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The value of internal sources of funding liquidity: U.S. broker-dealers and the financial crisis

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The Value of Internal Sources of Funding Liquidity: U.S. Broker-Dealers and the Financial Crisis

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The Value of Internal Sources of Funding Liquidity: U.S. Broker-Dealers and the Financial Crisis

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Abstract

We use confidential and novel data to measure the benefit to broker-dealers of being affiliated with a bank holding company and the resulting access to internal sources of funding. We accomplish this by comparing the balance sheets of broker-dealers that are associated with bank holding companies to those that are not and we find that the latter dramatically re-structured their balance sheets during the 2007-09 financial crisis, pivoting away from trading illiquid assets and toward more liquid government securities. Specifically, we estimate that broker-dealers that are not associated with bank holding companies both increased repo as a share of total assets by 10 percentage points and also increased the share of long inventory devoted to government securities by 15 percentage points, relative to broker-dealers associated with bank holding companies.

Key words: broker-dealers, shadow banking, liquidity risk, repo market

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This paper presents preliminary findings and is being distributed to economists and other interested readers solely to stimulate discussion and elicit comments. The views expressed in this paper are those of the author(s) and do not necessarily reflect the position of the Federal Reserve Bank of New York, the Board of Governors of the Federal Reserve System, or the Federal Reserve System. Any errors or omissions are the responsibility of the author(s).

To view the authors' disclosure statements, visit
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1 Introduction

The classic question of how a firm in the financial services sector organizes itself is often related to whether the entity is a bank or a non-bank or, more generally, whether the entity is affiliated with a bank holding company (BHC). This question is particularly relevant today given the importance of non-bank financial institutions to the U.S. financial sector and the current debate about lender of last resort to non banking organizations.¹ To shed some light on this question, we use confidential data collected by the Financial Industry Regulatory Authority (FINRA) on the population of broker dealers to study the benefits of being affiliated with a BHC.

Broker-dealers represent an ideal setting to analyze this question for two reasons. First, broker dealers exist as both stand alone firms and as part of bank holding companies, providing us with the necessary variation in organizational form.² Second, broker-dealers tend to be highly levered and as such are sensitive to changes in market and funding liquidity (Duffie (2010), Adrian and Shin (2010)). Whereas stand-alone broker-dealers rely solely on external sources of funding, broker-dealers that are affiliated with a BHC also have access to an internal source of funding. Because of the usual informational frictions associated with external funding markets, having access to an internal funding source can be valuable to a broker-dealer, especially during times of stress.³ Indeed, prior to 2008, five of the largest broker-dealers, Goldman Sachs, Morgan Stanley, Merrill Lynch, Lehman Brothers and Bear Stearns, were not BHC-affiliated. During 2008, the first three became BHC affiliated, Lehman declared bankruptcy, and Bear Stearns was purchased by J.P. Morgan, a BHC.

In this paper, we estimate how access to a BHC's internal funding affects a broker-dealer by examining changes to balance-sheet variables in response to an exogenous aggregate liquidity shock. Unlike most of the previous empirical literature

¹See Pozsar et al. (2013) for a comprehensive mapping of the shadow banking sector and its interconnections to the regulated sector.

²All broker-dealers are regulated by the U.S. Securities and Exchange Commission (SEC). However, broker-dealers that are part of a BHC are also subject to some restrictions imposed by the Federal Reserve Act, as the regulations that constrain BHCs indirectly affects the BHC-affiliated dealers (see appendix A).

³Although Regulation W places restrictions on transactions between entities of the same BHC, these restrictions do not apply to transactions involving liquid assets such as Treasuries. As a result, a broker-dealer associated with a BHC can obtain funding by selling its liquid assets to the parent company of the BHC or the associated depository institution. The BHC can access funding from multiple sources, including the Federal Reserve's Discount Window. See Pogach and Unal (2018) for both detailed information on the regulatory constraints and also an analysis of internal capital markets of BHCs.

which is focused on only the largest broker-dealers (Adrian and Shin, 2010; Carlson and Macchiavelli, 2020), our data covers the population of all U.S. broker-dealers. Furthermore, our data encompasses the 2007-09 financial crisis, a financial maelstrom that was predominantly a crisis of liquidity.⁴ We treat this crisis as an exogenous liquidity shock, allowing us to estimate the differential response between those broker-dealers with and without access to internal sources of funding.

Our empirical method is difference-in-differences, where only those broker-dealers associated with BHCs are assumed to have access to internal sources of liquidity. We examine a number of balance sheet variables where we expect to see differences across the two types of broker-dealers given a liquidity shock. Given the central role that Treasuries play in providing liquidity to market participants, we naturally focus on broker-dealers' trading of Treasuries. Since broker-dealers often resort to using repurchase agreements (repo) to move Treasuries on and off their balance sheet, we consider how the use of repo differs across the different types of broker-dealers. As expected, we find that broker-dealers without access to internal funding sources have a larger shift towards the use of repo relative to broker-dealers with such access. This effect shows up on both the liability and asset side of the balance sheet and the effects are economically significant; the difference across broker-dealer types averages more than 10 percent of a broker-dealer's total assets.

We also explore how broker-dealers managed their cash holdings and long inventory, because they are likely to change both of these assets in response to a liquidity shock. Although we do not find significant differences in the size of cash holdings or long inventory, we show a dramatic shift in the composition of the long inventory; broker-dealers without access to internal liquidity shifted the composition of their long inventory toward Treasuries to a much larger extent. Indeed, the coefficients imply these broker-dealers increased the share of Treasuries held in long inventory by 5 percentage points whereas broker-dealer with access to internal liquidity decreased that share by 10 percentage points.

We interpret this set of results as the effect of a deliberate change in trading strategy by broker-dealers without access to internal liquidity to transact with more liquid securities. Such a flight to safe, liquid assets is expected, given the general fall in market liquidity during the financial crisis and the related difficulties associated with wholesale funding markets (see, for example, the discussion in the "Liquidity"

⁴The 2007-09 financial crisis can be viewed as an information event that results in a decline in market and funding liquidity (Dang et al., 2018, 2019).

section in Krishnamurthy (2010)). Furthermore, the estimates imply the differences across broker-dealer types is large both relative to broker-dealers' total assets, and in aggregate. Using a back-of-the-envelope approach, we compute that if broker-dealers not affiliated with BHCs had access to internal funding sources, they, as a group, would have decreased their repo and reverse activity by \$90 and \$56 billion, respectively, and held \$84 billion less government securities in long inventory.

To better demonstrate that the mechanism behind our results is indeed driven by access to internal sources of liquidity, we employ a propensity-score method to match broker-dealers associated with BHCs to those which are not. The goal of this process is to ensure that we are comparing broker-dealers with similar business models. As such, the matching process compares broker-dealers in the two groups using the total asset size and the composition of revenue sources in the pre-crisis period. Using the output of this scoring method, we then re-do the difference-in-differences analysis and show that our results continue to hold.

Our benchmark analysis measures the average effect of the liquidity crisis on broker-dealers. In reality, over the financial crisis there was a gradual fall and subsequent rebound in market liquidity, with the default of Lehman Brothers marking a low point. To capture how this evolution in liquidity affects broker-dealers, we re-estimate our difference-in-differences regressions allowing for different effects in the first, second, and third year of the crisis. We find differences in the timing of the estimated effects. In general, the effects of the liquidity shock show up on the asset side of the balance sheet in the first year of the crisis and strengthen over time. In contrast, the effects of the liquidity shock show up later on the liability side. This differential timing effect may reflect the stability of the repo markets over the crisis as a source of funding for broker-dealers (Copeland et al. (2014)).

Finally, we provide evidence that the parent entity of a BHC is a source of liquidity. Using FR Y-9LP data, we document that the parent entities of BHCs regularly provide financial support to both banking and non-banking subsidiaries. We show that equity subsidies to non-banking subsidiaries jumped up at the start of the financial crisis and that parent entities increased non-equity subsidies to non-banking subsidiaries relative to those provided to banking subsidiaries. We interpret these results as being consistent with our premise that BHCs serve as an internal source of liquidity to affiliated broker-dealers. Complementary evidence of this point is provided by Correa et al. (2020), work that documents how large US BHCs use internal transfers between the depository institution and broker-dealer subsidiaries

to take advantage of opportunities to provide funding liquidity to the market.

Taken all together, our paper highlights that being associated with a BHC and its internal funding source is important during a crisis. Internal funding sources make BHC-affiliated dealers more resilient to financial stress, which may explain the decisions of Goldman Sachs, Morgan Stanley, and Merrill Lynch to become affiliated with a BHC. Because they are less vulnerable to liquidity shocks, during the financial crisis BHC-affiliated broker-dealers were able to make markets in more illiquid securities to greater extent relative to non-BHC affiliated broker-dealers.

More generally, our paper contributes to the policy debate related to access to the lender of last resort (LoLR). For example, Dudley (2013) suggests that there may be benefits to extending some access to LoLR liquidity to non-bank intermediaries. In a recent paper, Liang and Parkinson (2020) suggest that the Federal Reserve should create a new standing repo facility, available to dealers, to support market liquidity in periods of stress. Our results highlight the potential benefits of access to central bank liquidity for non-banks and suggest broader benefit for market functioning.⁵ Indeed, while broker-dealers generally do not have direct access to liquidity from the Federal Reserve, BHC affiliated dealers have access to internal sources of liquidity and, indirectly, to the discount window through their commercial bank affiliate, subject to the limitations imposed by sections 23 A and B of the Federal Reserve Act.

Our results are of general importance as they provide a comprehensive view of the broker-dealer sector, a crucial component of the financial system. To date, the empirical evidence on broker-dealers has been limited to non-representative sets of broker-dealers, such as only those associated with BHCs or those designated by the Federal Reserve as primary dealers. For example, Adrian and Shin (2010) studies the leverage cycle of broker-dealers using balance-sheet data on a small set of the largest broker-dealers. In contrast, in this paper we use confidential data that cover the universe of U.S. broker-dealers and allow us to highlight the heterogeneity among broker-dealers.

This paper adds to the growing literature on the 2007-09 financial crisis and broker-dealers. Part of this literature has focused on specific markets which are dominated by broker-dealers, such as the work by Copeland et al. (2014) and Krishnamurthy et al. (2014) on tri-party repo over the crisis. Another part of this

⁵Macchiavelli and Zhou (2021) provide evidence that shocks in the funding conditions faced by broker-dealer are connected to the market-making services they provide to their clients.

literature has focused on the effect of the Federal Reserve’s various liquidity facilities on broker-dealers or the markets in which they operate (Fleming et al., 2010; Acharya et al., 2017; Carlson and Macchiavelli, 2020). This paper builds on these efforts in two ways. First, we consider broker-dealer activity across a wide range of markets and so provide a broad view of the impact of the crisis. Our measure of repo, for example, consists of all transactions documented as repo, as opposed to those executed in a certain segment. Second, we consider a wide range of broker-dealers as opposed to only the very largest or those part of BHCs. As a result, we provide results on a large segment of the broker-dealer community that has not yet received much attention in the literature. In this way, our work is inline with Gorton and Metrick (2012) which “highlights the danger of relying exclusively on data from regulated institutions” to learn about the effects of a financial crisis.

This paper also complements those papers written by asset prices during the financial crisis. In particular, Musto et al. (2018) examine the price of liquidity over the crisis using detailed pricing data of on-the-run and off-the-run Treasury securities. They report an increase in the price of liquidity over the crisis, with a dramatic spike occurring after the Lehman bankruptcy in September 2008. This paper, which examines quantities, can be seen as a complement to this literature which focuses on prices.

Finally this paper also adds to the literature on internal versus external capital markets, which examines how capital is allocated through these two channels and seeks to better understand their relative efficiencies.⁶ Papers closest to this article focus on banks and how their access to internal markets for capital effects loan issuance or other investment decisions as well as the pass-through of monetary policy (e.g., see Campello (2002); Ashcraft and Campello (2007); Ashcraft (2008)). In particular, Cetorelli and Goldberg (2012a,b) highlight that internal capital markets have a direct impact on how banks manage their liquidity and, among other results, demonstrate that for global banks these internal markets may increase the international propagation of liquidity shocks. Although our focus is strictly domestic and examines broker-dealers, we also seek to better understand how internal sources of liquidity effect financial firms’ trading behavior, as observed through their balance sheet.

In the next section we provide a background on broker-dealers with a focus on their funding strategies. Section 3 describes our data and Section 4 presents the

⁶Maksimovic and Phillips (2013) provides a recent review of this literature.

empirical method and results. We link our results to current policy issues in Section 5 and then conclude with Section 6.

2 Background on U.S. Broker-Dealers

In this section we provide a brief overview of broker-dealers, their general trading strategies, and how these strategies are reflected on their balance sheet.

2.1 Overview of Broker-Dealers

Broker-dealers are both intermediaries that engage in the business of buying and selling securities either on behalf of a customer (a “broker”) as well as trading on their own account (a “dealer”). In their role as brokers and as dealers, these firms trade in the capital markets (securities, repurchase agreements, securities lending and OTC derivatives), provide asset management services to institutional investors, and act as prime dealers for hedge funds. In their role as dealers, these firms can act as investment banks, for example, underwriting and managing issues of securities. Further, and a central focus on this paper, broker-dealers differ in whether they are independent firms or part of a holding company, where the holding company controls depository institutions and other types of financial firms.

2.2 The Broker-Dealer Funding Model

Although broker-dealers finance their assets with both equity and debt, they heavily rely on debt and typically maintain a high leverage ratio. Before the crisis, our data show that the gross leverage ratio⁷ for the sample of broker-dealers affiliated and not-affiliated with BHC was 61 and 64 percent, respectively. The three main components of debt are long and short-term unsecured debt as well as secured funding, where the secured funding is most often documented as repo and securities lending activity.⁸ As demonstrated in figures 1a and 1b, broker-dealers lean the most on

⁷Gross leverage is computed as the ratio of total equity ownership over total assets.

⁸Another form of financing used by broker-dealers is to borrow money from their customers. Firms hold customer funds and generally do not pay interest on these balances. Since the options for this money is to hold it in a reserve bank account earning virtually no interest, or to lend it out to other customers, it makes economic sense for the firm to use customer money (i.e. customer credit balances) to finance lending to other customers (i.e. customer credit balances). Free credit balances are funds payable by a broker-dealer to its customers on demand. They may result from

secured funding; repo and securities lending activity typically accounts for the majority of their liabilities. Broker-dealers rely so heavily on secured funding because it is usually cheaper to obtain than unsecured funding, such as commercial paper. Further, a broker-dealer can usually access a larger amount of funding via repo and securities lending compared to the unsecured funding markets.

Before the 2007-09 crisis, there was a belief that secured funding was quite robust, as the cash lender is protected from the costs of default by the securities posted as collateral. In part because of this belief, broker-dealers often relied on short-term secured funding, as a way to lower their costs. The crisis revealed however, that secured short-term funding was not robust and even subject to runs (Martin et al., 2014; Infante, 2019). Indeed, the bankruptcy trustee for Lehman Brothers reports that in the days before its acquisition by J.P. Morgan, Bear Stearns could not acquire funding even against high quality collateral such as US Treasuries (Valukas, 2010). Copeland, Martin, and Walker (2014) argue that Lehman Brothers faced a similar run in days before it declared bankruptcy.

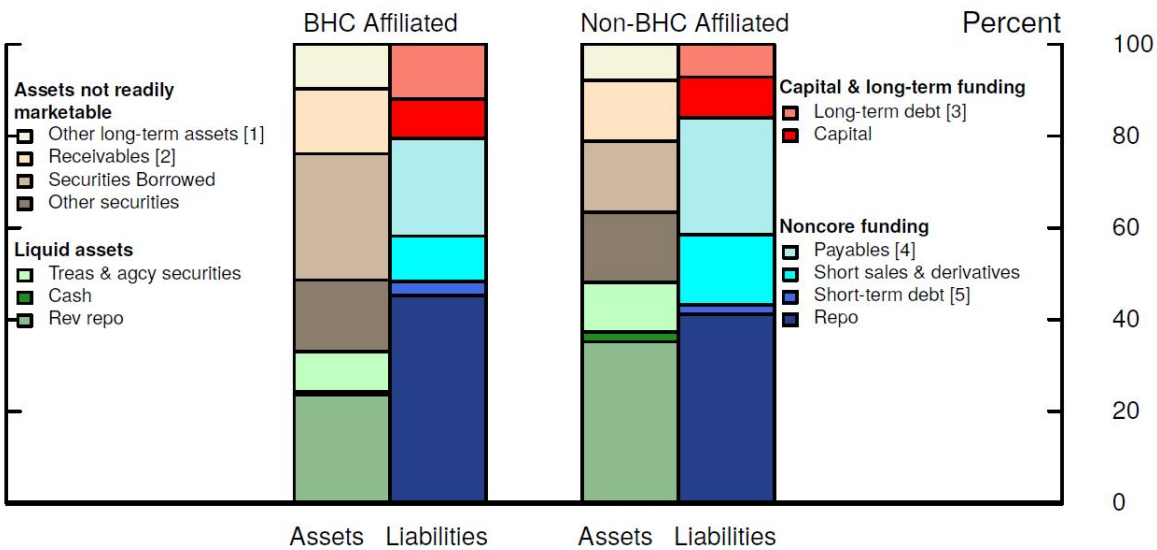
When the fragility of this model appeared evident during the financial crisis, special regulatory actions were taken in order to guarantee that broker-dealers could access liquidity and continue to finance their assets. First, on August 20, 2007, Citigroup, J.P. Morgan Chase and Bank of America were granted temporary exemptions from limits imposed by Federal Reserve Act (Section 23A) on lending between their bank and broker-dealer units. The exemption was aimed at enabling banks to better use the Federal Reserve's discount window to inject cash into illiquid credit markets. The Federal Reserve Board also allowed each of the three largest banks to extend credit to their securities affiliates in the form of reverse repo and securities borrowing transactions. The aim of this policy was to inject liquidity into the mortgage-backed and other asset-backed securities markets. For each bank, the exemption was granted for an aggregate amount of up to \$25 billion, which was less than thirty percent of the total regulatory capital. Similar exemptions were granted a few months later to Deutsche Bank, Barclays and the Royal Bank of Scotland.

Moreover, in the first quarter of 2008, the Board of Governor of the Federal Re-

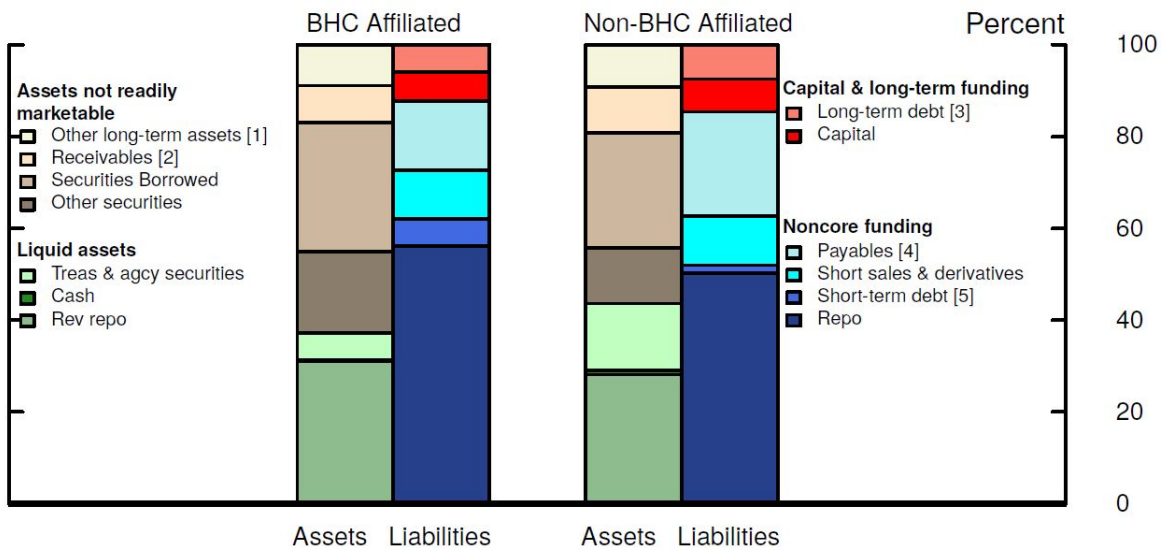
cash deposited by the customer to purchase securities, proceeds from the sale of securities or other assets held in the customer's account, or earnings from dividends and interest on securities and other assets held in the customer's account. Broker-dealers may, among other things, pay interest to customers on their free credit balances, or offer to transfer (sweep) them into a specific money market fund or interest bearing bank account. The customer earns dividends on the money market fund or interest on the bank account until such time as the customer chooses to liquidate the position in order to use the cash, for example, to purchase securities.

Figure 1: Balance Sheet Structure for BHC and Non-BHC affiliated broker dealers)

(a) First quarter of 2005



(b) First quarter of 2009



Note: [1] Non-marketable securities and investments, subordinated securities borrowed, investment in affiliates, seg. cash, secured demand notes, membership in exchanges, and other fixed assets; [2] Derivative and trade date receivables as well as receivables from broker dealers, clearing organizations, customers and non-customers; [3] Bank loans, notes, and subordinated debt; [4] Derivative and trade date payables as well as payables to broker dealers, clearing organizations, customers, and non-customers; [5] Account payables and accrued liabilities
Source: FOCUS reports and authors' calculations.

serve System exercised its authority under section 13(3) of the Federal Reserve Act to authorize three important lending facilities to provide funding to primary dealers: the Primary Dealer Credit Facility (PDCF), and the Term Securities Lending Facility (TSLF), including the TSLF Option Program (TOP). The PDCF was established as an overnight lending facility that provided funding to primary dealers in exchange for any collateral eligible in tri-party repurchase agreements with the major clearing banks. In addition, the Board of Governors authorized the Federal Reserve Bank of New York to provide liquidity support for securities subsidiaries of several institutions (Goldman Sachs, Morgan Stanley, and Merrill Lynch on September 21, 2008, and for Citigroup’s London-based broker-dealer subsidiary on November 23, 2008), under similar terms to that of PDCF. The TSLF was a 28-day facility that offered Treasury securities to the primary dealers in exchange for other program-eligible collateral, based on competitive auction. Finally, on July 30, 2008, the Fed announced the introduction of the TOP facility to offer options to the primary dealers to borrow securities from the TSLF to enhance the effectiveness of the TSLF by offering additional liquidity during periods of heightened market pressures in exchange for eligible collateral. The programs were terminated on February 1, 2010.

3 Data

In this section we provide an overview of the survey used to acquire our data and provide descriptive statistics.

3.1 FOCUS reports

Our analysis uses balance sheet and income statement data from the Financial and Operational Combined Uniform Single (FOCUS) report forms filed by all broker-dealers who are registered with the U.S. Securities and Exchange Commission (SEC) pursuant to Section 17 of the Securities Exchange Act of 1934 Rule 17a-10(a)(1). SEC Rule 17a-5 requires broker-dealers, among other things, to file monthly FOCUS Reports (Part II) ⁹ and quarterly FOCUS Reports (Part II or IIA) within 17 business days after month- or quarter-end. Focus reports include: Statement of Financial Condition; Statement of Income (Loss); Statement of Changes in Financial Condi-

⁹Monthly report that must be filed by every broker-dealer that clear transactions or carries customer accounts.

tion; Statement of Changes in Stockholders' Equity or Partners' or Sole Proprietors' Capital; Statement of Changes in Liabilities Subordinated to Claims of Creditors; Computation of Net Capital.

We use data from three FOCUS report forms: (1) the Part II Form, filed by all registered broker dealers that clear transactions or carry customer accounts; (2) the Part IIA Form, filed by all firms not clearing or carrying customer accounts; and (3) the Part II CSE Form, filed by all primary dealers. The FOCUS data is filed on a monthly and quarterly basis by roughly 4,000 total reporters (as of the end of 2017). FINRA staff review the FOCUS report to monitor a broker-dealer's financial trends and to determine if the firm has maintained net capital compliance. Our data is based on the reports filed with FINRA by its member firms, which are the vast majority of broker-dealers. Furthermore, we use the organizational hierarchy data available from the National Information Center to identify the broker-dealers affiliated with BHCs.¹⁰

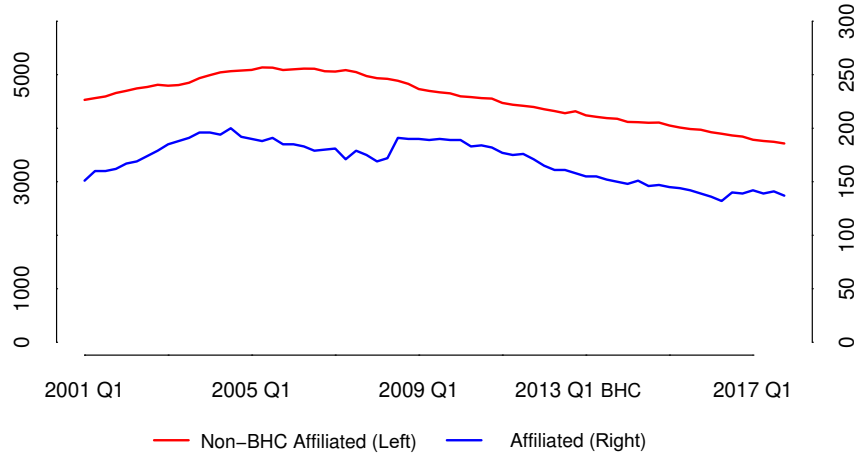
In this paper we focus on the quarterly filings. We filter the data in three ways. First, we exclude data for any broker-dealers who enter our sample as a result of changes in the regulatory responsibilities of the Federal Reserve, namely broker-dealer subsidiaries of thrift holding companies. By filtering out these firms, we seek to create a more balanced panel of reporting broker-dealers. Second, we exclude any broker-dealers which submit FOCUS reports for less than six consecutive quarters. Third, given our focus on BHC affiliation and the financial crisis, we remove those broker-dealers which changed their BHC affiliation during the financial crisis, including firms such as Goldman Sachs and Morgan Stanley. Finally, we focus our empirical analysis on 7 years of data, the first quarter of 2004 to the fourth quarter of 2011, centered around the 2007-09 financial crisis.

3.2 Descriptive Statistics

We begin by describing the size distribution of brokers-dealers and then introduce the balance sheet variables from the FOCUS reports on which we focus. We then present the revenue data in the FOCUS reports, which we use in our propensity score computations.

¹⁰The organizational hierarchy data can be found at <http://www.ffiec.gov/nicpubweb/nicweb/nichome.aspx>. When a broker-dealer has multiple parent companies, we identify the parent company as the one with the largest share of ownership. For a detailed look at the organizational structure of large U.S. BHCs, see Avraham et al. (2012).

Figure 2: Number of broker-dealers over time, by type



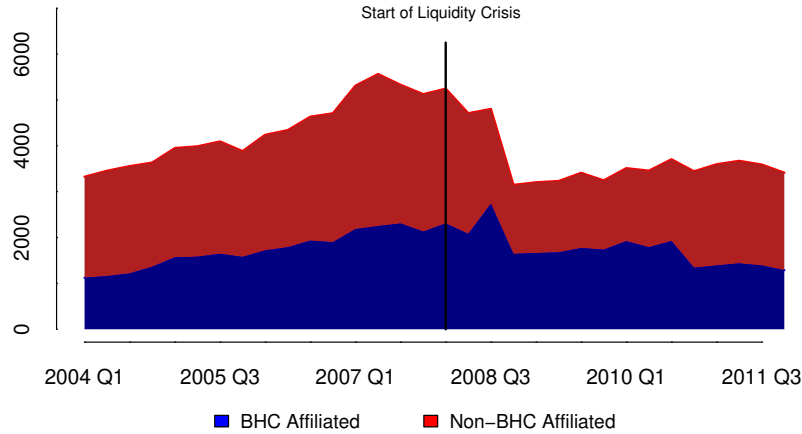
Note: BHC affiliate are broker-dealers affiliated with a bank holding company and non-BHC affiliate are those not affiliated with a bank holding company.
 Source: FOCUS reports and author's calculations

3.2.1 Size distribution of broker-dealers

Over our sample period the number of broker-dealers declines from 5,088 in the first quarter of 2004 to 4,568 at the end on 2011. This trend is also true for the subset of broker-dealers affiliated with BHCs, hereafter BHC broker-dealers, whose numbers declined from 196 to 171 (see Figure 2). On average, BHC broker-dealers are larger than broker-dealers not affiliated with a BHC, hereafter non-BHC broker-dealers, as measured by total assets. This difference in means reflects a large tail of smaller non-BHC dealers. Both broker-dealer types are large in aggregate, with the non-BHC affiliated broker-dealers holding a larger share of assets before the start of the financial crisis. After the crisis, starting in 2011, non-BHC affiliated broker-dealers once again held a clear majority of assets (see Figure 3).

Given the difference in the size distribution as well as the changes in total assets held over the sample period, there is a concern about comparing non-BHC and BHC dealers without further filtering the data. We address this concern in two ways. First, to better control for the size differences across broker-dealers, our analysis focuses on the variables of interest as a share of total assets. This allows for a more natural comparison across broker-dealers. In addition, this approach allows us to account for the large decline in the size of broker-dealers' balances sheets over the crisis, and so focus on the differences in the composition of the balance sheet across broker-dealer types. Second, we address concerns about comparing non-BHC and

Figure 3: Total assets by broker-dealer type



Note: BHC affiliate are broker-dealers affiliated with a bank holding company and non-BHC affiliate are those not affiliated with a bank holding company.
Source: FOCUS reports and author's calculations

BHC broker-dealers by using a propensity score method. This approach and its results are discussed in section 4.3.2.

3.2.2 Balance sheet variables

Our analysis of the balance sheet looks for evidence of broker-dealers changing their trading strategies in response to the liquidity crisis. We first examine activity documented by repurchase and securities lending agreements, a main way that broker-dealers move securities on and off of their balance sheets. Although both types of legal contracts are quite similar, market practice is that repurchase agreements are used almost exclusively for fixed income securities whereas securities lending agreements are used for a wide variety of securities, including equities (see, for example, the descriptive statistics in Baklanova et al. (2019)). As a result, a change in a broker-dealer's strategy to trade more liquid securities, in particular Treasuries, will show up on the balance sheet as a shift from the use of securities lending agreements to repurchase contracts. On the liabilities side of the balance sheet, such a shift is captured by repo and securities lending, whereas on the asset side we examine reverse repo and securities borrowing.¹¹

¹¹In a repo or securities lending transaction, the broker-dealer delivers securities and simultaneously receives cash. In a reverse repo or securities borrowing transaction, the broker-dealer delivers cash and simultaneously receives securities.

Starting with the liabilities side, we first consider repo and securities lending activity by broker-dealer type both before and during the crisis. Given the data are quarterly, for this analysis we mark the start of the crisis as the fourth quarter of 2007. The pre-crisis period is then the first quarter of 2004 through the third quarter of 2007, and the crisis period is the fourth quarter of 2007 through the fourth quarter of 2011.

As shown in table 1, repo accounts for more than 40 percent of total liabilities for BHC and non-BHC broker-dealers which engage in this activity. For those that engage in securities lending, this activity makes up a larger share of liabilities for non-BHC broker-dealers, at 32 percent, than BHC broker-dealers, at 13 percent. Strikingly, the two types of broker-dealers reacted differently to the liquidity crisis. Non-BHC broker-dealers slightly increased repo's share of total liabilities, from 40.7 to 43.4 percent. In contrast, BHC broker-dealers decreased repo's share of total liabilities from 45.3 to 30.0 percent. For securities lending, non-BHC broker-dealers decreased this activity's share of total liabilities by 6 percentage points whereas BHC broker-dealers increased the share by 3.9 percentage points. These conditional means are consistent with the story that broker-dealers without access to internal funding sources shifted their trading strategies towards Treasuries to a larger extent in response to the financial crisis.

Turning next to the asset-side of the balance sheet, we examine reverse repo and securities borrowing activity. Once again, given that broker-dealers engage in these activities, reverse repo and securities borrowing make up large shares of total assets, regardless of BHC affiliation. With the liquidity crisis, we find similar changes on the asset side compared to the liabilities side. In particular, non-BHC broker-dealers increased reverse repo's share of total assets from 31.9 to 37.9 percent, whereas BHC dealers reduced reverse repo's share of total assets from 33.2 to 21.6 percent (see table 1). Furthermore, non-BHC broker-dealers reduced securities borrowing share of total assets by 2.7 percentage points and BHC broker-dealers increased the same share by 4.3 percentage points.

Changes in broker-dealer trading strategies in response to liquidity shocks could also affect cash holdings as well as the size and composition of long inventory. For example, a flight to liquidity could result in a broker-dealer increasing its cash holdings, decreasing the size of their long inventory, and shifting the composition of inventory toward more liquid securities. As a result, for our analysis we consider cash holding's share of total assets, long inventory's share of total assets and the fraction of

securities in long inventory which are issued by the U.S. government.

The summary statistics on cash and long inventory as a share of total assets displays similar reactions to the crisis across the two types of broker-dealers. Both types increase their cash holdings as a share of total assets with the crisis, and both types decrease long inventory's share of total assets.

However, a difference in behavior across the two types of broker-dealers shows up when considering the government securities share of long inventory. Non-BHC broker-dealers increased this share from 50.2 percent to 54.7 percent. In contrast, BHC broker-dealers decreased this share by 3.1 percentage points, from 45.6 percent to 42.5 percent. Consistent with the changes we observed with repo, these statistics suggest that non-BHC broker-dealers shifted towards transacting in Treasuries to a larger extent than BHC broker-dealers.

Table 1: Means and Standard Deviations, by Broker-Dealer Type

	Pre-crisis		Crisis	
	non-BHC	BHC	non-BHC	BHC
Repo	0.407 (0.293)	0.453 (0.276)	0.434 (0.316)	0.300 (0.247)
Securities lending	0.318 (0.287)	0.126 (0.133)	0.258 (0.274)	0.165 (0.208)
Reverse repo	0.319 (0.283)	0.332 (0.228)	0.379 (0.312)	0.216 (0.177)
Securities borrowing	0.276 (0.288)	0.170 (0.179)	0.249 (0.272)	0.213 (0.221)
Cash	0.406 (0.346)	0.208 (0.294)	0.473 (0.349)	0.240 (0.310)
Long inventory	0.392 (0.304)	0.442 (0.283)	0.379 (0.313)	0.424 (0.287)
Govt Sec Share	0.502 (0.390)	0.456 (0.319)	0.547 (0.393)	0.425 (0.327)

Note: Govt Sec Share is the government securities share of long inventory. All the other variables are computed as a share of total assets. For each cell in the table, the mean and standard deviation are reported, where the latter are in parenthesis. BHC is the group of broker-dealers affiliated with a bank-holding company, non-BHC is the group of broker-dealers not affiliated with a bank-holding company. Further, pre-crisis is from the first quarter of 2004 to the third quarter of 2007 and crisis is from the fourth quarter of 2007 to the fourth quarter of 2011.
Source: FOCUS reports and authors' calculations.

An important difference across our analysis of the various balance sheet variables is the number of broker-dealers in the sample. Whereas almost all broker-dealers maintain cash holdings, a much smaller set of firms enter into repo and securities lending agreements. We illustrate this difference in Table 2, which reports the number

of unique broker-dealers by type for each balance sheet variable. Note that while our analysis of cash holdings includes all broker-dealers in the sample (374 BHC-affiliated and 7,960 nonBHC-affiliated broker-dealers), there is a smaller number of broker-dealers active in repo and securities lending markets for both types.

Table 2: Number of Broker-Dealers by Type

	Repo	Securities Lending	Reverse Repo	Securities Borrowing	Cash	Long Inventory	Govt Sec
BHC	57	52	70	69	374	295	101
nonBHC	160	190	270	242	7,960	4,468	448

Note: BHC are broker-dealers affiliated with a bank holding company and non-BHC are those not affiliated with a bank holding company. Govt Sev is share of long inventory devoted to government securities.
Source: FOCUS reports and authors' calculations

3.2.3 Revenue variables

We now turn to the revenue data in the FOCUS reports. In addition to the value of total assets, we use information on revenue sources to inform the propensity scoring method which pairs a BHC dealer with a non-BHC dealer based on observable characteristics, and as such briefly describe the revenue data here.

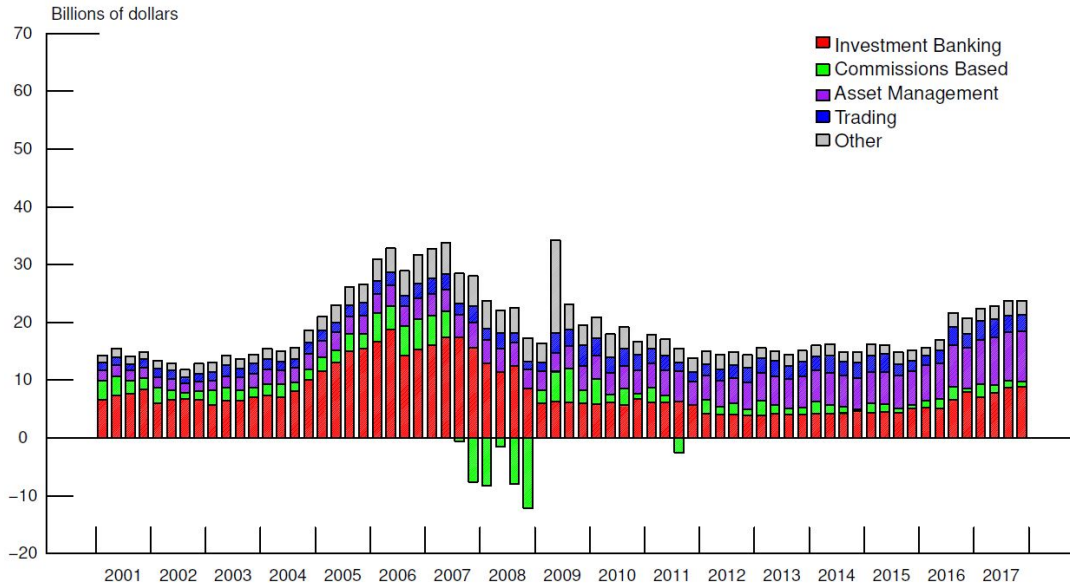
From the FOCUS Part II and IIA Income Statement sections, we create four revenue categories:

1. *Commission based* includes the following commissions, commodities revenue, and other revenue related to the securities business;
2. *Trading*, revenue from securities trading, derivative trading, and investment accounts;
3. *Investment Banking Asset Management* includes revenue from sale of investment company shares, research services, and fees for account supervision, investment advisory, and administrative services; and
4. *Other*.

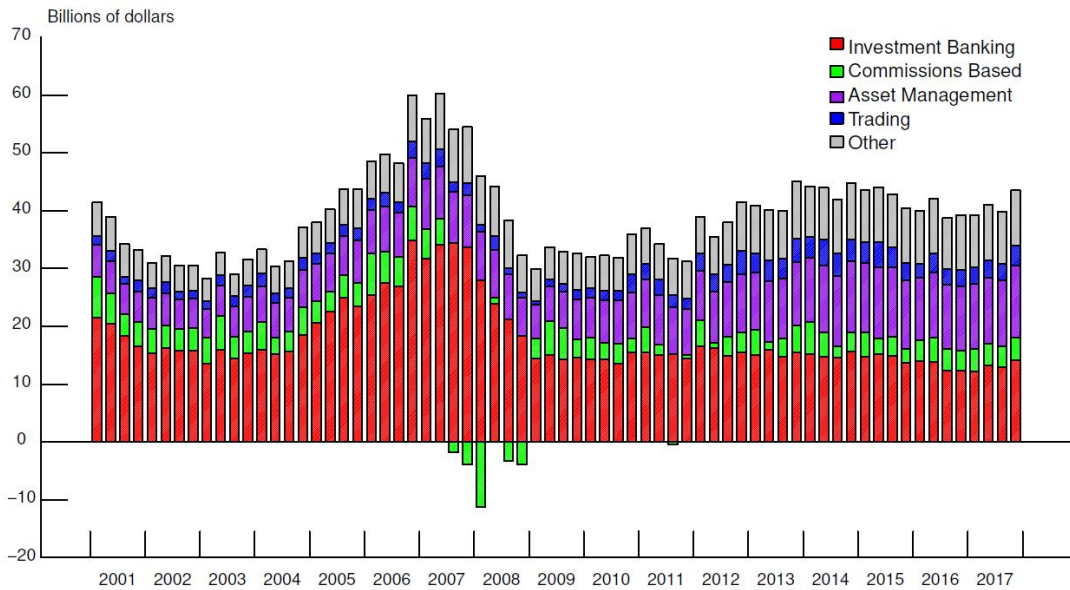
The revenues of broker-dealers non-affiliated and affiliated to BHC are shown in Figure 4. On average, before the financial crisis BHC broker-dealers earned relatively bigger shares of their revenues from investment banking. But starting in 2009, the assets management component of revenues increases for BHC broker-dealers and becomes the predominant revenue category.

Figure 4: Sources of Revenues by broker-dealer type

(a) BHC-affiliated broker dealers



(b) nonBHC-affiliated broker dealers



Source: FINRA and authors' calculations.

4 Empirical Analysis

In this section we describe our empirical design, discuss threats to inference, and then present our results.

4.1 Empirical Method

As described in the previous section, in this paper we test whether in response to an aggregate liquidity shock, broker-dealers shift towards trading more liquid securities, the consequence of a flight to liquidity. In particular, do broker-dealers that are more liquidity constrained shift to greater degree relative to those that are less constrained? On the liabilities side of the balance sheet, these actions are observed as an increase in repo and a decrease in securities lending. The same is true for the asset side, where we would expect to see an increase in reverse repo and a decrease in securities borrowing. We could also see effects on other assets, with more liquidity-constrained broker-dealers increasing their cash holdings, decreasing their long inventory, and shifting their long inventory toward more liquid securities.

To measure whether broker-dealers did react as expected when facing a funding liquidity shock, we analyze the seven balance sheet variables discussed above using a difference-in-differences approach. We divide broker-dealers into two groups depending on whether they are affiliated with a BHC. Those dealers with a BHC affiliation have access to internal liquidity sources, whereas those without a BHC affiliation are assumed to not have such access. We then use the 2007-09 financial crisis and the resulting adverse shock to funding liquidity as our treatment, where we assume the crisis begins in the fourth quarter of 2007.

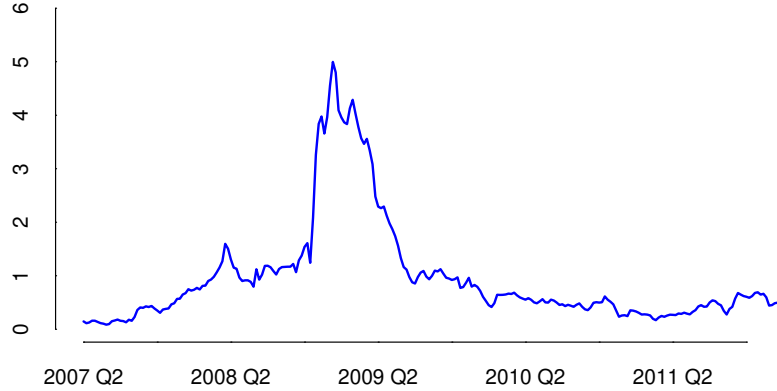
Before specifying our regression formally, we introduce some notation. Let BHC_{it} be a binary variable equal 1 if broker-dealer i is affiliated with a BHC at time t , and let crisis_{it} be a binary variable equal to 1 if date t is equal to or later than the fourth quarter of 2007. Letting Y_{it} denote one of the seven dependent variables listed earlier, the benchmark regression we estimate is given by

$$Y_{it} = \beta_0 + \beta_1 \text{crisis}_{it} + \beta_2 \text{BHC}_{it} + \delta \text{crisis}_{it} \cdot \text{BHC}_{it} + \varepsilon_{it}, \quad (1)$$

where ε is an error term.

The above specification captures an average effect over the crisis. We recognize, however, that the funding liquidity in the U.S. money markets became increasingly

Figure 5: Measure of Liquidity in the Treasury Market



Note: This liquidity measure, taken from Musto et al. (2018), is formed as the average price difference between a 10-year (original issue) Treasury note and a replicating portfolio comprised of a maturity-matched 30-year Treasury bond and a STRIP. A rise in this measure corresponds to worsening Treasury market liquidity. Price data are from FactSet.

worse as the crisis endured. This dynamic is well-captured by the Treasuries liquidity measure taken from Musto et al. (2018) and illustrated in figure 5. According to this measure, liquidity decreases with the start of the financial crisis in the fall of 2007 and there is a large and sustained decrease in liquidity following the bankruptcy of Lehman Brothers in September 2008. As a result, we also estimate a dynamic difference-in-differences specification which allows the effect of the funding liquidity shock to vary over time.

We accomplish this by dropping the term capturing the average effect and adding three indicator terms to the regression above, $DID\ 1_{it}$, $DID\ 2_{it}$, and $DID\ 3_{it}$. The first term is equal to 1 if t is in the first year of the crisis, from the fourth quarter of 2007 to the third quarter of 2008, and dealer i is part of a BHC. The second term is equal to 1 if t is in the second year of the crisis, from the fourth quarter of 2008 to the third quarter of 2009 and dealer i is part of a BHC. Finally, the third term is equal to 1 if t is in the third year of the crisis, from the fourth quarter of 2009 to the third quarter of 2010, and dealer i is part of a BHC. Using this notation, the regression we estimate is

$$Y_{it} = \beta_0 + \beta_1 \text{crisis}_{it} + \beta_2 \text{BHC}_{it} + \alpha_1 \text{DID}\ 1_{it} + \alpha_2 \text{DID}\ 2_{it} + \alpha_3 \text{DID}\ 3_{it} + \epsilon_{it}, \quad (2)$$

where ϵ is an iid error term.

4.2 Threats to inference

In the first specification, we are focused on accurately estimating the coefficient on the interaction term, δ . This estimate tells us by how much BHC and non-BHC broker-dealers differ in their management of the outcome variable, Y_{it} , over the crisis. The dynamic specification in equation (2) is similar except that in place of δ , we have the coefficients $\{\alpha_1, \alpha_2, \alpha_3\}$ to capture whether BHC and non-BHC broker-dealers differed over the first, second, and third years of the crisis.

Given our difference-in-differences approach, our identification of these coefficients relies upon the (reasonable) assertion that the treatment, or the financial crisis, is an exogenous event. Further, we mark the beginning of the crisis early enough (the fourth quarter of 2007) so as to minimize concerns about broker-dealers anticipating the crisis and changing their behavior before our designation of the treatment effect.

Identification also depends upon the parallel trends assumption of the outcome variables across the two broker-dealer types. To demonstrate that this assumption holds in the data, we plot the time-series of the mean value of each outcome variable conditional on broker-dealer type in figures 6-8.

Starting with the variables on the liabilities side of the balance sheet, in figures 6a and 6b we illustrate the time-series properties of repo and securities lending, respectively. Over the sample period used in our analysis, 2004 to 2011, these plots demonstrate that repo and securities lending for BHC and non-BHC broker-dealers were on parallel trends. Furthermore, these two figures highlight a difference in timing. Specifically, the impact of the liquidity crisis effects securities lending activity later in the crisis, starting in the second half of 2008, and materializes as a one-time persistent change. In contrast, broker-dealers seem to change their repo activity slowly over the crisis. The dynamics of the effect on the crisis on these variables is more fully explored in the second specification (equation 2).

We now turn to the variables on the asset-side of the balance sheet. In figures 7a and 7b we plot the time-series of reverse repo and securities borrowing, respectively. As before, both figures illustrate a parallel trend across the two broker-dealer types. Further, the dynamics of the effect of the liquidity crisis on these variables mirrors that seen for repo and securities lending. In particular, the difference in securities borrowing behavior manifests as a permanent one-time change in the latter half of 2008, whereas the differential behavior with regard to reverse repo occurs slowly and builds over the crisis.

Finally, we consider cash holdings, long inventory and the composition of long

Figure 6: Repo and Securities Lending over Total Liabilities, by broker-dealer type

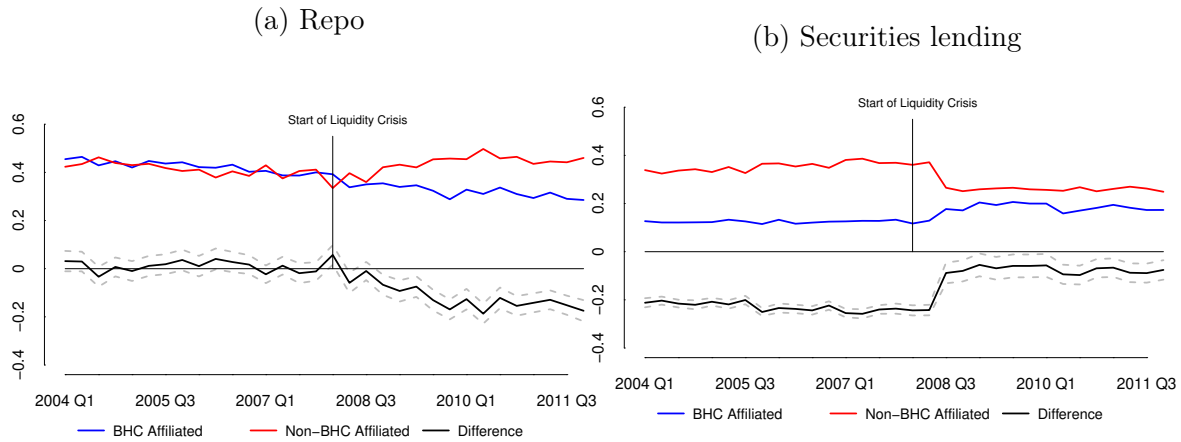
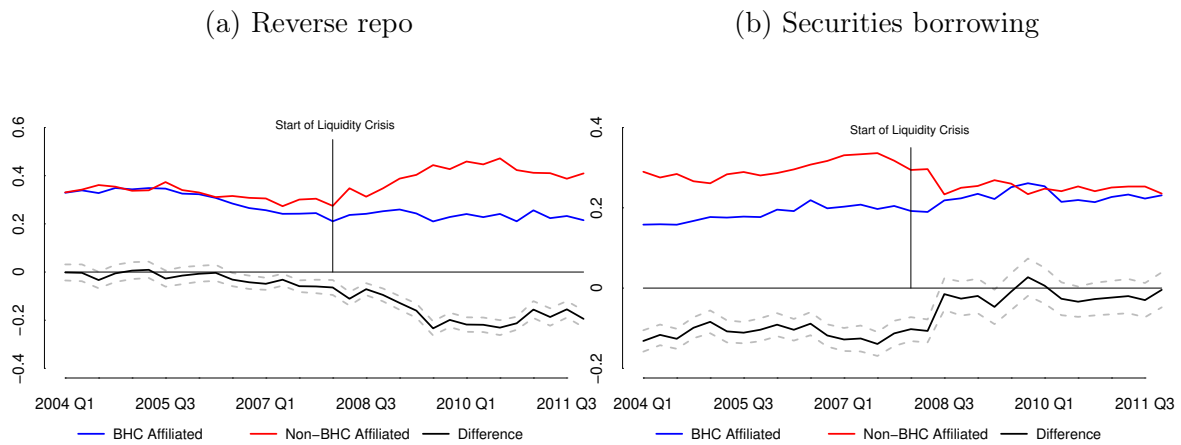
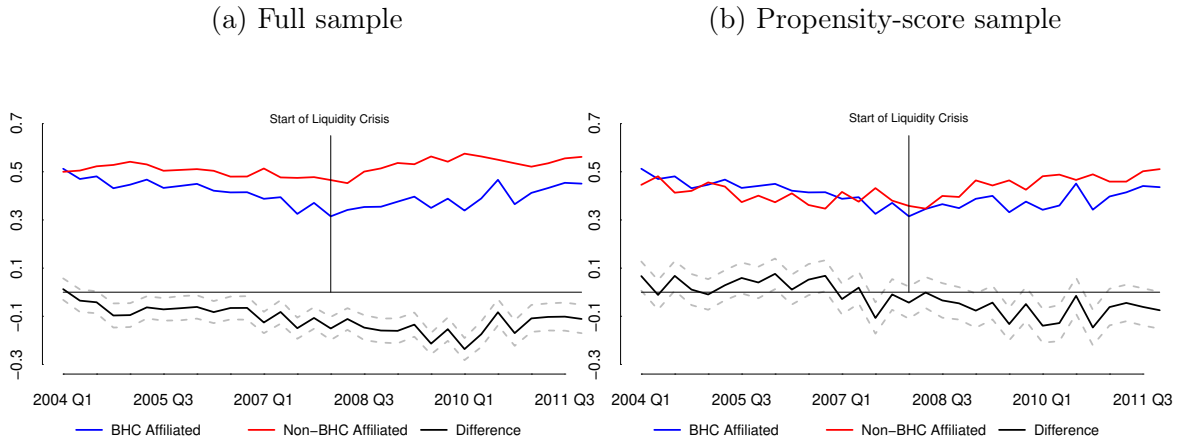


Figure 7: Reverse Repo and Securities Borrowing over Total Assets, by broker-dealer type



inventory. Because we do not find significant results for cash holdings and long inventory, we do not highlight these data here. We do find results for the composition of long inventory, and so in figure 8a we plot the time-series of the mean of government securities share of long inventory by broker-dealer type. The time-series of the means of this variable casts some doubt the parallel trends assumption, as the difference between lines does grow over time. This difference goes away after we implement a propensity-score approach (see figure 8b and the discussion later in this section).

Figure 8: Government securities share of long inventory by broker-dealer type



Note: BHC affiliate are broker-dealers affiliated with a bank holding company and non-BHC affiliate are those not affiliated with a bank holding company. Difference is BHC affiliate minus non-BHC affiliate.
Source: FOCUS reports and author's calculations

Another possible concern with our approach is whether the decision to become affiliated with a BHC is not exogenous to our analysis, introducing issues of selection to our econometric analysis. We argue this concern is unfounded in our application for two reasons. First, the broker-dealers in our sample made this organizational decision far in advance of the financial crisis. As such, it is not likely that broker-dealers made this organizational decision with the crisis in mind. Second, although it is possible for broker-dealers to change their status, becoming part of, or leaving a BHC, is a costly decision that can take awhile to implement. However, a few large well-known broker-dealers did re-organize themselves during the crisis and become part of a bank holding company. Furthermore, these re-organizations were driven in large part because of funding liquidity concerns. Because including these broker-dealers would weaken our identification, we filter the data so as to drop any broker-dealer that changed its status with respect to its association with a bank holding company during the 2007-09 financial crisis (as mentioned in section 3). With this

filter, we argue there are not any concerns about selection in our analysis.

A final concern relates to the mechanism behind our results. Although we argue that the margin of adjustment behind our results is access to internal funding sources, it could be argued that the difference in BHC-affiliation is related to differing business models (and so unrelated to internal funding sources). To address this concern, we use a propensity-scoring approach to match non-BHC broker-dealers to BHC broker-dealers based on total asset size and shares of revenue sources. By linking broker-dealers which are similar in size as well as sources of revenue, we argue that we are comparing broker-dealers with similar business models.

As a result of the propensity-scoring method, the number of observations in our analysis declines substantially. (This is most clearly seen in the subsequent Results subsection by comparing the number of observations in tables 3 and 4.) Nevertheless, the time-series of the mean of the outcome values is little changed, except for the composition of long inventories.¹² This is illustrated in figure 8b; note that in the pre-crisis period both types now hold similar shares of government securities.

Another potential mechanism behind our results could be changes in regulation of BHCs (and so BHC-affiliated broker dealers) with the start of the crisis. This is unlikely because although there was debate about changing regulations as the crisis wore on, the Dodd-Frank Act was passed in July 2010, towards the end of our sample, and the implementation of the new liquidity regulations on BHCs occurred after 2011, the end of our sample period. Importantly, changes in supervision and regulation of BHCs would presumably push BHC-affiliated broker-dealers toward less risky strategies. Yet our estimates show the opposite; they imply that nonBHC-affiliated broker-dealers shifted towards trading Treasury securities to a greater extent.

4.3 Results

In this subsection, we present and discuss 3 sets of results from our regression analysis. We begin with our benchmark specification estimated using the full sample, followed by results estimated using a refined data set constructed using a propensity score method. Finally, we present the results from the dynamic specification. Given the panel structure of our data, we cluster our standard errors by broker-dealer.

¹²In appendix B we report summary statistics for this restricted sample as well as illustrate the time-series of the mean value of the outcome variables by broker-dealer type in figures 10a to 11b.

4.3.1 Benchmark results

We start with our benchmark specification (see equation 1) which is estimated on the full sample of broker-dealers over the sample period of the first quarter of 2004 to the fourth quarter of 2011. The resulting estimated coefficients for the seven dependent variables discussed earlier are reported in table 3.

Beginning with the liability side of the balance sheet, we consider repo and securities lending activity (see the first two columns of table 3). The estimated coefficients imply that non-BHC and BHC broker-dealers differed in their repo activity by 11.7 percentage points, with BHC broker-dealers decreasing repo activity as a share of total liabilities by $11.7 - 1.8 = 9.9$ percentage points, and non-BHC broker-dealers slightly increasing repo by 1.8 percentage points from their pre-crisis average of 40.2 percent. As mentioned in the previous section, repo activity is in practice dominated by transactions involving Treasuries, and as such we interpret this result as consistent with the idea that in a liquidity crisis, non-BHC broker-dealers value the liquidity benefits of Treasuries to a larger extent than BHC broker-dealers.

Turning to securities lending, the estimated coefficients imply that non-BHC broker-dealers decreased its share of total liabilities by 7.2 percentage points while BHC broker-dealers increase the share by $12.3 - 7.2 = 5.1$ percentage points. Given that securities lending is used to document transactions involving a wide variety of securities (e.g., equities), these results provide further evidence that in the crisis non-BHC broker-dealers were decreasing their exposure to less liquid securities, in stark contrast to BHC broker-dealers. Note that in addition to statistical significance, these results, measured in terms of a broker-dealers total liabilities, are economically large

Flipping over to the asset side of the balance sheet, we first consider reverse repo and securities-borrowing activity. The estimated coefficients for reverse repo indicate that with the crisis non-BHC broker-dealers increased their reverse repo activity as a share of total assets, whereas BHC broker-dealer decreased activity. The difference across the two groups is substantial, with non-BHC broker-dealers increasing reverse repo's share of total assets by an average of 4 percentage points, whereas BHC broker-dealers decreased reverse repo share's of total assets by $12.4 - 4.0 = 8.4$ percentage points on average.

The results on securities borrowing tell a similar story, although statistically their significance is not as strong. The estimated coefficients imply that non-BHC broker-dealers decreased securities borrowing share of total assets by 3.5 percentage

Table 3: Effect of Liquidity Shock on Broker-dealers' Balance sheet, Full Sample

	Repo	Securities Lending	Reverse Repo	Securities Borrowing	Cash	Long Inventory	Govt Sec
BHC	0.013 (0.055)	-0.228*** (0.035)	0.072* (0.037)	-0.112*** (0.040)	-0.217*** (0.020)	0.043** (0.021)	0.065 (0.049)
Crisis	0.018 (0.032)	-0.072*** (0.023)	0.040** (0.018)	-0.035* (0.019)	0.024*** (0.003)	-0.017*** (0.005)	0.047* (0.027)
Interaction	-0.117** (0.055)	0.123** (0.055)	-0.124*** (0.035)	0.077* (0.045)	-0.009 (0.019)	0.001 (0.018)	-0.155*** (0.053)
Constant	0.415*** (0.032)	0.352*** (0.030)	0.172*** (0.019)	0.295*** (0.025)	0.425*** (0.004)	0.397*** (0.005)	0.369*** (0.032)
Observations	2,536	3,072	5,425	4,321	156,381	71,954	4,039
R ²	0.015	0.070	0.010	0.016	0.015	0.002	0.008

Note: This table presents the results of difference-in-differences regressions for broker-dealers affiliated and non-affiliated with BHCs. The dependent variables are computed as a share of total assets, except *Gov Sec* which is computed as the amount of government securities as a share of long inventory. *BHC* is a dummy variable equal to 1 if the broker-dealer is affiliated with a BHC. *Crisis* is a dummy variable equal to 1 if the date is after the third quarter of 2007. *Interaction* is the product of *BHC* and *Crisis*. Clustered standard errors by broker-dealer are reported in parentheses. *p<0.1; **p<0.05; ***p<0.01

points whereas BHC broker-dealers increased the securities borrowing share of total assets by $7.7 - 3.5 = 4.2$ percentage points, on average. The reverse repo and securities borrowing results are both consistent with the estimated changes in repo and securities borrowing.

We now consider other assets on the balance sheet. We start with cash holdings and find that BHC-affiliated broker-dealers hold significantly less cash compared to non-BHC-affiliated broker-dealers in the pre-crisis period. With the crisis, all broker-dealers increased the share of assets held as cash by 2.4 percentage points, the expected reaction to a crisis in funding liquidity. We do not, however, estimate a differential effect in cash holding across those broker-dealers depending on their BHC status.

We find a similar result when considering the size of long inventory holdings. In the crisis, broker-dealers decreased the value of their long inventory holdings as a share of total assets. We do not, however, find a differential effect across the two groups of broker-dealers. We then consider the composition of long inventory and find a large difference across the two types of broker-dealers. Before the crisis, government securities' share of non-BHC and BHC-affiliated broker-dealers' long inventory was 36.9 and 43.4 percent, respectively. With the crisis, non-BHC broker-dealers increased the share of government securities held in long inventory by an average of 4.7 percentage points, whereas BHC broker-dealers decreased government securities' share of long inventory by $15.5 - 4.7 = 10.8$ percentage points. Strikingly,

the difference across the two groups of broker-dealers is quite large at 15.5 percentage points and consistent with our expectation that non-BHC broker-dealers will shift towards liquid securities to a greater extent than BHC broker-dealers.

A notable feature of the above results is the large amount of observations for the cash holdings and long inventory regressions, relative to the other dependent variables. This result comes from the large number of broker-dealers of both types that report having cash and long inventory, but do not report entering into repo or securities lending agreements (see table 2).

The above results are large with respect to the size of broker-dealer balances. To gain a better sense of the aggregate magnitude, we convert the percentage point changes reported above into dollars. In the first quarter of 2009, non-BHC broker-dealers entered into \$711 and \$449 billion worth of repo and reverse repo contracts. Our results imply that with access to internal funding sources, non-BHC broker-dealers would have entered into only $\$711 \cdot (1 - 0.117) = \681 billion and $\$449 \cdot (1 - 0.124) = \393 billion repo and reverse repo, respectively, differences of \$90 and \$56 billion.¹³ Turning to government securities holdings, in the first quarter of 2009 non-BHC broker-dealers held \$99 billion of these securities. Our results imply that with access to internal funding sources, non-BHC dealers would have held only $\$99 \cdot (1 - 0.155) = \84 billion of these securities, holding fixed the size of total long inventory. Although these rough calculations ignore important equilibrium effects, they nonetheless highlight the large values at play, and so the aggregate importance of our empirical results.

We interpret the mechanism driving the difference across the two broker-dealers groups to be access to internal liquidity sources. However, as discussed, in section 4.2, there is substantial heterogeneity across broker-dealers and it is possible that differences related to the broker-dealers business model and size are driving our estimated results. To address this concern, in the next section we discuss our use of a propensity score method to more closely match BHC broker-dealers to non-BHC broker-dealers.

4.3.2 Propensity score results

Given concerns that our benchmark results may be driven by forces other than access to internal liquidity, we redo the analysis with the addition of a propensity score.

¹³For this exercise, we assume that total assets remain the same, and so these changes are offset by increases in other balance sheet variables, such as securities lending and securities borrowing.

The propensity score method matches BHC broker-dealers with non-BHC broker-dealers based on total asset size and shares of revenue from different business lines in the pre-crisis period. We argue that broker-dealers which are similar in size and similar in terms of business activity or business model will have similar unobservable characteristics (such as trading strategies). As a result, when we re-estimate the difference-in-differences regressions using the matched broker-dealer sample, the resulting estimates will more cleanly reflect the impact of the internal liquidity sources.

Overall, these estimated coefficients confirm the same story as those coefficients estimated on the full sample, although the magnitude of the effect is smaller in most cases (see table 4). For repo and securities lending, we continue to find that BHC broker-dealers decrease repo's share of total liabilities and increase securities lending's share relative to their non-BHC broker-dealer peers. We continue to find significant and large effects for reverse repo, with BHC broker-dealers decreasing reverse repo's share of total assets by 7.7 percentage points relative to non-BHC broker-dealers. The effect of the crisis does disappear for securities borrowing however, as we no longer find a difference in behavior across the two groups of broker-dealers. Finally, the estimated coefficient for the regression focused on government securities share of total long inventory implies a difference of 11.4 percentage points between BHC and non-BHC broker-dealers, versus a 15.5 percentage point difference using the full sample. Nevertheless, a 11.4 percentage point difference remains a large economic effect on a broker-dealer's balance sheet. In summary, the propensity scoring approach reinforces our claim that the mechanism behind the differences in broker-dealer balance sheets is indeed the internal liquidity sources of BHCs, as opposed another factors such as different business models.

4.3.3 Dynamic results

Finally, we return to the full sample and consider whether there are dynamic effects to the shortage of funding liquidity over the crisis. Indeed, as captured in figure 5, funding liquidity in the US money markets became especially acute after the Lehman bankruptcy on September 15, 2008. We capture this dynamic effect with three additional indicator variables that capture differences between BHC and non-BHC broker-dealers for 1 year increments over the crisis period, as specified in equation 2.

The estimated coefficients reveal there are indeed dynamic effects on how broker-dealers reacted to the crisis. Starting once again with repo and securities lending, the estimated coefficients imply that the effects of decreased funding liquidity were

Table 4: Effect of Liquidity Shock on Broker-dealers' Balance sheet, Propensity Score

	Repo	Securities Lending	Reverse Repo	Securities Borrowing	Cash	Long Inventory	Govt Sec
BHC	0.201*** (0.064)	-0.205*** (0.060)	0.068 (0.049)	-0.103 (0.064)	-0.074*** (0.024)	0.040 (0.028)	0.162*** (0.059)
Crisis	0.057 (0.037)	-0.085** (0.043)	0.007 (0.029)	-0.061 (0.039)	-0.013 (0.013)	-0.018 (0.016)	0.029 (0.047)
Interaction	-0.139** (0.057)	0.095* (0.056)	-0.077* (0.042)	0.065 (0.050)	-0.003 (0.022)	0.004 (0.024)	-0.114* (0.062)
Constant	0.174*** (0.048)	0.329*** (0.058)	0.177*** (0.038)	0.286*** (0.056)	0.276*** (0.016)	0.401*** (0.020)	0.273*** (0.050)
Observations	1,650	1,239	1,985	1,615	12,234	9,332	1,630
R ²	0.070	0.119	0.019	0.028	0.017	0.006	0.041

Note: This table presents the results of difference-in-differences regressions for broker-dealers affiliated and non-affiliated with BHCs. The dependent variables are computed as a share of total assets, except *Gov Sec* which is computed as the amount of government securities as a share of long inventory. *BHC* is a dummy variable equal to 1 if the broker-dealer is affiliated with a BHC. *Crisis* is a dummy variable equal to 1 if the date is after the third quarter of 2007. *Interaction* is the product of *BHC* and *Crisis*. Clustered standard errors by broker-dealer are reported in parentheses. *p<0.1; **p<0.05; ***p<0.01

larger later in the crisis. For repo, the effect is concentrated in the third year of the crisis and for securities lending the effect occurs in both the second and third years of the crisis and is of similar magnitude over this period (see table 5).

Turning to reverse repo and securities borrowing, we see different patterns in the estimated coefficients. At the start of the crisis, the estimated coefficients imply that the difference in reverse repo's share of total assets across the two broker-dealer groups gradually increases over time. In the first year of the crisis, BHC broker-dealers decreased reverse repo's share of total assets by 7.6 percentage points relative to non-BHC broker-dealers. This difference increases slightly in the second year of the crisis to 8.2 percentage points and then further increases in the third year of the crisis to 9.0 percentage points. In contrast, for securities borrowing, the estimated coefficients imply that the difference in behavior across the two groups of broker-dealers is concentrated in the third year of the crisis (the fourth quarter of 2009 to the third quarter of 2010).

Finally, we turn to the composition of long inventory. In the first year of the crisis, the results imply that BHC broker-dealers reduced government securities share of total assets by 8.6 percentage points relative to non-BHC broker-dealers. Then in the second year of the crisis, which starts right after the bankruptcy of Lehman Brothers, this difference widens considerable to 15.7 percentage points, after which, in the third year of the crisis the difference partially unwinds, although remains large,

Table 5: Effect of Liquidity Shock on Broker-dealers' Balance sheet, Dynamic Impact

	Repo	Securities Lending	Reverse Repo	Securities Borrowing	Cash	Long Inventory	Govt Sec
BHC	-0.032 (0.049)	-0.190*** (0.033)	0.038 (0.033)	-0.089** (0.037)	-0.217*** (0.018)	0.046** (0.019)	0.030 (0.045)
Crisis	-0.012 (0.027)	-0.056*** (0.020)	0.025 (0.016)	-0.026 (0.016)	0.024*** (0.003)	-0.017*** (0.005)	0.029 (0.025)
DID year 1	-0.011 (0.033)	0.028 (0.026)	-0.076*** (0.026)	0.020 (0.022)	-0.042*** (0.013)	0.002 (0.014)	-0.086** (0.041)
DID year 2	-0.040 (0.038)	0.087* (0.052)	-0.082*** (0.024)	0.049 (0.040)	-0.016 (0.016)	-0.013 (0.014)	-0.157*** (0.045)
DID year 3	-0.075* (0.042)	0.093* (0.048)	-0.090*** (0.025)	0.069* (0.037)	0.005 (0.016)	-0.008 (0.015)	-0.127*** (0.045)
Constant	0.431*** (0.031)	0.345*** (0.029)	0.179*** (0.019)	0.290*** (0.024)	0.425*** (0.004)	0.397*** (0.005)	0.378*** (0.031)
Observations	2,536	3,072	5,425	4,321	156,381	71,954	4,039
R ²	0.009	0.067	0.005	0.014	0.015	0.002	0.006

Note: This table presents the results of difference-in-differences regressions for broker-dealers affiliated and non-affiliated with BHCs. The dependent variables are computed as a share of total assets, except *Gov Sec* which is computed as the amount of government securities as a share of long inventory. *BHC* is a dummy variable equal to 1 if the broker-dealer is affiliated with a BHC. *Crisis* is a dummy variable equal to 1 if the date is after the third quarter of 2007. *DID 1_{it}*, *DID 2_{it}*, and *DID 3_{it}* are dummy variable equal to one if *t* is in the first year of the crisis (from the fourth quarter of 2007 to the third quarter of 2008), or in the second year of the crisis (from the fourth quarter of 2008 to the third quarter of 2009), or in the third year of the crisis (from the fourth quarter of 2009 to the third quarter of 2010), respectively, and dealer *i* is part of a BHC. Clustered standard errors by broker-dealer are reported in parentheses. *p<0.1; **p<0.05; ***p<0.01

at 12.7 percentage points.

4.3.4 Robustness

In this subsection, we consider the robustness of our results by re-running our benchmark specification on a sample of broker-dealers that did not change their affiliation during the entire sample period. This differs from our previous analysis, where we filtered out those BHCs which changed their affiliation around the start of the crisis.

With this subset of firms, our general results continue to hold, albeit with less statistical significance. The estimates continue to imply that nonBHC-affiliated broker-dealers increased their repo and reverse repo activity relative to BHC-affiliated broker-dealers, but we lose statistical significance on the repo coefficient (see Table 6). Further, the estimated coefficients continue to imply that nonBHC-affiliated broker-

Table 6: Effect of Liquidity Shock on Broker-dealers' Balance sheet, No Switching Firms

	Repo	Securities Lending	Reverse Repo	Securities Borrowing	Cash	Long Inventory	Govt Sec
BHC	0.009 (0.059)	-0.214*** (0.038)	0.095** (0.044)	-0.050 (0.048)	-0.221*** (0.024)	0.059** (0.025)	0.026 (0.049)
Crisis	0.008 (0.033)	-0.062*** (0.024)	0.037* (0.019)	-0.022 (0.018)	0.024*** (0.003)	-0.018*** (0.005)	0.047* (0.028)
Interaction	-0.058 (0.056)	0.060 (0.043)	-0.115*** (0.038)	-0.014 (0.033)	-0.041** (0.019)	0.011 (0.018)	-0.090* (0.055)
Constant	0.424*** (0.034)	0.347*** (0.031)	0.175*** (0.021)	0.287*** (0.026)	0.426*** (0.004)	0.398*** (0.005)	0.372*** (0.034)
Observations	2,244	2,675	4,785	3,787	153,086	69,508	3,567
R ²	0.003	0.067	0.010	0.008	0.012	0.003	0.004

Note: This table presents the results of difference-in-differences regressions for broker-dealers affiliated and non-affiliated with BHCs that did not switch across the two groups at any point over our sample period. The dependent variables are computed as a share of total assets, except *Gov Sec* which is computed as the amount of government securities as a share of long inventory. *BHC* is a dummy variable equal to 1 if the broker-dealer is affiliated with a BHC. *Crisis* is a dummy variable equal to 1 if the date is after the third quarter of 2007. *Interaction* is the product of *BHC* and *Crisis*. Clustered standard errors by broker-dealer are reported in parentheses. *p<0.1; **p<0.05; ***p<0.01

dealers increased the share of long inventory composed of government securities.

A difference from the benchmark results is found with cash-holdings. Using the subset of broker-dealers which never switched BHC affiliation, the estimated coefficients imply that with the start of the crisis, nonBHC-affiliated broker-dealers increased their holdings of cash as a share of total assets by 4.1 percentage points relative to BHC-affiliated broker-dealers. This is consistent with our dynamic results, which showed a similarly sized effect in the first year of the crisis (see the estimated

coefficient for DID year 1 in Table 5), and is consistent with the general result of the paper which demonstrates that nonBHC-affiliated broker-dealers moved to trade and hold more liquid assets with the start of the crisis.

5 Discussion

In this section we discuss how our results inform policy today. We then provide direct evidence that BHCs provided substantial support to their non-depository entities with the arrival of the crisis.

5.1 The importance of liquidity access

There is a vast economic literature, going back to Bagehot (1873), detailing the benefits of a lender of last resort. In most developed countries, broker-dealers are part of universal banks and, thus, have direct access to central bank liquidity provision. The U.S. financial system has kept a greater separation between investment banks and commercial banks, so broker-dealers generally do not have direct access to liquidity provided by the Federal Reserve. This has led to proposals that direct access to Federal Reserve liquidity should be extended to broker-dealers under some conditions.

For example, then-NY Fed President Dudley noted in a 2013 speech that “We have banking activity–maturity transformation–taking place today outside commercial banks. If we believe these activities provide essential credit intermediation services to the real economy that could not be easily replaced by other forms of intermediation, then the same logic that leads us to backstop commercial banking with a lender of last resort might lead us to backstop the banking activity taking place in the markets in a similar way.”¹⁴ Similarly, Liang and Parkinson (2020) suggest that the Federal Reserve should “create a new standing repo facility to support market liquidity in periods of broad stress through regulated dealers under pre-established arrangements.” While their objective is to enhance the liquidity of the U.S. Treasury market under stress, such a facility would likely have broad benefits for financial stability.

Our main result provides microeconomic evidence in support of the benefits of having access to liquidity during times of market stress. Our main result is that

¹⁴<https://www.newyorkfed.org/newsevents/speeches/2013/dud130201>

broker-dealers that are not associated with BHCs dramatically re-structured their balance sheet during the 2007-9 financial crisis, pivoting away from trading illiquid assets and towards more liquid government securities. We interpret this shift as the need to preserve some flexibility and liquidity given strained financial market conditions. Dealers associated with BHCs did not need to undergo such extreme changes in part because they had access to internal liquidity. This allows BHC-affiliated dealers to provide more intermediation services in a range of financial markets that were disrupted at the time, likely reducing the extent of the disruptions. We posit that the benefits from having access to internal liquidity would likely extend to the case of access to liquidity from the Federal Reserve. In fact, the benefits of direct access to central bank liquidity are likely to be greater, since that liquidity is expected to be more reliable than access to internal liquidity.

Extending the perimeter of the financial safety net would require expansion of the regulatory perimeter. Indeed, Dudley also emphasizes that “any expansion of access to a lender of last resort would require legislation and it would be essential to have the right *quid pro quo*—the commensurate expansion in the scope of prudential oversight. Substantial prudential regulation of entities—such as broker-dealers—that might gain access to an expanded lender of last resort would be required to mitigate moral hazard problems.” This point is also made in Liang and Parkinson (2020) and they suggest that the SEC and the Federal Reserve could agree on a set of prudential requirements broker dealers would need to meet to be granted access to the repo facility.

Our main result is particularly relevant to the policy debate regarding access to Federal Reserve liquidity if we can show that BHC-affiliated dealers did obtain internal liquidity. The next section provides evidence that this was indeed the case.

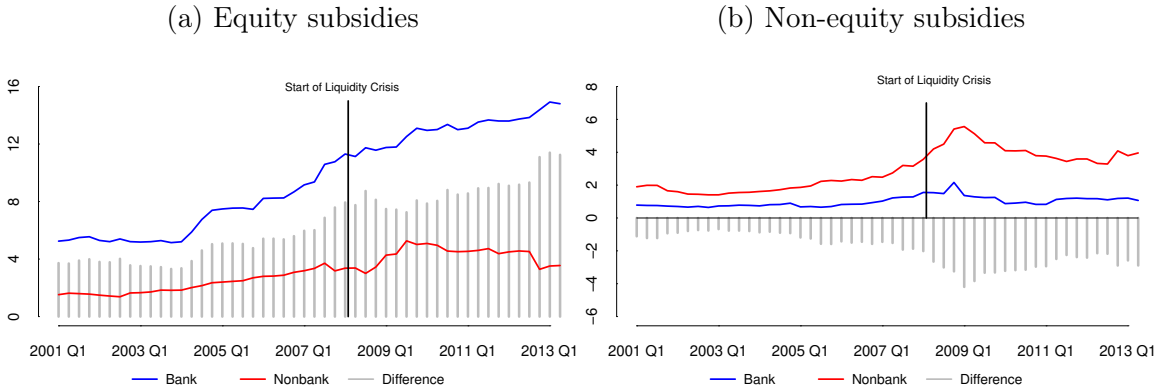
5.2 Evidence of support by BHCs

In this section we provide evidence that the parent entity of a BHC served as a source of strength for their subsidiaries over the crisis. We demonstrate this using the FR Y-9LP data, which, among other things, provides data on equity and non-equity subsidies from the parent entity of a BHC to bank and non-bank subsidiaries, where bank means a depository institution. Given the focus on this paper, we select only those BHCs which have a broker-dealer entity.

Using these data, we find that parent entities provide subsidies to both bank and

non-bank subsidiaries. Indeed, parent entities have steadily increased the mean equity subsidy to bank-entities over our sample period (see figure 9a). A different pattern is seen for the mean equity subsidy to non-bank entities, which sharply rose with the start of the liquidity crisis and then, a few quarters later, began a slow decline. As a result, the difference in the mean equity subsidy between bank and non-bank entities grew over the sample period.

Figure 9: Mean BHC subsidies to bank and non-bank entities, by type



Note: Equity subsidies are from Schedule PC-A in form FR Y-9LP, and are defined as the sum of Common and preferred stocks and intangible assets (including goodwill and other identifiable intangibles). Non-equity subsidies are from the same schedule and are defined as the sum of loans, advances, notes, bonds, debentures and other receivables. Difference is the mean bank subsidy minus the mean non-bank subsidy.
 Source: FR Y-9LP and author's calculations

Different trends are seen for non-equity subsidies. In the run-up to the financial crisis, the mean non-equity subsidy increased for both types of entities, although both the level and increase are larger for non-bank entities. After the start of the crisis, the average non-equity subsidy slowly declines for both types of entities. The changes are not equal across the two types of entities—the difference in mean subsidies between the two types widens over the sample period, to the favor of non-bank entities.

These data support the claim that BHCs provide liquidity to their broker-dealer subsidiaries. Furthermore, the data are consistent with the hypothesis that this benefit was valuable to broker-dealers at the start of the liquidity crisis, as evidenced by the increase in both mean equity and non-equity subsidies to non-bank entities.

6 Conclusion

This paper considers the classic question of how a financial firm organizes itself, with an eye on broker-dealer entities. A main organizational issue for broker-dealers is

whether to exist as a stand-alone firm or as part of a BHC. A major consequence of this decision is whether the broker-dealer has to rely solely on external sources of funding, or has access to internal funding provided by the associated BHC.

In this paper, we consider the value of internal funding to broker-dealers by examining changes to broker-dealer balance sheets in response to an exogenous aggregate liquidity shock, the 2007-08 financial crisis. Through a difference-in-differences approach, we estimate that non-BHC affiliated broker-dealers shifted to a larger degree towards using repo on both sides of the balance sheet, as well as increasing government securities' share of long inventory. The difference across the two types of broker-dealers is economically significant. For repo transactions, the differences averages more than 10 percent of total assets and for the composition of long inventory the difference in shares averages 15 percentage points.

We interpret these balance sheet changes as the result of non-BHC affiliated broker-dealers shifting their trading strategy towards transacting in Treasuries to a greater extent than BHC-affiliated broker-dealers. Especially given non-BHC affiliated broker-dealers reliance on external funding, this shift in strategy is emblematic of a flight to quality.

More generally, our paper contributes to the policy debate related to access to the lender of last resort. Both Dudley (2013) and Liang and Parkinson (2020) suggest that the Federal Reserve should extend liquidity to non-bank intermediaries, as a way to support market liquidity in times of stress. Our results highlight the potential benefits of access to central bank liquidity to broker-dealers and suggest there would be a broader benefit for market functioning.

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A Broker-Dealer legal framework

Broker-dealers' conduct is subject to comprehensive regulation under the Securities Exchange Act of 1934 ("Exchange Act") and the rules of each self-regulatory organization, usually a stock exchange and the Financial Industry Regulatory Authority (FINRA), to which the broker-dealer belongs. Broker-dealers that are part of Banking Holding Companies (BHC) are also subject to some restrictions imposed by the Federal Reserve Act.

A.1 Securities Exchange Act

There are three main rules that affect the activity of domestic and foreign broker-dealers: the "Net Capital Rule", and the "Customer Protection Rule", the "Registration of Foreign Broker Dealers Rule."

In terms of net capital requirements, different rules apply to registered broker-dealers, domestic and foreign, based on their involvement in customer transactions and whether they hold funds or securities for their customers. The "Net Capital Rule" (Rule 15c3-1) was created in 1975 by the SEC to regulate the ability of broker-dealers to meet their fiduciary obligations to customers and other creditors, and requires different minimum levels of capital based upon the nature of the firm's business and whether the broker-dealer handles customer funds or securities.¹⁵ The broker-dealer also must comply with the "basic" or "alternative" maximum debt-to-equity ratio. Under the basic method, the broker-dealer must limit its "aggregate indebtedness",¹⁶ to no more than 800 percent of net capital for the first year of operation, and 1,500 percent of net capital thereafter. Under the alternative method, the broker-dealer must maintain net capital of not less than \$250,000 or 2 percent of its customer-related.

The rule has been amended in 2004 to allow for a voluntary, alternative method of computing deductions to net capital for broker-dealers that maintains tentative

¹⁵Specifically, the rule requires minimum net capital of (i) \$250,000 for a broker-dealer that holds customer funds or securities, (ii) \$100,000 for a broker-dealer that clears customer transactions on a delivery versus payment basis and does not offer margin accounts, (iii) \$50,000 for a broker-dealer that introduces customer transactions and accounts to another registered broker-dealer that carries the accounts on a fully disclosed basis, or (iv) \$5,000 for a broker-dealer that does not receive, hold or owe customer funds or securities or carry customer accounts or trade securities other than on an agency or riskless principal basis.

¹⁶The aggregate indebtedness is defined as the total money liabilities of a broker-dealer arising in connection with any transaction. This measure, however, excludes "adequately secured debt", subordinated debt and other specified liabilities.

net capital of at least \$1 billion and net capital of at least \$500 million, to use mathematical modeling methods already used to manage their own business risk, including value-at-risk (VaR) and scenario analysis. The change has been seen as one of the causes of increased leverage from 2004 to 2007.

In 1972, the Commission adopted the “Customer Protection Rule” (Rule 15c3-3), to ensure that broker-dealers have sufficient liquid assets to meet their obligations to customers and counterparties, especially under in situations of financial distress. Specifically, under the rule, a broker-dealer must segregate customer funds and fully paid and excess margin securities held by the firm for the accounts of customers.

In 1989, the SEC adopted Rule 15a-6 in order to facilitate the access to foreign markets by U.S. institutional investors through foreign broker-dealers and to provide guidance about their rules of conduct.¹⁷ Non-U.S. broker dealers doing business in the United States are subject to regulation by the U.S. Securities and Exchange Commission (SEC) as well as the securities regulatory agencies in the states in which they do business, just like U.S. securities broker-dealers.¹⁸ The Rule exempts from SEC registration certain types of U.S. activities of non-U.S. broker-dealers, however the exemption from registration does not exclude that foreign broker-dealers need to register under the state securities law where they operate.¹⁹

A.2 Federal Reserve Act

Broker-dealers that are part of bank holding companies (BHCs) are subject to restrictions imposed by the Federal Reserve Act that limit the amount they can borrow from their parent company. In particular, section 23A seeks to restrict transfers of assets (“covered transactions”) between banks that are members of the Federal Re-

¹⁷See SEC Rule 15a-6 Adopting Release (SEC Release No. 34-27017 (July 11, 1989)).

¹⁸Rule 15a-6 under the Exchange Act provides a limited exemption from registration for non-U.S. broker-dealers for four significant types of U.S. activities of non-U.S. broker-dealers: (i) unsolicited transactions with U.S. customers; (ii) transactions for a defined group of U.S. institutional customers provided that the transactions happen through a registered broker or dealer; (iii) transactions, on a solicited or unsolicited basis, with U.S. broker-dealers and with banks acting as principal or agent; and (iv) providing research reports to major U.S. institutional investors that have limited contacts with investors in the United States.

¹⁹Rule 15a-6 under the Exchange Act provides a limited exemption from registration for non-U.S. broker-dealers for four significant types of U.S. activities of non-U.S. broker-dealers: (i) unsolicited transactions with U.S. customers; (ii) transactions for a defined group of U.S. institutional customers provided that the transactions happen through a registered broker or dealer; (iii) transactions, on a solicited or unsolicited basis, with U.S. broker-dealers and with banks acting as principal or agent; and (iv) providing research reports to major U.S. institutional investors that have limited contacts with investors in the United States.

serve System and their “affiliates”, based on the amount of the bank’s capital and surplus.²⁰ In addition, section 23B requires that transactions between the bank and its affiliates occur on market terms, i.e., on terms and under circumstances that are substantially the same, or at least as favorable to the bank as those prevailing at the time for comparable transactions with unaffiliated companies. Moreover, both section 23A and section 23B contain an “attribution rule”, which treats a transaction between a bank and a third party as a covered transaction if the proceeds of the transaction are used for the benefit of, or are transferred to, an affiliate of the bank. For example, a bank’s loan to a third party to acquire assets or securities from a bank’s affiliated broker-dealer is subject to the qualitative and quantitative limitations of sections 23A and 23B, as if the bank extended credit directly to the broker-dealer affiliate.

A few exemptions to Section 23A were granted during the financial crisis. Since then, the Dodd-Frank Act has placed significant additional restrictions on section 23A and section 23B. They still allow some possibility for exempted liquidity provision; however, lender-of-last-resort secured financing from the Fed can only be obtained under broad programs or subject to a finding by the Federal Deposit Insurance Corporation (FDIC) that the exemption does not place the Deposit Insurance Fund at risk, among other requirements.

B Additional figures and tables

²⁰Under section 23A, “covered transactions” generally include loans and other extensions of credit to an affiliate, investments in the securities of an affiliate, purchases of assets from an affiliate, issuances of guarantees on behalf of an affiliate, and other transactions exposing a bank to an affiliate’s credit or investment risk. Before the amendment to Section 23A by the Dodd Frank Act, the rule did not specifically enumerate a securities lending transaction or a securities borrowing transaction as a form of covered transaction; however, the Federal Reserve has treated them to be the equivalent of a loan and subjects them to Section 23A. See, e.g., Letter to Patrick S. Antrim, Assistant General Counsel, Bank of America Corporation (January 23, 2007) (securities lending transactions); Letter to John H. Huffstutler, Associate General Counsel, Bank of America Corporation (securities borrowing transaction).

Table 7: Means and Standard Deviations for Propensity-Score Sample, by Broker-Dealer Type

	Pre-crisis		Crisis	
	non-BHC	BHC	non-BHC	BHC
Repo	0.379 (0.258)	0.428 (0.277)	0.439 (0.253)	0.349 (0.252)
Securities lending	0.329 (0.294)	0.124 (0.106)	0.244 (0.270)	0.134 (0.195)
Reverse repo	0.177 (0.230)	0.244 (0.232)	0.183 (0.239)	0.173 (0.189)
Securities borrowing	0.286 (0.293)	0.183 (0.183)	0.225 (0.275)	0.187 (0.210)
Cash	0.276 (0.297)	0.202 (0.286)	0.263 (0.288)	0.186 (0.266)
Long inventory	0.401 (0.305)	0.441 (0.285)	0.383 (0.298)	0.427 (0.280)
Govt Sec Share	0.273 (0.301)	0.435 (0.294)	0.301 (0.337)	0.349 (0.296)

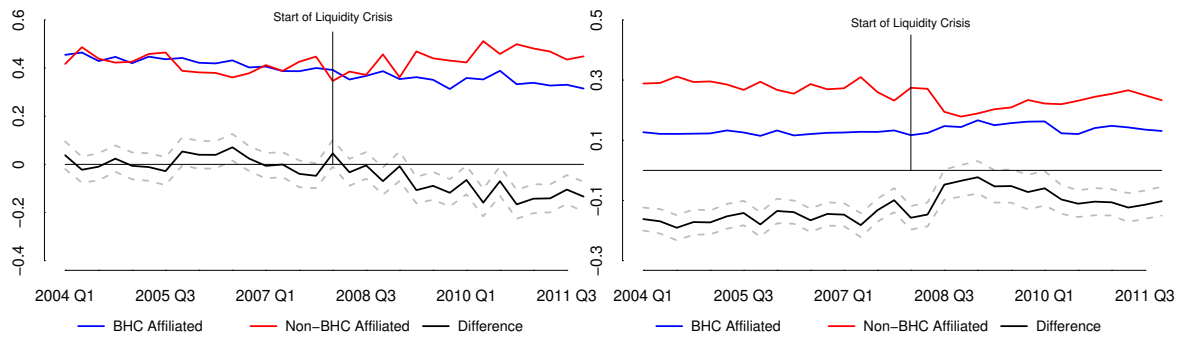
Note: Govt Sec Share is the government securities share of long inventory. All the other variables are computed as a share of total assets. For each cell in the table, the mean and standard deviation are reported, where the latter are in parenthesis. BHC is the group of broker-dealers affiliated with a bank-holding company, non-BHC is the group of broker-dealers not affiliated with a bank-holding company. Further, pre-crisis is from the first quarter of 2004 to the third quarter of 2007 and crisis is from the fourth quarter of 2007 to the fourth quarter of 2011.

Source: FOCUS reports and authors calculations.

Figure 10: Repo and securities lending over total liabilities, propensity score method

(a) Repo

(b) Securities lending

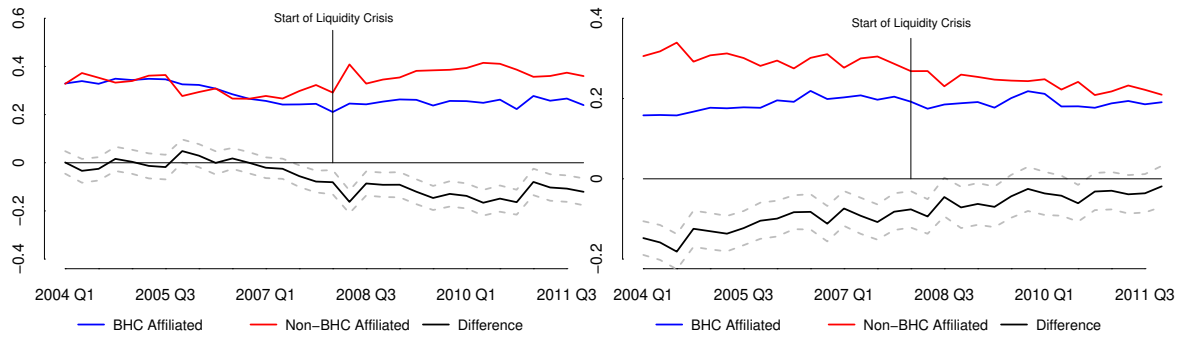


Note: BHC affiliate are broker-dealers affiliated with a bank holding company and non-BHC affiliate are those not affiliated with a bank holding company. Difference is BHC affiliate minus non-BHC affiliate. Confidence intervals at 95 percent are plotted in grey. Source: FOCUS reports and author's calculations

Figure 11: Reverse repo and securities borrowing over total assets, propensity score method

(a) Reverse repo

(b) Securities borrowing



Note: BHC affiliate are broker-dealers affiliated with a bank holding company and non-BHC affiliate are those not affiliated with a bank holding company. Difference is BHC affiliate minus non-BHC affiliate. Confidence intervals at 95 percent are plotted in grey. Source: FOCUS reports and author's calculations