by Equation (2).
HWM	A dummy variable equals 1 if a high-water mark is present.
IMR	The Inverse Mills Ratio from the probit analysis.
IncFee	The incentive fee a hedge fund charges.
kink1	The average number of return observations that are between 0 and 2% and -4% to -2% minus the number of return observations that are between -2% and 0
kink2	The value of the standard normal test statistic measuring the discontinuity given by Equation (3).
Leverage	A dummy variable equals 1 if a hedge fund uses leverage, and 0 otherwise.
LIQ	The Pástor and Stambaugh (2003) market liquidity factor.
LockUp	A hedge fund's lockup period.
MgtFee	The management fee a hedge fund charges.
MKT	The Standard & Poors (S&P) 500 index total return.
Negative	The percentage of returns below zero.
Phase1	A dummy variable equals 1 from July 2010 to March 2014, and 0 otherwise.
Phase2	A dummy variable equals 1 from April 2014 to July 2017, and 0 otherwise.
Phase3	A dummy variable equals 1 from August 2017 to December 2018, and 0 otherwise.
PTFSBD	The bond trend-following factor in Fung and Hsieh (2001).
PTFSCOM	The currency trend-following factor in Fung and Hsieh (2001).
PTFSFX	The commodity trend-following factor in Fung and Hsieh (2001).
Redemption	A hedge fund's redemption period.
Repeat	The percentage of returns that are repeated at least once.
Ret	The reported return for a hedge fund.
Rlp	The returns from providing liquidity calculated based on the method proposed by Jylhä et al. (2014).
$\text{Rlp}^{Illiquid}$	The returns from providing liquidity for less liquid stocks.
Rlp^{Liquid}	The returns from providing liquidity for more liquid stocks.
SMB	The difference between the Russell 2000 index total return and the S&P 500 total return.
STD	The standard deviation of returns for a hedge fund.
StyleFlow	The average flow into hedge funds from the same style category.
TERM	The change in the 10-year Treasury constant maturity yield.
TradedLiq	The Pástor and Stambaugh (2003) traded liquidity factor.
Volcker	A dummy variable which equals 1 after April 2014, and 0 otherwise.

Table 2: Classification of hedge fund strategies

This table reports the sample classification of hedge funds by investment strategy and the number of funds in each class. Funds of Funds are excluded from the sample.

Category	Strategy as labeled in the database	N of funds
Directional Funds		
Global Macro	Global Macro, Macro	329
Managed Futures	CTA/Managed Futures, Managed Futures	1002
Non-Directional Funds		
Fixed Income	Convertible Arbitrage, Fixed Income Arbitrage, Fixed Income, Distressed Debt	581
Relative Value	Relative Value, Arbitrage, Value, Equity Market Neutral	410
Semi-Directional Funds		
Event Driven	Event Driven	223
Long/Short Equities	Long/Short Equity Hedge, Long Short Equities, Dedicated Short Bias	1987
Multi-Strategy	Multi-Strategy, Dual Approach	512
Others		
Others	Others, Other, Bottom-Up, Top-Down, Diversified Debt, Options Strategy, Undefined	551
Total		5558

Table 3: Summary statistics for hedge fund returns

This table reports descriptive statistics of hedge fund monthly returns in percent from January 1994 to December 2018. Panel A reports the statistics for the full sample and Panel B reports the statistics by investment category. The figures within a category are equally weighted averages of the statistics across the funds in the category. The sample includes funds in the Eurekahedge database with at least 36 return observations which report returns in US dollars.

Category	Mean	Median	SD	Skewness	Kurtosis	Min.	Max.	N
Panel A: Full Sample								
All Funds	0.501	0.545	3.973	-0.128	6.379	-11.650	12.804	5558
Panel B: By Hedge Fund Investment Style								
Directional Funds								
Global Macro	0.398	0.341	3.691	0.083	5.275	-10.089	11.499	329
Managed Futures	0.459	0.297	4.629	0.167	5.766	-12.429	15.068	1002
Non-Directional Funds								
Fixed Income	0.464	0.510	2.031	-0.371	7.944	-6.929	6.791	581
Relative Value	0.524	0.587	3.266	-0.421	8.900	-11.183	11.003	410
Semi-Directional Funds								
Event Driven	0.603	0.676	3.543	-0.368	6.767	-11.298	11.717	223
Long/Short Equities	0.531	0.570	4.189	-0.048	5.328	-12.028	13.524	1950
Multi Strategy	0.483	0.544	3.715	-0.257	6.549	-11.376	11.535	512
Others								
Others	0.537	0.583	5.166	-0.381	8.034	-15.554	16.221	551

Table 4: Summary statistics of hedge funds' flows

This table reports descriptive statistics of hedge fund 12 month flows in percent from January 1994 to December 2018. Panel A reports the statistics for the full sample and Panel B reports the statistics by category. The figures within a category are equally weighted averages of the statistics across the funds in the category. The sample includes funds in the Eurekahedge database with at least 36 return observations which report returns in US dollars.

Category	Mean	Median	SD	Skewness	Kurtosis	Min.	Max.	N
Panel A: Full Sample								
All Funds	18.634	7.756	57.952	0.369	3.599	-61.989	147.282	5558
Panel B: By Hedge Fund Investment Style								
Directional Funds								
Global Macro	13.975	11.189	52.471	0.252	3.320	-68.639	128.191	329
Managed Futures	29.185	9.244	78.681	0.482	3.811	-73.366	213.002	1002
Non-Directional Funds								
Fixed Income	8.485	3.029	40.897	0.288	3.486	-55.674	100.587	581
Relative Value	17.135	5.015	58.306	0.496	4.067	-57.281	159.814	410
Semi-Directional Funds								
Event Driven	41.372	30.788	84.478	0.402	3.491	-58.439	208.333	223
Long/Short Equities	15.426	4.949	53.863	0.351	3.517	-61.124	132.056	1950
Multi Strategy	15.772	9.520	49.974	0.299	3.525	-58.850	121.700	512
Others								
Others	20.100	9.072	54.782	0.357	3.578	-56.090	139.211	551

Table 5: Summary statistics of hedge funds' characteristics

This table reports the descriptive statistics of hedge funds characteristics including: assets under management (AuM, in million USD), fund age (in months), use of leverage (Leverage), management fee ($MgtFee$ in percent), incentive fee ($IncFee$ in percent), lock-up period (in months), redemption period (in months), and subscription period (in months). Panel A reports the statistics for the full sample, and Panel B and C report the statistics for connected and unconnected funds, respectively. We conduct a t-test for differences in means between connected and unconnected funds. *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

	Mean	Median	SD	Skewness	Kurtosis	Min.	Max.	N
Panel A: Hedge fund data								
AuM ($M)	158.152	144.054	86.983	0.411	3.437	40.425	341.619	5558
Age (Months)	30.826	21.615	31.719	0.984	3.504	0.000	89.909	5558
Leverage	0.514	1.000	0.500	-0.057	1.003	0.000	1.000	5558
MgtFee (%)	1.513	1.500	0.581	2.584	61.225	0.000	15.000	5558
IncFee (%)	17.478	20.000	6.471	-1.441	6.490	0.000	50.000	5558
Lockup (Months)	2.816	0.000	6.632	3.760	30.695	0.000	120.000	5558
Redemption (Months)	1.531	1.000	1.884	4.430	40.655	0.033	36.000	5558
Subscription (Months)	0.858	1.000	0.685	5.805	84.258	0.033	12.000	5558
Panel B: Connected hedge funds								
AuM ($M)	127.503	117.949	70.099	0.358	3.155	35.011	275.198	427
Age (Months)	42.6342***	40.260	36.506	0.209	1.781	0.000	94.405	427
Leverage	0.4515***	0.000	0.498	0.195	1.038	0.000	1.000	427
MgtFee (%)	1.4297***	1.500	0.442	-0.010	2.231	0.000	2.500	427
IncFee (%)	19.1335***	20.000	4.255	-1.978	19.888	0.000	50.000	427
Lockup (Months)	4.8712***	0.000	8.153	1.972	7.120	0.000	36.000	427
Redemption (Months)	2.1277***	1.000	2.031	3.044	14.987	0.033	12.000	427
Subscription (Months)	1.1357***	1.000	0.821	6.355	75.030	0.033	12.000	427
Panel C: Unconnected hedge funds								
AuM ($M)	156.841	144.662	80.946	0.359	3.220	44.528	325.497	5131
Age (Months)	29.843	20.063	31.320	1.048	3.647	0.000	89.535	5131
Leverage	0.520	1.000	0.500	-0.079	1.006	0.000	1.000	5131
MgtFee (%)	1.520	1.500	0.591	2.651	61.926	0.000	15.000	5131
IncFee (%)	17.337	20.000	6.607	-1.388	6.101	0.000	50.000	5131
Lockup (Months)	2.644	0.000	6.459	4.030	35.387	0.000	120.000	5131
Redemption (Months)	1.480	1.000	1.863	4.623	44.414	0.033	36.000	5131
Subscription (Months)	0.834	1.000	0.667	5.758	86.130	0.033	12.000	5131

Table 6: Equity market liquidity around the Volcker Rule

This table reports the summary statistics of the Pástor and Stambaugh (2003) innovations in aggregate market liquidity (LIQ) and traded liquidity factor ($TradedLiq$), and Jylhä et al. (2014)'s returns from providing liquidity (Rlp). Panel A reports the statistics for the whole period and Panel B-E report the statistics during four sub-periods: pre-Volcker period (January 1994 to June 2010), implementation period (July 2010 to March 2014), compliance period (April 2014 to July 2017), and post-Volcker Rule full compliance period (August 2017 to December 2018). The tests statistics are reported for the t-test in mean differences, the Kolmogorov-Smirnov (ks-test) and Cramer-von Mises (cm-test) test for the difference in distributions. *, **, and *** denote significance at the 10%, 5%, and 1% levels respectively.

Category	Mean	Median	SD	Skewness	Kurtosis	Min.	Max.	t-test	ks-test	cm-test
Panel A: Whole period										
LIQ	0.0032	0.0044	0.0614	-0.6605	6.4343	-0.2572	0.2791			
TradedLiq	0.0049	0.0047	0.0354	-0.1116	4.1468	-0.1278	0.1119			
Rlp	-0.0000	-0.0001	0.0034	-0.3884	6.6388	-0.0137	0.0140			
Rlp^{Liquid}	0.0001	0.0002	0.0039	-0.2123	8.6897	-0.0204	0.0173			
$Rlp^{Illiquid}$	0.0000	0.0002	0.0039	-0.6375	6.6219	-0.0188	0.0134			
Panel B: Pre-Volcker period										
LIQ	-0.0038	-0.0020	0.0688	-0.5381	5.6760	-0.2572	0.2791			
TradedLiq	0.0078	0.0075	0.0393	-0.2643	3.8378	-0.1278	0.1119			
Rlp	0.0015	0.0012	0.0089	-0.5386	5.2966	-0.0370	0.0254			
Panel C: Implementation period										
LIQ	0.0137	0.0151	0.0359	0.2653	3.0860	-0.0599	0.0984	-1.6495	0.2121*	0.4996**
TradedLiq	-0.0008	-0.0025	0.0277	0.3947	4.2076	-0.0673	0.0866	1.3934	0.2071*	0.4996**
Rlp	0.0011	0.0015	0.0060	-0.6862	4.7801	-0.0191	0.0147	0.2629	0.1444	0.1765
Panel D: Compliance period										
LIQ	0.0132	0.0105	0.0414	0.0833	2.3341	-0.0778	0.0908	-1.5049	0.1975	0.2634
TradedLiq	-0.0029	0.0021	0.0241	-0.4640	2.7426	-0.0616	0.0397	1.6523*	0.2533**	0.5222**
Rlp	-0.0007	0.0011	0.0117	-1.7944	8.7838	-0.0487	0.0217	1.3720	0.1217	0.0979
Panel E: Post-Volcker Rule full compliance period										
LIQ	0.0335	0.0386	0.0470	0.1364	2.4010	-0.0406	0.1311	-2.1846	0.3877**	0.6308**
TradedLiq	0.0039	-0.0017	0.0226	0.1470	2.1687	-0.0376	0.0399	0.4031	0.2008	0.1603
Rlp	-0.0014	-0.0018	0.0069	-0.7103	3.4669	-0.0187	0.0086	1.2977	0.2282	0.2341

Table 7: The Volcker Rule and hedge funds' flow-performance relationship

This table reports the results from Equation (1) estimating the impact of the Volcker Rule on hedge funds' flow-performance relationship. We use the whole sample (All) and sub-samples of hedge funds with the operational risk measure above (High-OR) or below (Low-OR) the median separately. $Flow_{t:t+11}$ is the flow for a fund over a year between month t and $t+11$. Ret is the average past year return, and $Volcker$ is a dummy variable that equals 1 after April 2014. Other variables are defined in Table 1. Standard errors are reported in brackets. *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

	(1)	(2)	(3)
		$Flow_{t:t+11}$	
Sample=	All	High-OR	Low-OR
Ret (β_0)	5.522***	6.117***	5.241***
	(0.189)	(0.360)	(0.221)
Volcker (γ_0)	-4.375**	-8.232***	-2.116
	(2.047)	(3.042)	(2.784)
Ret·Volcker (β_1)	2.635***	6.169***	1.860***
	(0.431)	(0.935)	(0.482)
STD	-1.212***	-1.920***	-1.173***
	(0.142)	(0.288)	(0.164)
lnAUM	-41.952***	-37.049***	-47.634***
	(0.355)	(0.518)	(0.492)
HWM	10.404*	2.725	14.712**
	(6.201)	(12.445)	(6.893)
MgtFee	-2.361	1.094	-1.406
	(3.239)	(7.340)	(3.445)
IncFee	-1.293***	-1.069	-1.410***
	(0.364)	(0.712)	(0.411)
Age	-0.501	0.229	-2.441***
	(0.337)	(0.670)	(0.405)
Redemption	1.798	1.621	-0.143
	(1.260)	(2.006)	(1.673)
Subscription	-5.846*	-5.355	-7.390*
	(3.382)	(5.657)	(4.249)
Leverage	4.656	4.250	3.187
	(3.825)	(7.210)	(4.406)
LockUp	-0.252	-0.257	-0.286
	(0.331)	(0.589)	(0.397)
StyleFlow	0.517***	0.875***	0.104
	(0.094)	(0.130)	(0.137)
Constant	154.455***	149.915***	159.053***
	(10.923)	(18.851)	(14.163)
R-squared	0.011	0.011	0.011
Number of HFs	4,093	1,490	2,603
Year FE	Yes	Yes	Yes

Table 8: The Volcker Rule and hedge funds' market liquidity exposure

This table reports the results from Equation (4) estimating the impact of the Volcker Rule on hedge funds' exposure to market liquidity risk. We use the whole sample (All) and sub-samples of hedge funds with the operational risk measure above (High-OR) or below (Low-OR) the median separately. LIQ represents the Pástor and Stambaugh (2003) market liquidity factor and $TradeLiq$ represents the Pástor and Stambaugh (2003) traded liquidity factor. $Volcker$ is a dummy variable that equals 1 after April 2014, and $Connect$ is a dummy variable that equals 1 if a US-based LCFI is a prime broker of a hedge fund. MKT, SMB, TERM, CREDIT, PTFSBD, PTFSFX, and PTFSCOM are the Fung and Hsieh 7 factors. Standard errors are reported in brackets. *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

	(1)	(2)	(3)	(4)	(5)	(6)
Liquidity measure L=		LIQ			TradedLiq	
Sample=	All	High-OR	Low-OR	All	High-OR	Low-OR
L (γ_0)	8.428***	6.430***	10.406***	9.075***	7.699***	10.408***
	(0.243)	(0.241)	(0.411)	(0.401)	(0.404)	(0.680)
L·Volcker (γ_1)	-7.355***	-4.570***	-9.781***	-10.199***	-6.661***	-12.936***
	(0.392)	(0.396)	(0.603)	(0.638)	(0.707)	(0.966)
L·Connect (γ_2)	-0.686	0.185	-1.532	0.709	2.059	-0.681
	(0.709)	(0.890)	(1.100)	(1.431)	(1.774)	(2.235)
L·Volcker·Connect (γ_3)	2.203*	0.387	3.823*	10.452***	3.440	16.987***
	(1.310)	(1.639)	(2.025)	(2.970)	(3.549)	(4.829)
MKT	-1.377***	-0.182	-2.337***	-2.864***	-1.298***	-4.194***
	(0.217)	(0.233)	(0.349)	(0.220)	(0.235)	(0.352)
SMB	-3.225***	-1.679***	-4.616***	-2.273***	-0.918***	-3.495***
	(0.312)	(0.349)	(0.500)	(0.311)	(0.350)	(0.496)
Term	-1.177***	-1.085***	-1.264***	-0.887***	-0.885***	-0.885***
	(0.061)	(0.061)	(0.101)	(0.060)	(0.059)	(0.100)
Credit	-3.825***	-3.255***	-4.298***	-3.755***	-3.171***	-4.243***
	(0.106)	(0.109)	(0.172)	(0.104)	(0.106)	(0.169)
PTFSBD	-2.419***	-2.289***	-2.552***	-2.093***	-2.016***	-2.175***
	(0.089)	(0.092)	(0.144)	(0.087)	(0.089)	(0.141)
PTFSFX	1.109***	0.545***	1.581***	1.063***	0.529***	1.500***
	(0.053)	(0.054)	(0.084)	(0.053)	(0.053)	(0.084)
PTFSCOM	-0.612***	-0.798***	-0.446***	-0.687***	-0.893***	-0.498***
	(0.075)	(0.066)	(0.127)	(0.074)	(0.066)	(0.124)
Constant	1.889***	1.767***	1.982***	2.070***	1.904***	2.207***
	(0.127)	(0.107)	(0.247)	(0.128)	(0.107)	(0.248)
R-squared	0.023	0.023	0.023	0.023	0.023	0.023
Number of HFs	5,302	1,897	3,405	5,302	1,897	3,405
Strategy FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes

Table 9: The Volcker Rule and hedge funds' liquidity provision

This table reports the results from Equation (4) estimating the impact of the Volcker Rule on hedge funds' liquidity provision. We use the whole sample (All) and sub-samples of hedge funds with the operational risk measure above (High-OR) or below (Low-OR) the median separately. *Rlp* represents the returns from providing liquidity calculated based on the method proposed by Jylhä et al. (2014), Rlp^{Liquid} and $Rlp^{Illiquid}$ are calculated using sub-samples of stocks with the Amihud measure below and above the median respectively, $Volcker$ is a dummy variable that equals 1 after April 2014, and *Connect* is a dummy variable that equals 1 if a US-based LCFI is a prime broker of a hedge fund. MKT, SMB, TERM, CREDIT, PTFSBD, PTFSFX, and PTFSCOM are the Fung and Hsieh 7 factors. Standard errors are clustered at the fund level and reported in brackets. *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Rlp=		*Rlp*			Rlp^{Liquid}			$Rlp^{Illiquid}$	
Sample=	All	High-OR	Low-OR	All	High-OR	Low-OR	All	High-OR	Low-OR
Rlp (γ_0)	69.527***	49.097***	90.110***	-9.266***	-15.020***	-3.035	17.182***	15.564***	18.735***
	(3.095)	(3.154)	(5.273)	(3.052)	(2.980)	(5.273)	(1.487)	(1.776)	(2.346)
Rlp·Volcker (γ_1)	-28.220***	-5.956	-52.852***	75.253***	76.620***	68.798***	-24.259***	-12.258***	-34.416***
	(5.473)	(5.386)	(8.580)	(5.125)	(5.794)	(7.761)	(2.326)	(2.806)	(3.507)
Rlp·Connect (γ_2)	-10.849	-8.750	-11.535	8.587	-6.672	23.242*	2.974	3.887	2.697
	(8.670)	(9.883)	(14.068)	(10.104)	(14.311)	(13.779)	(4.183)	(4.842)	(6.796)
Rlp·Volcker·Connect (γ_3)	43.736**	11.128	83.395**	8.909	45.033*	-27.343	26.200***	8.816	43.442***
	(19.451)	(21.556)	(33.204)	(25.867)	(27.267)	(47.297)	(8.651)	(10.807)	(13.347)
MKT	-2.448***	-1.005***	-3.677***	-2.879***	-1.315***	-4.219***	-1.761***	-0.619***	-2.746***
	(0.220)	(0.235)	(0.352)	(0.220)	(0.235)	(0.350)	(0.134)	(0.168)	(0.202)
SMB	-1.504***	-0.319	-2.577***	-1.764***	-0.410	-2.992***	-1.997***	-1.067***	-2.823***
	(0.310)	(0.351)	(0.495)	(0.311)	(0.352)	(0.495)	(0.200)	(0.246)	(0.306)
Term	-0.591***	-0.631***	-0.552***	-0.709***	-0.713***	-0.702***	-0.221***	-0.297***	-0.156***
	(0.059)	(0.058)	(0.098)	(0.059)	(0.059)	(0.098)	(0.033)	(0.041)	(0.049)
Credit	-3.962***	-3.375***	-4.454***	-4.053***	-3.426***	-4.584***	-2.374***	-2.321***	-2.415***
	(0.108)	(0.111)	(0.175)	(0.107)	(0.111)	(0.173)	(0.044)	(0.057)	(0.066)
PTFSBD	-2.125***	-2.060***	-2.192***	-2.085***	-2.007***	-2.163***	-1.898***	-1.883***	-1.931***
	(0.088)	(0.090)	(0.142)	(0.087)	(0.089)	(0.141)	(0.062)	(0.073)	(0.096)
PTFSFX	1.061***	0.522***	1.504***	0.924***	0.432***	1.326***	0.995***	0.552***	1.359***
	(0.054)	(0.054)	(0.087)	(0.053)	(0.053)	(0.084)	(0.037)	(0.042)	(0.057)
PTFSCOM	-0.647***	-0.840***	-0.462***	-0.674***	-0.860***	-0.506***	-0.314***	-0.579***	-0.073
	(0.074)	(0.065)	(0.125)	(0.073)	(0.065)	(0.122)	(0.046)	(0.049)	(0.073)
Constant	2.106***	1.931***	2.251***	2.041***	1.875***	2.178***	1.729***	1.846***	1.567***
	(0.128)	(0.107)	(0.248)	(0.128)	(0.107)	(0.248)	(0.092)	(0.101)	(0.159)
R-squared	0.023	0.023	0.023	0.023	0.023	0.023	0.019	0.019	0.019
Number of HFs	5,302	1,897	3,405	5,302	1,897	3,405	5,302	1,897	3,405
Strategy FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Table 10: The Volcker Rule and hedge funds' equity holdings

This table reports the characteristics of hedge funds' equity holdings before and after the Volcker Rule. Panel A and B reports the statistics for the stocks that hedge funds' change of holdings from 2010-2014 to 2014-2018 is above and below the median, respectively. *Mcap* is the average market capitalization in million USD. *Amihud* is average of Amihud illiquidity measure, which is the ratio of the absolute value of daily returns scaled by daily dollar volume. *Spread* is the average bid-ask spread. *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

	Mean	Median	SD	Skewness	Kurtosis	Min.	Max.	N
Panel A: Hedge fund bought								
Mcap ($M)	4259.2***	732.596	14372.000	8.358	91.984	10.365	214000.000	2854
Amihud	0.0000095***	0.0000001	0.0000639	17.905	469.425	0.000	0.002	2854
Spread	0.126***	0.120	0.047	1.053	5.508	0.020	0.452	2854
Panel B: Hedge fund sell								
Mcap ($M)	3226.700	275.518	17599.000	13.825	244.055	1.503	398000.000	2854
Amihud	0.0000553	0.0000004	0.0004271	24.611	817.911	0.000	0.016	2854
Spread	0.151	0.138	0.068	1.197	5.528	0.005	0.614	2854

Table 11: The Volcker Rule and hedge funds' market liquidity exposure: implementation and full compliance periods

This table reports the results from Equation (4) estimating the impact of the Volcker Rule on hedge funds' exposure to market liquidity risk during three different phases. We use the whole sample (All) and sub-samples of hedge funds with the operational risk measure above (High-OR) or below (Low-OR) the median separately. *LIQ* represents the Pástor and Stambaugh (2003) market liquidity factor and *TradeLiq* represents the Pástor and Stambaugh (2003) traded liquidity factor. *Phase*1 is a dummy variable that equal 1 between July 2010 and March 2014, *Phase*2 is a dummy variable that equal 1 between April 2014 and July 2017, *Phase*3 is a dummy variable that equal 1 between August 2017 and December 2018, and *Connect* is a dummy variable that equals 1 if a US-based LCFI is a prime broker of a hedge fund. MKT, SMB, TERM, CREDIT, PTFSBD, PTFSFX, and PTFSCOM are the Fung and Hsieh 7 factors. Standard errors are clustered at the fund level and reported in brackets. *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

	(1)	(2)	(3)	(4)	(5)	(6)
Liquidity measure L=		LIQ			TradedLiq	
Sample=	All	High-OR	Low-OR	All	High-OR	Low-OR
L (γ_0)	7.541***	5.911***	9.203***	8.077***	7.391***	8.776***
	(0.259)	(0.254)	(0.445)	(0.431)	(0.436)	(0.740)
L·Phase1 (γ_1^{Phase1})	6.752***	4.452***	8.347***	5.657***	2.461***	8.048***
	(0.440)	(0.409)	(0.732)	(0.723)	(0.676)	(1.196)
L·Phase2 (γ_1^{Phase2})	-7.687***	-5.438***	-9.864***	-13.415***	-9.547***	-16.267***
	(0.430)	(0.438)	(0.666)	(0.708)	(0.789)	(1.072)
L·Phase3 (γ_1^{Phase3})	-3.871***	-0.974	-5.874***	-5.072***	-5.571***	-4.978***
	(0.615)	(0.668)	(0.896)	(1.169)	(1.363)	(1.662)
L·Connect (γ_2)	-0.361	0.393	-1.092	0.521	1.631	-0.698
	(0.725)	(0.911)	(1.124)	(1.456)	(1.809)	(2.276)
L·Phase1·Connect (γ_3^{Phase1})	0.950	-0.037	1.987	5.678**	4.877*	7.324*
	(1.251)	(1.384)	(2.057)	(2.458)	(2.621)	(4.054)
L·Phase2·Connect (γ_3^{Phase2})	1.273	-0.690	3.390	11.738***	3.900	19.025***
	(1.768)	(2.182)	(2.772)	(3.303)	(4.150)	(5.074)
L·Phase3·Connect (γ_3^{Phase3})	3.266	1.691	3.713	1.762	3.607	-2.390
	(2.266)	(2.053)	(4.628)	(4.599)	(5.306)	(7.960)
MKT	-1.412***	-0.196	-2.391***	-2.840***	-1.285***	-4.157***
	(0.218)	(0.233)	(0.350)	(0.220)	(0.235)	(0.352)
SMB	-3.522***	-1.896***	-5.006***	-2.380***	-0.989***	-3.640***
	(0.318)	(0.357)	(0.509)	(0.311)	(0.351)	(0.497)
Term	-1.194***	-1.101***	-1.284***	-0.879***	-0.880***	-0.875***
	(0.061)	(0.061)	(0.101)	(0.060)	(0.059)	(0.100)
Credit	-3.880***	-3.293***	-4.371***	-3.784***	-3.179***	-4.291***
	(0.106)	(0.110)	(0.173)	(0.104)	(0.106)	(0.170)
PTFSBD	-2.432***	-2.301***	-2.571***	-2.090***	-2.017***	-2.169***
	(0.089)	(0.092)	(0.144)	(0.087)	(0.089)	(0.141)
PTFSFX	1.179***	0.596***	1.668***	1.076***	0.535***	1.519***
	(0.054)	(0.055)	(0.086)	(0.053)	(0.053)	(0.084)
PTFSCOM	-0.647***	-0.821***	-0.491***	-0.654***	-0.875***	-0.453***
	(0.075)	(0.066)	(0.126)	(0.074)	(0.065)	(0.124)
Constant	1.895***	1.770***	1.990***	2.067***	1.904***	2.201***
	(0.127)	(0.107)	(0.247)	(0.128)	(0.107)	(0.248)
R-squared	0.023	0.023	0.023	0.023	0.023	0.023
Number of HFs	5,302	1,897	3,405	5,302	1,897	3,405
Strategy FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes

Table 12: The Volcker Rule and hedge funds' liquidity provision: implementation and full compliance periods

This table reports the results from Equation (4) estimating the impact of the Volcker Rule on hedge funds' liquidity provision during three different phases. We use the whole sample (All) and sub-samples of hedge funds with the operational risk measure above (High-OR) or below (Low-OR) the median separately. *Rlp* represents the returns from providing liquidity calculated based on the method proposed by Jylhä et al. (2014), Rlp^{Liquid} and $Rlp^{Illiquid}$ are calculated using sub-samples of stocks with the Amihud measure below and above the median respectively, *Phase*1 is a dummy variable that equal 1 between July 2010 and March 2014, *Phase*2 is a dummy variable that equal 1 between April 2014 and July 2017, *Phase*3 is a dummy variable that equal 1 between August 2017 and December 2018, and *Connect* is a dummy variable that equals 1 if a US-based LCFI is a prime broker of a hedge fund. MKT, SMB, TERM, CREDIT, PTFSBD, PTFSFX, and PTFSCOM are the Fung and Hsieh 7 factors. Standard errors are clustered at the fund level and reported in brackets. *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
		Rlp			Rlp^{Liquid}			$Rlp^{Illiquid}$	
Sample=	All	High-OR	Low-OR	All	High-OR	Low-OR	All	High-OR	Low-OR
Rlp (γ_0)	54.275***	42.272***	66.993***	-20.004***	-23.934***	-15.090**	26.292***	24.876***	27.761***
	(3.388)	(3.551)	(5.850)	(3.640)	(3.553)	(6.409)	(2.019)	(2.377)	(3.262)
Rlp·Phase1 (γ_1^{Phase1})	70.391***	47.540***	84.128***	59.442***	55.355***	60.503***	-12.137***	-12.496***	-12.799***
	(5.915)	(5.479)	(9.875)	(5.468)	(5.159)	(9.311)	(2.821)	(3.154)	(4.520)
Rlp·Phase2 (γ_1^{Phase2})	-101.935***	-74.398***	-127.310***	39.480***	52.578***	25.187**	-89.030***	-73.033***	-102.554***
	(7.265)	(7.397)	(11.137)	(7.563)	(8.025)	(11.655)	(3.358)	(4.182)	(5.023)
Rlp·Phase3 (γ_1^{Phase3})	89.771***	68.666***	90.114***	109.547***	97.977***	111.038***	51.920***	47.041***	53.528***
	(10.297)	(10.330)	(14.874)	(6.134)	(7.262)	(9.096)	(5.470)	(7.353)	(7.463)
Rlp·Connect (γ_2)	-5.063	-6.475	-2.951	16.242	-0.667	31.748**	1.862	3.744	0.395
	(9.280)	(10.659)	(15.115)	(11.183)	(15.907)	(15.259)	(5.006)	(5.714)	(8.190)
Rlp·Phase1·Connect (γ_3^{Phase1})	29.955*	8.786	60.774**	-29.007**	-26.835	-25.055	-3.477	-11.614	6.371
	(17.940)	(18.436)	(29.084)	(14.685)	(18.664)	(22.003)	(8.806)	(9.684)	(14.444)
Rlp·Phase2·Connect (γ_3^{Phase2})	3.401	-37.294	44.391	-25.202	16.780	-73.075	16.101	-0.843	31.073
	(33.609)	(38.853)	(56.103)	(38.471)	(38.754)	(68.686)	(16.011)	(20.551)	(24.771)
Rlp·Phase3·Connect (γ_3^{Phase3})	42.553	86.565	27.625	17.070	57.962	-15.200	42.743	48.305	49.098
	(46.467)	(58.663)	(74.115)	(31.272)	(41.411)	(48.283)	(30.213)	(40.716)	(44.138)
MKT	-2.699***	-1.163***	-4.008***	-2.721***	-1.191***	-4.036***	-1.790***	-0.638***	-2.783***
	(0.222)	(0.237)	(0.356)	(0.220)	(0.236)	(0.352)	(0.135)	(0.168)	(0.203)
SMB	-1.871***	-0.532	-3.064***	-2.121***	-0.690*	-3.413***	-2.206***	-1.175***	-3.124***
	(0.316)	(0.356)	(0.505)	(0.318)	(0.359)	(0.506)	(0.202)	(0.249)	(0.308)
Term	-0.607***	-0.638***	-0.574***	-0.650***	-0.666***	-0.632***	-0.196***	-0.276***	-0.128***
	(0.059)	(0.058)	(0.098)	(0.060)	(0.059)	(0.099)	(0.033)	(0.042)	(0.049)
Credit	-4.013***	-3.403***	-4.521***	-4.037***	-3.421***	-4.559***	-2.330***	-2.288***	-2.360***
	(0.110)	(0.113)	(0.178)	(0.107)	(0.111)	(0.174)	(0.044)	(0.057)	(0.066)
PTFSBD	-2.042***	-2.010***	-2.078***	-2.060***	-1.985***	-2.136***	-1.807***	-1.821***	-1.814***
	(0.087)	(0.090)	(0.142)	(0.087)	(0.089)	(0.140)	(0.062)	(0.073)	(0.097)
PTFSFX	1.016***	0.502***	1.436***	0.979***	0.476***	1.389***	0.998***	0.566***	1.353***
	(0.054)	(0.054)	(0.087)	(0.053)	(0.053)	(0.084)	(0.038)	(0.042)	(0.058)
PTFSCOM	-0.544***	-0.763***	-0.345***	-0.643***	-0.842***	-0.463***	-0.241***	-0.525***	0.016
	(0.073)	(0.064)	(0.124)	(0.073)	(0.065)	(0.123)	(0.045)	(0.047)	(0.071)
Constant	2.104***	1.934***	2.244***	2.038***	1.873***	2.175***	1.736***	1.853***	1.573***
	(0.128)	(0.107)	(0.248)	(0.128)	(0.107)	(0.248)	(0.092)	(0.101)	(0.159)
R-squared	0.023	0.023	0.023	0.023	0.023	0.023	0.019	0.019	0.019
Number of HFs	5,302	1,897	3,405	5,302	1,897	3,405	5,302	1,897	3,405
Strategy FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Table 13: The Volcker Rule and hedge funds' market liquidity exposure: matched funds

This table reports the results from Equation (4) estimating the impact of the Volcker Rule on hedge funds' exposure to market liquidity risk using only matched samples. We use the whole sample (All) and sub-samples of hedge funds with the operational risk measure above (High-OR) or below (Low-OR) the median separately. *LIQ* represents the Pástor and Stambaugh (2003) market liquidity factor and *TradeLiq* represents the Pástor and Stambaugh (2003) traded liquidity factor. *Volcker* is a dummy variable that equals 1 after April 2014, and *Connect* is a dummy variable that equals 1 if a US-based LCFI is a prime broker of a hedge fund. MKT, SMB, TERM, CREDIT, PTFSBD, PTFSFX, and PTFSCOM are the Fung and Hsieh 7 factors. Standard errors are reported in brackets. *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

	(1)	(2)	(3)	(4)	(5)	(6)
Liquidity measure L=		LIQ			TradedLiq	
Sample=	All	High-OR	Low-OR	All	High-OR	Low-OR
L (γ_0)	9.185***	7.066***	12.377***	12.478***	9.520***	16.641***
	(0.790)	(0.787)	(1.476)	(1.577)	(1.637)	(2.929)
L·Volcker (γ_1)	-6.810***	-3.100**	-11.296***	-10.049***	-4.047	-16.526***
	(1.507)	(1.371)	(2.552)	(2.562)	(2.997)	(4.198)
L·Connect-US (γ_2)	-1.984*	-0.392	-4.675**	-2.746	1.276	-8.021**
	(1.128)	(1.325)	(1.906)	(2.354)	(2.728)	(4.041)
L·Volcker·Connect-US (γ_3)	3.207	0.538	6.988**	13.138***	1.742	26.311***
	(1.951)	(2.105)	(3.222)	(4.161)	(4.883)	(6.903)
MKT	-0.444	0.168	-1.040	-1.948***	-1.036*	-2.948***
	(0.559)	(0.560)	(0.996)	(0.550)	(0.532)	(0.991)
SMB	-4.289***	-3.031***	-5.754***	-3.365***	-2.229**	-4.688***
	(0.871)	(1.044)	(1.455)	(0.867)	(1.052)	(1.432)
Term	-1.031***	-0.879***	-1.209***	-0.802***	-0.721***	-0.884***
	(0.168)	(0.157)	(0.310)	(0.163)	(0.152)	(0.302)
Credit	-3.872***	-3.317***	-4.461***	-3.731***	-3.163***	-4.335***
	(0.274)	(0.284)	(0.475)	(0.266)	(0.271)	(0.462)
PTFSBD	-3.006***	-2.908***	-3.131***	-2.617***	-2.559***	-2.699***
	(0.240)	(0.280)	(0.402)	(0.233)	(0.270)	(0.391)
PTFSFX	1.012***	0.491***	1.604***	0.995***	0.501***	1.544***
	(0.162)	(0.149)	(0.296)	(0.163)	(0.148)	(0.298)
PTFSCOM	-0.874***	-0.944***	-0.799**	-1.061***	-1.120***	-0.991***
	(0.177)	(0.172)	(0.323)	(0.176)	(0.173)	(0.319)
Constant	2.522***	1.793***	3.568***	2.690***	1.931***	3.770***
	(0.516)	(0.298)	(1.158)	(0.517)	(0.295)	(1.165)
R-squared	0.063	0.063	0.063	0.055	0.055	0.055
Number of HFs	654	285	369	654	285	369
Strategy FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes

Table 14: The Volcker Rule and hedge funds' liquidity provision: matched funds

This table reports the results from Equation (4) estimating the impact of the Volcker Rule on hedge funds' liquidity provision using only matched samples. We use the whole sample (All) and sub-samples of hedge funds with the operational risk measure above (High-OR) or below (Low-OR) the median separately. *Rlp* represents the returns from providing liquidity calculated based on the method proposed by Jylhä et al. (2014), Rlp^{Liquid} and $Rlp^{Illiquid}$ are calculated using sub-samples of stocks with the Amihud measure below and above the median respectively, *Volcker* is a dummy variable that equals 1 after April 2014, and *Connect* is a dummy variable that equals 1 if a US-based LCFI is a prime broker of a hedge fund. MKT, SMB, TERM, CREDIT, PTFSBD, PTFSFX, and PTFSCOM are the Fung and Hsieh 7 factors. Standard errors are clustered at the fund level and reported in brackets. *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
		Rlp			Rlp^{Liquid}			$Rlp^{Illiquid}$	
Sample=	All	High-OR	Low-OR	All	High-OR	Low-OR	All	High-OR	Low-OR
Rlp (γ_0)	77.754***	51.374***	118.616***	-38.896***	-27.665***	-53.892**	12.678**	9.950*	16.580*
	(10.293)	(11.073)	(19.163)	(10.643)	(10.451)	(21.426)	(5.280)	(5.844)	(9.561)
Rlp·Volcker (γ_1)	-35.198*	-16.964	-73.072**	96.015***	98.470***	97.818***	-11.846	-11.755	-15.939
	(19.343)	(17.782)	(33.464)	(18.872)	(20.513)	(31.548)	(8.587)	(9.334)	(14.416)
Rlp·Connect (γ_2)	-14.450	-2.699	-38.936	42.569***	11.806	78.070***	8.414	10.719	5.114
	(14.071)	(15.382)	(25.134)	(15.958)	(19.938)	(27.572)	(6.821)	(7.759)	(11.819)
Rlp·Volcker·Connect (γ_3)	73.837***	19.488	158.734***	-2.177	27.831	-38.779	25.457**	10.149	48.028**
	(27.739)	(28.531)	(48.324)	(32.785)	(36.188)	(58.821)	(12.244)	(14.687)	(19.519)
MKT	-1.476***	-0.738	-2.285**	-1.917***	-1.038*	-2.842***	-1.012***	-0.524	-1.565***
	(0.553)	(0.537)	(0.995)	(0.554)	(0.537)	(0.998)	(0.332)	(0.393)	(0.547)
SMB	-2.577***	-1.561	-3.795***	-2.838***	-1.651	-4.257***	-2.992***	-1.938***	-4.224***
	(0.866)	(1.043)	(1.439)	(0.869)	(1.046)	(1.445)	(0.602)	(0.735)	(0.986)
Term	-0.407**	-0.381***	-0.424	-0.541***	-0.470***	-0.615**	0.048	-0.085	0.198
	(0.158)	(0.146)	(0.293)	(0.160)	(0.148)	(0.295)	(0.089)	(0.102)	(0.153)
Credit	-4.010***	-3.457***	-4.602***	-4.114***	-3.518***	-4.749***	-2.424***	-2.450***	-2.406***
	(0.275)	(0.284)	(0.478)	(0.276)	(0.287)	(0.477)	(0.109)	(0.137)	(0.173)
PTFSBD	-2.706***	-2.642***	-2.796***	-2.650***	-2.574***	-2.755***	-2.251***	-2.284***	-2.226***
	(0.235)	(0.274)	(0.393)	(0.234)	(0.272)	(0.393)	(0.170)	(0.209)	(0.276)
PTFSFX	1.031***	0.508***	1.631***	0.898***	0.409***	1.444***	0.831***	0.496***	1.200***
	(0.165)	(0.153)	(0.301)	(0.161)	(0.145)	(0.297)	(0.106)	(0.101)	(0.191)
PTFSCOM	-0.945***	-0.989***	-0.889***	-0.964***	-1.018***	-0.903***	-0.467***	-0.642***	-0.259
	(0.175)	(0.171)	(0.318)	(0.174)	(0.170)	(0.314)	(0.113)	(0.121)	(0.195)
Constant	2.741***	1.973***	3.843***	2.674***	1.910***	3.771***	1.925***	1.801***	2.079***
	(0.517)	(0.297)	(1.161)	(0.516)	(0.299)	(1.155)	(0.297)	(0.274)	(0.626)
R-squared	0.056	0.056	0.056	0.058	0.058	0.058	0.033	0.033	0.033
Number of HFs	654	285	369	654	285	369	654	285	369
Strategy FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Table 15: The Volcker Rule and hedge funds' flow-performance sensitivity, market liquidity exposure, and liquidity provision: Within-fund analysis

This table compares hedge funds' flow-performance sensitivity, market liquidity exposure, and liquidity provision for the same hedge fund before and after the Volcker Rule. We regress flows on return and return on liquidity-related factors for the same hedge fund during the pre-Volcker (January 2010 to March 2014) and post-Volcker (April 2014 to December 2018) periods separately and report the coefficients on returns and liquidity-related factors. Panel A uses the whole sample, and Panels B and C use sub-samples of hedge funds with the operational risk measure above or below the median, respectively. *LIQ* represents the Pástor and Stambaugh (2003) market liquidity factor and $TradeLiq$ represents the Pástor and Stambaugh (2003) traded liquidity factor. *Rlp* represents the returns from providing liquidity calculated following Jylhä et al. (2014). t-test is the test statistics for the two-sample test for the mean difference, ks-test is the test statistics for the Kolmogorov-Smirnov test and cm-test is the test statistics for Cramer-von Mises test for the difference in distibutions. *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

	Average value		t-test	ks-test	cm-test	N
	Pre-Volcker	Post-Volcker				
Panel A: Full sample						
Flow regression						
Ret (β_0^R)	4.056	5.750	-0.522	0.074**	0.672**	927
Return regression						
LIQ (β_0^L)	7.538	3.760	4.963***	0.137***	4.368	1288
TradedLiq(β_0^L)	9.718	3.231	6.647***	0.135***	5.006***	1288
Rlp (β_0^L)	183.062	87.759	9.050***	0.196***	11.352***	1288
Panel B: Hedge fund with high operational risk						
Flow regression						
Ret (β_0^R)	3.465	6.382	-0.549	0.115***	1.038***	526
Return regression						
LIQ(β_0^L)	5.439	4.751	1.201	0.097***	0.937***	723
TradedLiq(β_0^L)	8.110	2.655	5.909***	0.148***	3.277***	723
Rlp(β_0^L)	127.861	70.495	7.473***	0.174***	5.426***	723
Panel C: Hedge fund with low operational risk						
Flow regression						
Ret (β_0^R)	4.816	4.936	-0.069	0.075	0.221	400
Return regression						
LIQ (β_0^L)	10.224	2.491	4.962***	0.195***	4.216***	565
TradedLiq (β_0^L)	11.775	3.969	4.142***	0.135***	1.989***	565
Rlp (β_0^L)	253.701	109.851	6.615***	0.266***	7.531***	565

Table 16: Probability of a hedge fund to be connected to LCFI prime broker

This table reports the probability of a hedge fund to be connected to LCFI prime broker. $lnAUM$ represents the natural logarithm of hedge fund dollar assets before April 2014. *Operational risk* is the sum of risk points for *Repeat* and $kink1$ if they are above the median, and for *Negative* and $kink2$ are below the median. We construct 59 dummy variables for each domicile and report only the significantly significant variables due to the limited space. *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

	(1) Connect
lnAUM	0.001***
	(0.000)
Operational risk	0.006***
	(0.000)
Domicile_Bermuda	0.014**
	(0.006)
Domicile_BVI	0.014***
	(0.005)
Domicile_Cayman	0.007**
	(0.004)
Domicile_IM	0.003*
	(0.002)
Domicile_Malta	0.003**
	(0.001)
Domicile_UK	0.003***
	(0.001)
Domicile_US	0.002***
	(0.001)
Constant	-0.017
	(0.041)
R-squared	0.018
Number of HFs	4374

Table 17: The Volcker Rule and hedge funds' market liquidity exposure: controlling for connection endogeneity

This table reports the results from Equation (4) estimating the impact of the Volcker Rule on hedge funds' exposure to market liquidity risk. We use the whole sample (All) and sub-samples of hedge funds with the operational risk measure above (High-OR) or below (Low-OR) the median separately. LIQ represents the Pástor and Stambaugh (2003) market liquidity factor and $TradeLiq$ represents the Pástor and Stambaugh (2003) traded liquidity factor. $Volcker$ is a dummy variable that equals 1 after April 2014, and $Connect$ is a dummy variable that equals 1 if a US-based LCFI is a prime broker of a hedge fund. MKT, SMB, TERM, CREDIT, PTFSBD, PTFSFX, and PTFSCOM are the Fung and Hsieh 7 factors. Standard errors are reported in brackets. *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

	(1)	(2)	(3)	(4)	(5)	(6)
Liquidity measure L=		LIQ			TradedLiq	
Sample=	All	High-OR	Low-OR	All	High-OR	Low-OR
L (γ_0)	8.594***	6.514***	10.621***	9.262***	7.989***	10.468***
	(0.262)	(0.261)	(0.441)	(0.425)	(0.430)	(0.717)
L·Volcker (γ_1)	-7.325***	-4.584***	-9.879***	-10.542***	-6.815***	-13.702***
	(0.452)	(0.415)	(0.734)	(0.712)	(0.730)	(1.135)
L·Connect (γ_2)	-0.503	0.125	-1.009	0.744	1.789	-0.245
	(0.752)	(0.919)	(1.194)	(1.516)	(1.832)	(2.429)
L·Volcker·Connect (γ_3)	1.963	0.305	3.625*	10.005***	3.669	16.474***
	(1.366)	(1.658)	(2.166)	(3.111)	(3.586)	(5.286)
MKT	-1.015***	-0.219	-1.644***	-2.575***	-1.349***	-3.644***
	(0.235)	(0.248)	(0.385)	(0.238)	(0.250)	(0.389)
SMB	-3.401***	-1.520***	-5.224***	-2.423***	-0.753**	-4.046***
	(0.340)	(0.366)	(0.562)	(0.338)	(0.368)	(0.558)
Term	-1.195***	-1.092***	-1.291***	-0.885***	-0.892***	-0.870***
	(0.067)	(0.065)	(0.113)	(0.065)	(0.062)	(0.111)
Credit	-3.827***	-3.319***	-4.271***	-3.753***	-3.225***	-4.215***
	(0.115)	(0.117)	(0.188)	(0.112)	(0.114)	(0.184)
PTFSBD	-2.420***	-2.319***	-2.533***	-2.070***	-2.038***	-2.116***
	(0.099)	(0.098)	(0.165)	(0.096)	(0.096)	(0.161)
PTFSFX	1.124***	0.565***	1.636***	1.084***	0.551***	1.563***
	(0.058)	(0.058)	(0.095)	(0.058)	(0.057)	(0.096)
PTFSCOM	-0.524***	-0.792***	-0.283**	-0.618***	-0.893***	-0.361***
	(0.082)	(0.071)	(0.142)	(0.081)	(0.070)	(0.140)
IMR	-0.010**	-0.009	-0.003	-0.010**	-0.009	-0.003
	(0.004)	(0.006)	(0.007)	(0.004)	(0.006)	(0.007)
Constant	2.533***	2.363***	2.133***	2.725***	2.489***	2.388***
	(0.346)	(0.438)	(0.560)	(0.346)	(0.437)	(0.559)
R-squared	0.037	0.037	0.037	0.037	0.037	0.037
Number of HFs	4,187	1,675	2,512	4,187	1,675	2,512
Strategy FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes

Table 18: The Volcker Rule and hedge funds' liquidity provision: controlling for connection endogeneity

This table reports the results from Equation (4) estimating the impact of the Volcker Rule on hedge funds' liquidity provision. We use the whole sample (All) and sub-samples of hedge funds with the operational risk measure above (High-OR) or below (Low-OR) the median separately. *Rlp* represents the returns from providing liquidity calculated based on the method proposed by Jylhä et al. (2014), Rlp^{Liquid} and $Rlp^{Illiquid}$ are calculated using sub-samples of stocks with the Amihud measure below and above the median respectively, *Volcker* is a dummy variable that equals 1 after April 2014, and *Connect* is a dummy variable that equals 1 if a US-based LCFI is a prime broker of a hedge fund. MKT, SMB, TERM, CREDIT, PTFSBD, PTFSFX, and PTFSCOM are the Fung and Hsieh 7 factors. Standard errors are clustered at the fund level and reported in brackets. *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Rlp=		*Rlp*			Rlp^{Liquid}			$Rlp^{Illiquid}$	
Sample=	All	High-OR	Low-OR	All	High-OR	Low-OR	All	High-OR	Low-OR
Rlp (γ_0)	70.148***	49.987***	90.651***	-8.325**	-14.352***	-1.846	18.741***	17.262***	20.416***
	(3.267)	(3.360)	(5.535)	(3.256)	(3.200)	(5.588)	(1.589)	(1.886)	(2.518)
Rlp·Volcker (γ_1)	-31.753***	-8.488	-56.340***	72.885***	76.014***	67.190***	-25.139***	-14.764***	-34.922***
	(5.899)	(5.588)	(9.691)	(5.757)	(5.938)	(9.237)	(2.564)	(3.011)	(3.972)
Rlp·Connect (γ_2)	-9.011	-8.581	-7.215	6.206	-7.850	20.670	1.359	1.976	1.322
	(9.104)	(10.286)	(15.009)	(10.716)	(14.915)	(14.803)	(4.422)	(5.000)	(7.376)
Rlp·Volcker·Connect (γ_3)	43.686**	12.222	84.526**	12.232	45.925*	-25.003	25.483***	11.400	41.958***
	(20.347)	(21.927)	(36.228)	(26.602)	(27.573)	(50.314)	(9.050)	(10.955)	(14.562)
MKT	-2.177***	-1.055***	-3.154***	-2.621***	-1.370***	-3.726***	-1.518***	-0.627***	-2.305***
	(0.238)	(0.250)	(0.389)	(0.238)	(0.250)	(0.387)	(0.145)	(0.178)	(0.222)
SMB	-1.625***	-0.144	-3.062***	-1.885***	-0.245	-3.477***	-2.097***	-0.949***	-3.204***
	(0.338)	(0.369)	(0.558)	(0.339)	(0.370)	(0.558)	(0.219)	(0.261)	(0.345)
Term	-0.573***	-0.629***	-0.512***	-0.700***	-0.713***	-0.678***	-0.191***	-0.284***	-0.106**
	(0.064)	(0.061)	(0.109)	(0.064)	(0.062)	(0.109)	(0.035)	(0.043)	(0.054)
Credit	-3.971***	-3.438***	-4.437***	-4.074***	-3.495***	-4.588***	-2.368***	-2.364***	-2.380***
	(0.117)	(0.119)	(0.191)	(0.115)	(0.119)	(0.188)	(0.047)	(0.060)	(0.070)
PTFSBD	-2.106***	-2.085***	-2.141***	-2.072***	-2.033***	-2.120***	-1.909***	-1.916***	-1.918***
	(0.097)	(0.097)	(0.162)	(0.096)	(0.096)	(0.161)	(0.069)	(0.078)	(0.110)
PTFSFX	1.096***	0.546***	1.596***	0.956***	0.454***	1.408***	1.026***	0.572***	1.432***
	(0.060)	(0.058)	(0.098)	(0.058)	(0.056)	(0.096)	(0.041)	(0.045)	(0.065)
PTFSCOM	-0.570***	-0.834***	-0.323**	-0.606***	-0.856***	-0.378***	-0.256***	-0.572***	0.034
	(0.081)	(0.069)	(0.140)	(0.080)	(0.069)	(0.137)	(0.050)	(0.052)	(0.082)
IMR	-0.010**	-0.009	-0.003	-0.010**	-0.009	-0.003	-0.012***	-0.010**	-0.003
	(0.004)	(0.006)	(0.007)	(0.004)	(0.006)	(0.007)	(0.003)	(0.005)	(0.004)
Constant	2.758***	2.522***	2.425***	2.695***	2.459***	2.357***	2.571***	2.576***	1.801***
	(0.346)	(0.438)	(0.559)	(0.346)	(0.438)	(0.559)	(0.255)	(0.380)	(0.365)
R-squared	0.038	0.038	0.038	0.038	0.038	0.038	0.027	0.027	0.027
Number of HFs	4,187	1,675	2,512	4,187	1,675	2,512	4,187	1,675	2,512
Strategy FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

The Volcker Rule and the hedge fund liquidity circle

Supplementary results

Appendix A Results for hedge fund investment categories

To account for potentially heterogeneous effects of the Volcker Rule across hedge fund strategies, we repeat the analysis for sub-samples of funds in different investment style categories (Table A1). We classify funds according to whether their strategy is arbitrage (non-directional), clearly directional or semi-directional. Previous studies show significant differences between these fund investment styles which maybe relevant when capturing the regulatory effects. Agarwal and Naik (2000) show that the performance of directional funds exhibits a high correlation with market returns, a feature absent from non-directional (market-neutral) funds. McGuire et al. (2005) find that the performance of market neutral funds is independent from the market movements, with exposure to fixed income market risk factors being more important for such funds. Such patterns suggest any reduction in market liquidity resulting from constraints on banks' market-making activities may have a more pronounced effect on directional funds. The results in Table A1 indicate that all categories of funds exhibit a positive and significant loading on the market liquidity factors, with semi-directional funds having the highest exposure. Subsequent to the Volcker Rule, while all categories of funds significantly reduce their exposure to market liquidity, the most pronounced effect is associated with directional funds, which is consistent with our expectations. The corresponding coefficients γ_1 of

-11.88 on LIQ and -16.38 on $TradedLiq$, both significant at the 1% level. Economically, after the Rule a one standard deviation increase in LIQ leads to a reduction of 73 bp in Directional hedge fund returns. Semi-directional funds with lower operational risk and prime brokerage connections to LCFIs evidence a more modest reduction in exposure to market liquidity following the Volcker Rule's implementation, which is captured by the positive and significant value of γ_3 for both liquidity measures.

Looking at hedge funds' liquidity provision, both non-directional and semi-directional funds customarily demand liquidity when trading liquid stocks, as evidenced by the negative and highly significant γ_0 coefficients in columns (2) and (3) of Table A2, whereas directional funds appear to provide it. Historically, directional and semi-directional funds provide liquidity to illiquid stocks. Following the Volcker Rule, several changes are apparent. All funds increase their liquidity provision to liquid stocks (positive and significant γ_1 in columns (1) to (3)), while directional and semi-directional funds reduce their liquidity provision to illiquid stocks (negative and significant γ_1 in columns (4) and (6)). Directional funds turn from liquidity providers to demanding liquidity for illiquid stocks. Connected semi-directional funds are more likely to provide liquidity to illiquid stocks before the Rule and further increase their liquidity provision subsequently.

[Tables A1 and A2 in here]

Table A1: The Volcker Rule and hedge funds' market liquidity exposure by investment style category

This table compares the results from Equation (4) estimating the impact of the Volcker Rule on directional, non-directional and semi-directional funds' exposure to market liquidity risk. *LIQ* represents the Pástor and Stambaugh (2003) market liquidity factor and *TradeLiq* represents the Pástor and Stambaugh (2003) traded liquidity factor. *Volcker* is a dummy variable that equals 1 after April 2014, and *Connect* is a dummy variable that equals 1 if a US-based LCFI is a prime broker of a hedge fund. MKT, SMB, TERM, CREDIT, PTFSBD, PTFSFX, and PTFSCOM are the Fung and Hsieh 7 factors. Standard errors are clustered at the fund level and reported in brackets. *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

liquidity measure L =	(1)	(2)	(3)	(4)	(5)	(6)
	LIQ			TradedLiq		
	Directional	Non-directional	Semi-directional	Directional	Non-directional	Semi-directional
L (γ_0)	5.784***	5.616***	9.266***	2.875***	7.083***	12.121***
	(0.454)	(0.521)	(0.326)	(0.719)	(0.720)	(0.566)
L·Volcker (γ_1)	-11.879***	-3.717***	-5.784***	-16.379***	-6.773***	-7.473***
	(0.830)	(0.888)	(0.547)	(1.297)	(1.151)	(0.933)
L·Connect (γ_2)	-2.058	-0.300	-1.371	0.049	-1.156	-1.676
	(1.338)	(1.242)	(0.842)	(4.014)	(2.194)	(1.737)
L·Volcker·Connect (γ_3)	1.970	-1.218	2.729*	16.454**	4.353	12.099***
	(4.446)	(1.544)	(1.593)	(7.571)	(3.848)	(3.455)
MKT	0.786	-0.945**	-1.456***	-0.347	-1.756***	-3.097***
	(0.489)	(0.441)	(0.287)	(0.488)	(0.457)	(0.289)
SMB	-1.511**	-1.293**	-4.393***	-1.047*	-0.632	-3.298***
	(0.612)	(0.538)	(0.470)	(0.597)	(0.538)	(0.467)
Term	-0.898***	-1.321***	-0.857***	-0.506***	-1.183***	-0.620***
	(0.138)	(0.113)	(0.085)	(0.137)	(0.111)	(0.083)
Credit	-1.148***	-3.839***	-4.313***	-1.200***	-3.752***	-4.177***
	(0.200)	(0.228)	(0.143)	(0.195)	(0.224)	(0.140)
PTFSBD	0.727***	-2.465***	-3.430***	0.951***	-2.274***	-3.046***
	(0.202)	(0.152)	(0.105)	(0.201)	(0.145)	(0.103)
PTFSFX	2.577***	0.251***	0.890***	2.605***	0.226***	0.824***
	(0.162)	(0.072)	(0.057)	(0.162)	(0.072)	(0.056)
PTFSCOM	2.014***	-1.132***	-1.384***	1.926***	-1.156***	-1.495***
	(0.201)	(0.096)	(0.083)	(0.196)	(0.095)	(0.083)
Constant	1.662***	1.352***	2.184***	1.805***	1.466***	2.371***
	(0.206)	(0.217)	(0.212)	(0.207)	(0.214)	(0.212)
R-squared	0.049	0.049	0.049	0.048	0.048	0.048
Number of HFs	1,230	934	2,604	1,230	934	2,604
Strategy FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes

Table A2: The Volcker Rule and hedge funds' liquidity provision by investment style category

This table compares the results from Equation (4) estimating the impact of the Volcker Rule on directional, non-directional and semi-directional funds' liquidity provision. Rlp^{Liquid} and $Rlp^{Illiquid}$ represent the returns from providing liquidity calculated based on the method proposed by Jylhä et al. (2014) for stocks with the Amihud illiquidity measure below and above the median respectively, $Volcker$ is a dummy variable that equals 1 after April 2014, $Connect$ is a dummy variable that equals 1 if a US-based LCFI is a prime broker or management company of a hedge fund. MKT, SMB, TERM, CREDIT, PTFSBD, PTFSFX, and PTFSCOM are the Fung and Hsieh 7 factors. Standard errors are clustered at the fund level and reported in brackets. *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

$Rlp =$	(1)	(2) Rlp^{Liquid}	(3)	(4)	(5) $Rlp^{Illiquid}$	(6)
	Directional	Non-directional	Semi-directional	Directional	Non-directional	Semi-directional
Rlp (γ_0)	22.850***	-11.478**	-25.009***	29.977***	2.197	17.972***
	(6.712)	(5.484)	(4.119)	(3.451)	(2.655)	(2.058)
Rlp·Volcker (γ_1)	57.707***	37.524***	90.627***	-54.839***	-5.762	-13.373***
	(11.870)	(7.860)	(6.992)	(5.240)	(3.735)	(3.285)
Rlp·Connect (γ_2)	45.394	8.867	24.252**	0.825	-5.881	9.820*
	(31.156)	(20.619)	(11.592)	(10.062)	(9.503)	(5.365)
Rlp·Volcker ·Connect (γ_3)	-17.227	-41.727	31.532	17.368	13.370	24.307**
	(148.326)	(41.601)	(24.472)	(22.738)	(14.023)	(11.468)
MKT	-0.497	-1.798***	-3.027***	-0.409	-0.916***	-1.759***
	(0.480)	(0.454)	(0.290)	(0.282)	(0.294)	(0.182)
SMB	-0.840	-0.253	-2.699***	-0.426	-0.347	-3.122***
	(0.603)	(0.534)	(0.471)	(0.406)	(0.339)	(0.304)
Term	-0.571***	-1.046***	-0.328***	-0.481***	-0.598***	0.161***
	(0.136)	(0.108)	(0.082)	(0.072)	(0.069)	(0.043)
Credit	-1.362***	-3.978***	-4.544***	-1.104***	-2.451***	-2.671***
	(0.198)	(0.232)	(0.144)	(0.089)	(0.101)	(0.058)
PTFSBD	0.926***	-2.253***	-3.041***	0.680***	-1.911***	-2.719***
	(0.198)	(0.148)	(0.104)	(0.131)	(0.100)	(0.074)
PTFSFX	2.424***	0.144**	0.708***	2.086***	0.256***	0.828***
	(0.161)	(0.070)	(0.056)	(0.112)	(0.049)	(0.041)
PTFSCOM	1.811***	-1.134***	-1.417***	1.300***	-0.776***	-0.797***
	(0.195)	(0.093)	(0.081)	(0.117)	(0.056)	(0.055)
Constant	1.799***	1.438***	2.339***	1.323***	1.536***	2.041***
	(0.206)	(0.214)	(0.213)	(0.146)	(0.148)	(0.147)
R-squared	0.048	0.048	0.048	0.026	0.026	0.026
Number of HFs	1,230	934	2,604	1,230	934	2,604
Strategy FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes

Appendix B Results for individual hedge fund styles

In this appendix, we classify funds according to their reported investment strategies. Prior literature documents that substantial differences in performance, leverage and liquidity risk exposure exist across hedge fund strategies. Klaus and Rzepkowski (2009) find that Fixed Income and Convertible Arbitrage funds, which are among the most leveraged funds, perform extremely poorly during the peak of the 2008 crisis. Ang et al. (2011) show that the average gross leverage of Relative Value funds is around 3 times higher than that of Equity and Event-Driven funds. Sadka (2010) argues that Long/Short Equity, Multi-Strategy and Emerging Markets are the top three performing fund indices with the highest market liquidity exposures. Jylhä et al. (2014) find that funds in the Equity Market Neutral and Event-Driven categories are more likely to supply market liquidity.

The results in Table B1 show that all styles have significant positive exposure to market liquidity. The largest coefficients, 16.416 and 9.635, are found for the Other and Long/Short Equities funds, respectively. After the Volcker Rule, hedge funds significantly decrease their exposure to market liquidity, especially those funds in the Managed Futures and Other categories. In addition, a more pronounced impact can be seen for connected funds in the Fixed Income style, with the coefficient γ_3 on the interaction term $LIQ \cdot Volcker \cdot Connect$ being significantly negative. As Fixed Income funds exploit price differences between related fixed income instruments, thereby reducing mispricing in this relatively illiquid market segment, one implication of this result is that overall market liquidity and efficiency may be adversely affected by hedge funds reducing their liquidity exposure. Table B2 reports the results using the traded liquidity measure of Pástor and Stambaugh (2003) and the interpretation of the results remain qualitatively unchanged.

[Table B1 and B2 in here]

Tables B3 and B4 reveal that the majority of investment styles exhibit a negative relation with Rlp^{Liquid} (with the exception of Managed Futures), and a positive relation with $Rlp^{Illiquid}$, suggesting that overall, hedge funds generally perform as liquidity re-distributors. As a class, they demand liquidity when trading the more liquid stock-market segment and provide it to the relatively less liquid segment. After the Volcker Rule, all styles increase their liquidity provision to the liquid stock segment, with the Multi Strategy funds connected to LCFIs exhibiting the strongest increase. In contrast, all styles reduce their liquidity provision to the illiquid stock segment, with the exception of Long/Short Equities and Other funds connected to LCFIs. Overall, after implementation of the Volcker Rule, hedge funds appear to collectively retrench from the role of liquidity re-distribution which they are previously undertaking.

[Tables B3 and B4 in here]

Table B1: The Volcker Rule and hedge funds' market liquidity exposure by investment strategy

This table reports the results from Equation (4) estimating the impact of the Volcker Rule on hedge funds' exposure to market liquidity risk by different investment strategies. *LIQ* represents the Pástor and Stambaugh (2003) market liquidity factor, *Volcker* is a dummy variable that equals 1 after April 2014, and *Connect* is a dummy variable that equals 1 if a US-based LCFI is a prime broker of a hedge fund. MKT, SMB, TERM, CREDIT, PTFSBD, PTFSFX, and PTFSCOM are the Fung and Hsieh 7 factors. Standard errors are clustered at the fund level and reported in brackets. *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

	(1) Long/Short Equities	(2) Global Macro	(3) Managed Futures	(4) Fixed Income	(5) Relative Value	(6) Event Driven	(7) Multi Strategy	(8) Others
LIQ (γ_0)	9.635***	5.656***	5.856***	4.749***	6.333***	7.998***	8.537***	16.416***
	(0.402)	(0.964)	(0.515)	(0.598)	(0.815)	(0.825)	(0.680)	(0.939)
LIQ·Volcker (γ_1)	-5.732***	-4.731***	-14.288***	-3.512***	-3.422*	-4.050**	-6.719***	-12.349***
	(0.691)	(1.540)	(0.957)	(0.654)	(2.042)	(1.688)	(0.969)	(1.235)
LIQ·Connect (γ_2)	-1.427	-0.406	-2.934**	2.220	-2.081	-1.449	-3.438*	-4.273
	(0.948)	(2.697)	(1.388)	(1.544)	(1.745)	(3.032)	(2.049)	(4.212)
LIQ·Volcker·Connect (γ_3)	2.332	-1.823	3.263	-2.715*	-1.106	5.673	4.910*	5.649
	(1.899)	(3.870)	(6.347)	(1.486)	(2.818)	(5.562)	(2.851)	(6.898)
MKT	-1.298***	-1.366	1.457**	0.166	-2.211***	1.298	-3.257***	-6.176***
	(0.335)	(0.866)	(0.581)	(0.468)	(0.764)	(1.113)	(0.632)	(0.820)
SMB	-4.816***	0.303	-1.975***	-0.754	-1.886**	-5.592***	-2.266**	-5.799***
	(0.570)	(1.148)	(0.711)	(0.581)	(0.895)	(1.409)	(0.994)	(1.242)
Term	-0.638***	-1.561***	-0.687***	-1.318***	-1.321***	-1.121***	-1.582***	-3.134***
	(0.099)	(0.253)	(0.161)	(0.128)	(0.186)	(0.335)	(0.173)	(0.209)
Credit	-4.119***	-1.730***	-0.949***	-3.477***	-4.217***	-5.307***	-4.646***	-7.706***
	(0.174)	(0.363)	(0.236)	(0.200)	(0.409)	(0.477)	(0.279)	(0.353)
PTFSBD	-3.536***	-0.807**	1.209***	-2.168***	-2.862***	-3.503***	-2.989***	-4.903***
	(0.125)	(0.347)	(0.236)	(0.148)	(0.283)	(0.320)	(0.238)	(0.304)
PTFSFX	0.970***	1.512***	2.919***	0.263***	0.232**	0.472***	0.770***	0.450***
	(0.067)	(0.221)	(0.199)	(0.088)	(0.116)	(0.160)	(0.142)	(0.143)
PTFSCOM	-1.459***	0.277	2.560***	-1.035***	-1.248***	-1.769***	-0.939***	-2.332***
	(0.100)	(0.251)	(0.246)	(0.091)	(0.179)	(0.192)	(0.195)	(0.217)
Constant	2.353***	2.978***	1.651***	1.315***	1.346***	1.795***	1.678***	1.519***
	(0.245)	(0.219)	(0.212)	(0.448)	(0.233)	(0.263)	(0.628)	(0.466)
R-squared	0.022	0.022	0.022	0.022	0.022	0.022	0.022	0.022
Number of HFs	1,897	308	922	532	402	215	492	534
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Table B2: The Volcker Rule and hedge funds' market liquidity exposure by investment strategy: traded liquidity

This table reports the results from Equation (4) estimating the impact of the Volcker Rule on hedge funds' exposure to market liquidity risk by different investment strategies. *TradeLiq* represents the Pástor and Stambaugh (2003) traded liquidity factor, *Volcker* is a dummy variable that equals 1 after April 2014, and *Connect* is a dummy variable that equals 1 if a US-based LCFI is a prime broker of a hedge fund. MKT, SMB, TERM, CREDIT, PTFSBD, PTFSFX, and PTFSCOM are the Fung and Hsieh 7 factors. Standard errors are clustered at the fund level and reported in brackets. *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

	(1) Long/Short Equities	(2) Global Macro	(3) Managed Futures	(4) Fixed Income	(5) Relative Value	(6) Event Driven	(7) Multi Strategy	(8) Others
TradedLiq (γ_0)	12.972***	4.744***	2.445***	5.465***	8.571***	10.163***	9.790***	14.400***
	(0.703)	(1.537)	(0.804)	(0.764)	(1.190)	(1.461)	(1.137)	(1.592)
TradedLiq ·Volcker (γ_1)	-6.049***	-10.106***	-18.533***	-6.641***	-5.853**	-4.763*	-12.754***	-15.066***
	(1.163)	(2.555)	(1.496)	(0.951)	(2.544)	(2.718)	(1.748)	(2.321)
TradedLiq ·Connect (γ_2)	-2.186	1.310	-1.407	5.002*	-5.834*	-0.598	-0.917	-0.086
	(1.956)	(5.816)	(5.116)	(2.834)	(3.058)	(6.477)	(4.460)	(8.053)
TradedLiq·Volcker ·Connect (γ_3)	14.581***	5.969	22.381**	0.089	6.049	-7.489	8.561*	2.831
	(4.041)	(7.374)	(10.069)	(5.021)	(5.854)	(10.074)	(5.135)	(18.986)
MKT	-3.027***	-2.435***	0.298	-0.527	-3.111***	0.011	-4.727***	-9.115***
	(0.336)	(0.882)	(0.578)	(0.467)	(0.801)	(1.089)	(0.647)	(0.834)
SMB	-3.667***	0.887	-1.546**	-0.217	-1.141	-4.531***	-1.381	-3.812***
	(0.568)	(1.141)	(0.691)	(0.580)	(0.895)	(1.354)	(0.991)	(1.252)
Term	-0.408***	-1.297***	-0.259	-1.187***	-1.173***	-0.932***	-1.295***	-2.554***
	(0.098)	(0.247)	(0.161)	(0.127)	(0.182)	(0.329)	(0.167)	(0.195)
Credit	-3.974***	-1.716***	-1.018***	-3.402***	-4.118***	-5.160***	-4.555***	-7.697***
	(0.170)	(0.347)	(0.231)	(0.196)	(0.402)	(0.479)	(0.271)	(0.355)
PTFSBD	-3.122***	-0.593*	1.437***	-2.022***	-2.624***	-3.192***	-2.678***	-4.339***
	(0.123)	(0.339)	(0.236)	(0.143)	(0.272)	(0.304)	(0.232)	(0.301)
PTFSFX	0.903***	1.475***	2.965***	0.230***	0.225**	0.377**	0.727***	0.247*
	(0.066)	(0.220)	(0.199)	(0.087)	(0.115)	(0.157)	(0.141)	(0.139)
PTFSCOM	-1.603***	0.300	2.434***	-1.015***	-1.331***	-1.807***	-0.967***	-2.300***
	(0.100)	(0.239)	(0.240)	(0.089)	(0.176)	(0.186)	(0.191)	(0.212)
Constant	2.543***	3.109***	1.797***	1.425***	1.480***	1.955***	1.866***	1.858***
	(0.245)	(0.219)	(0.213)	(0.441)	(0.234)	(0.265)	(0.627)	(0.469)
R-squared	0.023	0.023	0.023	0.023	0.023	0.023	0.023	0.023
Number of HFs	1,897	308	922	532	402	215	492	534
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Table B3: The Volcker Rule and hedge funds' liquidity provision to liquid stocks by investment strategy

This table reports the results from Equation (4) estimating the impact of the Volcker Rule on hedge funds' liquidity provision by different investment strategies. Rlp^{Liquid} represents the returns from providing liquidity calculated based on the method proposed by Jylhä et al. (2014) and using stocks with Amihud illiquidity measure below the median, $Volcker$ is a dummy variable that equals 1 after April 2014, and $Connect$ is a dummy variable that equals 1 if a US-based LCFI is a prime broker of a hedge fund. MKT, SMB, TERM, CREDIT, PTFSBD, PTFSFX, and PTFSCOM are the Fung and Hsieh 7 factors. Standard errors are clustered at the fund level and reported in brackets. *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

	(1) Long/Short Equities	(2) Global Macro	(3) Managed Futures	(4) Fixed Income	(5) Relative Value	(6) Event Driven	(7) Multi Strategy	(8) Others
Rlp^{Liquid} (γ_0)	-24.077***	4.490	27.439***	1.297	-22.302**	-60.405***	-12.652	-15.570
	(4.954)	(12.000)	(7.845)	(6.117)	(8.740)	(13.370)	(8.589)	(11.552)
Rlp^{Liquid} ·Volcker (γ_1)	92.522***	65.958***	57.628***	15.307**	64.830***	124.528***	69.853***	117.279***
	(8.802)	(25.025)	(13.293)	(7.534)	(16.084)	(20.284)	(13.121)	(19.053)
Rlp^{Liquid} ·Connect (γ_2)	25.026*	16.591	64.438*	-11.986	25.172	60.507*	-14.348	-51.111
	(13.009)	(45.432)	(37.941)	(44.023)	(20.399)	(36.594)	(29.933)	(45.614)
Rlp^{Liquid}·Volcker ·Connect (γ_3)	37.066	-19.753	-14.709	-7.752	-81.986	-108.604	98.089*	-185.042
	(28.580)	(89.229)	(230.784)	(53.314)	(85.838)	(66.992)	(57.848)	(162.090)
MKT	-2.961***	-2.514***	0.153	-0.617	-3.133***	0.245	-4.714***	-9.050***
	(0.337)	(0.860)	(0.569)	(0.468)	(0.793)	(1.100)	(0.647)	(0.840)
SMB	-3.078***	1.230	-1.388**	0.032	-0.624	-3.761***	-0.809	-2.961**
	(0.574)	(1.158)	(0.696)	(0.584)	(0.886)	(1.368)	(0.989)	(1.232)
Term	-0.089	-1.247***	-0.355**	-1.090***	-0.998***	-0.656**	-1.104***	-2.270***
	(0.097)	(0.249)	(0.160)	(0.127)	(0.174)	(0.318)	(0.163)	(0.190)
Credit	-4.371***	-1.898***	-1.174***	-3.611***	-4.367***	-5.391***	-4.865***	-8.097***
	(0.175)	(0.365)	(0.233)	(0.204)	(0.416)	(0.473)	(0.281)	(0.364)
PTFSBD	-3.133***	-0.594*	1.403***	-2.003***	-2.601***	-3.113***	-2.654***	-4.287***
	(0.124)	(0.339)	(0.232)	(0.145)	(0.277)	(0.303)	(0.233)	(0.299)
PTFSFX	0.790***	1.338***	2.771***	0.152*	0.143	0.289*	0.585***	0.016
	(0.066)	(0.217)	(0.197)	(0.085)	(0.113)	(0.159)	(0.142)	(0.144)
PTFSCOM	-1.497***	0.262	2.298***	-1.014***	-1.291***	-1.748***	-0.980***	-2.305***
	(0.099)	(0.240)	(0.239)	(0.087)	(0.175)	(0.181)	(0.188)	(0.211)
Constant	2.521***	3.094***	1.794***	1.406***	1.431***	1.872***	1.827***	1.803***
	(0.246)	(0.209)	(0.213)	(0.439)	(0.234)	(0.266)	(0.628)	(0.468)
R-squared	0.023	0.023	0.023	0.023	0.023	0.023	0.023	0.023
Number of HFs	1,897	308	922	532	402	215	492	534
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Table B4: The Volcker Rule and hedge funds' liquidity provision to illiquid stocks by investment strategy

This table reports the results from Equation (4) estimating the impact of the Volcker Rule on hedge funds' liquidity provision by different investment strategies. $Rlp^{Illiquid}$ represents the returns from providing liquidity calculated based on the method proposed by Jylhä et al. (2014) and using stocks with Amihud illiquidity measure above the median, $Volcker$ is a dummy variable that equals 1 after April 2014, and $Connect$ is a dummy variable that equals 1 if a US-based LCFI is a prime broker of a hedge fund. MKT, SMB, TERM, CREDIT, PTFSBD, PTFSFX, and PTFSCOM are the Fung and Hsieh 7 factors. Standard errors are clustered at the fund level and reported in brackets. *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

	(1) Long/Short Equities	(2) Global Macro	(3) Managed Futures	(4) Fixed Income	(5) Relative Value	(6) Event Driven	(7) Multi Strategy	(8) Others
$Rlp^{Illiquid}$ (γ_0)	16.369***	12.617**	35.001***	-3.852	8.353**	19.062***	23.225***	8.348*
	(2.484)	(5.413)	(4.127)	(3.307)	(4.105)	(6.020)	(4.538)	(4.726)
$Rlp^{Illiquid}$ ·Volcker (γ_1)	-7.167*	-9.857	-68.526***	-1.371	-8.001	-8.973	-36.103***	-26.381***
	(4.016)	(8.508)	(6.182)	(4.191)	(7.006)	(9.291)	(6.948)	(7.316)
$Rlp^{Illiquid}$ ·Connect (γ_2)	15.639***	-9.715	5.861	4.806	-14.661	-17.994	-15.645	-14.557
	(5.981)	(9.412)	(12.948)	(15.762)	(11.801)	(16.878)	(14.917)	(12.672)
$Rlp^{Illiquid}$·Volcker ·Connect (γ_3)	24.169*	-1.730	25.131	-1.564	26.719	26.683	28.304	61.326***
	(13.704)	(18.998)	(31.420)	(18.302)	(23.953)	(32.287)	(21.674)	(21.566)
MKT	-1.735***	-1.162**	-0.177	-0.329	-1.568***	-0.188	-2.526***	-5.971***
	(0.215)	(0.562)	(0.325)	(0.349)	(0.479)	(0.540)	(0.435)	(0.486)
SMB	-3.759***	0.888	-0.771*	-0.033	-0.735	-2.457***	-1.006*	-3.706***
	(0.373)	(0.907)	(0.451)	(0.387)	(0.551)	(0.909)	(0.596)	(0.727)
Term	0.326***	-0.738***	-0.399***	-0.708***	-0.486***	0.248*	-0.509***	-0.810***
	(0.051)	(0.165)	(0.080)	(0.097)	(0.097)	(0.131)	(0.096)	(0.114)
Credit	-2.611***	-1.102***	-1.096***	-2.519***	-2.392***	-2.950***	-2.791***	-3.811***
	(0.070)	(0.198)	(0.098)	(0.123)	(0.161)	(0.171)	(0.126)	(0.142)
PTFSBD	-2.793***	-0.543**	1.062***	-1.805***	-2.037***	-2.670***	-2.465***	-4.021***
	(0.088)	(0.233)	(0.151)	(0.105)	(0.179)	(0.220)	(0.173)	(0.200)
PTFSFX	0.866***	1.337***	2.324***	0.189***	0.335***	0.487***	0.835***	0.700***
	(0.048)	(0.163)	(0.135)	(0.060)	(0.076)	(0.124)	(0.100)	(0.094)
PTFSCOM	-0.832***	0.207	1.639***	-0.779***	-0.788***	-1.296***	-0.454***	-1.135***
	(0.065)	(0.152)	(0.142)	(0.064)	(0.097)	(0.144)	(0.134)	(0.123)
Constant	2.262***	3.110***	1.284***	1.665***	1.448***	2.153***	1.152***	1.656***
	(0.170)	(0.194)	(0.142)	(0.255)	(0.179)	(0.257)	(0.359)	(0.389)
R-squared	0.038	0.038	0.038	0.038	0.038	0.038	0.038	0.038
Number of HFs	1,897	308	922	532	402	215	492	534
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes