

Hedge Fund Stock Trading in the Financial Crisis of 2007-2008

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August 2010

Abstract

We study hedge fund trading in the stock market during the financial crisis of 2007-2008 and the surrounding years. We find that in the two quarters around the Lehman collapse (2008Q3-Q4) hedge funds reduced their equity holdings by about 29%, with nearly every fourth hedge fund cutting more than 40% of its equity portfolio in each quarter. We identify two main drivers of this behavior. First, in line with the presence of severe funding constraints, investor withdrawals and lender pressure account for about 78% of equity selloffs. These constraints are more binding for funds with low restrictions on investors' liquidity, and funds with low bargaining power vis-à-vis their brokers. Second, it appears that hedge funds reallocate capital to either cash, in an attempt to time the stock market, or other markets, in pursuit of more profitable investment opportunities. Finally, we find evidence for flight to quality (selloffs of high-volatility stocks) and static liquidity management (selloffs of high-liquidity stocks), which are consistent with distress selling driven by funding constraints.

* We thank Viral Acharya, Giovanni Barone-Adesi, Vyacheslav Fos, José-Miguel Gaspar, Massimo Massa, Ronnie Sadka, René Stulz, Dimitri Vayanos, and seminar and conference participants at the Ohio State University, the 2nd Annual Conference on Hedge Funds in Paris, the 3rd Erasmus Liquidity Conference, the Wharton/FIRS pre-conference, the FIRS conference (Florence), and LUISS University (Rome), for helpful comments.

1. Introduction

With over \$2.5 trillion of assets under management in mid-2007 (source: Hedge Fund Intelligence), hedge funds were prominent players in the investment industry at the eve of the recent financial crisis. A full account of the dramatic events that shook financial markets starting in 2007 cannot, therefore, abstract from the role played by these important actors.

In this paper, we study hedge fund trading behavior in the U.S. stock market in years surrounding the financial crisis of 2007-2008. While our attention falls largely on the crisis quarters, we start the analysis in 2004, to contrast the crisis time to a period of relative calm and expansion in financial markets, and track hedge funds' trading until the end of 2009. As a preview of our main stylized fact, Figure 1 plots the fraction of U.S. market capitalization held by pure-play hedge funds. The vertical lines denote quarters of special market stress: the 'Quant Meltdown' (2007Q3, see Khandani and Lo 2009) and the collapse of Lehman Brothers (2008Q3). The figure shows dramatic declines in hedge fund holdings around these events. The main goal of the paper is to understand the forces that drove hedge funds out of the equity market during this critical period. Furthermore, acknowledging that there is heterogeneity across hedge funds in their trading motives and consequent behavior during the crisis, we also investigate the fund characteristics that are more likely associated with selloffs, such as the extent of the restrictions to fund investors' liquidity. Finally, focusing on the stock level dimension, we study the characteristics of the stocks that hedge funds were more likely to sell during the crisis.

Theoretical guidance for our analysis comes from the observation that, at times of crisis, the balance of incentives that hedge funds face shifts. While in normal times hedge funds are commonly thought of as liquidity providers (e.g., Agarwal, Fung, Loon, and Naik 2007, Aragon 2007, Khandani and Lo 2009, Sadka 2010), scholars have postulated the existence of limits-to-arbitrage during crises (Shleifer and Vishny 1997, Gromb and Vayanos 2002, Vayanos 2004, and Brunnermeier and Pedersen 2009). In particular, in bad times, arbitrage capital becomes more expensive, raising arbitrageurs' cost of liquidity provision (Brunnermeier and Pedersen 2009, Aragon and Strahan 2010). On the other hand, the occurrence of liquidity dry-ups simultaneously across asset types (Boyson, Stahel, and Stulz 2008) provides an incentive for unconstrained arbitrageurs to reallocate capital towards more attractive investment opportunities.

We analyze hedge fund behavior using data from 13F mandatory equity holdings filing together with a proprietary hand-matched list of hedge funds, and combined with hedge fund characteristics data (from TASS). We report that hedge funds exited en masse the stock market as the crisis evolved. Specifically, hedge funds reduced their equity holdings by about 5% in each of the third and fourth quarters of 2007, and by about 15% in each of the third and fourth quarters of 2008.¹ Incidentally, we show that other institutional investors (excluding mutual funds) and retail investors took the other side of hedge fund trades.

Since we do not observe hedge fund short equity positions, we rely on the conjecture that most short selling is performed by hedge funds (in support of this claim, see also: Goldman Sachs, 2010). We document a decline in the overall short interest reported by the exchanges in these four quarters (partly driven by the short selling ban in October 2008). While closing short positions may pour liquidity into the market, we show that there is only little overlap between the stocks that were sold by hedge funds and those bought when short interest declined. Thus, the selloffs by hedge funds and the reduction in short interest did not compensate each other in terms of liquidity provision.

Next, we investigate the determinants of the equity selloffs by hedge funds. From the perspective of the balance sheet of a hedge fund, the decline in U.S. equity holdings must be matched by a combination of a drop in the assets under management (redemptions), a decrease in debt (deleveraging), or an increase in investments in asset classes other than U.S. equity (including cash). While this accounting identity guides some of our empirical analysis, i.e., on the role played by redemptions, it cannot help us with the remaining channels as we do not observe the time series evolution of leverage and of other investments made by hedge funds. To overcome this issue, we exploit cross-sectional variation in characteristics to identify the economic motives of hedge fund behavior. Specifically, we assume that among the exiting funds those with higher leverage are more likely to suffer from margin calls or to hit the limits set by risk management models. That is, they are likely to be forced to deleverage. Also, we assume that funds that exited the market during the crisis only to increase drastically their positions in

¹ These figures translate to an exit of 0.2% of total market capitalization in each of the third and fourth quarters of 2007, and to 0.4% of total market capitalization in each of the third and fourth quarters of 2008. This is a lower bound estimate as our sample is restricted to pure-play hedge funds. Hence, it excludes many of the large investment houses that provide other investment services beyond hedge funds.

the following quarter were following market timing strategies. Finally, we postulate that, among the selling funds, those that belonged to non-equity-focused styles (e.g., fixed income arbitrage, global macro, managed futures) were more likely to divert resources to other asset markets.

Our results suggest that each of the above-mentioned channels had a significant impact on hedge funds' actions during the crisis. First, we find evidence that funding constraints in the form of redemptions and forced deleveraging explain about 78% of hedge fund equity sales during the crisis. We view this set of findings as consistent with Shleifer and Vishny (1997), Gromb and Vayanos (2002), Vayanos (2004), and Brunnermeier and Pedersen (2009) and others, who suggest that there can be limits to arbitrageurs' ability to provide liquidity, especially during periods of market tension when capital becomes more expensive. Second, we present a set of results suggesting that some hedge funds reallocated part of their capital away from the equity market to other asset types (including cash). Specifically, we find significant evidence of market timing and of sales by non-equity-focused hedge funds. Also, exiting hedge funds earned higher total returns for at least two quarters starting from the selloff quarters (Q3/Q4 of 2007 and Q3/Q4 of 2008). Because we control for the return on the equity portfolio, this result suggests that they reallocated capital towards other investment opportunities outside the stock market.

Then, we focus on the hedge fund characteristics that are more highly correlated with the selloff channels described above. As expected, crisis selloffs caused by redemptions were more likely for liquid funds (i.e., those with short lockup period, redemption notice, and redemption frequency). Consistent with the margin call interpretation, crisis selloffs related to high leverage were more likely for small, young hedge funds, and for those with poor past performance. These funds had arguably lower bargaining power vis-à-vis their brokers. Market timing during the crisis was adopted by liquid, young, highly levered funds, with very volatile returns. Finally, the funds that likely sold to invest in other assets were bigger, more levered, highly liquid, and had poor past performance. The last two pieces of evidence suggest that, even when redemptions did not actually occur, the threat of redemptions (as proxied by low restrictions to investors' liquidity) caused funds to quickly reallocate their portfolio away from equity during the crisis.

We also investigate the characteristics of the stocks that hedge fund traded during the crisis. Hedge funds were more likely to close positions in high volatility stocks than in low volatility stocks. Symmetrically, short interest decreased more strongly for high-volatility stocks.

This evidence is consistent with both margin calls and with risk management. In particular, Brunnermeier and Pedersen (2009) argue that margin calls can force arbitrageurs' to reduce exposure to risky assets, especially assets with high volatility. Similarly, if hedge funds follow internal risk management practices (such as Value at Risk models) they would limit their exposure to high volatility assets (Vayanos 2004, Brunnermeier and Pedersen 2009). Also interesting, hedge funds were more likely to sell high liquidity stocks during the crisis, consistent with the static model of Scholes (2000) and with the behavior of myopic investors in the framework of Brown, Carlin, and Lobo (2010). This result also resonates with the findings of Manconi, Massa, and Yasuda (2010) for mutual funds, which during the crisis decided to sell more liquid securities first.

Finally, we quantify the returns earned by hedge funds during the crisis. We find that hedge funds that bought stocks during the selloff quarters experienced higher returns in other markets. Conversely, hedge funds that sold stocks during the selloff quarters achieved higher returns in other markets in the quarter following the selloff quarter. We view this additional evidence as suggesting that some of the hedge funds that sold equities invested the proceeds in other markets.

Overall, our results show that during the crisis of 2007-2008 stock market participation by hedge funds was dictated by capital limitations, market timing, and outside investment opportunities. The findings about the effects of capital constraints on hedge funds' trading patterns corroborate previous empirical results on the limits of arbitrage (Aragon and Strahan 2009, Hombert and Thesmar 2009, Comerton-Forde, Hendershott, Jones, Moulton, and Seasholes 2010, Hameed, Kang, and Viswanathan 2010). The evidence on selloffs appear to suggest that hedge funds destabilized the stock market during the crisis (in the line of the evidence of Khandani and Lo 2007, Boyson, Stahel, and Stulz 2008), and potentially symmetric to the finding that hedge funds ride bubbles in good times (Brunnermeier and Nagel 2004). Yet, our results that hedge funds reallocated capital across asset types imply that this destabilizing effect may have been soothed by providing liquidity to other markets.

The paper proceeds as follows. Section 2 describes the data sources that we use. In Section 3 explores the aggregate behavior of hedge funds during the crisis and study the distribution of hedge fund trades. Section 4 takes a close look at the determinants of hedge fund

behavior and investigates cross-sectional predictions of the funding constraints and capital reallocation. Section 5 examines the characteristics of stocks that were sold by hedge funds. Section 6 measures the returns of hedge funds that exited the stock market during selloff quarters. Section 7 concludes.

2. Data

2.1. Data Sources and Sample Construction

2.1.1. Hedge Fund Holdings Data

The main dataset used in the study combines a list of hedge funds (by Thomson-Reuters), quarterly portfolio holdings reporting (13F), and information about hedge fund characteristics and performance (TASS).

Our primary data source is the 13F mandatory institutional holdings reports that are filed with the SEC on a calendar quarter basis and are available to us since 1980 to the end of 2009.² The Thomson-Reuters institutional holdings database (formerly known as the 13F CDA Spectrum 34 database) provides institutional holdings as reported on Form 13F filed with the SEC. Form 13F requires all institutions with investment discretion on over \$100 million at the end of the year to report their long holdings (mainly publicly traded equity, convertible bonds, and options) in the next year.³ Therefore, all hedge funds with assets under management in such qualified securities of more than \$100 million are required to report their holdings in 13F filings on a quarterly basis.⁴ 13F reporting is done at the consolidated management company.

We then match the list of 13F institutions in Thomson-Reuters with a proprietary list of 13F hedge fund managing firms and other institutional filers, provided by Thomson-Reuters. It is worth stressing that Thomson-Reuters's proprietary list of hedge funds puts us in a privileged

² According to Lemke and Lins (1987), Congress justified the adoption of Section 13F of the Securities Exchange Act in 1975 because, among other reasons, it facilitates consideration of the influence and impact of institutional managers on market liquidity: "Among the uses for this information that were suggested for the SEC were to analyze the effects of institutional holdings and trading in equity securities upon the securities markets, the potential consequences of these activities on a national market system, block trading and market liquidity..."

³ With specific regard to equity, this provision concerns all long positions greater than 10,000 shares or \$200,000 over which the manager exercises sole or shared investment discretion. The official list of Section 13F securities can be found on the following SEC webpage: <http://www.sec.gov/divisions/investment/13Flists.htm>

⁴ More information about the requirements of Form 13F pursuant to Section 13F of the Securities Exchange Act of 1934 can be found at: <http://www.sec.gov/divisions/investment/13Ffaq.htm>.

position. Relative to the self-reported industry lists that are commonly used to identify hedge funds, the Thomson list is certainly more comprehensive as it classifies all 13F filers.⁵ Moreover, the Thomson-Reuters hedge fund list identifies hedge funds at the disaggregated advisor level, not at the 13F report consolidated level. For example, for Blackstone Group holdings in 13F data, Thomson-Reuters provided us with a classification of each of the advisors within Blackstone that reported its holdings in the same filing.^{6,7}

Before applying the filters described below, the number of hedge funds in the Thomson-Reuters list varies from a few dozens in the early 1980s to over 1,000 at the 2007 peak. We cross-check our list of hedge funds with the FactSet database and we find it congruent with the FactSet LionShares identification of hedge fund companies. With some caveats that we mention below, an additional advantage of 13F filings is that they are not affected by the selection and survivorship bias that occurs when relying on TASS and other self-reported databases for hedge fund identification (Agarwal, Fos, and Jiang 2010).

Data in the 13F filings have a number of known limitations. First, small institutions that fall below the reporting threshold (\$100 million in US equity) at the end of the year are not in the sample in the following year. Second, we do not observe positions that do not make the threshold

⁵ This comprehensiveness depends on Thomson's long-lasting and deep involvement with institutional filings. The SEC has long contracted the collection of various institutional data out to Thomson-Reuters, even when those reports were paper filings or microfiche in the public reference room. They also have directories of the different types of institutions, with extensive information about their businesses and staff. The list of hedge funds to which we have access is normally used by Thomson-Reuters for their consulting business and, to the best of our knowledge, has not been provided to other academic clients. References to Thomson-Reuters (or the companies that it acquired, such as CDA/Spectrum, which was formerly known as Disclosure Inc. and Bechtel) can be found at:

1. <http://www.sec.gov/rules/final/33-8224.htm> (search for Thomson);
2. SEC Annual Reports, 1982, http://www.sec.gov/about/annual_report/1982.pdf (page 37, or 59 of the pdf file);
3. <http://www.sec.gov/rules/final/33-7432.txt> (search for contractor);
4. http://www.sec.gov/about/annual_report/1989.pdf (search for contractor).

⁶ As a shortcut, from now on we will refer to the observational unit in our data set as a 'hedge fund'. It should be clear, however, that 13F provides asset holdings at the management firm level, or are at the advisor entity level, where different. Each firm/advisor reports consolidated holdings for all the funds that it has under management.

⁷ There are three advisor entities within Blackstone Group L.P. that report their holdings in the same consolidated Blackstone Group report. Among the three advisors included, GSO Capital Partners and Blackstone Kailix Advisors are classified by Thomson-Reuters as Hedge Funds (which an ADV form confirms), while Blackstone Capital Partners V LP is classified as an Investment Advisor. See the "List of Other Included Managers" section in the September 30 2009 Blackstone 13F reports filed on November 16 2009:

<http://www.sec.gov/Archives/edgar/data/1393818/000119312509235951/0001193125-09-235951.txt>

of \$200,000 or 10,000 shares. Third, short equity positions are not reported. Fourth, the filings are aggregated at the management company level. Still, as said above, the Thompson classification allows us to separately identify the advisors within the management company. Fifth, we only observe end-of-quarter snapshots on hedge fund holdings. In spite of these limitations, it must be stressed that our data is not plagued by survivorship bias as it contains the filings of defunct hedge fund companies too.

Because many financial advisors manage hedge-fund-like operations alongside other investment management services, we need to apply a number of filters to the data to ensure that the main line of operation of institutions that we capture in our sample is a hedge fund business. In order to limit our analysis to hedge funds, we drop institutions that have many advisors with majority of non-hedge-fund business (e.g., Goldman Sachs Group, JP Morgan Chase & Co., American International Group Inc.), even though they have hedge funds that are managed in-house and included with their holdings in the parent management company's 13F report. Thomson-Reuters' hedge fund list also provides the classification of non-hedge fund entities that file under the same 13F entity. We used this list to screen out all companies with other reported non-hedge fund advisors that file their 13F holdings along with their hedge funds. Additionally, we manually verified that large investment banks and prime brokers that might have internal hedge fund business are excluded from our list. As a further filter, we double-checked the hedge fund classification by Thomson-Reuters against a list of ADV filings by investment advisors since 2006, when available.⁸ We matched those filings by advisor name to our 13F data. Then, following Brunnermeier and Nagel (2004), we kept only the institutions with more than half of their clients classified as "High Net Worth Individuals" or "Other Pooled Investment Vehicles (e.g., Hedge Funds)" in Item 5.D (Information About Your Advisory Business) of Form ADV. Therefore, we believe that our final list of hedge funds contains only institutions with the majority of their assets and reported holdings in the hedge fund business.

We augment our data with hedge fund characteristics and monthly returns from the Thomson-Reuters' Lipper-TASS database (drawn in July 2010).⁹ We use both the "Graveyard"

⁸ All current advisor ADV filings are available on the SEC's investment advisor public disclosure website: http://www.adviserinfo.sec.gov/IAPD/Content/Search/iapd_OrgSearch.aspx. The ADV filings were mandatory for all hedge funds only for a short time in 2006. In the later period, they were filed on a voluntary basis.

⁹ While we use the most recent data feed of TASS for hedge fund information (July 2010), we use an older version (August 2007) to identify firms (as it included hedge fund names). Further, we use the 2007 extract for information

and “Live” databases.¹⁰ We use hedge fund company names in TASS and map it to the advisor company name that appears in 13F filings. The Lipper-TASS database provides hedge fund characteristics (such as investment style and average leverage) and monthly return information at the strategy or portfolio level. We aggregate the TASS data at the management company level, on a quarterly frequency, and match it to the 13F dataset using the consolidated management company name.¹¹ We exclude hedge funds with total assets under management of less than \$1 million, in order to ensure that our results are not driven by hedge funds with insignificant holdings.

Table 1, Panel D, provides the number of hedge funds in our sample by year, along with the number of hedge funds that are matched with TASS data. The first two columns show the explosion in the number of hedge funds over the last decade. The decrease in the number of matched TASS funds and total assets under management (AUM) is consistent with the recent patterns of hedge fund liquidations at the end of 2008 and in the first three quarters of 2009. According to Hedge Fund Research Inc., the total assets managed by hedge funds decreased by around 19% by 2009, due to the market crisis and the record-setting hedge fund closures in 2008 and 2009.¹² This pattern is strongly reflected in Figure 1, which plots hedge fund equity holdings over time as a fraction of total market capitalization. Finally, in Panel D of Table 1, we notice that our TASS-matched sample increases significantly after 2000, but misses a lot of hedge fund companies that are classified by Thomson-Reuters as hedge funds and file 13F filings.¹³ A similar argument applies to the funds that in 2009 appear in the 13F filings but not in TASS.

The main advantage of our dataset is that it includes most, if not all, hedge funds that are required to report their holdings in 13F filings. Thus, our dataset is broader and more

about the average leverage, as it is preceding the financial crisis of 2008. We note however that only in a small number of cases (less than 50 cases), there was a change in the reported average leverage.

¹⁰ TASS starts retaining information on ‘dead’ funds only in 1994, while our analysis starts in 1990. We have run the regressions that use TASS data excluding the period before 1994 and the results are largely unaffected. The reason is likely to be that most of our crisis periods occur after 1994.

¹¹ We used strategy portfolio assets as weights in aggregating fund characteristics and total reported returns.

¹² See BusinessWeek’s article “Hedge Your Bets like the Big Boys” by Tara Kalwarski, in the December 28, 2009 issue.

¹³ Griffin and Xu (2009) use a TASS sample that ends in 2000 and rely on other hedge fund databases to classify hedge funds with 13F filings. We notice from our 2009 TASS sample that the hedge fund coverage in TASS increases significantly after 2000, but it is still likely to suffer from selection bias because it appears that many hedge funds with 13F filings are not in TASS.

comprehensive than those of prior studies. For example, Griffin and Xu (2009) have a total of 306 different hedge fund companies (Table 1, Panel A, in their paper) whereas, after applying the sample selection criteria that we describe below, we end up with 1,154 distinct hedge fund companies over the entire sample period. A recent study by Agarwal, Fos, and Jiang (2010) slightly outperforms this number with 1,199 fund companies that result from matching 13F with CISDM, HFR, Eureka, MSCI, and TASS. In addition to the reliance on the comprehensive list of hedge funds provided by Thomson, the larger number of funds relative to previous studies also results from the fact that our sample period extends to a later period that witnessed an explosion in the number of funds.

While Thomson-Reuters collects all the institutional reports filed with the SEC, they only retain the common equity holdings in their 13F institutional holdings database. To be able to capture the stock options held by hedge funds with 13F institutional holdings reports, we downloaded and parsed all 13F electronic forms since 1999 available on the SEC website, a method similar to that of Aragon and Martin (2009). The SEC requires institutions to separately report all call and put options for a large set of 13F securities.^{14,15} We looked only at the original 13F reports that are filed within forty-five days of the end of the calendar quarter, and mapped the list of our hedge funds to the CIKs they used in reporting SEC filings.^{16,17}

¹⁴ The official list of Section 13F securities refer to options by their underlying securities: <http://www.sec.gov/divisions/investment/13flists.htm>, and requires CALL or PUT designations for options in the issuer description field. We used such “CALL” and “PUT” strings to identify option positions in 13F filings, where they appear under Item 2 or Item 6 or as a suffix to the company name in the body of the holdings table of the 13F report. Note that some filings used different identifiers for options, such as Goldman Sachs Group, which uses “CAL” for call options. We were able to capture and identify many such special cases.

¹⁵ As an accuracy check, we compared the common equity portion of our parsed 13F dataset with the common equity holdings in the Thomson-Reuters 13F institutional ownership data, and we found a 99% correlation.

¹⁶ We noticed that several hedge funds filed subsequent amendments with regard to their confidentially-treated holdings, which were excluded from the original 13F filings, but reported in the form of amendments only after the expiration or rejection of the confidential treatment requests. We also noticed that the Thomson-Reuters data usually excludes such individual holdings from their data; it is published as originally reported and apparently overlooks subsequent amendments. We rely on Thomson-Reuters 13F holdings data as it has better historical coverage from 1980 than the electronic 13F filings that have been posted on the SEC website since 1999. See Agarwal, Jiang, Tang, and Yang (2009) for more information about and statistics on the confidentially-treated holdings (Table 2, Panel B).

¹⁷ Firms can delay their 13F reporting to a limited number of stocks by up to one year, by applying for confidential filing. Agarwal, Jiang, Tang, and Yang (2010) find that about 3% of all filings are not complete as they include positions that are filed in the confidential section. They note that a large fraction of the confidential filers consist of hedge funds that use confidential filings to protect trades that are based on private information. In particular, hedge funds use confidential filings when building block ownership positions or acquiring stocks following merger

2.1.2. Short Interest Data

While hedge funds are known for holding both long and short positions, the information reported in the 13F filings includes only long transactions. To complement the long holding data, we use short interest data provided by the exchanges. These data are reported on a monthly basis since 1988 at the stock level (therefore we cannot identify the investors who hold the short positions). In our empirical analysis, we make the simplifying assumption that the short interest is mainly driven by arbitrageurs, among which hedge funds play an important part. This assumption is supported by Boehmer and Jones (2008) who document that 55% to 70% of all short selling transactions are performed by institutions (Table 7 in their paper). A recent research report by Goldman Sachs (2010) estimates that hedge funds account for 85% of short selling activity. The validity of our working assumption is also supported by the parallel trend in the aggregate short selling and hedge fund activities over time (compare Figures 1 and 2; the correlation of the quarterly changes is 0.38). Furthermore, aggregate short selling activity is quite small in magnitude, even in recent years, suggesting that only a small group of specialized arbitrageurs engage in it.

We employ several widely used datasets for stock level and market level information. Specifically, we use CRSP and Compustat for stock characteristics. In addition, we winsorize fund flows and changes in hedge fund equity holdings at the 5th and 95th percentiles within each quarter, as the distributions of these variables have fat tails. Finally, we verify that our results are not driven by extreme observations in other variables.

2.2. Summary Statistics

Table 1 presents summary statistics of the datasets used in the study. Panel A focuses on the time series of the aggregate variables. The table shows that the selected hedge funds hold 2.36% of the entire stock market capitalization on average, peaking at 3.18% (in the second quarter of 2007). The short interest ratio averages 2.71%, peaking at 3.77% (in the second quarter of 2008). Although pure-play hedge funds hold relatively small fractions of the stock market, their impact can be significant on the economy. In a recent study, Billio, Getmansky, Lo, and Pelizzon (2010) examine systemic risk in hedge funds, banks, brokers, and insurers. They

announcements (as part of a merger arbitrage strategy). It appears, therefore, that our study should not be materially biased due to confidential filings as we are interested in dispositions following public events.

also find that hedge fund assets are much smaller than other institutions and their contribution to systemic risk may not be as big as that from other institutions.

We are interested in the active changes in equity holdings by hedge funds that result from actual trading, and not from price changes. To this purpose, we evaluate the quarterly trades made by each fund at previous period prices and aggregate them across the funds in the sample in a given quarter. Then, we divide these dollar trades by either the total equity holdings by hedge funds in the previous quarter or by the total market capitalization in the previous quarter.¹⁸ The choice of previous-quarter prices allows us to focus on changes in equity holdings that are due to trades and not to price changes. The average quarterly change in total hedge fund holdings is 2.02% of their total equity holdings, or 0.034% of total market capitalization.

Panel B presents summary statistics for the stock-quarter level sample. The dependent variable that we use in our stock level regressions in Section 3 to 6 is the change in the number of shares of a firm held by hedge funds aggregated across all hedge funds in our sample divided by total number of shares outstanding for that firm. Across stocks, this figure averages 0.07%. Focusing on the level of stock ownership, hedge funds hold 7.43% of a firm's equity on average. From the comparison with the aggregate holdings in Panel A, which are weighted by market capitalization, it appears that hedge funds' equity holdings are tilted towards smaller stocks, consistent with the evidence in Griffin and Xu (2009). Volatility is computed as the standard deviation of monthly returns over a two-year window. Finally, we construct the past-twelve-month cumulative return to control for momentum strategies.

Panel C of Table 1 presents summary statistics for the hedge-fund-quarter level data. The dependent variable in some of the hedge-fund level analysis below is the fraction of the fund equity portfolio that is traded over the quarter. Again, the choice of previous-quarter prices

18 We first adjust shares held for splits and distributions. Then we use the quarterly holding snapshots to derive the trades and make sure that we are filtering out changes in holdings that originate from changes in the universe of 13F filers.¹⁸ To this purpose, we require hedge funds to appear in two consecutive quarters. When a hedge fund does not report (since it is below the \$100 million assets-under-discretion cutoff), we eliminate the observation (as opposed to reporting a large drop in holdings). More details about the sample construction and trade derivation are available as a WRDS research application with the SAS code: "Institutional Trades, Flows, and Turnover Ratios using Thomson-Reuters 13F data,"

http://wrds-web.wharton.upenn.edu/wrds/support/Data/_004Research%20Applications/_003Research%20Guides/_000Files%20for%20Thomson%20Reuters%2013F%20Database%20Research%20Applications/institutional_trades.cfm

avoids introducing a bias due to the change in prices over the quarter. To construct this variable we aggregate the quarterly changes in holdings for all the stocks in the fund portfolio and evaluate them at the previous quarter prices. Then, the total dollar value of the trades is divided by the lagged (previous quarter) value of the equity portfolio. The average percentage change in hedge funds' equity portfolios is 11.9%. We construct equity holdings returns in a given quarter by assuming that changes in reported 13F positions occur at end-of-quarter prices. The hedge-fund-quarter data is matched with TASS, as explained above. We use TASS data to construct total returns, by aggregating returns of funds within each management company (weighted by the size of assets under management of each fund in the company). Following the literature standard (Chevalier and Ellison 1997, Sirri and Tufano 1998, Agarwal, Daniel, and Naik 2009, among others), we compute quarter t fund flows as the quarterly difference in AUM minus the dollar return on quarter $t - 1$ AUM. Fund flows are then scaled by the lagged AUM. We also define a dummy for whether the fund holds put options on individual stocks according to the 13F filings (about 34% of the hedge-fund-quarter observations after 1999). For leverage, we use TASS average leverage variable (which is defined as debt over AUM) and we average it at the company level using fund level AUM as weights. The mean leverage is 72.7%. The other variables are described when we use them in the analysis.

Panel D provides a summary of coverage for the 13F and TASS data as well as summary statistics about hedge funds' equity portfolios. It shows that, over time, more small hedge funds entered the industry but held, on average, fewer stocks at a higher (annualized) turnover rate. As in Wermers (2000), Brunnermeier and Nagel (2004), and the CRSP mutual fund database, portfolio turnover is defined as the minimum of the absolute values of buys and sells during a quarter t divided by total holdings at the end of quarter $t - 1$, where buys and sells are measured with end-of-quarter $t - 1$ prices. This definition of turnover captures trading unrelated to inflows or outflows. Because it is computed from quarterly snapshots, it is understated; nevertheless it provides an important assessment of the relevance of quarterly holdings data. The average quarterly turnover in the sample is 98% annualized. The magnitude of turnover in our data is comparable to that found by Brunnermeier and Nagel (2004). While somewhat higher than the 72.8% (annualized) turnover for mutual funds in 1994 found by Wermers (2000), our figure indicates that a substantial part of portfolio holdings survives on the quarterly horizon. As argued by Brunnermeier and Nagel, this finding legitimates the use of quarterly snapshots to capture the

low frequency component of hedge fund trading. Also important for the purposes of our analysis, the high frequency turnover in portfolio composition is less of a concern than it has been for previous studies that used 13F data. Our focus is on aggregate changes in the equity participation by hedge funds. Arguably, aggregate participation in a market is less likely to be affected by high frequency turnover. Finally, a similar argument limits the problems arising from potential portfolio manipulation ahead of the filing date. While it is possible that fund managers reshuffle their stock holdings to conceal trading strategies, we find it less plausible that they alter the portfolio's overall exposure to the stock market.

3. Hedge Fund Trading during the Crisis

3.1. Aggregate Long Hedge Fund Holdings

Our first goal is to characterize hedge fund behavior during the crisis. In Figure 1, we look at aggregate hedge fund equity holdings as a fraction of total stock market capitalization for the period of 2004 to 2009. This period is comprised of a period of bull market which was associated with an expansion of the hedge fund industry (2004Q1 to 2007Q2), a crisis period (2007Q3-2009Q2), and post-crisis period (2009Q2-2009Q4). This classification of quarters is of course done after the fact. The main objective is to identify the regime shift in hedge funds investing behavior across the different periods. The figure seems to suggest that at the quarters of crisis (the Quant meltdown (2007Q3), and the fall of Lehman Brothers (2008Q3-Q4)), hedge funds' market participation decreases dramatically. Of course, this evidence is affected by the relative changes in market prices, which confound the pure effect of trading. For this reason, in the remainder of the paper we focus directly on actual hedge fund trades (using the number of shares traded with last quarter prices, as explained in Section 2.1.).

The main empirical fact that the paper presents is that hedge funds massively withdrew from the equity market during the quarters of the main events of the crisis. In Table 2, we present the quarter-on-quarter change in hedge fund holdings for the pre-crisis, during crisis, and post-crisis periods, including a breakdown of the trading activity for the crisis quarters. The Table shows that during the pre- and post-crisis period, hedge funds increased their stock market participation by about 6% per quarter. During the crisis, however, hedge funds reduced their participation by 3% each quarter on average. The quarter-by-quarter breakdown reveals that the withdrawals were concentrated in four quarters: the third and fourth quarters of 2007, and the

third and fourth quarters of 2008. We define these quarters as “selloff quarters”. In particular, in the third and fourth quarters of 2008, hedge funds sold 16.7% and 14.3%, respectively, of their aggregate holdings in the stock market. The table presents also the magnitudes of withdrawal in terms of percentage of total market capitalization.

The table shows that in the worst quarters of 2008, hedge funds withdrew 0.49% and 0.33% of the total market capitalization. Because pure-play hedge funds, which are examined here, hold only a small fraction of the market capitalization, their selling pressure appears to be small in magnitude relative to the total market capitalization. It is hard to draw implications on the price impact of these trades without an equilibrium model of the market. In particular, one needs to take in consideration the liquidity of the market and the informativeness of the trades. A study of the effect of the observed trades on market prices is therefore beyond the scope of this work. It is worth pointing out, however, that the measured changes in hedge fund portfolios have the potential to be disruptive. In Brunnermeier and Pedersen (2009), when arbitrageurs are constrained in their liquidity provision, the equilibrium is fragile. That is to say, small shocks to the net supply of assets can cause drastic price changes. Also important, the observed selloffs can be concentrated in a few illiquid assets, which are more likely to be held by arbitrageurs in normal times. This behavior is denoted as a flight to quality. In such a case, the losses in hedge fund capital, and the consequent drop in liquidity provision, are likely to be more relevant than the impact on a well-diversified portfolio. To further investigate this channel, in Section 4, we study the stock level cross-sectional dimension of selloffs.

The stylized fact that hedge funds massively exited the stock market during some of the crisis quarters sheds light on previous findings of the literature. First, Cao, Chen, Liang, and Lo (2009) find that hedge fund returns are less correlated with stock market returns around crises. Our main result shows that the low correlation results from lower participation to the stock market. Second, Ang, Gorovyy, and van Inwegen (2010) find that hedge funds started reducing their leverage prior to the financial crisis of 2008, as early as in 2007. Our evidence suggests that the deleveraging of hedge funds during this period could be related to the changes in their portfolio composition.

3.2. Aggregate Short Interest

The consumption of liquidity that is likely caused by the observed selloffs could potentially have been mitigated if hedge funds close short equity positions at the same time as they sell stocks. Brunnermeier and Pedersen (2009) clearly show that the limits to arbitrage can constrain speculators' positions on the long side as well as on the short side. Hence, we need to examine whether unwinding of short positions, if occurs, overlaps with the stock selloffs that we have documented so far. As noted above, we rely on Boehmer and Jones (2008) and Goldman Sachs (2010) and assume that the short interest reported by the exchanges is largely correlated with hedge funds' short interest. Indeed, comparing the charts of aggregate hedge fund holdings (Figure 1) and aggregate short interest (Figure 2), suggests that both economic variables display similar trend and participation patterns.

In Table 3, Panel A, we present the average changes in short interest during the three periods we examine, as well as a quarter-by-quarter breakdown. The table shows that the aggregate short interest changed by 2.3%, 2.7%, and -7.6%, during the pre-crisis, during crisis, and post-crisis periods, respectively. During the crisis, there was a great variation in the aggregate short interest. Most notable are the increase of 19.8% in the short interest following the fall of Bear Sterns in the first quarter of 2008, and the decline of 20.7% in short interest following the short selling bans in the last quarter of 2008. Also, there is a surge in short interest in the first quarter of 2009, the same period in which hedge funds returns to the market (Table 2).

To test the possibility that closing short positions compensated the loss of liquidity due to closing long positions, we resort to stock-quarter level analysis. We study the relation between stock level changes in hedge fund holdings and changes in short interest. In Table 3, Panel B, we regress stock-quarter changes in hedge fund ownership on changes in stock-quarter level of short interest and interaction with the selloff quarter dummy. We find that the correlation between hedge fund trading and short selling is positive and statistically significant, however, the coefficient is low: around 7.1% across specifications. We examine the effect in selloff quarters (Q3, Q4 of 2007 and Q3, Q4 of 2008). The correlated of hedge funds trades and changes in short interest is higher in these quarters by 2.2%. Results do not change when we include stock fixed effects (Column (2)). To illustrate the economic magnitude, if there is a 1% decline in short interest in a particular stock, hedge funds holdings decrease by 0.09% on average. Hence, only

9% of the liquidity consumption by hedge funds is compensated by liquidity provision from the unwinding of short positions. These results suggest that during the selloff quarters there was a dislocation of liquidity during the crisis quarters: liquidity is withdrawn from undervalued stocks (those that hedge funds held) and at the same time liquidity was added to the overvalued stocks (stocks in which short sellers held positions).

3.3. On the Other Side of Hedge Fund Trades

Since hedge funds reduced equity participation during the financial crisis, it is interesting to find out who buys their shares. In other words, we would like to see whether one can identify another type of investors who are the liquidity provider during financial crisis. In Table 4, we repeat the analysis from Table 2 for other types of investors: mutual funds, other institutions, and retail investors (including management). The holdings of mutual funds and other institutions are also identified using the 13F filings. For each stock, we impute the fraction of the holdings of retail investors as the complement to one of the fraction held by institutional investors that file the 13F.¹⁹

The general picture from Table 4 is that other types of investors did not exit the stock market in the same fashion and magnitude that hedge funds did. We observe that mutual funds reduced their holdings during 2008Q1, 2008Q3, and 2008Q4. The holdings by other institutional investors appear volatile over the crisis period. Major selloffs took place in 2007Q4, 2008Q2, and 2009Q1. Interestingly, other institutional investors exhibit poor market timing skills as they increased their participation in the stock market in the last quarter of 2008, and decreased their participation in the first quarter of 2009. Retail investors decreased their participation in the third quarter of 2007, the first quarter of 2008 and in the third quarter of 2008. Like hedge funds, retail investors increased a lot their stock market participation in the first quarter of 2009.

To summarize, it appears that both retail investors and other institutional investors (non-mutual fund) provided liquidity during the crisis.

¹⁹ This method of imputing retail investors' holdings provides an upper bound. The reason is that 13F filings do not include institutions that do not make the \$100 million threshold. However, given the small size of the excluded institutions, we believe the approximation error to be modest.

3.4. Heterogeneity in Hedge Fund Trades

Given the large selling on the part of the aggregate hedge fund sector during the crisis, we wish to explore the drivers of this effect. A first step is to understand whether the effect is driven by large sales on the part of a few hedge funds, while the rest of the sector continues to provide liquidity, or whether it is spread over the entire spectrum of funds. To explore this issue, we compute for each hedge fund the fraction of equity bought or sold at previous-quarter prices. In Table 5 we present the distribution of funds with respect to the degree of their buying or selling for the different periods. Panel A is equal-weighted and Panel B is weighted the value of the equity portfolios that hedge funds manage.

Comparing the crisis period of 2007Q3 to 2009Q1 to the growth period of 2004Q1 to 2007Q2 in Panel A of Table 5 shows a left shift in the distribution in the later period. However, when zooming in to the particular quarters of the crisis, it appears that a large cluster of firms exit in the third and fourth quarter of 2008. The figures are dramatic: nearly every fourth firm sold more than 40% of its portfolio in each of these quarters. The table shows that the massive exit in these quarters is not balanced by a massive expansion of other funds. Only 15% to 20% of the funds expand their portfolios by more than 20%. These numbers are low relative to the 24% to 27% of hedge funds expanding in other periods. There is however a massive return to the market in the first quarter of 2009: 23.7% of the funds bought more than 40% of their equity portfolio's value.

Panel B helps evaluate the economic significance of the massive exit in the last quarters of 2008. The panel shows that the hedge funds exiting the stock market in the second half of 2008 are representative of the hedge fund population. Conversely, hedge funds that expand their stock market portfolio holdings during this period are very small: less than 7% of hedge funds in the third quarter of 2008, and less than 13% of hedge funds in the fourth quarter of 2008 expand their portfolios by more than 20%. The table shows that the large increase in hedge fund participation in the first quarter of 2009 is primarily driven by hedge funds with small equity portfolios.

Overall, the results on the distribution of trades corroborate the impression that hedge funds do not make a positive contribution to aggregate liquidity during the crisis. The shift in the distribution of trades towards large sales is important in general, and is especially pronounced in

the second half of 2008. There is scant evidence that the selling pressure is counterbalanced by increased buying on the part of other funds. Also, the funds that expand their portfolios are primarily small and are likely unable to make a difference in terms of liquidity provision.

4. The Determinants of Hedge Fund Selloffs

So far, we have documented large selling by hedge funds during the crisis. Next, we turn to investigating the determinants of this behavior. Ideally, we would be able to explore what hedge funds do with the proceeds of their equity sales during the crisis: pay out to investors, reduce debt, or invest in cash or other assets. Based on the accounting identity linking the assets to the liabilities of a hedge fund, the change in equity holdings must be matched by the change in assets under management (AUM) plus the change in debt (including short positions) minus the change in other investments. Such a decomposition of the change in equity holdings would certainly be very informative on the economic channels behind the observed selloffs. Unfortunately, we cannot proceed in this way. While TASS allows us to retrieve the flows into AUM, there is no time-series information on leverage. The leverage variable in TASS is a snapshot at the time of reporting.²⁰ So, we cannot compute the change in debt. Investments in cash or other assets than US equities are also unobservable.

Given these constraints, we rely on an alternative empirical strategy to disentangle the relevant determinants of the observed selloffs. We conjecture that there are two non-mutually exclusive broad explanations for this phenomenon: financial constraints and asset reallocation. First, investors and lenders could force hedge funds to liquidate equity positions by tightening their funding. This channel characterizes the limits-of-arbitrage theories: hedge funds cannot exploit market mispricing and monetize the illiquidity premium because their capital is cut off (as in Shleifer and Vishny 1997). We test this explanation by examining the effect of investor fund flows on hedge fund trades, in addition to whether highly leveraged hedge funds are more likely to sell equities.

²⁰ We have also tried to construct a time series for leverage by comparing two TASS feeds from 2007 and 2009. However, out of 13,400 funds in 2009 and 7,800 funds in 2007, we found only 130 cases with changes to the leveraged dummy between 2007 and 2009, and 51 cases with changes to the `avg_leverage` (average leverage) variable, and only 10 cases had changes in both variables. So, we concluded that TASS updates the leverage information with a delay and that we could not rely on this approach.

Second, it is possible that equity selloff by hedge funds the crisis is due to asset reallocation: market timing (i.e., investment in cash) or investments in other, potentially less liquid, markets. In other words, hedge funds could sell equity during the crisis as part of portfolio reallocation across assets. To assess whether market timing is an important driver of trades, we study whether hedge funds that exited the stock market were those that returned as the market turned. We test whether a broader asset allocation motive was behind the exit by examining whether hedge funds that exited the equity market during the selloff quarters were more likely to have had an earlier foothold in other markets. Finally, we analyze the future returns on the non-equity part of the portfolios of the hedge funds that exit the stock market during crises.

4.1. Financial Constraints: Redemptions by Investors

We hypothesize that investor redemptions drive some of the selling by hedge funds. Redemptions may be at their peak during periods of market illiquidity, and may force hedge funds to sell relatively liquid assets, such as stocks. We explore this idea by analyzing the cross-section of hedge funds' quarterly trades. The prediction is that hedge funds that experience larger redemptions would sell more equity. We impute net fund flow data²¹ (scaled by lagged equity portfolio size) from TASS, and thus need to restrict the 13F dataset to the sample matched with TASS. We also consider two quarterly leads of fund flows, because redemptions are often known in advance due to the redemption notice that clients must give to the fund (Boyson, Helwege, and Jindra 2010). Even if the redemptions are not known in advance, fund managers in poor performing funds could rationally anticipate future redemptions based on the existence of a positive flow-performance relation (see, e.g., Agarwal, Daniel, and Naik 2009).

We present the results in Table 6, which explores how well the different variables explain the hedge fund trading. In all regressions, the dependent variable is the percent change in hedge fund quarterly equity holdings. Standard errors are clustered at the calendar quarter level. In Column (1), we present the baseline regression. We use the universe of firms that appear both in TASS and 13F between 2004Q1 and 2009Q4. We note that based on this sample, hedge funds reduce their equity portfolio by 11.5% per quarter on average during selloff quarters (2008Q3-Q4 and 2009Q3-Q4). In Column (2), we introduce fund flow variables as well as interactions of

²¹ Net fund flows are computed as TASS variables $\text{EstimatedAssets}(q) - \text{EstimatedAssets}(q-1)(1 + \text{RateOfReturn})$, scaled by lagged (q-1) equity portfolio size which is derived from 13F. EstimatedAssets are aggregated from the fund/style level to the management company level. RateOfReturns are weighted by the estimated assets.

the selloff quarter dummy with current and lead fund flows. The regression shows that future flows are positive and statistically significant, while the coefficients on the interactions with the selloff quarter dummy are statistically insignificant. Controlling for flows reduced the magnitude of the selloff quarter coefficient from -11.5% to -6.5%, a decline of 43%.

Next, we explore the characteristics of the hedge funds that exit due to equity withdrawals. To do so, we pursue a two-stage process. In the first stage we regress the changes in hedge funds holdings on interactions of selloff quarter dummy and current fund flows, in addition to one- and two-period lead flows, in addition to the main effects. The predicted value of this regression represents the changes in hedge funds holdings that are correlated with fund flows. In the second stage we regress the predicted value on hedge fund characteristics. The results are presented in Table 7, Panel A. As we are interested in the characteristics of selling hedge funds during the selloff quarters, we focus on the interaction between the selloff quarter indicator and the hedge fund characteristic variable. The panel shows that low lockup and redemption periods are the only variables that characterize hedge funds that sell stocks during the selloff quarters due to withdrawals of investors' capital. These results corroborate with Teo (2010) who finds that hedge funds with short lock up periods are more likely to liquidate their positions during liquidity crises.

4.2. Financial Constraints: Credit Tightening by Lenders

Next, we look for evidence that hedge funds reduced their equity positions because they are forced to do so by lenders, as suggested by the limits-to-arbitrage theories. We conjecture that higher leverage makes a fund more exposed to the threat of margin calls. Hence, we examine whether highly leveraged funds sell larger portions of their portfolios during the selloff quarters. In Column (4) of Table 6, we regress the fraction of the equity portfolio traded by hedge funds over the selloff quarter indicator interacted with hedge funds' average leverage.²² The resulting coefficient on the interaction is negative and statistically significant, suggesting that highly leveraged hedge funds are more likely to reduce their equity holdings during the selloff quarters. Average leverage is measured as debt over investor equity. The size of the coefficient is -6.0% and should be multiplied with the leverage in order to get the economic effect. A 2:1 leveraged

²² The Average Leverage variable is a cross-sectional variable provided by TASS. This variable describes the general level of leverage of hedge funds, reported by funds' managers. Like other variables from TASS, we aggregate this variable from the fund level to the management company level, weighting it by EstimatedAssets.

hedge fund sells 3.0%²³ more of its equity portfolio than an unleveraged fund during the selloff quarters. By comparing the slope on the selloff quarter dummy in Column (4) (-7.0%) with the same coefficient in the base specification in the sample of funds with available leverage (Column (3)) (-12.1%), we conclude that leverage explains about 42% of the sales during the selloff quarters.²⁴

We also assess the total effect of financial constraints on hedge fund equity trading (that is, redemptions and leverage combined). In Table 6, Column (5), we regress the changes in equity holdings on the crisis indicator interacted with both net fund flows variables and average leverage. The main effects are also included. By comparing the coefficient on the selloff quarter dummy to the coefficient in Column (3), we conclude that financing constraints account for about 78% of stock sales by hedge funds during the selloff quarters.

To explore the characteristics of the hedge funds that exit the stock market in association with having high leverage, we pursue again a two-stage procedure. In the first stage we regress the changes in hedge fund equity holdings on the selloff quarter dummy interacted with average leverage, and on the main effects. The results show that the hedge funds that sold equity during the selloff quarters had the following characteristics: large assets under management, poor 12-month past returns, short lockup period, high redemption notice period, and less established (young) hedge funds.

In a second set of tests, we explore the cross-section of stocks and test whether hedge funds are more likely to close positions in high volatility stocks during the crisis. We focus on return volatility because it is positively correlated with stock margin requirements. Drawing on Brunnermeier and Pedersen (2009), we conjecture that at times of low liquidity, hedge funds enact a flight to quality. That is to say that when they are forced by lenders to liquidate their positions, hedge funds may choose to sell high volatility stocks first because of their higher margin requirements. Hedge funds may be motivated to sell high volatility stocks for the sake of internal risk management as well (Vayanos 2004), as many hedge funds (like their capital providers) use value-at-risk (VaR) models as a tool to monitor risk exposure. Reducing risk

²³ $2 * (-5.982\% + 4.476\%) = -3.012\%$

²⁴ Since about 53% of the TASS hedge funds report an average leverage of zero, we repeat the test for the population that has non-zero average leverage. The coefficient on the interaction between the selloff quarter dummy and average leverage changes to -5.953% ($t = -3.3$).

exposure could be vital in preempting future redemptions and margin calls. In our tests, we cannot separate these two explanations as they are observationally equivalent with regard to the prediction of flights to quality.²⁵

In Table 7, we test whether stocks with higher volatility are more heavily sold by hedge funds selloff quarters. In these tests we use stock-quarter level data. The dependent variable is the change in hedge fund share holdings as a percentage out of the lagged total shares outstanding. The explanatory variable of interest is the stock level volatility indicator (indicating above-the-median volatility, calculated using 12 past returns, at the end of the preceding quarter) interacted with the selloff quarter indicator. If hedge funds reduce their holdings more in high volatility stocks during extreme episodes, then the expected interaction coefficient is negative. In all regressions, standard errors are clustered at the quarter level.

The results in Table 7, Panel A, Column (1) confirms this prediction: hedge funds are more likely to reduce their positions in high volatility stocks during periods of low aggregate market liquidity. In Column (1), high volatility stocks have almost twice the likelihood of being sold by hedge funds during selloff quarters than do low volatility stocks. Column (2) shows that market uncertainty, as measured by the VIX, does not affect the likelihood of selling stocks with respect to volatility. Interestingly, Column (3) presents evidence that the likelihood of selling high volatility stocks in periods of low market returns is only slightly (and statistically insignificantly) higher than that of low volatility stocks.

We repeat the analyses for changes in stock level short interest. The motivation for this analysis is twofold. First, we recognize that portfolio volatility can also be reduced by closing short interest positions. Second, we are interested to verify that hedge funds do not reduce their high volatility long positions because they are bearish on high volatility stocks. If the limits-to-arbitrage forces are at play, then we anticipate similar results in the short interest sample, i.e., that hedge funds more aggressively reduce positions in high volatility stocks.

²⁵ We note, however, that the distinction between internal and external forces is blurred. Consider the external pressure that lenders and investors may put on hedge funds to liquidate high volatility stock positions. Since hedge funds can anticipate the demands of risk reduction by external capital providers, they can respond ahead of time by liquidating high volatility positions. Hence, hedge funds' reduction of risk according to VaR models can be viewed as an attempt to preempt forced liquidation.

The evidence in Panel B validates this prediction. Column (1) shows that during selloff quarters, stock level short interest of high volatility stocks is reduced by a greater amount (measured as change in the short interest, as a fraction of market capitalization at previous-quarter end) than the short interest of low volatility stocks. Column (2) shows that during periods of high market uncertainty as measured by the VIX, short sellers reduce their overall positions, albeit less than for high volatility stocks. Column (3) presents evidence that during periods of low market returns, arbitrageurs close short positions (realizing profits), particularly for high volatility stocks.

To summarize, we find strong support for the hypothesis that sales of stocks by hedge funds during crises are motivated by financial constraints. These can take the form of redemptions, margin calls, and risk management models. The combined effect of these forces explains about 52% of hedge fund stock selloffs during selloff quarters. In order to explain the remaining fraction of stock sales, we next examine the hypothesis that hedge funds deliberately sell equity in pursuit of higher expected returns from other assets.

4.3. Capital Reallocation: Market Timing

It is reasonable to believe that hedge funds exit the equity market towards other markets if they expect negative returns in the stock market. Ideally, we would test whether hedge funds liquidated their equity positions and moved to cash. Unfortunately, we do not observe cash holdings of hedge funds and therefore resort to indirect evidence. We conjecture that hedge funds that time the market exit for a limited amount of time and return shortly after. We identify the rapid return, we assign an indicator to whether a hedge fund is a top buyer (top quintile) in the following quarter (Top Buyer (q+1)) and test whether this indicator explains current behavior.

In Table 6, Column (7), we regress the change in hedge fund holdings on a selloff quarter dummy interacted with the Top Buyer (q+1) variable, and on the main effects. The regression shows that hedge funds that were top buyers in the quarter following a selloff quarter reduced their holdings in the current selloff quarter by 21.3%. This means that the large net buyers in the quarter following a selloff quarter were, in fact, the large net sellers during the selloff quarter itself. Hence, we believe that this is evidence that some of the large sellers during the selloff quarters were market timers.

To explore the characteristics of the funds that are considered market timers, we repeat the two-stage analysis as before. First, we regress the changes in hedge funds holdings on the top buyer indicators interacted with selloff indicator, and on the main effects. Then, we regress the predicted value on hedge fund characteristics. The results are presented in Table 7, Panel C. Focusing on the interaction, the results show that market timers have high leverage, low standard deviation of past fund returns, low lockup period and low redemption period, and are young funds. These characteristics may suggest that market timing is driven by a concern of managers about their performance and do not wish to take excessive risks.

4.4 Capital Reallocation: Investments in Other Markets

We also explore whether hedge funds reallocate capital across markets by examining the relation between hedge funds' trades and their access to other markets. The idea is that hedge funds with access to other markets are potentially more likely to exit the stock market during selloff quarters and search for opportunities elsewhere. We classify hedge funds as having access to other markets if their self-reported styles include multi-asset strategies.

The test is presented in Table 6, Columns (8), (9) and (12). As before, the dependent variable is the percentage change in hedge funds' equity portfolios. Column (8) shows that hedge funds with multi-asset strategies sold more heavily during the selloff quarters by 8.8% ($t = 1.71$). The effect is weaker when we control for being top buyer in the next quarter (Column (9)). After controlling for funding constraints, the effect of this variable becomes stronger (Column (12)).

We use the two-stage analysis to study the characteristics of the hedge funds that sold during the selloff quarters in conjunction to their multi-asset strategies. In Table 7, Panel B, we present the second stage results. Hedge funds with multi-asset strategies that sold during the selloff quarters tend to have: large base of asset under management, high leverage, low past returns, short lockup and redemption periods, and young in age.

Overall, these results provide support to the hypothesis that sales of stocks during the crisis also occurred because some funds, specifically those following multi-asset styles, reallocated their portfolio to cash or to other markets as investment opportunities arise.

5. Stock-Level Analysis

To better understand hedge fund behavior, we exploit another dimension of the data: the cross-sectional differences in the stocks that were traded by hedge funds during the crisis. Among the stock characteristics that we study, we focus on total return volatility (computed on the twenty-four monthly returns up to the beginning of the quarter) in order to identify the risk management motive. Then, we look at liquidity as measured by the price impact ratio of Amihud (2002). In this case, we wish to relate to the debate started by Scholes (2000) on the liquidation problem faced by an investor with both liquid and illiquid securities in his portfolio. Next, we consider market capitalization (at the beginning of the quarter) as a proxy for both risk and liquidity, and as a signal of potential under-pricing (Fama and French, 1992). Also, we study book-to-market (measured using the stock price and the latest book value at the beginning of the quarter) as an indicator of potential under-pricing that value investors look at (Fama and French, 1992). Finally, we focus on past-six-month returns at the beginning of the quarter to capture momentum strategies. For each of these characteristics, we compute a dummy variable that equals one if the company is in the top half of the distribution in a given quarter.

For each stock-quarter, we compute the change in hedge fund holdings, as the total number of shares held by hedge funds at the end of the quarter scaled by the total number of shares outstanding at the beginning of the quarter.²⁶ This is our dependent variable in Panel A of Table 8. All our specifications include the level of hedge fund ownership in the prior quarter to account for the fact that the amounts traded also depend on the amount of ownership at the beginning of the period. The coefficient of interest is the interaction between the stock characteristic dummy and the selloff quarter dummy.

From column (1) of Panel A, we infer that hedge funds sold high volatility stocks first during the crisis. This is consistent with the ‘flights to quality’ that are postulated by some of the limits-to-arbitrage theories. For example, Brunnermeier and Pedersen (2009) posit that high volatility assets are especially prone to margin calls and thus may get disposed first. Furthermore, hedge funds may close high volatility positions in an attempt to reduce the overall portfolio volatility due to risk management considerations (e.g., if they are constrained by VaR limits as in Vayanos, 2004). Next, the estimates in column (2) suggest that hedge funds tended to

²⁶ The number of shares is adjusted for stock splits.

hold on to illiquid stocks and to sell the ones with low price impact first. This evidence confirms the static liquidation behavior described by Scholes (2004) and is consistent with the assumption of myopic investors in the model of Brown, Carlin, and Lobo (2010). With a similar flavor to our findings, Manconi, Massa, and Yasuda (2010) show that during the 2007-8 crisis mutual funds decided to sell liquid securities first. Next, column (4) shows that hedge funds shifted their portfolio towards larger stocks during the crisis. This result confirms the flight-to-quality evidence from column (1). Finally, columns (5) and (6) suggest that hedge fund were not pursuing value or momentum strategies more intensely during the selloff quarters.

To proxy for the unobservable evolution in hedge fund short positions, we also study the change in stock-quarter-level short interest as a percentage of shares outstanding, and use this variable as the dependent variable in Panel B of Table 8. The specifications resemble those in Panel A. Column (1) shows that during the selloff quarters short sellers are more likely to close positions of high-volatility stocks, providing evidence of flights to quality that is symmetric to that in Panel A. Indeed, a hedge funds can reduce its VaR by limiting exposure to volatile stocks on the long and short sides of its portfolio. The other significant result is an increase in the short interest of value relative to growth stocks during the crisis. Possibly, short-sellers bet that the price of distressed securities would keep falling during the crisis. Finally, price impact, size, and momentum were not important determinants of stock short selling during selloff quarters.

6. Hedge Fund Trading and Returns

In a recent paper, Teo (2010) shows that hedge funds with high net flows outperform funds with low inflows and this effect is stronger when liquidity is low. Also, Hombert and Thesmar (2010) conjecture and provide evidence for the fact that funds with stable funding exhibit stronger ability to bounce back after negative shocks. Our data allow us to directly link returns to actual trading behavior of hedge funds, so that we can at least partially shed light on the mechanics behind these previous results. Furthermore, by analyzing the returns of hedge funds that exit the equity market during a crisis, we can indirectly infer their use of the proceeds from the stock sales.

We construct total portfolio returns at the management company-quarter level. TASS provides portfolio returns at the fund level. We value-weight the fund level returns at the management company level using lagged fund assets and we compound them at quarterly

frequency to match the 13F data frequency. Also, we compute abnormal returns from TASS fund level returns using the procedure in Boyson, Stahel, and Stulz (2010). Briefly, we take the residuals from the regression of individual hedge fund monthly total returns over an AR(1) term and Fama and French (1993), Fung and Hsieh (2004), and Agarwal and Naik (2004) factors.²⁷ To have sufficient power and given the large number of factors that are included in the regressions, when taking the residuals, we require at least 60 months of available data. These residual returns are then aggregated at the management company level and compounded at the quarterly frequency.

Panel A of Table 9 focuses on returns that are contemporaneous to the hedge fund trades. The trade variables of interest are the net change in the equity portfolio (Δ HF equity portfolio, columns (1) and (3)) and its break-down into buy and sell trades (buys and sales, columns (2), (4), and (5)). All the trade variables are evaluated at prior-quarter prices and expressed as a fraction of prior-quarter equity portfolio value. In all specifications, we include prior-quarter total returns to control for the serial correlation in returns that is documented by Getmansky, Lo, and Makarov (2004). First, we observe that in all specifications, returns are significantly lower during the selloff quarters. In column (1), we notice that funds with a higher net portfolio change during the selloff quarters have higher returns. Column (2) reveals that this effect is mainly due to funds that have higher buy trades. Likely, this evidence suggests that unconstrained funds which were able to expand their portfolio captured under-priced securities. In terms of magnitude, the coefficients in column (2) suggest that a 50% addition to the stock portfolio value during the selloff quarters raised quarterly returns by roughly 2.95% ($= 50 \times (0.051 + 0.008)$). In columns (3) and (4), we control for prior-quarter fund flows. We do not use contemporaneous or future flows in order to avoid endogeneity. Different from Teo (2010), lagged flows does not turn out significant, not even during the selloff quarters.²⁸ We tend to believe that this difference is due to the quarterly frequency of our data, as opposed to the monthly frequency in Teo (2010). Likely, quarterly lagged flows are stale information for current quarter returns. Yet, we think that our finding of a significant relation between returns and contemporaneous increases in portfolio holdings corroborates and sheds light on the evidence in Teo (2010) and Hombert and Thesmar

²⁷ We refer to Boyson, Stahel, and Stulz (2010) for further details on the factors. We thank Professors French and Hsieh to make the factors available on their websites.

²⁸ Lagged flows are insignificant also in specifications from which the trade variables are excluded.

(2010). Arguably, the positive relationship between buy trades and returns subsumes the link between flows and returns, as funds that are net buyers are likely to be recipients of recent inflows.

Using 13F filings, we construct equity holdings returns by assuming that trades occur at quarter-end prices. We include the contemporaneous equity holdings return as a control variable in column (5) of Panel A, Table 9. The striking result is that controlling for equity holdings returns, stock sales during the selloff quarters become positively and significantly related to total returns. We interpret this result as suggesting that the funds that sold their equity investments during the crisis profited from reinvesting the proceeds in securities other than U.S. equity. With some caveats that we discuss below, we can make this statement because our specification controls for contemporaneous equity holdings returns. Consistent with this finding, the coefficient on the buy trades becomes even more significant suggesting that the increase in returns for funds that can expand their equity portfolio during the crisis is mostly earned in other asset classes. Likely, the increase in the equity portfolio is a proxy for the increase in the total exposure of these funds.

Columns (6) to (10) replicate the analysis of the previous specifications replacing abnormal returns for total returns. The results are qualitatively similar, although less significant. While the lower significance of the trade variables is possibly due to the noise introduced by the return filtering process, one can also argue that the hedge funds were generating returns largely by trading the common factors.

In Panel B of Table 9, we shift our focus to returns that are measured in the quarter following the trades. The specifications follow the same pattern as in Panel A. The main evidence from Panel B is that hedge funds that sold stocks during the selloff quarters had higher returns in the following quarter. The result appears for both raw (Columns (1) to (5)) and abnormal returns (Columns (6) to (10)) suggesting that these funds are generating alphas for their investors. Note that this result becomes even stronger when controlling for equity portfolio returns (columns (5) and (10)). From column (5), a hedge fund that sold 50% of its equity portfolio in one of the selloff quarters earned about 3.75% (3.65%) higher raw (abnormal) returns in the next quarter.²⁹ One may be concerned that this result is just a mechanical

²⁹ Total returns: $50 * (0.084 - 0.009) = 3.75\%$. Abnormal returns: $50 * (0.067 + 0.006) = 3.65\%$.

consequence of the contemporaneous relationship found in Panel A, given that the fourth quarters of 2007 and 2008 are both following a selloff quarter and are selloff quarters themselves. In fact, we find similar results when we define the selloff quarters only as 2007Q4 and 2008Q4, and focus on returns in the next quarters (that is, 2008Q1 and 2009Q1).

Incidentally, the coefficient on the equity portfolio return is strongly significantly related to total returns in all specifications of Panels A and B. This evidence highlights the tight link between the changes in quarter-end 13F holdings and actual trades, which in turn generate returns. For this reason, it provides implicit support for our empirical methodology that hinges on quarterly snapshots of portfolio holdings.

Our attempt at isolating the return on the non-equity part of the portfolio relies on the implicit assumption that the relation between equity-portfolio returns and the total return is the same across funds. In other words, we estimate a unique slope on the equity return variable across funds, while different funds may very well have different splits between equities and other assets, including short positions. We cannot directly address this issue because we only observe long equity positions. However, we can mitigate this concern by letting the slope on equity returns vary for funds with different styles. The hope is that styles can help to control the across-fund difference in asset allocation. In an untabulated analysis, we add interactions of the equity portfolio returns with style indicators. The effect of interest, the slope on the interaction between sales and the crisis indicator, remains virtually unchanged. This evidence gives us additional confidence on the validity of our identification strategy.

Overall, the results in Table 9 are consistent with the hypothesis that hedge funds that exit the equity market during crises invest the proceeds successfully in other markets. The crisis of 2007-2008 was characterized by the contemporaneous deterioration of liquidity for different asset classes. Hence, the last set of results is consistent with the conjecture that a motive for hedge fund equity selloffs during crises is the prospect of earning a premium from providing liquidity to other markets.

7. Conclusion

The question of how the behavior of arbitrageurs is affected at times of market stress is a fundamental issue in understanding how financial markets work. Hedge funds are the investor class most closely associated with arbitrage activity and financial crises are the period in which

arbitrage activity is the most costly. In this paper, we present new evidence about the trading behavior of hedge funds in the 2007-2008 crisis.

We present evidence showing that hedge funds exited the equity market en-masse during the crisis. They reduced their equity holdings by about 5% in each of the third and fourth quarters of 2007, and by about 15% in each of the third and fourth quarters of 2008.

Consistent with the limits-to-arbitrage theories, our results suggest that the overwhelming majority of the selloffs during the crisis are related to capital withdrawals by investors and pressure by lenders. Furthermore, during crises, hedge funds more intensely close their positions in high volatility stocks. This finding also supports the flight-to-quality predictions of the theories that postulate financial constraints for arbitrageurs.

However, limits to arbitrage likely do not tell the whole story behind hedge fund selloffs during the last crisis. Stock sales by hedge funds also appear to happen as a deliberate portfolio reallocation strategy in pursuit of a better risk-expected return tradeoff. Consistent with this conjecture, we find that hedge funds engage in market timing by exiting during the crisis quarters to come back in the following quarters. Furthermore, based on their styles, we infer that some of the selling hedge funds are likely to have experience of other markets and search for investment opportunities therein. This inference is confirmed by the fact that on average the hedge funds that exit the stock market during selloff quarters exhibit significantly higher returns in the next periods on the non-equity part of their portfolios, suggesting that they invest in other, potentially more illiquid, markets.

To summarize, our main conclusion is that hedge fund liquidity provision in the stock market was drastically decreased at the peak of the last financial crisis. While we do not rule out the possibility that some of the stock sales by hedge funds are motivated by the deliberate reallocation of capital to less liquid asset classes, the more important determinant of their behavior seems to be limits to arbitrage, in the form of investor redemptions and lender pressure. Our findings strongly resonate with theoretical arguments that postulate pro-cyclical liquidity provision by arbitrageurs (Brunnermeier and Pedersen, 2009).

From the point of view of regulators and policy makers that are concerned about systemic risk, our results about hedge funds complements the evidence that other important actors in financial markets, namely broker-dealers, provide liquidity in a pro-cyclical manner (Adrian and

Shin, 2010). Compounding this set of results, there is mounting evidence that the “shadow banking system” contributes to amplify the negative shocks to financial markets.

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Table 1. Summary Statistics

The table presents summary statistics for the data used in the study. The sample period is Q1/2004 to Q4/2009. Panel A presents summary statistics for the hedge fund holdings sample, aggregated at the calendar quarter level. Panel B presents summary statistics for the hedge fund holdings sample, aggregated at the stock-quarter level. Panel C provides summary statistics the hedge fund level variables, conditioning on a successful match with TASS. Panel D presents time-series summary statistics at the hedge-fund level, by year.

Panel A: Aggregate Level, Quarterly Frequency

	N	Mean	St.Dev.	Min	Median	Max
HF holdings over mkt cap (%)	19	2.360	0.499	1.460	2.490	3.180
Δ HF Holdings (% , share of equity holdings)	19	2.020	8.260	-16.700	3.570	13.100
Δ HF Holdings (% , share of mkt cap)	19	0.034	0.213	-0.489	0.071	0.336
MF holdings over mkt cap (%)	19	13.600	0.784	12.200	13.700	14.700
Δ MF Holdings (% , share of mkt cap)	19	0.068	0.098	-0.094	0.065	0.296
Other inst. holdings over mkt cap (%)	19	40.800	1.160	39.500	40.300	43.200
Δ Other inst. holdings (% , share of mkt cap)	19	-0.026	0.931	-2.370	0.008	1.620
Retail holdings over mkt cap (%)	19	43.200	1.240	40.300	43.200	44.800
Δ Retail holdings (% , share of mkt cap)	19	-0.076	0.866	-1.360	-0.254	2.330
Short interest ratio (SIR) (%)	19	2.710	0.533	2.160	2.540	3.830
Δ Short interest ratio (Δ SIR) (% , share of short interest)	19	2.230	8.680	-20.700	2.720	19.800
Δ Short interest ratio (Δ SIR) (% , share of shares outstanding)	19	0.068	0.260	-0.605	0.056	0.676

CORRELATIONS	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	
HF holdings over mkt cap (%)	(1)	1.00											
Δ HF Holdings (% , share of equity holdings)	(2)	0.18	1.00										
Δ HF Holdings (% , share of mkt cap)	(3)	0.25	0.99	1.00									
MF holdings over mkt cap (%)	(4)	0.03	0.32	0.31	1.00								
Δ MF Holdings (% , share of mkt cap)	(5)	-0.10	0.36	0.35	0.40	1.00							
Other inst. holdings over mkt cap (%)	(6)	0.18	-0.66	-0.63	-0.51	-0.68	1.00						
Δ Other inst. holdings (% , share of mkt cap)	(7)	-0.38	-0.25	-0.28	0.34	-0.42	0.30	1.00					
Retail holdings over mkt cap (%)	(8)	-0.60	0.34	0.29	-0.17	0.42	-0.69	-0.34	1.00				
Δ Retail holdings (% , share of mkt cap)	(9)	0.36	-0.01	0.01	-0.49	0.25	-0.09	-0.96	0.25	1.00			
Short interest ratio (SIR) (%)	(10)	0.58	-0.39	-0.34	-0.55	-0.40	0.76	-0.25	-0.60	0.40	1.00		
Δ Short interest ratio (Δ SIR) (% , share of short interest)	(11)	0.50	0.54	0.56	-0.04	0.19	-0.13	-0.37	-0.06	0.24	0.26	1.00	
Δ Short interest ratio (Δ SIR) (% , share of shares outstanding)	(12)	0.52	0.53	0.55	-0.11	0.14	-0.06	-0.37	-0.09	0.24	0.32	0.99	1.00

Table 1. Summary Statistics (Cont.)

Panel B: Stock Level, Quarterly Frequency

	N	Mean	St.Dev.	Min	Median	Max
Total hedge fund holdings (%)	102,406	7.427	9.307	0.000	4.112	100.000
Δ Total hedge fund holdings (%)	97,111	0.095	1.997	-6.911	0.000	8.184
Short interest ratio (SIR) (%)	138,503	3.621	5.592	0.000	1.519	97.287
Δ Short interest ratio (SIR) (%)	136,301	0.056	2.428	-87.192	0.001	87.197
Volatility	96,565	0.128	0.079	0.000	0.108	0.500
Amihud ratio	99,825	0.652	1.425	0.000	0.017	5.000
Size (\$ million)	101,683	3017.784	14633.887	0.253	312.991	513362.000
BM	97,534	0.770	2.116	0.000	0.502	238.798
Past 6m ret	142,670	0.012	0.421	-0.991	0.002	65.056

CORRELATIONS	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	
Total hedge fund holdings (%)	(1)	1.00								
Δ Total hedge fund holdings (%)	(2)	0.15	1.00							
Short interest ratio (SIR) (%)	(3)	0.22	0.00	1.00						
Δ Short interest ratio (SIR) (%)	(4)	0.03	0.10	0.23	1.00					
Volatility	(5)	0.09	0.00	0.06	-0.04	1.00				
Amihud ratio	(6)	-0.15	-0.01	-0.30	-0.01	0.09	1.00			
Size (\$ million)	(7)	-0.09	0.00	-0.06	0.00	-0.15	-0.09	1.00		
BM	(8)	-0.02	-0.02	-0.04	-0.02	0.04	0.14	-0.04	1.00	
Past 6m ret	(9)	-0.01	0.03	-0.01	0.07	0.06	-0.01	0.02	-0.13	1.00

Table 1. Summary Statistics (Cont.)

Panel C: Hedge-Fund Level, Quarterly Frequency

	N	Mean	St.Dev.	Min	Median	Max
Δ HF Holdings (% , share of equity holdings)	4576	11.900	48.300	-76.700	3.070	530.000
Buys (% , share of equity holdings)	4576	51.200	50.800	0.000	37.700	630.000
Sales (% , share of equity holdings)	4576	39.800	22.200	0.000	37.400	100.000
Equity holdings return next quarter (% , eqret(Q1))	4590	2.870	16.300	-81.400	3.010	432.000
Equity holdings return next two quarters (% , eqret(Q1:Q2))	4078	5.310	21.200	-86.400	6.260	130.000
Equity holdings return next four quarters (% , eqret(Q1:Q4))	3673	9.780	31.100	-89.100	11.600	162.000
Fund flows (% , share of AUM)	4483	1.750	19.000	-83.100	0.703	311.000
Fund return next quarter (% , ret(Q1))	4248	2.310	9.120	-56.200	2.120	77.500
Fund return next two quarters (% , ret(Q1:Q2))	3931	4.780	14.100	-78.800	4.540	150.000
Fund return next four quarters (% , ret(Q1:Q4))	3404	10.100	22.200	-84.900	9.180	225.000
Fund return past 12 months (% , Past ret 12)	3886	10.700	21.900	-84.900	9.560	225.000
Equity portfolio size (log(assets))	4576	19.100	1.560	10.800	19.200	24.700
Assets under management (log(AUM))	4590	19.700	1.460	14.200	19.700	24.800
Avg leverage	2959	0.727	0.805	0.000	0.424	3.000
Top buyer next period dummy	4126	0.193	0.395	0.000	0.000	1.000
Multiasset strategy dummy	4394	0.217	0.412	0.000	0.000	1.000
Standard deviation of past-one-year returns	4026	0.061	0.060	0.000	0.042	0.611
Lock-up period	4590	5.820	6.730	0.000	3.180	49.200
High redemption period dummy	4584	0.835	0.372	0.000	1.000	1.000
Poor relative performance dummy	4544	0.245	0.430	0.000	0.000	1.000
Age (in quarters since first 13F filing)	4590	16.800	14.200	1.000	13.000	80.000
Convertible arbitrage	4394	0.059	0.225	0.000	0.000	1.000
Short bias	4394	0.002	0.032	0.000	0.000	0.729
Emerging markets	4394	0.011	0.079	0.000	0.000	1.000
Market neutral	4394	0.047	0.197	0.000	0.000	1.000
Event driven	4394	0.215	0.399	0.000	0.000	1.000
Fixed income arbitrage	4394	0.012	0.102	0.000	0.000	1.000
Fund of funds	4394	0.028	0.147	0.000	0.000	1.000
Global macro	4394	0.033	0.168	0.000	0.000	1.000
Long-short	4394	0.511	0.487	0.000	0.633	1.000
Futures	4394	0.013	0.100	0.000	0.000	1.000
Multistrategy	4394	0.069	0.226	0.000	0.000	1.000

CORRELATIONS	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	
Δ HF Holdings (% , share of equity holdings)	(1)	1.00																				
Buys (% , share of equity holdings)	(2)	0.90	1.00																			
Sales (% , share of equity holdings)	(3)	-0.13	0.28	1.00																		
Equity holdings return next quarter (% , eqret(Q1))	(4)	0.03	0.00	-0.07	1.00																	
Equity holdings return next two quarters (% , eqret(Q1:Q2))	(5)	-0.01	-0.03	-0.06	0.73	1.00																
Equity holdings return next four quarters (% , eqret(Q1:Q4))	(6)	0.00	-0.02	-0.05	0.47	0.71	1.00															
Fund flows (% , share of AUM)	(7)	0.04	0.02	-0.03	0.03	0.03	-0.01	1.00														
Fund return next quarter (% , ret(Q1))	(8)	0.00	0.00	0.00	0.65	0.50	0.33	0.00	1.00													
Fund return next two quarters (% , ret(Q1:Q2))	(9)	-0.01	-0.01	-0.01	0.45	0.66	0.48	0.00	0.73	1.00												
Fund return next four quarters (% , ret(Q1:Q4))	(10)	-0.01	-0.02	0.00	0.28	0.44	0.64	-0.02	0.48	0.71	1.00											
Fund return past 12 months (% , Past ret 12)	(11)	0.03	-0.03	-0.12	0.06	0.00	-0.15	0.12	0.11	0.05	-0.11	1.00										
Equity portfolio size (log(assets))	(12)	-0.28	-0.34	-0.19	0.02	0.02	0.01	0.04	0.00	-0.02	-0.04	0.12	1.00									
Assets under management (log(AUM))	(13)	0.04	0.06	0.05	-0.09	-0.11	-0.13	0.09	-0.07	-0.09	-0.11	0.06	0.41	1.00								
Avg leverage	(14)	0.02	0.06	0.11	-0.02	-0.03	-0.05	0.00	-0.02	-0.03	-0.04	-0.08	-0.10	-0.05	1.00							
Top buyer next period dummy	(15)	0.04	0.12	0.19	-0.02	-0.01	-0.04	0.10	0.03	0.04	0.03	0.01	-0.21	0.03	0.04	1.00						
Multiasset strategy dummy	(16)	0.05	0.10	0.14	-0.05	-0.07	-0.09	-0.02	-0.05	-0.06	-0.07	-0.09	-0.19	0.28	0.32	0.09	1.00					
Standard deviation of past-one-year returns	(17)	-0.11	-0.16	-0.14	0.05	0.05	0.03	-0.07	0.11	0.13	0.13	0.16	0.07	-0.14	-0.07	-0.07	-0.19	1.00				
Lock-up period	(18)	-0.04	-0.04	0.00	0.00	0.00	0.00	0.00	-0.01	-0.01	0.00	-0.01	-0.08	-0.11	-0.01	-0.04	-0.26	0.00	1.00			
High redemption period dummy	(19)	-0.05	-0.08	-0.08	0.07	0.08	0.10	0.02	0.06	0.08	0.10	0.08	0.10	-0.03	0.02	-0.06	-0.22	0.06	0.27	1.00		
Poor relative performance dummy	(20)	-0.06	-0.03	0.06	-0.04	-0.03	0.00	-0.09	-0.06	-0.06	-0.02	-0.36	-0.06	-0.10	0.08	-0.07	0.02	0.11	0.02	-0.05	1.00	
Age (in quarters since first 13F filing)	(21)	-0.07	-0.08	-0.05	-0.04	-0.04	-0.01	-0.06	-0.03	-0.02	0.00	-0.03	0.26	0.09	-0.07	-0.10	-0.11	0.06	-0.05	0.05	-0.01	1.00

Table 1. Summary Statistics (Cont.)

Panel D: Hedge-Fund Level, by Year

Year	Number of Mgrs.		Total AUM in Tass (\$bn)	Equity portfolio (\$m, TASS match)	Equity portfolio (\$m, whole sample)			Number of Stocks per manager			Annual portfolio turnover		
	13F	TASS match		Mean	Mean	Median	St. dev.	Mean	Median	St. dev.	Mean	Median	St. dev.
1989	37	2	2.176	424	1,274	257	3,453	181	87	274	0.6	0.45	0.56
1990	45	4	1.619	249	1,078	240	2,921	185	79	279	0.7	0.51	0.64
1991	48	5	2.49	428	1,350	230	3,609	202	83	301	0.69	0.55	0.57
1992	56	6	4.538	1,034	1,379	202	3,689	191	80	296	0.71	0.52	0.61
1993	64	11	8.708	1,024	1,331	210	3,694	191	76	375	0.8	0.62	0.67
1994	71	18	14.298	733	836	173	2,140	136	73.5	254	0.8	0.6	0.7
1995	84	19	17.111	1,027	918	224	2,097	136	71	181	0.88	0.75	0.68
1996	93	22	22.63	1,008	1,077	265	2,907	138	57	209	0.88	0.75	0.66
1997	108	26	30.429	828	963	277	2,414	126	55	209	0.96	0.77	0.75
1998	149	43	39.857	656	889	253	2,257	119	52	222	0.92	0.75	0.74
1999	167	55	28.955	568	899	239	2,561	103	48	199	1.06	0.92	0.79
2000	215	67	38.909	569	819	252	2,636	91.3	45	181	1.15	1.04	0.85
2001	253	78	40.879	385	566	157	1,772	86.5	40	175	1.16	1.03	0.89
2002	271	86	52.054	375	492	135	1,533	85.4	41	166	1.19	1.07	0.87
2003	289	93	65.069	398	565	171	1,683	93.5	43	185	1.23	1.12	0.87
2004	360	104	92.783	466	645	237	1,608	90.9	42	193	1.22	1.1	0.81
2005	433	124	111.95	597	812	267	2,026	94.5	39	213	1.16	1.04	0.77
2006	513	133	147.076	747	886	247	2,400	97.2	35	237	1.11	1.03	0.75
2007	586	136	188.828	910	964	262	2,816	92.4	33	229	1.15	1.03	0.79
2008	624	114	149.064	610	640	143	2,015	71.1	25	204	1.06	0.93	0.81
2009	667	98	146.718	521	599	126	1,657	78.5	27	206	1.1	0.9	0.93

Table 2. Hedge Fund Trading

The table reports the average quarterly changes in aggregate hedge fund holdings in selected subperiods. In column (1), the variable of interest is the percentage change in aggregate hedge fund holdings between two quarters. In column (2), the variable of interest is the change in hedge fund holdings as a percentage of total market capitalization, using prior-quarter prices to evaluate the trades. To be included in the sample, a hedge fund must have equity holdings in both quarters. The sample period is Q1/2004 to Q4/2009.

	Avg Qtr Δ Holdings Hedge Funds	
	%	% of total mktcap
	(1)	(2)
2004Q1-2007Q2	6.134	0.129
2007Q3-2009Q1	-3.055	-0.104
2009Q2-2009Q4	5.595	0.166
2007Q3	-9.866	-0.312
2007Q4	-2.737	-0.077
2008Q1	4.721	0.129
2008Q2	3.574	0.100
2008Q3	-16.697	-0.489
2008Q4	-14.261	-0.329
2009Q1	13.882	0.254

Table 3. Short Selling Activity

Panel A reports the average quarterly changes in aggregate short interest in selected subperiods. In column (1), the variable of interest is the percentage change in aggregate short interest between two quarters. In column (2), the variable of interest is the change in short interest as a percentage of total market capitalization, using prior-quarter prices to evaluate the short interest. Panel B reports estimates from OLS stock-level regressions of the % change in hedge fund holdings (as a fraction of prior-period holdings, evaluated at prior-period prices) on the stock level change in % short interest (as fraction of shares outstanding). In columns (1) and (2), the Selloff quarters are Q3/Q4 of 2008 and Q3/Q4 of 2009. Standard errors are clustered at the quarter level in columns (1) and (3), and at the stock level in columns (2) and (4). *t*-statistics are reported in parentheses. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively. The sample period is Q1/2004 to Q4/2009.

Panel A: Aggregate Short Interest

	Avg Qtr Δ Short Interest	
	%	% of total mktcap
	(1)	(2)
2004Q1-2007Q2	2.333	0.063
2007Q3-2009Q1	2.711	0.104
2009Q2-2009Q4	-7.750	-0.213
2007Q3	-5.647	-0.155
2007Q4	7.494	0.214
2008Q1	19.840	0.676
2008Q2	7.900	0.285
2008Q3	-2.095	-0.073
2008Q4	-20.691	-0.605
2009Q1	12.176	0.385

Panel B: Stock Level Long Hedge Fund Holdings on Short Interest

	Dependent variable: Δ HF holdings (%)			
	(1)	(2)	(3)	(4)
Δ Short interest	0.071***	0.071***	0.071***	0.071***
	(8.382)	(11.173)	(10.659)	(13.354)
× Selloff quarter	0.022	0.021**		
	(0.909)	(2.026)		
Selloff quarter	-0.449**	-0.402***		
	(-2.225)	(-21.630)		
Firm FE	No	Yes	No	Yes
Time FE	No	No	Yes	Yes
Observations	103982	103982	103982	103982
Adj. R ²	0.017	0.016	0.029	0.028
Number of permnos		6242		6242

Table 4. Trading by Other Groups of Investors

The table reports the average quarterly changes in aggregate holdings by different groups of investors in selected subperiods. The variable of interest is the change in holdings as a percentage of total market capitalization, using prior-quarter prices to evaluate the trades. The groups of investors are: mutual funds (1), other institutions that are not classified as hedge funds or mutual funds, (3) retail investors. Retail investors' holdings are defined residually by subtracting hedge fund, mutual fund, and other institutions' holdings from total shares outstanding. The sample period is Q1/2004 to Q4/2009.

	Avg Qtr Δ Holdings (% of total mkt cap)		
	Mutual funds	Other institutions	Retail investors
	(1)	(2)	(3)
2004Q1-2007Q2	0.101	0.069	-0.298
2007Q3-2009Q1	0.031	-0.402	0.474
2009Q2-2009Q4	0.035	0.215	-0.416
2007Q3	0.050	1.620	-1.357
2007Q4	0.120	-2.369	2.326
2008Q1	-0.053	0.238	-0.313
2008Q2	0.065	-1.126	0.962
2008Q3	-0.019	-0.295	0.803
2008Q4	-0.094	0.885	-0.462
2009Q1	0.148	-1.764	1.362

Table 5. The Distribution of Hedge-Fund Trades

The table reports the cross-sectional distribution of hedge fund trades as a fraction of hedge fund equity portfolio, evaluated at prior-quarter prices, in selected subperiods. In Panel A, each fund-observation receives equal weight. In Panel B, each fund observation receives a weight equal to the dollar size of hedge fund equity portfolio in the prior quarter.

Panel A: Equal-Weighted

% HFs that trade:	N	Equally-Weighted								
		Sell			Unchanged			Buy		
		40%+	20%-40%	10%-20%	5%-10%	±5%	5%-10%	10%-20%	20%-40%	40%+
2004Q1-2007Q2	6,284	0.053	0.091	0.100	0.081	0.204	0.084	0.117	0.134	0.135
2007Q3-2009Q1	4,062	0.140	0.136	0.110	0.065	0.164	0.063	0.098	0.096	0.130
2009Q2-2009Q4	1,867	0.071	0.085	0.109	0.068	0.217	0.066	0.110	0.103	0.171
2007Q3	585	0.104	0.121	0.133	0.074	0.179	0.072	0.116	0.103	0.097
2007Q4	564	0.110	0.122	0.105	0.066	0.190	0.062	0.117	0.115	0.113
2008Q1	624	0.098	0.115	0.128	0.059	0.181	0.071	0.111	0.112	0.125
2008Q2	619	0.084	0.099	0.110	0.094	0.187	0.092	0.111	0.105	0.118
2008Q3	600	0.233	0.162	0.100	0.057	0.153	0.050	0.070	0.068	0.107
2008Q4	530	0.238	0.219	0.100	0.030	0.109	0.042	0.068	0.075	0.119
2009Q1	540	0.120	0.122	0.087	0.069	0.139	0.048	0.087	0.091	0.237
Selloff quarters	2,279	0.171	0.155	0.110	0.057	0.159	0.057	0.093	0.090	0.109

Panel B: Value-Weighted

% HFs that trade:	N	Value-Weighted								
		Sell			Unchanged			Buy		
		40%+	20%-40%	10%-20%	5%-10%	±5%	5%-10%	10%-20%	20%-40%	40%+
2004Q1-2007Q2	6,284	0.023	0.065	0.093	0.074	0.275	0.122	0.153	0.145	0.051
2007Q3-2009Q1	4,062	0.101	0.121	0.129	0.115	0.212	0.096	0.099	0.080	0.047
2009Q2-2009Q4	1,867	0.029	0.053	0.125	0.093	0.298	0.087	0.134	0.100	0.081
2007Q3	585	0.107	0.156	0.104	0.226	0.195	0.060	0.064	0.058	0.030
2007Q4	564	0.039	0.128	0.191	0.109	0.266	0.067	0.082	0.070	0.047
2008Q1	624	0.031	0.087	0.118	0.044	0.232	0.156	0.165	0.102	0.066
2008Q2	619	0.024	0.067	0.118	0.158	0.187	0.131	0.156	0.114	0.045
2008Q3	600	0.243	0.154	0.126	0.098	0.172	0.080	0.059	0.035	0.032
2008Q4	530	0.229	0.163	0.147	0.029	0.206	0.030	0.068	0.095	0.034
2009Q1	540	0.047	0.055	0.066	0.061	0.228	0.203	0.099	0.121	0.119
Selloff quarters	2,279	0.142	0.149	0.141	0.129	0.211	0.062	0.069	0.062	0.036

Table 6. The Determinants of Hedge-Fund Trades

The table reports results from OLS fund-level regressions in which the dependent variable is hedge fund trades as a fraction of the hedge fund equity portfolio, evaluated at prior-quarter prices. The explanatory variables include the selloff quarter dummy and the level and interactions of: fund flows (current and two leads), average leverage, a dummy variable for funds with more than 50% of their assets in multi-assets strategies, a dummy variable for whether the fund was in the top quintile of the trades distribution in the next quarter. Selloff quarters are Q3/Q4 of 2008 and Q3/Q4 of 2009. *t*-statistics are reported in parentheses. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively. The sample period is Q1/2004 to Q4/2009.

	Dependent variable: Δ HF equity portfolio (%)											
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Selloff quarter	-11.529*** (-4.130)	-6.516 (-1.718)	-12.118*** (-4.445)	-6.991 (-1.564)	-2.653 (-0.544)	-13.244*** (-4.146)	-9.090*** (-3.287)	-11.140*** (-3.427)	-7.638** (-2.568)	-11.807*** (-4.316)	-2.411 (-0.491)	0.937 (0.251)
× Fund flows		-0.198 (-0.750)			-0.421 (-1.316)						-0.411 (-1.285)	-0.435 (-1.280)
× lead(Fund flows)		0.100 (0.884)			0.070 (0.385)						0.077 (0.430)	0.064 (0.369)
× lead2(Fund flows)		0.020 (0.141)			0.066 (0.493)						0.066 (0.454)	0.069 (0.605)
× Avg. leverage				-5.982** (-2.281)	-5.711*** (-2.903)						-5.606*** (-2.832)	-2.991 (-1.578)
× Top buyer (q+1)							-21.292*** (-3.338)		-20.423*** (-3.281)			-8.144 (-0.830)
× Multi-asset strategy								-8.842 (-1.710)	-6.901 (-1.376)			-13.286* (-2.039)
Fund flows		0.160 (0.874)			0.193 (1.461)						0.177 (1.380)	0.155 (1.222)
lead(Fund flows)		0.396*** (3.892)			0.384** (2.400)						0.375** (2.347)	0.382** (2.329)
lead2(Fund flows)		0.157* (2.036)			0.060 (0.954)						0.069 (1.008)	0.077 (1.151)
Avg. leverage				4.476*** (4.293)	4.326*** (4.382)						4.240*** (4.186)	2.736** (2.245)
Top buyer (q+1)							14.399** (2.810)		13.475** (2.716)			7.618* (1.746)
Multi-asset strategy								8.923*** (2.858)	7.491** (2.686)			7.301** (2.312)
Constant	12.704*** (6.487)	11.863*** (5.878)	13.038*** (6.841)	9.309*** (4.267)	8.919*** (4.062)	12.735*** (6.616)	9.940*** (6.679)	10.608*** (6.802)	8.334*** (6.263)	12.810*** (6.716)	8.780*** (3.985)	6.549*** (3.465)
Observations	2053	2053	1332	1332	1332	2313	2313	2313	2313	1320	1320	1320
Adj R ²	0.009	0.038	0.009	0.016	0.039	0.012	0.027	0.018	0.031	0.009	0.037	0.044

Table 7. Explaining Trading Behavior with Fund Characteristics

The table reports results from second-stage fund-level OLS regressions. The dependent variables are the fitted values from a first-stage regression of hedge fund trades as a fraction of the hedge fund equity portfolio, evaluated at prior-quarter prices, onto determinants of hedge fund trades interacted with selloff quarter dummies (see Table 6). The determinants are: fund flows (current and two leads, Panel A), average leverage (Panel B), a dummy variable for whether the fund was in the top quintile of the trades distribution in the next quarter (Panel C), a dummy variable for funds with more than 50% of their assets in multi-assets strategies (Panel D). The explanatory variables in the second stage regressions are hedge fund characteristics and their interactions with the selloff quarter dummy. The characteristics (measured at the beginning of the quarter) are: the log of AUM, average leverage, hedge fund past-twelve-month returns, the standard deviation of past-twelve-month returns, the length of the lockup period, a dummy variable for whether the redemption period plus redemption notice are above ninety days (long redemption), a dummy variable for whether the fund was in the bottom quartile of performance in the previous six months, fund age measured as the number of quarters of 13F filings. Selloff quarters are Q3/Q4 of 2008 and Q3/Q4 of 2009. *t*-statistics are reported in parentheses. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively. The sample period is Q1/2004 to Q4/2009.

Panel A: First-stage variable, Fund Flows

		Dependent variable: Δ HF equity portfolio (%) predicted by fund flows						
HF Characteristic:	log(AUM)	Average leverage	12 mths past ret	lag(std dev)	Lockup period	Long redemption	Poor relative performance	Age
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Selloff quarter	-3.498 (-0.591)	-11.725*** (-5.008)	-11.841*** (-7.446)	-10.713*** (-3.806)	-12.599*** (-4.072)	-13.889*** (-5.857)	-11.701*** (-4.719)	-11.064*** (-3.969)
× HF Characteristic	-0.392 (-1.145)	-0.150 (-0.275)	8.013 (1.599)	-11.216 (-0.551)	0.163* (1.739)	2.943*** (3.463)	1.394 (0.982)	-0.013 (-0.409)
HF Characteristic	-0.299*** (-4.192)	0.235 (0.647)	13.440*** (5.171)	-11.457 (-1.593)	-0.012 (-0.416)	-0.200 (-0.302)	-4.504*** (-12.643)	-0.052*** (-5.144)
Constant	18.676*** (12.818)	12.128*** (28.313)	10.847*** (21.562)	12.920*** (27.762)	12.784*** (21.998)	12.874*** (15.988)	13.537*** (30.692)	13.643*** (23.498)
Observations	2053	1332	1697	1833	2053	2053	1906	2053
Adj. R ²	0.241	0.239	0.348	0.252	0.239	0.239	0.296	0.247

Panel B: First-stage variable, Average Leverage

		Dependent variable: Δ HF equity portfolio (%) predicted by average leverage						
HF Characteristic:	log(AUM)	12 mths past ret	lag(std dev)	Lockup period	Long redemption	Poor relative performance	Age	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	
Selloff quarter	-9.665*** (-9.411)	-11.806*** (-69.558)	-11.499*** (-81.619)	-11.824*** (-85.210)	-10.004*** (-50.815)	-11.379*** (-57.959)	-11.029*** (-99.868)	
× HF Characteristic	-0.088* (-1.845)	2.952*** (3.454)	0.143 (0.041)	0.070*** (4.381)	-1.830*** (-7.435)	-0.429 (-0.913)	-0.020*** (-3.155)	
HF Characteristic	0.079** (2.421)	-1.498*** (-3.147)	-0.882 (-0.411)	-0.038*** (-4.441)	0.421* (1.869)	0.455* (2.032)	0.004 (0.749)	
Constant	11.178*** (16.441)	13.012*** (173.798)	12.905*** (130.899)	12.986*** (200.093)	12.407*** (73.275)	12.700*** (160.333)	12.689*** (151.633)	
Observations	1693	1335	1488	1713	1713	1541	1713	
Adj. R ²	0.549	0.579	0.569	0.548	0.548	0.570	0.546	

Table 7. Explaining Trading Behavior with Fund Characteristics (Cont.)

Panel C: First-stage variable, Being Top Buyer in q+1 dummy

		Dependent variable: Δ HF equity portfolio (%) predicted by being top buyer in q+1						
HF Characteristic:	log(AUM)	Average leverage	12 mths past ret	lag(std dev)	Lockup period	Long redemption	Poor relative performance	Age
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Selloff quarter	-13.503*** (-5.429)	-13.375*** (-66.656)	-13.407*** (-97.470)	-14.331*** (-68.515)	-13.847*** (-87.781)	-14.082*** (-45.132)	-13.415*** (-156.767)	-14.885*** (-117.395)
× HF Characteristic	-0.001 (-0.004)	-0.497** (-2.292)	0.861 (0.866)	19.039*** (4.846)	0.047** (2.074)	0.672* (1.842)	0.031 (0.091)	0.070*** (9.262)
HF Characteristic	-0.029 (-0.323)	0.653*** (4.196)	-0.452 (-0.531)	-17.132*** (-5.644)	-0.053*** (-3.347)	-0.401 (-1.160)	-0.706** (-2.723)	-0.039*** (-5.997)
Constant	13.378*** (7.596)	12.455*** (86.399)	12.676*** (105.806)	13.529*** (91.830)	13.177*** (120.106)	13.161*** (44.580)	12.867*** (172.903)	13.534*** (113.042)
Observations	2315	1517	1894	2064	2333	2333	2124	2333
Adj. R ²	0.469	0.470	0.496	0.508	0.470	0.468	0.493	0.474

Panel D: First-stage variable, Multi-Asset Strategy dummy

		Dependent variable: Δ HF equity portfolio (%) predicted by multi asset strategy indicator						
HF Characteristic:	log(AUM)	Average leverage	12 mths past ret	lag(std dev)	Lockup period	Long redemption	Poor relative performance	Age
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Selloff quarter	-3.699*** (-4.414)	-10.189*** (-110.046)	-11.003*** (-173.871)	-10.978*** (-125.787)	-11.584*** (-81.614)	-12.117*** (-66.262)	-10.743*** (-82.767)	-11.229*** (-89.435)
× HF Characteristic	-0.362*** (-8.241)	-1.078*** (-16.031)	1.890*** (5.176)	2.787 (1.175)	0.107*** (12.074)	1.468*** (8.667)	-0.422 (-1.333)	0.020*** (5.937)
HF Characteristic	0.451*** (10.829)	1.278*** (19.271)	-2.231*** (-6.215)	-2.967 (-1.275)	-0.130*** (-15.194)	-1.706*** (-10.342)	0.559* (1.773)	-0.026*** (-8.217)
Constant	3.343*** (4.221)	11.503*** (124.546)	12.463*** (207.750)	12.431*** (152.261)	13.181*** (94.692)	13.750*** (77.019)	12.152*** (94.497)	12.780*** (102.705)
Observations	2573	1697	2083	2311	2611	2611	2363	2611
Adj. R ²	0.561	0.579	0.581	0.573	0.571	0.558	0.570	0.551

Table 8. Hedge Fund Trading and Stock Characteristics

The table reports results from stock-level OLS regressions. In Panel A, the dependent variable is the change in hedge fund holdings as a percentage of shares outstanding. In Panel B, the dependent variable is the change in short interest as a percentage of shares outstanding. The explanatory variables include a dummy variable for a given stock characteristic being above the median in the quarter, the selloff quarter dummy, the interaction between the two, and hedge fund ownership in the previous quarter. The stock characteristics (measured at the beginning of the quarter) are: total volatility, the Amihud (2002) ratio, market capitalization (size), the book-to-market ratio, past six-month returns. Selloff quarters are Q3/Q4 of 2008 and Q3/Q4 of 2009. *t*-statistics are reported in parentheses. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively. The sample period is Q1/2004 to Q4/2009.

Panel A: Long Holdings

Stock characteristic:	Dependent variable: Δ HF holdings (%)				
	Volatility	Amihud Ratio	Size	BM	Past 6m ret
	(1)	(2)	(3)	(4)	(5)
High characteristic	0.299*** (6.957)	-0.155** (-2.699)	-0.101* (-1.933)	-0.135*** (-3.851)	0.032* (1.760)
× Selloff quarter	-0.353** (-2.096)	0.810*** (3.972)	0.610*** (3.133)	0.078 (0.936)	-0.062 (-0.806)
Selloff quarter	-0.570*** (-3.045)	-1.142*** (-3.759)	-1.032*** (-3.667)	-0.769*** (-3.051)	-0.710** (-2.692)
Holdings (q-1)	-0.043*** (-6.128)	-0.040*** (-6.021)	-0.040*** (-5.903)	-0.040*** (-5.861)	-0.040*** (-5.892)
Constant	0.430*** (8.800)	0.641*** (8.696)	0.624*** (9.181)	0.632*** (9.172)	0.542*** (8.813)
Observations	98805	102041	103871	99761	100880
Adj R ²	0.024	0.024	0.022	0.021	0.022

Panel B: Short Interest

Stock characteristic:	Dependent variable: Δ Short interest ratio (%)				
	Volatility	Amihud Ratio	Size	BM	Past 6m ret
	(1)	(2)	(3)	(4)	(5)
High characteristic	0.076 (1.252)	-0.611*** (-4.412)	-0.631*** (-5.219)	-0.286*** (-5.850)	0.065* (1.927)
× Selloff quarter	-0.474*** (-4.598)	0.640 (1.471)	0.347 (0.987)	0.225** (2.135)	-0.118 (-0.759)
Selloff quarter	-0.491 (-1.437)	-0.987 (-1.654)	-0.829 (-1.500)	-0.799* (-1.891)	-0.636* (-1.862)
Short interest (q-1)	-0.077** (-2.764)	-0.095*** (-3.414)	-0.094*** (-3.384)	-0.080** (-2.791)	-0.075** (-2.743)
Constant	0.473*** (4.814)	0.886*** (4.917)	0.901*** (5.394)	0.676*** (5.099)	0.454*** (4.128)
Observations	102247	105670	107597	103506	112654
Adj R ²	0.054	0.062	0.064	0.052	0.048

Table 9. Hedge Fund Trading and Returns

The table reports results from fund-level OLS regressions. In Panel A, the dependent variables are hedge fund contemporaneous total returns (columns (1)-(5)) and hedge fund contemporaneous abnormal returns (columns (6)-(10)). In Panel B, the dependent variables are hedge fund next-quarter total returns (columns (1)-(5)) and hedge fund next-quarter abnormal returns (columns (6)-(10)). The abnormal return is computed as in Boyson, Stahel, and Stulz (2010). The explanatory variables include levels and interactions of: the selloff quarter dummy, net hedge fund trades as a fraction of the hedge fund equity portfolio, evaluated at prior-quarter prices, hedge fund buy trades as a fraction of the hedge fund equity portfolio, evaluated at prior-quarter prices, hedge fund sell trades as a fraction of the hedge fund equity portfolio, evaluated at prior-quarter prices, fund flows in the prior quarter (Panel A) and in the current quarter (Panel B). Also included among the explanatory variables are: the total and abnormal returns in the prior period (Panel A) and in the current period (Panel B), the returns on the equity portfolio in the current period (Panel A) and in the next period (Panel B). Selloff quarters are Q3/Q4 of 2008 and Q3/Q4 of 2009. *t*-statistics are reported in parentheses. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively. The sample period is Q1/2004 to Q4/2009.

Panel A: Contemporaneous Returns

	HF Total Returns (q)					HF Abnormal Returns (q)				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Selloff quarters	-5.855** (-2.398)	-8.715*** (-3.028)	-6.053** (-2.420)	-8.844*** (-2.898)	-5.971** (-2.726)	-0.488 (-0.399)	-3.107*** (-3.305)	-0.458 (-0.366)	-2.983*** (-3.278)	-1.753** (-2.342)
× Δ HF equity portfolio (%) (q)	0.040*** (5.730)		0.033*** (6.667)			0.007 (0.442)		0.007 (0.519)		
× Total Buys (q) / Portfolio Holding (q-1)		0.051*** (7.315)		0.043*** (5.176)	0.056*** (9.394)		0.026 (1.303)		0.026 (1.311)	0.025 (1.130)
× Total Sales (q) / Portfolio Holding (q-1)		0.015 (1.084)		0.022 (1.385)	0.051** (2.602)		0.035 (1.215)		0.033 (1.228)	0.039 (1.520)
× Fund flows (q-1)			0.042 (0.522)	0.046 (0.574)	0.020 (0.303)			-0.008 (-0.176)	-0.009 (-0.193)	-0.021 (-0.450)
Δ HF equity portfolio (%) (q)	0.013*** (3.026)		0.014*** (3.335)			0.015*** (4.409)		0.015*** (4.121)		
Total Buys (q) / Portfolio Holding (q-1)		0.008* (1.756)		0.008* (1.822)	0.005 (0.871)		0.013*** (3.470)		0.013*** (3.379)	0.012*** (3.037)
Total Sales (q) / Portfolio Holding (q-1)		-0.032*** (-4.598)		-0.041*** (-4.473)	-0.035*** (-3.603)		-0.010 (-1.351)		-0.010 (-1.300)	-0.007 (-0.857)
Fund flows (q-1)			-0.038 (-1.320)	-0.042 (-1.388)	-0.009 (-0.954)			0.000 (0.016)	0.001 (0.125)	0.012 (1.039)
HF Total Returns (q-1)	0.167* (1.896)	0.166* (1.853)	0.151* (1.851)	0.146* (1.772)	0.073 (1.529)					
HF Total Abnormal Returns (q-1)						-0.078 (-0.776)	-0.069 (-0.734)	-0.079 (-0.768)	-0.070 (-0.728)	-0.079 (-0.836)
Equity portfolio returns (q)					0.340*** (11.680)					0.105*** (3.247)
Constant	2.350*** (3.090)	3.358*** (3.291)	2.353*** (3.113)	3.702*** (3.344)	2.312*** (2.980)	-0.632** (-2.188)	-0.730 (-1.493)	-0.628** (-2.173)	-0.728 (-1.490)	-1.194** (-2.340)
Observations	2484	2484	2197	2197	2197	1267	1267	1260	1260	1260
Adj R ²	0.139	0.142	0.142	0.147	0.387	0.015	0.024	0.014	0.022	0.078

Table 9. Hedge Fund Trading and Returns (Cont.)

Panel B: Next-Quarter Returns

	HF Total Returns (q+1)					HF Abnormal Returns (q+1)				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Selloff quarters	-4.071*	-8.712**	-4.171*	-8.684**	-3.535*	1.154	-0.392	1.144	-0.438	1.445*
	(-2.044)	(-2.271)	(-2.029)	(-2.380)	(-1.778)	(1.381)	(-0.387)	(1.340)	(-0.413)	(1.726)
× Δ HF equity portfolio (%) (q)	0.013		0.012			-0.031*		-0.032*		
	(0.789)		(0.685)			(-1.899)		(-1.884)		
× Total Buys (q) / Portfolio Holding (q-1)		0.036		0.032	0.027		-0.021		-0.022	-0.029*
		(1.219)		(1.184)	(1.332)		(-1.100)		(-1.109)	(-1.744)
× Total Sales (q) / Portfolio Holding (q-1)		0.069**		0.070***	0.084***		0.056*		0.058*	0.067*
		(2.420)		(2.948)	(3.658)		(1.814)		(1.777)	(1.956)
× Fund flows (q)			-0.021	-0.002	-0.028			0.019	0.026	0.026
			(-0.221)	(-0.023)	(-0.642)			(0.813)	(1.082)	(0.909)
Δ HF equity portfolio (%) (q)	-0.004		-0.002			0.002		0.002		
	(-0.746)		(-0.288)			(0.764)		(0.687)		
Total Buys (q) / Portfolio Holding (q-1)		-0.005		-0.003	-0.003		0.004		0.004	0.005
		(-0.874)		(-0.505)	(-0.903)		(1.109)		(1.037)	(1.383)
Total Sales (q) / Portfolio Holding (q-1)		-0.007		-0.011	-0.009		0.006		0.007	0.006
		(-0.935)		(-1.235)	(-1.039)		(1.284)		(1.526)	(1.169)
Fund flows (q-1)			-0.037	-0.038	0.006			0.002	0.003	0.017
			(-1.146)	(-1.170)	(0.494)			(0.233)	(0.351)	(1.478)
HF Total Returns (q)	13.169	12.448	11.640	11.056	8.529**					
	(1.431)	(1.382)	(1.328)	(1.287)	(2.133)					
HF Total Abnormal Returns (q)						-0.061	-0.070	-0.059	-0.066	-0.075
						(-0.660)	(-0.762)	(-0.610)	(-0.699)	(-0.872)
Equity portfolio returns (q+1)					0.372***					0.130***
					(9.525)					(4.941)
Constant	2.199**	2.698**	2.168**	2.763**	1.194	-0.798**	-1.196**	-0.781**	-1.196**	-1.699***
	(2.512)	(2.523)	(2.428)	(2.400)	(1.539)	(-2.343)	(-2.261)	(-2.315)	(-2.247)	(-3.358)
Observations	2504	2504	2219	2219	2219	1323	1323	1309	1309	1309
Adj R ²	0.067	0.076	0.070	0.079	0.371	0.016	0.023	0.015	0.022	0.112

Figure 1. Time Series of Hedge Funds Holdings (% of Total Market Capitalization)

The figure plots the fraction of U.S. stock market capitalization held by the hedge funds in our sample. The vertical lines represent the Quant Melt Down (8/2007) and the Lehman Brothers' Bankruptcy (9/2008). The series ranges from Q1/2004 to Q4/2009.

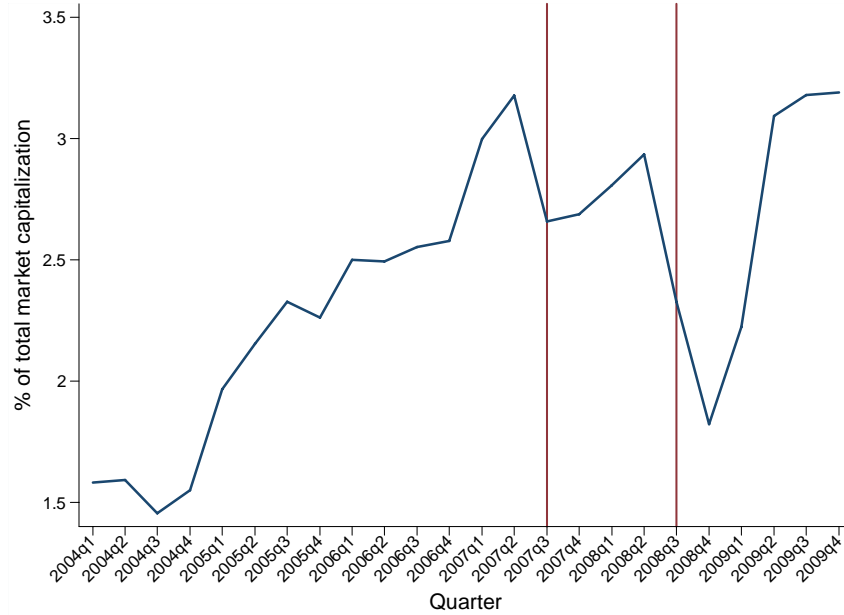


Figure 2. Time Series of Aggregate Short Interest (% of Total Market Capitalization)

The figure plots the fraction of U.S. stock market capitalization corresponding to total open short interest as provided by the exchanges. The vertical lines represent the Quant Melt Down (8/2007) and the Lehman Brothers' Bankruptcy (9/2008). The series ranges from Q1/2004 to Q4/2009.

