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Do Hedge Fund Fire Sales Disrupt the Stock Market?

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ABSTRACT

Using a comprehensive dataset of hedge fund 13F filings, we analyze hedge fund trading from 1998-2010 to determine if investor redemptions cause fire sales and stock market disruptions. We find evidence of hedge fund fire sales in the two quarters with the worst stock market performance. During these quarters, fire sales are concentrated among low liquidity stocks and typically involve hedge funds with a preference for holding low liquidity stocks. Fire sales comprise a relatively small proportion of hedge fund portfolios, reducing performance for these funds but having a negligible impact on overall stock market performance.

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> First, the money rushed into hedge funds. Now, some fear, it could rush out…To pay back investors, some funds may be forced to dump investments at a time when the markets are already shaky. The big worry is that a spate of hurried sales could unleash a vicious circle within the hedge fund industry, with the sales leading to more losses, and those losses leading to more withdrawals, and so on.
>
> (New York Times, 9/29/2008)

Recent research points to hedge fund fire sales as a potential driver of the dramatic decline in the stock market during the subprime crisis (e.g., Ben-David, Franzoni, and Moussawi (2012)). However, the structure of hedge funds may help them avoid selling into a falling market, and hence, they may not be so vulnerable to shocks that their selling activity disrupts the stock market (Aiken, Clifford, and Ellis (2013)). Therefore, the degree to which hedge fund stock selling affects individual stock prices and the overall stock market during market downturns remains an empirical question. In this paper we investigate the extent to which capital outflows and forced deleveraging cause hedge funds to sell stocks into a falling market, leading to fire sales. We provide evidence on the fund and stock characteristics that make hedge funds susceptible to fire sales. Finally, we consider the impact of fire sales on hedge fund performance as well as on the overall stock market.

Hedge fund stockholdings declined dramatically in the recent financial crisis, falling from $1.3 trillion in March 2007 to just $550 million in March 2009 (Figure 1), suggesting that the market's underperformance could owe to fire sales. Ben-David, Franzoni, and Moussawi (2012) link this decline in stockholdings to hedge fund outflows and forced deleveraging during the crisis. Brunnermeier and Pedersen (2009) and Krishnamurthy (2009) derive theoretical models showing that market-wide funding problems can force funds to liquidate assets, which leads to lower prices in the market overall.

Yet hedge funds, unlike mutual funds, do not provide daily liquidity to their investors and instead limit withdrawals with lockups and redemption notice periods, and sometimes *ex post* via

"gates" and "side pockets" (Aiken, Clifford, and Ellis (2013)).[1] For example, lockup periods average about one year and restrict investors from withdrawing any money at all, while redemption notice periods require advance planning by investors that want to withdraw their capital. Hedge funds also frequently restrict the days on which redemptions can occur as well as the number of times per year that an investor may withdraw capital.[2] Furthermore, most hedge fund contracts allow a manager the discretion to prevent withdrawals in uncertain times – if redemptions would force the fund to liquidate assets too quickly at unfavorable prices, the hedge fund can use gates or side pockets. Aiken, Clifford, and Ellis (2013) show that during the recent financial crisis, over 30% of hedge fund managers used these extraordinary measures. These unique features of hedge funds reduce their pressure to sell stocks during times of stress, but withdrawals do occur in downturns, and the contracts do not shield hedge funds from margin calls and forced deleveraging. Therefore, the effect of sales of stock by hedge funds on the overall market is an important and as of yet unanswered, empirical question.

In this paper, we examine the impact of hedge fund trading activity on overall stock market performance during market downturns using data from 1998-2010. We first examine the impact of outflows and forced deleveraging on individual stocks' prices by following the method of Coval and Stafford (2007). That is, we test whether stocks sold in large quantities by hedge funds with large capital outflows or evidence of significant deleveraging (pressure sold stocks) experience price pressure. If these stocks are sold at fire sale prices, we expect to find a pattern of declining performance during the period of selling and a rebound when the selling pressure subsides. Based on both monthly and weekly return data, we find evidence of fire sales in the two quarters with the worst stock market returns – the final quarters of 2000 and 2008.

[1] A gate is a temporary suspension of fund redemptions whereas a side pocket allows the fund manager to segregate a portion of its assets into a separate illiquid investment vehicle.
[2] See Aragon (2007) and Agarwal, Daniel and Naik (2009).

We next analyze the likely determinants of fire sales and show that the stocks exhibiting fire sale patterns are less liquid than other pressure sold stocks, as measured by Amihud liquidity, bid-ask spread, or market capitalization. Sorting pressure sold stocks by median Amihud liquidity, we find that the subset of low liquidity stocks drives fire sales in the final quarters of 2000 and 2008.[3] We also investigate the types of funds that pressure sell low liquidity stocks during these two quarters. We study whether funds with portfolios mostly consisting of low liquidity stocks are more likely to sell low liquidity stocks when faced with outflows. Indeed, we find that funds with less liquid stock portfolios account for over 86% of the low liquidity stocks sold during the two quarters. We investigate whether these portfolios became less liquid as a result of the crisis. The data suggest otherwise, since these funds typically follow a strategy of investing in less liquid stocks (i.e., there is strong evidence of liquidity persistence over time).

Next, we consider how hedge funds manage the risk of fire sales from less liquid stocks. We hypothesize that all funds faced with significant redemption requests – regardless of their average stock portfolio liquidity – will sell their most liquid stocks first and avoid selling low liquidity stocks that could result in fire sales. We examine all hedge funds that pressure sell at least one low liquidity stock during the two fire selling quarters and find strong evidence of cherry-picking. First, the average pressure selling hedge fund sells about ten times as many other stocks as pressure stocks with low liquidity, and these other stock sales do not exhibit fire sale patterns. Second, stocks that are not pressure sold have much higher market capitalization and liquidity than the stocks that are pressure sold, implying a clear preference for higher liquidity when forced to sell.[4]

Finally, we estimate the impact of stock fire sales on individual hedge fund performance for the subset of funds that engage in fire sales (representing about 12% of all funds) and on the

[3] Results are similar when we use either bid-ask spread or stock market capitalization as alternative liquidity proxies.
[4] This result is consistent with Scholes (2000) and Ben-David, Franzoni, and Moussawi (2012).

aggregate stock market. We show that impact of fire sales on the average hedge fund that engages in fire selling is to reduce performance by about 50 to 70 basis points during the quarter of selling. However, from a macroeconomic perspective, the aggregate trading volume of low liquidity pressure sold stocks as a proportion of total stock market capitalization is economically inconsequential at 0.003% and 0.012% in the fourth quarters of 2000 and 2008, respectively. Fire sales are concentrated among small and illiquid stocks – only one of the 484 low liquidity stocks sold during the two quarters is in the S&P 500 index. Therefore, despite evidence of fire sales during these quarters and the impact that the sales have on the funds themselves, hedge fund fire sales do not disrupt the overall stock market.

Our paper makes several contributions to the literature. We are the first to directly investigate the existence of hedge fund fire sales using the Coval and Stafford (2007) approach over a long sample period. Second, our dataset of 13F holdings is the largest in the literature to date with 1465 funds, allowing us to draw broad conclusions about the macroeconomic impact of the trading activity of all large hedge funds. Third, we document that when hedge funds are forced to sell, they cherry-pick stocks with high liquidity when possible. Finally, we provide aggregate evidence that fire selling by hedge funds did not substantially disrupt the aggregate U.S. stock market, even during times of market stress.

The paper is organized as follows. The next section discusses the literature and describes our methodology. Section II describes the data. Section III provides evidence on the existence of fire sales and data on the types of funds that experience them. Section IV considers the potential market impact of hedge fund trading in downturns. Section V concludes.

I. Literature Review and Methodology

The recent financial crisis has focused attention on the importance of funding shortfalls in a downturn. For example, in Brunnermeier and Pedersen (2009), hedge funds and other

speculators finance their trades through collateralized borrowing from banks, which could cause a liquidity squeeze if their assets decline in value, margins increase, or investors withdraw funds suddenly. In these situations, hedge funds are forced to sell assets, which in turn causes downward price pressure on the assets they sell. Similarly, Shleifer and Vishny (1992, 2011) argue that fire sales occur because firms sell assets to repay debt when other firms in the industry (that could extract full value from the assets) are unable to purchase them. Amplification models, such as in Krishnamurthy (2009), link fire sales to loss spirals that erode capital and ultimately cause a financial crisis.[5] Hameed, Kang and Viswanathan (2010) and Maier, Schaub, and Schmid (2011) argue that funding problems lead to lower liquidity and stock prices, while Sadka (2010) ties aggregate liquidity risk to underperformance during crises. These studies suggest that sharp declines in the overall stock market could arise from funding problems at hedge funds.

While the evidence shows significant selling by hedge funds in the recent crisis (Ben-David, Franzoni, and Moussawi (2012) and He, Khang, and Krishnamurthy (2010)), the impact of these sales on the market is less clear. Aragon and Strahan (2012), Cella, Ellul, and Gianetti (2013), and Jiao (2013) provide evidence suggesting that hedge fund selling leads to stock price declines. Cao and Petrasek (2011) argue that hedge funds reduce the liquidity of the stocks they trade, leading to possible fire sales. By contrast, Ben-David, Franzoni, and Moussawi (2012) and Anand, Irvine, Puckett, and Venkataraman (2012) show that during the last crisis, institutions sold more liquid stocks. Ang, Gorovvy, and van Inwegan (2012) find that hedge funds decreased leverage before the subprime crisis, consistent with Liu and Mello's (2011) theory that hedge funds will hold more cash during a crisis. Brown, Green, and Hand (2013) note that few hedge funds failed during the crisis, while Shadab (2009) argues that hedge funds actually reduced the severity of the financial crisis by acting as liquidity providers and

[5] See also Gromb and Vayanos (2002), Adrian and Shin (2008, 2010), Diamond and Rajan (2010), Geanakoplos (2010), Allen and Carletti (2006), and Uhlig (2010).

purchasing distressed assets. Aiken, Clifford, and Ellis (2013) show that hedge funds regularly used gates and side pockets to manage investor withdrawals in the recent crisis. Finally, Chen and Liang (2007), Li and Shawky (2013), and Cao, Chen, Liang, and Lo (2013)), find that hedge funds can time various types of market risks. Good market timing skills imply a lower need to engage in fire sales during a market downturn.

We address the question of whether selling by hedge funds drives down asset prices in a market downturn by first testing for the existence of fire sales and then estimating their overall impact on the stock market. We identify hedge funds with outflows or forced deleveraging using stock holdings data reported to the SEC in quarterly 13F filings, and examine price pressure around forced stock sales using the methodology in Coval and Stafford (2007).[6] Since we are interested in whether hedge funds disrupt markets, we focus on periods of stock market downturns. Examining the return on the S&P 500 for all quarters from 1998-2010, we select the quarters with worst performance. Table 1 presents quarterly returns on the S&P 500 index that are negative, sorted from worst to best. The five worst quarters are those ending in December 2008, December 2000, September 2002, September 1998, and September 2001.[7]

We examine forced sales of stocks by hedge fund managers experiencing severe fund outflows during market downturns. We identify outflows by calculating the change in holdings each quarter using 13F data on holdings. As in Ben-David, Franzoni, and Moussawi (2012), we compute the market value of the trade using the prices from the prior quarter so as not to confuse price effects with the effects of trading.[8] It is also possible that the holdings decline because hedge funds are forced to deleverage, rather than as the result of investor redemptions. In either

[6] The results in Cella, Ellul and Gianetti (2013) imply that hedge fund trading may have caused fire sales around the time of the Lehman bankruptcy, but their analysis is of institutional investors with short trading horizons and returns on their stock holdings rather than hedge fund outflows and pressure sales. Their sample of hedge funds is also much smaller (about a quarter of our funds). Finally, we focus on the entire time frame 1998-2010 while they focus mainly on the Lehman event.

[7] We obtain the same five quarters if we use the value-weighted CRSP index.

[8] We believe this approach captures the economic substance of the trade better than using the change in shares as in Coval and Stafford (2007).

case, the hedge funds are unable to maintain their previous stock portfolio levels.[9] Severe flows are those below/above the 20th/80th percentile of quarterly fund flows, where flows are scaled by prior period assets.

To determine if these outflows lead to unusually large selling activity that puts downward pressure on stock prices, we follow Coval and Stafford's (2007) method of identifying widely sold stocks and create the variable *PRESSURE*. If hedge fund outflows cause fire sales through downward pressure on prices, using the difference between flow-induced purchases and sales each quarter should identify the stocks most affected by redemptions. The calculation of *PRESSURE* for stock *i* during quarter *t* is as follows:

$$PRESSURE_{i,t} = \frac{\sum_j \left(\max\left(0, \Delta Holdings_{j,i,t} \middle| flow_{j,t} > Percentile(80th)\right)\right) - \sum_j \max\left(0, \Delta Holdings_{j,i,t} \middle| flow_{j,t} < Percentile(20th)\right)}{AvgVolume_{i,t-12:t-6}} \quad (1)$$

where *j* indexes hedge funds and *i* indexes individual stocks. *PRESSURE* measures the difference between selling of stock *i* by funds with extreme outflows and buying of stock *i* by funds with large inflows, scaled by the stock's average trading volume in the past two quarters. We then rank the stocks based on the *PRESSURE* variable, and define those falling in the 10th percentile as pressure sale stocks.[10]

The next step in determining whether hedge funds disrupt the stock market is to test if the pressure sales cause a decline in stock prices. Of course, in a crisis stock prices may also decline

[9] For ease of exposition and following Coval and Stafford (2007), we refer to this activity as "outflows" for the remainder of the paper.

[10] Our approach differs slightly from that of Coval and Stafford (2007) to avoid small samples. First, while we use flow quintiles to identify pressure selling/buying funds, they use deciles. Second, they require that the stock be traded by at least 10 funds in order to be considered a pressure stock, while we do not have a minimum requirement for the number of funds that trade the stock. Following their procedure exactly results in much smaller sample sizes, due both to the smaller overall stockholdings by hedge funds and because hedge fund portfolio holdings do not overlap as much as those of mutual funds. Our results are similar if we follow their procedure, despite the much smaller sample size.

due to information, but the focus on forced sales should help differentiate price pressure from information.[11] If pressure from selling large quantities of stock drives down prices, returns should drop during the selling period and rebound afterwards.[12] Thus, we calculate cumulative abnormal returns for pressure sold stocks by using a factor model where the market factor is the S&P 500, as in Cella, Ellul and Giannetti (2013). In addition to this approach (Model 1), we also calculate cumulative abnormal returns using four other specifications of abnormal returns: Model 2: the S&P 500 return, size, and book-to-market factors (Fama and French (1992)); Model 3: Model 2 including the momentum factor from Carhart (1997); Model 4: Model 3 including the Pastor and Stambaugh (2003) liquidity factor; and Model 5: Model 4 including the percent change in the VIX, a proxy for fear in the market (Adrian and Shin (2010)).[13,14]

We consider abnormal returns of pressure stocks by examining returns on portfolios of stocks, which is particularly helpful in controlling for contemporaneous correlation of residuals in a situation where all stocks share the same event date (as is the case in our analysis). We perform the analysis using two different time horizons: weekly and monthly. Using weekly data can help identify fire sales that might be obscured in monthly data, while using monthly data is the standard approach pioneered by Coval and Stafford (2007). In both cases, we use data for 5 years prior to the event date and 1.5 years following the event date to estimate the models.

[11] Ambrose, Cai and Helwege (2012) do not find price pressure on corporate bonds once information is held constant.

[12] In addition to Coval and Stafford (2007), a large number of other papers use this approach to measure price pressure. For example, see Chen, Hanson, Harrison, and Stein (2008), Lou (2010), Ellul (2006), Ellul, Jotikasthira, and Lundblad (2011), Frazzini and Lamont (2008), Greenwood (2005), Jotikasthira, Lundblad, and Ramodarai (2012), and Khon, Kogan, and Serafaim (2012).

[13] Results do not change if we use the value-weighted CRSP index instead of the S&P 500. We use the S&P in our tests to be consistent with prior literature and with our use of the S&P to identify quarters with market downturns.

[14] We calculate the cumulative abnormal returns following Karafiath (1988), Binder (1998), and Salinger (1992). This approach produces identical results to a standard event study approach and has been widely used in the literature, for example, Malatesta (1986), Kho and Stulz (2000), Kho, Lee, and Stulz (2000).

II. Data

Data on hedge fund stock holdings for the period 1998-2010 are obtained from mandatory 13F filings as reported in Thomson-Reuters Institutional Holdings (13F) Database. By law, all entities with over $100 million in assets under management are required to report their stock and stock-related holdings to the SEC on a quarterly basis using Form 13F. These data provided by Thomson-Reuters only include long positions in stocks, which prevents us from capturing fire sales that are caused by hedge fund short selling.[15] While we might miss some fire sales related to short selling, we do not believe that our conclusion regarding the magnitude of market disruption by hedge funds will be affected for two reasons. First, as stated in Ben-David, Franzoni, and Moussawi (2012) short selling makes up only a small portion of total market capitalization (averaging about 2.7% from 2004-2009). Second, there was a short selling ban in place for many stocks for much of October and November of 2008, the quarter in which we document the most fire sales, which reduces the likelihood of short sale induced fire sales during this quarter.[16]

We use an exhaustive process to identify filers that are hedge fund managers, beginning with the classification scheme of Bushee and Noe (2000). Next, we extend and refine the Thomson classification codes through 2010, since they are not reliable after 1998. Then, we create a dataset with unique manager numbers ("mgrno") over time (since Thomson recycles manager numbers), so that each manager has a unique identifier. We identify pure-play hedge funds starting with the complete list of 6,529 unique filers in the Thomson database during 1998-2010. We select the independent investment advisors (IIA) and miscellaneous (MSC) categories,

[15] The actual 13F filings also include some equity-related instruments, such as, convertible bonds and options. However, Thomson only reports long stock holdings.

[16] By using quarterly 13F filings, we can miss fire sales that occur intra-quarter, a problem that affects all studies that use this data. By contrast, a test that attempts to infer intra-quarter fire sales (such as that in Cella, Ellul, and Giannetti (2013)) is by definition an indirect test in which researchers must infer when the selling activity took place and which stocks were sold.

since the other categories are unlikely to contain hedge funds.[17] This yields a list of 4,621 unique IIA and MSC filers that might be hedge funds. Since we wish to exclude companies with a substantial part of their business coming from non-hedge fund entities (i.e., we want only pure-play hedge funds), we hand check SEC-required ADV filings for each filer to determine whether filers charge incentive fees and have at least 50% of their assets in hedge funds or at least 50% of their assets owned by high net worth individuals.[18] We find ADV filings for 3,602 funds and identify 1,303 as hedge funds. For each of the remaining 1,019 filers without ADV forms, we search the Internet to determine whether a reliable source identifies the fund as a pure-play hedge fund. In this search, we focus on the fund's own website, reputable news sources such as Bloomberg, and interviews with hedge fund managers. Using this approach, we identify additional 199 filers as hedge funds, bringing the total to 1,502. We require two consecutive quarters of data to perform our tests, reducing the final sample to 1,465 hedge fund filers. Since most hedge funds file at the "fund family" level, this dataset represents more than 1,465 individual hedge funds.[19]

Since we use the entire population of 13F filers to identify hedge funds, our sample is the largest to date and we believe that it covers the entire population of hedge fund filers during this time frame. Agarwal, Jiang, Tang, and Yang (2013) perform a search similar to ours for the period 1999-2007 and identify 942 unique hedge funds, which is more than the 871 hedge funds in a proprietary list from Thomson-Reuters used by Ben-David, Franzoni, and Moussawi (2012). Bae, Baik, and Kim (2011) obtain a list from Bloomberg to identify the 671 hedge funds in their

[17] The classification codes are as follows: BNK = bank trust, INS=insurance company, INV = investment company, IIA = independent investment advisor, CPS = corporate (private) pension fund, PPS = public pension fund, UFE = university and foundation, and MSC = miscellaneous.

[18] Using Form ADV to identify hedge funds in this manner was pioneered by Griffin and Xu (2009) and later used by Ben-David, Franzoni, and Moussawi (2012) and others. For a brief period in 2006, hedge funds were required to file ADV forms but filing did not become mandatory again until 2009. Hence, in some cases, we are imputing the fund's classification from an ADV form filed after the sample data. To test that this approach is appropriate, we compare a random sample the ADV filings for 2006 with those for 2009 or later for the same fund and find no differences in classification between the two filings.

[19] For ease of exposition, we refer to these 13F filers as "hedge funds."

sample. Cao and Petrasek (2011) use lists from a variety of sources and identify 1,225 hedge funds that file 13F forms between 1989 and 2009.

Summary statistics for the hedge fund sample are in Table 2. Variables are winsorized at the 5% and 95% tails. Panel A presents characteristics at the fund family level. The 1,465 hedge funds have a mean stock portfolio size of about $1.1 billion, and a median of $305 million. Despite winsorizing, the mean is greater than the 75th percentile, indicating a few very large funds in the sample. The average number of stocks held also reflects skewness, with a mean of 173, a median of 73, and a 75th percentile of 142 stocks per fund. The mean and median market capitalizations of the stocks in the portfolios are both about $4 billion. The changes in hedge fund stockholdings indicate significant cross-sectional variation in average annual flow and performance. The Amihud liquidity average is 0.014 and the average bid-ask spread is 0.006, implying that the average stockholding is quite liquid.

Table 2 Panel B presents summary statistics by year. The number of funds nearly quadruples from 1998 to 2010, with some decline between 2008 and 2010.[20] There is significant variation in fund flows, with small average net outflows in 2000 and large mean net outflows of 18.2% in 2008. These results are consistent with Ben-David, Franzoni, and Moussawi (2012), who document significant selling among hedge funds during 2008. Amihud liquidity decreases over time, although it is higher in 2008 and 2009 than in the prior 5 years, but drops again in 2010. This pattern likely reflects the effect of the financial crisis. Regardless, even for the recent crisis, the Amihud measure still indicates high average liquidity of the stocks held by hedge

[20] Since all institutions with assets greater than $100 million are required to file form 13F, funds only drop out of the sample if they have gone out of business, merged, or if their assets have dropped below $100 million. However, we find that funds that file in any quarter during a year generally continue filing through December of that year, even if their assets have dropped below $100 million. Since we require two quarters for our analysis, this could induce survivorship bias in that a fund selling its entire portfolio and not appearing in the next quarter will not be included in our analysis. As a robustness check, we perform all our tests again assuming that funds dropping out of the sample have sold their entire portfolios (which is an extreme assumption), and find no additional evidence of fire sales, mostly because these funds are typically very small in size and hold a small number of stocks.

funds. The average size of the equity portfolio does not change much over time, while the average number of stocks declines.

Table 2 Panel C presents data on the characteristics of the stocks held in the hedge fund portfolios, which we obtain from CRSP and Compustat. During the sample period, there are 13,003 unique stocks held by hedge funds. The average annual stock return is 9.2%, with a standard deviation of 15.1%; the average firm size is $1.5 billion; and market capitalization averages $941 million. The quarterly stock trading volume is 13 million shares and the average Amihud liquidity is 0.278. While these data suggest that the portfolios are comprised of illiquid stocks, the median is a much lower 0.036. The bid-ask spread is fairly low at 0.013. The figures in Panel C are based on averages for stocks in the hedge fund portfolios, and therefore weight each stock equally, in contrast to the value-weighted figures in Panel A that are at the hedge fund level. Since Panel A shows that the typical fund holds a well-diversified portfolio of stocks, based on size and stock liquidity, and Panel C shows lower market capitalizations and worse liquidity, we characterize hedge fund portfolios as generally very liquid but containing some small stocks with low liquidity.

In comparison to the average stock in CRSP, stocks held by hedge funds have better performance, higher volatility, larger assets and market capitalization, higher Tobin's Q, higher volume, and lower bid-ask spreads. The average Amihud liquidity of hedge fund stocks is higher than for CRSP stocks, but this value is clearly influenced by the presence of a small number of very illiquid stocks in hedge fund portfolios, since the average Amihud liquidity of the hedge fund portfolios is much smaller (0.014, shown in Panel A).

III. Results

A. Does Hedge Fund Trading Lead to Fire Sales?

First, we perform fire sale tests based on Coval and Stafford (2007) for the entire sample period to determine if sales by hedge funds cause an abnormal decline in the stock prices of the pressure sold stocks. The cumulative abnormal monthly returns shown in Figure 2 are the excess returns (alphas) of the pressure stocks using the S&P 500 as the market factor for the 12 months prior and 18 months after the quarter of sale (Model 1). Following Coval and Stafford (2007), we label the three months during the quarter of sale as M1, M2, and M3, since holdings data are reported quarterly and the sale can occur any time during the quarter. All other months are labeled relative to this quarter.

As shown in Panel A of Figure 2, using the aggregate value of these sales across all quarters, and checking for price declines in the months of the pressure sales, we do not find evidence of fire sales. This is true whether we aggregate across all quarters or only across the quarters with negative S&P 500 returns, although the latter shows a slight dip and recovery in months M1-M3. In Panel B of Figure 2, we consider the five worst quarters identified in Table 1. Here, we find evidence suggestive of fire sales in the worst two quarters: the fourth quarters of 2000 and 2008.

Coval and Stafford (2007), Lou (2012), and Frazzini and Lamont (2008) use monthly data to analyze fire sales, but it is possible that the calendar month time frame obscures fire sales that occur over other windows. If prices drop and then reverse during a single calendar month or if they occur over a 20-day or longer trading period that crosses over two months, the monthly window would miss the fire sales. Thus, we repeat the analysis using weekly data, which is the approach used by Cella, Ellul, and Gianetti (2013), Ellul, Jotikasthira, and Lundblad (2011), Jotikasthira, Lundblad, and Ramodarai (2012) and Greenwood (2005).

Figure 3 graphs the same five quarters as in Panel A of Figure 2, but it uses weekly data. Here, since time is measured in weeks, not months, W-15 is 15 weeks before the start of the selling quarter; the weeks during the quarter of sale are W1 to W13; and the weeks after the sale are W+1 to W+22. For the quarter ending December 2008, the weekly data shows a similar pattern to the monthly data. The pattern in the fourth quarter of 2000 looks stronger with monthly data. Using weekly data, there is also some evidence of a fire sale pattern in the last quarter of 1998. Therefore, to maximize our chances of detecting fire sales, our initial tests investigate the December 2000 and December 2008 quarters using monthly data and the September 1998, December 2000, and December 2008 quarters using weekly data.

Table 3 provides tests of statistical significance for the December 2000 and 2008 quarters, using all five abnormal return models with monthly data, and the September 1998, December 2000, and December 2008 quarters, using weekly data and four abnormal return models. While it is not obvious exactly when the sale of a stock by a hedge fund will affect the price, we look for a pattern of a drop in price in the time leading up to and including the quarter of sale, and a rebound in price after the quarter of sale. For monthly data in Panel A for the 328 pressure sale stocks in the quarter ending December 2000, we find evidence of fire sales for Models 2 through 5. The results are similar for December 2008 (Panel B), consistent with the stock price patterns reported by Cella, Ellul, and Giammetti (2013) around the Lehman bankruptcy. In untabulated results, we carry out the same tests on the other quarters with negative returns in Table 1 and do not find significant evidence of fire sales in monthly returns.

Panels C, D, and E of Table 3 report results for weekly data for the September 1998, December 2000, and December 2008 quarters, respectively. As with the monthly data, the timing of when the price impact should be realized is not obvious, so we examine several subperiods before, during, and after the quarter of sale. Since we use weekly data, it is possible to divide the

quarter of sale into subperiods as well. For December 1998 in Panel C, the negative returns are only statistically significant using a single factor model, but there is no rebound in prices until W+1 and even then it is not statistically significant. Models 2 through 4 do not indicate that fire sales occurred because there are no abnormal price declines. As with the monthly data, there is statistically significant evidence of fire sales for December 2000 and 2008 in Panels D and E. In untabulated results, we carry out the same tests on all quarters with negative returns in Table 1 and do not find evidence of fire sales using weekly data. Therefore, since the weekly and monthly results are similar, the remainder of the paper focuses on analyses using monthly data.

In untabulated results, we find that the median hedge fund has net flows in the last quarters of 2000 and 2008 of -4.8%, and -7.5%, respectively. Furthermore, in both quarters nearly two-thirds of hedge funds have net outflows leading to a large number of pressure sales. In the quarters ending December 2000 and 2008, there are 2,038 and 3,952 stocks held by all hedge funds, respectively, and of these 328 and 436, respectively, are pressure stocks. Overall, we find that hedge fund trading caused fire sale patterns in stock prices in the two worst stock market performance quarters between 1998 and 2010.

B. Which Stocks Are Susceptible to Fire Sales?

We now analyze the characteristics of stocks that exhibit fire sale patterns in the final quarters of 2000 and 2008. Specifically, we investigate if there is a relationship between stock liquidity and the fire sale patterns. We focus on stock liquidity for two reasons. First, liquidity plays an important role in how prices are affected by concentrated trading. Second, since less liquid stocks also tend to have lower market capitalization, and since hedge funds often hold

fairly large positions in individual stocks, trading by even a few hedge funds might involve enough volume to move stock prices.[21]

Table 4 uses a logit analysis to examine the characteristics of fire sale stocks. The dependent variable is set to 1 if the stock exhibits a fire sale pattern using the Model 3 (four factor) estimates from individual stock regressions. Specifically, the stock must have a cumulative average abnormal return both below the mean return in the event quarter and above the mean return in the next quarter. We recognize that this is a strict definition of a fire sale stock, as the price might take more than one quarter to rebound (Coval and Stafford (2007)), but it avoids counting sales as fire sales when they are not. Further, we note that the results are not affected if we allow the price to rebound in either three or six months after the sale quarter.[22]

Using this definition, of the 328 (436) pressure sold stocks in the last quarter of 2000 (2008), 67 (89) are classified as fire sales. Next, we consider whether these fire sale stocks differ in liquidity from other pressure sold stocks by examining characteristics in the prior quarter. We have sufficient trading volume data to calculate the liquidity measures for 300 stocks in the fourth quarter 2000 and for 377 stocks in the final quarter of 2008. In the logit regressions, we also control for the stock's prior quarter cumulative performance and Tobin's Q. The regressions that require Tobin's Q restrict the sample further, since not all firms appear in Compustat. As proxies for liquidity, we use the Amihud liquidity measure, the bid-ask spread, and the log of market capitalization. Since these measures are highly correlated, we include them separately.

In Table 4 Panel A, we perform the analysis for the December 2000 quarter and find strong evidence that the likelihood of being a fire sale stock is related to liquidity. The probability is increasing in Amihud liquidity and bid-ask spreads and decreasing in market capitalization. Results for the final quarter of 2008 also indicate that stocks with low liquidity are

[21] Ben-David, Franzoni, and Moussawi (2012) document an average hedge fund holding of about 7.5% of the market capitalization of the stocks they hold.

[22] The results are also unchanged if we use models 1, 2, 4, or 5.

more likely to be sold in fire sales (Panel B). Prior quarter stock performance is negatively related to fire sales, but this result is significant only for the December 2000 quarter. Finally, in most specifications, Tobin's Q has a positive and significant relationship with the likelihood of a fire sale. Overall, these results indicate that stocks with fire sale patterns are more likely to be less liquid stocks. Therefore, we examine the subset of pressure stocks with low liquidity to determine whether, in the aggregate, these stocks exhibit more pronounced fire sale patterns than stocks with high liquidity.

We first separate the sample of pressure stocks into two groups based on the median Amihud liquidity calculated across all stocks held by hedge funds in the previous quarter.[23] For the quarter ending December 2000, there are 174 pressure sold stocks with an Amihud liquidity value below the median, representing 53% of all pressure sold stocks in that quarter. For the quarter ending December 2008 there are 310 such stocks, representing 71% of all pressure sold stocks that quarter. Consistent with the results of the logit analysis in Table 4, low liquidity stocks are over-represented in the sample of pressure sold stocks, especially in 2008.

Figure 4 graphs price patterns for the subsets of low and high liquidity stocks within the pressure sold stocks. The low liquidity stocks show much stronger evidence of fire sales than the sample as a whole. By contrast, the stocks with higher liquidity exhibit a hump-shaped pattern, rather than the U-shape associated with price pressure and reversals. The cumulative abnormal returns of the less liquid pressure sold stocks are statistically and economically significant for each of the two quarters (Table 5). Both quarters show evidence of fire sales, and the results are statistically significant in four of the five models. While the price change is not significant in the single factor model for either quarter, the price does initially decline and the reversal is statistically significant in both periods. We also examine whether the subset of low liquidity

[23] Results are robust to using bid-ask spread or stock market capitalization.

stocks exhibits fire sale patterns during the 50 other quarters in the sample period. In untabulated results, we find that no other quarters show statistically significant evidence of fire sales among less liquid stocks. All results hold for weekly as well as monthly data.

To summarize, we show that fire sales during the last two quarters of 2000 and 2008 are driven by pressure selling of low liquidity stocks. We find no evidence of fire sales during any quarters between 1998 and 2010 for stocks with either low or high liquidity. We next examine the characteristics of hedge funds engaging in fire sales during the last quarters of 2000 and 2008.

C. Which Hedge Funds Sell Low Liquidity Stocks?

Our evidence so far suggests that some hedge fund managers react to withdrawals in a downturn by selling less liquid stocks at fire sale prices. Since fire sales can negatively affect the fund's performance, we hypothesize that funds with large holdings of more liquid stocks avoid selling their less liquid stocks to circumvent price effects, while funds with large holdings of less liquid stocks are more likely to sell these less liquid stocks during a crisis.[24] We separate funds into two groups: those with a larger fraction of more liquid stocks and those with a larger fraction of less liquid stocks. We then analyze whether funds with a larger fraction of less liquid stocks engage in fire sales more frequently. For this test, we only use funds that experience outflows in the quarter of interest, since these are likely to be the funds that sell the most stock. Our results do not change if we use all funds in this analysis. We calculate the average portfolio liquidity as the prior quarter dollar-holdings-weighted average Amihud liquidity of the stocks in the portfolio. We refer to this characteristic as the "fund Amihud liquidity" or "hedge fund portfolio liquidity."

[24] This hypothesis – that firms attempt to avoid fire sales in illiquid markets – has found support in prior literature. See, for example, Asquith, Gertner, and Scharfstein (1994), Schlingemann, Stulz, and Walkling (2002), Almeida, Campello, and Heckbarth (2009), and Boyson, Helwege and Jindra (2013a, 2013b).

To assess whether lower hedge fund portfolio liquidity is associated with sales of low liquidity stocks, we must first determine, for each stock, whether it is sold by hedge funds with low (or high) portfolio liquidity. Therefore, we develop a classification that relies on the average hedge fund portfolio liquidity of all hedge funds with outflows that sell a particular stock. The average is calculated as a trade-size weighted average of the fund Amihud liquidity across all funds that sell the stock. Then, if for a particular stock, this average hedge fund portfolio liquidity is higher than the median Amihud liquidity for all pressure sold stocks, this stock is labeled as "mostly sold by funds with less liquid portfolios." Likewise, if the average hedge fund portfolio liquidity is lower than the median Amihud liquidity, we say the stock is "mostly sold by funds with more liquid portfolios." Using this classification scheme, we find (in untabulated results) that funds with less liquid portfolios are the most frequent sellers of low liquidity stocks. The results are striking. Of the 174 low liquidity stocks pressure sold in 2000, 150 (86%) were mostly sold by funds with less liquid portfolios, and of the 310 low liquidity stocks pressure sold in 2008, 270 (87%) were mostly sold by funds with less liquid portfolios.

We next assess whether funds sell these stocks due to an unexpected decrease in hedge fund portfolio liquidity, or rather, whether these funds typically hold less liquid stocks as a matter of strategy or style. Hedge funds that hold illiquid stocks receive an illiquidity premium in most markets (e.g., Sadka (2010) and Cao, Chen, Liang, and Lo (2013)), so, it would not be surprising if these same funds suffer the ill effects of owning illiquid stocks during market downturns. To test for liquidity persistence, we examine a hedge fund's portfolio liquidity category at time t-1 and again at time t. We then assign the fund to one of four cells in a transition matrix: high-high (high hedge fund portfolio liquidity in period t-1, high hedge fund portfolio liquidity in period t), high-low, low-high, and low-low. We then calculate the percentage of funds in each cell. Results using annual data, presented in Table 6, show strong

evidence of persistence in hedge fund portfolio liquidity.[25] If hedge fund portfolio liquidity is random, the unconditional probability of being in a particular quadrant is 0.25. Using the cross-product ratio test, as in Brown and Goetzmann (1995), we reject the null hypothesis that the pattern we observe in Table 6 occurs by chance (p-value of 0.00). Funds rarely change their hedge fund portfolio liquidity categories, indicating that funds that suffer from fire sales knowingly undertake the risk of losses in a crisis and buy illiquid stocks despite the higher likelihood of fire sales.

To summarize, we find that less liquid stocks are predominantly sold by hedge funds with illiquid portfolios. The illiquidity of the hedge funds' portfolios does not change over time, indicating that funds that hold a large fraction of less liquid stocks as a result of their portfolio strategy or style.

D. Cherry-Picking

In this section, we examine the choices that hedge funds make when they need to sell stock. Thus far, the evidence in the December 2000 and 2008 quarters shows that some hedge funds sell low liquidity stocks at fire sale prices. Figure 4 also shows that high liquidity stocks are not sold at fire sale prices. All else constant, we expect that, when possible, hedge funds will avoid fire sales and sell high liquidity stocks in a downturn. To the extent that hedge funds have a choice, we hypothesize that they "cherry-pick" and sell their most liquid stocks when faced with large withdrawals.

First, we analyze the types of funds that pressure sell low liquidity stocks and compare them to funds that do not. Panel A of Table 7 shows that the majority of funds in the last quarters of 2000 and 2008 never sell stocks in a pressure sale. That is, they avoid selling the same stocks in large enough (aggregated) volume to constitute a fire sale. Among the funds that contribute to

[25] Using quarterly data or data every two years yields similar patterns in persistence and does not affect our conclusions.

the pressure sales, during both quarters only 40 funds pressure sell stocks with high liquidity. Only 42 funds in 2000 and 117 funds in 2008 pressure sell stocks with low liquidity. The other evidence in Panel A of Table 7 does not present a clear picture of whether the funds that pressure sell low liquidity stocks are forced to sell these stocks. While these funds have fewer stocks in their portfolios than funds that do not pressure sell, they hold more stocks than funds that pressure sell high liquidity stocks. The funds that pressure sell low liquidity stocks have worse outflows than those that do not engage in pressure sales but the outflows are not worse than for funds that pressure sell more liquid stocks. The stocks owned by these funds generally have a lower market cap but the differences are not always statistically significant. In contrast, the fund Amihud liquidity measure is always higher for the funds that pressure sell low liquidity stocks indicating that these funds choose to invest in less liquid stocks as a matter of style or strategy. Overall, there is mixed evidence that low liquidity pressure sales occur because the funds that own the stocks have few other choices when facing redemptions.

To further determine how these low liquidity stocks are pressure sold, we consider the choices facing funds with at least one such sale. For each period, we sort stockholdings into five mutually exclusive categories: "Buys" are stocks bought during the fourth quarter and "Holds" are stocks reported in both the September and December 13F filings. Sales are separated into three categories. If the fund sells a stock that is not classified as a pressure stock, we categorize it as a "Non-pressure sale." For the remaining stocks (pressure sold stocks), we separate them into two categories based on their stock liquidity: "Pressure sale, high liquidity" and "Pressure sale, low liquidity." This last group represents the 174 and 310 low liquidity stocks sold in the December 2000 and 2008 quarters, respectively. It is among this group in both quarters that we have found fire sale patterns. Hedge fund sales may represent partial decreases or liquidations of the entire position, and our results do not systematically vary if we test these two groups

separately. We use these categories to analyze hedge funds that sell at least one low liquidity stock in the December 2000 and 2008 quarters.

The results in Panel B of Table 7 show that hedge funds avoid selling low liquidity stocks. For both quarters, most of these funds' sold stocks are in the non-pressure sale category. On average 50 and 82 non-pressure sale stocks are sold per fund during the December 2000 and 2008 quarters, respectively.[26] In comparison, the funds sold only 5 and 7 pressure stocks with low liquidity during the same quarters. These differences are statistically significant at the 1% level. Further, the average and median market capitalization for non-pressure sale stocks is significantly higher than for the less liquid pressure sold stocks, with mean differences of $14 billion versus $0.2 billion and $10 billion versus $0.3 billion, in the two quarters, respectively. Finally, the stock Amihud liquidity is significantly lower for non-pressure sale stocks when compared to the pressure sold low liquidity stocks, implying that when given the choice and facing the need to sell, funds prefer to sell their most liquid stocks. Overall, the results in this section imply that when funds face large withdrawals or are forced to delever in market downturns, they generally opt to cherry-pick to sell more liquid stocks.

IV. Hedge Fund Trading, Performance, and the Market Impact of Fire Sales

Results in the prior section indicate that, despite severe market downturns in the quarters studied, hedge funds still bought a non-trivial amount of stock. This result suggests that hedge funds are strategic about portfolio rebalancing during market downturns. The results also show that the lower the liquidity of a stock, the higher the probability of a fire sale of the stock. We next examine whether hedge fund trading in the aggregate involves enough cherry-picking to avoid disrupting the stock market in general.

[26] Non-pressure stocks may also be sold by other hedge funds, but the quantities sold across all funds as a proportion of the stock's volume are not large enough to be classified as pressure sales.

Table 8 considers the net impact that pressure selling of illiquid stocks has on performance of both the hedge funds and the stock market. We focus on illiquid stocks subject to pressure selling since our results imply that these stocks are most likely subject to fire sales. The first column of Table 8 reports the average dollar value of the stock trade relative to the total market capitalization of the stock for four categories of stocks traded by hedge funds: buys, non-pressure sales, pressure sales of high liquidity stocks, and pressure sales of low liquidity stocks. Non-pressure sales average about 0.3% of a stock's total market cap each quarter and buys average about 0.6%, explaining why hedge fund trades in these stocks do not have a price impact. However, hedge fund trading in illiquid pressure sold stocks averages around 2% each quarter, which is both economically significant and statistically larger than both non-pressure sales and buys.

While these potential fire sales of illiquid stocks represent a relatively large percentage of the stocks' market capitalizations on average, they represent about 4% of each fund's assets each quarter. Further, the dollar size is also fairly small, averaging $17 million in 2000 and $12 million in 2008. By comparison, buys represent 19% and 9% of a fund's total assets, and non-pressure sales represent 28% and 38% of a fund's assets for December 2000 and 2008, respectively. We next estimate the impact these trades have on the fund's quarterly performance. From Table 5, the average risk-adjusted return for low liquidity pressure sold stocks in the quarter of sale for Model 3 is -17% for 2000 and -13% for 2008. Multiplying this return by the 4% of assets that potential fire sales of illiquid stocks constitute, we calculate a risk-adjusted quarterly performance impact of -0.7% for 2000 and -0.5% for 2008. Given that most of these stocks had poor returns in the quarter prior to selling, their sales might represent a rational response on the part of the manager to realize losses during a downturn quarter, despite the potential for fire sale effects (or potentially for tax purposes, since both selloff quarters are at

calendar year-end). Regardless of the motivation, the impact of these sales on fund performance is not negligible.

We next estimate the total stock market impact of hedge fund fire sales. The sum of all illiquid pressure sold stock trades across all funds is $510 million and $1.456 billion for the quarters ending December 2000 and 2008, respectively. By comparison, the amounts of non-pressure sales for the two quarters are substantially higher at $7.0 billion and $41.9 billion or 14 times and 20 times greater. Even buys are significantly higher at $6.0 billion for 2000 and $9.0 billion for 2008, or about 6 times greater than the amount of potential fire sales for both quarters. To put the size of the potential fire sales into perspective, we note that the U.S. stock market capitalization of listed companies was $15.104 trillion in December 2000 and $11.738 trillion December 2008.[27] Therefore, the total value of illiquid stocks that were pressure sold by hedge funds equals 0.003% and 0.012% of the total capitalization of the stock market, respectively.

Another way to assess on how fire sales affect the overall stock market is to count the number of such stocks that are included in the S&P 500 index. Of the 174 and 310 illiquid stocks that might have been sold in fire sales in the final quarters of 2000 and 2008, respectively, we find only one stock that belonged to the S&P 500 index. This analysis provides further evidence that fire sales take place in less important stocks, and that any price effects due to hedge fund trading have little market impact.

Overall, we conclude that while pressure selling has an impact on the prices of illiquid stocks and its impact on hedge fund performance is not negligible, its impact on the stock market is very small. Even if our analysis understates fire sales by ignoring those induced by short selling, and even if the fire sales related to short sales are of the same magnitude as for the long sales, the market impact would still be insignificant for the overall market.

[27] We obtain stock market capitalization data from www.census.gov/compendia/statab/2012/tables/12s1397.pdf. We note that total dollar trading volume of the U.S. securities exceeds the U.S. stock market capitalization by approximately a factor of two. Hence using stock market capitalization leads us to overstate the size of the fire sales.

V. Conclusion

Investor redemptions in the recent financial crisis led to dramatic sell-offs of stock by hedge funds, leading to the question of whether hedge fund fire sales disrupt markets. We examine this question by testing for the existence of fire sales during all crises since 1998. We also investigate whether fire sales affect the stock market in general. If hedge fund fire sales disrupt the stock market, these problems should occur among the stocks sold in large quantities by funds with large outflows or funds that are forced to delever (pressure sold stocks).

Our analysis of hedge funds with large outflows/delevering over the sample period 1998-2010 finds evidence that hedge funds engage in fire sales in two quarters; those ending December 2000 and December 2008. We investigate these two quarters in detail and find that fire sales arise when hedge funds invest in illiquid stocks that are difficult to sell without a price impact. Sorting pressure stocks based on their median Amihud liquidity, the fire sales in the final quarters of 2000 and 2008 occur among the least liquid stocks. In contrast, more liquid stocks sold during these periods do not exhibit fire sale patterns and we find no evidence of fire sales among stocks, regardless of their liquidity, during other quarters.

Next, we investigate why hedge funds facing redemption requests or significant pressure to reduce leverage would choose to sell illiquid stocks and suffer losses due to fire sales. We find that hedge funds do their best to avoid fire sales by cherry-picking stocks they sell – they select their most liquid holdings most of the time, suggesting that they only sell illiquid stocks as a last resort. Redemptions are met far more often with sales of large and liquid stocks. Further, hedge funds that sell stocks at fire sale prices hold a larger fraction of illiquid stocks, and appear to hold these stocks as part of their overall strategy.

Finally, we estimate the impact of fire sales on hedge fund performance and on stock market performance. Our estimates imply that fire sales impact fund performance by about 50 to

70 basis points per quarter, but they do not impact the stock market's return in a meaningful way. As a percentage of aggregate market capitalization, total dollar trading volume in fire sale stocks accounts for less than 0.1% of aggregate market capitalization in each of the quarters we analyze. Further, only one fire sold stock is in the S&P 500 index. Therefore, we conclude that the overall market impact of hedge fund fire selling is very small.

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Table 1: Stock Market Downturn Quarters

This table presents the return on the S&P 500 for all negative return quarters in the period 1998-2010, ordered from worst to best return. Return is calculated using CRSP data and assuming reinvestment of all dividends.

Quarter	Stock Return
2008-IV	-0.282
2000-IV	-0.189
2002-III	-0.185
1998-III	-0.181
2001-III	-0.139
2008-III	-0.108
2008-I	-0.092
2002-II	-0.086
2010-II	-0.076
2007-IV	-0.070
2000-II	-0.067
1998-II	-0.051
1999-III	-0.047
2005-I	-0.044
2009-I	-0.039
2007-III	-0.030
2006-II	-0.029
2008-II	-0.022
2004-II	-0.008
2003-I	-0.003
2004-III	-0.003
1999-I	-0.002

Table 2: Summary Statistics

Panel A reports statistics about hedge funds that owned stocks during 1998-2010. Statistics are calculated at year-end and then across years. Panel B presents additional hedge fund data, by year. Data in Panel C are based on individual stocks in hedge fund portfolios. Annual flow based on stock portfolio is the estimated capital flow as a percent of prior period assets, using the stocks reported in the 13F filings, and accounting for gains or losses during the period. The fund Amihud liquidity is the dollar-position weighted stock Amihud liquidity across all stocks in the fund's portfolio. Fund B/A Spread is the dollar-position weighted stock bid-ask spread across all stocks in the fund's portfolio. B/A Spread is the bid-ask spread. Amihud liquidity $*10^8$ is the Amihud liquidity multiplied by 10^8. Volume is average quarterly volume, in millions of shares.

Panel A: Quarterly Fund Family and Stock Characteristics at the Fund Family Level

(Number of Funds = 1,465)	*Mean*	*Median*	*Q1*	*Q3*
Stock portfolio size ($ million)	1,082	305	134	852
Number of stocks per filing	173	73	48	142
Stock market cap ($ million)	4,119	3,913	2,496	5,473
Annual flow based on stock portfolio	0.073	-0.009	-0.498	0.508
Annual stock portfolio return	0.098	0.087	-0.077	0.260
Fund Amihud liquidity * 10^8	0.014	0.009	0.004	0.019
Fund Bid/Ask spread * 10^2	0.006	0.006	0.005	0.007

Panel B: Fund Family Detail by Year

Year	Number of Funds	Annual Flow based on Stock Portfolio		Mean Fund Amihud Liq.	Equity Portfolio (13F) ($ million)	Number of Stocks Per Manager	
	N	*Mean*	*Median*	*Mean*	*Mean*	*Mean*	*Median*
1998	211	0.012	-0.005	0.029	1,000	190	90
1999	240	0.084	-0.043	0.022	1,220	185	87
2000	289	-0.038	-0.065	0.016	1,253	179	88
2001	347	0.105	0.011	0.021	879	173	79
2002	379	0.029	0.006	0.021	778	166	74
2003	399	0.093	0.050	0.010	883	175	82
2004	488	0.182	0.041	0.005	1,005	176	82
2005	586	0.174	0.061	0.005	1,193	182	74
2006	715	0.100	0.011	0.005	1,303	184	69
2007	823	0.142	0.028	0.004	1,424	179	65
2008	899	-0.182	-0.157	0.019	1,000	154	54
2009	838	0.183	-0.020	0.019	903	145	48
2010	786	0.063	-0.032	0.005	1,220	160	55

Panel C: Stock Characteristics at the Stock Level, All Stocks (Number of Stock-Quarters = 260,745)

	All CRSP Stocks	Sample Unique Stocks (N = 13,003)			
	Mean	*Mean*	*Median*	*Q1*	*Q3*
Prior year annual return	0.068	0.092	0.065	-0.088	0.220
Return standard deviation	0.094	0.151	0.139	0.091	0.200
Total assets ($ million)	567	1,513	131	2	813
Market cap ($ million)	466	941	202	65	717
Tobin's Q	1.54	1.83	1.33	0.00	2.50
Quarterly volume (millions of shares)	10	13	3	1	8
Amihud liquidity * 10^8	0.073	0.278	0.036	0.003	0.312
Bid/Ask spread * 10^2	0.029	0.013	0.009	0.003	0.020

Table 3: Analysis of Pressure Sales in 1998, 2000, and 2008

This table reports cumulative abnormal returns for "pressure" stocks, based on six models. *PRESSURE* is a stock-level variable calculated as the quantity of shares bought by hedge funds with inflows above the 80th percentile less the quantity of shares sold by hedge funds with outflows below the 20th percentile scaled by the average monthly trading volume for the stock, requiring at least 25 hedge funds during the event quarter. Stocks in the bottom decile of *PRESSURE* are "pressure" stocks. Statistical significance is denoted with *, **, and *** at the 1%, 5%, and 10% levels, respectively. Results for Model 1 are graphed in Figure 2B.

Panel A: Monthly CAAR for the Fourth Quarter of 2000 (Number of Pressure Sale Stocks = 328)

Event Period	Model 1: Single Factor	Model 2: Three Factor	Model 3: Four Factor	Model 4: Four Factor + Liq.	Model 5: Four Factor + Liq. + VIX
M-12 to M3	0.063	-0.087	-0.030	-0.030	-0.030
M-6 to M3	-0.036	-0.103*	-0.085	-0.091	-0.092
M-3 to M3	-0.005	-0.054	-0.034	-0.034	-0.034
M1 to M3	-0.053	-0.098***	-0.093***	-0.093***	-0.093***
M+1 to M+3	0.174***	0.091***	0.086***	0.086***	0.087***
M+1 to M+6	0.254***	0.092**	0.081*	0.081*	0.083**
M+1 to M+12	0.314***	0.112*	0.105*	0.106*	0.107*
M+1 to M+18	0.477***	0.162**	0.181**	0.183**	0.186***

Panel B: Monthly CAAR for the Fourth Quarter of 2008 (Number of Pressure Sale Stocks = 436)

Event Period	Model 1: Single Factor	Model 2: Three Factor	Model 3: Four Factor	Model 4: Four Factor + Liq.	Model 5: Four Factor + Liq. + VIX
M-12 to M3	-0.032	-0.117	-0.093	-0.088	-0.099
M-6 to M3	-0.018	-0.121*	-0.119**	-0.117**	-0.123**
M-3 to M3	-0.025	-0.101*	-0.134***	-0.133***	-0.142***
M1 to M3	-0.027	-0.058	-0.067**	-0.067**	-0.080***
M+1 to M+3	0.136***	0.104***	0.062*	0.066*	0.065*
M+1 to M+6	0.277***	0.229***	0.159***	0.160***	0.157***
M+1 to M+12	0.304***	0.259***	0.171***	0.172***	0.174***
M+1 to M+18	0.388***	0.300***	0.210***	0.208***	0.219***

Table 3, Analysis of Pressure Sales in 1998, 2000, and 2008, continued

Panel C: Weekly CAAR for the Third Quarter of 1998 (Number of Pressure Sale Stocks = 287)

Event Period	Model 1: Single Factor	Model 2: Three Factor	Model 3: Four Factor	Model 4: Four Factor + VIX
W-15 to W13	-0.209***	0.011	0.024	0.020
W-15 to W7	-0.116*	-0.000	0.014	0.010
W1 to W13	-0.134*	0.026	0.018	0.011
W1 to W7	-0.041	0.012	0.011	0.006
W8 to W13	-0.091*	0.014	0.007	0.005
W+1 to W+11	0.078	0.018	0.018	0.014
W+1 to W+22	0.067	0.100***	0.103***	0.095***

Panel D: Weekly CAAR for the Fourth Quarter of 2000 (Number of Pressure Sale Stocks=328)

Event Period	Model 1: Single Factor	Model 2: Three Factor	Model 3: Four Factor	Model 4: Four Factor + VIX
W-15 to W13	0.014	-0.058	-0.006	-0.008
W-15 to W7	0.026	-0.022	0.002	0.001
W1 to W13	-0.054	-0.085***	-0.058**	-0.060**
W1 to W7	-0.041	-0.049**	-0.049**	-0.050***
W8 to W13	-0.013	-0.033	-0.007	-0.007
W+1 to W+11	0.172**	0.097***	0.096***	0.098***
W+1 to W+22	0.254**	0.127***	0.119***	0.120***

Panel E: Weekly CAAR for the Fourth Quarter of 2008 (Number of Pressure Sale Stocks = 436)

Event Period	Model 1: Single Factor	Model 2: Three Factor	Model 3: Four Factor	Model 4: Four Factor + VIX
W-15 to W13	-0.036	-0.089	-0.091	-0.092
W-15 to W7	-0.091	-0.132**	-0.117**	-0.116**
W1 to W13	-0.008	0.013	0.000	-0.001
W1 to W7	-0.064*	-0.029	-0.024	-0.024
W8 to W13	0.053	0.039	0.022	0.021
W+1 to W+11	0.177***	0.216***	0.189***	0.189***
W+1 to W+22	0.399***	0.408***	0.356***	0.356***

Table 4: Fire Sales and Stock Liquidity

This table estimates a logit model in which the dependent variable is set to 1 if the stock exhibits a fire sale pattern, and 0 otherwise. A stock is considered to have a fire sale pattern if both a) the return in the quarter of sale is less than the mean return for all pressure stocks for that period and b) above the mean return for the following quarter. For Panel A, December 2000, there are 328 pressure stocks, 300 of which we can calculate liquidity proxies. Of the 300, 67 are classified as fire sales. For 2008, there are 436 pressure stocks, 377 of which we can calculate liquidity proxies. Of the 377, 89 are classified as fire sales. Tobin's Q is measured as of the year-end prior to sale. p-values are below the coefficients in parentheses.

Panel A: December 2000 Quarter

	Liq. Proxy=Amihud			Liq. Proxy=Bid/Ask Spread			Liq. Proxy = Mkt. Cap.		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Intercept	-1.287***	-1.396***	-1.439***	-1.653***	-1.798***	-1.843***	9.597***	11.082***	9.946***
	(0.00)	*(0.00)*	*(0.00)*	*(0.00)*	*(0.00)*	*(0.00)*	*(0.00)*	*(0.00)*	*(0.00)*
Stock Liquidity Proxies									
Amihud liquidity * 10^8	0.224*	0.403***	0.599***						
	(0.06)	*(0.01)*	*(0.00)*						
Bid/Ask spread * 10^2				17.416***	20.377***	22.970***			
				(0.00)	*(0.00)*	*(0.00)*			
Log market cap							-0.556***	-0.637***	-0.577***
							(0.00)	*(0.00)*	*(0.00)*
Controls									
Tobin Q		0.046	0.042		0.053*	0.048		0.064**	0.057*
		(0.11)	*(0.16)*		*(0.07)*	*(0.11)*		*(0.04)*	*(0.07)*
Prior quarter return			-1.887***			-1.950***			-1.233**
			(0.00)			*(0.00)*			*(0.03)*
N	300	260	258	300	260	258	300	260	258

Table 4, Continued.

Panel B: December 2008 Quarter

	Liq. Proxy=Amihud			Liq. Proxy=Bid/Ask Spread			Liq. Proxy = Mkt. Cap.		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Intercept	-1.176***	-1.319***	-1.411***	-1.355***	-1.498***	-1.545***	2.446*	2.564*	1.778
	(0.00)	*(0.00)*	*(0.00)*	*(0.00)*	*(0.00)*	*(0.00)*	*(0.08)*	*(0.08)*	*(0.26)*
Stock Liquidity Proxies									
Amihud liquidity * 10^8	0.026**	0.026**	0.020						
	(0.03)	*(0.03)*	*(0.13)*						
Bid/Ask spread * 10^2				15.381***	14.852***	12.446**			
				(0.00)	*(0.00)*	*(0.02)*			
Log market cap							-0.189***	-0.202***	-0.165**
							(0.01)	*(0.00)*	*(0.04)*
Controls									
Tobin Q		0.066*	0.073*		0.067*	0.072*		0.072*	0.077*
		(0.09)	*(0.06)*		*(0.09)*	*(0.07)*		*(0.06)*	*(0.05)*
Prior quarter return			-0.628			-0.489			-0.406
			(0.15)			*(0.27)*			*(0.38)*
N	377	343	342	377	343	342	377	350	349

Table 5: Analysis of Pressure Sale Stocks with Below-Median Amihud Liquidity

This table reports cumulative abnormal returns for the subset of less liquid "pressure" stocks, based on six models. Less liquid stocks are those with below median Amihud liquidity in the period prior to sale. Amihud liquidity is calculated for all stocks held by hedge funds during the quarter of interest. Statistical significance is denoted with *, **, and *** at the 1%, 5%, and 10% levels, respectively. Results for Model 1 are graphed in Figure 4.

Panel A: CAAR for the Fourth Quarter of December 2000 (Number of Pressure Sale Stocks with Below Median Amihud Liquidity = 174)

Event Period	Model 1: Single Factor	Model 2: Three Factor	Model 3: Four Factor	Model 4: Four Factor + Liq.	Model 5: Four Factor + Liq. + VIX
M-12 to M3	-0.089	-0.273***	-0.183*	-0.167	-0.170
M-6 to M3	-0.181	-0.257***	-0.228***	-0.219***	-0.219***
M-3 to M3	-0.089	-0.141*	-0.107	-0.097	-0.099
M1 to M3	-0.134	-0.185***	-0.177***	-0.174***	-0.175***
M+1 to M+3	0.232***	0.133***	0.124***	0.127***	0.129***
M+1 to M+6	0.322***	0.121*	0.102	0.095	0.100
M+1 to M+12	0.380**	0.128	0.117	0.107	0.108
M+1 to M+18	0.553***	0.165	0.197*	0.188	0.194

Panel B: CAAR for the Fourth Quarter of December 2008 (Number of Pressure Sale Stocks with Below Median Amihud Liquidity = 310)

Event Period	Model 1: Single Factor	Model 2: Three Factor	Model 3: Four Factor	Model 4: Four Factor + Liq.	Model 5: Four Factor + Liq. + VIX
M-12 to M3	-0.252	-0.348***	-0.315***	-0.318***	-0.323***
M-6 to M3	-0.152	-0.270***	-0.268***	-0.268***	-0.270***
M-3 to M3	-0.126	-0.212***	-0.258***	-0.262***	-0.266***
M1 to M3	-0.078	-0.114*	-0.127***	-0.127***	-0.134***
M+1 to M+3	0.194***	0.160***	0.107*	0.109**	0.110**
M+1 to M+6	0.369***	0.316***	0.239***	0.240***	0.242***
M+1 to M+12	0.356***	0.303***	0.188*	0.190*	0.189*
M+1 to M+18	0.472***	0.373***	0.261**	0.262**	0.264**

Table 6: Liquidity Persistence Tests

Each fund is categorized as high liquidity or low liquidity based on the median position weighted Amihud liquidity across all stocks held by the fund in a given year. We then classify funds into one of four quadrants depending on its liquidity categorization in year t-1 and year t. A fund that is high liquidity in both periods is called High-High, a fund that switches from high to low is called High-Low, a fund that switches from low to high is called Low-High, and a fund that is low liquidity in both periods is called Low-Low. The proportion of funds that fall into each category is reported in the table. The unconditional probability of being in a particular quadrant is 0.25. Statistical significance is denoted with *, **, and *** at the 1%, 5%, and 10% levels, respectively, based on a Chi-Squared test.

Year	Total	High-High	High-Low	Low-High	Low-Low
1999	221	43%***	7%***	7%***	43%***
2000	244	44%***	7%***	8%***	41%***
2001	302	43%***	5%***	8%***	44%***
2002	349	42%***	8%***	8%***	42%***
2003	376	42%***	8%***	8%***	42%***
2004	401	42%***	8%***	8%***	42%***
2005	500	41%***	9%***	8%***	42%***
2006	601	44%***	6%***	5%***	45%***
2007	702	44%***	6%***	6%***	44%***
2008	816	44%***	5%***	6%***	45%***
2009	844	42%***	8%***	8%***	42%***
2010	762	43%***	6%***	9%***	42%***

Table 7: Fund Characteristics: All Funds that Sell Low Liquidity Stocks

Panel A presents summary statistics, by fund, separated into three fund categories: those that never pressure sell stocks, those that pressure sell only high liquidity stocks and those that pressure sell at least one low liquidity stock. Variables are measured at the end of the quarter. Panel B presents summary statistics for the subset of funds that sell at least one low liquidity stock, separated into buying, holding, and selling. Selling activity is further broken down into 3 categories based on the pressure variable and the stock's liquidity. If a sold stock is not classified as a pressure stock by the Coval and Stafford (2007) classification, it is called "Non-pressure sale." If a sold stock is classified as a pressure stock and has high liquidity, it is called "Pressure sale, high liquidity." Finally, if a sold stock is classified as a pressure stock and has low liquidity, it is called "Pressure sale, low liquidity."

Panel A: All Funds, Categorized by Selling of Low Liquidity Stocks

	# Funds	Number of Stocks (by Fund)	Fund Size ($ million)	Fund Flows (%)	Stock Market Cap ($ million; by Fund)		Stock Amihud Liquidity * 10^8 (by Fund)	
December 2000	*N*	*Mean*	*Mean*	*Mean*	*Mean*	*Median*	*Mean*	*Median*
Never pressure sell[a]	310	177	949	-0.118	10,393	8,152	0.075	0.024
Pressure sell only high liq. stks.[b]	11	53	171	-0.374	17,000	14,778	0.008	0.003
Pressure sell ≥1 low liq. stk.[c]	42	102	378	-0.411	9,696	8,869	0.105	0.049
Difference a-c		*75****	*571****	*0.293****	*697*	*-717*	*-0.030*	*-0.025****
Difference b-c		*-49***	*-207***	*0.037*	*7,304**	*5,909***	*-0.097****	*-0.046****
December 2008								
Never pressure sell[a]	698	142	703	-0.021	8,718	7,507	0.215	0.014
Pressure sell only high liq. stks.[b]	29	42	122	-0.581	12,311	12,290	0.069	0.003
Pressure sell ≥1 low liq. stk.[c]	117	134	270	-0.509	7,617	6,911	0.216	0.050
Difference a-c		*8*	*433****	*0.488****	*1,101***	*596*	*-0.001*	*-0.036****
Difference b-c		*-92****	*-148***	*-0.072***	*4,694****	*5,379****	*-0.147****	*-0.047****

Panel B: Only Funds that Sell Low Liquidity Stocks, by Transaction Type

Transaction Type	Number of Stocks Traded (by Fund)	Stock Market Cap ($ million; by Fund)		Stock Amihud Liquidity * 10^8 (weight: trade size) (by Fund)	
December 2000, N=42 funds	*Mean*	*Mean*	*Median*	*Mean*	*Median*
Buy	32	12,477	4,863	0.055	0.011
Hold	12	7,165	3,477	0.200	0.040
Non-pressure sale[a]	50	13,995	5,737	0.024	0.001
Pressure sale, high liquidity	8	4,086	2,524	0.006	0.005
Pressure sale, low liquidity[b]	**5**	**204**	**174**	**0.705**	**0.486**
Difference b-a	*-50****	*-13,791****	*-5,563****	*0.681****	*0.475****
December 2008, N=117 funds					
Buy	38	8,999	4,741	0.113	0.019
Hold	6	3,918	2,672	0.780	0.519
Non-pressure sale[a]	82	9,874	3,985	0.051	0.001
Pressure sale, high liquidity	7	5,502	2,962	0.002	0.003
Pressure sale, low liquidity[b]	**7**	**323**	**290**	**0.686**	**0.398**
Difference b-a	*-75****	*-9,551****	*-3,695****	*0.635****	*0.397****

Table 8: Measuring the Market Impact of Hedge Fund Trading

This table presents aggregate statistics for the subset of funds that sell low liquidity stocks as described in Table 7. Trade/Stock Market Cap is the mean trade value divided by the stock's market capitalization, calculated at the stock level, then at the fund level, and then across funds. Trade/Fund Assets is the sum of all trades for a fund divided by total fund assets and then averaged across funds. Mean trade is the average trade in dollars calculated at the stock level, then at the fund level, and then across funds. Sum of trades is the total dollar value of all trades across all funds. Aggregate stock market capitalization is the total market capitalization of all listed U.S. companies at the end of the year, obtained from the Census Bureau. Sum Trades/Aggregate Stock Market Cap is the sum of the trades divided by the Aggregate Stock Market Cap. Two-tailed t-tests are performed for the tests of differences of means.

Transaction Type	Trade/Stock Market Cap	Trade/Fund Assets	Trades ($ million)		Aggregate Stock Market Cap ($ million)	Sum Trades/ Aggregate Stock Market Cap
	Mean	*Mean*	*Mean*	*Sum*	*Sum*	*Ratio*
December 2000, n=42 funds						
Buy	0.008	0.194	148	6,062	15,104,000	0.040%
Non-pressure sale[a]	0.003	0.282	167	7,030	15,104,000	0.047%
Pressure sale, high liquidity	0.008	0.111	65	2,591	15,104,000	0.017%
Pressure sale, low liquidity[b]	**0.020**	**0.042**	**17**	**510**	**15,104,000**	**0.003%**
Difference b-a	*0.017****	*-0.242****	*-150****			
December 2008, N=117 funds						
Buy	0.003	0.094	82	9,002	11,737,600	0.077%
Non-pressure sale[a]	0.004	0.376	358	41,877	11,737,600	0.357%
Pressure sale, high liquidity	0.010	0.079	83	7,914	11,737,600	0.067%
Pressure sale, low liquidity[b]	**0.016**	**0.040**	**12**	**1,456**	**11,737,600**	**0.012%**
Difference b-a	*0.012****	*-0.336****	*-346****			

Figure 1
Total Hedge Fund Stockholdings and Number of Funds, by Quarter

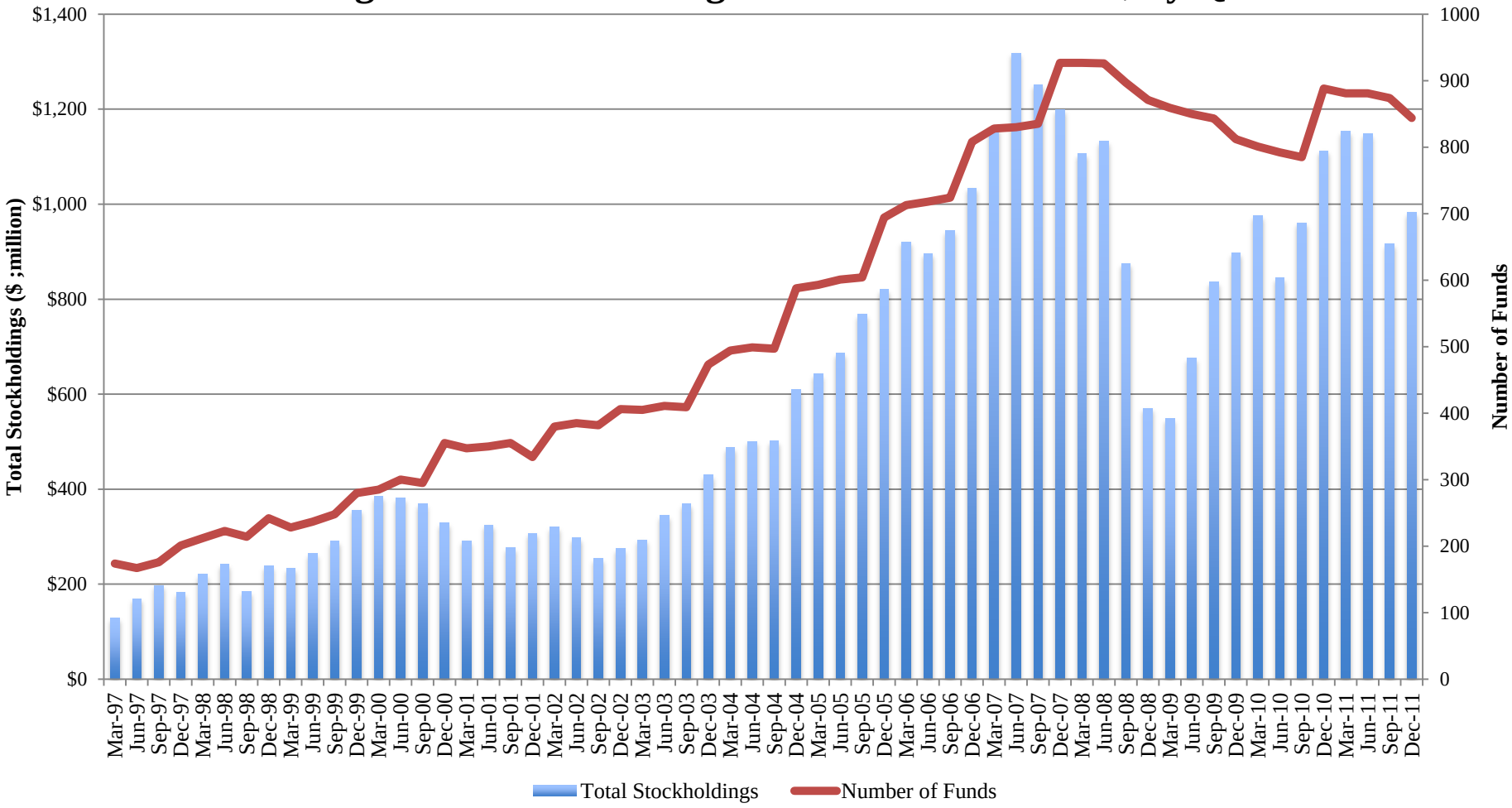

Figure 2, Panel A
Abnormal Returns Around All Periods and All Negative Periods, Monthly Data

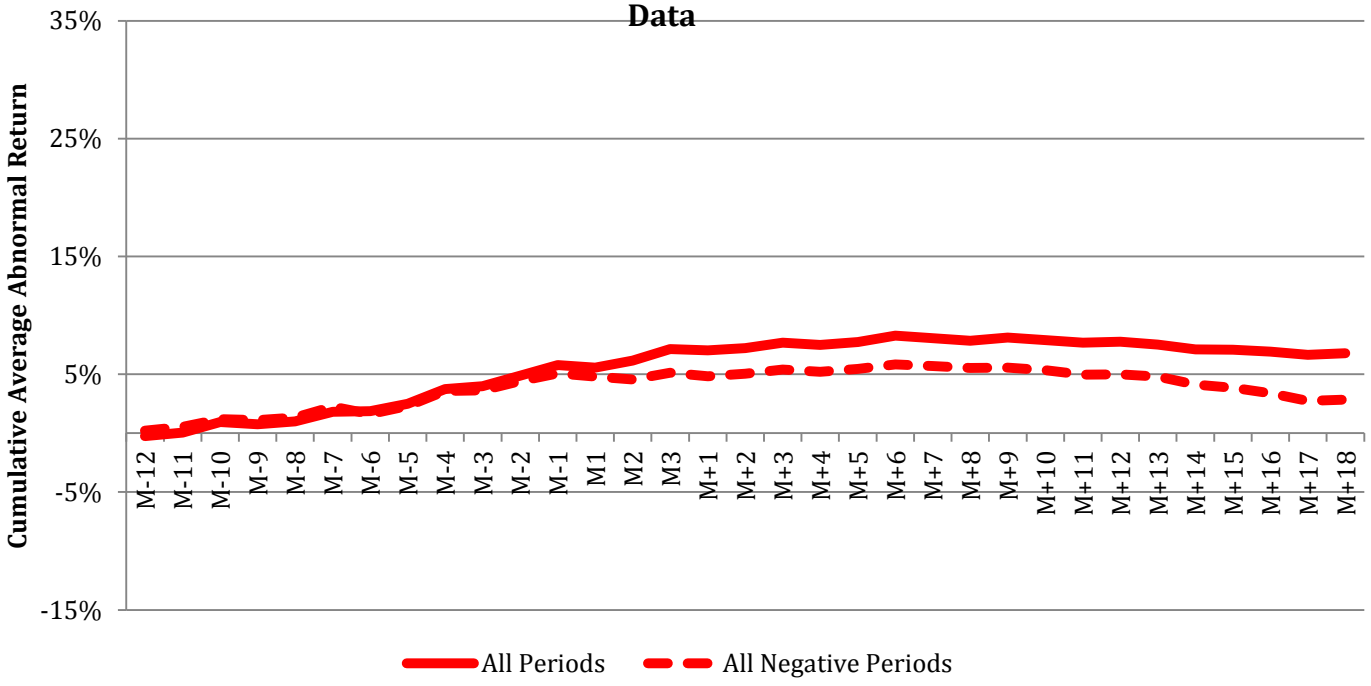

Figure 2, Panel B
Abnormal Returns Around Worst S&P Quarters 1998-2010, Monthly Data

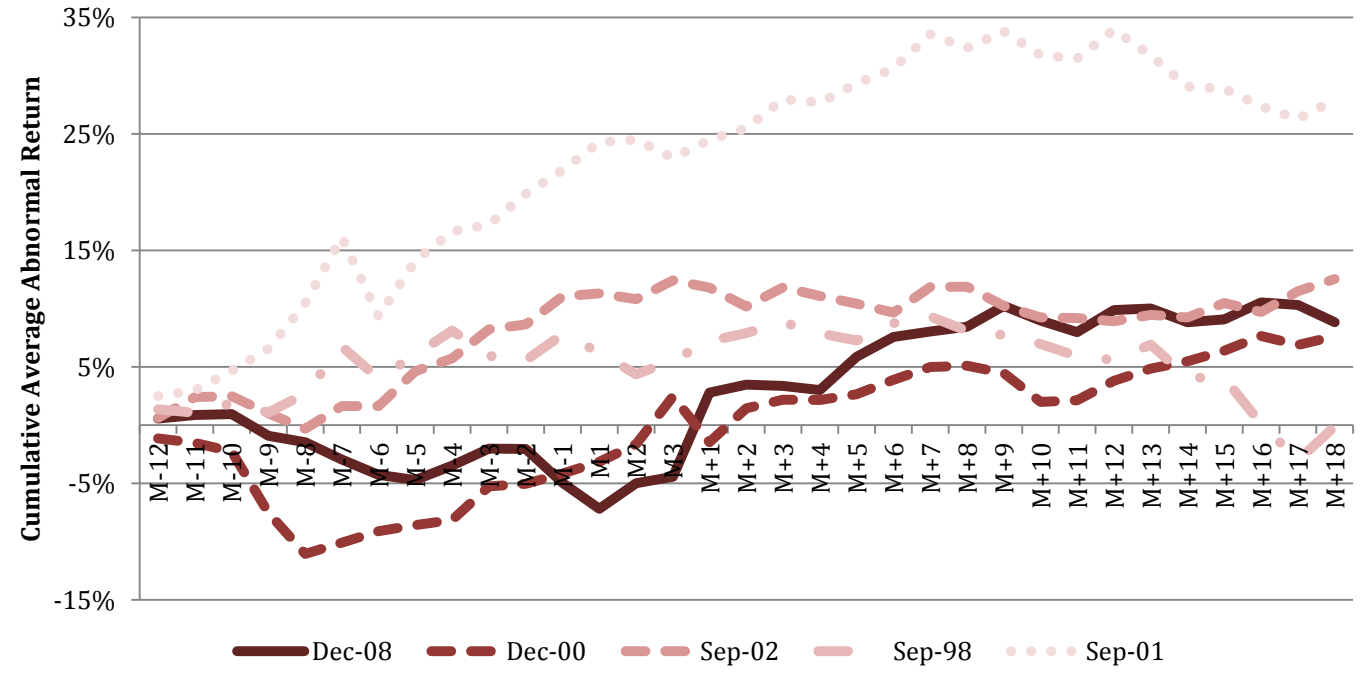

Figure 3
Abnormal Returns Around Worst S&P Quarters 1998-2010, Weekly Data

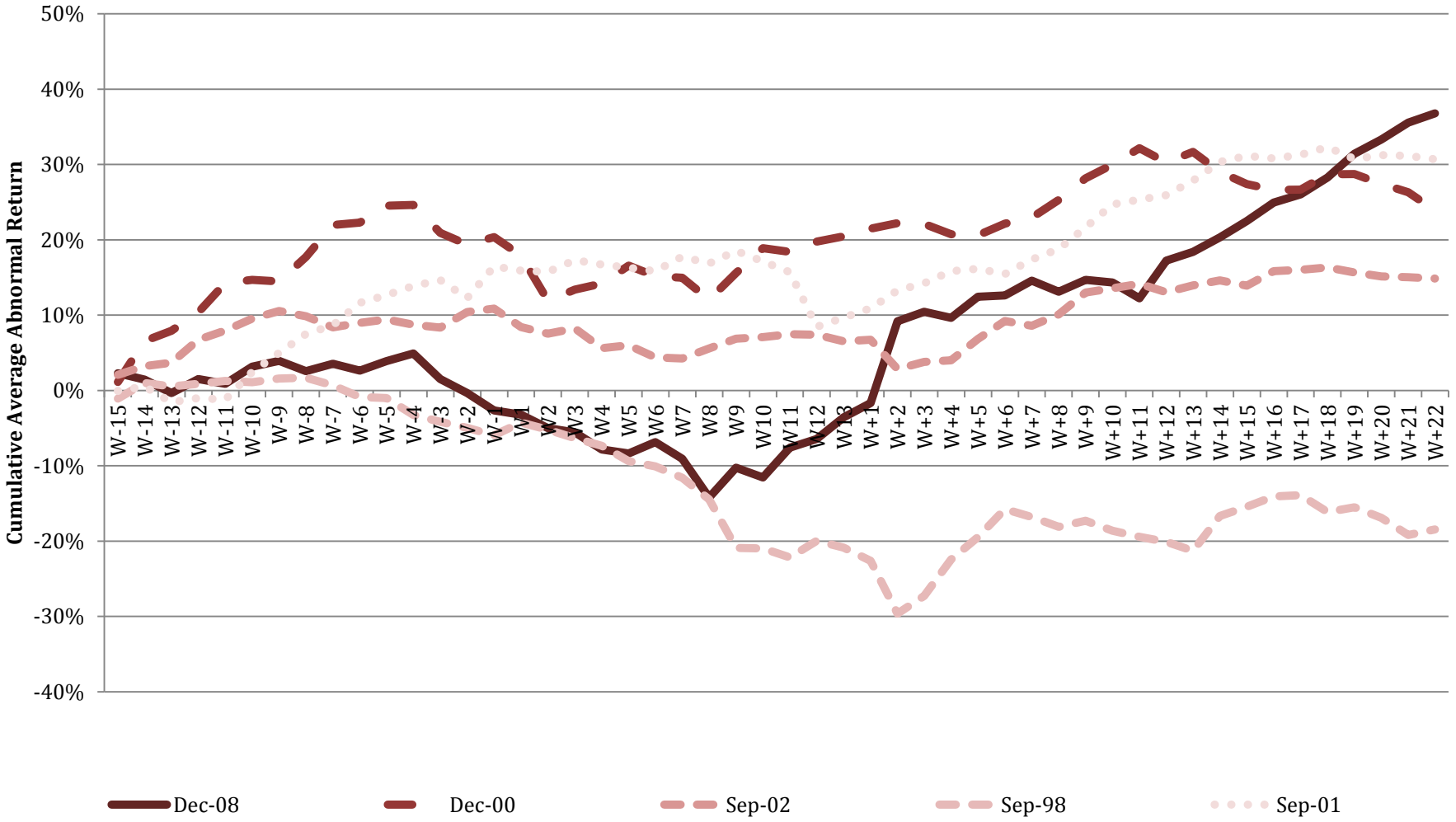

Figure 4: Price Patterns for Sales of Pressure Stocks Sorted by Amihud Liquidity: Monthly Data
Each quarter, pressure stocks are sorted into two portfolios based on their median Amihud liquidity in the quarter before the stock is pressure sold. Panel A graphs cumulative abnormal returns, in excess of the returns on the S&P 500 for the December 2000 quarter and Panel B graphs returns for the December 2008 quarter.