

The Role of Equity Funds in the Financial Crisis Propagation

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Abstract

The early stage of the recent financial crisis was marked by large value losses for bank stocks. This paper identifies the equity funds most affected by this valuation shock and examines its consequences for the non-financial stocks owned by the same funds. We find that (i) ownership links to “distressed equity funds” relate to large underperformance for the most exposed stocks and contribute an additional 10% to the overall stock market downturn; (ii) distressed fire sales and the associated price discounts are concentrated among the best performing stocks; and (iii) stocks with a high share of fund ownership generally performed much better throughout the crisis.

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1 Introduction

Financial sector stocks accounted for only 15% of the total U.S. stock market value in 2007. Their widespread exposure to the subprime market not only hurt their own stock prices, but eventually led to a near 50% value decrease for non-financial stocks as well. This paper examines asset fire sales by distressed equity funds as a channel for such price contagion and shows that equity funds played a major role in propagating the crisis.

A large empirical literature documents ‘price contagion’ across countries and asset classes.¹ Yet, as Forbes and Rigobon (2002) argue, it is often difficult to separate contagion from ordinary asset interdependence. A promising new approach focuses on data at the stock and fund/investor level for a clear identification of the contagion channel. To this end, we use a new comprehensive sample on the equity positions of 20,477 equity funds around the world. For each fund, we calculate *fund exposure* to financial stocks as the losses induced by financial sector positions in the initial phase of the financial crisis. Exposed funds faced larger investor redemptions and therefore had to engage in asset fire sales of their non-financial stocks. To capture this selling pressure on non-financial stocks, we define *stock exposure* as the ownership weighted average fund exposure of all mutual funds owning that stock. Thus, non-financial stocks held by funds with heavy loadings on underperforming financial stocks would be considered highly exposed stocks. Our identifying assumption is that the stock picks among non-financial stocks by exposed funds is random in the sense that it is not feature any performance bias other than the fire sales effect.

Our empirical analysis focuses on the relative return of the 15% non-financial stocks worldwide with the highest stocks exposure.² Exposed stocks are found particularly in the U.S. stock market where they represent 27% of all U.S. stocks and cover all industries. This allows us to control for industry-specific asset sensitivities to the crisis using industry fixed effects. We show that non-financial stocks with high stock exposure to distressed funds considerably underperformed during the financial crisis. For example, the stock price for the 27% most exposed U.S. stocks underperformed relative to non-exposed industry peers by 37% at the peak of the stock market downturn. This highlights the role of funding constraints for mutual funds and their importance for stock market “contagion.” Our analysis suggests that some 10% of the 52% crisis-related decline in the U.S. stock market can be attributed to distressed selling by mutual funds.

¹See Kindleberger (1978); Dornbusch, Park, and Claessens (2000); Kaminsky, Reinhart, and Vegh (2003) for excellent surveys.

²Our findings do not qualitatively depend on the choice of this particular cut-off.

Our paper also uncovers two additional insights about the 2008 stock market crash. First, the fire sale discount is most pronounced for stocks that performed best during the crisis. This somewhat counterintuitive result can be explained by fund discretion about which asset positions to liquidate. Faced with funding constraints and investor redemption requirements, distressed equity funds liquidated the best performing stocks rather than stocks with recent large capital losses. Thus, fire sales were more pronounced for stocks among the 10% best performing stocks. For these stocks, we find average fire sale discounts above 75%. Second, we find that – while ownership by distressed funds adversely affected the performance of a stock during the crisis – the opposite holds for overall fund ownership. Stocks in the top 15% quantile of the highest fund ownership share suffered considerably lower capital depreciation than otherwise similar stocks. This suggests that investors who delegate investment decisions might have a lower propensity for equity sales or “flight to quality” than direct investors. The implication is that during bad times (i.e. when the overall index is strongly declining), stocks mostly held by funds experience less selling pressure than those primarily held directly. We test this hypothesis using VAR (vector autoregression) techniques to identify Granger causality of index changes on the relative overperformance of stocks with a high fund ownership share. High frequency data confirm that the performance gap during the crisis between stocks with high and low fund ownerships can be traced back to index return shocks on the previous day. This suggests that a stock’s sensitivity to “flight to quality” is strongly determined by its fund ownership share.

Our analysis relates to a growing literature on limits to arbitrage and fire sales surveyed by Gromb and Vayanos (2010) and Shleifer and Vishny (2011), respectively. This research has highlighted the role of funding constraints of financial intermediaries in determining asset prices (see Shleifer and Vishny (1992), Gromb and Vayanos (2002), Brunnermeier and Pedersen (2009), and Adrian and Shin (2009)). For equity funds, Coval and Stafford (2007) demonstrate that funding constraints following large investor outflows trigger fire sales with strong and persistent return effects for several months or a year. This paper extends this research by quantifying the return effect of funding constraints in the recent financial crisis. Financial crises may give rise to a more pervasive and larger asset mispricing. For example, covered arbitrage relationships in the foreign exchange market hold almost perfectly for covered interest parity during normal times, but appear to have broken down during the financial crisis (Baba and Packer, 2009). Rinne and Suominen (2010) show that asset liquidity in U.S. stocks generally dropped during the 2007/08 crisis. Aragon and Strahan (2009) show that this applied in particular to stocks traded by hedge funds connected to the investment bank Lehman Brothers. Recent theoretical work has also linked liquidity variations to information problems. A

more extensive arbitrage breakdown may arise endogenously from larger asset valuation complexity if a crisis generates new unknown liquidity externalities (Caballero and Simsek, 2009). Hence, limits of arbitrage may shift during a crisis and the large-scale fire sale discounts documented in this paper is suggestive of such a displacement of the arbitrage boundaries.

Our paper contributes to a larger research agenda on financial crisis transmission. Previous work has used portfolio data at the fund level to identify channels of asset contagions. For example, Broner, Gelos and Reinhart (2006) find that rebalancing towards the index (‘retrenchment’) by global equity funds during the last emerging market crisis (Thailand 1997, Russia 1998, and Brazil 1999) had a pronounced effect on the cross-section of international equity index returns. Manconi, Massa, and Yasuda (2010) find that in 2007/08, fixed income mutual funds transmitted the crisis from the securitized bond market to the corporate bond market. This points to a more general role of mutual funds as vehicles of asset price contagion. Other work has taken a broader approach to characterize contagion channels. Calomiris, Love, and Peria (2010) examines how the collapse of global demand, the contraction of credit supply, and the selling pressure for firm equity jointly depressed non-U.S. stock prices in the 2007/2008 crisis. They use a stock’s free float share and stock turnover as measures of asset liquidity and proxies for equity selling pressure – a weaker identification scheme than the stock exposure measure in our paper. Longstaff (2010) provides complementary evidence on contagion from the ABX subprime indices to the bond market and financial stocks.

Section 2 lays out the paper’s principal hypotheses. Section 3 discusses data issues and variable definitions. Section 4.1 presents evidence for the fire sale discounts along the time line of the crisis. Section 4.2 uses quantile regressions to document the asymmetric effect of fire sale discounts by stock performance quantiles. Section 4.3 presents evidence of distressed fund selling which matches the return evidence. The hypothesis of different propensities for “flight to quality” for directly and indirectly invested capital is examined in Section 4.4. Section 4.5 discusses various robustness issues. Section 5 concludes.

2 Hypotheses

The first fallout of the subprime crisis in 2007 was a substantial value loss for bank stocks.³ The mean return for U.S. financial stocks in the second semester of 2007 and the first semester of 2008 was a catastrophic -27.4% and -32.5% , respectively.⁴ As a consequence, equity funds with a large share

³See Gorton (2008) for a detailed discussion of the crisis chronology. An important public signal at the beginning of the crisis is the downgrading of mortgage back securities by S&P and Moody’s, on July 10, 2007.

⁴These numbers are calculated based on the S&P1500 Banking index.

ownership in financial stocks suffered a substantial negative shock to their fund performance. In this paper we explore how such fund exposure to bank stocks was propagated to other non-financial stocks through common equity share ownership. Bank-stock-exposed equity funds are likely to face stronger fund outflows after large value losses — the so-called “flow performance relationship” that has been extensively documented in the literature (Chevalier and Ellison (1997), Sirri and Tufano (1998), Del Guercio and Tkac (2002), Huang, Wei, and Yan (2007), Ivkovic and Weisbenner (2009), and Ferreira et al. (2010)). To meet redemption requirements from investors, such equity funds will have to liquidate other stocks in their equity portfolio, which in turn depreciates equity values of non-financial stocks.⁵ This mechanism can be summarized in the following hypothesis:

H1: Simple Fire Sales Hypothesis

Non-financial stocks linked by stock ownership to funds with high exposure to banking stocks underperform during the financial crisis. Aggregate fund holding decreases in such stocks relative to other stocks.

Empirically, we can test this hypothesis by defining a stock exposure dummy, that marks all non-financial stocks with distressed equity funds as principal owners. Fund distress or fund exposure itself is measured by the percentage value loss experienced by a fund in the second semester of 2007 and the first semester of 2008 due to investments in financial stocks. In addition to a negative return effect for exposed stocks, the fire sales hypothesis also predicts that the aggregate holdings share of all equity funds owning a stock at the onset of the crisis should decrease more strongly for exposed than for non-exposed stocks.

The above hypothesis does not discriminate between the type of stocks a distressed equity fund might choose to sell. If stock prices feature more pronounced deviations from their fundamental value during a crisis, then a simple heuristic decision rule suggests that a fund first sells stocks with the highest realized crisis returns. The latter stocks are least likely to suffer from temporary underpricing. By contrast, stocks in the lower performance quantiles provide the hope for a later price reversal and are less likely to suffer fire sales.⁶ This allows us to refine the unconditional simple fire sales as follows:

H2: Stock Performance Dependent Fire Sales Hypothesis

The relative underperformance of exposed stocks is bigger for stocks that perform better

⁵See also Pulvino (1998) for related evidence that fire sales by distressed firms (airlines) also produce lower asset values (for used airplanes).

⁶A behavior argument based on the disposition effect supports a similar prediction.

during the financial crisis, because exposed funds pick the best performing stocks for fire sales.

A straightforward procedure to explore hypothesis H2 is to measure the fire sales effect for different stock performance quantiles. Hypothesis H2 predicts that the coefficient for the stock exposure dummy is considerably larger for stocks at the higher performance quantiles than for lower return quantiles. Alternatively, we can look directly at the decrease in fund holdings for stocks that were both exposed and performed relatively well in the crisis. The interaction of both effects should mark stocks with the largest relative fund holdings changes.

While distressed funds may have a negative influence on the crisis performance of stocks they initially own, we do not expect such an effect will pertain to equity fund ownership in general. Here, even the opposite hypotheses can be stated. Professional equity fund managers might be less prone to panic sales of equity than, for example, retail investors with direct investments. After all, fund managers' own economic future may depend more on their relative performance, while a retail investor might be more concerned with absolute value loss. Moreover, retail investors who delegate their capital to fund managers might be less performance sensitive in their decisions to reduce or liquidate equity investments compared to investors who manage their capital directly. Such investor self-selection may also generate a propensity for stocks with a low share of fund ownership to be more exposed to "flight for quality" than stocks with a high share. All else being equal, a high initial share of equity fund ownership might therefore imply a much better crisis performance for a stock.

H3: Fund Share Stability Hypothesis

Non-financial stocks with a large ownership share of equity funds perform better during the financial crisis. Investors who delegate stock selection to funds are less prone to "flight for quality" than investors who invest their capital directly.

Our data allow us to calculate the proportion of a stock's market capitalization that is held by funds. Based on the Fund Share Stability Hypothesis, we predict that fund ownership is an important positive determinant for the cross-sectional risk-adjusted crisis performance of stocks. Cross-sectional regression analysis of crisis returns provides a first straightforward test.

But our analysis goes one step further in identifying a "panic effect" afflicting directly invested capital. We estimate a VAR that identifies the role of lagged return shocks of the U.S. stock market index on an (equally weighted) long-short portfolio of the 15% stocks with the lowest fund ownership minus the 15% stocks with the highest fund ownership. This allows us to explore how the impulse

response to (negative) market-wide shocks has changed during the crisis period relative to the pre-crisis response. If “flight to quality” is triggered by shocks to the market index and its propensity is stronger for directly invested (non-fund) capital, then the long-short portfolio return should show a strong positive cumulative impulse response to index return shocks during the crisis.

3 Data and Variable Definitions

3.1 Fund Holding Data

Our fund holding data are from the Thomson Reuters mutual fund database, which contains information on equity mutual funds worldwide. The detailed holdings file provides fund name, management company name, country code, and reporting date. In addition, it provides the security number and number of shares held by the fund, net changes in shares held since prior report dates, the security country code, security price in U.S. dollars and shares outstanding. Most funds report only at six month intervals — hence the analysis is carried out at a semi-annual frequency. To reduce data outliers and limiting the role of non-synchronous reporting, we apply a number of data filters. We retain holding data only from the last reporting date of a fund in each half-year. Moreover, we require funds to have a total net asset value of at least 10 million dollars and hold at least five stock positions in a semester. Also discarded are funds with asset weights producing a Herfindahl-Hirschman index above 20%, which characterizes a non-diversified fund with extreme investment biases in very few stocks. The final sample includes 27,274 mutual funds with equity investments in 25 developed and 54 emerging markets over the period from 2007-2009. A total of 6,327 funds are domiciled in the U.S., 16,667 are located in other developed markets, and 4,280 are from emerging markets.

The number of funds reporting over the three-year period is unbalanced. Table 1 summarizes fund holdings for June 2007 by mutual fund domicile. A total of 20,477 funds reported stock positions with a combined total net asset value (TNA) of 16 trillion dollars. Our data coverage therefore exceeds the Lipper Hindsight database used by Ferreira, Massa, and Matos (2010), who report total net assets of 10.9 trillion dollars for December 2007. Less than half of the reported equity holdings in our sample concern U.S. domiciled funds. We also highlight that 16,710 (or 82%) of all mutual funds hold at least one foreign stock and can therefore be classified as international funds. This percentage, at 73%, is somewhat smaller for U.S. domiciled funds.

3.2 Fund Exposure and Stock Exposure

In the first step, we identify exposure of a fund to financial stocks.⁷ Let $h^{f,s}(t)$ denote the number of shares held by fund f in stock s at time t and $P_s(t)$ the corresponding stock price. The portfolio shares of fund f (for the equity components of its investments) are as follows

$$w^{f,s}(t) = \frac{h^{f,s}(t)P_s(t)}{\sum_s h^{f,s}(t)P_s(t)}.$$

We calculate the bank stock related fund return as the value loss over a semester attributable to financial stock (banks) ownership, hence

$$\bar{r}_{f,t}^{Bank} = \sum_{s \in Financials} \frac{1}{2} [w^{f,s}(t) + w^{f,s}(t-1)] r_{s,t} \quad ,$$

where $r_{s,t}$ denotes the semester stock return and the summation involves all financial sector stocks worldwide. The average return is measured for the arithmetic midpoint between the beginning and the end of semester weights. Fund exposure is defined as return shortfall due to bank stock investments below the -1% threshold, that is

$$Exp^f(t) = \begin{cases} 0 & \text{if } \bar{r}_{f,t}^{Financials} > -0.01 \\ \bar{r}_{f,t}^{Financials} & \text{if } \bar{r}_{f,t}^{Financials} \leq -0.01 \end{cases} .$$

Below a -1% return shortfall, funds may face more investor scrutiny and large fund redemptions such that fund fire sales become important. Highly negative fund exposure can result from either large portfolio weights for bank stocks in general and/or portfolio holdings in banks with particularly low returns. The identification of the valuation shock focuses on two semesters from July 2007 to June 2008, before the subprime crisis turned into a general financial crisis with the collapse of Lehman Brothers on September 15, 2008. The fund exposure for the second semester of 2007 is denoted by $Exp^f(2007/2)$ and for the first semester of 2008 by $Exp^f(2008/1)$. Both fund return losses combined measure the total fund exposure given by

$$Exp^f = Exp^f(2007/2) + Exp^f(2008/1).$$

The mean (median) fund exposure (return loss due to bank investment) investment in financial stocks is -2.12% (-1.37%) with a skewness of -2.3 . The 25%, 15% and 10% lowest fund exposure quantiles are given by -3.45% , -4.56% , and -5.53% , respectively.

⁷Funds that had more than 75% of their asset holdings in financial stocks in more than one year prior to June 2007 were deemed to be financial sector funds. For those funds, the investment focus on banking stocks might be non-discretionary, so investors may not attribute underperformance to a poor sectorial fund allocation. We therefore exclude such funds from the sample and focus on those with discretionary investment in financial stocks.

In a second step, we aggregate the exposure of funds with ownership shares in a particular stock to an ownership share weighted measure of stock exposure. Let

$$\omega^s(f) = \frac{h^{f,s}(t)}{\sum_f h^{f,s}(t)}$$

denote the ownership share of fund f in June 2007 relative to the total fund ownership in stock s and Fsh^s denote the total fund ownership relative to the stock capitalization. The exposure of a non-financial stock Exp^s to banking stocks (via common equity fund ownership) can then be defined as

$$Exp^s = Fsh^s \sum_f \omega^s(f) Exp^f.$$

A high stock exposure Exp^s implies that a relatively large share of its capitalization is owned by equity funds with high exposure to banking stocks. These stocks should therefore face the largest selling pressure if fund exposure captures the need for fire sales by individual funds. Summary statistics on stock exposure are reported in Table 2. The mean (median) stock exposure is -0.11% (-0.01%) with a skewness of -7.7 . The 20%, 15% and 10% most negative stock exposure measures are -0.13% , -0.26% , and -0.36% , respectively. For example, a stock exposure of -0.36% is obtained if a 10% share of the stocks capitalization is owned by funds that on average lost -3.6% on their portfolio returns due to financial stock investments.

The distribution of stock exposure is highly skewed and its effect on return and holding change might be non-linear. It is therefore useful to define a dummy variable $DExp^s$ that marks all stock exposures below a certain quantile $Q(Exp^s)$, where

$$DExp^s = \begin{cases} 1 & \text{for } Exp^s < Q(Exp^s) \\ 0 & \text{otherwise} \end{cases}.$$

Our empirical analysis focuses on the 15% quantile, but using the 10% or 20% gives qualitatively similar results. However, the qualitative effects tend to increase if we move to a smaller subset of more exposed stocks. Most of the analysis in this paper is based on the 15% exposure threshold applied to all stocks worldwide. U.S. stocks are strongly represented in the global sample of exposed stocks with 1,654 (or 39.1%) stocks compared to 1,713 (or 40.5%) for other developed markets and 862 (or 20.4%) for emerging markets.

Stock exposure is therefore more frequent for U.S. stocks where 27.0% of all U.S. stocks are labeled “exposed” compared to 11.93% and 11.18% for other developed markets and emerging markets,

respectively. We also note that the U.S. stock sample contains many of the most strongly exposed stocks: The 10% quantile for Exp^s is -0.0050 in the U.S. stock sample, compared to only -0.0030 and -0.0029 in the developed market and emerging market stock sample, respectively. For this reason, some of our analysis will focus on the subset of U.S. stocks.

Table 3 provides a comparison of exposed and non-exposed stocks. For each stock, we examine its market capitalization value on June 30, 2007 and its average monthly stock liquidity from July 2006 to June 2007. Following Bekaert, Harvey, and Lundblad (2007), we calculate a stock's liquidity by $\ln(1 - ZR)$, where ZR refers to the proportion of zero daily returns. Exposed stocks tend to be larger and more liquid than non-exposed stocks. This corresponds to the general finding that fund ownership is biased toward larger and more liquid stocks. It should simultaneously attenuate any return effect of fire sales, which might be even more pronounced for small and illiquid stocks. Exposed stocks also tend to differ in their loading on standard risk factors used in the asset pricing literature. The loading on the size factor SMB in particular differs between exposed and non-exposed stocks. This is not surprising given that exposed stocks are on average larger. A comparison of crisis returns by stock exposure should therefore be based on risk-adjusted returns.

3.3 Fund Holding Change and Aggregate Holding Change

The fund ownership data allow us directly to observe holding changes. Let $F(s)$ denote the set of funds with positive stock holdings in stock s in June 2007. The percentage fund holding change $\Delta h^{f,s}$ in stock s over k semesters (from t to $t+k$) can be expressed as (for $f \in F(s)$)

$$\Delta h^{f,s}(k) = \frac{h^{f,s}(t+k) - h^{f,s}(t)}{h^{f,s}(t)}.$$

The aggregate percentage holding change in a stock follows as the ownership weighted average of fund ownership changes; that is,

$$\Delta H^s(k) = \frac{\sum_{f \in F(s)} h^{f,s}(t+k) - \sum_{f \in F(s)} h^{f,s}(t)}{\sum_{f \in F(s)} h^{f,s}(t)} = \sum_{f \in F(s)} \omega^s(f) \Delta h^{f,s}(k).$$

We then define the capitalization scaled aggregate stock holding changes as

$$\Delta \tilde{H}^s(k) = Fsh^s \Delta H^s(k) = Fsh^s \sum_{f \in F(s)} \omega^s(f) \Delta h^f(s, k),$$

where the product $Fsh^s \times \omega^s(f)$ denotes the ownership share of each fund f relative to the total capitalization of the stock.

The holding share of all funds with initial holdings in June 2007 decreases over consecutive semesters as fund ownership in any particular stock changes. The average aggregate holding change $\Delta\tilde{H}(k)$ for $k = 1, 2, 3, 4, 5$ is given by -1.5% , -2.7% , -3.6% , -4.2% , and -4.5% , respectively. Section 4.2 explores whether this aggregate fund holding decrease is more pronounced for stocks with mostly exposed fund owners.

3.4 Risk Adjustment of Returns

Our analysis of the fire sale effects on stock prices first removes risk premia from the return analysis. For this risk adjustment we use the international version of the Carhart (1997) four-factor model. For each country, we construct a domestic and international version of the four factors: the market factor (MKT), the size factor (SML), the book-to-market factor (HML) and the momentum factor (MOM). The factor construction is based on monthly stock returns in U.S. dollars from Datastream over the five-year period from July 2002 to June 2007 and discusses in the appendix.

A country's international factors are calculated in a second step as the weighted average of the respective domestic factors of all other countries, where the weights are given by the relative stock market capitalization of each foreign country at the beginning of the year. The stock market capitalization data are obtained from World Development Indicator. We estimate the factor loadings of each stock on the four domestic and four international risk factors ($j = Dom, Int$) using a regression over the 60 months from July 2002 to June 2007,

$$r_{s,t} = \sum_{j=Dom,Int} \beta_{1,j}MKT_t^j + \beta_{2,j}SML_t^j + \beta_{3,j}HML_t^j + \beta_{4,j}MOM_t^j + \epsilon_{s,t},$$

where $r_{s,t}$ denotes a stock's monthly (cum dividend) return in U.S. dollars net of the one-month treasury bill rate. Table 3 reports summary statistics for the factor loadings of exposed and non-exposed stocks, respectively. For the pre-crisis period July 2002 to June 2007, the average factor loadings on the market, size, and value factors are positive. Only for the momentum factor do we find a negative average loading. Unreported t -test shows that all eight factors have explanatory power for the cross-section of returns. In particular, international factors have explanatory power beyond the domestic factors. The observation that domestic risk factors play an important role in the pricing of international stocks corroborates the recent evidence advanced by Eun et al. (2010) that investors can enhance the risk-return tradeoff of their portfolios by holding country-specific version of SMB, HML, and MOM factor funds in addition to the global version of these funds.

For estimated factor loadings $\hat{\beta}_{i,j}$, the monthly risk adjusted (or excess) return for the crisis period

from July 2007 to December 2009 is defined as

$$r_{s,t}^{Ex} = r_{s,t} - \sum_{j=Dom,Int} \widehat{\beta}_{1,j} MKT_t^j + \widehat{\beta}_{2,j} SML_t^j + \widehat{\beta}_{3,j} HML_t^j + \widehat{\beta}_{4,j} MOM_t^j.$$

Finally, the total risk adjusted (or excess) return of stock s over k semesters (or $6 \times k$ months) is denoted by

$$r_s^{Ex}(k) = \prod_{i=1}^{6 \times k} (1 + r_{s,t+i}^{Ex}) - 1.$$

The summary statistics for cumulative risk adjusted (excess) returns are stated in Table 2 for all non-financial stocks. The standard deviation of cumulative excess returns increases from 0.471 to 1.400 as the return horizon under consideration increase from one semester (December 2007) to three semesters (December 2008). The cumulative excess return dispersion decreases thereafter to 0.974 and 0.994 as we consider returns extending until June 2009 and December 2009, respectively. This reveals some degree of excess return reversal for non-financial stocks in 2009.

4 Evidence on the Role of “Fund Distress”

4.1 Stock Exposure Effects on the Crisis Time Line

Did losses in financial stock investments by a fund affect the performance of other (non-financial) stocks held by the same fund? The dummy variable $DExp^s$ indicates the 15% of stocks with the most distressed fund ownership. Similarly, we define a dummy $DFsh^s$ indicating the 15% of stocks with the highest share of fund ownership relative to total stock capitalization as of June 2007. A simple OLS regression of the risk-adjusted returns $r_s^{Ex}(k)$ over k semesters on this dummy variable reveals the role of fund ownership distress for the crisis performance of a stock:

$$r_s^{Ex}(k) = \alpha_0^k + \alpha_1^k DExp^s + \alpha_2^k DFsh^s + \mu_s.$$

The simple fire sales hypothesis predicts $\alpha_1^k < 0$. The dummy variable $DExp^s$ should allow for direct identification of the fire sale effect if the stock picks of exposed funds in non-financial stocks is not systematically different from non-exposed funds in terms of their expected stock return. Our identifying assumption here is that a high ownership concentration of exposed funds in a particular stock is comparable to a random treatment effect across stocks with similar fund ownership. Supporting evidence for this hypothesis is provided in Section 5.1. First, we show that the (non-financial) portfolio weights of exposed funds are similarly dispersed as those of non-financial funds. Second, we examine fund performance in the 3 year period prior to the crisis shows. It shows no evidence for any

systematic performance differences between exposed and non-exposed U.S. funds in their respective investments in non-financial stocks. This evidence suggests that (conditional on a stock's fund ownership share) stock exposure can be regarded as a random attribute unrelated to any expected over- or underperformance beyond the fire sale effect itself.

The variable $DFsh^s$ serves as a control variable because a higher fund ownership share allows for more stock exposure. Moreover, the high fund ownership dummy also provides a test for the Fund Share Stability Hypothesis, whereby stocks with a large share of fund-managed capital perform better during the crisis. The regression discards the 1% highest and lowest return outliers. We include fixed country and industry effects as well as their interaction in the regression. The coefficient α_1^k therefore captures (risk-adjusted) fire sales discounts over k semesters for the 15% most exposed stocks relative to other stocks in the same industry and country.

Panel A of Table 4 reports the regression results for the pooled sample of all stocks. For the return period from July 1, 2007, to December 31, 2007, the stock exposure dummy $DExp^s(2007/2)$ is based on contemporaneous fund return losses in the second semester of 2007. The exposure dummy reveals an underperformance of -3.9% after one semester in December 2007, of -7.8% after two semesters in June 2008, and of -10.0% after three semesters in December 2008. For June 2009 (after four semesters) we find a reversal of the discount to -4.5% and by December 2009 (after five semesters) the discount is no longer significantly different from zero. The dummy for high fund ownership $DFsh^s$ shows a significantly positive coefficient, indicating that stocks with a high fund ownership share experience better crisis performance. The latter effect is economically large and increasing over time to 11.1% by December 2009. This represents support for the Fund Share Stability Hypothesis. Also, the relative overperformance for the 15% stocks with the highest fund share appears more persistent compared to the fire sales effect identified by the stock exposure dummy.

Panel B of Table 4 reports the results for the subsample of U.S. stocks. The exposure dummy $DExp^s$ here marks 27% of all U.S. sample stocks including many stocks from the lower tail distribution of Exp^s . It is therefore not surprising to find much stronger fire sales effects. The crisis underperformance reaches -13.7% in June 2008 and -19.7% in December 2008. Thereafter, this effect diminishes until full reversal is reached by December 2009. As for the full sample, a high fund ownership share is associated with much better crisis performance. Here the difference reaches a cumulative 17.7% by June 2009.

Panels C and D of Table 4 report corresponding results for the (non-U.S.) developed market and emerging market stocks. For emerging market stocks, the fire sales effect captured by $DExp^s$ is

statistically and economically significant at -6.9% in June 2008. The corresponding return shortfall for exposed stocks in developed markets outside the U.S. is only -4.0% . For emerging market stocks, a high fund share ($DFsh = 1$) is also related to strong overperformance in June 2008 and December 2008, while non-U.S. developed markets provide no evidence for the Fund Share Stability Hypothesis. If the latter originates in “panic sales” by directly invested retail investors, then it may be less surprising to find much weaker effects outside the U.S. because of more concentrated (non-retail) stock ownership in general.

The cross-sectional analysis so far has focused on five event dates given by the end of each semester. These dates are unlikely to coincide with the peak of the crisis and may therefore underestimate the maximal fire sale discount. We therefore repeat the above regressions using cumulative risk-adjusted returns with weekly return increments (instead of semester return increments) to obtain a finer time series. The regressions after 26, 52, 78, 104, 156 weeks coincide with the previous regressions after $k = 1, 2, 3, 4, 5$ semesters. The coefficient for the exposure dummy $DExp^s$ and a confidence interval (of ± 1 SE) is plotted in Figure 1. The five reported regressions correspond to the end-of-semester dates highlighted by dashed vertical lines. The fire sale effect for U.S. stocks shows negative twin peaks around November 7, 2008 and February 27, 2009 with a average return shortfall for exposed stocks of -29.79% and -36.80% , respectively. By comparison, the point estimate for (the end of) December 2008 (reported in Table 4, Panel B) yields only -19.7% . The end-of-semester dates for the return regressions therefore considerably underestimates two event peaks.

These results also highlight that crisis propagation through fund exposure played a quantitatively important role for the overall index decline in the second part of 2008. An incremental return shortfall of 37% for the 27% exposed U.S. stocks implies an aggregate 10% value decline for an equally weighted U.S. stock index. Considering the fact that exposed sample stocks are on average larger than non-exposed stocks, the contribution of this effect to the decline of the overall U.S. stocks index (which would be value weighted) is likely to be at least as large. It is therefore not surprising that the maximum fire sales effect identified above is close to the two weekly stock index minima on November 7, 2008, and March 6, 2009.

4.2 Stock Exposure Effects by Stock Performance Quantile

Discretionary liquidation of stock positions by distressed funds implies a refinement of the simple fire sales hypothesis. Funds may choose to sell first the best performing or the most crisis resilient stocks, which may limit loss realizations and preserve the chance of price reversal for the most depressed

stocks in the fund portfolio. This implies that the negative effect of stock exposure should increase with the overall performance of a stock during the financial crisis. We therefore estimate regressions for the 25%, 50%, 75%, 90%, and 95% quantile of the cumulative excess return distribution as a linear function of the stock exposure dummy $DExp^s$ and the fund ownership dummy $DFsh^s$. As the reference dates for the cumulative return we use both November 7, 2008, and February 27, 2009 as the two peaks of the fire sale discount shown in Figure 1. The regression includes fixed effects for all countries. Table 5 reports the corresponding regression results. For the full sample (all stocks) and the February 2009 date, the exposure dummy coefficient decreases from a positive effect of 6.4% and 2.7% for the 25% and 50% quantile, respectively, to -10.1% , -43.5% , -97.2% for the 75%, 90%, and 95% quantile, respectively. A similar pattern is observed for the earlier crisis peak of November 2008. The exposure measure has therefore an extremely asymmetric effect on the distribution of cumulative stock returns, with most of the negative impact found for the best performing stocks. For the subsample of U.S. stocks, the corresponding performance difference of exposed stocks decreases from an insignificant 3.9% and -2.7% for quantiles 25% and 50%, respectively, to -20.5% , -78.9% , and -169.4% for the following three cumulative return quantiles (75%, 90% and 95%) corresponding to February 2009. Figure 2 graphically illustrates how the fire sales effect of exposed stocks increases with return quantile of the stock. This concentration of the fire sales effect in the best performing stock quantiles is strong evidence for the Stock Performance Dependent Fire Sales Hypothesis.

For the dummy variable $DFsh^s$, we find the strongest positive coefficient estimates in the 25% and 50% quantiles, but not in 90% and 95% quantiles. This suggests that the stabilizing effect of a high fund ownership share was strongest for stocks with median or poor performance. This intuitive result supports the Fund Share Stability Hypothesis. Less institutional ownership by mutual funds may correlate with a higher percentage of retail investors. Their panic selling induces poor stock performance, so that the relative stability contribution of fund ownership is most evident in the median and low performance quantiles.

4.3 Fund Redemption and Fund Holding Changes

This section explores how fund exposure to financial stocks implied higher investor redemptions and stock fire sales to finance these redemptions. We first look at redemption pressures faced by exposed funds relative to non-exposed funds. We define as “exposed funds” the 15% of funds that had the largest losses from holding financial stocks. The rest of the funds are defined as “non-exposed”. The analysis here is based upon 11,409 funds for which we could match the fund identity in the Thomson

database to the Lipper database providing complementary data on the exact fund returns in order to calculate monthly investor redemption. We excluded the 1% funds with the highest monthly net flows because of concerns about reporting errors. Figure 3 shows the average cumulative net subscription/redemption from July 2007 through December 2009, for exposed and non-exposed funds, respectively. Exposed funds started to experience net investor outflows after January 2008, which accumulated to a sizeable average fund outflow of more than 15% over following 24 months. By contrast, for non-exposed funds the average net cumulative remains positive over the full 30 month period.

In the absence of sufficient cash holdings, exposed equity funds had to finance their substantial investor redemption by equity fire sales. It is therefore instructive to examine fund holding changes in a stock as a function of stock exposure. We denote by $\Delta\tilde{H}^s(k)$ the aggregate percentage holding change in a stock s over k semesters of all funds with initial positions in June 2007. First, we take a closer look at the distribution of holding changes. Figure 4 compares the distribution of holding changes $\Delta\tilde{H}^s(4)$ for exposed and non-exposed stocks between June 2007 and June 2009. Exposed stocks feature a much larger left tail distribution, indicating that large aggregate holding reductions for these stocks were much more frequent. Such drastic holding reductions by distressed funds can explain the earlier finding that the crisis returns reported in Tables 4 and 5 for exposed stocks were much more negative than for other stocks in the same industry and country.

Analogous to the return regression, the holding change is related to the dummy variable $DExp^s$, marking the 15% stocks with the most distressed fund owners, and the dummy variable $DFsh(s)$, marking the 15% stocks with the highest share of fund owners. The 1% smallest and largest holding changes are discarded from the linear regression given by

$$\Delta\tilde{H}^s(k) = \beta_0^k + \beta_1^k DExp^s + \beta_2^k DFsh^s + \nu_s.$$

The fire sales hypothesis implies $\beta_1^k < 0$ as exposed stocks should show a faster holding decline for the initial owners in June 2007. To test for the Stock Performance Dependent Fire Sales Hypothesis, we extend the above specification by a dummy variable $DHighR^s$ marking all stocks in the 25% quantile with the highest return over the k semesters since June 2007. A second dummy $DExp^s \times DHighR^s$ is defined as the product of the stock exposure dummy, $DExp^s$, and the high return dummy $DHighR^s$. The extended specification becomes

$$\Delta\tilde{H}^s(k) = \beta_0^k + \beta_1^k DExp^s + \beta_2^k DFsh^s + \beta_3^k DHighR^s + \beta_4^k (DExp^s \times DHighR^s) + \nu_s,$$

where the last term captures incrementally larger holding reduction for exposed stocks that do relatively well during the crisis. More pronounced position liquidations in these stocks imply a negative coefficient $\beta_4^k < 0$.

Table 6, panels A to C, provides the regression results for all stocks, U.S. stocks and non-U.S. stocks, respectively. For each incremental semester, we first report the baseline specification and the extended specification. Exposed stocks (with $DExp^s = 1$) show an accelerated decrease in the aggregate holdings by funds that are stock owners in June 2007. The additional cumulative decrease amounts to -1.05% , -1.84% , -2.29% , -2.70% , over a period of $k = 1, 2, 3, 4$ semesters, respectively. Compared to the average holding decreases of -1.51% , -2.75% , -3.60% , -4.24% (reported in Table 2), these figures reveal approximately 65% more net fund selling for the 15% most exposed stocks than for an average stock.

The dummy interaction term $DExp^s \times DHighR^s$ is statistically significant and shows that exposed stocks with good crisis performance had more dramatic holding reductions relative to initial positions in June 2007. The incremental holding decrease captured by the coefficient β_4^k is -0.39% , -0.68% , -1.05% , -1.05% relative to -0.92% , -1.63% , -1.94% , -2.35% measure by the coefficient β_1^k . The ratio -1.05% to -2.35% suggests a 45% larger decrease of exposed stock holdings if the stock was among the 25% best performing stocks. This findings supports the Stock Performance Dependent Fire Sales Hypothesis and matches the return evidence from the quantile regressions in Table 5.

Finally, we note that stocks with high fund shares ($DFsh^s = 1$) also experience a more pronounced reduction of their aggregate fund holdings. This may be less surprising if concentrated fund ownership in any stock tends to have a transitory (or time changing) component. But this mean reversion toward lower fund ownership appears to have occurred without any distressed selling, as revealed by the positive return effect for the dummy $DFsh^s$ in the return regressions.

4.4 Asymmetric “Flight to Quality” by Ownership Type

The relative crisis resilience of stocks with a high fund ownership share is surprising and calls for more analysis. A possible explanation is that capital under fund management has a lower propensity for a “flight to quality” and therefore creates less selling pressure for stocks with a high fund ownership share. By contrast, direct retail investor might be more prone to panic sales and direct retail ownership might be higher for stocks with low fund ownership. The second part of this hypothesis can be examined based on NYSE trading volume data which separately accounts for retail trading volume.⁸

⁸We thank NYSE Technologies Global Market Data for providing this data. See <http://www.nyxdata.com/Data-Products/ReTrac-EOD>

We calculate the percentage of retail trading for all 1793 NYSE traded share in our sample over a one year period prior to July 2007 and find a high negative correlation of -0.584 with the fund ownership share. A high fund ownership share in a stock therefore proxies for low retail trading and therefore also for low direct retail ownership.

Two arguments may explain why retail investors show more “flight to quality” during the crisis. First, households might self-select into either fund investors or (direct) retail investors. Those willing to delegate their portfolio decisions might be less confident in their investment judgment and request fund redemption only under strong relative underperformance of the fund under consideration. Direct investors follow the market more closely and may be more prone to a “flight to quality” as a panic reaction to large absolute losses. Second, household investors might dispose of directly invested capital and fund investments. Since fund redemption can be more costly (given redemption and loading fees), any desire to reduce aggregate stock exposure may first and foremost concern directly invested stock capital.

Important to the “flight to quality” phenomenon is a strong reaction to negative past return shocks for the whole market or index. An asymmetric “flight to quality” propensity implies that the impulse response of an index shock should be larger for stocks with a high share of directly invested (retail) stock capital. We therefore construct an (equally weighted) long-short portfolio with long positions in the 15% of stocks with the lowest fund ownership share and a short position in the 15% stocks with the highest fund ownership share ($DMF = \text{Direct Minus Fund ownership}$). The portfolio return R_t^{DMF} captures the “flight to quality sentiment” of direct investors relative to those investors who delegate fund management decisions. The daily return on such a long-short portfolio is combined with the daily return on the U.S. market index (MSCI USA U\$ - TOT RETURN IND.) to build a simple structural VAR in $y_t = (R_t^{DMF}, R_t^{Index})^T$ with innovations $\epsilon_t = (\epsilon_{1t}, \epsilon_{2t})^T$ of the form

$$Ay_t = (C_1L + C_2L^2 + \dots + C_kL^p)y_t + B\epsilon_t,$$

where L^p is the lag operator (for p lags of y_t) and C_1, C_2, \dots, C_p are unconstrained 2×2 matrices capturing the delayed influence of the lagged dependent variables. Identification is achieved under the restrictions

$$A = \begin{bmatrix} 1 & 0 \\ a_{21} & 1 \end{bmatrix} \quad \text{and} \quad B = \begin{bmatrix} b_{11} & 0 \\ 0 & b_{22} \end{bmatrix}.$$

This identification structure allows for a contemporaneous effect of the long-short portfolio return R_t^{DMF} on the index return R_t^{Index} . By contrast, the index return R_t^{Index} influences the long-short

portfolio as a proxy for “flight to quality sentiment” only with a lag of one or more trading days. Such a delayed reaction is particularly plausible for retail investors, who may observe index changes at the end of the day and only execute their trades on the following trading day. Of particular interest is the role of index innovations ϵ_{2t} on the portfolio return R_t^{DMF} . Under high “flight to quality” propensity for directly invested capital, we should expect such index innovations to have a strong positive effect on R_t^{DMF} .

We estimate the VAR for three different time periods of 12 months each, namely 01/07/2006 – 30/06/2007, 01/07/2007 – 30/06/2008, and 01/07/2008 – 30/06/2009, referred to as pre-crisis period, crisis period I and crisis period II, respectively. The pre-crisis period can provide a suitable benchmark against which to assess a change in the dynamics between index returns R_t^{Index} and portfolio returns R_t^{DMF} . For both crisis periods, the AIC and HQIC criteria indicate that a lag order length $p = 2$ is sufficient to capture the system dynamics. For both crisis periods, the statistically most significant VAR coefficient is c_{12}^1 and captures the effect of index returns on the portfolio return at the one-day lag. The parameter estimates are 0.346 and 0.173 (with corresponding z-statistics of 4.72 and 4.47) for crisis period I and II, respectively. Hence, the portfolio return reacts strongly and positively to the index return on the previous trading day.

More generally, causality tests show that the index return is not Granger caused by the portfolio return. On the other hand, there is strong evidence that the stock index return predicts future returns for the long-short portfolio during both crisis periods, but not during the pre-crisis period. The respective Wald tests reject exclusion of the index return from the return dynamics of the long-short portfolio at levels of $\chi^2(2) = 25.27$ and $\chi^2(2) = 33.67$ for crisis period I and II, respectively. For the pre-crisis period, we cannot assert a similar role for the index return as $\chi^2(2) = 2.30$.

Figure 5, Panel A, plots the cumulative impulse response of the *DMF* portfolio return to a unit shock to the index return for all three time periods. The pre-crisis period does not provide any evidence for a stable relationship between index shocks and the return to the long-short portfolio, as indicated by the wide confidence intervals. This changes during the two consecutive crisis periods. A 1% innovation to the index return now implies an average 0.41% cumulative return impact on the long-short portfolio during crisis period I and still 0.26% for crisis period II. The 95% confidence interval around the point estimates narrows particularly for crisis period II.

The fund ownership share variable is negatively correlated with retail trading volume and therefore proxies (inversely) for retail ownership. Alternatively, we can construct an (equally weighted) long-short portfolio directly from the NYSE trading share of retail investors; using long positions in the

15% of NYSE stocks with the highest retail share trading and short positions in the 15% stocks with the lowest retail share trading ($RMI = \text{Retail Minus Institutional trading}$). Figure 5, Panel B, shows the analogous impulse response function of the RMF portfolio following a unit market return shock. Stocks dominated by retail investor trading show an strong additional return effect on the day after an index shock. The cumulative return effect after 5 days (to a unit index return shock) is here 0.27 and 0.22, in the crisis periods I and II, respectively. In light of a 50% price drop of the index during the crisis, stocks predominantly held directly by retail investors should show a return shortfall — compared to mostly fund held stocks — of approximately 12.5%.

In summary, the considerable economic magnitude of the estimated VAR effects suggests that “flight to quality” as a reaction to (negative) market-wide shocks concerned directly invested (retail) equity capital much more than capital under delegated management. A higher share of fund ownership made a stock more immune to “flight to quality” sales. The VAR evidence therefore explains the result in Tables 4 and 5 showing that a higher fund ownership share correlates with a better crisis performance.

5 Robustness Issues

5.1 Stock Selection Biases of Exposed relative to Non-Exposed Funds

Our research design assumes that the ownership concentration of exposed funds in a particular (non-financial) stock corresponds to a random treatment effect. The underlying assumption is that exposed funds and non-exposed funds do not chose systematically different stocks outside the financial sector; hence concentrated ownership of exposed funds in any single stock becomes a ‘quasi random’ coincidence. The holding data allow us to examine this hypothesis further by documenting the similarity of stock portfolios based on the average overlap of their portfolio weights. For any pair of funds (f_1, f_2) , we define portfolio overlap in the non-financial sector as the sum of the minimum common weight in each stock given

$$Overlap(f_1, f_2) = \sum_{s \in \text{Non-Financials}} \min[\hat{w}^{f_1,s}, \hat{w}^{f_2,s}],$$

where $\hat{w}^{f_1,s}$ and $\hat{w}^{f_2,s}$ represent the (re-scaled) portfolio shares in all non-financial stocks of funds f_1 and f_2 , respectively. Consider the set of all exposed funds with the 15% highest funds exposure and a matching set of non-exposed funds with the same fund size distribution. We can calculate the average portfolio overlap within the group of exposed funds and compare it to the average portfolio overlap of all pairs matching an exposed to a non-exposed fund. If exposed funds do not share any particular

investment biases with respect to non-financial stocks different from those of non-exposed funds, then the average portfolio overlap between exposed funds on the one hand and between exposed funds and (matched) non-exposed funds on the other hand should be similar.

Table 7 shows the average portfolio overlay within group (among exposed funds) and across groups (between exposed and non-exposed funds). The portfolio overlap is zero for 38.1% of the within groups pairs and 43.6% of the cross groups pairs. The mean (median) portfolio overlap is just 8.4% (2.4%) and 4.6% (0.5%) for within and across group pairs, respectively. At the 10 percent quantile with the highest overlap, we find an average portfolio overlap of 24.7% among exposed funds compared to 15.4% between exposed funds and non-exposed funds. While we can statistically reject the hypothesis that both distributions are identical, this evidence nevertheless shows that the non-financial portfolio allocations of exposed funds are qualitatively as dispersed as those of non-exposed funds. Overall, we do not find any evidence for an economically large selection bias in the non-financial stock allocations of exposed funds.

A second test of investment differences between exposed and non-exposed funds concerns their pre-crisis performance. We identify 390 exposed funds and 3,144 non-exposed funds with a minimum reporting history of 3 years from June 2004 to June 2007 and calculate (based on their reported holdings) their total fund returns in all non-financial stocks. The two samples show no significant difference in their average total asset return (in non-financial stocks) either with or without various risk adjustments. This is again evidence against systematic investment biases across exposed and non-exposed funds.

5.2 Stock Liquidity and Changing Risk Premia

The investment bias of mutual funds toward large caps implies that stock exposure occurs more often for large stocks. In principle this should bias the results against finding strong fire sales effects as large stocks tend to be more liquid. It is interesting to confirm this intuition by splitting the sample into small caps and all other stocks (large and mid caps). We define small caps as all stocks with a capitalization below the 10% size quantile of all NYSE listed firms in June 2007. Table 7, Panel A, repeats the regressions in Table 4, Panel B, for the respective subsamples. Small caps do indeed show a stronger fire sales effect than larger stocks for both June 2008 and December 2009. The difference is statistically significant at the 1% level.

An alternative stock sort is undertaken based on Bekaert, Harvey, and Lundblad (2007)'s stock liquidity measure $\ln(1 - ZR)$, where the monthly liquidity measure is averaged over the period from

July 2006 to June 2007 and the sample of all U.S. stocks is split at the median. Liquidity and small cap status have a correlation of 0.63 in the U.S. stock sample. As shown in Panel B, illiquid stocks feature a much stronger fire sales effect with a return shortfall for exposed stocks of -27.4% in June 2008 compared to only -10.9% for liquid stocks. This difference is statistically significant at the 1% confidence level. In unreported results, we also sort stocks based on the Amihud illiquidity measure and find similar results.⁹

An additional robustness test consists of changing the inclusion threshold for stock exposure. The analysis so far has focused on the 15% globally most exposed stocks. As argued earlier, this global threshold amounts to an effective threshold at the 27% quantile of stock exposure for U.S. stocks. We therefore explore whether censoring U.S. stock exposure at the 20% stock exposure cutoff or at the 35% cutoff produces similar results. The corresponding evidence is shown in Panel C of Table 7. The fire sales effect (for December 2008) of originally -19.7% (Table 4, Panel B) changes to -20.5% and -17.6% for the 25% and 35% U.S. exposure cutoff, respectively. This shows that the estimated fire sales effect is not very sensitive to our choice of the exposure cutoff.

We also explore the relationship between fund holding changes and stock liquidity in more detail. While more liquid stocks generally have a higher fund turnover, there is no evidence for an important interaction between stock liquidity and exposure. In other words: accelerated holding reductions for exposed stocks occurred across all levels of stock liquidity. Therefore, our earlier findings that distressed fire sales are more pronounced among best performing stocks cannot be explained by the liquidity effect. The latter finding is confirmed if we repeat the quantile regressions in Table 5 using stock liquidity measures as control variables; the strong dependence of the exposure variable on the return quantile quantitatively is unchanged.¹⁰

Time changing risk premia and/or risk factors represent another robustness concern. Risk premia for certain factors might plausibly increase during the crisis or factors loadings may jointly increase and thus produce the same scaling of the expected excess return. The return effect of both these changes can be captured by including stock betas as additional control variables in the cumulative return regressions of Table 4. But such a more flexible specification does not qualitatively alter the regression coefficients for the stock exposure variable. Premium changes for the standard risk factors therefore cannot account for our evidence.

⁹The Amihud illiquidity measure requires the trading volume data, so the measure is available only for U.S. stocks.

¹⁰See for additional robustness evidence the Web Appendix to this paper available on www.haraldhau.com or www.sandylai-research.com.

6 Conclusions

During financial crises, funding liquidity is reduced and investment losses may therefore trigger widespread fire sales of selected assets. This paper studies this phenomenon for mutual funds during the 2007 – 2008 financial crisis. Our evidence supports the view that fire sale discounts became very widespread during the crisis.

Our identification scheme is based on the return shortfall of mutual funds due to investments in financial stocks between July 1, 2007 and June 30, 2008. This initial phase of the financial crisis is marked by dramatic value losses of many bank stocks and corresponding underperformance of the mutual funds that invest in them. We then study the price externality of such investment losses in financial sector stocks for the pricing of non-financial stocks. For each non-financial stock, we aggregate the underperformance of a fund due to bank sector losses with the ownership share of the fund in the non-financial stock. This results in a measure of stock exposure capturing the financial distress of its fund owners. The analysis carefully controls for real linkages between the banking sector and various industries using industry fixed effects.

An analysis of the 15% globally most exposed stocks reveals their dramatic risk-adjusted underperformance. Unlike Coval and Stafford (2007), we do not condition our analysis directly on fund outflows because of concerns about outflow endogeneity in the context of the crisis. Instead, we directly identify the contagion channel of poor allocation decisions in financial sector stocks. For the sample of U.S. stocks, we show that the price discount for exposed stocks peaks at 37% in late February 2009, which is strong evidence that “distressed funds” played an important role in the deepening of the crisis. At least 10% out of the 52% U.S. index decline can be attributed to distressed selling by mutual funds.

An additional insight concerns the asset choice of distressed fund selling. The Stock Performance Dependent Fire Sales Hypothesis suggests that selling pressure should be greatest for stocks that perform relatively well during a crisis. This way, funds seek to avoid large loss realization when selling the most depressed stocks. The much stronger price effect of the exposure dummy on the best performing stocks supports this hypothesis. Paradoxically, stocks least affected by the crisis in terms of their fundamental value may thus become subject to the largest mispricing.

While ownership by distressed funds had a negative effect on stock performance during the crisis, the opposite holds for overall fund ownership, which correlates with positive excess returns. This suggests that institutional ownership generally has a stabilizing influence on a stock’s crisis resilience — presumably because indirectly (mutual fund) invested capital has a lower propensity to “flight to quality” than directly invested (retail) capital. Additional evidence to support this interpretation

comes from daily return data on the U.S. market index and two long-short portfolio with positive portfolio shares in stocks with the lowest fund share (or highest retail volume) and negative weights in stocks with the highest fund share (or lowers retail volume). U.S. stock index returns Granger cause (with a one- to two-day lag) returns on these two long-short portfolio during the financial crisis, but not prior to it. Moreover, the impulse response of index shocks on the long-short portfolio return is sufficiently large to explain the significant role that the fund ownership share plays for the cross-section of crisis returns. Stock-specific investor propensity for “flight to quality” is therefore an important determinant for the crisis resilience of a stock.

Overall, we conclude that the fund ownership structure at the outset of the crisis in June 2007 had a surprisingly strong effect on the crisis performance of individual stocks and stock groups. The generally positive effect of higher fund ownership is counterbalanced by the extremely poor performance of (fewer) stocks owned mostly by distressed funds. This dual result prevents us from drawing more general conclusions about the role of increasing fund investment for stock market stability during a financial crisis. Future empirical research should provide more insights about (retail) investors self-selected into fund and direct investors, and how this choice affects consequent crisis behavior.

Appendix

This appendix describes the construction of the risk factors. They based on monthly stock returns in U.S. dollars from Datastream over the five-year period from July 2002 to June 2007. We exclude non-common stocks such as REITs, closed-end funds, warrants, etc. We also exclude those firms that are incorporated outside their home countries as well as those indicated by Datastream as duplicates. To filter out the recording errors in Datastream, we assign missing values to R_t and R_{t-1} if $(1 + R_t)(1 + R_{t-1}) < 0.5$ and at least one of them is greater than or equal to 300%. R_t is the stock return in month t . For weekly and daily data, we use 200% as the cut-off instead. In addition, in view of Datastream's practice to set the return index to a constant once a stock ceases trading, we treat those constant values as missing values in the inactive file.

In the first step we determine domestic factors for each country. The domestic market factor is given by the excess return in U.S. dollars of the country's equity index return over the U.S. treasury bill rate. We calculate country indexes returns using MSCI country market indices obtained from Datastream. For the size and book-to-market factors we follow a methodology similar to Fama and French (1993). All stocks reporting a market capitalization at the end of June and a positive book-to-market ratio are double sorted into two size groups and three book-to-market classifications. Half the stocks are classified as large-cap (B) and the other half as small-cap (S). For the book-to-market classification, the bottom 30% of firms are classified as L , the middle 40% as M , and the highest 30% as H . The intersection of the rankings allows for six value-weighted portfolios: HB , MB , LB , HS , MS , and LS . Formally, we define

$$\begin{aligned}SMB &= \frac{1}{3}(HS + MS + LS) - \frac{1}{3}(HB + MB + LB) \\HML &= \frac{1}{2}(HB + HS) - \frac{1}{2}(LB + LS).\end{aligned}$$

The monthly returns for SMB and HML are then calculated from July in one year to June in the next. The momentum factor (MOM) is constructed on a monthly basis, where we rank stocks at the end of month $t - 1$ based on their cumulative returns from $t - 13$ to $t - 2$ (i.e., prior 2-12 month returns by skipping month $t - 1$) and market value at the end of $t - 1$. Stock inclusion in the portfolio construction requires non-missing values for the cumulative return and market value. For the market-cap classification, half of the stocks are again classified as large-cap (B) and the other half as small-cap (S). For the past returns classification, the bottom 30% are classified as LR (low return), the middle

40% as *MR*, and the highest 30% as *HR*. The momentum factor is defined as

$$MOM = \frac{1}{2}(SHR + BHR) - \frac{1}{2}(SLR + BLR).$$

For the U.S. factors, we use the data posted on Kenneth R. French's website. If a country has fewer than 100 stocks qualifying for the portfolio construction, we set *SMB*, *HML*, and *MOM* factors as missing for the respective year.

A country's international factors are calculated in a second step as the weighted average of the respective domestic factors of all other countries, where the weights are given by the relative stock market capitalization of each foreign country at the beginning of the year. The stock market capitalization data are obtained from World Development Indicator. A complete sample of domestic and international factors by country over the period 1981 to 2010 is available at www.sandylai-research.com.

References

- [1] Adrian, T., and H. Shin, 2010, Liquidity and leverage, *Journal of Financial Intermediation* 19, 418-437.
- [2] Amihud, Yakov, 2002, Illiquidity and stock returns: Cross-section and time-series effects, *Journal of Financial Markets* 5, 31-56.
- [3] Bekaert, G., C.R. Harvey, and C. Lundblad, 2007, Liquidity and expected returns: lessons from emerging markets, *Review of Financial Studies* 20, 1783–1831.
- [4] Aragon, G., and Ph. Strahan, 2009, Hedge funds as liquidity providers: Evidence from the Lehman bankruptcy. Available at SSRN: <http://ssrn.com/abstract=1462315>.
- [5] Baba, N., and F. Packer, 2009, Interpreting deviations from covered interest parity during the financial market turmoil of 2007–08, *Journal of Banking and Finance* 33(11), 1953-1962.
- [6] Broner, F., R. G. Gelos, and C. Reinhart, 2006, When in peril, retrench: Testing the portfolio channel of contagion, *Journal of International Economics* 69, 203-230.
- [7] Brunnermeier, M., and L. Pedersen, 2009, Market liquidity and funding liquidity, *Review of Financial Studies* 22(6), 2201-2238.
- [8] Caballero, R., and A. Simsek, 2009, Fire sales in a model of complexity, MIT Department of Economics Working Paper No. 09-28. Available at SSRN: <http://ssrn.com/abstract=1496592>.
- [9] Carhart, M., 1997, On persistence in mutual fund performance, *Journal of Finance* 52, 57-82.
- [10] Calomiris, Ch., I. Love, and M. S. Martinez Peria, 2010, Crisis ‘shock factors’ and the cross-section of global equity returns, NBER Working Paper no. 16559. Available at SSRN: <http://ssrn.com/abstract=1712236>.
- [11] Chevalier, J., and G. Ellison, 1997, Risk taking by mutual funds as a response to incentives, *Journal of Political Economy* 105, 1167-1200.
- [12] Coval, J., and E. Stafford, 2007, Asset fire sales (and purchases) in equity markets, *Journal of Financial Economics* 86, 479-512.
- [13] Del Guercio, D., and P. Tkac, 2002, The determinants of the flow of funds of managed portfolios: Mutual funds versus pension funds, *Journal of Financial and Quantitative Analysis* 37, 523-558.

- [14] Dornbusch, R., Y. Park and S. Claessens, 2000, Contagion: understanding how it spreads, *The World Bank Research Observer* 15, 177–197.
- [15] Eun, C. , S. Lai, F. de Roon, and Z. Zhang, 2010, International diversification with factor funds, *Management Science* 56, 1500-1518.
- [16] Fama, E., and K. French, 1993, Common risk factors in the returns on stocks and bonds, *Journal of Financial Economics* 33, 3–56.
- [17] Ferreira, M., A., Keswani, A. Miguel, and S. Ramos, 2010, The flow-performance relationship around the world, working paper. Available at <http://ssrn.com/abstract=1364062>.
- [18] Ferreira, M., M. Massa, and P. Matos, 2010, The geography of mutual funds: The advantage of having distant investors, working paper, Marshall school of business working paper No. FBE 07-10. Available at <http://ssrn.com/abstract=1571838>.
- [19] Forbes, K., and R. Rigobon, 2002, No contagion, only interdependence: Measuring stock market comovements, *Journal of Finance* 57(5), 2223-2261.
- [20] Gorton, G., 2008, The panic of 2007, Yale ICF Working Paper No. 08-24. Available at SSRN: <http://ssrn.com/abstract=1255362>.
- [21] Gromb, D., and D. Vayanos, 2010, Limits of arbitrage: The state of the theory, working paper, INSEAD working paper No. 2010/23/Fin. Available at <http://ssrn.com/abstract=1582361>.
- [22] Gromb, D., and D. Vayanos, 2002, Equilibrium and welfare in markets with financially constrained arbitrageurs, *Journal of Financial Economics* 66, 361-407.
- [23] Huang, J., K. Wei, and H. Yan, 2007, Participation costs and the sensitivity of fund flows to past performance, *Journal of Finance* 62, 1273-1311.
- [24] Ivkovic, Z., and S. Weisbenner, 2009, Individual investor mutual fund flows, *Journal of Financial Economics* 92, 223-237.
- [25] Kaminsky, G., C. Reinhart, and C. Vegh, 2003, The unholy trinity of financial contagion, *Journal of Economic Perspectives* 17, 51–74.
- [26] Kindleberger, C. , 1978, *Manias, Panics, and Crashes*, Basic Books, New York, NY (1978).

- [27] Longstaff, F., 2010, The subprime credit crisis and contagion in financial markets, *Journal of Financial Economics* 97(3), 436-450.
- [28] Manconi, A., M. Massa, and A. Yasuda, 2010, The role of institutional investors in propagating the crisis of 2007-2008, UC Davis Graduate School of Management Research Paper No. 04-10. Available at SSRN: <http://ssrn.com/abstract=1454831>.
- [29] Pulvino, T., 1998, Do asset fire sales exist? An empirical investigation of commercial aircraft transactions, *Journal of Finance* 53, 939-978.
- [30] Rinne, K., and M. Suominen, 2010, Short term reversals, returns to liquidity provision and the costs of immediacy, working paper. Available at SSRN: <http://ssrn.com/abstract=1537923>.
- [31] Shleifer, A., and R. Vishny, 1992, Liquidation values and debt capacity: A market equilibrium approach, *Journal of Finance* 47, 1343-1366.
- [32] Shleifer, A., and R. Vishny, 1997, The limits of arbitrage, *Journal of Finance* 52, 35-55.
- [33] Shleifer, A., and R. Vishny, 2011, Fire Sales in Finance and Macroeconomics, *Journal of Economic Perspectives* 25(1), 29-48.
- [34] Sirri, E., and P. Tufano, 1998, Costly search and mutual fund flows, *Journal of Finance* 53, 1589-1622.

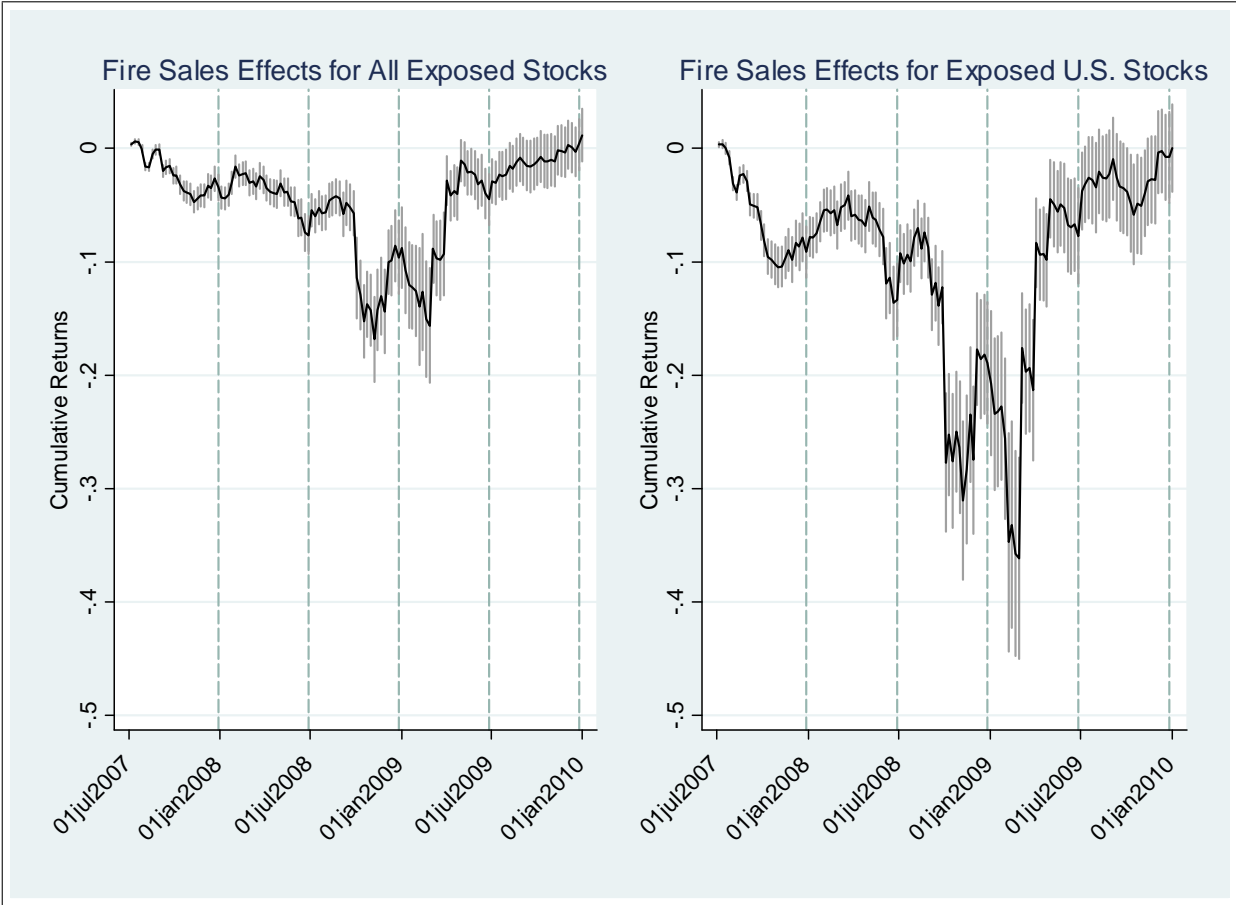


Figure 1: The graphs show the cumulative underperformance of exposed stocks worldwide and in the U.S. relative to stocks in the same country and industry and after accounting for risk premia from a model with four local and four international risk factors. Exposed stocks are those 15% of all non-financial stocks worldwide for which (weighted by stock ownership shares) fund owners experienced the highest fund return shortfall due to stock positions in financial stocks in the second semester of 2007 and first semester of 2008. The vertical bars provide robust standard errors ($\pm 1 SE$) around the point estimate of the average cumulative underperformance.

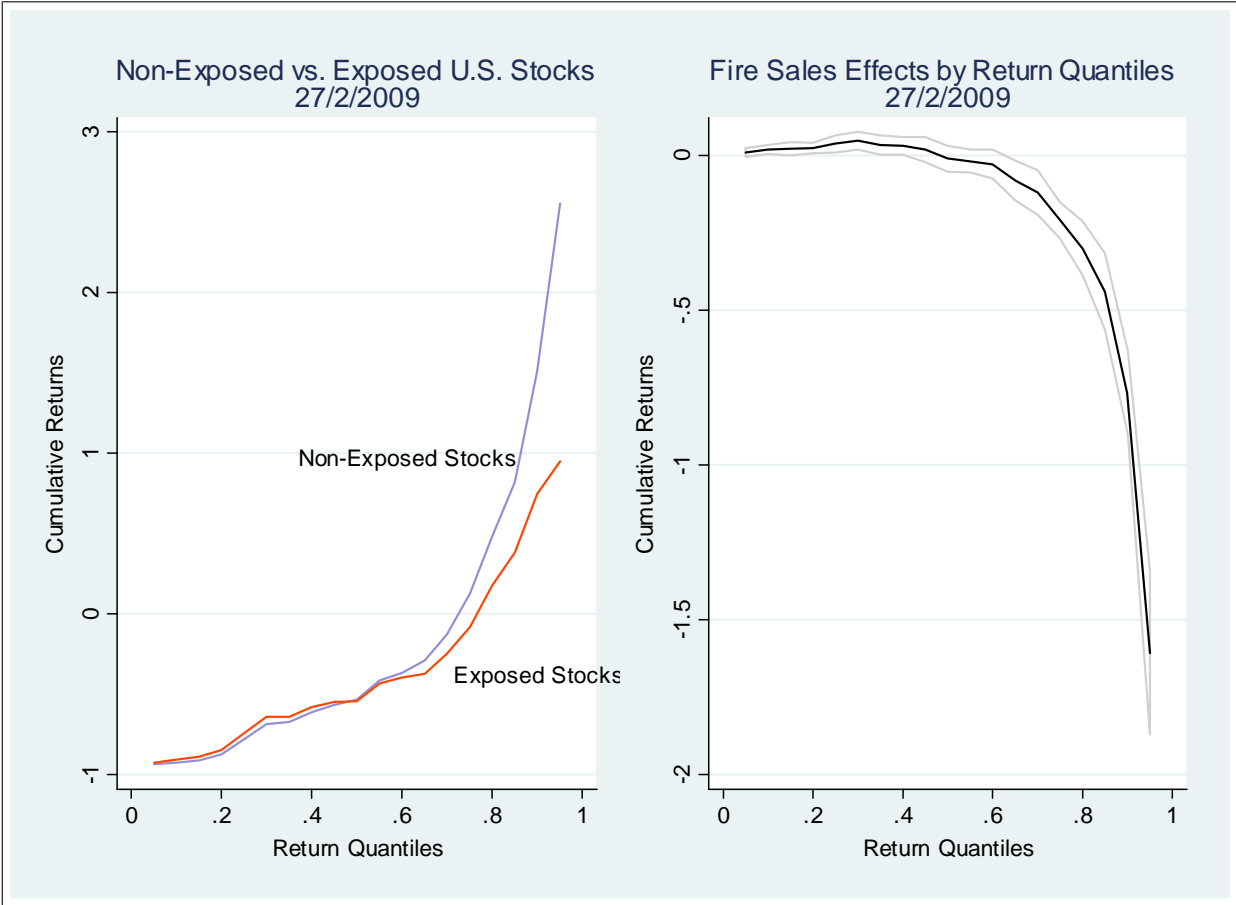


Figure 2: The graph on the left shows the relative performance of exposed and non-exposed U.S. stocks by stock return quantiles, controlling for industry fixed-effects. The y-axis denotes the cumulative (weekly) returns from June 29, 2007 to February 27, 2009, adjusting for risk premia from a model with four local and four international risk factors. The x-axis denotes the quantiles of the cumulative stock returns. The right graph plots the performance difference between the exposed and non-exposed U.S. stocks. The robust standard errors ($\pm 1 SE$) around the point estimate of the average cumulative underperformance are also plotted.

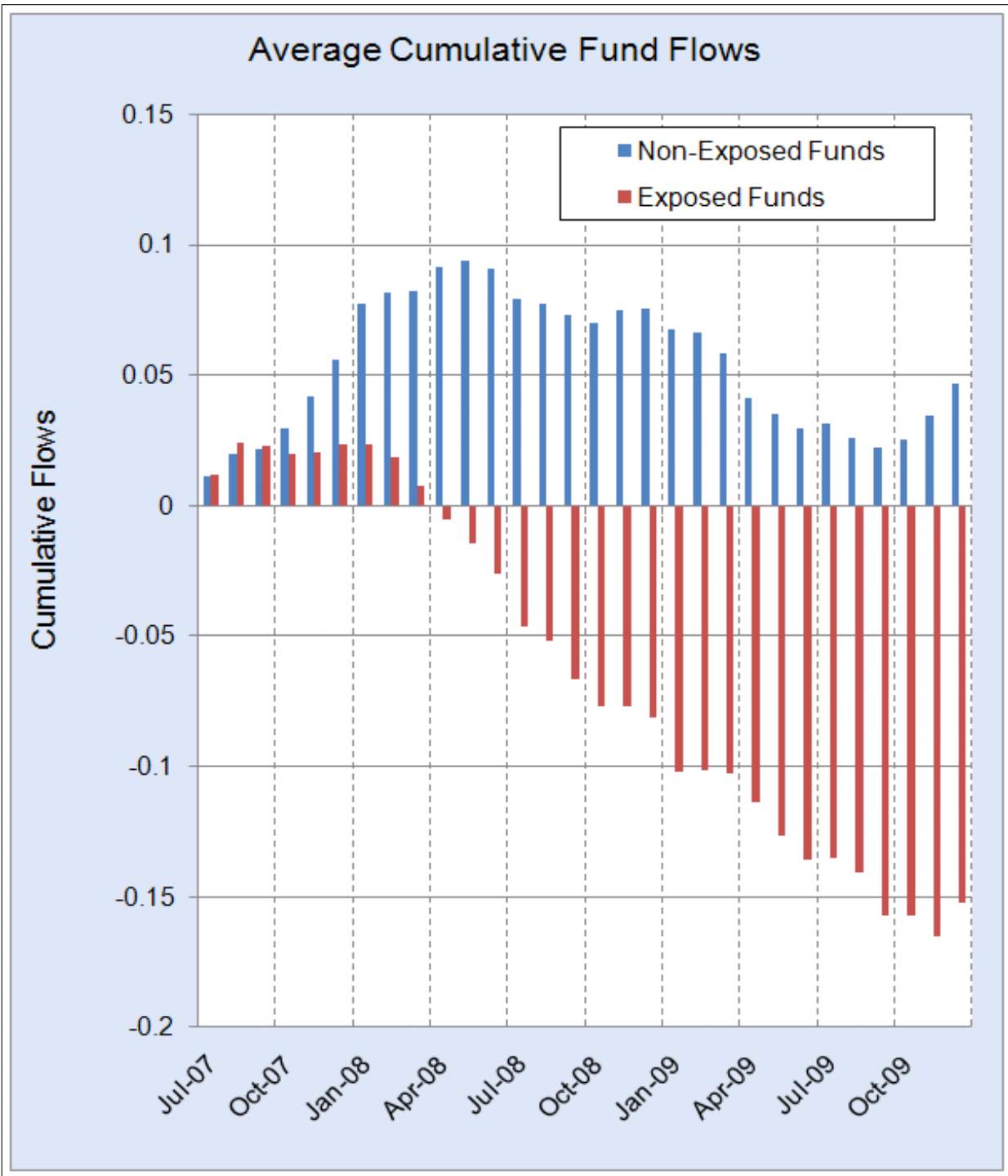


Figure 3: Plotted are the average cumulative fund flows (in percentage of total assets under management) for the 15% funds with the highest investment losses in financial sector stocks (exposed funds) and the 85% remaining funds (non-exposed funds).

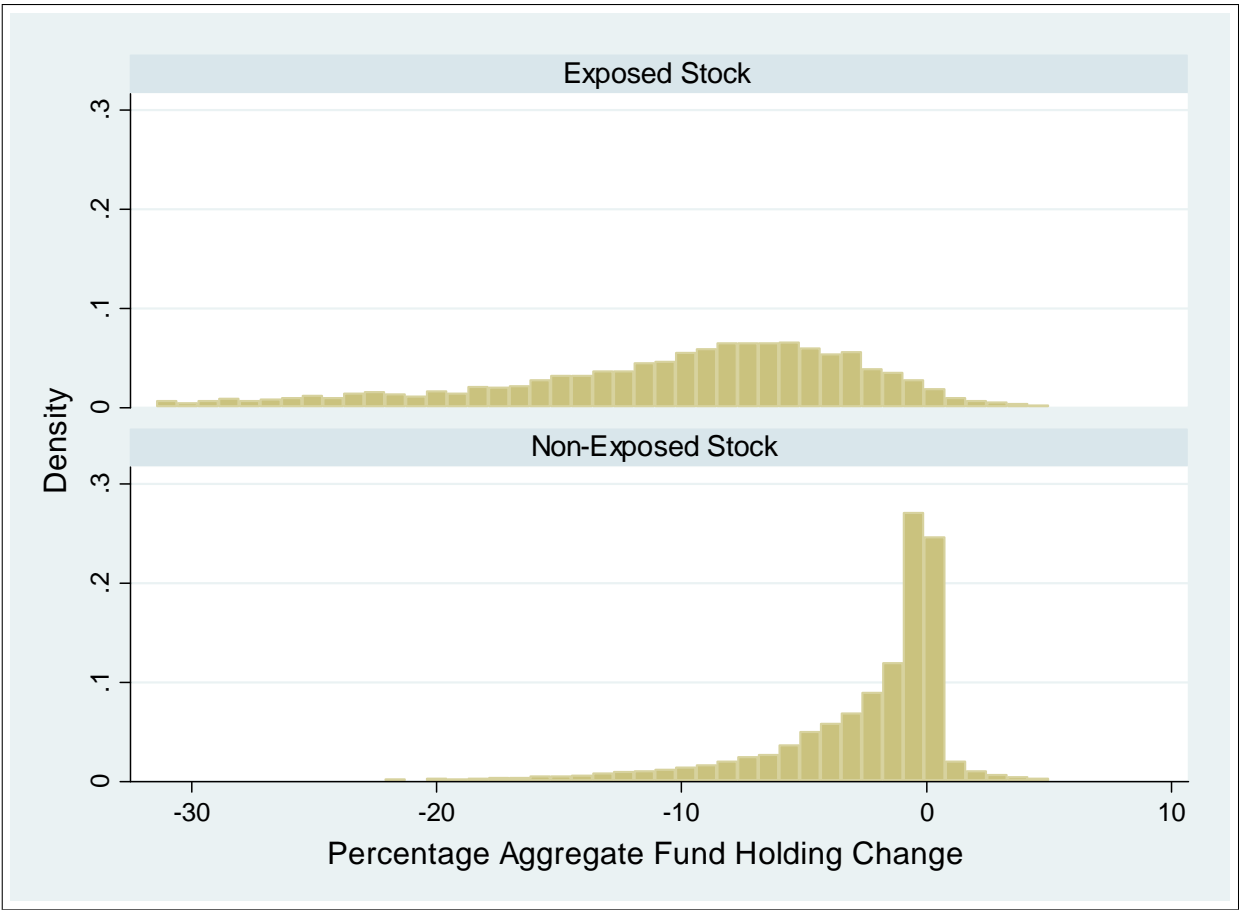


Figure 4: Plotted is the distribution of the percentage change $\Delta \tilde{H}^s(4)$ in the aggregate stock holdings in stock s for funds with stock positions in June 2007 over four consecutive semesters. Exposed stocks are the 15% of stocks with the most distressed funds as their owners.

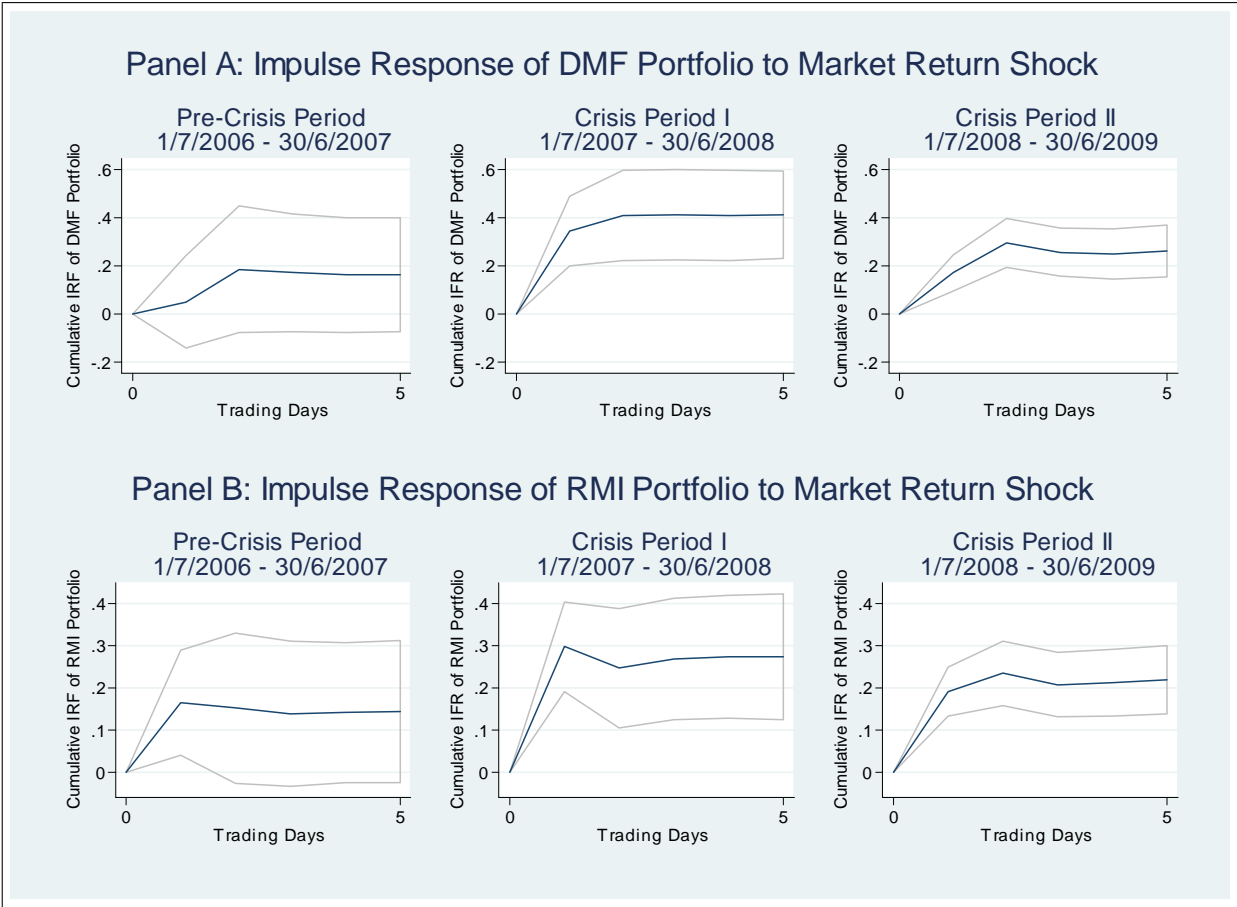


Figure 5: In Panel A, we estimated a VAR consisting of the daily MSCI return index for all U.S. stocks and in an (equally weighted) long-short portfolio DMF (Direct Minus Fund) consisting of the 15% U.S. stocks with the lowest share of fund investment minus the 15% U.S. stocks with the highest share of fund investment in June 2007. In Panel B, we use (instead of the DMF portfolio) a long-short portfolio RMI (Retail Minus Institutional) consisting of (equally weighted) long position in the 15% of NYSE stocks with the highest percentage of retail trading volume minus the 15% of stocks with the lowest percentage retail trading volume. Plotted are the cumulative impulse response functions (IRFs) for the DMF and RMI portfolio return after a unit innovation to the U.S. index return for three separate time periods. The upper and lower line provides a 95% confidence interval for the point estimates.