Real effects of stock underpricing

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Abstract

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.

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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 controversial. Do managers base capital budgeting decisions on private information and ignore stock prices?[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 could not reach a definite answer 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 with large-scale stock mispricing that can render clear evidence of a causal effect of stock prices on corporate investment. Using global fund ownership data, we find a large sample of US stocks exposed to fire sales by distressed equity funds. These distressed funds are identified as having had large investment losses in bank stocks and, therefore, having experienced high fund redemptions. Nonfinancial stocks with high ownership by distressed equity funds were

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

substantially underpriced relative to industry peers with nondistressed fund owners. In the absence of systematic investment bias by distressed funds in their portfolio of nonfinancial 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 that stock underpricing had a powerful causal effect on both investment and 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 percentage points (pps) in 2009 relative to industry peers.[4] 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 sort stocks into a top tercile of financially most constrained firms and a bottom tercile of least constrained firms.[5] We find that the former group accounts for most of the strong decline in the investment share among underpriced stocks. By contrast, the 33% least constrained firms 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

[4]Hau and Lai (2012) show that the stock price for the 30% most exposed US stocks under-performed relative to non-exposed industry peers by 37% at the peak of the stock market downturn, a result based on the regression analysis of the cumulative weekly risk-adjusted excess returns (from June 29, 2007 to Feb. 27, 2007) for all US stocks on a stock exposure dummy (marking the 30% most exposed US stocks). The regression carefully controls for the different level of fund ownership for each stock as well as industry fixed effects.

[5]Hadlock and Pierce (2010) collect detailed qualitative information from financial filings and subject various proxies of financial constraints to a rigorous test. They find that only firm size and age are robust and sufficiently exogenous measures of financial constraints and, therefore, construct a new AS index based on these two variables.

constrained firms.

Any welfare interpretation of the finding on the stock price–based monitoring depends on the degree of market efficiency and the pervasiveness of agency problems in corporate investment.[6] 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, Gilchrist et al. (2005) and Polk and Sapienza (2009) provide evidence that managers actively 'cater' to market sentiment by investing more at inefficiently high stock prices. 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).[7]

The previous literature has shown a positive correlation between stock market returns and subsequent corporate investment in both the time series and the cross section (Fama, 1981; Barro, 1990; and Morck, Shleifer, and Vishny, 1990). But this is uninformative about causality. Stock prices could just passively reflect changing investment opportunities and the respective investment decisions—suggesting that corporate investment efficiency does not depend on stock prices. 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.[8]

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

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

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

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), and 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 could 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 could 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 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 nonfundamental component during the 1987–1990 Japanese stock market boom and find that the latter strongly correlates with investment.[9] But their identification of the nonfundamental q is based on regression residuals that 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 fund flows are exogenous and not determined by investor expectations regarding the return prospects of individual firms held by the fund. By contrast, our identification strategy is not based on fund flows, but on a negative return shock to a particular component of the fund portfolio. This constitutes an even more solid identification strategy as it provides a clear explanation as to why the fund outflows occur.

Our analysis is related to the recent work by Chen, Goldstein, and Jiang (2007) and Grullon, Michenaud, and Weston (2011). Chen et al. find evidence that firm managers extract from stock prices the private information that they do not already know and incorporate it into

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

their investment decisions. Grullon et al. examine an exogenous event of SEC's removal of the uptick rule in 2005 and show that the removal leads to a decrease in equity issuance and corporate investment for the affected firms, particularly for financially constrained firms. Our finding also echoes the recent evidence advanced by Edmans, Goldstein, and Jiang (2012) on the disciplinary role of the stock market. Specifically, they find that stock price discounts for reasons unrelated to firm fundamentals trigger takeover threats for the discounted firms. We find a similar monitoring role of stock prices but via an independent event of the recent financial crisis. Our study is also related to Hau and Lai (2012), who examine the propagation of the 2007-2009 financial crisis from financial stocks to nonfinancial stocks. They identify 'distressed' fund ownership as well as retail investor behavior as important channels of crisis transmission and find large temporary price discount for nonfinancial stocks during the crisis. The current study differs in its focus on the real effects of such stock underpricing on corporate investment and employment.

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. (2011, 2012) show 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) show that corporate investment declined significantly following the crisis for firms with low internal and external capital. Almeida et al. (2012) 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 afterward. 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 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 26% 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 toward efficiency implies that cases of economically large stock mispricing tend to be 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 (2012), in particular, show that fire sales by distressed equity funds in the recent crisis generated extremely large stock underpricing: Roughly one-third of all US 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 sale exposure*

To measure fire sale exposure for nonfinancial stocks via their fund owners, we use the Thomson Reuters global mutual fund database. The database accounts for pure equity funds as well as the equity holdings of balanced funds that also hold other assets such as bonds. In the latter case only the equity portion of the fund holdings is reported. Most international funds outside the US report only at six-month intervals—hence our analysis is carried out at a semiannual 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 fewer 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 US, 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.[10]

In the first step, we calculate the return shortfall—called "fund exposure" (Exp^f)—for all equity funds worldwide based on their portfolio positions in financial stocks from July 2007 to June 2008. Specifically, fund exposure is defined as a fund's overall return from bank stock investments below the -1% return threshold.[11] With more than 1% of return loss, funds

[10] 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 for December 2007. Less than half of the reported equity holdings in our sample concern US domiciled funds. In addition, 16,710 (or 82%) of all mutual funds hold at least one foreign stock and can, therefore, be classified as international funds. The corresponding figure (73%) is somewhat smaller for US domiciled funds. See also Ferreira et al. (2012).

[11] For robustness, we have also tried alternative return thresholds at 0% and -2%. The results remain qualitatively similar.

could face more investor scrutiny and large fund redemptions such that fund fire sales become important. 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 under-performing 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. Table 1 shows that the mean (median) fund exposure to financial stocks (i.e., return loss due to bank investment) is -1.19% (-1.12%).

[Insert Table 1 near here]

In the second step, fund exposure is aggregated to a stock-specific measure of "stock exposure" (Exp^s) for all nonfinancial US stocks.[12] We define stock exposure as the value-weighted average fund exposure of all funds holding equity shares in a stock. The value weights are measured relative to the stock's total market capitalization. Formally, stock exposure for stock s is defined as

$$Exp^s = Fsh^s \sum_f \omega^s(f) Exp^f, \tag{1}$$

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 a

[12] The focus on US stocks is justified because our holdings data are most complete for US stocks. In addition, the fund fire sales effect is most pronounced in the US due to the generally large share of stock ownership by equity funds. For a clean identification of nonfinancial 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.

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 US nonfinancial stocks are reported in Table 1. The mean (median) stock exposure is -0.249 (-0.181) pp, with large negative skewness of -2.0. The 25%, 10%, and 5% most negative stock exposure quantiles are, respectively, -0.35, -0.46, and -0.56 pp. For example, a stock exposure of -0.35 pp is obtained if 10% of a stock's capitalization is owned by funds that on average lost 3.5 pps in their portfolio returns due to financial stock investments. The most negative values for stock exposure are obtained for stocks with fund owners who suffer the largest losses in bank stock investments and together own a large share of the stock's market capitalization; the upper bound is zero if none of a stock's fund owners suffers a portfolio return loss of more than 1% in bank stock investments. The relation between fire sale discounts and stock exposure might not be linear; hence, we define a squared stock exposure measure, $(Exp^s)^2$, for inclusion in the regression analysis. Another parsimonious way of capturing nonlinear effects consists in defining an exposure dummy $DExp^s$ that marks the 33% of US stocks with the highest stock exposure. The regression coefficient for the exposure dummy conveniently summarizes the average fire sale discount within the most exposed stock tercile.

An alternative definition of fund distress could use fund outflows directly as an identifying measure. However, in this case, fund outflows could simply reflect a fund's portfolio choice and, therefore, become endogenous. For example, a high beta fund is likely to under-perform during a financial crisis, experience larger fund outflows, and sell predominantly high beta stocks so that the fire sale price effect becomes entangled with a possible increase in stock risk premiums.

Fund outflows could also be driven by a few investors' foresight about the future performance of a fund. In this case, outflows correlate with future stock under-performance and, therefore, the fire sale 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 show this, we define as 'exposed funds' the 33% of funds that had the largest losses from holding financial stocks. The rest of the funds are defined as "nonexposed." 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 to estimate monthly investor redemption. We excluded the 2% of funds with extreme monthly net flows because of concerns about reporting errors. Fig. 1 shows the average cumulative net subscription from July 2007 through December 2009 separately for exposed and nonexposed funds. Exposed funds experience net investor outflows after September 2007, which accumulated to a sizable average fund outflow of more than 7% in March 2009. By contrast, for nonexposed funds the average net cumulative inflow remains positive over the full 30-month period and climbs to 12% at the end of 2009.

[Insert Figure 1 near here]

2.2 *Fire sale effects by return quantiles*

Fund managers have considerable discretion over which stocks to sell to meet investor redemptions. Three reasons suggest that their fire sale behavior could condition on the recent performance of a stock: (1) If stock prices generally deviate away from their fundamental values during a crisis, fund managers could choose to first sell stocks with the highest realized crisis returns; (2) fund managers could suffer from the behavior bias commonly referred to as the disposition effect, which makes them averse to "loss taking" (Frazzini, 2006); and (3) investor tax management considerations could motivate fund managers to realize capital gains during market downturns when capital losses are abundant from elsewhere for their fund investors. To capture the possible concentration of fund fire sales in the tails of the stock return distribution, we run quantile regressions that capture the effect of stock exposure for different quantiles of the (cumulative) stock return distribution.

We measure stock returns as risk-adjusted cumulative excess returns $r_s^{Ex}(k)$ over k consecutive weeks since June 29, 2007. The 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. During the crisis period, the market and HML risk premiums were highly negative in the US For firms with positive loadings on these two factors, the factor model produces highly negative benchmark returns. Because the risk-adjusted excess returns represent differences to these low benchmark returns, some cumulative risk-adjusted excess returns appear large even though raw returns of the firms are much more modest. A detailed description of the excess return calculation is provided in Appendix A. Alternative risk adjustment based, for example, on domestic risk factors produces qualitatively similar results.

Next, we present quantile regressions, in which the cumulative risk-adjusted excess returns $r_s^{Ex}(k)$ of all nonfinancial stocks are regressed on the dummy $DExp^s$, which marks the 33% of US stocks with the highest ownership share by distressed equity funds;

$$r_s^{Ex}(k) = \alpha_0^k + \alpha_1^k DExp^s + \alpha_2^k Fsh^s + \mu_s. \tag{2}$$

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 toward larger and more liquid stocks. That is, any stock return differences pertaining to general investment biases of equity funds are captured by the fund share variable. The coefficient α_1^k captures the fire sale effect for the 33% most exposed stocks relative to nonexposed stocks in the same industry.

[Insert Figure 2 near here]

Fig. 2, Panel A plots the evolution of the coefficient α_1^k in Eq. (2) for each week of the financial crisis at the 50% quantile of risk-adjusted cumulative excess returns; Panel B plots the same evolution at the 75% quantile; Panel C at the 90% quantile; and Panel D at the 95% quantile. Vertical bars around the main line indicate a confidence interval of 2 standard deviations around the point estimate. Exposed stocks with median return performance (Panel A) show no discernible evidence for a discount relative to nonexposed stocks. At the 75% quantile of better-performing stocks, the exposure discount is economically and statistically significant and peaks at -27 pps in February 2009. At the 90% and 95% quantile of the best-performing stocks, the fire sale discount reaches a large -70 pps and -144 pps, respectively, before reverting in the spring of 2009. No statistically significant effects are found for lower performance quantiles.

The fire sale discount in the right tail of the return distribution can be further explored in a cross-sectional analysis that focuses on the peak of the discounts at the end of February

2009. For this particular date, we repeat the quantile regression in Eq. (2) over the entire range of quantiles from 0.05 to 0.95. Fig. 3 plots for each quantile the fixed effect α_0^k, which captures the return performance for nonexposed stocks (dashed line), and the corresponding fixed effect $\alpha_0^k + \alpha_1^k$ for exposed stocks (solid line), where α_1^k represents the quantile-specific cumulative risk-adjusted excess return wedge between exposed and nonexposed stocks due to fire sale discounts. The graph shows that the discount effect of stock exposure is concentrated among the best performing stocks in the right tail of the cumulative risk-adjusted excess return distribution. As argued by Hau and Lai (2012), distressed equity funds avoided loss realization implicit in selling under-performing stocks and instead liquidated the best-performing stocks to finance investor redemptions.

[Insert Figure 3 near here]

2.3 *Fire sale effects and stock exposure*

Next, we undertake a more detailed analysis of fire sale discounts and stock exposure. Again, we focus on the cross section of cumulative crisis returns but now examine the discount as a function of the continuous exposure measure Exp^s. We also allow for a nonlinear (quadratic) effect of stock exposure by including the squared value $(Exp^s)^2$ in the regression specification. For example, a nonlinear effect could result from an endogenous response of fund managers. They could restrict further asset sales in stocks that have already experienced strong fire sale discounts, which should produce a convex relation between stock exposure and fire sale discounts. As shown in the previous section, fire sale discounts are concentrated among the 50% best-performing stocks. Therefore, we interact the exposure measures with a high return dummy $DHighR(t)$ marking the 50% of stocks with the highest risk-adjusted excess return from the beginning of 2007/3 to the end of quarter $t-1$.

Table 2 reports a separate OLS regression for each quarter of cumulative risk-adjusted excess returns $r_s^{Ex}(t)$, measured from the beginning of 2007/3 to the end of quarter $t = 2007/3, ..., 2009/4$. For comparison purposes, we also include regression outcomes for the two pre-crisis quarters, 2007/1 and 2007/2. Panel A reports the coefficient estimates for the continuous stock exposure measure Exp^s and its squared value $(Exp^s)^2$, as well as their interactions with the high return dummy

$$\begin{aligned} r_s^{Ex}(t) &= \beta_0^t + \beta_1^t Exp^s + \beta_2^t (Exp^s)^2 + \beta_3^t DHighR(t) + \\ &\quad + \beta_4^t [Exp^s \times DHighR(t)] + \beta_5^t [(Exp^s)^2 \times DHighR(t)] + \beta_6^t Fsh^s + \mu_s. \end{aligned} \quad (3)$$

The regression includes 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. The coefficients for $Exp^s \times DHighR(t)$ and $(Exp^s)^2 \times DHighR(t)$ are highly significant for all crisis quarters with a positive sign for both the linear term and the quadratic term. This implies a convex relation between stock exposure Exp^s and fire sale discounts among high return stocks. In line with the evidence from the quantile regression, the coefficient for $Exp^s \times DHighR(t)$ peaks in 2009/1 and then declines again. For stocks with below median performance, we find at best a weak fire sale discount.

[Insert Table 2 near here]

Table 2, Panel B reports a more parsimonious OLS regression. The two continuous exposure variables Exp^s and $(Exp^s)^2$ are replaced with the exposure dummy, $DExp^s$, used previously in the quantile regressions. The regression

$$r_s^{Ex}(t) = \beta_0^t + \beta_1^t DExp^s + \beta_2^t [DExp^s \times DHighR(t)] + \beta_3^t Fsh^s + \mu_s \quad (4)$$

again includes industry fixed effects. The coefficient for the interaction term $DExp^s \times DHighR(t)$ indicates the fire sale discount for the 33% most exposed above-median performance stocks. The average fire sale discount peaks at around -60 pps in 2008/4 and 2009/1 before stock prices revert again. The high statistical and economic significance of stock underpricing captured by the interaction term $DExp^s \times DHighR(t)$ should make the term a good instrument to explore the causal effect of underpricing on investment and employment. Next we discuss related endogeneity issues and justify this instrument choice.

2.4 *Identification issues and endogeneity*

Our identification of causal investment and employment effects due to stock underpricing is based on the interaction term $DExp^s \times DHighR(t)$ composed of the high exposure dummy and the high return dummy. For a clear discussion of potential problems with this identification strategy, it is useful to highlight three separate dimensions in which a fund's portfolio choice could be endogenous. First, all funds exhibit common investment biases toward 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 could furthermore choose particular high return stocks for sales. Third, exposed funds (with large investments in under-performing bank stocks) could differ from nonexposed funds in their selection of nonfinancial stocks and cluster their portfolios in a subsample of stocks exposed to omitted risk factors. Next, we discuss each of the three issues in turn.

A general investment bias of all funds toward particular stock types means only 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.[13]

The endogenous fund choice of high return stocks for fire sales suggests that the interaction term $DExp^s \times DHighR(t)$ could be subject to an endogenous selection effect even if the exposure dummy $DExp^s$ is strictly exogenous. In particular, stocks with a fundamental value change above the median can be pushed out of the high return subsample due to a strong fire sale effect on their returns. Such endogenous median-crossing for some stocks can create an attenuation bias for any investment regression using $DExp^s \times DHighR(t)$ as the identifying regressor because exposed stocks with strong fire sale effects (and possibly the strongest investment effect) are more likely to drop out of the high return subsample. To gauge the importance of such median-crossing for exposed stocks in our sample, we examine Fig. 3, which plots the cumulative risk-adjusted excess returns separately for exposed and nonexposed stocks at different stock performance quantiles, based on a sequence of quantile regressions over the entire range $[0.05, 0.95]$ of cumulative stock return quantiles. The graph shows that the cumulative risk-adjusted excess returns of the median stocks, marked by a vertical line, are similar across the two stock subsamples and that the fire sale discount for exposed stocks becomes discernible only at above the 60% quantile, suggesting that the median return cutoff we use to examine the fire sale effect is low enough that the endogenous stock selection effect is not likely to bias the coefficient estimate. It is important to note that any static difference in investment behavior between the high and low return subsamples is directly accounted for by the high return dummy. In other words, under the null hypothesis that stock price discounts do not

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

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, always include $DHighR(t)$ as a separate control variable.

The third concern is about the potential clustering of stock picks by exposed funds on a small subsample of stocks that are exposed to omitted risk factors. Such clustering would contradict the identifying assumption that the selection of nonfinancial stocks by exposed funds is quasi-random. Exposed stocks could in turn inherit a (non-random) stock selection bias of the exposed funds. By contrast, a low level of similarity in stock selection among exposed funds would provide evidence that their stock picks are quasi-random. It is, therefore, instructive to explore the similarity of portfolio choice in nonfinancial stocks by exposed funds. A convenient benchmark for portfolio similarity among pairs of exposed funds is the portfolio similarity between pairs of exposed and nonexposed funds. Formally, for any pair of funds (f_1, f_2), we define their portfolio overlap (in nonfinancial sector stocks) as the sum of the portfolio weights in all stocks s that both funds share, that is

$$Overlap(f_1, f_2) = \sum_{s \,\in\, Non-Financials} \min[\widehat{w}^{f_1,s}, \widehat{w}^{f_2,s}], \tag{5}$$

where $\widehat{w}^{f_1,s}$ and $\widehat{w}^{f_2,s}$ represent the portfolio weights of a nonfinancial stock s in funds f_1 and f_2, respectively. Fig. 4 plots the portfolio overlap measures sorted by quantiles for all pairs of exposed funds, all pairs of exposed and nonexposed funds, and all pairs of nonexposed funds based on fund holdings in December 2006. All three overlap measures show considerable independence of stock picks across funds. The average overlap between two exposed funds is 7.3%, compared with 3.2% for a pair of exposed and nonexposed funds and 2.6% for two nonexposed funds. While the stock selections among exposed funds shows a somewhat higher similarity than those between pairs of exposed and nonexposed funds, the similarity remains economically small. Any two exposed funds differ on average in 92.7% of stock picks, suggesting a limited scope of clustering on stocks with particular unobserved risk factors. On average, 32.6% of exposed fund pairs do not share a single stock. The relatively low portfolio overlap among exposed funds suggests that their nonfinancial stock selections are to a large extent independent from each other and could be considered as quasi-random for the purpose of our analysis.

[Insert Figure 4 near here]

Finally, we explore whether exposed funds (stocks) feature any abnormal returns prior to the crisis relative to nonexposed funds (stocks). Such abnormal returns can indicate omitted risk factors. Table 3 reports test statistics for abnormal return differences between exposed and nonexposed funds (Panel A) and between exposed and nonexposed stocks (Panel B). Using a methodology employed by Fama and French (2010), we form an equal- (or asset value-) weighted portfolio of nonfinancial holdings for the 33% most exposed funds and a corresponding portfolio for the remaining 67% of funds each month from January 2002 to December 2006.[14] We also form monthly portfolios of nonfinancial, exposed stocks and nonfinancial, nonexposed stocks for the same pre-crisis period. We then test for the difference in risk-adjusted excess returns using four different factor models, allowing factor loadings to differ across the two types of funds and stocks. We find only insignificant return differences after controlling for the standard risk factors in the literature. This suggests that exposed stocks were not priced according to

[14] We exclude financial firms as well as firms with more than 1% of sales in the financial sector from a fund's semiannual holdings. The portfolio returns are estimated each month using the stock holdings at the beginning of the semester.

any omitted risk factor. Apparently, the market did not anticipate their exposure to fire sales during a banking crisis.

[Insert Table 3 near here]

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 US companies from a mean of 36.6 pps in 2007 to 31.6 pps in 2008 and to 20.2 pps in 2009. Median employment growth was 3.7, 0.0, and -4.0 pps in the years 2007, 2008, and 2009, respectively. The analysis of the investment share in Subsection 3.1 is based on quarterly data because capital expenditure is typically reported at that frequency, whereas the firm-level employment data used in Subsection 3.2 are available only at the annual frequency.

3.1 *Quarterly investment outcomes*

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:

$$Inv_{st} = \gamma_0 + \gamma_1[DExp^s \times DHighR(t)] + \gamma_2 X_s + \mu_{st}. \tag{6}$$

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 winsorize 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 $DExp^s \times DHighR(t)$ as shown in Eq. (6) 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 12.90. 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 -1.23 pps for 2008/4 represents an economically significant investment shortfall of 20% relative to an already depressed quarterly average investment of 6.17 pps in 2008/4. The corresponding investment shortfall is 23% (= -1.08 pps / 4.61 pps) 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.

[Insert Table 4 near here]

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. The point estimates for the undervaluation effect on investment are (individually) statistically significant at the 4% level for each of the five quarters 2008/3 to 2009/3. The hypothesis of joint statistical insignificance for all four quarters 2008/3–2009/2 can be rejected, with an F-value of 12.10. 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 -0.89 pp (-0.85 pp) is slightly smaller and represents a relative investment decrease of -14% (-18%). 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 examine whether general investment biases of funds (for example, toward 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.

[Insert Table 5 near here]

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.

[Insert Table 6 near here]

Table 6, column (1), presents the OLS regression results in which 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 -4.41 pps, which implies a change of -22% relative to a mean investment share of 20.23 pps 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 -4.68 pps. The mean (median) employment change for all firms in 2009 is -3.78 pps (-4.02 pps); hence, firms with depressed stock prices reduced employment by 124% (117%) 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 -3.81 pps, slightly smaller than the corresponding OLS estimate (-4.41 pps); the estimate for the employment effect is -4.59 pps, also somewhat smaller than the OLS coefficient (-4.68 pps). 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 rejected at the 4% level of significance. The Breusch-Pagan test rejects the null hypothesis of independence for the residuals of the two equations. 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 and the transmission channel

4.1 *Evidence from two subsamples*

We can highlight two reasons that external financing constraints could codetermine any causal link between stock underpricing and the incremental reduction in investment and employment shown in the previous subsections. First, equity matters as collateral. A large stock price decline reduces the value of equity collateral and could, therefore, deter external investors in general and banks in particular from providing new capital. Second, a declining stock price generally sends out a negative signal about a firm's investment opportunities. External investors might not be able to trace stock underpricing to fund fire sales and, therefore, misinterpret the fire sale–induced stock price signal by suspending the investment finance of underpriced firms. In the absence of external financing needs, firm management might just ignore the transitory underpricing of firm equity and maintain its investment plan.

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) subject these measures to a rigorous test and find 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. In the following analysis, firms are considered as financially constrained if they are in the top tercile of the index distribution and unconstrained if they are in the bottom tercile. As an alternative sorting variable for financial constraints we use book asset size, in which the bottom (top) tercile, i.e., small (large) firms, is considered financially constrained (unconstrained).

Table 7 repeats the panel regression for the quarterly investment share in Table 4 for the financially constrained and unconstrained subsamples. Columns 1–2 present the results based on a Hadlock and Pierce index sort; Columns 3–4 present the corresponding results for a sort based on firm size. Financially constrained firms show a much stronger investment shortfall [as measured by the coefficient of the dummy $DExp^s \times DHighR(t)$] than an average firm in the full sample reported in Table 4. For example, the fire sale effect in 2009/1 increases fourfold from -0.865 (Table 4, Column 2) to -4.187 (Table 7, Column 1). By contrast, in the financially unconstrained sample, exposed high return firms do not feature any significant relative investment shortfall. The joint hypothesis that all coefficients for $DExp^s \times DHighR(t)$ are zero for the most relevant crisis quarters is strongly rejected for the subsample of financially constrained firms but not rejected for the subsample of unconstrained firms. The regression results are very similar for the two alternative financial constraint proxies.

[Insert Table 7 near here]

Fig. 5 uses the estimated coefficients in Eq. (6) to provide a graphical illustration of the differential investment effect between exposed and nonexposed high return stocks, separately for the subsample of constrained and unconstrained firms. The financially constrained firms depicted in Panel A feature a higher pre-crisis investment share than the (generally larger) financially unconstrained firms in Panel B. The most notable feature in Panel A is the relatively large investment decline for exposed stocks compared with nonexposed stocks—the combined effect of the coefficients for $DExp^s \times DHighR(t)$ and $DExp^s$ creates a wedge of roughly 2 pps between the two groups of stocks after the second quarter of 2008. The total investment share over the four quarters from 2008/3 to 2009/2 was 19.67 pps and 26.74 pps, respectively, for the financially constrained exposed and nonexposed firms. Thus, the yearly investment shortfall for the exposed firms amounts to approximately 7 pps or a 26% lower investment share relative to nonexposed firms. Such an incremental reduction in investment is economically significant.

[Insert Figure 5 near here]

The financially unconstrained firms in Panel B show no evidence of a statistically or economically significant investment shortfall for exposed stocks with stock underpricing. We conclude that financial constraints play a crucial role in the transmission of stock underpricing into real investment effects. Stock underpricing translates into real effects for financially constrained firms, but not for financially unconstrained firms.

4.2 *Permanent valuation effects*

Any investment shortfall due to stock underpricing for financially constrained firms should have permanent valuation effects on these firms because of their reduced capital stock and lower employment and output. How large are such permanent valuation effects?[15]

Financially constrained firms that are subject to fire sales experience a cumulative investment shortfall of 11 pps over the four quarters from 2008/3 to 2009/2 (Table 7). The employment decrease induced by stock underpricing occurs only in 2009 and is approximately 5 pps (Table 6). We can calibrate the output effect for 2009, based on a neoclassical production function with

[15] Fund fire sales due to bank stock exposure are likely to represent only part of the crisis-related stock price inefficiencies. Due to lack of relevant information, our calibration ignores all other sources of stock mispricing that are unrelated to fund fire sales.

a capital share of 1/3 and a labor share of 2/3, to be -7 pps [$= (1/3) \times (-11 \text{ pps}) + (2/3) \times (-5$ pps)]. If we assume that 20% of the production costs are fixed in the short run, and the corporate profit margin is 10%, then the output decrease translates into a profit shortfall of 19.6 pps [$= (0.8 + 0.2/0.1) \times (-7 \text{ pps})$].[16] At an average price-to-earnings ratio of 16, the latter estimate implies a permanent price effect of -1.23 pps [$= (-19.6 \text{ pps}) \times (1/16)$].

This calibration ignores any long-run effects due to strategic competition, in which delayed investment by one firm could imply a permanent loss of competitiveness and market share. Some of the small-growth firms in the financially constrained sample could face such situations. Therefore, the permanent valuation effects can be much larger than the estimate we provided earlier. But such a competitive gain of one firm at the expense of an investment-constrained competitor amounts mostly to a value transfer, but not a macroeconomic welfare loss.

Overall, temporary stock underpricing caused by fund fire sales distorted the capital and labor allocation process during the 2008–2009 crisis. The permanent valuation effect of stock underpricing appears non-negligible among the financially constrained firms in spite of the transitory nature of the fire sale itself.

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'

[16] The earning change can be approximated by $dE/E = (1/m) \times [1 - \theta(1 - m)] \times dR/R$, in which m denotes the profit margin, θ denotes the share of variable costs, and dR/R represents the revenue change.

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 percentage points in 2009. We further investigate the transmission channel through which stock underpricing matters. Using the Hadlock and Pierce index of financial constraints, we sort stocks into a top tercile of most constrained firms and a bottom tercile of least constrained firms. The constrained firms feature a large incremental investment shortfall when subject to fire sale–related stock underpricing, whereas unconstrained firms show no such relative investment shortfall.

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 codetermine 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 sale effects on stock prices first removes risk premiums 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 (SMB), the book-to-market factor (HML), and the momentum factor (MOM). The factor construction is based on monthly stock returns in US 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, in which 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 the 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,

$$r_{s,t} = \alpha + \sum_{j=Dom,Int} \beta_{1,j} MKT_t^j + \beta_{2,j} SMB_t^j + \beta_{3,j} HML_t^j + \beta_{4,j} MOM_t^j + \epsilon_{s,t}, \tag{7}$$

where $r_{s,t}$ denotes a stock's monthly (cum dividend) return in US 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, Lai, de Roon, and Zhang (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

$$er_{s,t} = \sum_{j=Dom,Int} \widehat{\beta}_{1,j} MKT_t^j + \widehat{\beta}_{2,j} SMB_t^j + \widehat{\beta}_{3,j} HML_t^j + \widehat{\beta}_{4,j} MOM_t^j. \qquad (8)$$

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

$$1 + er_{s,t}(k) = (1 + er_{s,m+1})^{n/4} \prod_{i=1}^{m} (1 + er_{s,t+i}), \qquad (9)$$

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 excess return of stock s over k weeks can be calculated from the weekly stock return (wr) and the estimated expected return as

$$r_s^{Ex}(k) = \prod_{i=1}^{k} (1 + wr_{s,t+i}) - (1 + er_{s,t}(k)). \qquad (10)$$

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

$$r_s^{Ex}(q) = \prod_{i=1}^{3\times q} (1 + r_{s,t+i}) - \prod_{i=1}^{3\times q} (1 + er_{s,t+i}). \qquad (11)$$

Appendix B. Accounting variable definitions

$Inv(t)$: The ratio of capital expenditures in period t 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.]

$\Delta Emp(t)$: The ratio of the change in the number of employees over period t to the number of employees at the start of the period, 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 millions of US dollars 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, in which 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 nonfinancial and nonutility 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, and the weights are given by the ownership share of a fund relative to the stock's market capitalization. The squared stock exposure is denoted by $(Exp^s)^2$. The dummy variable $DExp^s$ marks the 33% 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 property, plant, and equipment in period $t-1$, multiplied by 100. The percentage employment change $\Delta Emp(t)$ measures the percentage change in the number of employees over year t relative to the number at the end of period $t-1$. Summary statistics are also reported for exposure measures interacted with the high return dummy $DHighR(t)$ for $t = 2009/1$. The high return dummy $DHighR(t)$ marks all stocks with above median risk-adjusted excess returns from the beginning of quarter 2007/3 to the end of quarter $t-1$. As control variables, we use *Stock size* measured by the natural logarithm of total book assets in millions of US dollars 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 property, plant, and equipment at the end of 2005, and the (risk-adjusted) *Stock return* in 2006. The detailed definitions of the accounting variables are available in Appendix B.

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 (×100)	3,084	−0.249	−0.181	0.253	−2.261	0.000
$(Exp^s)^2$ $(\times 100)^2$	3,084	0.126	0.033	0.283	0.000	5.112
$DExp^s$	3,084	0.334	0.000	0.472	0.000	1.000
Fund ownership share						
Fsh^s	3,084	0.219	0.222	0.153	0.000	0.781
Percentage investment share						
$Inv(2007)$	2,861	36.630	25.038	37.235	2.611	197.740
$Inv(2008)$	2,697	31.570	22.680	30.164	2.067	158.759
$Inv(2009)$	2,541	20.232	14.829	18.176	0.805	86.987
Percentage employment change						
$\Delta Emp(2007)$	2,813	6.908	3.728	23.293	−44.715	93.185
$\Delta Emp(2008)$	2,650	1.305	0.000	20.368	−48.339	73.268
$\Delta Emp(2009)$	2,494	−3.784	−4.015	17.208	−47.907	53.011
Interacted stock exposure						
$Exp^s \times DHighR(2009/1)$	2,589	−0.151	0.000	0.235	−1.786	0.000
$(Exp^s)^2 \times DHighR(2009/1)$	2,589	0.078	0.000	0.210	0.000	3.189
$DExp^s \times DHighR(2009/1)$	2,589	0.210	0.000	0.407	0.000	1.000
Control variables						
Stock size (log of assets)	3,015	5.908	5.849	1.949	2.150	10.787
Tobin's q	3,012	2.262	1.781	1.427	0.884	8.093
Cash flow	2,504	−0.494	0.359	4.863	−24.147	7.857
Stock return(2006)	3,084	0.000	−0.076	0.543	−0.872	2.813

Table 2

Cumulative risk-adjusted excess return effect of stock fire sales

Reported are separate (cross-sectional) OLS regressions of Eq. (3) and (4) for the cumulative risk-adjusted excess 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 risk-adjusted return. In Panel A we report fire sales discounts for the continuous stock exposure variable Exp^s and the squared stock exposure $(Exp^s)^2$, as well as their interactions with the high return dummy $DHighR(t)$, marking stocks with above median cumulative risk-adjusted excess 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 equal to that in 2007/4. Panel B uses a high exposure dummy $DExp^s$ marking the 33% of stocks with the highest stock exposure. We include as control variables the high return dummy $DHighR(t)$ and the fund share (Fsh^s) measuring the ownership share of all reporting equity funds relative to stock capitalization. Also included are fixed effects for each industry. We report robust T-values (in parentheses below the coefficient) adjusted for clustering at the stock level.

Panel A: Continuous stock exposure measure

Independent variable	Dependent variable: Cumulative risk-adjusted return until (end of quarter)											
	2007/01	2007/02	2007/03	2007/04	2008/01	2008/02	2008/03	2008/04	2009/01	2009/02	2009/03	2009/04
	(pre-crisis)	(pre-crisis)										
Exp^s	0.015	−0.048	−0.188	−0.267	−0.323	−0.394	−0.311	−0.536	−0.397	−0.218	−0.348	−0.515
	(0.34)	(−1.07)	(−3.96)	(−2.45)	(−2.84)	(−1.95)	(−1.84)	(−1.83)	(−1.86)	(−1.07)	(−1.61)	(−2.86)
$(Exp^s)^2$	0.014	−0.007	−0.105	−0.115	−0.140	−0.321	−0.174	−0.426	−0.165	−0.064	−0.168	−0.314
	(0.49)	(−0.24)	(−3.02)	(−1.38)	(−1.60)	(−1.71)	(−1.19)	(−1.54)	(−1.46)	(−0.53)	(−0.97)	(−2.55)
$DHighR$	0.027	0.073	0.600	0.941	0.858	1.265	0.918	1.723	1.883	1.354	1.338	1.394
	(1.73)	(4.54)	(33.68)	(21.76)	(22.07)	(20.65)	(15.85)	(16.53)	(16.55)	(15.03)	(17.27)	(20.35)
$Exp^s \times DHighR$	−0.032	0.019	0.820	1.433	1.002	1.854	1.084	2.472	2.609	1.464	1.413	1.614
	(−0.48)	(0.29)	(10.11)	(7.42)	(6.02)	(6.80)	(4.61)	(5.72)	(5.60)	(4.31)	(4.79)	(6.09)
$(Exp^s)^2 \times DHighR$	−0.027	−0.005	0.474	0.827	0.525	1.102	0.599	1.399	1.440	0.649	0.634	0.892
	(−0.53)	(−0.09)	(6.69)	(4.86)	(3.65)	(4.50)	(3.17)	(3.70)	(3.80)	(2.73)	(2.88)	(4.81)
Fsh^s	0.142	0.045	0.070	0.105	0.130	0.218	0.164	0.179	0.116	0.145	0.306	0.137
	(4.31)	(1.35)	(1.76)	(1.08)	(1.39)	(1.59)	(1.39)	(0.89)	(0.53)	(0.81)	(1.80)	(0.89)
Obs	2,913	2,914	2,924	2,919	2,730	2,732	2,721	2,710	2,561	2,561	2,540	2,552
Adj. R^2	0.045	0.090	0.555	0.355	0.384	0.383	0.255	0.296	0.298	0.272	0.325	0.396

Panel B: Stock exposure dummy

Independent variable	Dependent variable: Cumulative risk-adjusted return until (end of quarter)											
	2007/01	2007/02	2007/03	2007/04	2008/01	2008/02	2008/03	2008/04	2009/01	2009/02	2009/03	2009/04
	(pre-crisis)	(pre-crisis)										
$DExp^s$	0.008	0.015	0.038	0.064	0.062	0.018	0.081	0.086	0.143	0.100	0.071	0.078
	(0.77)	(1.61)	(3.51)	(2.65)	(2.63)	(0.51)	(2.68)	(1.90)	(2.72)	(2.25)	(1.63)	(1.95)
$DHighR$	0.038	0.074	0.518	0.798	0.756	1.088	0.837	1.502	1.635	1.193	1.177	1.214
	(3.59)	(6.80)	(42.52)	(27.14)	(27.38)	(25.69)	(20.45)	(20.94)	(21.58)	(19.71)	(21.82)	(25.81)
$DExp^s \times DHighR$	−0.018	−0.020	−0.168	−0.295	−0.221	−0.394	−0.304	−0.603	−0.619	−0.354	−0.310	−0.295
	(−1.30)	(−1.50)	(−10.58)	(−8.13)	(−6.08)	(−7.12)	(−6.33)	(−7.30)	(−6.80)	(−4.97)	(−4.74)	(−4.96)
Fsh^s	0.146	0.067	0.032	0.025	0.137	0.185	0.163	0.097	−0.048	−0.002	0.220	0.075
	(4.85)	(2.20)	(0.88)	(0.29)	(1.71)	(1.58)	(1.51)	(0.56)	(−0.25)	(−0.01)	(1.50)	(0.56)
Obs	2,913	2,914	2,924	2,919	2,730	2,732	2,721	2,710	2,561	2,561	2,540	2,552
Adj. R^2	0.046	0.090	0.546	0.348	0.380	0.380	0.258	0.295	0.295	0.267	0.319	0.389

Table 3
Test of abnormal pre-crisis return difference

We test for abnormal return differences (α differences) prior to the crisis between exposed and nonexposed funds (Panel A) and between exposed and nonexposed stocks (Panel B) using different multifactor models. Each month from January 2002 to December 2006, we form two (equal-weighted or asset value-weighted) portfolios composed of the nonfinancial portfolio component of exposed and nonexposed funds (Panel A) or directly of all nonfinancial, exposed stocks and nonfinancial, nonexposed stocks (Panel B). Differences in risk-adjusted returns between the two groups are estimated using the US one-factor (market) model, the US four-factor model, the international two-factor model (US and international market factor), or the international eight-factor model. The independant variables are monthly portfolio returns for both Panels A and B. Column 1 reports the difference in regression intercept (α) for the two portfolios, Column 2 the associated standard deviation, Column 3 the t-value, and Column 4 the adjusted R^2 of the regression.

	(1)	(2)	(3)	(4)
Panel A: Abnormal pre-crisis return differences between exposed and nonexposed funds				
Equal-weighted returns	Diff. in α	Std. Dev.	T-value	Adj. R^2
US one-factor model	0.0004	0.0016	0.25	0.956
US four-factor model	−0.0003	0.0012	−0.24	0.978
International two-factor model	−0.0004	0.0016	−0.27	0.961
International eight-factor model	−0.0015	0.0019	−0.79	0.979
Value-weighted returns	Diff. in α	Std. Dev.	T-value	Adj. R^2
US one-factor model	0.0013	0.0015	0.86	0.960
US four-factor model	0.0000	0.0013	0.00	0.973
International two-factor model	0.0003	0.0015	0.18	0.964
International eight-factor model	−0.0021	0.0020	−1.05	0.975
Panel B: Abnormal pre-crisis return differences between exposed and non-exposed stocks				
Equal-weighted returns	Diff. in α	Std. Dev.	T-value	Adj. R^2
US one-factor model	−0.0008	0.0048	−0.16	0.772
US four-factor model	−0.0016	0.0029	−0.56	0.932
International two-factor model	−0.0007	0.0052	−0.13	0.774
International eight-factor model	0.0013	0.0038	0.35	0.952
Value-weighted returns	Diff. in α	Std. Dev.	T-value	Adj. R^2
US one-factor model	−0.0007	0.0030	−0.23	0.874
US four-factor model	−0.0021	0.0020	−1.05	0.953
International two-factor model	−0.0012	0.0032	−0.38	0.872
International eight-factor model	−0.0058	0.0031	−1.88	0.954

Table 4

Investment effect of fund ownership exposure

Reported are ordinary least square (OLS) regressions of Eq. (6) for the quarterly percentage investment share (capital expenditure in quarter t relative to the net property, plant, and equipment at the beginning of the quarter) over the three-year period from 2007/1 to 2009/4. The exposure dummy $DExp^s$ marks the 33% US stocks with the highest ownership exposure to distressed equity funds. The exposure dummy is then interacted with a high return dummy $DHighR(t)$, marking stocks with above median cumulative risk-adjusted excess 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 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.

Dependent variable: quarterly percentage investment share	(1)		(2)	
	Coefficient	T-value	Coefficient	T-value
$DExp^s \times DHighR(2007/1)$	0.330	0.61	−0.107	−0.22
$DExp^s \times DHighR(2007/2)$	0.313	0.57	0.099	0.20
$DExp^s \times DHighR(2007/3)$	0.809	1.56	0.378	0.85
$DExp^s \times DHighR(2007/4)$	0.236	0.40	0.044	0.09
$DExp^s \times DHighR(2008/1)$	−0.416	−0.82	−0.647	−1.64
$DExp^s \times DHighR(2008/2)$	−0.579	−1.12	−0.612	−1.56
$DExp^s \times DHighR(2008/3)$	−0.656	−1.26	−0.879	−2.19
$DExp^s \times DHighR(2008/4)$	−1.228	−2.64	−0.893	−2.31
$DExp^s \times DHighR(2009/1)$	−1.079	−2.89	−0.848	−2.51
$DExp^s \times DHighR(2009/2)$	−1.004	−2.74	−0.735	−2.14
$DExp^s \times DHighR(2009/3)$	−0.286	−0.78	−0.729	−2.01
$DExp^s \times DHighR(2009/4)$	−0.011	−0.03	−0.281	−0.72
Stock size (*log of assets*)	−0.180	−3.83		
Tobin's q	0.673	9.19		
Cash flow	0.027	1.01		
Stock return(2006)	0.748	4.23		
Industry fixed effects	yes		no	
Industry time fixed effects	yes		no	
Stock fixed effects	no		yes	
Time fixed effects	yes		yes	
Obs	25,580		26,223	
Adj. R^2	0.165		0.438	
F-statistic (p-value)				
H_0 : no effect 2008/1 to 2009/4	8.333	(0.00)	13.224	(0.00)
H_0 : no effect 2008/3 to 2009/2	12.896	(0.00)	12.101	(0.00)

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 aggregate ownership of all reporting equity funds in stock s relative to the stock's market capitalization. The exposure dummy $DExp^s$ marks the 33% US stocks with the highest ownership exposure to distressed equity funds. The exposure dummy is then interacted with a high return dummy $DHighR(t)$, marking stocks with above median cumulative risk-adjusted excess 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 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; Specification 2 adds the fund share interacted with time fixed effects as additional controls. The dependent variable of the regressions is the quarterly percentage investment share (capital expenditure in quarter t relative to the net property, plant, and equipment at the beginning of the quarter). We report robust T-values adjusted for clustering at the stock level.

Dependent variable: quarterly percentage Investment share	(1)		(2)	
	Coefficient	T-value	Coefficient	T-value
$DExp^s \times DHighR(2007/1)$	−0.107	−0.22	−0.096	−0.19
$DExp^s \times DHighR(2007/2)$	0.099	0.20	0.162	0.34
$DExp^s \times DHighR(2007/3)$	0.378	0.85	0.379	0.86
$DExp^s \times DHighR(2007/4)$	0.044	0.09	0.059	0.12
$DExp^s \times DHighR(2008/1)$	−0.647	−1.64	−0.609	−1.55
$DExp^s \times DHighR(2008/2)$	−0.612	−1.56	−0.605	−1.54
$DExp^s \times DHighR(2008/3)$	−0.879	−2.19	−0.906	−2.25
$DExp^s \times DHighR(2008/4)$	−0.893	−2.31	−0.969	−2.49
$DExp^s \times DHighR(2009/1)$	−0.848	−2.51	−0.914	−2.67
$DExp^s \times DHighR(2009/2)$	−0.735	−2.14	−0.832	−2.41
$DExp^s \times DHighR(2009/3)$	−0.729	−2.01	−0.845	−2.31
$DExp^s \times DHighR(2009/4)$	−0.281	−0.72	−0.377	−0.95
Stock fixed effects	yes		yes	
Time fixed effects	yes		yes	
Time fixed effects $\times Fsh^s$	no		yes	
Obs	26,223		25,914	
Adj. R^2	0.438		0.439	
F-statistic (p-value)				
H_0 : no effect 2008/1 to 2009/4	13.224	(0.00)	15.058	(0.00)
H_0 : no effect 2008/3 to 2009/2	12.101	(0.00)	13.972	(0.00)

Table 6
Investment and employment effect of fund ownership exposure

Reported are ordinary least square (OLS) regressions and seemingly unrelated regressions (SUR) for the annual percentage investment share (capital expenditure in year t relative to the net property, plant, and equipment at the beginning of the year) and the annual percentage employment change over the three-year period from 2007 to 2009. The exposure dummy $DExp^s$ marks the 33% US stocks with the highest ownership exposure to distressed equity funds. The exposure dummy is then interacted with a high return dummy $DHighR(t)$, marking stocks with above median cumulative risk-adjusted excess return from July 2007 to the end of year $t-1$. The $DHighR(t)$ dummy for 2007 is set 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. Also included are fixed time effects for each year, fixed effects for each industry, and the interaction of industry and fixed time effects. We report robust T-values adjusted for clustering at the stock level. Under the SUR model, we examine two additional null hypotheses: The joint zero coefficient of $DExp^s \times DHighR(2009)$ and the independence of the investment and employment equations. The latter is conducted based on the Breusch and Pagan test. The F-statistics and p-values are reported.

	(1) OLS		(2) SUR	
	Coefficient	T-value	Coefficient	T-value
Equation 1: Annual percentage investment share				
$DHighR(2007)$	1.223	0.54	1.223	0.86
$DHighR(2008)$	4.432	2.26	4.706	3.12
$DHighR(2009)$	5.214	4.37	4.865	2.74
$DExp^s \times DHighR(2007)$	1.345	0.46	1.297	0.57
$DExp^s \times DHighR(2008)$	−0.583	−0.24	−0.979	−0.41
$DExp^s \times DHighR(2009)$	−4.407	−2.94	−3.809	−1.44
$Stock\ size\ (log\ of\ assets)$	−1.896	−6.21	−1.901	−7.96
$Tobin's\ q$	5.098	9.41	5.100	17.75
$Cash\ flow$	−0.003	−0.01	0.036	0.37
$Stock\ return(2006)$	5.279	4.22	5.254	7.02
Obs	6,419		6,240	
Adj. R^2	0.199		0.330	
Equation 2: Annual percentage employment change				
$DHighR(2007)$	4.865	3.33	4.852	4.84
$DHighR(2008)$	5.422	4.10	5.426	5.13
$DHighR(2009)$	5.587	5.14	5.389	4.34
$DExp^s \times DHighR(2007)$	−1.820	−0.88	−1.829	−1.14
$DExp^s \times DHighR(2008)$	0.493	0.28	0.479	0.29
$DExp^s \times DHighR(2009)$	−4.681	−3.50	−4.592	−2.48
$Stock\ size\ (log\ of\ assets)$	0.086	0.45	0.071	0.42
$Tobin's\ q$	1.974	6.66	2.010	9.98
$Cash\ flow$	0.323	2.58	0.345	5.05
$Stock\ return(2006)$	5.042	6.33	5.115	9.74
Obs	6,294		6,240	
Adj. R^2	0.142		0.282	
F-statistic (p-value)				
H_0 : no real effect in 2009		–	6.610	(0.04)
H_0 : two equations are independent			615.437	(0.00)

Table 7
Financial constraints as transmission channel

The stock fixed effect regression in Table 4 is examined separately for the top tercile (marked as financially constrained) and the bottom tercile (marked as financially unconstrained) of firms sorted by the Hadlock and Pierce AS index, with the results reported in Columns–2. In Columns 3–4, we sort firms by their book asset values (Size). Included in the regressions (but not reported) are stock fixed effects and separate time fixed effects, as well as $DExp^s$ and $DHighR$, each interacted with all time dummies. The dependent variable of the regressions is the quarterly percentage investment share (capital expenditure in quarter t relative to the net property, plant, and equipment at the beginning of the quarter). We report robust T-values adjusted for clustering at the stock level. We also report the F-statistics and p-values testing for the joint effect of 2008/1–2009/4, the joint effect of 2008/3–2009/2, and the equality of coefficient for $DExp^s \times DHighR$(2009/1) between the constrained and unconstrained firms.

	Financial constraints sorted by							
Dependent variable: quarterly percentage investment share	Hadlock and Pierce Index				Size			
	(1) Constr. firms		(2) Unconstr. firms		(3) Constr. firms		(4) Unconstr. firms	
	Coef.	T-value	Coef.	T-value	Coef.	T-value	Coef.	T-value
$DExp^s \times DHighR$(2007/1)	0.267	0.10	0.532	0.85	0.436	0.16	0.489	0.77
$DExp^s \times DHighR$(2007/2)	0.427	0.17	−0.159	−0.23	0.833	0.35	−0.298	−0.43
$DExp^s \times DHighR$(2007/3)	2.373	1.22	−0.787	−1.45	2.334	1.25	−0.691	−1.26
$DExp^s \times DHighR$(2007/4)	0.215	0.10	−0.085	−0.11	0.204	0.10	0.087	0.11
$DExp^s \times DHighR$(2008/1)	−0.548	−0.32	−0.342	−0.76	−0.625	−0.38	−0.334	−0.72
$DExp^s \times DHighR$(2008/2)	−0.993	−0.60	−0.153	−0.30	−0.779	−0.50	−0.042	−0.08
$DExp^s \times DHighR$(2008/3)	−2.533	−1.01	0.652	1.02	−2.617	−1.10	0.747	1.19
$DExp^s \times DHighR$(2008/4)	−1.914	−1.46	−0.304	−0.61	−1.795	−1.42	−0.462	−0.92
$DExp^s \times DHighR$(2009/1)	−4.187	−2.64	0.159	0.32	−4.076	−2.62	0.247	0.50
$DExp^s \times DHighR$(2009/2)	−2.330	−1.42	−0.370	−0.86	−2.150	−1.33	−0.341	−0.79
$DExp^s \times DHighR$(2009/3)	−1.937	−1.27	−0.242	−0.48	−1.876	−1.26	−0.092	−0.17
$DExp^s \times DHighR$(2009/4)	−2.304	−1.20	−0.626	−1.13	−2.299	−1.26	−0.569	−1.05
Obs	7,638		9,209		7,651		9,210	
Adj. R^2	0.323		0.582		0.325		0.580	
F-statistic (p-value) for multiple zero coefficients								
H_0 : no effect 2008/1 to 2009/4	4.656	(0.03)	0.349	(0.55)	4.463	(0.03)	0.169	(0.68)
H_0 : no effect 2008/3 to 2009/2	4.974	(0.03)	0.011	(0.92)	4.828	(0.03)	0.021	(0.89)
F-statistic (p-value) for equal coefficients across constrained and unconstrained firms								
H_0 : same effect in 2009/1	7.660	(0.01)			7.920	(0.00)		

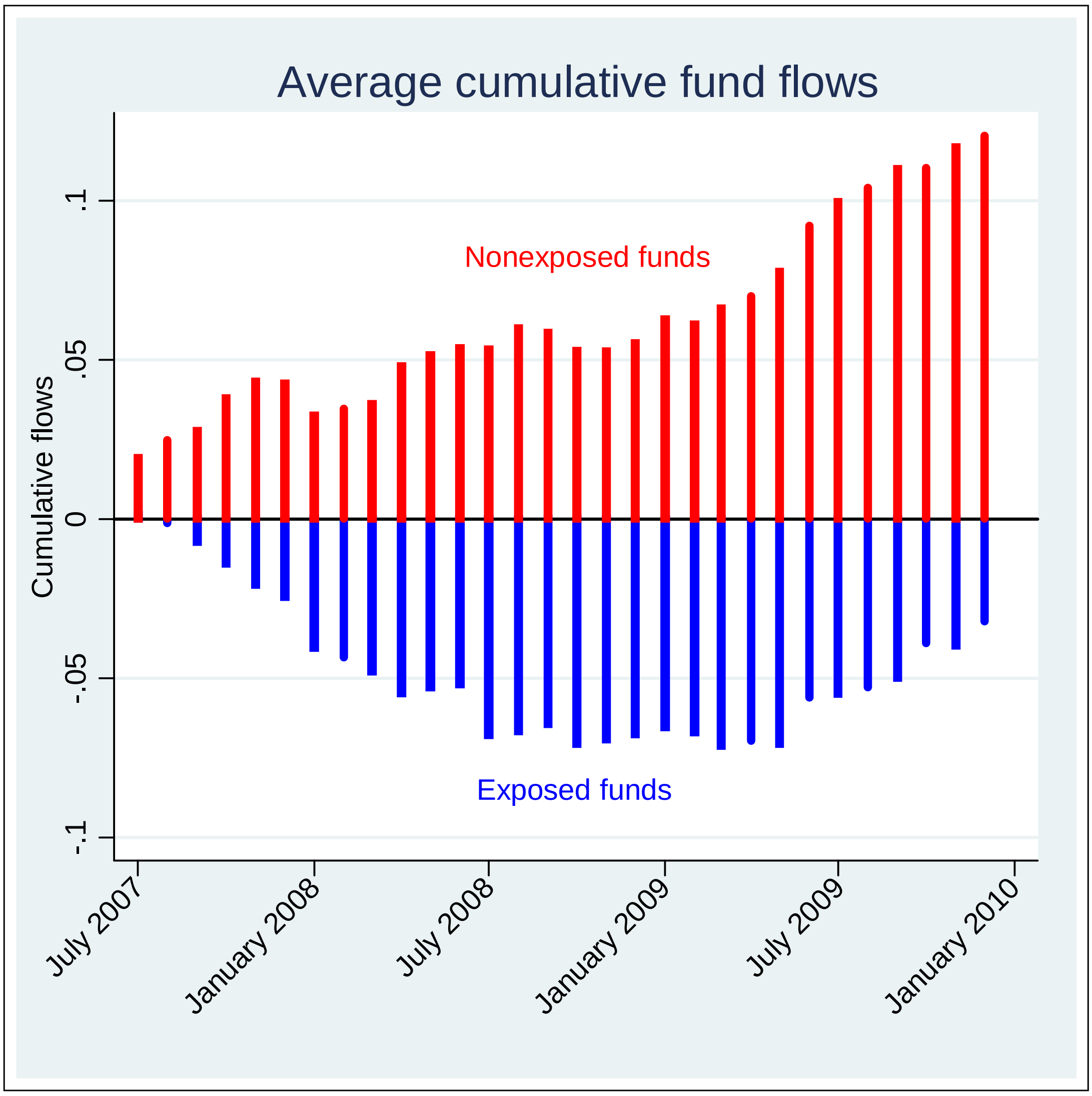

Figure 1: Plotted are the average cumulative fund flows for the 33% of funds with the highest investment losses in financial sector stocks (exposed funds) and the remaining 67% of funds (non-exposed funds). A fund's cumulative fund flow is estimated by its cumulative dollar flows since July 2007 relative to its asset holdings in June 2007.

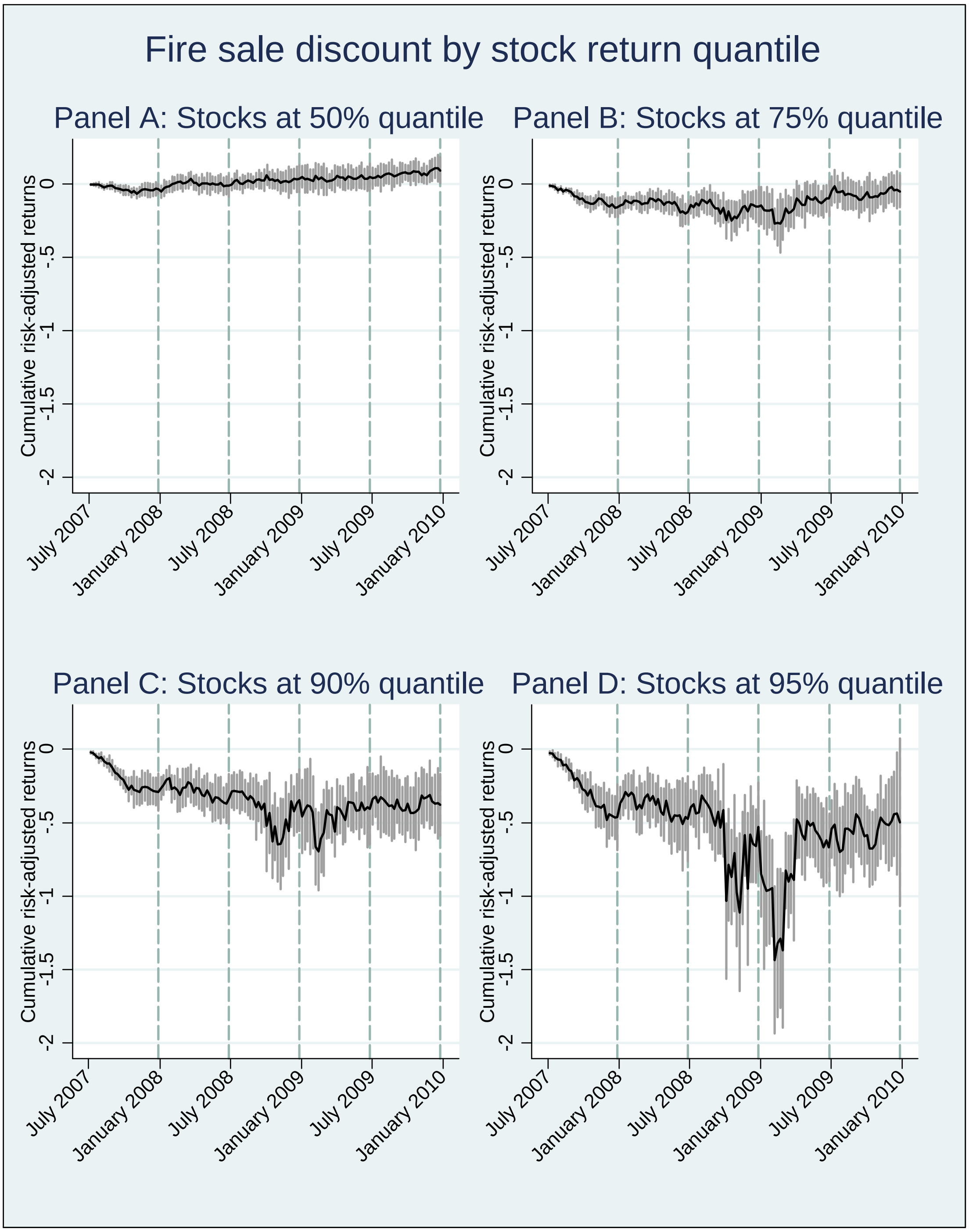

Figure 2: The graphs show the fire sale discounts [measured by the coefficient α_1^k in Eq. (2)] for exposed stocks in different cumulative risk-adjusted stock excess return quantiles measured over the period from June 29, 2007 to the end of each subsequent week ending December 25, 2009. Panel A shows fire sale discounts for stocks at the 50% (median) cumulative risk-adjusted excess return quantile and Panel B for the better-performing stocks at the 75% cumulative risk-adjusted excess return quantile. In Panels C and D, we plot the fire sale discounts for exposed stocks at the highest 90% and 95% cumulative risk-adjusted excess quantiles, respectively. Stock exposure is measured by ownership share of distressed equity funds in a particular stock. The vertical bars provide a confidence interval of 2 standard deviations around the point estimate.

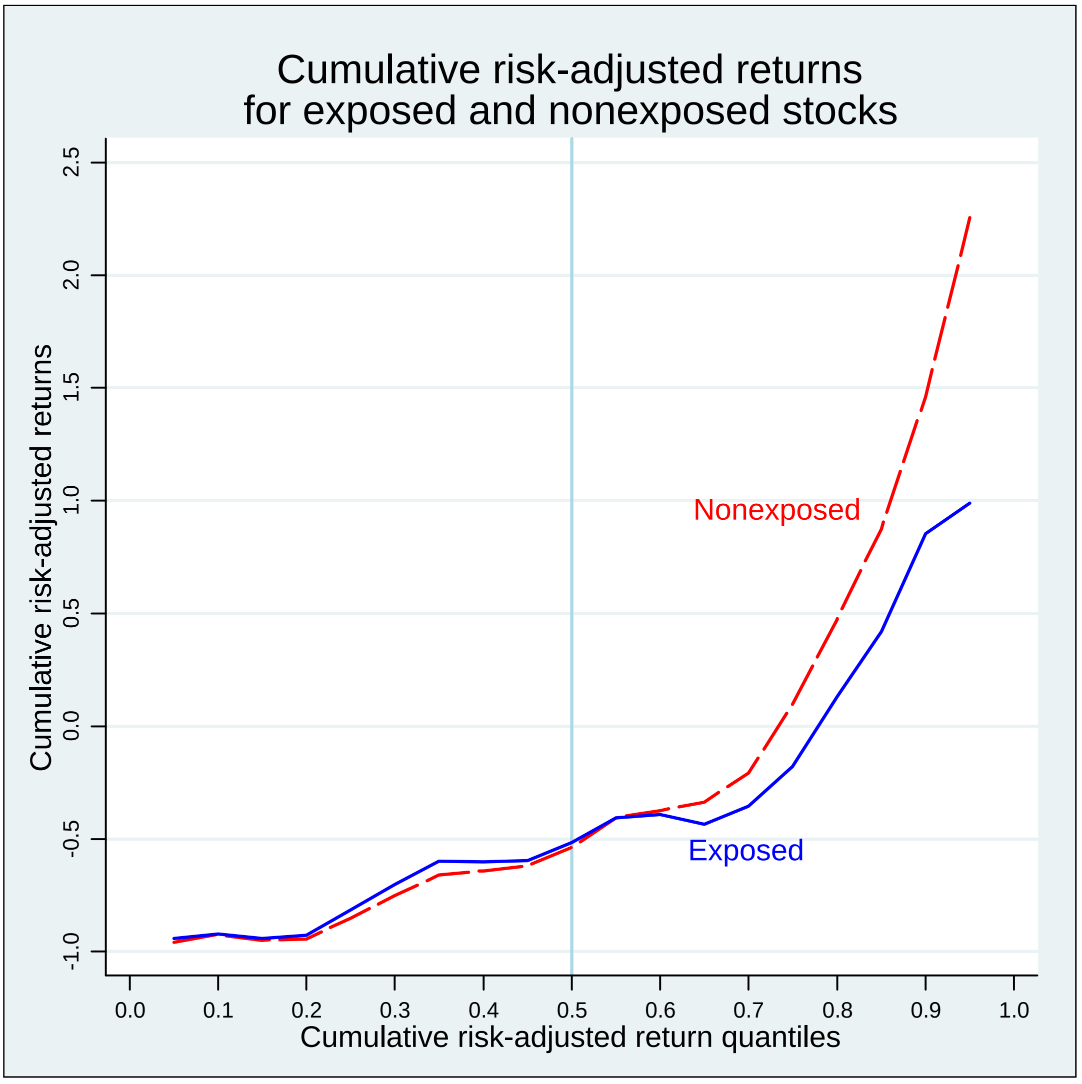

Figure 3: Plotted are the estimated cumulative risk-adjusted excess returns for exposed and non-exposed stocks during the period from June 29, 2007 to February 27, 2009 based on quantile regressions for cumulative risk-adjusted excess return quantiles from 0.05 to 0.95. The dashed line represents the fixed effect α_0^k in the quantile regression using EQ. (2) and the solid line the fixed effect $\alpha_0^k + \alpha_1^k$, which includes the quantile-specific fire sale discounts α_1^k.

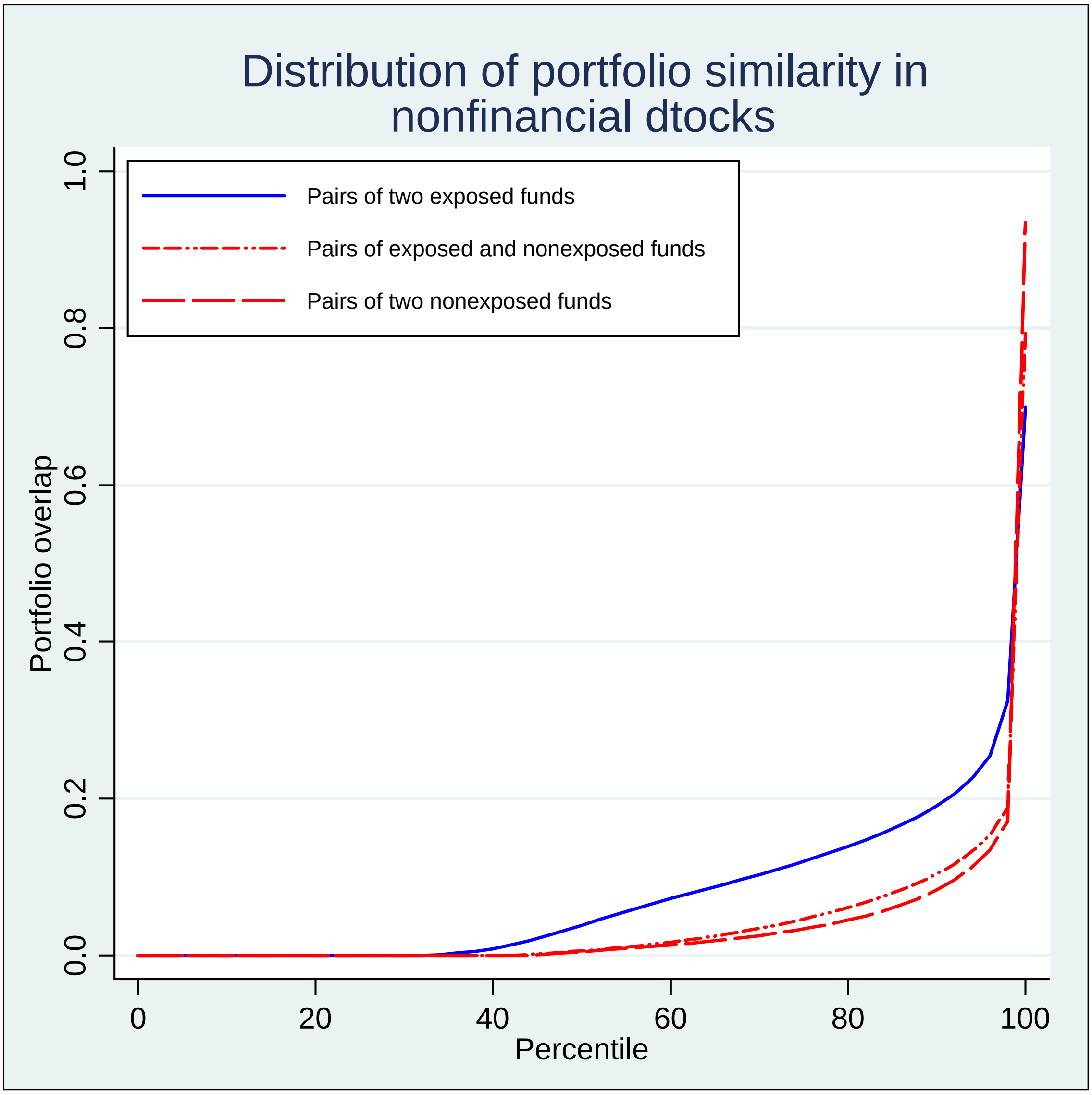

Figure 4: Plotted are the distributions of the shared portfolio weights [i.e., fund overlap as described in EQ. (5)] in nonfinancial stocks for three different types of fund pairs: Pairs of two exposed funds, pairs of exposed and non-exposed funds, and pairs of non-exposed funds. This 'fund overlap' is measured based on fund holdings in December 2006.

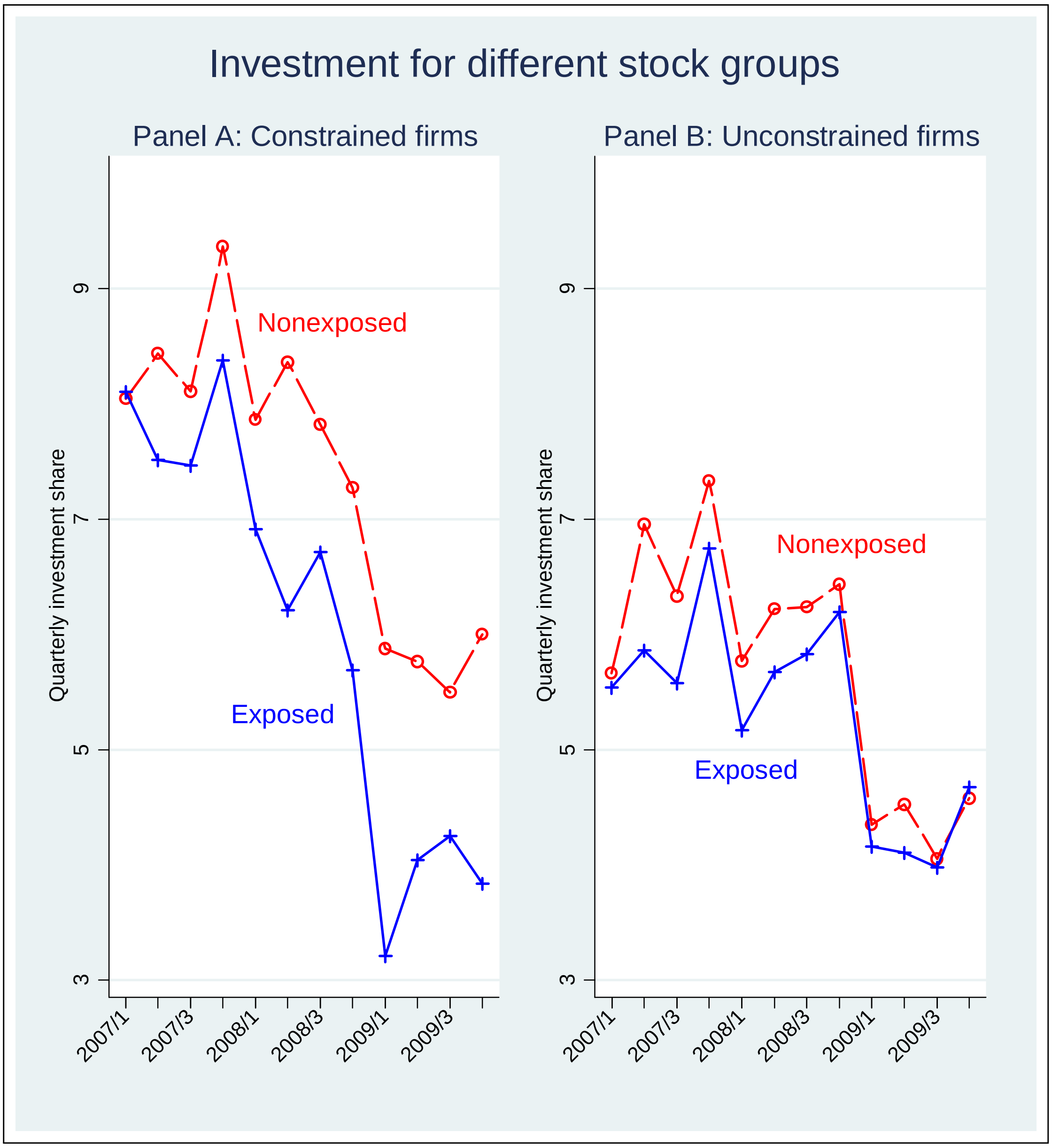

Figure 5: Plotted are the quarterly percentage investment shares (capital expenditure in quarter t relative to the net property, plant, and equipment at the beginning of the quarter) for the financially constrained firms (Panel A) and unconstrained firms (Panel B) based on the fixed effect obtained from Table 7, Columns 1 and 2. The evolution of the investment share for stocks with (without) fire sale exposure and above median cumulative risk-adjusted return is given by the solid (dashed) line marked by crosses (circles).