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ABSTRACT

Real Effects of Stock Underpricing*

This paper provides evidence for a causal effect of equity prices on corporate investment and employment. We use fire sales by distressed equity funds during the 2007-2009 financial crisis to identify substantial exogenous underpricing. Firms whose stocks are most underpriced have considerably lower investment and employment than industry peers not subject to any fire sale discount. The causal effect of underpricing on investment is found to be largely concentrated on the most financially constrained firms.

JEL Classification: G11, G14 and G23
Keywords: employment, fire sales, investment, market inefficiency and mutual funds

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1 Introduction

Do stock listings and the subsequent information aggregation in equity prices constitute a stock-price-based monitoring channel and contribute to better investment quality? The economic literature has extensively discussed governance benefits of stock listings (and cross-listings) in terms of their impact on the legal and shareholder environment, which in turn affects how resources are allocated within a firm.[1] Yet the very role of the stock price itself in determining corporate investment remains elusive. Do managers base capital budgeting decisions on private information and ignore stock prices so that the latter become a "sideshow"?[2] Or do stock prices play an important role in coordinating investment decisions across firms and sectors by channeling capital to its most profitable use after adjusting for risk? Prior empirical research has been inconclusive on this issue because of the difficulty in identifying exogenous mispricing events that can reliably test for the independent role of stock prices in corporate investment.[3]

This paper argues that the 2007–2009 financial crisis provides a natural experiment of large-scale stock mispricing which can render clear evidence on a causal effect of stock prices on corporate investment. Using global fund ownership data, we find a large sample of U.S. stocks exposed to fire sales by distressed equity funds. These distressed funds are identified as having large investment losses in bank stocks and therefore they experienced high fund redemptions. Non-financial stocks with high ownership by distressed equity funds were substantially under-priced relative to industry peers with non-distressed fund owners. In the absence of systematic investment bias by distressed funds in their portfolio of non-financial stocks, funds' fire sale behavior represents an exogenous treatment effect and therefore provides a robust way to test for the causal effect of stock prices on the allocation of real resources.

We find, indeed, that stock underpricing had a powerful causal effect on both investment and

[1] For a recent discussion of how cross-listings can constrain the private consumption of control benefits, see Doidge *et al.* (2009). Ferreira and Matos (2008) provide evidence that institutional owners in particular limit corporate overinvestment by large firms and improve their operating performance.

[2] See Blanchard, Rhee and Summers (1993), who refer to the stock market as a "sideshow". See also Morck, Shleifer, and Vishny (1990).

[3] Supportive evidence on the role of stock prices in investment is provided by Baker, Stein, and Wurgler (2003) as well as Goyal and Yamada (2004). On the other hand, Morck, Shleifer, and Vishny (1990), and Blanchard, Rhee and Summers (1993) argue that the capital allocation role played by the stock price is only modest. Recent work by Bakke and Whited (2010) find no evidence that corporate investment responds to stock mispricing.

employment in the 2007–2009 crisis. On average, stocks subject to fire sales were underpriced by 37%, and they simultaneously reduced quarterly investment in 2008/4 and 2009/1 by an additional 20% compared with industry peers; the employment of these underpriced firms also incrementally decreased by 4.7% in 2009 relative to industry peers. Our further analysis focuses on the role of external finance in the dependence of real investments on stock valuation. Using the Hadlock and Pierce index of financial constraints (the "AS index"), we divide firms into the 30% most likely to face external financing constraints and the rest. We find that the former group accounts for most of the strong decline in the investment share among underpriced stocks. By contrast, the 70% of firms least likely to be subject to external financing constraints do not reduce their own investment relative to industry peers even when their stocks are severely underpriced. This finding suggests that external financial constraints play a key role in the causal effect of stock prices on investment. A direct stock-price-based monitoring channel operates through the availability of external finance—mostly affecting small and financially constrained firms.

Any welfare interpretation of the above finding on the stock-price-based monitoring depends on the degree of market efficiency and the pervasiveness of agency problems in corporate investment.[4] Any direct allocation role of stock prices implies distortion of the investment process whenever stock prices are inefficient. Such a distortion in investment concerns not only stock underpricing (as in our natural experiment), but also stock overpricing. For example, Polk and Sapienza (2009) provide evidence that managers actively "cater" to market sentiment by investing more at inefficiently high stock prices.[5] However, if corporate agency problems affect investment efficiency, then even a less than fully efficient stock price can be beneficial—external monitoring based on stock price information can restrain value destroying investments. In this latter case, stock market development contributes positively to economic efficiency (Holmström and Tirole, 1993).[6]

The previous literature has documented a positive correlation between stock market returns and subsequent corporate investment in both the time series and the cross section (Fama, 1981;

[4] See Stein (2003) for a review of the effect of agency conflicts on corporate investment.

[5] See also Gilchrist *et al.* (2005).

[6] See Dow and Gorton (1997) for a discussion about the relationship of financial market efficiency and economic efficiency.

Barro, 1990; Morck, Shleifer, and Vishny, 1990). But this is uninformative about causality. Stock prices may just passively reflect changing investment opportunities and the respective investment decisions—suggesting that corporate investment efficiency does not depend on stock prices. On the other hand, an opposing "market centric view" of capital allocation sees stock prices as crucial for the external monitoring of the investment process. The latter view is predicated on a causal stock price effect on investment.[7]

In order to explore causality, previous work focused on the effect of asset mispricing on investment. The extant literature employs firm-level mispricing proxies to show that the sensitivity of investment to stock mispricing varies in the cross-section according to certain firm characteristics. In particular, small equity-dependent firms are found to reveal much stronger investment sensitivity to mispricing measures such as Tobin's q (Baker, Stein, and Wurgler, 2003); opaque firms with high R&D intensity are shown to have a higher investment sensitivity with respect to a mispricing measure based on discretionary accruals (Polk and Sapienza, 2009). But these mispricing measures are noisy proxies and their measurement errors correlate with the correct valuation. Hence, one should expect to find different investment sensitivities whenever firm characteristics also drive both investment and the correct stock valuation. For example cross-sectional differences in the severity of agency problems may imply that small firms react faster to new investment opportunities. This should generate differences in investment sensitivities to Tobin's q even in the absence of any mispricing or any causal effect of stock mispricing on investment. Similarly, discretionary accruals may occur in firms for which investment is per se more reactive to new investment opportunities. These considerations show that convincing evidence for a causal link between stock valuation and investment depends on truly exogenous identification of mispricing such that measurement errors are uncorrelated with particular firm characteristics. This paper provides such an identification by using fund-level investment information sufficiently exogenous to the corporate investment process and agency problems.

Another research strategy consists in directly confronting the measurement problem with respect to Tobin's q. Bakke and Whited (2010) develop an errors-in-variables model that

[7] For a theoretical analysis of the role of stock listings (and market liquidity) see for example Holmström and Tirole (1993).

allows investment sensitivity to depend on a "true" q observable only to managers. Here, the authors find no evidence that investment responds to the non-fundamental error component in q. But even their generalized framework must assume that the error in the measurable q is independent of other unobservable firm characteristics that might also influence a firm's investment share. Goyal and Yamada (2004) decompose Tobin's q into a firm specific and a non-fundamental component during the 1987–1990 Japanese stock market boom and find that the latter strongly correlates with investment.[8] But their identification of the non-fundamental q is based on regression residuals which might still comprise unobservable components of the fundamental valuation. Moreover, (macroeconomic) fixed time effects (such as the general market exuberance) might influence both the investment and the stock price process without a causal effect of the latter on the former.

The identification strategy in our paper is related to Gao and Lou (2011), who use price pressure resulting from mutual fund flow-induced trading to identify equity mispricing. They show that equity overvaluations lead to more investment (as well as equity and debt issuance), particularly for the financially most constrained firms. Important for the authors' identification is that investor mutual fund inflows are exogenous and not determined by investor expectations regarding return prospects of the fund portfolio. By contrast, our identification strategy is not based on (possibly endogenous) fund flows, but on a negative return shock to a particular component of the fund portfolio. This constitutes an even more solid identification strategy.

The 2007–2009 crisis provides a new research opportunity to reach a better understanding of the transmission channels from financial to real activities. Using survey-based data, Campello, Graham, and Harvey (2010) and Campello *et al.* (2011a, 2011b) document that financially constrained firms, especially those without access to credit lines, planned more cuts in their capital spending and employment than other firms. Duchin, Ozbas, and Sensoy (2010) document that corporate investment declined significantly following the crisis for firms with low internal and external capital. Almeida *et al.* (2011) identify firms whose long-term debt was mostly maturing right after the third quarter of 2007 and show that these firms reduced their investment substantially afterwards. The contribution of our paper is to show that a stock market crash *by itself* has a causal effect on the real investment. Firms with relatively

[8] See also Chirinko and Schaller (1996, 2001).

more depressed stock prices due to fund fire sales during the crisis are particularly negatively impacted in their investment and employment. In particular, relative to all other financially constrained firms, those constrained firms whose stock prices are severely underpriced have a roughly 45% lower investment share at the peak of the crisis.

The following section discusses our identification strategy for equity mispricing during the financial crisis. Section 3 presents evidence for the real effects of such mispricing. Section 4 discusses the role of firms' external financial constraints for the effect of stock prices on investment, followed by concluding remarks in Section 5.

2 Stock Price Effects of Fund Fire Sales

The stock market's tendency towards efficiency implies that cases of economically large stock mispricing tend to be rather exceptional. In this paper, we identify such an exceptional event based on fire sales by distressed equity funds over the 2007–2009 financial crisis. For individual stocks, fire sales by equity funds have been shown to imply relatively large transitory price effects (Coval and Stafford, 2007). Hau and Lai (2011), in particular, show that fire sales by distressed equity funds in the recent crisis generated extremely large stock underpricing: Roughly one quarter of all U.S. stocks were subject to fire sales by equity funds and these stocks were underpriced relative to industry peers by 37% on average. Transitory underpricing relative to industry peers is particularly pronounced for stocks with above-median performance during the crisis because distressed funds tended to sell their best-performing stocks. The 2007–2009 financial crisis therefore serves as an event study in which a large scale of relative stock underpricing can be clearly identified.

2.1 Measuring Fire Sales Exposure

Following Hau and Lai (2011), we use the Thomson Reuters mutual fund database. It accounts for pure equity funds as well as the equity holdings of balanced funds that also hold other assets like bonds. In the latter case only the equity portion of the fund holdings is reported. Most funds report only at six-month intervals—hence our analysis is carried out at a semi-annual frequency. For funds with multiple reporting dates within a semester, we retain only the last reporting date.

Our analysis discards highly concentrated fund holdings with less than five stock positions in a semester. Based on this filter, we obtain a sample of 27,274 mutual funds with equity investments in 25 developed and 54 emerging markets over 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 in each semester is uneven. In June 2007, the data cover a total of 20,477 funds reporting stock positions with a combined total net equity value of 9.7 trillion dollars.[9]

In the first step, we calculate the return shortfall—called "fund exposure" (Exp^f)—for all equity funds worldwide due to ownership in financial stocks from July 2007 to June 2008. A fund exposure of -15% implies that a fund suffered a decrease of 15% in its total equity return over the 12-month period due to portfolio positions in bank stocks. The fund exposure measure identifies funds most likely to face strong investor redemptions because of overinvestment in underperforming financial stocks. The one-year period prior to the Lehman collapse coincides with the dramatic decline of many bank stocks because of their exposure to the subprime market. In the second step, fund exposure is aggregated to a stock-specific measure of "stock exposure" (Exp^s) for all non-financial U.S. stocks.[10] Formally, stock exposure for stock s is defined as

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

where $\omega^s(f)$ denotes the holdings of fund f in stock s relative to the aggregate holdings of all funds in the stock; and Fsh^s denotes the "fund share", defined as the aggregate fund holdings in stock s relative to its shares outstanding. Both the holding weights $\omega^s(f)$ and the fund share Fsh^s are measured at the end of June 2007. A high stock exposure Exp^s implies that

[9] Our data coverage is therefore comparable to the Lionshares database used by Cremers *et al.* (2011), who reported total net equity assets of 7.97 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. At 73%, this figure is somewhat smaller for U.S. domiciled funds. See also Ferreira *et al.* (2010).

[10] The focus on U.S. stocks is justified because our stock holding data are most complete for U.S. stocks and fund fire sales are most powerful here due to the large share of fund ownership. For a clean identification of non-financial stocks, we use the Compustat industry segment file and exclude from the sample all conglomerates that have finance divisions accounting for more than 1% of total sales.

a relatively large proportion of a stock's capitalization is owned by equity funds with high fund exposure to banking stocks. Such stocks therefore face the largest selling pressure if fund exposure captures the need for fire sales by individual funds.

Summary statistics on stock exposure of U.S. non-financial stocks are reported in Table 1. The mean (median) stock exposure is -0.249% (-0.181%), with large negative skewness of -2.0. The 25%, 10%, and 5% most negative stock exposure quantiles are -0.35%, -0.46%, and -0.56%, respectively. For example, a stock exposure of -0.35% is obtained if 10% of a stock's capitalization is owned by funds that on average lost 3.5% in their portfolio returns due to financial stock investments. The non-normality of the stock exposure variable makes it convenient to define a dummy $DExp^s$ which marks the 25% of U.S. stocks with the highest stock exposure. Quantifying the stock exposure effect in linear regressions is thus straightforward.

An alternative definition of fund distress could use fund outflows directly as an identifying measure. However, in this case fund outflows may simply reflect a fund's portfolio choice and therefore become endogenous. For example, a high beta fund is likely to underperform during a financial crisis, experience larger fund outflows, and sell predominantly high beta stocks so that the fire sales price effect becomes entangled with a possible increase in stock risk premia. Fund outflows may also be driven by a few investors' foresight about the future performance of a fund. In this case, outflows correlate with future stock underperformance and therefore the fire sales effect becomes entangled with a confounding selection effect. We argue that the identification strategy we propose in this paper represents a more exogenous measure than fund outflows.

However, fund exposure to financial stocks (as defined above) should be highly correlated with fund outflows. To document this, 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." For 8,250 funds we are able to match the fund identity in the Thomson database to the Lipper database, which provides complementary data on the exact fund returns and fund size in order to estimate monthly investor redemption. We excluded the 1% of funds with extreme monthly net flows because of concerns about reporting errors. Figure 1 shows the average cumulative net subscription/redemption from July 2007 through December 2009 separately for exposed and non-exposed funds. Exposed funds experience net investor outflows after September 2007, which accumulated to a sizeable average fund outflow of more than 10% in April 2009. By contrast, for non-exposed funds the average net cumulative inflow remains positive over the full 30-month period and climbs to 15% at the end of 2009.

2.2 Fire Sale Effects by Return Quantiles

Stock returns are measured as cumulative excess returns $r_s^{Ex}(k)$ from July 1, 2007, over k consecutive weeks. Risk adjustment of returns is based on the international version of the four-factor Carhart model, estimated on pre-crisis data from July 2002 to June 2007. The four domestic factors and four international factors each consist of the market, size, book-to-market, and momentum factors. More detailed description is provided in the Appendix A. Alternative risk adjustment based, for example, on domestic risk factors produces qualitatively similar results.

First, we use quantile regressions to infer the fire sales effect. Risk-adjusted cumulative returns $r_s^{Ex}(k)$ over k weeks since June 29, 2007 of all non-financial stocks are regressed on the dummy $DExp^s$, which marks the 25% of U.S. stocks with the highest ownership share by distressed equity funds;

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

The regression controls for a stock's fund share Fsh^s (aggregate fund ownership relative to stock capitalization) and also includes industry fixed effects. Controlling for fund share captures the holding bias of equity funds towards larger and more liquid stocks. Moreover, fund share is (strongly) negatively correlated with a stock's retail investor ownership and therefore controls for panic sales by retail investors over the 2007–2009 crisis (Hau and Lai, 2011). The coefficient α_1^k captures the fire sales effect for the 25% most exposed stocks relative to non-exposed stocks in the same industry.

Figure 2, graph A plots the evolution of the coefficient α_1^k for each week of the financial crisis at the 50% quantile of risk-adjusted cumulative returns, graph B plots the same evolution at the 75% quantile, graph C at the 90% quantile, and graph D at the 95% quantile. Vertical bars around the main line indicate a confidence interval of two standard deviations around the point estimate. Exposed stocks with median return performance (graph A) show no discernible evidence for a discount relative to non-exposed stocks. At the 75% quantile of better-performing stocks, the exposure discount is economically and statistically significant and peaks at -29% in February 2009. At the 90% and 95% quantile of the best-performing stocks, the fire sale discount reaches a large -74% and -145%, respectively, before reverting in the spring of 2009. No statistically significant effects are found for lower performance quantiles. As argued by Hau and Lai (2011), distressed equity funds avoided loss realization implicit in selling underperforming stocks and instead liquidated the best-performing stocks in order to finance investor redemptions.

Second, we use cross-sectional OLS regressions to characterize the discount for cumulative returns measured at the quarterly frequency. As fire sales discounts are concentrated on the 50% best-performing stocks, we focus on this stock group and define a high return dummy variable $DHighR(t)$ marking the 50% of stocks with the highest (risk-adjusted) return from the beginning of 2007/3 to the end of quarter $t-1$. The high return dummy for quarters 2007/1, 2007/2, and 2007/3 is set equal to that for quarter 2007/4**.** The high return dummy is then interacted with the exposure dummy $DExp^s$ to produce a proxy $DExp^s \times DHighR(t)$ of fire sales intensity and stock underpricing. Formally, the regression is of the form

$$r_s^{Ex}(t) = \beta_0 + \beta_1^t[DExp^s \times DHighR(t)] + \beta_2 X_s + \mu_s,$$

where $r_s^{Ex}(t)$ represents cumulative excess returns from the beginning of 2007/3 to the end of quarter t, and the coefficient β_1^t measures cumulative stock price discounts from fire sales. As a robustness check, we add cross-sectional regressions for the two quarters prior to the crisis, 2007/1 and 2007/2 , in which $r_s^{Ex}(t)$ measures excess returns for the respective quarter. The control variables X_s include the fund share Fsh^s as well as the exposure dummy $DExp^s$ and the high return dummy $DHighR(t)$ as separate terms (not reported). In addition, we use industry fixed effects based on four-digit SIC codes so that the influence of macroeconomic crisis at the industry level is purged from the return regression.

Table 2 shows the price discounts captured by the interaction dummy $DExp^s \times DHighR(t)$ over the entire period from 2007/3 to 2009/4. The discounts peak in 2008/4 and 2009/1 with a -43.1% and -44.6% cumulative return, respectively, before declining again. The OLS coefficient β_1^t therefore shows a time pattern for stock underpricing similar to the coefficients (for the high-performance quantiles) plotted in Figure 2. We also note that the fund share control variable is frequently significantly positive. A change of two standard deviations (= 0.306) in the fund share (towards more equity fund and less retail ownership) at the end of 2008/3 implies an increase in crisis performance of 8.1% (= $0.306 \times 26.4\%$). A higher share of (institutional) fund ownership in a stock generally correlates with lower crisis discounts. Section 3 uses the dummy $DExp^s \times DHighR(t)$ as a measure of stock underpricing in panel regressions of investment and employment.

2.3 Identification Issues and Endogeneity

For a clear discussion of potential problems with our identification strategy, it is useful to highlight three dimensions in which a fund's portfolio choice may be endogenous. First, all funds exhibit common investment biases towards larger and more liquid stocks. Second, exposed funds pick high return stocks for their fire sales (which we mark by the dummy $DHighR(t)$), and they may furthermore choose particular high return stocks for sales. Third, exposed funds (with large investments in underperforming bank stocks) may differ from non-exposed funds in their selection of non-financial stocks in their portfolio. Next, we discuss each of the three issues in turn.

A general investment bias of all funds toward particular stock types only means that the causal effect should also concentrate in stocks with higher fund ownership. Given the observability of the fund share in all stocks, we are able to control for general fund investment biases.[11]

The endogenous fund choice of high return stocks for fire sales documented in the previous section requires more discussion. To identify the groups of stocks most subject to fire sales, we use the high return dummy $DHighR(t)$ and interact it with the exposure dummy. The interaction term $DExp^s \times DHighR(t)$ yields an unbiased estimate of the investment effect under the assumption that the exposure dummy $DExp^s$ is uncorrelated with the error term in the investment regression when conditioning on the dummy $DHighR(t)$. In other words, the assumption requires the orthogonality of the exposure dummy $DExp^s$ and the regression residual to extend to the two subsamples of stocks: Those above and those below median per-

[11] The respective robustness test is provided in Table 5.

formance. An endogenous selection effect may interfere with this assumption. It is possible that stocks with a fundamental value change above the median may be pushed out of the high return subsample due to a strong negative fire sales effect on their returns. Such endogenous median-crossing for some observations can create an attenuation bias for the estimated coefficient because those exposed stocks with strong fire sales effects are more likely to drop out of the high return subsample. How important is such median-crossing for exposed stocks in our sample? In Figure 3, we plot the fire sale discount for exposed stocks relative to non-exposed stocks based on a sequence of quantile regressions over the entire range $[.05, .95]$ of cumulative return quantiles. The reference period for the cumulative return is from July 2007 to the crisis peak in February 2009. The graph shows that the fire sale discount becomes discernible only at above the 60% quantile, beyond which level exposed stocks show significantly lower returns than non-exposed stocks. The median stock, marked by a vertical line, has a cumulative return of less than -50% for both subsamples. At higher performance quantiles (on the right of the graph), returns increase rapidly even for exposed stocks, suggesting that the median-crossing is relatively insignificant for the high return sample. Under the null hypothesis that stock price discounts do not affect investment, the level coefficient for $DHighR(t)$ should fully account for any investment effect specific to the high return sample. Our regression specifications therefore include $DHighR(t)$ as a separate control variable.

The third endogeneity dimension potentially poses the biggest challenge to our identification procedure, which requires that exposed and non-exposed funds differ only randomly in their selection of (high return) non-financial stocks. Fortunately, the fund holding data allows us to examine such independence in stock selection by comparing the portfolio similarity for pairs of exposed funds to that for pairs of one exposed and one non-exposed fund. Formally, for any pair of funds (f_1, f_2), we define their portfolio overlap in the non-financial sector as the sum of the common weights in all stock groups g as

$$Overlap(f_1, f_2) = \sum_{g \in \text{Set of Stock-Groups}} \min[\widehat{w}^{f_1,g}, \widehat{w}^{f_2,g}],$$

where $\widehat{w}^{f_1,g}$ and $\widehat{w}^{f_2,g}$ represent the portfolio weights of high return stocks (relative to all non-financial stocks holdings) in stock group g by funds f_1 and f_2, respectively. We use all exposed funds (defined as those with the 15% highest fund exposure) and a matching set of non-exposed funds with the same fund size distribution and define 48 distinct stock groups based on the 12 Fama-French industry groups, two stock size categories, and two leverage categories.

Table 3 reports the portfolio similarity in these 48 stock groups between all pairs of any two exposed funds (column (1)) and between all pairs of exposed and non-exposed funds (column (2)). The distribution of the overlap statistics is extremely similar. For example, the median stock group overlap is 9.7% between two exposed funds compared to 8.4% for an exposed and a non-exposed fund. Given the large number of fund pairs, we reject the hypothesis that the two distributions are identical (in a statistical sense). Economically, however, both distributions are so similar and dispersed that we can justify our random treatment assumption—that the portfolio allocation of exposed funds in non-financial stocks is randomly (and not systematically) different from that of non-exposed funds.

3 Stock Underpricing and Its Real Effects

The financial crisis was characterized by a general decline in firm investment. We measure the investment share as the capital expenditure reported in period t relative to the net capital stock in period $t-1$. This share declined for U.S. companies from a mean of 33.9% in 2007 to 29.4% in 2008 and to 19.2% in 2009. Median employment growth was 3.7%, 0.0%, and −4.1% in the years 2007, 2008, and 2009, respectively. The analysis of the investment share in section 3.1 is based on quarterly data since capital expenditure is typically reported at that frequency, whereas the firm-level employment data used in section 3.2 are available only at the annual frequency.

3.1 Quarterly Investment Outcomes

In order to quantify the effect of stock undervaluation on investment, we first use panel regressions with the quarterly investment share as the dependent variable and the undervaluation proxy $DExp^s \times DHighR(t)$ as the explanatory variable:

$$Inv_{st} = \gamma_0 + \gamma_1[DExp^s \times DHighR(t)] + \gamma_2 X_s + \mu_{st}.$$

The coefficient γ_1 measures the investment shortfall due to exogenous stock underpricing.

In the first specification in Table 4, column (1), we use industry fixed effects interacted with time fixed effects to control for all macroeconomic effects at the industry level. As additional control variables X_s, we include the exposure dummy $DExp^s$ and the high return dummy $DHighR(t)$ as separate terms, and pre-crisis measures of $Stock\ Size$ (log of assets at the end of 2006), $Tobin's\ q$ (in 2006), $Cash\ Flow$ (for 2006), and risk-adjusted $Stock\ Return$ (for 2006). We discard the 2% highest and lowest outliers for all accounting variables and 1% for return variables. Summary statistics for these variables are reported in Table 1. Appendix B provides detailed definitions of accounting variables used in the paper. The undervaluation proxy $DExp^s \times DHighR(t)$ is (individually) statistically insignificant from 2007/1 to 2008/3. Around the peak of the underpricing of exposed stocks in 2008/4 and 2009/1, the coefficient becomes negative with a significance level of 1% before turning statistically insignificant in the second part of 2009. The F-test rejects the hypothesis that all four coefficients for the quarters 2008/3 to 2009/2 are jointly zero with an F-value of 11.37. We can therefore assert a negative investment effect from stock underpricing for these four quarters at a very high level of statistical significance. The point estimate of -1.22% for 2008/4 represents an economically significant investment shortfall of -20% relative to an already depressed quarterly average investment share of 6.22% in 2008/4. The corresponding investment shortfall is -23% ($= -1.07\%/4.61\%$) in 2009/1. The control variables have the expected signs: Large firms feature a lower investment share, while the 2006 observations on Tobin's q, cash flow, and stock return correlate with higher firm investment. All standard errors are adjusted for clustering at the stock level. As a robustness check, we also allow for serial correlation in the error structure with similar results for statistical significance.

A second specification in Table 4, column (2), is based on stock fixed effects and separate time fixed effects. The stock fixed effects replace the four control variables; they provide a much better regression fit with an adjusted R^2 of 0.455 compared with 0.161 using industry fixed effects. The point estimates for the undervaluation effect on investment are (individually) statistically significant at the 4% level for each of the five quarters 2008/2 to 2009/2. The hypothesis of joint statistical insignificance for all four quarters 2008/3–2009/2 can be rejected, with an F-value of 13.36. The reported standard errors are adjusted for clustering at the stock level. The economic significance of the investment shortfall is very similar to the first specification; for 2008/4 (2009/1) the point estimate of -1.00% (-0.96%) is slightly smaller and represents a relative investment decrease of -16% (-21%). Overall, the regressions based on quarterly investment data provide strong evidence that the undervaluation of stocks subject to equity fund fire sales had a large adverse effect on the behavior of the firms themselves.

As an additional robustness test, we check that general investment biases of funds (for example, towards larger and more liquid stocks) are of only minor influence on these results. In Table 5, column (2) we add interaction terms of the fund share in each stock (Fsh^s) and quarterly time fixed effects as control variables. The results for the investment shortfall for 2008/3 to 2009/2 remain very strong.

3.2 Annual Investment and Employment Outcomes

For a large cross-section of companies, employment data are reported at the end of the year. We therefore repeat the above regressions using both the annual investment and employment data. The dependent variable in the employment equation is given by the percentage change in the number of employees relative to the previous year.

Table 6, column (1), presents the OLS regression results where the investment share and employment change equations are estimated separately. We use the same pre-crisis controls as in Table 4, column (1), and include (as before) industry fixed effects interacted with time fixed effects. Both the investment and the employment equations yield a statistically significant negative coefficient for the undervaluation effect in 2009, as shown in $DExp^s \times DHighR(2009)$. The point estimate for the investment shortfall is -4.31%, which implies a change of -22% relative to a mean investment share of 19.20% for all firms in 2009. The yearly investment data therefore produce quantitatively similar results compared with the quarterly regressions in Table 4. The point estimate for the employment change in firms with depressed stock prices is -4.70%. The mean (median) employment change for all firms in 2009 is -4.10% (-4.06%); hence firms with depressed stock prices reduced employment by 115% (116%) more than the average (median) firm in the sample.

We also estimate both equations simultaneously as Seemingly Unrelated Regressions (SUR); the regression coefficients are reported in Table 6, column (2). The point estimate for the relative investment effect in 2009 is -3.69%, slightly smaller than the corresponding OLS estimate

(-4.31%); the estimate for the employment effect is -4.69%, also somewhat smaller than the OLS coefficient (-4.70%). However, the simultaneous equation approach does not yield any significant reduction in the standard errors of the coefficients. Under the SUR approach, however, we can test the cross-equation restriction that both coefficients for the undervaluation effect are jointly zero. Such a hypothesis is again strongly rejected at the 1% level of significance. Overall, the annual data show that the investment shortfall in 2009 for firms with depressed stock prices is matched by a simultaneous employment reduction above the reduction experienced by industry peers.

4 Financial Constraints as a Transmission Channel

External financing constraints might play a particular role in the causal link between stock price underpricing and the incremental reduction in investment and employment documented above. Equity may play an important role as collateral, particularly for small and young firms. In the presence of asymmetric information, a large stock price decline may deter external investors in general and banks in particular from providing new capital.

The finance literature has developed a variety of measures to evaluate firm financing constraints, including investment-cash flow sensitivities (Fazzari, Hubbard, and Petersen, 1988), the Kaplan and Zingales (1997) index of constraints (Lamont, Polk, and Saa-Requejo, 2001), the Whited and Wu index (Whited and Wu, 2006), and a variety of different sorting criteria based on firm characteristics. Using detailed qualitative information from financial filings, Hadlock and Pierce (2010) have subjected these measures to a rigorous test and found that only firm size and age are robust (and sufficiently exogenous) measures of financial constraints. We therefore focus here on the Hadlock and Pierce AS index, which is based on both firm asset size and age. Stocks are marked as financially constrained by dummy $DFinC$ if they are among the 30% of stocks with the highest AS index value; we also test our results at the 50% cutoff.

Figure 4 provides three scatter plots each pairing two of the three dimensions for the new triple-exposure dummy ($DExp^s \times DHighR(t) \times DFinC$). The 105 stocks that are simultaneously (i) in the 25% quantile of high "Fire Sale Exposure", (ii) feature a high "Log Cumulative Return" (above the median return from 01/07/2007 to 31/12/2008), and (iii) are in the 50%

quantile of the "Financial Constraint Index" are marked by black crosses, whereas all other firms are represented by red circles. The vertical and horizontal cutoffs for the respective dummies are shown by black solid lines. In each of the three dimensions, the first quadrant shows a mix of black crosses and red circles, which implies that a sizable sample of comparable firms in each dimension allows a triple difference in differences approach.

The panel regression for the quarterly investment share in column (2) of Table 4 is now expanded to capture the triple interaction between the fire sale exposure dummy ($DExp^s$), the high return dummy ($DHighR(t)$), and the new financial constraint dummy ($DFinC$). Formally:

$$Inv_{st} = \gamma_0 + \gamma_1[DExp^s \times DHighR(t) \times DFinC] + \gamma_2 X_s + \mu_{st},$$

where the control variables X_s include the three double interaction terms ($DExp^s \times DHighR(t)$, $DExp^s \times DFinC$, and $DHighR(t) \times DFinC$) as well as the individual control terms ($DExp^s$, $DHighR(t)$, and $DFinC$). Similar to Table 4, column (2), we again allow for stock fixed effects and time fixed effects.

In Table 7, columns (1) and (2) report the regression results for the 30% and 50% cutoffs of the Hadlock-Pierce index. The first 12 regressors ($DExp^s \times DHighR(t)$) represent the quarterly investment shortfall captured by the interaction of stock exposure and high returns, while the following 12 regressors ($DExp^s \times DHighR(t) \times DFinC$) state the incremental investment shortfall due to financial constraints in each quarter. For the 30% financially most constrained firms (column (1)), the incremental effect peaks in 2009/1 with an economically large investment shortfall of -4.48%. For the four peak crisis quarters between 2008/3 and 2009/2 we obtain an aggregate investment decrease of 11.7% captured by the triple interaction term. Relative to an average investment share of 26.23% for all non-exposed, high return and constrained firms in these four quarters, this represents a 45% incremental investment decrease for the exposed, high return, and constrained firms.[12] An F-test easily rejects the null hypothesis that the four coefficients for 2008/3, 2008/4, 2009/1, and 2009/2 are jointly equal to zero.

For the 50% financially most constrained firms (column (2)), the interaction of fire sale exposure and high stock returns produces a more modest investment shortfall of -1.76% for 2009/1.

[12] The regression coefficients for the dummies $DExp^s$ and $DExp^s \times DHighR(t)$ are economically and statistically insignificant and set to zero in this comparison.

But this is still an economically large reduction relative to a mean quarterly investment share of 6.2% for the entire sample period. We also highlight that the investment shortfall of financially unconstrained firms at both cutoff points, captured by the regressor $DExp^s \times DHighR(t)$, is economically much smaller and statistically insignificant. Severe stock underpricing only mattered for investment if the company was among the 50% most financially constrained firms. As a robustness test, we also mark the 30% smallest firms as financially constrained. Unlike for the Hadlock-Pierce index, firm age no longer enters into the dummy construction. The corresponding results reported in Table 7, column (3), are slightly weaker than for the Hadlock-Pierce index with the same 30% cutoff, but qualitatively, such a simple size-based dummy of financial constraints produces very similar results.

Figure 5 provides a graphical illustration of the significant investment reduction by the subsample of fire sale exposed, high return, and financially constrained firms. The quarterly investment of these firms is plotted (based on the fixed effect obtained in Table 7, column (1)) as the solid black line marked by crosses, and it drops to as low as 2.41% in 2009/1 as shown in the graph. For comparison, the red dotted line represents the investment share of the exposed, high return stocks which are financially unconstrained; the red long-dashed line shows the investment share of constrained, high return stocks without fire sale exposure; and the red short-dashed line shows all high return firms. These three comparison groups all show a substantial reduction in their investment share, but not by nearly as much as the stocks marked by the triple interaction. Fire sale related stock underpricing reduced the investment of the 30% financially most constrained firms, but not for the majority of stocks.

5 Conclusions

Judgments on the role of financial market development for economic efficiency and growth hinge on evidence that the financial market plays a role in the capital allocation process. Previous work has used stock mispricing as a way of inferring such a capital allocation role. If the stock market matters in equilibrium, then it should also matter "out of equilibrium" when stock prices do not (fully) reflect future investment opportunities. Instances of market inefficiency are therefore informative about the capital allocation role of the market.

However, the endogeneity of investment and its entanglement with both agency problems and measurement errors of mispricing proxies often make inference problematic. Ideally, the identification strategy for mispricing should rely on data unrelated to the investment problem of a firm—a standard not met by any work we know of. Our paper makes an important contribution by using fund fire sales as a truly exogenous source of identification: The treatment effect for stock underpricing is based on the fire sale pressure of a firm's distressed mutual fund owners and is therefore removed from the firm's investment problem.

We find evidence that (fire sale based) stock underpricing negatively affects investment and employment. The effects are statistically and economically significant; thus, we can deduce an important capital allocation role for the stock price. Relative to industry peers, the most underpriced stocks experience an investment shortfall of roughly 20% prior to their stock price recovery and a relative annual employment decrease of 4.7% in 2009. We further investigate the transmission channel through which stock underpricing matters. Using the Hadlock-Pierce index of financial constraints, we identify that most of the investment shortfall caused by stock underpricing is concentrated in the 30% financially most constrained firms, for which investment is cut roughly by half relative to unconstrained firms.

The role of stock market development for economic efficiency and growth has long been an unresolved issue because of the econometric challenges of causal inference (Beck, 2009). The evidence in this paper shows that stock prices co-determine corporate investment and do so most strongly for firms dependent on external finance. For these firms, stock price information must represent an important input into the external monitoring process.

Appendix A: Risk Adjustment

Our analysis of the fire sales 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 an 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.

A country's international factors are calculated in the 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 is 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 60 months from July 2002 to June 2007,

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

where $r_{s,t}$ denotes a stock's monthly (cum dividend) return in U.S. dollars net of the one-month Treasury bill rate. For the pre-crisis period, July 2002 to June 2007, the average factor loadings on the market, size, and value factors are positive. A negative average loading is found only for the momentum factor. All eight factors have explanatory power for the cross-section of returns. The observation that both domestic and international risk factors play an important role in the pricing of stocks corroborates the recent evidence advanced by Eun *et al.* (2010) on the risk-return trade-off of investment by global investors.

With the estimated factor loadings $\widehat{\beta}_{i,j}$ for monthly returns, the monthly expected return during the crisis period from July 2007 to December 2009 is defined as

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

The cumulative expected return over k weeks (since month t) follows as

$$1 + er_{s,t}(k) = (1 + er_{s,m+1})^{n/4} \prod_{i=1}^{m} (1 + er_{s,t+i}),$$

where m denotes the number of full months and n the number of weeks falling into the last month $m+1$. The cumulative risk-adjusted (or excess) return of stock s over k weeks can be calculated from the weekly stock return (wr) and the estimated expected return as

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

The cumulative risk-adjusted return of stock s over q quarters can be calculated in a similar manner as

$$r_s^{Ex}(q) = \prod_{i=1}^{3\times q}(1 + r_{s,t+i}) - \prod_{i=1}^{3\times q}(1 + er_{s,t+i}).$$

Appendix B: Accounting Variable Definitions

Inv(t): The ratio of capital expenditures to the start-of-period net property, plant, and equipment, multiplied by 100. [Compustat data item: $100 \times capxyq(t)/ppentq(t-1)$ for the quarterly data and $100 \times capx(t)/ppent(t-1)$ for the annual data]

ΔEmp(t): The ratio of the change in the number of employees over a year to the number at the start of the year, multiplied by 100. [Compustat data item: $100 \times (emp(t) - emp(t-1))/emp(t-1)$]

Stock Size: The natural logarithm of total book assets in 2006/4. [Compustat data item: natural logarithm of atq]

Tobin's q: The ratio of the market value of assets to total book assets in 2006/4, where the numerator is defined as the sum of market equity and book assets less book equity, deferred taxes and investment tax credits. [Compustat data item: $(prccq \times cshoq + atq - ceqq - txdbq)/atq$]

Cash flow: The ratio of income before extraordinary items plus depreciation and amortization in 2006 to the net property, plant, and equipment in 2005/4. [Compustat data item: (sum of ibq and dpq over the four quarters of 2006)/$ppentq$ in the fourth quarter of 2005]

Leverage: The ratio of total debt to total book assets in 2006/4. [Compustat data item: $(dlttq + dlcq)/atq$]

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Table 1: Summary Statistics

Reported are summary statistics for all non-financial and non-utility stocks. Fund exposure, Exp^f, is measured by the return loss of a fund due to ownership in financial stocks over the one-year period from July 1, 2007 to June 30, 2008. Stock exposure, Exp^s, measures the average fund exposure of all funds owning a stock, where the weights are given by the ownership share of a fund relative to the stock's market capitalization. The dummy variable $DExp^s$ marks the 25% of stocks with fund owners most exposed to financial stocks. Fund share Fsh^s measures the aggregate holdings of all funds in a stock relative to the stock's market capitalization. The percentage investment share $Inv(t)$ in year or quarter t is defined as the capital expenditure in period t relative to the net capital stock in period $t-1$, multiplied by 100. The percentage employment change $\Delta Emp(t)$ measures the percentage change in the number of employees relative to the number at the end of period $t-1$. The dummy $DExp^s \times DHighR(t)$ is the product of the exposure $DExp^s$ and the high return dummy $DHighR(t)$. The high return dummy $DHighR(t)$ marks all stocks with above median (risk-adjusted) returns from the beginning of quarter 2007/3 to the end of quarter $t-1$. As control variables, we use $Stock\ Size$ measured by (log of) the asset size in 2006, $Tobin's\ q$ calculated for 2006, $Cash\ Flow$ defined as income in 2006 (before extraordinary items but with depreciation and amortization) relative to net capital stock at the end of 2005, and the (risk-adjusted) $Stock\ Return$ in 2006.

Variable	Obs.	Mean	Median	STD	Min	Max
Fund Exposure Measures						
Exp^f	13,369	−0.019	−0.012	0.026	−0.363	0.000
Stock Exposure Measures						
$Exp^s \times 100$	3,084	−0.249	−0.181	0.253	−2.261	0.000
$DExp^s$	3,084	0.250	0.000	0.433	0.000	1.000
Fund Ownership Share						
Fsh^s	3,084	0.219	0.222	0.153	0.000	0.781
Percentage Investment Share						
$Inv(2007)$	2,736	33.917	25.004	29.488	2.634	194.611
$Inv(2008)$	2,575	29.352	22.643	23.911	2.107	157.602
$Inv(2009)$	2,427	19.197	14.770	15.549	0.812	86.827
Percentage Employment Change						
$\Delta Emp(2007)$	2,690	6.193	3.726	18.816	−44.324	92.818
$\Delta Emp(2008)$	2,531	0.805	0.000	16.526	−48.268	73.077
$\Delta Emp(2009)$	2,381	−4.101	−4.057	14.120	−47.534	51.402
Stock Undervaluation Dummy						
$DExp^s \times DHighR(2007)$	2,879	0.195	0.000	0.396	0.000	1.000
$DExp^s \times DHighR(2008)$	2,705	0.200	0.000	0.400	0.000	1.000
$DExp^s \times DHighR(2009)$	2,545	0.235	0.000	0.424	0.000	1.000
Control Variables						
$Stock\ Size\ (log\ of\ assets)$	2,924	5.937	5.878	1.847	2.210	10.712
$Tobin's\ q$	2,886	2.175	1.782	1.200	0.888	7.677
$Cash\ Flow$	2,393	−0.076	0.365	3.188	−22.760	7.857
$Stock\ Return(2006)$	3,039	−0.023	−0.078	0.468	−0.872	2.813

Table 2: Cumulative Return Effect of Stock Fire Sales

Reported are separate (cross-sectional) OLS regressions for the cumulative return measured from the beginning of quarter 2007/3 to the end of quarter $t = 2007/3, ..., 2009/4$. For the two pre-crisis quarters 2007/1 and 2007/2, the dependent variable is given by the respective quarterly return. The exposure dummy $DExp^s$ marks the 25% U.S. stocks with the highest ownership exposure to distressed equity funds. The latter is interacted with a high return dummy $DHighR(t)$ marking (with one) all observations in a quarter $t = 2007/4, .., 2009/4$ if and only if the stock is among the 50% of stocks with the highest cumulative return from the beginning of 2007/3 to the end of quarter $t-1$. For quarters 2007/1, 2007/2, and 2007/3, $DHighR(t)$ is set to equal to that in 2007/4. We include as a control variable the fund share (Fsh^s) measuring the ownership share of all reporting equity funds relative to stock capitalization. Included as additional controls (but not reported) are the exposure dummy $DExp^s$ and the high return dummy $DHighR(t)$. Also included are fixed effects for each industry. We report robust T-values adjusted for clustering at the stock level.

Dep. Variable: Cumulative Return	Indep. Variables					
	$DExp^s \times DHighR(t)$		*Fund Share* (Fsh^s)		*Obs.*	$Adj.R^2$
	Coefficient	T-value	Coefficient	T-value		
2007/1 (pre-crisis)	−0.014	−0.99	0.141	4.65	2,810	0.042
2007/2 (pre-crisis)	−0.008	−0.56	0.102	3.29	2,806	0.103
2007/3	−0.156	−10.32	0.030	0.84	2,841	0.568
2007/4	−0.238	−7.35	0.029	0.36	2,832	0.365
2008/1	−0.197	−6.04	0.166	2.21	2,655	0.399
2008/2	−0.363	−7.62	0.173	1.54	2,656	0.401
2008/3	−0.215	−4.73	0.264	2.50	2,642	0.263
2008/4	−0.431	−6.20	0.220	1.36	2,630	0.336
2009/1	−0.446	−5.99	0.155	0.86	2,489	0.342
2009/2	−0.229	−3.66	0.150	1.08	2,489	0.334
2009/3	−0.222	−3.82	0.310	2.34	2,467	0.369
2009/4	−0.247	−4.73	0.161	1.35	2,478	0.438

Table 3: Distribution of Portfolio Similarity in Non-Financials by Fund Pairs

We match the 15% most exposed funds with the same number of non-exposed funds based on the size of their total asset holdings in non-financial stocks. We then examine for all high return stocks (with above median return from July 2007 to June 2008) whether the portfolio allocation in groups of non-financial stocks is independent across the exposed and non-exposed funds. For any pair of funds (f_1, f_2), we define portfolio overlap in stock groups as

$$Overlap(f_1, f_2) = \sum_{g \,\in\, \text{Set of Stock-Groups}} \min[\widehat{w}^{f_1,g}, \widehat{w}^{f_2,g}],$$

where $\widehat{w}^{f_1,g}$ and $\widehat{w}^{f_2,g}$ represent the (non-financial) portfolio share in stock group g of funds f_1 and f_2, respectively. We sort stocks into 12 industries (based on the Fama-French industry classification), 2 size categories (based on capitalization in 2006), and 2 leverage categories (based on data in 2006)–48 stock groups in total. Column (1) reports the distribution of portfolio overlap for all pairs of any two (different) exposed funds and column (2) for all pairs of exposed and non-exposed funds, with one from each type of funds. We test the equality of the distribution using the median test and the Wilcoxon-Mann-Whitney ranksum test.

	(1) $Overlap(f_1, f_2)$ Between all Pairs of Two Exposed Funds	(2) $Overlap(f_1, f_2)$ Between all Pairs of Exp. and Non-Exp. Funds
Percentiles		
1%	0.000	0.000
5%	0.000	0.000
10%	0.000	0.000
25%	0.000	0.004
50%	0.097	0.084
75%	0.170	0.153
90%	0.230	0.208
95%	0.261	0.240
99%	0.307	0.299
Obs.	216,153	432,964
Mean	0.101	0.092
STD	0.091	0.083
Skewness	0.438	0.574
Kurtosis	2.107	2.454
Percentage zeros	25.2%	21.4%
Median Test	$\chi^2(1) = 1049.92$	
	$p = 0.00$	
Wilcoxon Test	$z = 25.31$	
	$p = 0.00$	

Table 4: Investment Effect of Fund Ownership Exposure

Reported are Ordinary Least Square (OLS) regressions for the quarterly percentage investment share (capital expenditure in quarter t relative to the net capital stock in quarter $t-1$) over the 3-year period from 2007/1 to 2009/4. The exposure dummy $DExp^s$ marks the 25% U.S. stocks with the highest ownership exposure to distressed equity funds. The latter is interacted with a high return dummy $DHighR(t)$ marking (with one) all observations in a quarter $t = 2007/4, .., 2009/4$ if and only if the stock is among the 50% of stocks with the highest cumulative return from the beginning of 2007/3 to the end of quarter $t-1$. For quarters 2007/1, 2007/2, and 2007/3, $DHighR(t)$ is set to equal to that in 2007/4. Included as controls (but not reported) are the interaction terms between the exposure dummy $DExp^s$ and time fixed effects and also the interaction terms between the high return dummy $DHighR(t)$ and time fixed effects. Specification (1) uses industry fixed effects (given by four-digit SEC codes), time fixed effects, and their interactions, as well as the (pre-crisis) control variables $Stock\ Size$, $Tobin's\ q$, $Cash\ Flow$, and $Stock\ Return$ as defined in Table 1. Specification (2) uses stock fixed effects and separate time fixed effects. We report robust T-values adjusted for clustering at the stock level.

Dep. Variable: Quarterly Investment Share	(1)		(2)	
	Coefficient	T-value	Coefficient	T-value
$DExp^s \times DHighR(2007/1)$	0.226	0.41	−0.286	−0.58
$DExp^s \times DHighR(2007/2)$	0.135	0.24	−0.158	−0.33
$DExp^s \times DHighR(2007/3)$	0.263	0.49	−0.127	−0.28
$DExp^s \times DHighR(2007/4)$	0.156	0.26	−0.043	−0.09
$DExp^s \times DHighR(2008/1)$	−0.394	−0.75	−0.659	−1.67
$DExp^s \times DHighR(2008/2)$	−0.752	−1.40	−0.838	−2.12
$DExp^s \times DHighR(2008/3)$	−0.663	−1.22	−0.832	−2.04
$DExp^s \times DHighR(2008/4)$	−1.215	−2.57	−1.002	−2.53
$DExp^s \times DHighR(2009/1)$	−1.068	−2.79	−0.958	−2.76
$DExp^s \times DHighR(2009/2)$	−0.919	−2.38	−0.815	−2.33
$DExp^s \times DHighR(2009/3)$	−0.194	−0.51	−0.673	−1.83
$DExp^s \times DHighR(2009/4)$	−0.029	−0.07	−0.383	−0.97
$Stock\ Size\ (log\ of\ assets)$	−0.221	−4.35		
$Tobin's\ q$	0.634	7.26		
$Cash\ Flow$	0.055	1.26		
$Stock\ Return(2006)$	0.865	3.95		
Industry Fixed Effects	yes		no	
Industry-Time Fixed Effects	yes		no	
Stock Fixed Effects	no		yes	
Time Fixed Effects	yes		yes	
$Obs.$	23,432		24,000	
$Adj.R^2$	0.161		0.455	
F-tests (F-statistics)				
H_0 : No effect 2008/1 to 2009/4		7.642		15.456
H_0 : No effect 2008/3 to 2009/2		11.367		13.355

Table 5: Robustness to Fund Share Controls

The regressions in Table 4, column (2) are repeated by controlling for fund share (Fsh^s) interacted with time fixed effects for each quarter. Fsh^s measures the ownership share of all reporting equity funds relative to stock capitalization. The exposure dummy $DExp^s$ marks the 25% U.S. stocks with the highest ownership exposure to distressed equity funds. The latter is interacted with a high return dummy $DHighR(t)$ marking (with one) all observations in a quarter $t = 2007/4, .., 2009/4$ if and only if the stock is among the 50% of stocks with the highest cumulative return from the beginning of 2007/3 to the end of quarter $t - 1$. For quarters 2007/1, 2007/2, and 2007/3, $DHighR(t)$ is set to equal to that in 2007/4. Included as controls (but not reported) are the interaction terms between the exposure dummy $DExp^s$ and time fixed effects and also the interaction terms between the high return dummy $DHighR(t)$ and time fixed effects. Specification (1) uses stock fixed effects and time fixed effects as in Table 4, column (2), whereas specification (2) adds the fund share interacted with time fixed effects as additional controls. We report robust T-values adjusted for clustering at the stock level.

Dep. Variable: Quarterly Investment Share	(1)		(2)	
	Coefficient	T-value	Coefficient	T-value
$DExp^s \times DHighR(2007/1)$	−0.286	−0.58	−0.266	−0.54
$DExp^s \times DHighR(2007/2)$	−0.158	−0.33	−0.076	−0.16
$DExp^s \times DHighR(2007/3)$	−0.127	−0.28	−0.107	−0.24
$DExp^s \times DHighR(2007/4)$	−0.043	−0.09	−0.053	−0.11
$DExp^s \times DHighR(2008/1)$	−0.659	−1.67	−0.616	−1.57
$DExp^s \times DHighR(2008/2)$	−0.838	−2.12	−0.857	−2.16
$DExp^s \times DHighR(2008/3)$	−0.832	−2.04	−0.882	−2.16
$DExp^s \times DHighR(2008/4)$	−1.002	−2.53	−1.098	−2.75
$DExp^s \times DHighR(2009/1)$	−0.958	−2.76	−1.047	−2.98
$DExp^s \times DHighR(2009/2)$	−0.815	−2.33	−0.919	−2.62
$DExp^s \times DHighR(2009/3)$	−0.673	−1.83	−0.770	−2.08
$DExp^s \times DHighR(2009/4)$	−0.384	−0.97	−0.464	−1.16
Stock Fixed Effects	yes		yes	
Time Fixed Effects	yes		yes	
Time Fixed Effects $\times$ Fsh^s	no		yes	
Obs.	24,000		23,697	
Adj.R^2	0.455		0.456	
F-tests (F-statistics)				
H_0 : No effect 2008/1 to 2009/4		15.456		17.720
H_0 : No effect 2008/3 to 2009/2		13.555		16.091

Table 6: Investment and Employment Effect of Fund Ownership Exposure

Reported are Ordinary Least Square (OLS) regressions and Seemingly Unrelated Regressions (SUR) for the percentage investment share (capital expenditure in year t relative to the net capital stock in year $t-1$) and the annual percentage employment change over the 3-year period from 2007 to 2009. The exposure dummy $DExp^s$ marks the 25% U.S. stocks with the highest ownership exposure to distressed equity funds. The latter is interacted with a high return dummy $DHighR(t)$ marking (with one) all observations in year $t = 2007, 2008, 2009$ if and only if the stock is among the 50% of stocks with the highest cumulative return from July 2007 to the end of year $t-1$. The $DHighR(t)$ dummy for 2007 is set to equal to that for 2008. We include (pre-crisis) control variables defined in Table 1. Included as additional controls (but not reported) are interaction terms between the exposure dummy $DExp^s$ and year fixed effects. Both equations include fixed time effects for each year, fixed effects for each industry (based on four-digit SEC industry codes) and the interaction of industry and fixed time effects. We report robust T-values adjusted for clustering at the stock level.

	(1) OLS		(2) SUR	
	Coefficient	T-value	Coefficient	T-value
Equation 1: Annual Investment Share				
$DHighR(2007)$	-0.066	-0.04	-0.466	-0.38
$DHighR(2008)$	1.822	1.07	1.598	1.24
$DHighR(2009)$	5.107	4.42	4.753	3.51
$DExp^s \times DHighR(2007)$	2.400	0.96	2.565	1.37
$DExp^s \times DHighR(2008)$	1.098	0.50	1.018	0.53
$DExp^s \times DHighR(2009)$	-4.306	-2.95	-3.688	-1.83
$Stock\ Size\ (log\ of\ assets)$	-1.423	-5.43	-1.421	-7.25
$Tobin's\ q$	3.376	7.10	3.287	12.30
$Cash\ Flow$	0.240	1.11	0.210	1.94
$Stock\ Return(2006)$	4.983	4.28	5.086	7.41
$Obs.$	5,886		5,603	
$Adj.R^2$	0.202		0.349	
Equation 2: Annual Employment Change				
$DHighR(2007)$	2.839	2.29	2.611	2.96
$DHighR(2008)$	4.879	4.35	4.629	5.01
$DHighR(2009)$	5.680	5.25	5.571	5.73
$DExp^s \times DHighR(2007)$	-0.510	-0.29	-0.502	-0.37
$DExp^s \times DHighR(2008)$	-0.119	-0.08	0.027	0.02
$DExp^s \times DHighR(2009)$	-4.699	-3.52	-4.687	-3.23
$Stock\ Size\ (log\ of\ assets)$	0.305	1.79	0.286	2.03
$Tobin's\ q$	1.693	6.36	1.706	8.88
$Cash\ Flow$	0.352	2.61	0.356	4.59
$Stock\ Return(2006)$	3.319	4.82	3.360	6.81
$Obs.$	5,732		5,603	
$Adj.R^2$	0.160		0.312	
F-test (F-statistic)				
H_0 : No real effect in 2009		–		5.660

Table 7: Financial Constraints as Transmission Channel

The stock fixed effect regression in Table 4 is extended to allow for interaction between the fire sale dummy $DExp^s \times DHighR(t)$ and a dummy ($DFinC$) marking firms with financial constraints. Three different proxies of financing constraints are considered: In column (1) we mark firms with the Hadlock-Pierce AS index (based on firm Age and Size) above the 30% cutoff as financially constrained; in column (2) we mark firms with greater than the median Hadlock-Pierce AS index as financially constrained; and column (3) uses a dummy for the 30% smallest firms based on book asset value (Size). Included in the regressions (but not reported) are stock fixed effects and separate time fixed effects and all remaining subcomponents of the triple interaction term: $DHighR \times DFinC$, $DExp^s \times DFinC$, $DExp^s$, $DHighR$, and $DFinC$, each interacted with all time dummies. We report robust T-values adjusted for clustering at the stock level.

	Type of Financial Constraint Dummy ($DFinC$)					
Dep. Variable:	(1)		(2)		(3)	
Quarterly Investment Share	Hadlock-Pierce 30% cutoff		Hadlock-Pierce 50% cutoff		Size 30% cutoff	
	Coefficient	T-value	Coefficient	T-value	Coefficient	T-value
$DExp^s \times DHighR(2007/1)$	0.552	0.99	0.688	1.24	0.491	0.88
$DExp^s \times DHighR(2007/2)$	−0.019	−0.04	−0.005	−0.01	0.003	0.01
$DExp^s \times DHighR(2007/3)$	−0.435	−0.89	−0.721	−1.39	−0.409	−0.84
$DExp^s \times DHighR(2007/4)$	0.733	1.33	0.549	0.91	0.789	1.43
$DExp^s \times DHighR(2008/1)$	−0.552	−1.31	−0.451	−0.98	−0.647	−1.54
$DExp^s \times DHighR(2008/2)$	−0.601	−1.38	−0.594	−1.32	−0.625	−1.43
$DExp^s \times DHighR(2008/3)$	−0.267	−0.61	−0.010	0.02	−0.314	−0.71
$DExp^s \times DHighR(2008/4)$	−0.540	−1.19	−0.630	−1.25	−0.617	−1.36
$DExp^s \times DHighR(2009/1)$	−0.341	−0.85	−0.278	−0.64	−0.378	−0.94
$DExp^s \times DHighR(2009/2)$	−0.494	−1.30	−0.608	−1.52	−0.500	−1.32
$DExp^s \times DHighR(2009/3)$	−0.417	−0.96	−0.287	−0.59	−0.461	−1.06
$DExp^s \times DHighR(2009/4)$	−0.148	−0.33	−0.352	−0.74	−0.197	−0.43
$DExp^s \times DHighR(2007/1) \times DFinC$	−1.867	−0.70	−1.873	−1.52	−1.745	−0.67
$DExp^s \times DHighR(2007/2) \times DFinC$	−1.108	−0.48	−0.316	−0.26	−1.184	−0.52
$DExp^s \times DHighR(2007/3) \times DFinC$	0.722	0.29	0.978	0.90	0.561	0.22
$DExp^s \times DHighR(2007/4) \times DFinC$	−0.485	−0.19	−0.433	−0.33	−0.894	−0.34
$DExp^s \times DHighR(2008/1) \times DFinC$	−0.513	−0.26	−0.079	−0.08	−0.476	−0.24
$DExp^s \times DHighR(2008/2) \times DFinC$	−2.028	−1.15	−0.497	−0.53	−1.989	−1.14
$DExp^s \times DHighR(2008/3) \times DFinC$	−2.259	−0.82	−1.813	−1.72	−2.196	−0.81
$DExp^s \times DHighR(2008/4) \times DFinC$	−2.414	−1.67	−0.969	−0.98	−2.112	−1.47
$DExp^s \times DHighR(2009/1) \times DFinC$	−4.481	−2.89	−1.761	−2.08	−4.257	−2.81
$DExp^s \times DHighR(2009/2) \times DFinC$	−2.578	−1.52	−0.458	−0.52	−2.443	−1.47
$DExp^s \times DHighR(2009/3) \times DFinC$	−1.791	−1.00	−0.132	−0.15	−1.573	−0.90
$DExp^s \times DHighR(2009/4) \times DFinC$	−2.315	−1.16	−0.538	−0.58	−2.031	−1.04
Obs.	23,711		23,711		23,711	
$Adj.R^2$	0.457		0.457		0.457	
F-tests for triple interaction terms (F-statistics):						
H_0 : No effect 2008/1 to 2009/4		4.730		2.560		4.160
H_0 : No effect 2008/3 to 2009/2		5.160		4.260		4.670

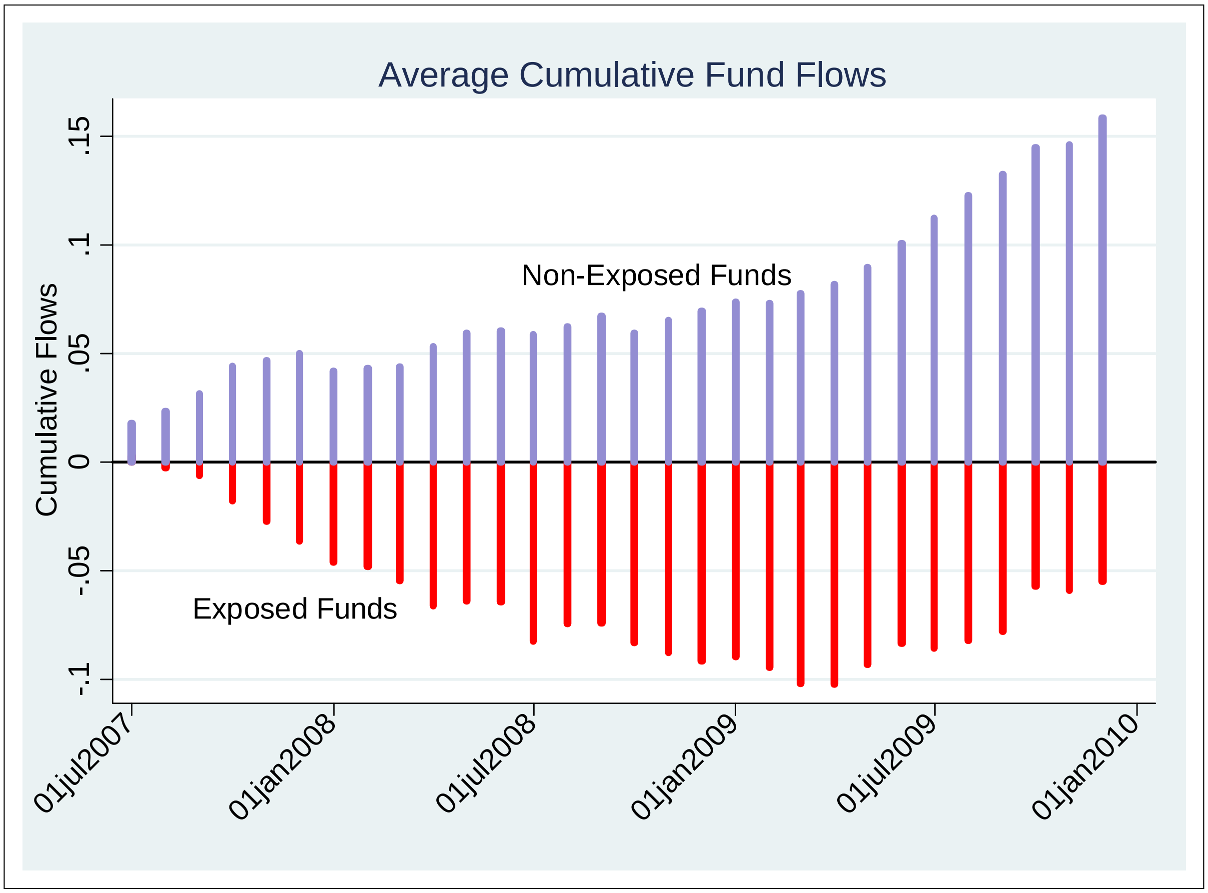

Figure 1: Plotted are the average cumulative fund flows for the 15% of funds with the highest investment losses in financial sector stocks (exposed funds) and the remaining 85% of funds (non-exposed funds). A fund's cumulative fund flow is estimated by its cumulative dollar flows since July 2007 relative to its asset holdings in June 2007.

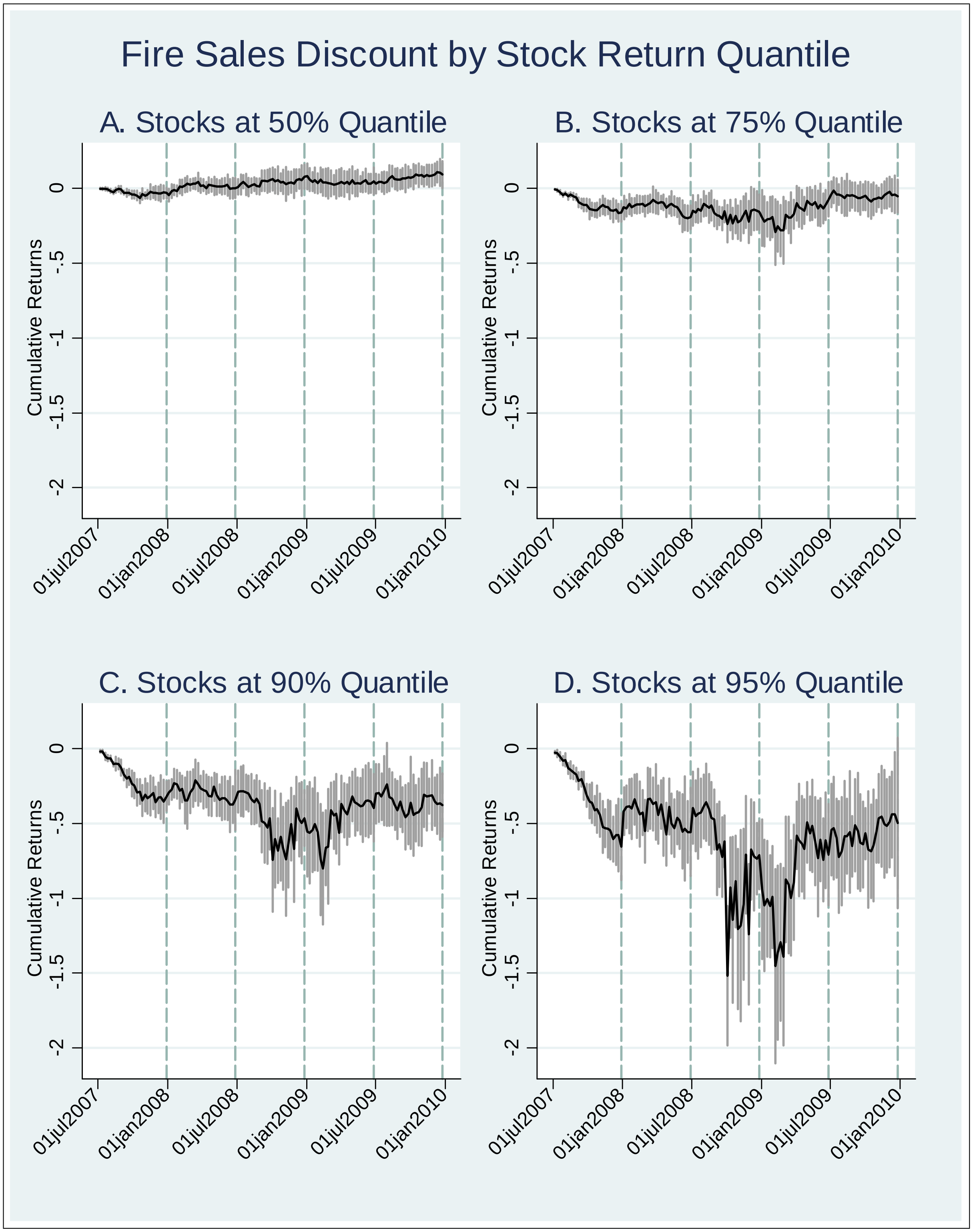

Figure 2: The graphs show the fire sales discounts (measured by the coefficient α_1^k) for exposed stocks in different performance quantiles measured over the period from June 29, 2007 to December 25, 2009. Graph A shows fire sales discounts for stocks at the 50% (median) stock return quantile and graph B for the better performing stocks at the 75% stock return quantile. In graphs C and D, we plot the fire sales discounts for exposed stocks at the highest 90% and 95% performance quantiles, respectively. Stock exposure is measured by ownership share of distressed equity funds in a particular stock. The vertical bars provide a 2 S.D. confidence interval around the point estimate.

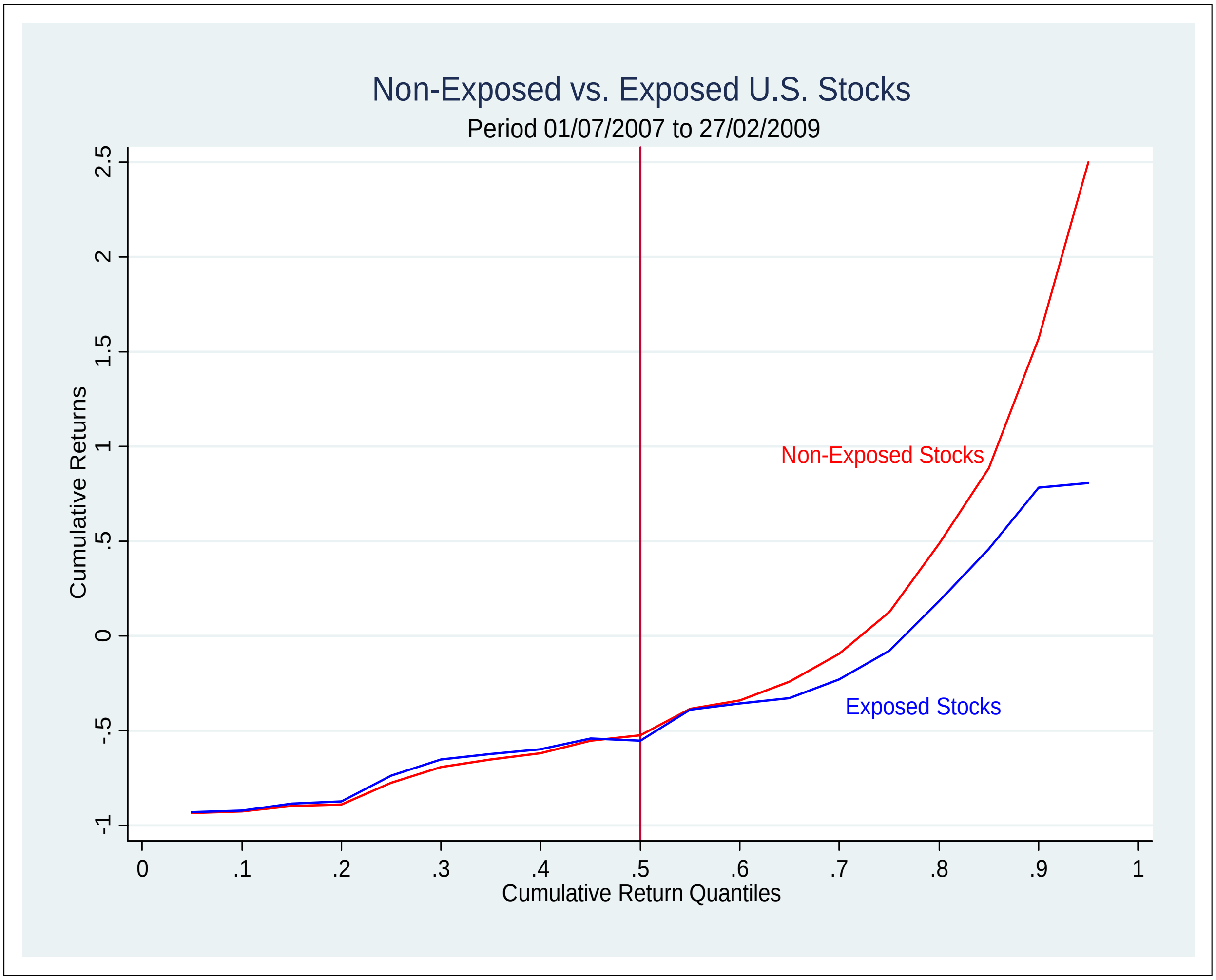

Figure 3: Plotted are the average cumulative returns for exposed and non-exposed stocks during the period 01/07/2007 to 27/02/2009 based on quantile regressions for cumulative return quantiles from 0.05 to 0.95. In the regression, the cumulative weekly stock returns are regressed on the dummy variable $DExp^s$ (marking the 15% of stocks with the highest exposure to distressed funds), Fsh^s (measuring the ownership share of all reporting equity funds relative to stock capitalization), and industry fixed effects.

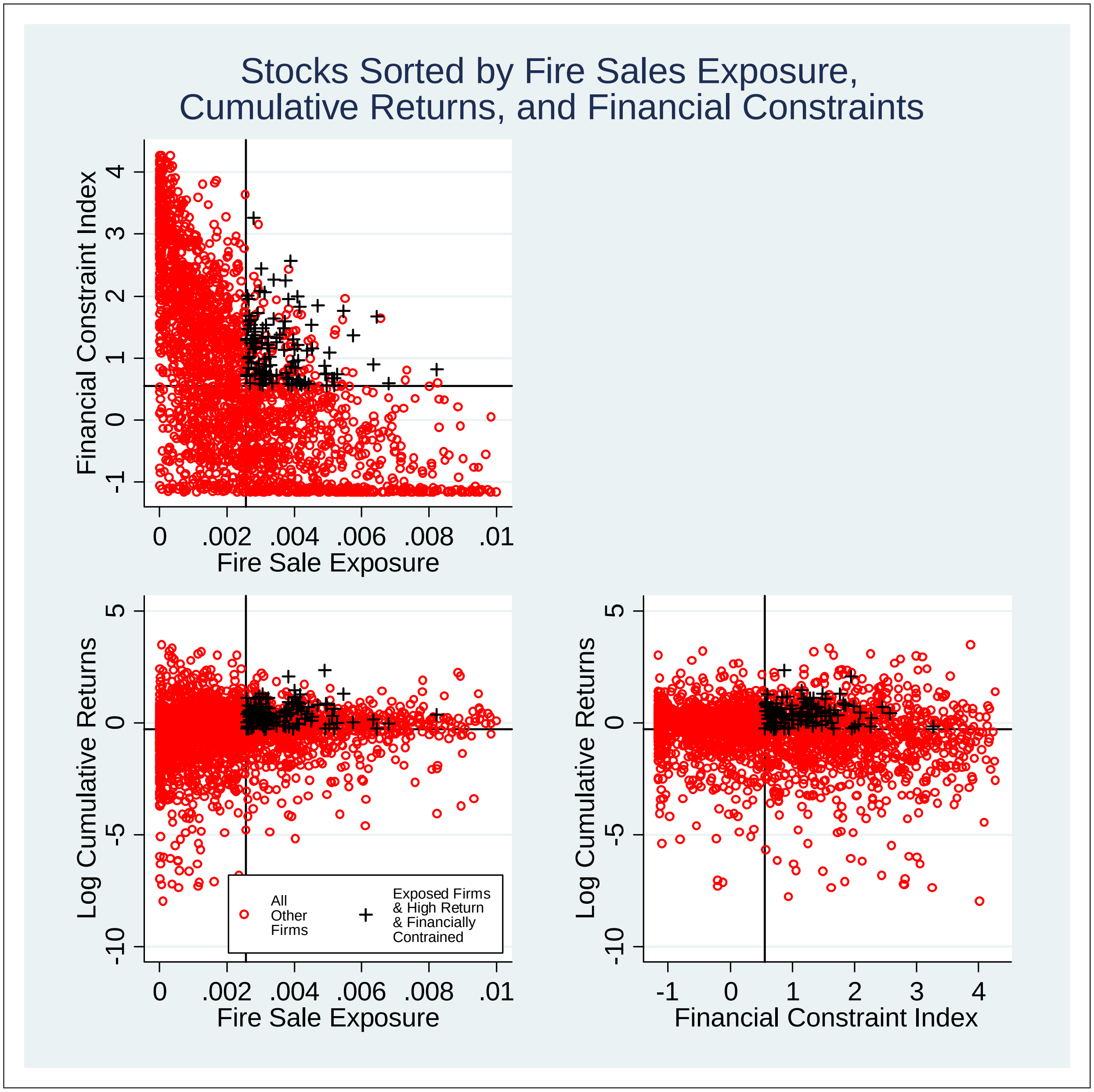

Figure 4: Plotted are all stocks in the three dimensions of (i) the Fire Sale Exposure, (ii) the Log Cumulative Return over the crisis period from July 2007 to December 2008 and (iii) the Financial Constraint Index (AS) by Hadlock and Pierce. The black vertical and horizontal lines mark the cut-off values for the three dummy variables, which are the 25% quantile for Fire Sale Exposure, the 50% quantile for Log Cumulative Returns, and the 50% quantile for Financial Constraint Index. Financially constrained stocks with high crisis returns and high fire sale exposures (the triple interaction dummy) are marked by black crosses and all other stocks with red circles.

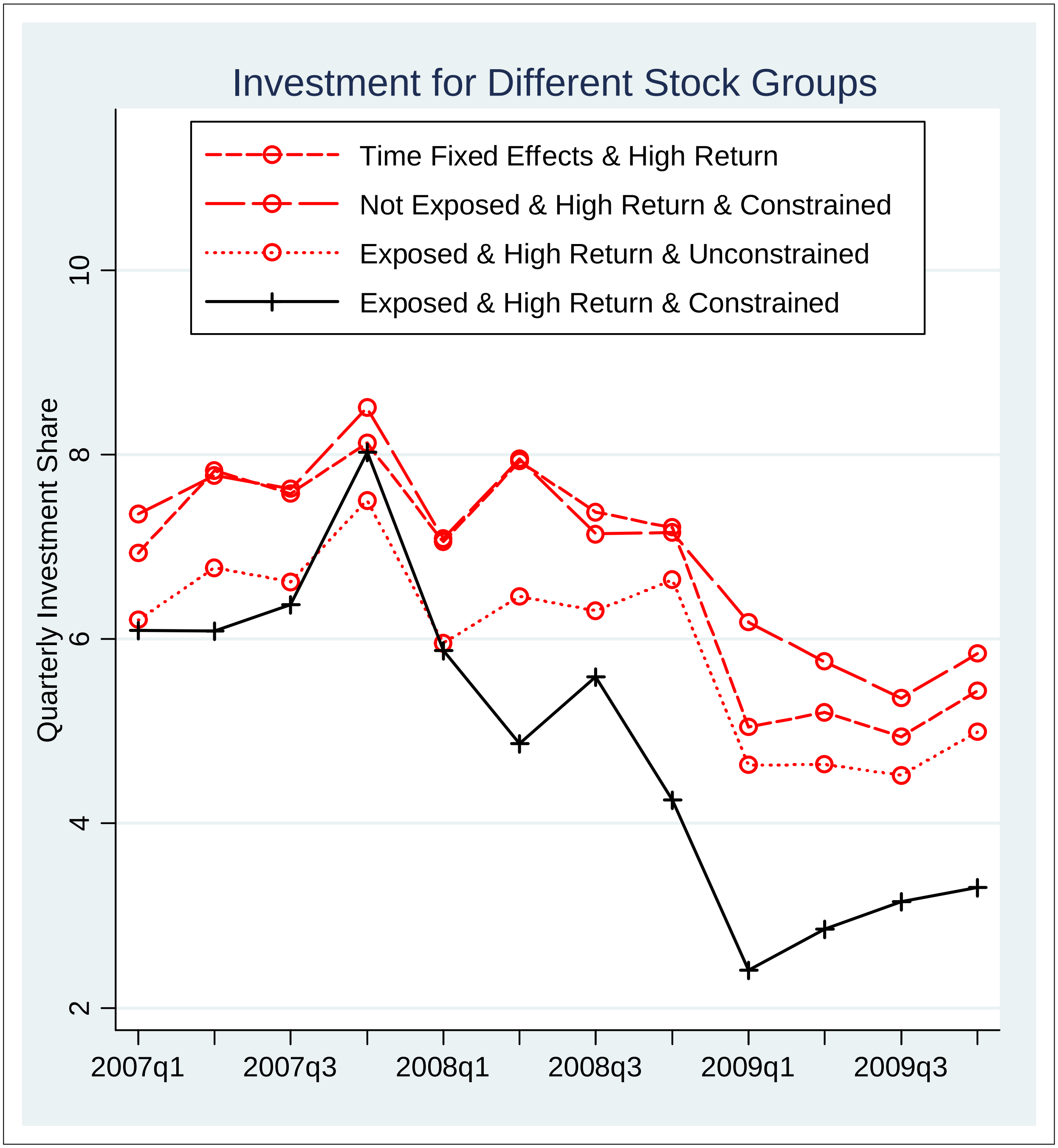

Figure 5: Plotted is the quarterly percentage investment share (capital expenditure in quarter t relative to net capital stock in quarter $t-1$) for different groups of stocks based on the fixed effect obtained in Table 7, column (1). The evolution of the investment share for stocks with fire sale exposure (Exposed), above median return (High Return), and financial constraints (Constrained) is given by the black solid line marked by crosses.