The Volcker Rule and the hedge fund liquidity circle

Abstract

The implementation of the Volcker Rule (section 619 of the 2010 Dodd-Frank Act) profoundly impacts the funding liquidity of hedge funds, their liquidity risk exposure and liquidity provision to the market. Using a sample of 5,697 hedge funds, we find that following the legislation, capital flows to hedge funds decline, and their flow-performance sensitivity increases. In addition, hedge funds reduce their market liquidity exposure and realign their market-making activities towards the most liquid segment of stocks. These results provide support for the Brunnermeier-Pedersen model of the link between market liquidity and funding liquidity.

Keywords: Volcker Rule; Hedge funds; Liquidity risk; Liquidity provision; Market liquidity.

1 Introduction

In response to the financial crisis of 2008, the US government implements one of the most all-encompassing financial regulations of the current millennium, the 2010 Dodd-Frank Wall Street Reform and Consumer Protection Act. Section 619 of this Act, incorporates one of its core regulatory directives, known as the Volcker Rule, aiming to reduce banks' overall risk profile. This key provision restricts banking entities from proprietary trading, and either maintaining an ownership interests in or sponsoring, 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 timeframe to achieve full regulatory compliance. Recent literature examines the Volcker Rule's impact on the banking sector. Keppo and Korte (2016) show that following the Volcker Rule, banks reduce the size of their trading books although their overall risk profile does not decrease. Chung et al. (2016) calibrate a stochastic control model to US banks, and find that the Volcker Rule raises the default probability of regulated banks. Schäfer et al. (2015) and Elayan et al. (2018) provide evidence that the Volcker Rule's effects are heterogeneous across the banking sector. Specifically, US investment banks and systemically important banks experience a decrease in equity prices and an increase in credit default swap (CDS) spreads relative to both non-investment and non-systemic banks. The Volcker Rule also affects other financial market sectors. For example, Bao et al. (2018) find that the liquidity of stressed bonds deteriorates after the Volcker Rule as banks retrench from market-making activity.

In this paper we examine whether these regulations, targeted at the banking sector, also influence the risk profile and channels of liquidity transmission in the hedge fund industry. Hedge funds play an increasingly important role in global financial markets.

According to BarclayHedge,[1] global hedge fund assets under management have grown 75-fold within 30 years, increasing from $40 billion in 1990 to nearly $3 trillion in 2017. Indeed, hedge fund trades now account for at least one-third of the total daily trading volume on the New York Stock Exchange (NYSE) alone (Cao et al., 2017). Hedge funds are crucial providers of liquidity and drivers of price formation in global financial markets (Mügge, 2014); they also help to attenuate aggregate stock mispricing (Akbas et al., 2015). At the same time, given their relatively high use of leverage, hedge funds are particular vulnerable to market and funding liquidity risk. They may also pose risks to financial stability due to their close relationship with large and complex financial institutions (LCFIs) as became evident following the collapse of Long-Term Capital Management L.P. (Dardanelli, 2011; King and Maier, 2009).[2] This network of institutional connectivity has initiated increasing calls for controlling hedge fund activities. Indirectly regulating hedge funds through constraining their counterparties is often considered to be the most effective mechanism for restraining hedge fund operations (King and Maier, 2009; Dardanelli, 2011; Nabilou and Pacces, 2015).

Figure 1 illustrates the hedge funds 'circle of liquidity' (henceforth, liquidity circle), clarifying the interconnected relationships which are likely to be affected by the regulation. First, the ban on proprietary trading by banks and the reduction in their market-making activity may create liquidity shortages in certain financial instruments, adversely affecting overall market liquidity and funds' trading environment. Second, hedge funds that customarily attract investments from banks may experience negative liquidity shocks, following the prohibition of bank investment into hedge funds. In fact, in the period encompassing implementation of the Volcker Rule, the hedge fund industry experiences

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

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

deteriorating performance, and in 2016 suffers a significant net outflow of $102 billion. Large investment banks retreat from hedge fund investments. Morgan Stanley, for example, sold its 19% stake in the $17.5 billion London-based Lansdowne Partners LLP in 2015.[3] Goldman Sachs undertook a continuous sale of its hedge fund holdings,[4] cutting its total exposure to non-Volcker-compliant investments by 60% over the five year period up to 2016.[5] Large investor redemptions are important determinants of hedge funds exposure to funding risk (Klaus and Rzepkowski, 2009). Both of these channels, market liquidity and funding liquidity, impact the trading decisions of hedge funds and their liquidity provision to the market, thus completing the liquidity circle. In addition, hedge funds obtain financing and leverage from prime brokers, which also contributes to their funding liquidity.

Historically, hedge funds have been assuming significant liquidity risk, as reflected in their documented positive returns from providing liquidity (Sadka, 2010). However, this is likely to change as the Volcker Rule affects the institutional nexus in the liquidity circle.

[Figure 1 in here]

In this paper we analyse how implementation of the Volcker Rule's impacts the evolution of the entire spectrum of the liquidity-related channels embedded in the liquidity circle. We motivate our hypotheses with reference to the theory of illiquidity spirals, formulated by Brunnermeier and Pedersen (2008), which demonstrates how adverse funding shocks can lead to portfolio liquidations by investors, depressing both asset

[3]Juliet Chung and Emily Glazer. Morgan Stanley Aims to Sell Stake in Lansdowne Partners. The Wall Street Journal, February 8, 2015.

[4]Nathaniel Popper. Goldman Sachs Sells $285 Million in Hedge Fund Holdings. The New York Times, November 5, 2014.

[5]Ryan Tracy. Big Banks Could Get More Time to Sell Funds Banned by Volcker Rule. The Wall Street Journal, December 12, 2016.

values and market liquidity. In their model, increases in margin requirements following an adverse shock engender a tightening of funding constraints, leading to further reductions in market liquidity. This pattern of illiquidity spirals deters dealers from providing liquidity to the market. Using the Volcker Rule implementation as an exogenous shock to the financial system, our analysis lends empirical support to the Brunnermeier and Pedersen (2008) model of the dependence between funding liquidity, market liquidity, and incentives for liquidity provision by market participants.

We find that following the Volcker Rule enactment, average flows to hedge funds reduce and their flow-performance sensitivity increases, indicating an environment of tighter funding liquidity. These two factors lead to a reduction in hedge funds' exposure to market liquidity risk, inducing a drift towards more liquid investments. The decrease in funding liquidity and market liquidity gives rise to a further reduction in hedge funds' liquidity provision to illiquid market segments. One implication of this finding is that overall market efficiency may be negatively affected by hedge funds' collective response to the changing trading environment after the Volcker Rule. These effects are mitigated if hedge funds have other business connections with the large US banks (LCFIs) targeted by the Rule. LCFIs seem to channel clients' money which that may have previously manged in house into the connected hedge funds. The negative effect of the Volcker Rule on funds' flows is milder. Hence such funds, facing less funding uncertainty than unconnected funds, do not reduce liquidity provision to illiquid market segment a strong as unconnected funds.

Our analysis extends a growing literature analysing the interconnectedness between hedge funds and other major financial institutions (Chan et al., 2005). Billio et al. (2012) find that the returns of banks, insurance companies, broker-dealers, and hedge funds exhibit increasing correlation during the 2000s, with the returns of banks and

insurance companies influencing hedge fund returns. Franzoni and Giannetti (2019) show that hedge funds affiliated with financial conglomerates can access more stable funding, enabling them to provide liquidity during periods of financial turmoil. Using fund-of-funds data, Ang et al. (2011) report that hedge fund leverage is counter-cyclical in comparison to the leverage of listed financial intermediaries. They find that both reductions in funding costs and enhanced bank returns predict an increase in hedge fund leverage.

Another strand of research focuses on the relationship between hedge funds and their prime brokers. Chung and Kang (2016) provide evidence that hedge funds sharing prime brokerage services exhibit a strong co-movement in returns, which the authors attribute to information flows initiated by the common broker. Kumar et al. (2018) document evidence that information regarding corporate client loans disseminates from prime brokers to hedge funds. Prime brokerage relations also expose hedge funds to significant counterparty risk. Boyson et al. (2010) find that the probability of hedge fund contagion increases significantly following adverse shocks to their prime broker's stock price. Aragon and Strahan (2012) show that hedge funds using Lehman Brothers as their prime broker experience a decline in funding liquidity subsequent to the institution's bankruptcy in 2008. Furthermore, 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, in its role as a prime broker, and its affiliated hedge funds, finding that liquidity shocks are transmitted to these connected funds, resulting 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 the maximum permitted leverage. In turn, hedge funds diversify away from these prime brokers and tend to employ a larger number of brokers.

This study contributes to the literature as follows. First we examine whether the documented relationship between large financial institutions and affiliated hedge funds extends beyond the widely studied prime brokerage connection. A recent study by Dahlquist et al. (2019) maintains that the documented empirical relation between the returns of hedge funds and their prime brokers is entirely driven by systematic risk exposure. Once they control for this risk factor, the remaining return linkages are no longer significant, except in cases such as Lehman's, where the prime broker experiences extremely large adverse shocks (akin to bankruptcy). We build on this insight, analysing the nexus of relationships between LCFIs and hedge funds, including both the prime brokerage function and the relationship arising from other business links, relating to investment, audit, custodianship or the advisory roles of banks. We test whether the presence of such relationships contribute to the changes in hedge fund flows, liquidity exposure and liquidity provision following Volcker Rule implementation. The evidence indicates that business relationships with large banks significantly influence the measurable effects of the Volcker Rule.

This paper also extends the literature on the contribution of hedge funds to the operational efficiency of financial markets. Cao et al. (2017) find that stocks purchased by hedge funds experience an improvement in their pricing efficiency during non-crisis periods, while Ben-David et al. (2013) and Jiao (2012) document hedge fund holdings contain predictive power for future stock returns. Kolokolova et al. (2017) focus on the impact of hedge fund flows in the bond market and find that an increase in fund flows predicts a future decline in corporate bond yields. This effect is amplified when market liquidity is low. Other studies document that market liquidity risk plays an important role in determining hedge fund performance. For example, hedge funds that load up on liquidity risk outperforming 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 such 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. They document that liquidity risk betas are significantly positive. Indeed, the superior performance these hedge fund portfolios generate 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). Hedge funds with lower funding risk generate higher returns. This effect is driven by the increased exposure to various equity-mispricing anomalies (Aiken et al., 2019). One important role of hedge funds is market liquidity provision. 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. In addition, 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 less liquidity risk, and relocate 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 unregulated market players, hedge funds, contributes to a better understanding of the complex network of relationships and interdependencies connecting hedge funds and the banking sector.

2 Research Design

This section develops testable hypotheses related to the hedge fund liquidity circle. We begin by discussing the time line for implementation of the Volcker Rule, then proceed to analyse the Rule's effect on the funding liquidity of hedge funds. Finally, we discuss hedge funds' exposure to market liquidity and changes in their liquidity provision.

2.1 The Volcker Rule: Implementation time line

The Volcker Rule is first publicly endorsed by President Obama on January 21, 2010 and 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 work together to 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 during his report to Congress on February 29, 2012, warning that regulators could not satisfy this deadline. On December 10, 2013, the regulations are endorsed by the above five financial regulatory agencies. The Volcker Rule regulations 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 requisite quantitative measurements from July 1, 2014, and to become fully compliant by July 21, 2015. However, a number of subsequent extensions occur 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 extended in 2018 to July 21, 2019 and once more in 2019 to July 21, 2021.

Figure 2 depicts the timeline of these events. Despite the series of extensions subsequently granted to banks to achieve full compliance with the Rule, they must endeavour to implement the legislation from April 1, 2014. Importantly, from July that year their efforts at compliance are monitored through a formal reporting channel. Thus, we expect that any major adjustments in bank-hedge fund relations and the resulting changes in hedge fund trading decisions will be 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 funds' flow-performance sensitivity

In this section, we test if implementation of the Volcker Rule results in a funding shock to hedge funds. Any such shock can potentially interact with market liquidity and generate a liquidity spiral as formalised in Brunnermeier and Pedersen (2008). In addition to the ban on proprietary trading, a second important ingredient of the Volcker Rule consists of the prohibitions it imposes upon banking institutions relating to sponsoring or investing in hedge funds. It follows that hedge funds receiving investment funding from banking entities may face outflows following the Dodd-Frank Act. Cumming et al. (2017) analyze the impact of the Dodd-Frank Act on hedge fund performance, risk and capital flows. They find 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. We conjecture that the Volcker Rule, which explicitly limits hedge funds' relationships with banking entities, may exert an even more pronounced effect on the hedge fund industry, effecting not only the level of flows, but also flow-performance sensitivity.

While the Volcker Rule increases general financial market uncertainty, we anticipate its impact is likely to be particularly evident in the hedge fund industry (see, for example, Whitehead, 2011). Uncertainty relating to fund returns and the existence of diffuse beliefs both magnify investor responses to fund performance. Chevalier and Ellison (1997) find that flows of younger funds are more sensitive to performance than those

of mature funds, suggesting that beliefs about funds with limited track records are more diffuse. Similarly, Bollen (2007) claims that diffuse prior beliefs about the effectiveness of a socially responsible investment strategy can underpin a stronger flow-performance relation for socially responsible funds. Enhanced uncertainty after the Volcker Rule may further increase investors' aversion to downside risk. The literature indicates that investors use past performance to identify funds with lower downside risk and display a differential response to performance according to the stage of the market cycle. For example, De Andrade Jr (2009) finds that investors invest more heavily in mutual funds with a good previous performance record in in declining markets. Artavanis et al. (2018) document that investors' sensitivity to downside risk increases significantly following Lehman Brother's bankruptcy. Applying the same reasoning to hedge funds, we should observe that their flow-performance sensitivity becomes stronger after the Volcker Rule.

The legal restrictions the Volcker Rule imposes on LCFI prevents then from keeping in-house hedge funds. When advising the former customers where to re-locate the capital, LCFIs may be more likely to suggest hedge funds, they have business relations with. Hence, the funding shock induced by the Volcker rule may be mitigated by the presence of such connections. The above analysis informs our first set of hypotheses, as follows:

Following implementation of the Volcker Rule:
H1(a) flows to hedge funds decline,
H1(b) hedge fund flow-performance sensitivity increases,
H1(c) funds connected to LCFIs experience a milder decline in flows and a milder increase in the flow-performance sensitivity decreases.

To test these hypotheses we first estimate Equation (1) using sub-samples of connected and unconnected hedge funds separately, and then consider all the funds jointly in Equation (2).

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

$$\begin{aligned} Flow^i_{t:t+11} =& \alpha + (\beta_0 + \beta_1 Volcker_t + \beta_2 Connect^i_t + \beta_3 Volcker_t \cdot Connect^i_t) \cdot \overline{Ret^i}_{t-12} + \\ & \gamma_0 Volcker_t + \gamma_1 Connect^i_t + \gamma_2 Volcker_t \cdot Connect^i_t + \delta Controls^i_t + \varepsilon^i_t \end{aligned} \quad (2)$$

where $Flow^i_{t:t+11}$ is the flow for hedge fund i over a year between month t and $t+11$, where the monthly flow is measured using Equation (3); 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, and $\overline{Ret^i}_{t-12}$ is the average return of fund i over the previous 12 months.

$$Flow^i_t = \frac{AUM^i_t - AUM^i_{t-1}(1 + Ret^i_t)}{AUM^i_{t-1}} \quad (3)$$

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 substitute for the single variable Volcker by using three variables capturing different stages of the regulation's implementation. We report the results in Section 5.1, and they are consistent with those obtained from the more parsimonious specification we discuss here.

A dummy variable *Connect* measures a hedge fund's 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, administrator, custodian, or management company of a hedge fund, and zero otherwise.[6] These connections to US-based LCFIs facilitates hedge funds' access to capital through various channels. In particular, LCFIs may directly sponsor connected hedge funds, they may have partial ownership of one or more funds, and/or they may also be more likely to advise their clients to invest in any connected funds, especially after the Volcker Rule.

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 recently updated. of the database. However, hedge funds are likely to 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 a very inaccurate proxy for pre-Volcker Rule connections.[7] 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 exclusively focus on hedge funds' connections to these SIFIs for the following reasons. First, 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.[8] Additionally, the service provision business appears

[6]Looking at prime brokerage and other connections separately gives similar results to those reported here.

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

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

very concentrated. For example, in our sample, 57.03% of funds reporting a prime broker use one of the eight US banks as a prime broker in 2013, accounting for 61.55% of the total assets under management of these funds. The implicit assumption we are making here is that those funds with business connections to LCFIs are more likely to receive larger direct investments from LCFIs or their clients. If effect, we are undertaking a joint hypothesis test: the validity of our proxy and the existence of the effect.

Our group of unconnected funds contains both funds using non-LCFIs as prime brokers, custodians and advisors and also funds connected to non-US based LCFIs in an equivalent capacity, on the basis that the Volcker Rule does not directly target these institutions. Overall, 12.4% of hedge funds in our sample report connections with the following eight non-US LCFIs: HSBC Bank plc, UBS Group AG, Deutsche Bank AG, Credit Suisse Group AG, BNP Paribas S.A., Barclays plc, Banco Santander S.A., and Société Générale S.A.

In choosing the remaining control variables, 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 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 a fund charges; $Leverage^i$ 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), and $StyleFlow^i_t$ is the average flow into hedge funds in the same style category as fund i, which more generally captures the time-varying effects of other macro factors that can potentially affect hedge fund flows in a systematic way. 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) and (2), indicating that after the Volcker Rule, flow-performance sensitivity increases and hedge funds experience outflows. We expect β_3 to be nagative and γ_2 to be positive in Equation (2), indicating that funds connected to US LCFIs experience less outflows and exhibit a smaller increase in flow-performance sensitivity after the Volcker Rule compared to unconnected funds. If funds with LCFI connections have access to a more stable funding environment and are able to attract higher flows of capital before the Volcker Rule, β_2 would be be negative and γ_1 would be positive.

[Table 1 in here]

2.3 The Volcker Rule and hedge funds' liquidity exposure and provision

This section analyses both the extent and the manner in which hedge funds adjust the liquidity risk of their portfolios and market liquidity provision in response to the changing environment of lower market liquidity and a potentially diminished ability to access new capital after the Volcker Rule.

Brunnermeier and Pedersen (2008) suggest that a funding shock which increases market illiquidity often leads to losses on dealers' initial positions, forcing them to divest, further reducing market liquidity. Such illiquidity spirals constrain dealers in their efforts to enhance market liquidity. According to Cao et al. (2013), hedge fund managers reduce their funds' exposure to market liquidity when market liquidity deteriorates. If this is the case, we should observe that hedge funds decrease their exposure to the market liquidity factors after the Volcker Rule's implementation.

At the same time, Jylhä et al. (2014) argue that in periods of reduced market liquidity but when funding conditions are favourable, hedge funds' propensity to supply liquidity increases. Our previous analysis suggests that market liquidity deteriorates subsequent to the Volcker Rule as a result of a reduction in banks' market-making activities, which ceteris paribus should increase hedge funds' propensity to supply liquidity. Indeed, Duffie (2012) show that non-bank broker-dealers play a more important role in providing market-making services and market liquidity after the Volcker Rule. However, hedge funds also experience outflows after the Volcker Rule. Such funding shock reduces their incentives to trade illiquid assets. Therefore, facing conflicting incentives, hedge funds may choose not to uniformly increase/decrease their liquidity provision. Instead, they may selectively increase their market-marking activities in a market segment which includes the more liquid stocks, but decrease such activities in less liquid stocks owing to the uncertain funding conditions, reducing the overall exposure to market liquidity factors, as suggested above.

If our intuition underlying Hypothesis *H1(c)* is proved to be valid, hedge funds that have business connections to US banks experience not so strong capital outflows and face lower funding liquidity risk subsequent to the Volcker Rule, due to the redirection of the former bank clients' money into the connected funds. Thus, such funds are likely to be less disincentivized to provide market liquidity than non-connected funds. Additionally, such funds may find it easier to move into the market making activity compared to non-connected funds. Their connectivity to LCFIs (institutions that may previously have undertaken market-making, but are now retrenching from it after Volcker Rule implementation) may facilitate access to the requisite advice and information for undertaking these activities, which in consequence may more likely be observed in liquid stocks with greater analyst following. LCFIs are less likely to share the relevant expertise with their connected hedge funds before the Rule, since they will use such knowledge

to support their own trading activities. This relationship may grant an informational advantage to connected over non-connected funds when moving into relevant areas of market-making activity. 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(a) hedge funds shift their liquidity provision to the more liquid segment of stocks,
H2(c) the effect is milder for funds connected to US-based LCFIs.

To tests these hypotheses, we estimate Equation (4) for connected and unconnected funds separately, and then use all the hedge funds to estimate Equation (5), similar to the ones employed by Jylhä et al. (2014).

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

$$Ret_t^i = \alpha + \sum_{k=1}^{7} \beta_k F_{k,t} + (\gamma_0 + \gamma_1 Volcker_t + \gamma_2 Connect_t^i + \gamma_3 Volcker_t \cdot Connect_t^i) \cdot L_t + \varepsilon_t^i \tag{5}$$

where Ret_t^i is hedge fund i's return in month t, $F_{k,t}$ are the 7 Fung-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 including strategy fixed effects to capture

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

systematic differences in hedge fund returns and may also reflect any style-specific effects of other market factors. The standard errors are clustered at the fund level to account for potential correlations within fund return residuals documented in Boyson et al. (2010) and Brown et al. (2019).

L_t is a liquidity-related factor, which captures liquidity exposure and liquidty provision of hedge funds in turn. We use monthly innovations in aggregate market liquidity (LIQ) and the traded liquidity factor ($TradedLiq$) of Pástor and Stambaugh (2003) to capture liquidity exposure of hedge funds.[10] The aggregate market-wide liquidity captures the idea that when liquidity is low, a larger trading volume induces greater 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 purchases stocks with the highest exposure to the innovations in aggregate market liquidity and shorts stocks with the lowest exposure. These measures are both widely used in the literature (see, for example, Teo, 2011; Jylhä et al., 2014).

We further use as L_t the return from providing liquidity (Rlp_t) which we calculate following Jylhä et al. (2014). It is a return to a zero-investment contrarian long-short trading strategy, utilising short-term return reversals.[11] Specifically, for each day we estimate a cross-sectional regression relating 5-day return to twenty lagged daily returns and a set of controls. Jylhä et al. (2014) show that the average loadings on the lagged returns are negative, indicating price reversals. The expected 5-day returns are then

[10] This data is available at https://faculty.chicagobooth.edu/lubos.pastor/research/.

[11] As an alternative, 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 large investors aggregated at the company level are available through 13f filings to the Security and Exchange Commission. This information is not sufficient to capture the liquidity supply/demand of hedge funds, which often entails short selling.

calculated. Every day a long position is opened in stocks with a positive expected 5-day return and a short position taken in stocks with a negative expected 5-day return. The positions are held for five days and then closed. The daily returns are calculated as the average returns of all positions opened on that day, and then the measure uses monthly averages to obtain the final value of the measure. A similar approach and methodology is adopted by, for example, Khandani and Lo (2011) and Nagel (2012).

We first run the regression using our general Rlp factor as discussed above, and then we consider two sub-factors, namely, the return from providing liquidity for more liquid stocks Rlp^{Liquid}, and the return from providing liquidity for less liquid stocks $Rlp^{Illiquid}$. To construct these sub-factors, we follow the same procedure as in Jylhä et al. (2014), but use sub-samples of stocks with the Amihud illiquidity measure below (for liquid stocks) or above (for illiquid stocks) the median value as of the sorting date.

We expect γ_1 to be positive when using the Rlp^{Liquid} factor and negative when using the $Rlp^{Illiiquid}$, LIQ, or $TradedeLiq$ factors in Equations (4) and (5), indicating that hedge funds increase their liquidity provision in a more liquid market segment, but decrease it in a less liquid segment reducing the overall exposure. We expect γ_3 to take the opposite sign of γ_1 in Equations (5), indicating the milder effect on liquidity provision of connected funds.

3 Data

We collect our hedge fund data from the Eurekahedge database, which includes a history of returns as well as a set of hedge fund characteristics and information on affiliated companies. We use multiple snapshots of the data, and have information on on affiliated

companies as of 2010, 2013, 2015, and 2018. This allows us to use the 2013 snapshot of the data to more precisely capture the pre-Volcker Rule LCFI-fund connections, while having the return observations up to 2018. The complete original sample runs from January 1990 to December 2018 and includes 18,582 funds. We restrict our sample to comprise funds with at least 36 return observations, and report their returns in US dollars. To address a potential backfilling bias, we exclude the first 12 months of returns for each fund. We also filter out any observations before 1994 to control for survivorship bias, and exclude Funds of Funds. The final sample includes 5,697 funds and our sample period extends from January 1994 to December 2018.

We classify funds into 8 broad strategies: Long/Short Equities, Fixed Income, Relative Value, Event Driven, Global Macro, Managed Futures, Multi-Strategy and Others (Table 2). Following Ilerisoy et al. (2017), we further divide hedge funds into three broad investment style categories: directional funds, non-directional funds, and semi-directional funds.

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 reports 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 0.496% per month. The most profitable funds were those in the Event Driven category, with an average return of 0.594% followed by Relative Value funds with an average return of 0.536%. Global Macro funds have the lowest average returns of 0.387% per month followed by Managed Futures funds with the average return of 0.457%. Fixed Income funds exhibit the smallest return volatility of 2.018% per month and the highest mean to standard deviation ratio of 0.23. The flows seem to approximately follow the return patterns, with Event Driven funds receiving, on average, the highest inflow,

whereas Fixed Income funds experience the lowest inflow during our sample periods. There is still substantial heterogeneity in terms of the returns and flows of individual hedge funds within each investment style.

[Tables 2, 3 and 4 in here]

Table 5 reports the descriptive statistics relating to other hedge fund characteristics. The average fund size is approximately $170 million and the average fund age, after excluding the first 12 months, is less than 3 years. Just over half of the funds report the use of leverage. The average management and performance fees are 1.51% and 17%, respectively. Lock-up, redemption and subscription periods are around 3, 1.5 and 1 month, respectively.

In our sample, 22.2% of hedge funds (1,267 of 5697) are connected to US-based LCFIs in 2013, and the connection mainly arises from a LCFI serving as an administrator for a fund (Panel D).[12] 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, lockup, redemption, and subscription periods. On average, the life span of connected funds is 10 months longer, they charge higher incentive fees (18.728% versus 17.014%), and their lockup, redemption, and subscription periods are one month, two weeks, and one week longer, respectively.

[Table 5 in here]

The Volcker Rule prohibits banks from engaging in proprietary trading, although banks' underwriting and market-making activities are exempt from the restrictions. In

[12]Further, 12.4% funds are connected to non-US LCFIs.

reality, however, it is often difficult to disentangle proprietary trading and market making (Chow and Surti, 2011). Consequently, the affected banks greatly reduce their trading activities. The implementation of the Volcker Rule adversely affects both the scale and quality of market-making services that banks provide to investors, resulting in a deterioration in market liquidity (Duffie, 2012). There is a reduction in the size of banks' trading books (Keppo and Korte, 2016), and the liquidity of the bond market is found to deteriorate during periods of market stress (Bao et al., 2018). The changes in market liquidity, however, cannot be solely attributed to the Volcker Rule, as there are other relevant overlapping events which can impact market liquidity. One of the prominent events, for example, is the US debt ceiling crisis, which began in January 2013, leading to enactment of a legal mandate to increase the limits on US Government debt limit. This crisis initially ended in October 2013, following the Continuing Appropriations Act, and in February 2014 the ceiling is suspended until March 2015.

Table 6 reports the summary statistics of the market liquidity measures we use in this paper across different periods surrounding the adoption of the Volcker Rule. We report the statistics of the Pástor and Stambaugh (2003) innovations in aggregate market liquidity (LIQ) and the traded liquidity ($TradedLiq$) factor, and Jylhä et al. (2014)'s returns from liquidity provision (Rlp). In comparison to the pre-Volcker period, the distributions of LIQ and $TradedLiq$ change significantly during the later periods, 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 periods, before it again turns positive in the post-Volcker Rule full compliance period. The average returns from liquidity provision become 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 implementation of the Volcker Rule, fails to deliver positive returns in the later periods. It appears to take longer

than five trading days for any price reversals to be realised in the second sub-period, which suggests a trading environment characterised by reduced market liquidity and a lack of arbitrage capital.

[Table 6 in here]

4 Empirical Results

4.1 Hedge fund flows and the Volcker Rule

We report the estimation results for Equations (1) and (2), capturing the impact of Volcker Rule implementation on investor flows to hedge funds, in Table 7. The first column reports the results for connected funds, the second column documents the results for the unconnected funds, and the third column uses them jointly as in Equation (2).

After the Volcker Rule, fund flows significantly decrease, as indicated by the significantly negative coefficient on $Volcker$ (γ_0) in all columns, consistent with our hypothesis $H1(a)$. Remarkably, the flows to connected funds are reduced by around 2.87% per year, while flows to unconnected funds drop by 6.40% per year. After the Volcker Rule, flow-performance sensitivity increases (positive β_1), but the increase is statistically significant only for unconnected funds, while it is not significant for connected funds, indicating not change in flow-performance sensitivity for connected funds. Further, β_3 is negative and significant in Column (3), showing that the increase in flow-performance sensitivity after the Volcker Rule is significantly smaller for connected funds than for unconnected. γ_1 is also positive and highly significant for the $Connect$ variable in Column (3), indicating that various business relationships with LCFIs lead to additional inflows of capital to these funds,

in line with our assumption that *Connect* also captures the likelihood of LCFIs directly investing into hedge funds and the indirect positive effect on hedge fund investments arising from LCFI recommendations to their clients. Overall, our results support deterioration of funding liquidity conditions for hedge funds after the Volcker Rule, which is ameliorated, but not completely reversed, for funds having business connections to US-based LCFIs.

The effects of other control variables are consistent with the findings in previous literature. Hedge funds with high return volatility, larger size, older age, and higher incentive fees attract lower inflows, while funds with a high-water mark provision and longer redemption periods attract more inflows. Finally, capital flows into the same-style category positively impact individual fund flows.

[Table 7 in here]

4.2 Hedge funds' liquidity exposure and provision

Table 8 reports the estimation results for Equations (4) and (5) capturing changes in hedge funds' exposure to market liquidity in response to Volcker Rule implementation. Columns (1) to (4) report the results for connected and unconnected funds separately, and columns (5) and (6) report the joint results.

The significantly positive coefficient γ_0 on the liquidity measures in all columns indicates that hedge funds customary take on liquiduty risk, consistent with the prior literature (Sadka, 2010; Teo, 2011). Subsequent to the Volcker Rule, hedge funds significantly decrease their exposure to market liquidity as indicated by the negative coefficient γ_1, supporting our hypothesis $H2(a)$. This result is consistent with the Brunnermeier and Pedersen (2008) model. The reduction in liquidity exposure is similar in magnitude for

connected and unconnected funds, on average.

[Table 8 in here]

To gain a deeper understanding of potentially heterogeneous effects of the Volcker Rule across hedge fund strategies, we re-estimated the models for sub-samples of funds in different investment categories (Table 9). We classify funds according to whether they are arbitrage (non-directional), clearly directional or semi-directional. Previous studies find there are significant differences between these fund types which are potentially relevant when capturing the incidence of 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 of the direction of the market, and the exposure to fixed income market risk factors is more important for such funds. Hence, the loss of market liquidity resulting from the reduction in banks' market-making activities may have a more pronounced effect on directional funds. The results in Table 9 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. After the Volcker Rule, all categories of funds significantly reduce their exposure to market liquidity. The strongest effect is associated with directional funds, consistent with our expectations. The corresponding coefficients of -12.74 on LIQ and -18.43 on $TradedLiq$, significant at the 1% level, indicate that one standard deviation increase in LIQ leads to 78 bp reduction in Directional hedge fund returns after the Volcker Rule. Interestingly, semi-directional funds having contractual connections with LCFIs are generally less exposed to the market liquidity factors. However, for those funds the reduction in exposure to market liquidity following the Volcker Rule's implementation is

milder, which is captured by positive and significant γ_3 for both measures of liquidity.[13]

[Table 9 in here]

Table 10 reports the estimation results for the impact of Volcker Rule implementation on hedge funds' provision of liquidity to different segments of the equity market. The significantly positive coefficient γ_0 on Rlp in columns (1) and (7) indicates that hedge funds customarily supply liquidity, consistent with Jylhä et al. (2014) and Franzoni and Plazzi (2013). However, splitting the Rlp factor into liquid and illiquid stocks reveals a more subtle result. Hedge funds demand liquidity when trading liquid stocks, but supply it for illiquid ones (negative and significant γ_0 for Rlp^{Liquid} and positive significant γ_0 for $Rlp^{Iliquid}$). Before the Volcker Rule, connected funds demand more liquidity in the liquid segment of the market compared to unconnected funds, as captured by the negative and significant γ_2 in column (8).

In terms of the impact of the Volcker Rule, once again we observe the effects operating in opposite directions for liquid and illiquid stocks. The coefficient γ_1 on the interaction term $Rlp^{Liquid} \cdot Volcker$ is significantly positive, while it is negative for $Rlp^{Illiquid} \cdot Volcker$, supporting our hypothesis $H2(a)$. Hedge funds increase their liquidity provision to the more liquid market segment following the Volcker Rule, but reduce liquidity provision to less liquid stocks after Volcker Rule implementation. Hedge funds that have contractual connections with large banks seem to be less effected by tightening funding liquidity as suggested by our previous results, and exhibit milder reduction in market-making activity for illiquid stocks, as indicated by a positive and significant γ_3 in column (9).

[Table 10 in here]

[13] In supplementary online appendix we also report the results for a more granular hedge fund strategy classification.

In relation to fund strategies, non-directional and semi-directional funds generally demand liquidity when trading liquid stocks as evidenced by the negative and highly significant coefficients γ_0 in columns (2) and (3) of Table 11, whereas directional funds appear to provide it. For illiquid stocks, all fund categories are historically liquidity providers. Following the Volcker Rule, non-directional and semi-directional funds increase their liquidity provision to liquid stocks (positive and significant γ_1 in columns (2) and (3)) and directional and semi-directional funds reduce their liquidity provision to illiquid stocks (negative and significant γ_1 in columns (4) and (6)), with directional funds turning from liquidity providers to liquidity demanders. Connected non-directional funds are less likely to provide liquidity to illiquid stocks before the Rule, but increase the liquidity provision subsequently.

[Table 11 in here]

5 Robustness

5.1 The Volcker Rule: Implementation and full compliance periods

In our main analysis we concentrate on the effect of the Volcker Rule after it becomes operative, namely from April 1, 2014 to the end of the sample period. However, the Rule became law much earlier, on July 21, 2010, forming part of the Dodd-Frank Act, and initially requiring banks to be fully compliant by July 21, 2017. In this section we examine if hedge funds begin to adjust their liquidity provision strategies subsequent to information about the Rule being released and if it still continues to influence the hedge fund environment after full compliance is enforced. We expect to observe gradual adjustments of fund flows, 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 the main analysis, substituting the single dummy variable $Volcker$ with three new ones: $Phase1$, $Phase2$, and $Phase3$, capturing the implementation, compliance, and the 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 12, 13, and 14 report the results.

Flows to hedge funds decrease significantly after the Volcker Rule becomes law as part of the Dodd-Frank Act in July 2010 (Table 12). The effect amplifies after April 2014, and is even more pronounced following the compliance period. The corresponding coefficients increase in absolute value, from -6.990 to -11.861 and -17.705, which are all significant at the 1% level. Hedge funds connected to LCFIs experience a stronger drop in their long-term flows after the announcement of the regulation, suggesting that LCFIs respond by quickly withdrawing their funding support from hedge funds to conform with the new regulation. Afterwards, there is no significant difference in the level of flows during the compliance period, but a stronger drop in flows again during the post implementation period, suggesting a long-term effect on flows. Similarly, flow-performance sensitivity keeps increasing over time for unconnected hedge funds between the implementation and post-Volcker Rule full compliance periods. The flow-performance sensitivity of connected funds evolves in a non-linear fashion. It increases stronger than for non-connected funds during the implementation and the post-Volcker Rule phases, but the increase is milder during the compliance period.

Hedge funds increase their market liquidity exposure during the implementation phase with the values of γ_1^{Phase1} being positive and highly significant for all types of funds both for LIQ and $TradedLiq$ (Table 13). After the Volcker Rule effectively becomes operative in April 2014, hedge funds significantly reduce their exposure to market liquidity and the effect persists throughout the post-Volcker Rule full compliance period.

Regarding liquidity provision by hedge funds (Table 14), we see that hedge funds immediately relocate their liquidity provision from illiquid to liquid stock segments after the Volcker Rule becomes law in July 2010. During the compliance period, hedge funds further reduce their liquidity provision to illiquid stocks. After the compliance period, hedge funds return to offering liquidity provision to both liquid and illiquid stocks, but the effect is stronger for liquid stocks.

[Tables 12 and 13 and 14 in here]

5.2 Hedge funds connected to US- and non-US LCFIs

In this section we repeat the analysis using only the sub-sample of hedge funds connected to either US or non-US based LCFIs to check if our results are robust to exclusion of those funds that are not connected to any systemically important institutions. Since non-US based LCFIs are not the primary targets of the Volcker Rule, if our the findings are not driven by small, unconnected funds, one may expect qualitatively similar results to the main analysis. In addition, comparing US with non-US LCFIs helps to control for the potential effects on the aggregate hedge fund industry of other confounding factors during the same period, helping to more precisely disentangle the impact of the Volcker Rule, which targets only US LCFIs.

At the same time, European based financial institutions are also facing tighter regulations during the period of analysis. Among the key elements are the Basel III regulations, initiated between 2013 and 2015, whose provisions can influence banks' prime brokerage and investment activity. For example, Basel III requires banks to hold sufficient high quality liquid assets to enable them to withstand a 30 day market stress event. Any hedge fund investment is considered extremely illiquid, and consequently would not contribute to the requisite liquidity ratios of banks. Furthermore, Basel III regulations attempt to reduce banks' reliance on short-term funding for fear of liquidity mismatches, and are enacted through the regulatory "Net Stable Funding Ratio (NSFR)". As hedge fund cash deposits at prime brokerage arms of banks become susceptible to "cash capital flight" in times of market volatility, regulators are demanding that banks hold more capital to safeguard against this risk. This is likely to incentivise a number of banks to sever their relationships with hedge funds, especially smaller or less profitable ones. Additionally on January 29, 2014, the European Commission proposes new rules to prevent the largest and most complex banks from engaging in the risky activity of proprietary trading. The proposal follows recommendations in the Liikanen report delivered in October 2012, and potentially impacts 29 European banks, although it is subsequently withdrawn in July 2018. Thus, while large European banks are not directly targeted by the Volcker Rule, they may also be gradually disengaging from the hedge fund business during this period, resulting in measured effects similar to those attributable to the Volcker Rule. It follows that the results based on the sub-sample of hedge funds linked to US and non-US LCFIs only may be weaker than those obtained using the complete sample of hedge funds.

Tables 15, 16 and 17 indicate that our main results for flow, liquidty exposure and liquidity provision remain qualitatively unchanged when using this LCFI sub-sample of hedge funds. One difference for fund flows in Table 15 is that the coefficient of *Connect*

loses significance, whereas that of $Volcker \cdot Connect$ becomes significantly negative in column (3), suggesting that funds connected to US LCFIs do not receive higher flows compared to those connected to non-US LCFIs before the Volcker Rule while experience lower flows subsequently.

[Tables 15 and 16 and 17 in here]

5.3 Matched sample analysis

In this section we repeat the analysis using only funds matched by propensity score matching (PSM) to check if the differences between connected funds and unconnected funds are related to funds' characteristics such as redemption period, initial size, and strategy. We implement PSM in three steps. In the first step, for each hedge fund style we estimate a probit regression for the probability of a fund being connected to US-based LCFIs. We include a number of fund characteristics, such as the initial fund size, management and incentive fees, the use of HWM and leverage, redemption, subscription, and lockup periods. In the second step, we obtain each fund's propensity score based on the probability that a fund with given characteristics is a connected fund. In the third step, connected funds and non-connected funds are matched 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 979 matched pair of funds and repeat the analysis based on this sub-sample. Table 18 and 19 and 20 show that our main results remain unchanged using matched funds.

[Tables 18 and 19 and 20 in here]

6 Conclusion

The evolving nature of the relationship between hedge funds and LCFIs is attracting increasing attention from both academics and policy-makers subsequent to the 2008 financial crisis, amid enhanced concerns about financial stability. In this paper, we examine the impact of the implementation of the Volcker Rule, a post-crisis banking regulation, on the hedge fund circle of liquidity. The Volcker Rule prohibits LCFIs from proprietary trading and constrains their ability to invest in hedge funds. To the best of our knowledge, the indirect regulatory effects of the Volcker Rule on hedge funds 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 is the increasing uncertainty surrounding funding liquidity of hedge funds, arising from banks' retrenchment from hedge fund investment; the second is the resulting decrease in hedge funds' willingness to assume liquidity risk and a reorientation of their market-making activities away from illiquid to liquid stocks. These results provide support for the theoretical model of Brunnermeier and Pedersen (2008). The Volcker Rule created favourable conditions for market liquidity and funding liquidity to become mutually reinforcing, leading to the creation of illiquidity spirals.

Specifically, we find that after the implementation of the Volcker Rule hedge funds experience lower capital flows and their flow-performance relationship becomes stronger. The decline in flows is less pronounced and the flow-performance sensitivity less affected for those hedge funds that have business relationship with US LCFIs, when a US-based LCFI serves as a prime broker, administrator, custodian, or management company for the fund.

Facing a deterioration in funding liquidity, hedge funds appear to rebalance their

portfolios towards more liquid holdings after the implementation of the Volcker Rule, reducing their exposure to market liquidity factors. Prior to the Volcker Rule, hedge funds undertake the important role of re-distributing liquidity. They can be characterised as liquidity demanders when trading in more liquid equity market segments and liquidity suppliers in relation to their trading in the less liquid segments, thus contributing balance to the market. Subsequent to the implementation of the Volcker Rule, hedge funds appear to step into a market making role, one previously undertaken by the LCFIs, but only in the liquid stock segment. They retreat from making a market in less liquid stocks. The liquidity re-distribution in the market is thereby disrupted, potentially leading to a further dispersion in liquidity for individual stocks following implementation of the Volcker Rule. The retreat of hedge funds from less liquid investments after the Volcker Rule is likely to further adversely impact market liquidity, and negatively affect 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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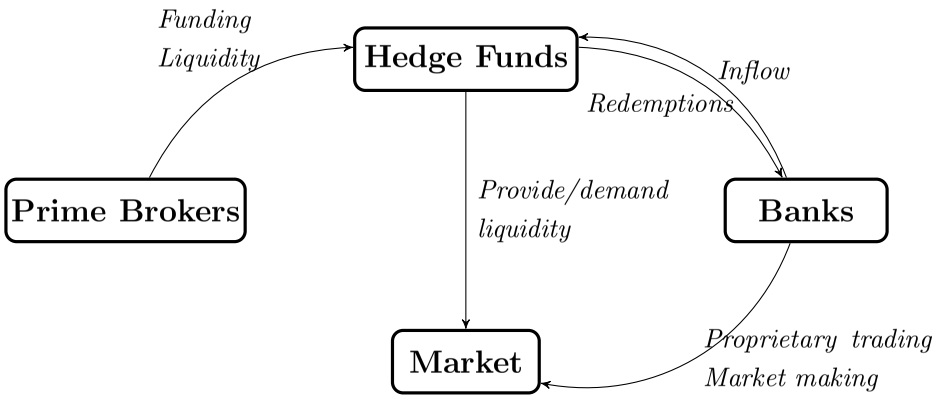
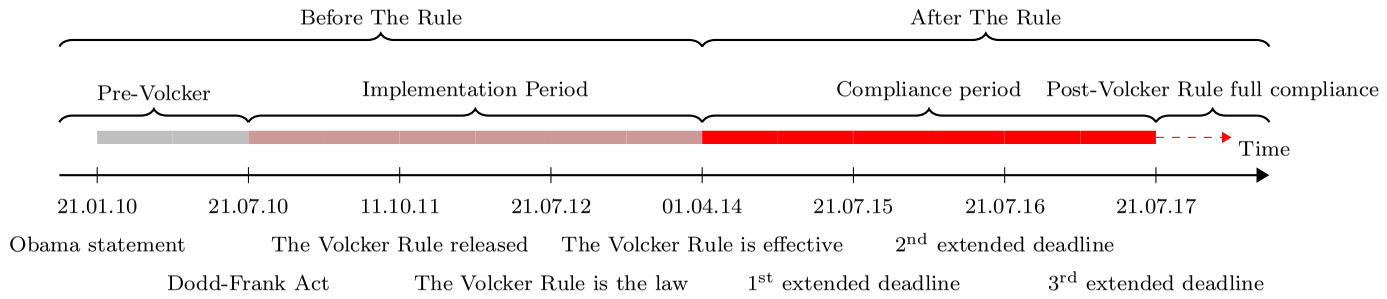


The figure depicts the direction of liquidity flows constituting the 'circle of liquidity' of hedge funds.

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, administrator, custodian, or management company 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.
IncFee	The incentive fee a hedge fund charges.
Leverage	A dummy variable equals 1 if a hedge fund uses leverage, and 0 otherwise.
LIQ	The Pástor and Stambaugh (2003) market liquidity factor.
Lock	A dummy variable equals 1 for funds with lock-up periods.
LockUp	A hedge fund's lockup period.
LowRed	A dummy variable equals 1 for funds with a redemption period below the median.
MgtFee	The management fee a hedge fund charges.
MKT	The Standard & Poors (S&P) 500 index total return.
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.
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.
Small	A dummy variable equals 1 if a fund's assets under management are below the median.
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 equals 1 after April 2014, and 0 otherwise.
Weak	A dummy variable equals 1 for funds with returns below the median in each hedge fund category.
Young	A dummy variable equals 1 if a fund's age is below the median across all live funds.

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'	343
Managed Futures	CTA/Managed Futures', 'Managed Futures'	1023
Non-Directional Funds		
Fixed Income	Convertible Arbitrage', 'Fixed Income Arbitrage', 'Fixed Income', 'Distressed Debt'	594
Relative Value	Relative Value', 'Arbitrage', 'Value', 'Equity Market Neutral'	416
Semi-Directional Funds		
Event Driven	'Event Driven'	227
Long/Short Equities	Long/Short Equity Hedge', 'Long Short Equities', 'Dedicated Short Bias'	1987
Multi-Strategy	Multi-Strategy', 'Dual Approach'	535
Others		
Others	Others', 'Other', 'Bottom-Up', 'Top-Down', 'Diversified Debt', 'Options Strategy', 'Undefined'	572
Total		5697

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	0.496	0.504	3.955	-0.135	6.317	-11.537	12.647	5697
Panel B: By Hedge Fund Investment Style								
Directional Funds								
Global Macro	0.387	0.343	3.716	0.066	5.182	-10.045	11.346	343
Managed Futures	0.457	0.298	4.583	0.164	5.726	-12.269	14.871	1023
Non-Directional Funds								
Fixed Income	0.459	0.506	2.018	-0.378	7.867	-6.843	6.704	594
Relative Value	0.536	0.594	3.304	-0.417	8.832	-11.157	11.096	416
Semi-Directional Funds								
Event Driven	0.594	0.669	3.505	-0.379	6.745	-11.175	11.550	227
Long/Short Equities	0.525	0.568	4.174	-0.058	5.297	-11.948	13.384	1987
Multi Strategy	0.471	0.536	3.680	-0.264	6.429	-11.182	11.278	535
Others								
Others	0.521	0.576	5.135	-0.385	7.886	-15.326	15.904	572

Table 4: Summary statistics of hedge funds' flows

This table reports descriptive statistics of hedge fund 12 month flows 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	19.424	8.850	57.111	0.358	3.573	-60.061	145.667	5697
Panel B: By Hedge Fund Investment Style								
Directional Funds								
Global Macro	16.250	13.711	51.278	0.242	3.276	-64.075	126.982	343
Managed Futures	30.464	11.014	77.756	0.467	3.784	-71.082	211.263	1023
Non-Directional Funds								
Fixed Income	8.924	3.522	40.506	0.291	3.472	-54.540	99.942	594
Relative Value	17.184	5.263	57.683	0.488	4.059	-56.613	158.017	416
Semi-Directional Funds								
Event Driven	41.194	30.783	83.087	0.409	3.488	-57.021	205.424	227
Long/Short Equities	15.851	5.614	53.203	0.337	3.502	-59.829	130.613	1987
Multi Strategy	15.828	9.863	48.628	0.288	3.478	-56.808	118.524	535
Others								
Others	22.444	11.913	53.878	0.342	3.516	-52.301	138.578	572

Table 5: Summary statistics of hedge funds' characteristics

This table reports the descriptive statistics of the 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, Panel B and C report the statistics for connected and unconnected funds, respectively, and Panel D reports the percentage of different connections. The t-test in mean differences between connected and unconnected funds is conducted. *, **, 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($M)	170.269	155.275	94.676	0.446	3.626	42.710	367.141	5697
Age(Months)	30.093	21.087	31.025	1.071	3.994	0.000	88.229	5697
Leverage	0.519	1.000	0.500	-0.075	1.006	0.000	1.000	5697
MgtFee(%)	1.507	1.500	0.583	2.483	59.212	0.000	15.000	5697
IncFee(%)	17.399	20.000	6.550	-1.418	6.247	0.000	50.000	5697
Lockup(Months)	2.811	0.000	6.619	3.736	30.331	0.000	120.000	5697
Redemption(Months)	1.518	1.000	1.875	4.431	40.721	0.033	36.000	5697
Subscription(Months)	0.854	1.000	0.699	6.068	87.607	0.033	12.000	5697
Panel B: Connected hedge funds								
AuM($M)	183.686	163.424	108.784	0.499	3.672	37.722	413.109	1267
Age(Months)	37.924***	29.931	36.180	0.507	2.099	0.000	97.191	1267
Leverage	0.513	1.000	0.500	-0.050	1.003	0.000	1.000	1267
MgtFee(%)	1.513	1.500	0.593	9.696	224.247	0.000	15.000	1267
IncFee(%)	18.728***	20.000	4.448	-2.606	14.047	0.000	50.000	1267
Lockup(Months)	3.520***	0.000	7.175	2.664	12.040	0.000	60.000	1267
Redemption(Months)	1.854***	1.000	2.005	3.921	26.288	0.033	24.000	1267
Subscription(Months)	1.013***	1.000	0.772	7.701	101.859	0.033	12.000	1267
Panel C: Unconnected hedge funds								
AuM($M)	166.341	152.889	90.546	0.430	3.612	44.170	353.684	4430
Age(Months)	27.853	18.558	29.550	1.232	4.535	0.000	85.666	4430
Leverage	0.521	1.000	0.500	-0.082	1.007	0.000	1.000	4430
MgtFee(%)	1.505	1.500	0.580	0.283	7.664	0.000	6.000	4430
IncFee(%)	17.014	20.000	6.995	-1.211	5.365	0.000	50.000	4430
Lockup(Months)	2.607	0.000	6.437	4.148	38.357	0.000	120.000	4430
Redemption(Months)	1.419	1.000	1.824	4.668	47.408	0.033	36.000	4430
Subscription(Months)	0.807	1.000	0.669	5.409	80.150	0.033	12.000	4430

Panel D: Percentage of different connections

	Administrator	Custodian	Prime Broker	Management Company
Connect	52.11%	36.92%	32.82%	0.94%
Connect_non_US	60.68%	35.05%	20.39%	3.79%

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) tests 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 estimation results for the impact of the Volcker Rule on hedge funds' flow-performance relationship. $Flow_{t:t+11}$ is the flow for a fund over a year between month t and $t+11$. *Ret* is the average past year return, $Volcker$ 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, administrator, custodian, or management company of a hedge fund. Standard errors are reported in brackets. *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

	(1)	(2)	(3)
		$Flow_{t:t+11}$	
	Connected	Unconnected	Both
Ret (β_0)	5.431***	4.578***	4.499***
	(0.139)	(0.081)	(0.080)
Volcker (γ_0)	-2.874***	-6.295***	-5.577***
	(0.679)	(0.399)	(0.378)
Ret·Volcker (β_1)	0.446	1.993***	2.062***
	(0.380)	(0.178)	(0.177)
Connect (γ_1)			5.166***
			(1.515)
Volcker·Connect (γ_2)			0.895
			(0.663)
Ret·Connect (β_2)			1.286***
			(0.161)
Ret·Volcker·Connect (β_3)			-1.824***
			(0.428)
STD	-1.780***	-1.258***	-1.370***
	(0.106)	(0.057)	(0.050)
lnAUM	-24.448***	-24.626***	-24.558***
	(0.252)	(0.155)	(0.132)
HWM	3.914	9.059***	8.235***
	(4.625)	(2.389)	(2.111)
MgtFee	3.337*	-3.493***	-1.510
	(1.942)	(1.327)	(1.102)
IncFee	-0.292	-0.922***	-0.864***
	(0.332)	(0.136)	(0.124)
Age	-0.798***	-0.516***	-0.591***
	(0.078)	(0.049)	(0.042)
Redemption	1.370**	1.643***	1.565***
	(0.684)	(0.537)	(0.428)
Subscription	-2.769	-5.269***	-4.469***
	(2.084)	(1.372)	(1.147)
Leverage	3.666	5.264***	5.202***
	(2.452)	(1.524)	(1.295)
LockUp	-0.597***	0.113	-0.090
	(0.194)	(0.137)	(0.113)
StyleFlow	0.474***	0.226***	0.296***
	(0.016)	(0.010)	(0.009)
Constant	437.323***	452.289***	108.187***
	(7.528)	(3.939)	(2.525)
R-squared	0.029	0.021	0.023
Number of HFs	982	3,131	4,113

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

This table reports the estimation results for the impact of the Volcker Rule on hedge 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, administrator, custodian, 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 reported in brackets. *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

	(1)	(2)	(3)	(4)	(5)	(6)
	Connected		Unconnected		Both	
liquidity measure L =	LIQ	TradedLiq	LIQ	TradedLiq	LIQ	TradedLiq
L (γ_0)	7.341***	9.419***	7.623***	9.319***	7.378***	8.918***
	(0.298)	(0.507)	(0.220)	(0.385)	(0.226)	(0.404)
L·Volcker (γ_1)	-9.334***	-10.052***	-10.078***	-13.700***	-9.797***	-13.119***
	(0.594)	(1.221)	(0.337)	(0.595)	(0.330)	(0.609)
L·Connect (γ_2)					0.598	1.611**
					(0.430)	(0.795)
L·Volcker·Connect (γ_3)					-0.292	1.346
					(0.664)	(1.508)
MKT	0.195	-0.686**	-0.969***	-1.903***	-0.682***	-1.600***
	(0.300)	(0.300)	(0.201)	(0.199)	(0.168)	(0.166)
SMB	-3.919***	-3.329***	-3.269***	-2.664***	-3.419***	-2.819***
	(0.502)	(0.498)	(0.297)	(0.293)	(0.256)	(0.253)
TERM	-0.432***	-0.160**	-1.048***	-0.733***	-0.883***	-0.581***
	(0.081)	(0.080)	(0.053)	(0.052)	(0.045)	(0.044)
CREDIT	-3.204***	-3.089***	-3.502***	-3.391***	-3.430***	-3.318***
	(0.126)	(0.123)	(0.089)	(0.087)	(0.073)	(0.072)
PTFSBD	-2.965***	-2.591***	-2.614***	-2.265***	-2.700***	-2.345***
	(0.144)	(0.138)	(0.095)	(0.092)	(0.080)	(0.077)
PTFSFX	1.023***	0.928***	1.429***	1.317***	1.325***	1.217***
	(0.085)	(0.085)	(0.054)	(0.054)	(0.046)	(0.046)
PTFSCOM	-0.787***	-0.945***	-0.388***	-0.466***	-0.491***	-0.590***
	(0.103)	(0.102)	(0.075)	(0.074)	(0.062)	(0.061)
Constant	0.507***	0.479***	0.498***	0.481***	0.484***	0.461***
	(0.019)	(0.018)	(0.015)	(0.014)	(0.012)	(0.011)
R-squared	0.058	0.054	0.037	0.033	0.041	0.038
Number of HFs	1,227	1,227	4,177	4,177	5,404	5,404
Strategy fixed effect	Yes	Yes	Yes	Yes	Yes	Yes

Table 9: The Volcker Rule and hedge funds' market liquidity exposure by investment style category

This table compares 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, administrator, custodian, 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.

liquidity measure L =	(1)	(2)	(3)	(4)	(5)	(6)
	LIQ			TradedLiq		
	Directional	Non-directional	Semi-directional	Directional	Non-directional	Semi-directional
L (γ_0)	4.538***	4.924***	9.909***	4.088***	7.137***	14.489***
	(0.458)	(0.560)	(0.402)	(0.766)	(0.886)	(0.724)
L·Volcker (γ_1)	-12.738***	-5.574***	-10.703***	-18.427***	-6.412***	-12.303***
	(0.787)	(0.699)	(0.606)	(1.316)	(1.261)	(1.048)
L·Connect (γ_2)	-0.061	1.865	-1.640**	1.764	2.596	-3.521***
	(1.010)	(1.162)	(0.647)	(2.374)	(1.899)	(1.235)
L·Volcker·Connect (γ_3)	-1.008	-3.109	2.115**	3.463	-0.923	7.651***
	(1.847)	(2.218)	(0.994)	(4.925)	(3.205)	(2.117)
MKT	0.083	-0.960**	-0.386	-0.644	-1.480***	-1.490***
	(0.435)	(0.417)	(0.274)	(0.433)	(0.425)	(0.273)
SMB	-0.630	-0.838	-4.985***	-0.324	-0.321	-4.200***
	(0.539)	(0.530)	(0.463)	(0.529)	(0.523)	(0.456)
TERM	-1.105***	-1.336***	-0.705***	-0.778***	-1.187***	-0.420***
	(0.132)	(0.108)	(0.082)	(0.130)	(0.106)	(0.081)
CREDIT	-1.131***	-4.371***	-4.756***	-1.083***	-4.250***	-4.572***
	(0.182)	(0.245)	(0.148)	(0.177)	(0.239)	(0.144)
PTFSBD	0.446**	-2.487***	-3.637***	0.712***	-2.254***	-3.190***
	(0.184)	(0.152)	(0.104)	(0.183)	(0.143)	(0.100)
PTFSFX	2.914***	0.353***	1.065***	2.911***	0.268***	0.895***
	(0.157)	(0.070)	(0.055)	(0.157)	(0.069)	(0.055)
PTFSCOM	2.119***	-1.177***	-1.412***	2.049***	-1.268***	-1.588***
	(0.188)	(0.093)	(0.080)	(0.185)	(0.094)	(0.081)
Constant	0.612***	0.404***	0.504***	0.569***	0.397***	0.477***
	(0.031)	(0.027)	(0.022)	(0.031)	(0.026)	(0.021)
R-squared	0.020	0.070	0.064	0.019	0.069	0.062
Number of HFs	1,366	1,010	2,749	1,366	1,010	2,749
Strategy fixed effect	Yes	Yes	Yes	Yes	Yes	Yes

Table 10: The Volcker Rule and hedge funds' liquidity provision

This table reports the estimation results for the impact of the Volcker Rule on hedge funds' liquidity provision. *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, administrator, custodian, 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.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
		Connected			Unconnected			Both	
	Rlp	Rlp^{Liquid}	$Rlp^{Illiquid}$	*Rlp*	Rlp^{Liquid}	$Rlp^{Illiquid}$	*Rlp*	Rlp^{Liquid}	$Rlp^{Illiquid}$
Rlp (γ_0)	54.261***	-15.295***	28.111***	61.863***	-6.105**	23.381***	61.369***	-5.086*	24.465***
	(3.760)	(3.713)	(3.441)	(2.845)	(2.702)	(2.305)	(2.796)	(2.783)	(2.261)
Rlp·Volcker (γ_1)	-25.546***	34.261***	-13.704**	-47.842***	35.574***	-32.309***	-43.512***	35.108***	-30.199***
	(7.880)	(8.807)	(5.684)	(4.826)	(4.486)	(3.536)	(4.623)	(4.478)	(3.390)
Rlp·Connect (γ_2)							-6.447	-12.863**	0.305
							(4.624)	(5.343)	(4.038)
Rlp·Volcker·Connect (γ_3)							5.640	-0.084	10.662*
							(8.864)	(10.018)	(6.207)
MKT	-0.472	-0.772**	-0.636**	-1.692***	-1.974***	-1.983***	-1.388***	-1.678***	-1.643***
	(0.303)	(0.301)	(0.304)	(0.200)	(0.201)	(0.202)	(0.167)	(0.167)	(0.169)
SMB	-2.505***	-2.801***	-2.727***	-1.848***	-2.192***	-2.133***	-1.997***	-2.328***	-2.265***
	(0.496)	(0.502)	(0.503)	(0.293)	(0.293)	(0.296)	(0.252)	(0.253)	(0.255)
TERM	0.113	0.046	0.055	-0.527***	-0.607***	-0.581***	-0.356***	-0.432***	-0.412***
	(0.081)	(0.081)	(0.081)	(0.052)	(0.052)	(0.052)	(0.044)	(0.044)	(0.044)
CREDIT	-3.379***	-3.422***	-3.507***	-3.676***	-3.731***	-3.805***	-3.605***	-3.657***	-3.734***
	(0.130)	(0.129)	(0.130)	(0.092)	(0.091)	(0.092)	(0.075)	(0.075)	(0.076)
PTFSBD	-2.647***	-2.611***	-2.620***	-2.286***	-2.278***	-2.255***	-2.375***	-2.360***	-2.345***
	(0.140)	(0.138)	(0.140)	(0.093)	(0.092)	(0.093)	(0.078)	(0.077)	(0.078)
PTFSFX	0.944***	0.878***	0.914***	1.310***	1.212***	1.279***	1.215***	1.126***	1.184***
	(0.087)	(0.084)	(0.086)	(0.056)	(0.054)	(0.055)	(0.047)	(0.046)	(0.047)
PTFSCOM	-0.867***	-0.907***	-0.931***	-0.437***	-0.485***	-0.459***	-0.548***	-0.592***	-0.581***
	(0.102)	(0.101)	(0.103)	(0.074)	(0.072)	(0.074)	(0.061)	(0.060)	(0.061)
Constant	0.535***	0.519***	0.527***	0.524***	0.504***	0.519***	0.507***	0.487***	0.500***
	(0.018)	(0.018)	(0.018)	(0.015)	(0.015)	(0.015)	(0.012)	(0.011)	(0.012)
R-squared	0.049	0.048	0.048	0.031	0.029	0.029	0.034	0.033	0.033
Number of HFs	1,227	1,227	1,227	4,177	4,177	4,177	5,404	5,404	5,404
Strategy fixed effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Table 11: The Volcker Rule and hedge funds' liquidity provision by investment style category

This table compares 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, administrator, custodian, 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)	(3)	(4)	(5)	(6)
		Rlp^{Liquid}			$Rlp^{Illiquid}$	
	Directional	Non-directional	Semi-directional	Directional	Non-directional	Semi-directional
Rlp (γ_0)	27.207***	-13.777***	-25.680***	32.341***	9.167***	25.102***
	(4.860)	(4.117)	(3.959)	(4.536)	(3.498)	(3.274)
Rlp·Volcker (γ_1)	4.864	21.692***	57.896***	-82.981***	-4.709	-15.219***
	(8.928)	(6.223)	(6.360)	(6.935)	(4.701)	(4.728)
Rlp·Connect (γ_2)	-4.981	1.416	7.286	18.121*	-16.260**	9.541*
	(15.431)	(8.490)	(6.492)	(9.709)	(6.415)	(5.394)
Rlp·Volcker ·Connect (γ_3)	-7.392	-21.821	10.486	-19.269	24.092***	9.527
	(33.601)	(13.348)	(13.115)	(16.802)	(8.044)	(8.681)
MKT	-0.998***	-1.156***	-1.245***	-1.041***	-1.140***	-1.162***
	(0.331)	(0.321)	(0.227)	(0.334)	(0.322)	(0.229)
SMB	0.118	0.103	-3.933***	0.388	0.053	-3.912***
	(0.458)	(0.363)	(0.376)	(0.454)	(0.366)	(0.380)
TERM	-0.869***	-0.753***	0.132**	-0.775***	-0.766***	0.136**
	(0.098)	(0.077)	(0.057)	(0.096)	(0.078)	(0.057)
CREDIT	-1.280***	-3.469***	-4.070***	-1.298***	-3.512***	-4.188***
	(0.124)	(0.145)	(0.096)	(0.126)	(0.147)	(0.097)
PTFSBD	0.611***	-2.085***	-3.258***	0.712***	-2.102***	-3.272***
	(0.157)	(0.118)	(0.092)	(0.160)	(0.118)	(0.093)
PTFSFX	2.637***	0.284***	0.879***	2.778***	0.278***	0.925***
	(0.139)	(0.054)	(0.048)	(0.142)	(0.055)	(0.048)
PTFSCOM	1.739***	-1.003***	-1.217***	1.866***	-1.015***	-1.247***
	(0.154)	(0.064)	(0.068)	(0.157)	(0.066)	(0.069)
Constant	0.581***	0.418***	0.495***	0.608***	0.418***	0.506***
	(0.027)	(0.023)	(0.018)	(0.027)	(0.023)	(0.018)
R-squared	0.022	0.073	0.061	0.023	0.073	0.061
Number of HFs	1,366	1,010	2,749	1,366	1,010	2,749
Strategy fixed effect	Yes	Yes	Yes	Yes	Yes	Yes

Table 12: The Volcker Rule and hedge funds' flow-performance relationship: implementation and full compliance periods

This table reports the estimation results for the impact of the Volcker Rule on hedge funds' flow-performance relationship during three different phases. $Flow_{t:t+11}$ is the flow for a fund over a year between month t and $t+11$. *Ret* is the average past year return, $Phase1$ is a dummy variable that equal 1 between July 2010 and March 2014, $Phase2$ is a dummy variable that equal 1 between April 2014 and July 2017, $Phase3$ 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, administrator, custodian, or management company of a hedge fund. 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)
		$Flow_{t:t+11}$	
	Connected	Unconnected	Both
Ret (β_0)	4.686***	4.145***	4.057***
	(0.155)	(0.093)	(0.092)
Phase1 (γ_0^{Phase1})	-6.090***	-7.526***	-6.971***
	(0.749)	(0.474)	(0.444)
Phase2 (γ_0^{Phase2})	-7.014***	-13.321***	-11.955***
	(1.050)	(0.637)	(0.581)
Phase3 (γ_0^{Phase3})	-15.973***	-19.367***	-17.842***
	(1.930)	(0.948)	(0.889)
Ret·Phase1 (β_1^{Phase1})	3.458***	1.674***	1.734***
	(0.325)	(0.186)	(0.184)
Ret·Phase2 (β_1^{Phase2})	0.843**	2.624***	2.695***
	(0.406)	(0.196)	(0.194)
Ret·Phase3 (β_1^{Phase3})	7.206***	2.963***	3.081***
	(1.185)	(0.403)	(0.399)
Connect (γ_1)			4.144***
			(1.545)
Phase1·Connect (γ_2^{Phase1})			-1.221*
			(0.698)
Phase2·Connect (γ_2^{Phase2})			0.753
			(0.797)
Phase3·Connect (β_2)			-3.084*
			(1.837)
Ret·Connect (β_3^{Phase1})			0.972***
			(0.182)
Ret·Phase1·Connect (β_3^{Phase1})			1.690***
			(0.382)
Ret·Phase2·Connect (β_3^{Phase2})			-2.047***
			(0.460)
Ret·Phase3·Connect (β_3^{Phase2})			3.922***
			(1.285)
Constant	445.784***	461.087***	114.020***
	(7.615)	(3.973)	(2.543)
R-squared	0.027	0.018	0.020
Number of HFs	982	3,131	4,113
Other HF specific controls	yes	yes	yes

Table 13: The Volcker Rule and hedge funds' market liquidity exposure: implementation and full compliance periods

This table reports the estimation results for the impact of the Volcker Rule on hedge funds' exposure to market liquidity risk during three different phases. LIQ represents the Pástor and Stambaugh (2003) market liquidity factor and $TradeLiq$ represents the Pástor and Stambaugh (2003) traded liquidity factor. $Phase1$ is a dummy variable that equal 1 between July 2010 and March 2014, $Phase2$ is a dummy variable that equal 1 between April 2014 and July 2017, $Phase3$ 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, administrator, custodian, 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.

	(1)	(2)	(3)	(4)	(5)	(6)
	Connected		Unconnected		Both	
liquidity measure L =	LIQ	TradedLiq	LIQ	TradedLiq	LIQ	TradedLiq
L (γ_0)	6.801***	8.624***	6.797***	8.779***	6.563***	8.374***
	(0.315)	(0.533)	(0.237)	(0.411)	(0.243)	(0.429)
L·Phase1 (γ_1^{Phase1})	4.669***	4.999***	5.811***	2.885***	5.729***	2.888***
	(0.608)	(0.991)	(0.400)	(0.683)	(0.393)	(0.676)
L·Phase2 (γ_1^{Phase2})	-8.316***	-7.621***	-8.974***	-12.642***	-8.576***	-11.897***
	(0.751)	(1.246)	(0.400)	(0.666)	(0.390)	(0.682)
L·Phase3 (γ_1^{Phase3})	-9.255***	-15.322***	-9.170***	-14.662***	-9.128***	-14.536***
	(0.950)	(2.174)	(0.471)	(0.906)	(0.466)	(0.907)
L·Connect (γ_2)					0.830*	1.352*
					(0.451)	(0.819)
L·Phase1·Connect (γ_3^{Phase1})					-0.677	2.241*
					(0.690)	(1.213)
L·Phase2·Connect (γ_3^{Phase2})					-0.744	2.201
					(0.825)	(1.594)
L·Phase3·Connect (γ_3^{Phase3})					-0.160	-1.156
					(1.063)	(2.411)
MKT	0.149	-0.702**	-1.053***	-1.910***	-0.756***	-1.611***
	(0.301)	(0.299)	(0.203)	(0.199)	(0.169)	(0.166)
SMB	-4.021***	-3.336***	-3.464***	-2.673***	-3.585***	-2.826***
	(0.510)	(0.501)	(0.303)	(0.295)	(0.261)	(0.255)
TERM	-0.435***	-0.159**	-1.051***	-0.732***	-0.885***	-0.580***
	(0.081)	(0.080)	(0.053)	(0.052)	(0.045)	(0.044)
CREDIT	-3.231***	-3.102***	-3.548***	-3.400***	-3.470***	-3.327***
	(0.126)	(0.124)	(0.089)	(0.087)	(0.073)	(0.072)
PTFSBD	-2.971***	-2.589***	-2.627***	-2.263***	-2.710***	-2.344***
	(0.144)	(0.138)	(0.095)	(0.092)	(0.080)	(0.077)
PTFSFX	1.063***	0.918***	1.483***	1.312***	1.374***	1.211***
	(0.087)	(0.085)	(0.056)	(0.054)	(0.047)	(0.046)
PTFSCOM	-0.816***	-0.935***	-0.425***	-0.461***	-0.526***	-0.585***
	(0.104)	(0.102)	(0.075)	(0.074)	(0.062)	(0.061)
Constant	0.496***	0.485***	0.479***	0.484***	0.466***	0.465***
	(0.019)	(0.018)	(0.015)	(0.014)	(0.012)	(0.011)
R-squared	0.058	0.054	0.037	0.033	0.041	0.038
Number of HFs	1,227	1,227	4,177	4,177	5,404	5,404
Strategy fixed effect	Yes	Yes	Yes	Yes	Yes	Yes

Table 14: The Volcker Rule and hedge funds' liquidity provision: implementation and full compliance periods

This table reports the estimation results for the impact of the Volcker Rule on hedge funds' liquidity provision during three different phases. *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, $Phase1$ is a dummy variable that equal 1 between July 2010 and March 2014, $Phase2$ is a dummy variable that equal 1 between April 2014 and July 2017, $Phase3$ 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, administrator, custodian, 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.

	(1)	(2) Connected	(3)	(4)	(5) Unconnected	(6)	(7)	(8) Both	(9)
	Rlp	Rlp^{Liquid}	$Rlp^{Illiquid}$	Rlp	Rlp^{Liquid}	$Rlp^{Illiquid}$	Rlp	Rlp^{Liquid}	$Rlp^{Illiquid}$
Rlp (γ_0)	35.387***	-26.500***	33.573***	38.007***	-16.108***	25.118***	37.879***	-15.093***	28.880***
	(4.166)	(4.247)	(4.538)	(3.168)	(3.210)	(3.182)	(3.108)	(3.310)	(2.224)
Rlp·Phase1 (γ_1^{Phase1})	125.844***	66.905***	-21.505***	130.483***	47.346***	-6.094	127.871***	47.445***	-13.929***
	(9.000)	(6.803)	(7.338)	(6.514)	(5.171)	(4.611)	(6.336)	(5.186)	(3.445)
Rlp·Phase2 (γ_1^{Phase2})	-30.777***	-8.573	-24.034***	-63.491***	-3.833	-46.957***	-56.913***	-2.370	-49.064***
	(9.122)	(13.287)	(6.764)	(5.808)	(6.647)	(4.544)	(5.484)	(6.525)	(3.196)
Rlp·Phase3 (γ_1^{Phase3})	92.230***	97.550***	20.181	94.980***	83.671***	41.633***	91.863***	81.492***	24.628***
	(17.299)	(10.864)	(15.252)	(8.212)	(5.347)	(7.517)	(8.181)	(5.467)	(5.740)
Rlp·Connect (γ_2)							-2.597	-14.172**	-0.005
							(5.036)	(6.237)	(3.800)
Rlp·Phase1·Connect (γ_3^{Phase1})							4.770	20.173**	-10.717*
							(10.272)	(8.921)	(6.441)
Rlp·Phase2·Connect (γ_3^{Phase2})							8.932	-9.367	12.472**
							(10.090)	(14.888)	(5.638)
Rlp·Phase3·Connect (γ_3^{Phase3})							8.658	21.531*	-2.382
							(19.611)	(13.008)	(13.820)
MKT	-0.629**	-0.613**	-0.645**	-1.906***	-1.855***	-1.953***	-1.584***	-1.550***	-1.210***
	(0.305)	(0.300)	(0.302)	(0.201)	(0.202)	(0.201)	(0.168)	(0.168)	(0.131)
SMB	-3.020***	-3.099***	-2.657***	-2.386***	-2.423***	-2.168***	-2.530***	-2.574***	-1.914***
	(0.510)	(0.510)	(0.505)	(0.301)	(0.295)	(0.298)	(0.259)	(0.256)	(0.195)
TERM	0.071	0.108	0.058	-0.553***	-0.545***	-0.570***	-0.387***	-0.371***	-0.212***
	(0.081)	(0.081)	(0.081)	(0.052)	(0.052)	(0.052)	(0.044)	(0.044)	(0.034)
CREDIT	-3.463***	-3.389***	-3.499***	-3.753***	-3.691***	-3.780***	-3.684***	-3.619***	-2.667***
	(0.133)	(0.128)	(0.130)	(0.094)	(0.091)	(0.093)	(0.077)	(0.075)	(0.050)
PTFSBD	-2.604***	-2.546***	-2.601***	-2.190***	-2.226***	-2.193***	-2.294***	-2.305***	-1.998***
	(0.139)	(0.137)	(0.140)	(0.093)	(0.092)	(0.094)	(0.078)	(0.077)	(0.062)
PTFSFX	0.869***	0.925***	0.938***	1.232***	1.256***	1.279***	1.138***	1.170***	1.100***
	(0.087)	(0.084)	(0.088)	(0.056)	(0.054)	(0.056)	(0.047)	(0.046)	(0.037)
PTFSCOM	-0.699***	-0.876***	-0.951***	-0.216***	-0.444***	-0.417***	-0.342***	-0.555***	-0.333***
	(0.103)	(0.102)	(0.102)	(0.075)	(0.073)	(0.075)	(0.062)	(0.060)	(0.045)
Constant	0.542***	0.535***	0.525***	0.534***	0.518***	0.516***	0.515***	0.501***	0.491***
	(0.018)	(0.018)	(0.018)	(0.015)	(0.014)	(0.015)	(0.012)	(0.011)	(0.009)
R-squared	0.0507	0.0485	0.0483	0.0322	0.0297	0.0297	0.0358	0.0335	0.0315
Number of HFs	1,227	1,227	1,227	4,177	4,177	4,177	5,404	5,404	5,404
Strategy fixed effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Table 15: The Volcker Rule and hedge funds' flow-performance relationship: funds connected to US and non-US LCFIs

This table reports the estimation results for the impact of the Volcker Rule on hedge funds' flow-performance relationship using only the sub-sample of funds connected to either US or non-US based LTCIs. $Flow_{t:t+11}$ is the flow for a fund over a year between month t and $t+11$. *Ret* is the average past year return, $Volcker$ 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, administrator, custodian, or management company of a hedge fund. The sample includes only those funds that are linked to US-based and non-US-based LCFIs. Standard errors are reported in brackets. *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

	(1)	(2)	(3)
		$Flow_{t:t+11}$	
	Connected	Unconnected	Both
Ret (β_0)	0.963***	1.494***	4.435***
	(0.207)	(0.342)	(0.077)
Volcker (γ_0)	-3.547***	4.235**	-0.757**
	(1.266)	(1.713)	(0.332)
Ret·Volcker (β_1)	0.350	-1.086	1.587***
	(0.519)	(0.774)	(0.164)
Connect (γ_1)			-1.021
			(1.061)
Volcker·Connect (γ_2)			-2.120***
			(0.509)
Ret·Connect (β_2)			0.216*
			(0.127)
Ret·Volcker·Connect (β_3)			-1.487***
			(0.327)
STD	-1.300***	-1.142***	-1.200***
	(0.197)	(0.272)	(0.046)
lnAUM	-27.188***	-40.025***	-15.123***
	(0.485)	(0.741)	(0.110)
HWM	10.015	-8.215	-0.248
	(7.369)	(8.704)	(1.805)
MgtFee	4.741*	-6.683	0.881
	(2.514)	(4.487)	(0.929)
IncFee	0.745	-1.013**	-0.338***
	(0.523)	(0.502)	(0.112)
Age	-0.949***	-1.808***	-0.880***
	(0.185)	(0.332)	(0.035)
Redemption	1.120	3.717**	0.824***
	(0.967)	(1.582)	(0.314)
Subscription	-5.625**	-5.815	-2.160**
	(2.813)	(3.635)	(0.863)
Leverage	-0.341	19.971***	2.363**
	(3.738)	(4.933)	(1.010)
LockUp	-0.735**	0.041	-0.005
	(0.302)	(0.380)	(0.083)
StyleFlow	0.650***	0.636***	0.307***
	(0.026)	(0.046)	(0.007)
Constant	91.510***	199.250***	68.958***
	(10.495)	(10.348)	(2.151)
R-squared	0.020	0.0270	0.012
Number of HFs	523	444	2,876

Table 16: The Volcker Rule and hedge funds' market liquidity exposure: funds connected to US and non-US LCFIs

This table reports the estimation results for the impact of the Volcker Rule on hedge funds' exposure to market liquidity risk using only the sub-sample of funds connected to either US or non-US based LTCIs. *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, *Connect* is a dummy variable that equals 1 if a US-based LCFI is a prime broker, administrator, custodian, or management company of a hedge fund. MKT, SMB, TERM, CREDIT, PTFSBD, PTFSFX, and PTFSCOM are the Fung and Hsieh 7 factors. The sample includes only those funds that are linked to US-based and non-US-based LCFIs. 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)
	Connected		Unconnected		Both	
liquidity measure L =	LIQ	TradedLiq	LIQ	TradedLiq	LIQ	TradedLiq
L (γ_0)	7.272***	9.246***	7.959***	9.487***	7.748***	7.192***
	(0.295)	(0.502)	(0.271)	(0.469)	(0.283)	(0.307)
L·Volcker (γ_1)	-9.095***	-9.702***	-10.418***	-12.432***	-10.204***	-2.182***
	(0.594)	(1.219)	(0.398)	(0.703)	(0.391)	(0.269)
L·Connect (γ_2)					-0.142	6.366***
					(0.458)	(0.325)
L·Volcker·Connect (γ_3)					0.763	-5.698***
					(0.689)	(0.620)
MKT	0.228	-0.647**	-0.416*	-1.411***	-0.198	-0.826***
	(0.298)	(0.298)	(0.236)	(0.235)	(0.185)	(0.186)
SMB	-3.688***	-3.090***	-3.296***	-2.615***	-3.425***	-2.817***
	(0.483)	(0.478)	(0.355)	(0.350)	(0.286)	(0.283)
TERM	-0.428***	-0.158**	-0.981***	-0.662***	-0.775***	-0.659***
	(0.081)	(0.081)	(0.063)	(0.061)	(0.050)	(0.049)
CREDIT	-3.163***	-3.054***	-3.505***	-3.404***	-3.384***	-3.300***
	(0.125)	(0.123)	(0.103)	(0.102)	(0.080)	(0.079)
PTFSBD	-2.925***	-2.557***	-2.747***	-2.382***	-2.805***	-2.562***
	(0.144)	(0.137)	(0.110)	(0.106)	(0.088)	(0.085)
PTFSFX	1.020***	0.925***	1.317***	1.186***	1.210***	1.083***
	(0.089)	(0.089)	(0.059)	(0.059)	(0.049)	(0.049)
PTFSCOM	-0.743***	-0.898***	-0.622***	-0.717***	-0.663***	-0.809***
	(0.102)	(0.102)	(0.081)	(0.080)	(0.063)	(0.064)
Constant	0.513***	0.487***	0.474***	0.456***	0.485***	0.478***
	(0.019)	(0.018)	(0.016)	(0.015)	(0.009)	(0.008)
R-squared	0.057	0.053	0.046	0.042	0.050	0.047
Number of HFs	1,243	1,243	2,576	2,576	3,819	3,819
Strategy fixed effect	Yes	Yes	Yes	Yes	Yes	Yes

Table 17: The Volcker Rule and hedge funds' liquidity provision: funds connected to US and non-US LCFIs

This table reports the estimation results for the impact of the Volcker Rule on hedge funds' liquidity provision using only the sub-sample of funds connected to either US or non-US based LTCIs. *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, *Connect* is a dummy variable that equals 1 if a US-based LCFI is a prime broker, administrator, custodian, or management company of a hedge fund. MKT, SMB, TERM, CREDIT, PTFSBD, PTFSFX, and PTFSCOM are the Fung and Hsieh 7 factors. The sample includes only those funds that are linked to US-based and non-US-based LCFIs. 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)
		Connected			Unconnected			Both	
	Rlp	Rlp^{Liquid}	$Rlp^{Illiquid}$	*Rlp*	Rlp^{Liquid}	$Rlp^{Illiquid}$	*Rlp*	Rlp^{Liquid}	$Rlp^{Illiquid}$
Rlp (γ_0)	55.334***	-15.612***	28.610***	56.197***	-8.220**	22.645***	56.677***	-8.024**	20.459***
	(3.829)	(3.663)	(3.374)	(3.173)	(3.251)	(2.758)	(3.139)	(3.378)	(1.525)
Rlp·Volcker (γ_1)	-29.044***	33.792***	-15.223***	-37.315***	31.150***	-26.211***	-35.311***	31.244***	-27.490***
	(8.237)	(8.883)	(5.704)	(5.122)	(5.171)	(4.030)	(4.996)	(5.206)	(2.328)
Rlp·Connect (γ_2)							-2.649	-7.863	0.823
							(4.825)	(5.582)	(2.394)
Rlp·Volcker·Connect (γ_3)							2.929	2.856	6.863*
							(9.102)	(10.346)	(4.051)
MKT	-0.425	-0.724**	-0.591**	-1.198***	-1.467***	-1.450***	-0.933***	-1.214***	-0.497***
	(0.301)	(0.300)	(0.302)	(0.236)	(0.237)	(0.238)	(0.185)	(0.186)	(0.115)
SMB	-2.275***	-2.578***	-2.503***	-1.881***	-2.176***	-2.125***	-2.007***	-2.305***	-1.508***
	(0.477)	(0.483)	(0.484)	(0.351)	(0.349)	(0.353)	(0.283)	(0.283)	(0.169)
TERM	0.113	0.046	0.055	-0.453***	-0.520***	-0.501***	-0.243***	-0.310***	-0.065**
	(0.081)	(0.081)	(0.081)	(0.061)	(0.061)	(0.061)	(0.049)	(0.049)	(0.030)
CREDIT	-3.336***	-3.378***	-3.465***	-3.696***	-3.741***	-3.815***	-3.568***	-3.611***	-2.001***
	(0.129)	(0.128)	(0.129)	(0.107)	(0.107)	(0.108)	(0.083)	(0.082)	(0.040)
PTFSBD	-2.611***	-2.575***	-2.584***	-2.410***	-2.395***	-2.379***	-2.478***	-2.455***	-1.709***
	(0.139)	(0.138)	(0.139)	(0.107)	(0.106)	(0.107)	(0.085)	(0.084)	(0.052)
PTFSFX	0.945***	0.877***	0.914***	1.178***	1.100***	1.152***	1.093***	1.019***	0.822***
	(0.091)	(0.088)	(0.090)	(0.060)	(0.059)	(0.060)	(0.051)	(0.049)	(0.030)
PTFSCOM	-0.816***	-0.859***	-0.881***	-0.679***	-0.719***	-0.702***	-0.725***	-0.766***	-0.336***
	(0.101)	(0.100)	(0.102)	(0.079)	(0.078)	(0.080)	(0.063)	(0.062)	(0.036)
Constant	0.543***	0.526***	0.534***	0.495***	0.479***	0.492***	0.508***	0.492***	0.512***
	(0.018)	(0.018)	(0.018)	(0.015)	(0.015)	(0.015)	(0.008)	(0.008)	(0.006)
R-squared	0.0486	0.0472	0.0475	0.0386	0.0373	0.0374	0.0418	0.0404	0.0357
Number of HFs	1,243	1,243	1,243	2,576	2,576	2,576	3,819	3,819	3,819
Strategy fixed effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Table 18: The Volcker Rule and hedge funds' flow-performance relationship: matched funds

This table reports the estimation results for the impact of the Volcker Rule on hedge funds' flow-performance relationship using only matched samples. $Flow_{t:t+11}$ is the flow for a fund over a year between month t and $t+11$. *Ret* is the average past year return, $Volcker$ 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, administrator, custodian, or management company of a hedge fund. Standard errors are reported in brackets. *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

	(1)	(2)	(3)
		$Flow_{t:t+11}$	
	Connected	Unconnected	Both
Ret (β_0)	5.402***	0.415	3.481***
	(0.138)	(0.266)	(0.127)
Volcker (γ_0)	-2.715***	-4.934**	-0.459
	(0.679)	(2.084)	(0.602)
Ret·Volcker (β_1)	0.443	-0.378	2.349***
	(0.378)	(1.089)	(0.314)
Connect (γ_1)			3.211*
			(1.674)
Volcker·Connect (γ_2)			-1.871**
			(0.764)
Ret·Connect (β_2)			1.988***
			(0.181)
Ret·Volcker·Connect (β_3)			-1.917***
			(0.479)
STD	-1.770***	-1.948***	-1.350***
	(0.106)	(0.164)	(0.067)
lnAUM	-24.152***	-30.486***	-23.928***
	(0.251)	(0.651)	(0.180)
HWM	4.390	17.620	1.372
	(4.618)	(12.240)	(3.277)
MgtFee	3.777*	4.210	1.187
	(1.951)	(5.017)	(1.510)
IncFee	-0.351	-1.107	-0.474**
	(0.337)	(0.814)	(0.223)
Age	-0.822***	-1.430***	-0.924***
	(0.077)	(0.222)	(0.055)
Redemption	1.453*	1.504	1.289**
	(0.777)	(1.534)	(0.520)
Subscription	-3.806	-7.715	-3.894**
	(2.600)	(5.071)	(1.797)
Leverage	3.707	0.766	4.600***
	(2.456)	(5.154)	(1.697)
LockUp	-0.565***	-0.206	-0.460***
	(0.195)	(0.404)	(0.138)
StyleFlow	0.471***	0.313***	0.404***
	(0.016)	(0.033)	(0.011)
Constant	432.595***	557.167***	433.738***
	(7.540)	(21.053)	(5.375)
R-squared	0.030	0.028	0.022
Number of HFs	975	361	1,936

Table 19: The Volcker Rule and hedge funds' market liquidity exposure: matched funds

This table reports the estimation results for the impact of the Volcker Rule on hedge funds' exposure to market liquidity risk using only matched samples. *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, administrator, custodian, 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 reported in brackets. *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

	(1)	(2)	(3)	(4)	(5)	(6)
	Connected		Unconnected		Both	
liquidity measure L =	LIQ	TradedLiq	LIQ	TradedLiq	LIQ	TradedLiq
L (γ_0)	7.297***	9.144***	8.127***	11.151***	8.118***	11.356***
	(0.327)	(0.548)	(0.420)	(0.810)	(0.444)	(0.852)
L·Volcker (γ_1)	-9.017***	-8.899***	-9.378***	-11.007***	-9.319***	-11.793***
	(0.641)	(1.246)	(0.620)	(1.310)	(0.603)	(1.327)
L·Connect (γ_2)					-0.819	-2.424**
					(0.603)	(1.133)
L·Volcker·Connect (γ_3)					0.230	3.644*
					(0.859)	(1.913)
MKT	-0.008	-0.939***	-0.287	-1.325***	-0.145	-1.126***
	(0.320)	(0.317)	(0.396)	(0.395)	(0.251)	(0.249)
SMB	-4.191***	-3.552***	-4.478***	-3.775***	-4.294***	-3.624***
	(0.558)	(0.553)	(0.599)	(0.591)	(0.409)	(0.404)
TERM	-0.375***	-0.095	-0.760***	-0.482***	-0.549***	-0.269***
	(0.090)	(0.089)	(0.103)	(0.101)	(0.068)	(0.067)
CREDIT	-3.176***	-3.070***	-3.941***	-3.795***	-3.517***	-3.393***
	(0.134)	(0.132)	(0.169)	(0.166)	(0.106)	(0.104)
PTFSBD	-2.994***	-2.618***	-3.264***	-2.887***	-3.124***	-2.749***
	(0.158)	(0.151)	(0.171)	(0.163)	(0.116)	(0.111)
PTFSFX	1.109***	0.995***	1.165***	1.023***	1.132***	1.005***
	(0.097)	(0.097)	(0.085)	(0.084)	(0.065)	(0.065)
PTFSCOM	-0.783***	-0.940***	-0.910***	-1.040***	-0.841***	-0.984***
	(0.115)	(0.114)	(0.126)	(0.124)	(0.085)	(0.084)
Constant	0.494***	0.472***	0.520***	0.502***	0.507***	0.486***
	(0.020)	(0.019)	(0.022)	(0.021)	(0.015)	(0.014)
R-squared	0.058	0.054	0.060	0.058	0.059	0.056
Number of HFs	979	979	979	979	1,958	1,958
Strategy fixed effect	Yes	Yes	Yes	Yes	Yes	Yes

Table 20: The Volcker Rule and hedge funds' liquidity provision: matched funds

This table reports the estimation results for the impact of the Volcker Rule on hedge funds' liquidity provision using only matched samples. *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, administrator, custodian, 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.

	(1)	(2) Connected	(3)	(4)	(5) Unconnected	(6)	(7)	(8) Both	(9)
	Rlp	Rlp^{Liquid}	$Rlp^{Illiquid}$	*Rlp*	Rlp^{Liquid}	$Rlp^{Illiquid}$	*Rlp*	Rlp^{Liquid}	$Rlp^{Illiquid}$
Rlp (γ_0)	57.425***	-15.227***	29.092***	62.344***	-18.339***	21.951***	63.836***	-21.291***	21.242***
	(4.247)	(4.185)	(3.895)	(5.223)	(5.391)	(4.674)	(5.152)	(5.663)	(4.471)
Rlp·Volcker (γ_1)	-28.024***	38.068***	-14.716**	-31.969***	43.648***	-16.868**	-36.426***	45.483***	-18.383***
	(8.718)	(9.516)	(6.359)	(9.538)	(9.138)	(7.206)	(9.184)	(9.202)	(6.783)
Rlp·Connect (γ_2)							-7.682	8.489	8.736
							(6.552)	(7.655)	(5.772)
Rlp·Volcker·Connect (γ_3)							12.805	-8.437	4.936
							(12.189)	(13.367)	(8.781)
MKT	-0.694**	-0.978***	-0.850***	-1.029***	-1.308***	-1.289***	-0.859***	-1.139***	-1.062***
	(0.320)	(0.320)	(0.321)	(0.395)	(0.395)	(0.399)	(0.250)	(0.250)	(0.252)
SMB	-2.800***	-3.104***	-3.036***	-3.026***	-3.325***	-3.328***	-2.874***	-3.175***	-3.139***
	(0.549)	(0.557)	(0.557)	(0.594)	(0.594)	(0.601)	(0.404)	(0.407)	(0.409)
TERM	0.178**	0.105	0.118	-0.201**	-0.266***	-0.262***	0.006	-0.063	-0.054
	(0.089)	(0.090)	(0.090)	(0.102)	(0.101)	(0.102)	(0.067)	(0.067)	(0.067)
CREDIT	-3.348***	-3.387***	-3.479***	-4.128***	-4.156***	-4.254***	-3.695***	-3.729***	-3.825***
	(0.139)	(0.137)	(0.138)	(0.174)	(0.172)	(0.175)	(0.109)	(0.108)	(0.110)
PTFSBD	-2.684***	-2.649***	-2.656***	-2.945***	-2.908***	-2.914***	-2.811***	-2.775***	-2.782***
	(0.153)	(0.151)	(0.153)	(0.166)	(0.164)	(0.166)	(0.113)	(0.111)	(0.113)
PTFSFX	1.036***	0.954***	0.998***	1.040***	0.957***	0.998***	1.035***	0.953***	0.996***
	(0.100)	(0.096)	(0.098)	(0.086)	(0.084)	(0.085)	(0.066)	(0.064)	(0.065)
PTFSCOM	-0.850***	-0.890***	-0.913***	-0.955***	-0.991***	-0.998***	-0.897***	-0.935***	-0.951***
	(0.113)	(0.112)	(0.113)	(0.124)	(0.123)	(0.126)	(0.084)	(0.083)	(0.085)
Constant	0.526***	0.509***	0.518***	0.551***	0.533***	0.543***	0.539***	0.521***	0.532***
	(0.019)	(0.019)	(0.019)	(0.021)	(0.021)	(0.022)	(0.015)	(0.015)	(0.015)
R-squared	0.050	0.048	0.049	0.053	0.052	0.052	0.051	0.050	0.050
Number of HFs	979	979	979	979	979	979	1,958	1,958	1,958
Strategy fixed effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Appendix A Results for individual hedge fund styles

In this appendix, we classify funds according to their reported investment strategies. Prior literature documents that substantial performance, leverage and liquidity risk exposure differences 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 loadings. Jylhä et al. (2014) find that funds in the Equity Market Neutral and Event-Driven categories are more likely to supply market liquidity.

Table A1 indicates that all styles have significant positive exposure to market liquidity. The largest coefficients, 16.940 and 10.549, 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 Other and Managed Futures categories. In addition, a more pronounced impact is found 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 A2 reports the results using the traded liquidity measure of Pástor and Stambaugh (2003) and the interpretation of the results remain qualitatively unchanged.

[Table A1 and A2 in here]

Tables A3 and A4 reveal that the majority of investment styles (with the exception of Managed Futures) exhibit a significantly negative relation with Rlp^{Liquid}, 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 Relative Value 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 A3 and A4 in here]

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

This table reports 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, administrator, custodian, 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.

	(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)	10.549***	5.063***	4.506***	4.217***	5.466***	9.286***	8.323***	16.940***
	(0.513)	(1.211)	(0.492)	(0.564)	(0.889)	(0.999)	(0.758)	(1.172)
LIQ·Volcker (γ_1)	-11.284***	-6.859***	-14.707***	-5.308***	-5.228***	-9.933***	-9.313***	-15.267***
	(0.783)	(1.598)	(0.898)	(0.626)	(1.432)	(1.819)	(1.028)	(1.363)
LIQ·Connect (γ_2)	-2.264***	-0.789	-0.417	3.181**	0.727	-4.211**	1.130	-2.343
	(0.765)	(1.912)	(1.248)	(1.329)	(1.855)	(1.884)	(1.708)	(2.217)
LIQ·Volcker·Connect (γ_3)	2.928**	-2.783	-1.183	-2.754**	-5.095	5.422*	-2.761	-1.841
	(1.177)	(2.445)	(2.853)	(1.389)	(5.473)	(3.066)	(2.383)	(2.892)
MKT	-0.070	-1.946**	0.669	-0.078	-2.059***	1.462	-2.338***	-4.489***
	(0.323)	(0.818)	(0.510)	(0.454)	(0.735)	(1.009)	(0.584)	(0.818)
SMB	-5.521***	1.152	-1.061*	-0.068	-1.728*	-4.901***	-3.087***	-6.875***
	(0.573)	(1.085)	(0.616)	(0.533)	(0.925)	(1.205)	(0.932)	(1.267)
TERM	-0.442***	-1.604***	-0.947***	-1.353***	-1.300***	-1.051***	-1.540***	-2.849***
	(0.097)	(0.258)	(0.153)	(0.120)	(0.184)	(0.320)	(0.167)	(0.303)
CREDIT	-4.517***	-2.055***	-0.833***	-3.979***	-4.788***	-6.095***	-5.093***	-8.052***
	(0.178)	(0.372)	(0.206)	(0.213)	(0.449)	(0.542)	(0.297)	(0.643)
PTFSBD	-3.703***	-0.950***	0.870***	-2.110***	-3.001***	-3.580***	-3.385***	-5.546***
	(0.124)	(0.321)	(0.215)	(0.138)	(0.300)	(0.312)	(0.235)	(0.311)
PTFSFX	1.133***	1.695***	3.298***	0.318***	0.375***	0.599***	1.017***	0.832***
	(0.066)	(0.205)	(0.192)	(0.081)	(0.117)	(0.156)	(0.130)	(0.166)
PTFSCOM	-1.495***	0.250	2.688***	-1.002***	-1.412***	-1.749***	-0.977***	-2.377***
	(0.096)	(0.228)	(0.229)	(0.084)	(0.182)	(0.188)	(0.186)	(0.211)
Constant	0.533***	0.451***	0.642***	0.396***	0.487***	0.540***	0.435***	0.337***
	(0.015)	(0.034)	(0.026)	(0.019)	(0.029)	(0.028)	(0.031)	(0.044)
R-squared	0.061	0.011	0.027	0.097	0.060	0.111	0.068	0.085
Number of HFs	1,987	343	1,023	594	416	227	535	572

Table A2: The Volcker Rule and hedge funds' market liquidity exposure by investment strategy: traded liquidity

This table reports 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, administrator, custodian, 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.

	(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)	15.737***	6.989***	3.596***	4.502***	9.391***	12.805***	11.353***	16.076***
	(0.934)	(1.870)	(0.826)	(0.877)	(1.463)	(1.860)	(1.278)	(2.034)
TradedLiq ·Volcker (γ_1)	-11.700***	-13.814***	-20.278***	-4.863***	-6.940***	-9.825***	-14.665***	-20.774***
	(1.351)	(2.994)	(1.457)	(1.095)	(2.680)	(2.878)	(1.817)	(2.623)
TradedLiq ·Connect (γ_2)	-4.870***	0.426	0.100	6.015***	-0.618	-6.989*	3.123	0.239
	(1.455)	(3.564)	(3.265)	(1.895)	(3.262)	(3.585)	(3.432)	(4.351)
TradedLiq·Volcker ·Connect (γ_3)	9.945***	4.782	5.173	-3.596	0.860	13.602**	-10.669*	-8.615
	(2.398)	(7.436)	(6.815)	(2.466)	(7.364)	(5.927)	(5.863)	(7.768)
MKT	-1.215***	-2.613***	-0.078	-0.625	-2.534***	0.632	-3.389***	-6.547***
	(0.321)	(0.815)	(0.508)	(0.445)	(0.761)	(0.996)	(0.590)	(0.831)
SMB	-4.714***	1.488	-0.753	0.510	-1.312	-4.145***	-2.420***	-5.371***
	(0.566)	(1.061)	(0.604)	(0.525)	(0.916)	(1.152)	(0.915)	(1.254)
TERM	-0.159*	-1.391***	-0.588***	-1.192***	-1.161***	-0.813**	-1.229***	-2.176***
	(0.096)	(0.251)	(0.151)	(0.121)	(0.179)	(0.322)	(0.162)	(0.296)
CREDIT	-4.326***	-1.925***	-0.807***	-3.902***	-4.624***	-5.946***	-4.921***	-7.968***
	(0.173)	(0.357)	(0.201)	(0.209)	(0.440)	(0.542)	(0.287)	(0.635)
PTFSBD	-3.230***	-0.702**	1.145***	-1.897***	-2.748***	-3.210***	-2.997***	-4.917***
	(0.119)	(0.309)	(0.215)	(0.129)	(0.284)	(0.291)	(0.225)	(0.304)
PTFSFX	0.952***	1.628***	3.312***	0.218***	0.322***	0.413***	0.893***	0.507***
	(0.065)	(0.205)	(0.191)	(0.080)	(0.116)	(0.150)	(0.130)	(0.169)
PTFSCOM	-1.705***	0.217	2.601***	-1.057***	-1.550***	-1.887***	-1.052***	-2.336***
	(0.097)	(0.217)	(0.226)	(0.085)	(0.184)	(0.187)	(0.184)	(0.210)
Constant	0.505***	0.436***	0.592***	0.399***	0.456***	0.524***	0.415***	0.367***
	(0.014)	(0.033)	(0.025)	(0.018)	(0.028)	(0.027)	(0.029)	(0.043)
R-squared	0.059	0.011	0.025	0.095	0.059	0.109	0.066	0.077
Number of HFs	1,987	343	1,023	594	416	227	535	572

Table A3: The Volcker Rule and hedge funds' liquidity provision to liquid stocks by investment strategy

This table reports 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, administrator, custodian, 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.

	(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)	-26.379***	7.020	30.011***	1.096	-26.522***	-58.950***	-9.174	-5.955
	(4.911)	(9.790)	(5.440)	(4.982)	(6.515)	(11.224)	(7.771)	(11.378)
Rlp^{Liquid} ·Volcker (γ_1)	62.643***	25.355	1.322	2.045	46.559***	75.479***	35.802***	63.250***
	(8.030)	(18.502)	(10.034)	(6.460)	(12.869)	(18.247)	(12.113)	(16.637)
Rlp^{Liquid} ·Connect (γ_2)	9.524	-13.388	19.989	-13.478	19.089	36.790**	-17.341	-23.647
	(7.626)	(23.657)	(18.926)	(10.057)	(13.237)	(17.487)	(16.905)	(21.163)
Rlp^{Liquid}·Volcker ·Connect (γ_3)	6.796	45.290	-54.412	-6.800	-45.840*	-39.806	51.875*	-109.053***
	(15.902)	(38.016)	(56.733)	(13.433)	(26.677)	(31.699)	(31.008)	(36.819)
MKT	-1.015***	-2.037***	-0.635*	-0.520	-2.067***	0.056	-2.620***	-6.261***
	(0.272)	(0.657)	(0.381)	(0.346)	(0.581)	(0.628)	(0.515)	(0.628)
SMB	-4.603***	1.634*	-0.255	0.625*	-0.547	-2.679***	-1.993***	-4.750***
	(0.470)	(0.979)	(0.516)	(0.362)	(0.661)	(0.938)	(0.734)	(1.013)
TERM	0.358***	-1.041***	-0.788***	-0.775***	-0.668***	0.133	-0.705***	-1.554***
	(0.067)	(0.209)	(0.111)	(0.094)	(0.123)	(0.176)	(0.123)	(0.168)
CREDIT	-3.951***	-1.778***	-1.072***	-3.204***	-3.700***	-4.665***	-4.239***	-7.374***
	(0.115)	(0.274)	(0.134)	(0.145)	(0.270)	(0.298)	(0.205)	(0.284)
PTFSBD	-3.315***	-0.676***	1.010***	-1.784***	-2.522***	-3.099***	-3.096***	-5.017***
	(0.110)	(0.257)	(0.185)	(0.101)	(0.245)	(0.268)	(0.214)	(0.273)
PTFSFX	0.933***	1.470***	3.012***	0.210***	0.367***	0.533***	0.846***	0.508***
	(0.058)	(0.175)	(0.172)	(0.058)	(0.095)	(0.145)	(0.111)	(0.126)
PTFSCOM	-1.293***	0.217	2.221***	-0.839***	-1.253***	-1.548***	-0.813***	-2.177***
	(0.081)	(0.182)	(0.189)	(0.061)	(0.131)	(0.154)	(0.165)	(0.165)
Constant	0.512***	0.432***	0.600***	0.417***	0.501***	0.559***	0.446***	0.382***
	(0.013)	(0.030)	(0.020)	(0.017)	(0.024)	(0.025)	(0.025)	(0.030)
R-squared	0.0583	0.0090	0.0300	0.0970	0.0600	0.1101	0.0579	0.0892
Number of HFs	1,987	343	1,023	594	416	227	535	572

Table A4: The Volcker Rule and hedge funds' liquidity provision to illiquid stocks by investment strategy

This table reports 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, administrator, custodian, 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.

	(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)	20.463***	-4.152	40.887***	-0.121	15.906***	24.500***	38.581***	10.274
	(4.226)	(7.570)	(5.234)	(4.122)	(5.562)	(7.351)	(6.242)	(7.623)
$Rlp^{Illiquid}$ ·Volcker (γ_1)	-7.594	0.442	-106.469***	3.763	-11.455	1.961	-45.249***	1.810
	(6.056)	(10.664)	(8.027)	(5.079)	(9.243)	(10.485)	(9.195)	(11.968)
$Rlp^{Illiquid}$ ·Connect (γ_2)	20.858***	40.785***	16.965	2.240	-33.487***	-3.328	-33.595**	-2.316
	(6.314)	(11.800)	(14.148)	(7.625)	(10.182)	(17.884)	(14.331)	(15.023)
$Rlp^{Illiquid}$·Volcker ·Connect (γ_3)	2.576	-41.000**	-25.558	-3.837	59.847***	1.913	37.709*	-2.847
	(10.513)	(19.059)	(27.630)	(8.548)	(16.352)	(24.644)	(19.443)	(21.871)
MKT	-0.908***	-2.037***	-0.705*	-0.498	-2.052***	0.121	-2.610***	-6.242***
	(0.274)	(0.663)	(0.385)	(0.350)	(0.584)	(0.633)	(0.522)	(0.627)
SMB	-4.573***	1.680*	0.070	0.614*	-0.611	-2.836***	-1.914***	-4.739***
	(0.476)	(0.977)	(0.511)	(0.362)	(0.671)	(0.949)	(0.738)	(1.042)
TERM	0.363***	-1.017***	-0.673***	-0.780***	-0.694***	0.094	-0.683***	-1.550***
	(0.067)	(0.208)	(0.108)	(0.094)	(0.125)	(0.179)	(0.122)	(0.168)
CREDIT	-4.064***	-1.789***	-1.094***	-3.213***	-3.762***	-4.841***	-4.347***	-7.434***
	(0.116)	(0.283)	(0.137)	(0.146)	(0.273)	(0.301)	(0.207)	(0.284)
PTFSBD	-3.331***	-0.659**	1.137***	-1.790***	-2.560***	-3.157***	-3.080***	-5.021***
	(0.111)	(0.258)	(0.190)	(0.101)	(0.244)	(0.270)	(0.215)	(0.277)
PTFSFX	0.981***	1.529***	3.174***	0.203***	0.362***	0.520***	0.919***	0.559***
	(0.057)	(0.180)	(0.174)	(0.059)	(0.095)	(0.143)	(0.112)	(0.123)
PTFSCOM	-1.337***	0.213	2.384***	-0.849***	-1.275***	-1.592***	-0.790***	-2.221***
	(0.082)	(0.185)	(0.192)	(0.064)	(0.134)	(0.160)	(0.167)	(0.170)
Constant	0.523***	0.443***	0.630***	0.415***	0.502***	0.561***	0.464***	0.395***
	(0.013)	(0.031)	(0.020)	(0.017)	(0.024)	(0.026)	(0.025)	(0.030)
R-squared	0.0584	0.0090	0.0311	0.0969	0.0598	0.1086	0.0582	0.0887
Number of HFs	1,987	343	1,023	594	416	227	535	572

Appendix B Extensions: Hedge fund ability to retain capital

In this appendix, we examine effects of hedge funds' ability to retain capital, on their exposure to market liquidity and liquidity provision. As discussed in the main body of the paper, prohibiting LCFIs from sponsoring and investing in hedge funds may result in outflows from funds with large existing investments from these institutions. In response, hedge funds may choose to undertake an advance restructuring of their portfolios towards more liquid assets, reducing their exposure to market liquidity and better enabling them to meet any redemptions. We conjecture these adjustments may be more pronounced for funds with a lower ability to retain capital in adverse situations, such as those with relatively poor past performance, high leverage and fewer lockup and redemption restrictions. During the process of Volcker Rule implementation, banks redeeming their capital are likely to initially target these funds, while attempting to maintain their investment into more profitable funds, or those with higher redemption costs, until legal prohibitions take effect. Franzoni and Plazzi (2013), for example, document that hedge funds with higher leverage, more illiquid assets, lower reputational capital, and lower share restrictions are those most exposed to funding constraints. Kruttli et al. (2018) show that small, poorly performing hedge funds, and those with fewer prime brokers and having a large share of illiquid OTC trades are those most negatively impacted by the 2016 Deutsche Bank liquidity shock.

However, those funds that are less able to retain investment capital, due to poor past performance or lax share restrictions, may also find it more difficult to accumulate sufficient capital to engage in market-making, so we expect them to be less likely to increase their liquidity provision. This suggests the following corollary:

Following implementation of the Volcker Rule the effect on hedge fund liquidity provision and liquidity risk exposure is stronger for funds with lower ability to retain capital.

To test this corollary, we estimate Equation (B1) incorporating fund characteristics X as further controls.

$$Ret_t^i = \alpha + \sum_{k=1}^{7} \beta_k F_{k,t} + (\gamma_0 + \gamma_1 Volcker_t + \gamma_2 Connect_t^i + \gamma_3 Volcker_t \cdot Connect_t^i) \cdot L_t + \delta X_t^i + (\eta_0 X_t^i + \eta_1 Volcker_t \cdot X_t^i + \eta_2 Connect_t^i \cdot X_t^i + \eta_3 Volcker_t \cdot Connect_t^i \cdot X_t^i) \cdot L_t + \varepsilon_t^i \tag{B1}$$

X denotes one of six fund characteristics in turn: $Weak$ is a dummy variable that equals 1 for funds with returns below the median in each hedge fund category; $Leverage$ is a dummy variable that equals 1 if a fund uses leverage; $Young$ is a dummy variable that equals 1 if a fund's age is below the median across all live funds; $Small$ is a dummy variable that equals 1 if a fund's assets under management are below the median; $Lock$ is a dummy variable that equals 1 for funds with lock-up periods; $LowRed$ is a dummy variable that equals 1 for funds with a redemption period below the median. These characteristics, X_t^i, are constant within a specific month and are based on prior 12 months information.

The key coefficients of interest here are δ that captures the unconditional impact of a characteristic on fund's returns, and the set of η-s, that capture the effect of a characteristic of the liquidity exposure and provision in general (η_0), its changes post the Volcker Rule (η_1), and any differences between connected and non-connected funds before and after the Volcker Rule (η_2 and η_3).

Table B5 reports the estimated effects of hedge funds' ability to retain capital, on

their exposure to market liquidity.[14] For expositional clarity, we omit the coefficients on the Fung and Hsieh 7 factors. The key coefficient of interest is η_3 in Equation (B1), capturing the effect of the interaction terms $LIQ \cdot Volcker \cdot Connect \cdot X$. Connected funds using leverage or with a younger age significantly reduce their market liquidity exposure after the Volcker Rule. The corresponding coefficient η_3 in columns (2) and (3) of -3.146 and -2.442 are significant at the 5% and 10% level, respectively, which supports our hypothesis $H2(b)$. The η_3 coefficients in columns (5) and (6), which also capture funds with a lesser ability to retain capital, are negative as expected but statistically insignificant.

[Table B5 in here]

Examining the relationship between hedge fund characteristics and their liquidity provision (Table B6) reveals that the Volcker Rule's implementation may elicit a strategic management response from all funds, one which can be broadly characterised as involving a reversal or moderation of their pre-Volcker Rule decisions to provide liquidity. Following Rule implementation, funds with a lockup period re-orientate their operations from providing less to more liquidity in both liquid and illiquid stocks, whereas funds that are more likely to engage in liquidity provision in both stock segments before the Rule, namely funds with short redemption periods, become less likely to provide liquidity to the less liquid market segment subsequently. Young funds and funds using leverage are less likely to provide liquidity to the less liquid market segment before the Rule, but more likely to do so subsequently. Funds with poor past performance switch from undertaking more market-making activity in the relatively liquid component of the market, to decreasing their liquidity provision in both liquid and illiquid stocks. Finally, subsequent to the

[14]The results we discuss in this analysis use the innovations in the aggregate liquidity factor. They remain qualitatively unchanged if the traded liquidity factor is used. The latter results are tabulated in Appendix.

Volcker Rule, young funds and funds with a short redemption period having connections to LCFIs further decrease their liquidity provision to the more liquid market segment, while connected fund characteristics do not influence their liquidity provision behaviour in relation to illiquid stocks.

[Table B6 in here]

Table B5: The Volcker Rule and hedge funds' market liquidity exposure by fund characteristics

This table reports the impact of the Volcker Rule on hedge funds' exposure to market liquidity risk after controlling for fund characteristics. *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, administrator, custodian, or management company of a hedge fund. *X* indicates hedge fund characteristics: *Weak* equals 1 for funds with returns below the median in each hedge fund category; *Leverage* equals 1 if a fund uses leverage; *Young* equals 1 if a fund's age is below the median across all live funds; *Small* equals 1 if a fund's assets under management are below the median; *Lock* equals 1 for funds with lock-up periods; *LowRed* equals 1 for funds with a redemption period below the median. 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)	(10)	(11)	(12)
liquidity measure L =			LIQ						TradedLiq			
X =	Weak	Leverage	Young	Small	Lock	LowRed	Weak	Leverage	Young	Small	Lock	LowRed
L (γ_0)	7.904***	8.251***	7.363***	7.502***	6.882***	7.633***	10.433***	10.239***	9.901***	8.977***	7.665***	9.361***
	(0.265)	(0.348)	(0.272)	(0.291)	(0.266)	(0.258)	(0.500)	(0.614)	(0.514)	(0.517)	(0.478)	(0.461)
L·Volcker (γ_1)	-12.010***	-10.492***	-10.676***	-9.856***	-9.716***	-9.565***	-15.248***	-16.073***	-13.775***	-13.248***	-13.285***	-11.529***
	(0.408)	(0.491)	(0.438)	(0.390)	(0.376)	(0.398)	(0.773)	(0.935)	(0.845)	(0.750)	(0.695)	(0.746)
L·Connect (γ_2)	0.655	0.797	0.393	0.738	0.278	0.443	1.552	1.757	0.998	1.482	1.192	1.050
	(0.491)	(0.638)	(0.487)	(0.507)	(0.500)	(0.444)	(0.964)	(1.176)	(0.931)	(0.936)	(0.934)	(0.830)
L·Volcker·Connect (γ_3)	-0.417	1.397	0.574	-0.496	0.250	-0.385	-0.242	-0.234	2.528	2.245	0.982	2.335
	(0.911)	(0.907)	(0.807)	(0.720)	(0.714)	(0.721)	(2.002)	(2.262)	(1.857)	(1.681)	(1.761)	(1.665)
X (δ)	-0.158***	-0.014	-0.103***	0.065***	0.134***	-0.078***	-0.120***	-0.000	-0.028*	0.063***	0.118***	-0.067***
	(0.013)	(0.016)	(0.017)	(0.017)	(0.018)	(0.019)	(0.013)	(0.015)	(0.016)	(0.016)	(0.017)	(0.018)
L·X (η_0)	-1.386***	-1.837***	0.102	-0.302	2.209***	-1.034*	-3.643***	-2.726***	-3.933***	-0.137	5.569***	-1.925*
	(0.370)	(0.490)	(0.523)	(0.456)	(0.563)	(0.596)	(0.609)	(0.928)	(0.909)	(0.838)	(1.051)	(1.158)
L·Volcker·X (η_1)	4.889***	1.524**	1.797***	0.104	-0.186	-0.292	5.123***	5.699***	3.344***	0.304	1.134	-4.128***
	(0.585)	(0.653)	(0.674)	(0.641)	(0.769)	(0.727)	(1.121)	(1.350)	(1.282)	(1.293)	(1.592)	(1.551)
L·Connect·X (η_2)	-0.096	-0.339	1.186	-0.526	0.612	0.175	0.161	-0.201	1.927	0.403	0.170	2.819
	(0.613)	(0.850)	(0.969)	(0.797)	(0.957)	(1.388)	(1.050)	(1.586)	(1.645)	(1.483)	(1.739)	(2.754)
L·Volcker·Connect·X (η_3)	0.337	-3.146**	-2.442*	0.853	-1.956	-0.063	2.775	2.874	-4.275	-3.097	1.863	-8.703**
	(1.224)	(1.303)	(1.461)	(1.554)	(1.698)	(1.914)	(2.539)	(3.006)	(3.042)	(3.183)	(3.330)	(4.219)
Constant	0.570***	0.492***	0.523***	0.456***	0.454***	0.504***	0.528***	0.462***	0.470***	0.435***	0.435***	0.479***
	(0.012)	(0.014)	(0.013)	(0.013)	(0.012)	(0.012)	(0.012)	(0.014)	(0.013)	(0.013)	(0.012)	(0.012)
R-squared	0.041	0.041	0.041	0.041	0.041	0.041	0.038	0.038	0.038	0.038	0.038	0.038
Number of HFs	5,404	5,392	5,404	5,404	5,392	5,404	5,404	5,392	5,404	5,404	5,392	5,404
Strategy fixed effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Fung and Hsieh 7 factors	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Table B6: The Volcker Rule and hedge funds' liquidity provision by fund characteristics

This table reports the impact of the Volcker Rule on hedge funds' liquidity provision after controlling for fund characteristics. 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 and $Connect$ is a dummy variable that equals 1 if a US-based LCFI is a prime broker, administrator, custodian, or management company of a hedge fund. X indicates hedge fund characteristics: $Weak$ equals 1 for funds with returns below the median in each hedge fund category; $Leverage$ equals 1 if a fund uses leverage; $Young$ equals 1 if a fund's age is below the median across all live funds; $Small$ equals 1 if a fund's assets under management are below the median; $Lock$ equals 1 for funds with lock-up periods; $LowRed$ equals 1 for funds with a redemption period below the median. 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)	(10)	(11)	(12)
$Rlp =$				Rlp^{Liquid}						$Rlp^{Illiquid}$		
$X =$	Weak	Leverage	Young	Small	Lock	LowRed	Weak	Leverage	Young	Small	Lock	LowRed
Rlp (γ_0)	-23.703***	-9.492**	-3.897	-11.214***	4.619	-11.748***	24.714***	28.057***	40.286***	21.070***	27.687***	22.462***
	(3.835)	(4.139)	(3.358)	(3.926)	(3.271)	(3.179)	(3.072)	(3.077)	(2.685)	(2.902)	(2.614)	(2.567)
Rlp·Volcker (γ_1)	78.261***	44.532***	31.443***	35.553***	26.292***	38.391***	-17.644***	-37.506***	-42.287***	-26.586***	-34.897***	-23.488***
	(6.304)	(6.945)	(6.122)	(5.700)	(5.060)	(5.366)	(4.511)	(4.858)	(4.441)	(4.101)	(3.813)	(3.932)
Rlp·Connect (γ_2)	2.186	-10.836	-10.960*	-12.831*	-13.654**	-10.184*	2.272	-8.109	-4.728	2.177	-0.215	1.236
	(7.332)	(7.811)	(6.068)	(6.751)	(6.281)	(5.610)	(5.486)	(5.596)	(4.720)	(5.003)	(4.637)	(4.424)
Rlp·Volcker ·Connect (γ_3)	-7.399	-14.895	12.228	11.373	-6.622	7.593	13.570	20.365**	12.864*	6.519	8.176	8.945
	(13.604)	(15.307)	(11.875)	(10.862)	(10.926)	(11.405)	(8.968)	(8.504)	(7.701)	(7.006)	(6.944)	(7.090)
X (δ)	-0.129***	-0.019	-0.089***	0.058***	0.146***	-0.092***	-0.134***	-0.018	-0.099***	0.062***	0.137***	-0.087***
	(0.013)	(0.015)	(0.016)	(0.016)	(0.018)	(0.018)	(0.013)	(0.015)	(0.016)	(0.016)	(0.018)	(0.018)
Rlp·X (η_0)	47.228***	8.415	-5.474	14.761**	-43.440***	26.730***	0.823	-7.918*	-52.949***	8.204*	-15.479***	8.511*
	(6.088)	(6.178)	(7.162)	(6.380)	(6.784)	(7.734)	(5.067)	(4.403)	(4.519)	(4.847)	(4.974)	(5.169)
Rlp·Volcker·X (η_1)	-104.215***	-17.154*	11.742	-2.590	40.646***	-15.952	-30.853***	14.769**	46.803***	-8.792	22.515***	-22.481***
	(9.802)	(9.149)	(10.158)	(9.613)	(11.011)	(10.199)	(6.826)	(6.335)	(6.437)	(6.829)	(7.377)	(7.018)
Rlp·Connect·X (η_2)	-38.278***	-3.362	-13.006	4.281	12.978	7.577	-5.183	17.475**	5.684	-3.845	5.981	3.032
	(10.584)	(10.650)	(13.130)	(10.989)	(11.648)	(16.343)	(9.042)	(8.061)	(9.151)	(9.476)	(9.266)	(11.982)
Rlp·Volcker·Connect ·X (η_3)	28.630	26.563	-42.589*	-34.644	14.595	-52.394**	-1.137	-19.658	-2.025	11.755	5.063	-8.323
	(21.479)	(20.192)	(23.200)	(24.139)	(24.969)	(24.619)	(14.081)	(12.363)	(14.085)	(15.768)	(15.011)	(15.385)
Constant	0.558***	0.498***	0.523***	0.463***	0.455***	0.511***	0.573***	0.511***	0.535***	0.475***	0.470***	0.523***
	(0.012)	(0.014)	(0.013)	(0.013)	(0.012)	(0.012)	(0.012)	(0.014)	(0.013)	(0.013)	(0.012)	(0.012)
R-squared	0.033	0.033	0.033	0.033	0.033	0.033	0.033	0.033	0.033	0.033	0.033	0.033
Number of HFs	5,404	5,392	5,404	5,404	5,392	5,404	5,404	5,392	5,404	5,404	5,392	5,404
Strategy fixed effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Fung and Hsieh 7 factors	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes