Corporate Responses to Stock Price Fragility*

Richard Friberg † Itay Goldstein ‡ Kristine W. Hankins §

June 4, 2020

Abstract

We study whether stock price fragility (exposure to non-fundamental demand shocks) stemming from changes in the composition of equity ownership poses a salient corporate risk. We model ex-ante corporate responses to higher potential for *future* stock market misvaluation and then empirically document that within firm variation in equity fragility has effects in line with the model: higher fragility raises cash holdings and lowers investment. Multiple natural experiments support a causal interpretation of the results. The results are shown to be more prominent in the face of high uncertainty and financial constraints. The evidence presents a new dimension in the feedback channel which connects the stock market and corporate policies.

Keywords: Financial fragility, Precautionary cash holding, Real effects of misvaluation
JEL: D84, G31, G32, G35

*We thank seminar participants at IFN, Syracuse University and Stockholm School of Economics for valuable comments.

†Norwegian School of Economics, CEPR and Stockholm School of Economics, P.O. Box 6501, 113 83 Stockholm, Sweden. Email:nerf@hhs.se

‡Department of Finance, Wharton School, University of Pennsylvania, Philadelphia, PA 19104; Email: itayg@wharton.upenn.edu

§University of Kentucky, Gatton College of Business and Economics, 550 S Limestone, Lexington, KY 40506, United States. Email: kristine.hankins@uky.edu

1 Introduction

The interaction between corporate finance and financial markets is at the heart of financial economics. Firms rely on financial markets in different ways and so might be affected by shocks that originate in them. One of the key questions that has been the focus of a large volume of research is whether non-fundamental mispricing shocks in the equity market affect firms' behavior. Such concerns are often voiced in practice. Take, for example, George Soros in a testimony in 1994 before Congress, arguing that: "In certain circumstances, financial markets can affect the so called fundamentals which they are supposed to reflect. When that happens, markets enter into a state of dynamic disequilibrium and behave quite differently from what would be considered normal by the theory of efficient markets. Such boom/bust sequences do not arise very often, but when they do, they can be very disruptive, exactly because they affect the fundamentals of the economy."[1]

A common strategy for evaluating such forces in previous empirical research was to identify mispricing shocks and analyze their effect on various corporate-finance outcomes, such as corporate investment (e.g., Baker et al. (2003) or Hau and Lai (2013)) and takeovers (e.g. Dong et al. (2006) or Edmans et al. (2012)). The debate that often follows naturally, given the difficulties in identifying mispricing, centers on the extent to which shocks to prices indeed reflect non-fundamental changes.[2]

Another approach to answer the important question of whether financial-market shocks affect firms is to ask whether firms change their behavior when they anticipate that their stock price fragility has increased and, thus, that they are more prone to future mispricing. This is the analysis we undertake in this paper. To the best of our knowledge, despite the large literature trying to understand the relation between financial-market shocks and the real economy, our paper is the first one to provide such analysis. Documenting that firms respond in a precautionary manner to an increased risk of mispricing offers a new way, which sidesteps the controversy around identifying non-fundamental changes in prices, to understand the important relation between shocks in financial markets and corporate finance decisions. It also provides vastly new implications, pointing to the effect that financial-market shocks have before they materialize. Corporations react directly to the increased threat of mispricing.

[1] See: https://www.valuewalk.com/2014/06/george-soros-mit-speech/.

[2] See recent critiques on the Edmans et al. (2012) fund-flows measure of mispricing by Berger (2019) and Wardlaw (2020), and, on the other hand, recent papers showing that the measure continues to work after addressing these critiques (Dessaint et al. (2019b), Gredil et al. (2019), and Bian et al. (2018)).

To capture the risk that firms face due to stock-price fragility, we use the measure developed by Greenwood and Thesmar (2011). The logic behind their measure is that firms that face greater correlation in the liquidity needs of their stocks' owners are prone to higher idiosyncratic volatility in order flows and ultimately in stock prices. Such firms are considered to be more exposed to stock price fragility. Hence, their measure links the ownership composition of stocks to the non-fundamental demand that these stocks might face. Greenwood and Thesmar (2011) build their measure based on the readily available data on mutual fund ownership. They note that fragility has increased dramatically over the last two decades due to changes in the landscape of the mutual fund industry, e.g., its concentration of holdings.[3] Following their approach, we focus on mutual funds' holdings to measure fragility. We then examine whether stock price fragility affects important aspects of firms' behavior, such as their cash holding and investment.

Why would non-fundamental changes in prices be a concern to firms? Stock prices serve as a signal to many decision makers who end up taking actions that affect the firms' investments, operations, and cash flows. A recent literature has developed around this idea to explore the feedback effect from stock prices to firms' investments and cash flows (see Bond et al. (2012) for a survey and Luo (2005), Chen et al. (2006), and Foucault and Fresard (2014), among others, for empirical evidence). While the feedback effect is usually perceived to have a beneficial role since it helps provide information to decision makers and guide them into making more efficient decisions, it can be destabilizing in certain circumstances when speculators' incentives are affected by the expected feedback leading them to trade in a way that is not aligned with information available (see models by Goldstein and Guembel (2008), Goldstein et al. (2013), and Brunnermeier and Oehmke (2013), among others).

More specific to our setting, in the presence of a feedback effect, mispricing is expected to affect firms' investments and operations. As prices move for fundamental and non-fundamental reasons, decision makers update their views and decisions - and are sometimes affected by non-fundamental changes in price since it is difficult to disentangle fundamental from non-fundamental changes (see, e.g., Edmans et al. (2012), Khan et al. (2012), Hau and Lai (2013), and Dessaint et al. (2019a)). If decision makers learning from the price are potential creditors or other capital providers, mispricing shocks will affect the access that the firm has to capital, and ultimately also its ability to invest and operate. Hence, a greater anticipated volatility in stock prices due to potential for misvaluation may concern firms and encourage them to take precautionary steps.

[3]See related evidence on fragility in Ben-David et al. (2017).

We start the paper by providing a simple model to illustrate the channel. Firms choose how much cash buffer to keep in the business. The cost of an increased cash buffer is the forgone return on alternative illiquid investment opportunities. The benefit comes from the fact that the firm may face a future financing need if its cash balances fall below a certain level. The cost of raising cash in the future depends on the pricing of the securities of the firm in the market, a feature that we take as given but is motivated by the feedback-effect literature described above. While all firms face some risk of equity misvaluation raising their cost of raising capital in the future, changes in the degree of misvaluation risk should affect the benefit of increasing current cash holdings. This implies that firms exposed to greater stock fragility will hold more cash and invest less in capital expenditure. The model is in the same tradition as in Baker et al. (2003) (building on Stein (1996)) in which a firm, after observing its current stock market valuation, decides on investment and whether to issue new equity. We differ from previous work on corporate responses to mispricing by modeling the *ex ante* decision of precautionary corporate behavior.

It is important to emphasize that the above mechanism does not rely on any asymmetry between underpricing and overpricing. A fragile stock price implies a higher probability of bigger overpricing just like it does for bigger underpricing. The key, however, is that the gains from overpricing do not play any role in the choice of cash buffer of the firm, since the firm will always exploit these gains when they arise regardless of its level of cash. It is only the loss from underpricing that is forced on the firm when it faces cash shortage, and this is why the firm will attempt to reduce cash shortages when it expects a higher likelihood of severe underpricing.

After setting up the model to illustrate the mechanism, we proceed to the main part of the paper, which is the empirical analysis based on the model's predictions. As mentioned above, we use stock holdings by US mutual funds to build the measure of stock price fragility developed by Greenwood and Thesmar (2011). The key premise behind this measure is that fragility depends on the structure of ownership in the firm's stock. If liquidity needs are more correlated among shareholders or if there is greater concentration in holdings, then the firm faces more fragility with respect to possible mispricing.[4]

[4]The Greenwood and Thesmar (2011) fragility measure builds on evidence that liquidity needs of mutual funds can drive stock prices of individual firms. This goes back to Coval and Stafford (2007). There is also evidence by Anton and Polk (2014) and Koch et al. (2016) that ownership patterns matter for stock price fragility. To the best of our knowledge only one other paper brings this measure of fragility to a corporate-finance context. Xiao (2018) documents a negative link between noise trading and firm performance as measured by returns on assets, cash flows and operating profits. His results emphasize managerial learning from the market rather than real effects through access to capital.

Our main set of results relate this measure of fragility to cash holdings and other precautionary corporate decisions. Panel regressions control for industry-time and firm fixed effects as well as a set of additional time variant firm characteristics. We show a strong positive (negative) relation between the level of fragility and the firm's choice of cash holdings (capital expenditures, R&D, payout). These within-firm specifications imply that firm policies respond to changing institutional ownership patterns and the resulting stock price fragility. Firms take precautionary actions – increasing their cash buffers and reducing their expenditures – when they are subject to greater stock price fragility due to the characteristics of their investors base. These results emphasize how the real effect of financial markets extends beyond what happens when prices are shocked: anticipation of future shocks also causes firms to increase their precautionary behavior.

An obvious concern about the previous results is whether they indeed indicate a causal effect of fragility on corporate policies. There is a possibility that investors expect a corporate policy change in the future (such as an announcement of a higher future cash holding target for a firm) which could change the ownership composition and thereby the degree of financial fragility. Alternatively, potential endogeneity may be due to an omitted variable that is correlated with both shareholder composition and corporate cash policies. While there are no obvious alternative channels which could generate the results we obtain after controlling for both firm and industry-year fixed effects, we examine the effect of multiple episodes of financial institution mergers which provide exogenous shocks to stock price fragility to buttress the panel regression evidence.

First, we look at the very prominent 2009 merger between Blackrock and Barclays Global Investors (BGI), which previously has been used as an exogenous shock to ownership concentration. For example, Massa et al. (2018) used it to examine the response of other funds to an increase in holding concentration and Azar et al. (2018a) used it to examine the effect of the increased ownership concentration on product market (airlines) competition. As highlighted by Massa et al. (2018), the merger has several attractive features for identification purposes: It came as a surprise, it affected many stocks (stocks held by both BlackRock and BGI represent more than 60% of world market capitalization), and it was associated with a substantial change in ownership concentration for many affected stocks (concentration increased by 8.5% in the quintile of stocks with the highest overlap of portfolios). The results from a close examination of the BlackRock and BGI merger support the notion that the panel regressions capture a causal effect. With an exogenous change in ownership concentration and financial fragility, we again document that firms adjust their cash holding in the expected direction in response to

fragility risk.

Second, since the BlackRock-BGI merger is widely debated in the context of the literature investigating the effect of common ownership on *product market competition* (see e.g. Dennis et al. (2018), Azar et al. (2018b), Lewellen and Lowry (2019)), we follow Lewellen and Lowry (2019) and evaluate the effect of other episodes of financial institution mergers that occur in non-crisis years. For their two largest mergers, where we can reasonably expect to find a meaningful effect on fragility, we again establish that cash holdings increase in response to greater financial fragility. That said, we note that the concerns raised in this literature about the BGI-BlackRock merger do not seem as relevant for the purpose of our study. Examinations of common ownership on product market competition hinge on very different mechanisms than what concerns us here. When studying the effects of common ownership on product market competition, issues of passive vs. actively managed funds and possibilities for fund managers to control corporate managers take center stage. In contrast, the mechanism of interest in this paper rests on the well documented premise that more concentrated mutual fund ownership of a firm is associated with greater stock price volatility.

Additional important analysis in our paper demonstrates that fragility does not affect corporate policies equally across firms and over time. Consistent with the theory, we find that firms increase their cash buffers in response to heightened fragility when they are constrained or face high uncertainty and when aggregate conditions are stressed or uncertain. In particular, we show that the sensitivity of cash holdings to fragility is higher for firms which are small, have more volatile earnings, and do not have a bond rating. Similarly, we show that the sensitivity is increasing in times when the volatility in the market is high, according to the VIX measure. These results lend further support to our interpretation about the mechanism via which stock fragility affects corporate policies.

Across the different specifications we consistently document non-trivial effects. Using within firm variation in stock price fragility we find that a one standard deviation increase in stock price fragility raises cash holding by around 1% when evaluated at the mean. The corresponding effect for earnings volatility, a highly salient motivation for precautionary cash holding, is around 2%. We also note that treated firms raised their cash holdings by more than one percentage point in response to the exogenous change in stock price fragility associated with the BlackRock-BGI merger. In sum, the empirical results support the hypothesis that stock price fragility is something managers pay attention to when they set corporate policies and that the effects are important.

In addition to the stock price feedback (or 'real effects') literature, this paper relates

to two broader streams of the literature not explicitly discussed above. First, we relate to extensive work on links from uncertainty to investment. Uncertainty can stem from firm or project risk - as is the focus of theory by Bernanke (1983) - and there is broad evidence that firms adjust investment and/or the propensity to save when facing such risks (see Baker et al. (2016) and Riddick and Whited (2009)). Our results highlight that uncertainty exists in external financing access or cost, regardless of project risk, if there are concerns regarding the supply of bank credit (Peek and Rosengren (2000) and Becker and Ivashina (2015)) or the ability to go public (Pástor and Veronesi (2005)) in addition to general macroeconomic uncertainty (Jurado et al. (2015)). Stock price fragility is a specific but potentially economically important and distinct source of financing uncertainty. We are the first to provide evidence that managers identify increasing stock fragility – and the resulting potential exposure to non-fundamental shocks – as a salient risk.[5]

Second, we relate to work on precautionary cash holding and financial flexibility - using financial policies to ensure cost-efficient access to capital in a wide range of states of the world (see, e.g., Denis (2011)). A precautionary motive for cash holdings is supported by numerous studies, for instance Bates et al. (2009) or Faulkender et al. (2018). While the precautionary cash literature is not new, this paper is the first to demonstrate that fragility is indeed a salient risk for public firms, providing an important piece of evidence in support of the feedback-effect theory. Another implication is that the costs of market fragility are not just captured by the events following price changes, but rather that there is significant cost imposed on firms due to the need to protect themselves against this risk. Firms may forego investments and hoard cash when this exposure increases. Overall, it is possible that growth of the asset management industry and the associated increase in equity fragility may be a force deterring firms from public markets.

The next section presents our model and then Section 3 presents the data and the measure of financial fragility. Section 4 presents the results from the panel analysis of fragility on our prime variable of interest, cash holding, but also on measures of investment and liquidity management. Section 5 uses asset management mergers to examine the causal impact of more concentrated institutional ownership on cash holding and the

[5]To this end, we are similar in spirit to Ivashina and Scharfstein (2010) and Balakrishnan et al. (2014). Ivashina and Scharfstein (2010) documents an uptick in credit line drawdowns following Lehman Brothers' failure as firms sought to lock in future financing options when there was bank market uncertainty. Balakrishnan et al. (2014) shows firms responding to an analyst loss by increasing disclosure to improve liquidity. Further, we complement the investor horizon literature (Derrien et al. (2013)) with a new perspective on investor composition risk.

other variables of interest. Section 6 explores alternative mechanisms, related to bank lending and weak product market competition, that in principle could be driving results. Section 7 concludes.

2 Model

There are three dates, 0, 1, and 2. At date 0, the firm decides how much to invest in a long term illiquid project maturing at date 2, and how much cash (or liquid assets) to keep in the business. At date 1, the firm's intermediate earnings are realized, exposing it to potential financing needs. At that point, the firm can raise more cash in the capital markets, generating either a gain or loss, depending on the mispricing of its stock (or other securities), which is realized at the same time. Finally, at date 2, the long-term investment matures and all cash flows realize. Below, we start by describing the actions of the firm at date 1, and then go back to describe its choices at time 0.

Date 1: Financing Needs, Mispricing, and the Firm's Interaction with Capital Markets

At date 1, the firm's cash balance is given by $c \equiv x + e$, where x is the initial cash balance the firm carried from date 0, and e is the realization of earnings generated during the period. We assume that e is distributed with a cumulative distribution function $F(e)$ and a density function $f(e)$ in the range $[\underline{e}, \overline{e}]$, where $\underline{e} < 0 < \overline{e}$.

At date 1, the firm can raise new cash $\Delta c \geq 0$ in the capital market, up to a ceiling of $\overline{\Delta c}$. The terms at which the firm is able to do this depend on the market price of its stock (or other securities). In particular, the terms of financing depend on the degree of mispricing. We use Δp to denote the level of mispricing. If the firm's stock is overpriced, then $\Delta p > 0$, and if it is underpriced, then $\Delta p < 0$. If $\Delta p > 0$, the firm generates a net profit from raising new cash, and if $\Delta p < 0$, it generates a net loss from doing so. We assume that the mispricing Δp is distributed with a cumulative distribution function $G(\Delta p)$ and a density function $g(\Delta p)$. We assume that the density function is symmetric around the mean of zero. That is, we do not want to have any asymmetry between overpricing and underpricing built into the model. For simplicity, we also keep the mispricing Δp independent of the earnings e.

We use Δp^+ to denote the positive realizations of Δp, and we use Δp^- to denote the absolute value of the negative realizations of Δp. Thus, both Δp^+ and Δp^- are positive.

We use the function $G(\Delta c, \Delta p^{+}) \geq 0$ to denote the financing gain whenever $\Delta p > 0$ and $L(\Delta c, \Delta p^{-}) \geq 0$ to denote the financing loss whenever $\Delta p < 0$. Both $G(\cdot,\cdot)$ and $L(\cdot,\cdot)$ are increasing and weakly convex in the first element. They are increasing in the second element as well, and exhibit a positive cross-derivative. That is, $G_1 > 0,\ L_1 > 0,\ G_{11} \geq 0,\ L_{11} \geq 0,\ G_2 > 0,\ L_2 > 0,\ G_{12} > 0,\ L_{12} > 0$. We set $G(\cdot,\cdot)$ and $L(\cdot,\cdot)$ to be zero when $\Delta c = 0$ or $\Delta p = 0$.

For continuation of its operation, we assume that the firm's cash balances must stay at or above a threshold c^* between dates 1 and 2. Hence, if the firm finds itself with a lower cash balance c, it will need to go to the capital market and raise additional cash to bring it back at least to the threshold. We assume that the ceiling $\overline{\Delta c}$ faced by the firm for raising cash is sufficiently high to cover the firm's maximum potential cash shortfall, i.e., $\overline{\Delta c} > c^* - x - \underline{e}$.

Given the possibility of mispricing and the resulting financing gains and losses, and given the potential financing needs, the firm's optimal date-1 behavior will be as follows:

$$\Delta c = \begin{array}{ccc} \overline{\Delta c} & if & \Delta p > 0 \\ c^* - x - e & if & \Delta p \leq 0 \text{ and } x + e < c^* \\ 0 & Otherwise & \end{array} . \tag{1}$$

Hence, whenever the firm experiences a positive mispricing Δp^{+}, it will get a financing gain of $G\left(\overline{\Delta c}, \Delta p^{+}\right)$. Whenever the firm experiences a negative mispricing Δp^{-} and faces a cash shortfall because $x + e$ is below the threshold c^*, it will incur a financing loss of $L\left(\left(c^* - x - e\right), \Delta p^{-}\right)$. Otherwise, if the firm has a negative mispricing and no cash shortfall, it will refrain from raising new cash and will have no financing gain or loss.

Date 0: The Initial Decision of the Firm on Cash Holdings

At date 0, the firm has to choose its starting cash balance x. The firm faces an opportunity cost given by investment in a long-term project that matures at date 2. Hence, for a choice of cash x to be carried between date 0 and date 1, the firm is giving up return of $h(x)$ in the long-term project at date 2. We assume that the long-term project is completely illiquid and has no liquidation value at date 1. We assume that $h(x)$ is an increasing and convex function, i.e., $h'(x) > 0$ and $h''(x) > 0$.

For simplicity, we assume that there is no discounting in this environment. Then, given the description so far, and the choice of the firm in date 1, as given by Equation

(2), the firm chooses cash balance x at date 0 to maximize the following objective function:

$$\begin{aligned} V &= x + E[e] - h(x) \\ &\quad + \int_{\Delta p=0}^{\Delta p=\infty} G\left(\overline{\Delta c}, \Delta p^{+}\right) g(\Delta p)\, d\Delta p \\ &\quad - \int_{e=\underline{e}}^{e=c^{*}-x} \left(\int_{\Delta p=-\infty}^{\Delta p=0} L\left((c^{*}-x-e), \Delta p^{-}\right) g(\Delta p)\, d\Delta p \right) f(e)\, de. \end{aligned} \tag{2}$$

Here, the first line captures the direct payoff from cash balances minus the cost due to the forgone investment. The second line captures the gains from additional financing whenever the firm finds itself in a situation of overpriced securities. The third line captures the losses from additional financing whenever the firm finds itself in a situation of cash shortfall and underpriced securities.

The first-order condition coming out of the maximization of V in Equation (2) is:

$$h'(x) = 1 + \int_{e=\underline{e}}^{e=c^{*}-x} \left(\int_{\Delta p=-\infty}^{\Delta p=0} L_1\left((c^{*}-x-e), \Delta p^{-}\right) g(\Delta p)\, d\Delta p \right) f(e)\, de. \tag{3}$$

Essentially, the firm equates the marginal cost from increasing its cash buffer with the marginal benefit. On the left-hand side, the marginal cost is the marginal return lost from the alternative long-term project. On the right-hand side, the marginal benefit is the sum of the direct benefit from increasing the cash balance and the indirect benefit due to the decrease in financing losses incurred whenever the firm finds itself in an underpricing situation and a cash shortfall. By keeping a larger cash buffer, the firm can reduce those future financing losses because it does not need to raise as much cash in case of underpricing. Note that the financing gains in case of overpricing do not enter the first-order condition at all. This is because the firm will maximize these financing gains whenever the mispricing is positive and raise the maximum amount possible $\overline{\Delta c}$ irrespective of how much cash x it kept from date 0 to date 1.

There is a unique solution to (3) because the left-hand side is increasing in x and the right-hand side is decreasing in x. Hence, the level of cash buffer chosen by the firm is pinned down uniquely by this equation.

The Effect of Stock Price Fragility

Our main goal is to understand the effect that stock price fragility has on the choice of cash buffer made by the firm at date 0. Stock price fragility implies that higher levels

of mispricing should be expected both on the negative side and on the positive side. We capture this in the model by comparing two distributions of mispricing $g(\Delta p)$ and $g'(\Delta p)$; both are symmetric functions around the mean of Δp, i.e., around zero. We say that $g'(\Delta p)$ represents more fragility than $g(\Delta p)$ if there exists a value $\widehat{\Delta p} > 0$, such that:

$$\begin{array}{lll} g'(\Delta p) > g(\Delta p) & iff & \Delta p > \widehat{\Delta p} \quad or \quad \Delta p < -\widehat{\Delta p} \\ g'(\Delta p) < g(\Delta p) & iff & -\widehat{\Delta p} < \Delta p < \widehat{\Delta p} \end{array} . \tag{4}$$

Essentially, $g'(\Delta p)$ is a mean-preserving spread of $g(\Delta p)$

Under the definition of fragility in Equation (4) and the first-order condition in Equation (3), it is clear that the firm chooses a higher level of cash buffer x when it faces mispricing distribution that represents more fragility $g'(\Delta p)$. Under the distribution $g'(\Delta p)$, weight is shifted from lower values of Δp^- to higher values of Δp^-. Then, because the cross derivative of the loss function $L(\Delta c, \Delta p^-)$ is positive ($L_{12} > 0$), the marginal benefit of cash buffer on the right-hand side of (3) increases for every level of x. Since the marginal cost on the left-hand side does not change for a given x, and since it is increasing in x, the solution to the equation then has to generate a higher x in equilibrium.

Intuitively, a more fragile stock price entails a higher probability of bigger underpricing. This increases the cost of the firm when it needs to raise cash if it faces a shortfall in its cash balance. The firm prepares for this in advance by increasing its cash buffer and reducing the likelihood and magnitude of cash shortfalls. It is important to emphasize again that we did not assume any asymmetry between underpricing and overpricing. A fragile stock price implies a higher probability of bigger overpricing just like it does for bigger underpricing. The key, however, is that the gains from overpricing do not play any role in the choice of cash buffer of the firm, since the firm will always exploit these gains when they arise regardless of its level of cash. It is only the loss from underpricing that is forced on the firm when it faces cash shortage, and this is why the firm will attempt to reduce cash shortages when it expects greater likelihoods of underpricing with greater magnitude.

In the model the firm makes a choice about one variable x, capturing greater cash buffer and lower long-term investment. In our empirical investigation, we hypothesize that firms facing greater fragility will increase cash and reduce other spending such as capital expenditures.

3 Data and Empirical Model

Corporate Variables

Our sample construction begins with quarterly corporate data from Compustat starting with 2001 Q1 up to and including 2017 Q1. Variables that are reported as year-to-date are transformed to quarterly flow variables based on the fiscal year-end. We exclude companies with primary SIC codes between 4900 and 4999, between 6,000 and 6,999, or greater than 9,000. We also restrict the sample to firms with positive book equity (CEQQ), sales (SALEQ), and leverage.

We control for firm size using the natural logarithm of total assets (ATQ). Total assets are also used to scale all dependent variables. *Cash* is cash and short-term investments (CHEQ). *CapEx* is capital expenditures (CAPXY) net of sales of property, plant, and equipment (SPPEY). *R&D* is research and development expenditures (XRDQ). *Payout* is dividends (DIVQ) plus preferred stock (PRSTKQ). Short-term debt (*ST Debt*) is debt in current liabilities (DLCQ) plus long term debt due in one year (DD1Q).

Debt is measured as current liabilities (DLCQ) plus long-term debt (DLTTQ). Market equity is the product of share price (PRC) and number of shares outstanding (CSHOQ). *MktLev* is defined as debt divided by debt plus market equity. *Oper. Cash Flow* is operating income after depreciation (OIBDPQ) minus total interest and related expenses (XINTQ) minus total income taxes (TXTQ). *Fixed Assets* is total property plant and equipment (PPENTQ) scaled by total assets. *Inventory* is total inventories (INVTQ) scaled by total assets. We measure *Earnings volatility* as the 12 quarter rolling standard deviation of income before extraordinary items (IBQ) after it has been scaled by total assets (ATQ).

Description of Fragility

The measure of fragility is constructed following Greenwood and Thesmar (2011) for 2001 Q1-2016 Q4. Mutual fund holdings are collected from the Thomson Reuters S-12 file as of the filing data (FDATE). For all mutual funds in the sample, total net assets are collected from the CRSP mutual fund file. Mutual funds with less than 5 million dollars in total net assets are excluded. Funds with missing data are excluded.

Stock level data is collected from the CRSP Stock File. To join data with the CRSP Stock File, a two-step process is used: stocks are first joined by CUSIP. When the CUSIP within the holdings data fails to match with the CRSP file, the NCUSIP within CRSP

is matched to the CUSIP in the holdings file. This reflects how the two databases record CUSIPs: Thomson Reuters maintains the original CUSIPand CRSP uses the firm's most recent CUSIP and backfills through time. In CRSP, NCUSIP generally corresponds with the historical CUSIP.

At the stock level, fragility captures the volatility of non-fundamental demand from mutual funds. *Fragility* G is defined as:

$$G_{it} = \left(\frac{1}{\theta_{it}}\right)^2 W_{it}' \Omega W_{it}, \tag{5}$$

where W_{it} is a vector of each mutual fund investor's portfolio allocation weight to stock i, Ω_t is the covariance matrix of monthly dollar flows for the firm's mutual fund owners, and θ_{it} is the market capitalization of the firm's stock. Each element of W_i is equal to the number of shares of stock i held by fund j multiplied by the price of stock i, divided by the total net assets of fund j.

Holdings data is joined with the CRSP mutual fund file using MFLINKS. Holdings are aggregated to the portfolio level according to wficn, the unique portfolio identifier within MFLINKS. Monthly percentage flows are calculated for each fund from the CRSP mutual fund file:

$$f_{jt}^{\%} = \frac{TNA_{jt} - TNA_{jt-1}(1 + R_{jt})}{TNA_{jt-1}} \tag{6}$$

where TNA_{jt} is the total net assets and R_{jt} is the return to fund j at time t. Each quarter t, a covariance matrix of percentage flows, $\Omega_t^{\%}$, is calculated using all available months as of January 1990. *Fragility* requires the covariance matrix of dollar flows Ω_t, which is not estimated directly due to heteroskedasticity as discussed in Greenwood and Thesmar (2011). Instead, $\Omega_t^{\%}$ is transformed by the following equation:

$$\widehat{\Omega}_t = diag(TNA_t)\Omega_t^{\%} diag(TNA_t) \tag{7}$$

where TNA_t is a matrix with values equal to each fund's total net assets on the diagonal elements and zero elsewhere. Finally, *Fragility* is estimated by the following equation:

$$G_{it} = \left(\frac{1}{\theta_{it}}\right)^2 W_{it}' \widehat{\Omega}_t W_{it}, \tag{8}$$

Description of the Herfindahl Measure of Ownership Concentration

We examine multiple financial institution mergers as natural experiments. For BlackRock-BGI, we focus on the years 2008 to 2010 and a Herfindahl index of ownership concentration is measured using all the institutional investors included in the Thomson Reuters S34 (13F) file. This is computed as the sum of the squared fractional positions of each investor for a given stock:

$$Herfindahl_t = \sum_{j=1}^{N} \left(\frac{Shares_{jt}}{SharesOutstanding_t} \right)^2 \tag{9}$$

where $Shares_j$ represents the number of shares held by institution j. The firm's shares outstanding is recorded from the CRSP Stockfile at quarter end. In the S34 file, each institutional investor (manager) has a distinct manager number (mgrno). Following Azar et al. (2018a), holdings are aggregated to the parent company's manager number using a mapping key from Martin Schmalz's website.[6] This combines several managers under BlackRock, for example.

To join holdings data with the CRSP Stock File, a two-step process is used: stocks are first joined by CUSIP. When the CUSIP within the holdings data fails to match with the CRSP file, the NCUSIP within CRSP is matched to the CUSIP in the holdings file. This reflects how the two databases record CUSIPs: Thomson Reuters maintains the original CUSIP and CRSP uses the firm's most recent CUSIP and backfills through time. In CRSP, NCUSIP generally corresponds with the historical CUSIP. Fractional holdings are winsorized at the 0.5% and the 99.5% levels. For each firm-quarter, the Herfindahl index is measured as the sum of the squared fractional positions of all the institutional investors. To calculate what the Herfindahl measure would be had BlackRock and BGI been the same entity before the merger, the mgrno for BGI (7900) is set to the mgrno of BlackRock (9385) and the procedure is repeated. The fraction of holdings from BlackRock, BGI, and all the total of institutional investors are also recorded.

To confirm the Blackrock-BGI evidence, we also examine the Lewellen and Lowry (2019) mergers which occur during our sample period but not during the financial crisis. For these eight mergers (First Union-Wachovia, Goldman Sachs-Ayco, Bank of America-Fleet Boston, JP Morgan-Bank One, Wells Fargo-Strong Capital, Transamerica-Westcap,

[6]The mapping key is available within the replication package for Azar et al. (2018a) on Martin-Schmalz's website. https://sites.google.com/site/martincschmalz/.

MSDW-Frontpoint, and Goldman Sachs-Level Global), we follow the same procedure as with the Blackrock-BGI merger and calculate the equivalent Herfindahl measure of ownership concentration.

Summary statistics

We present summary statistics on the main variables used in regressions in Table 1. Unless otherwise noted, variables used as explanatory variables are lagged one quarter in regressions. All variables are winsorized at the 1st and 99th percentiles.

[Table 1 about here]

Empirical Model

To investigate the relationship between changes in the exposure to non-fundamental price shocks, we pursue two distinct sets of analyses. First, we explore corporate responses to changing fragility within firms. We regress cash holdings and our measures of investment and liquidity management on the Greenwood and Thesmar (2011) fragility measure, other observable corporate factors such as firm size, year-industry interacted fixed effects (industry measured at the SIC three-digit level), and firm fixed effects. Specifically we estimate

$$\frac{DEP_{it}}{Assets_{it}} = \phi_i + \gamma_{yr-ind} + \alpha Fragility_{it-1} + \beta X_{it-1} + \epsilon_{it}, \tag{10}$$

where DEP is our measure of cash holding, of investment ($CapEx, R\&D$) or of liquidity management ($Payout$, $STdebt$) for firm i in quarter t. ϕ_i is a firm fixed effect, γ_{yr-ind} is a year-industry fixed effect, $Fragility_{it-1}$ is the Greenwood-Thesmar measure of fragility that varies by firm and quarter and finally X_{it-1} contains $Ln(Assets)$, $MktLev$, $OperCashFlow$, $FixedAssets$ and $Inventory$. The error term is denoted by ϵ_{it} and the standard errors are adjusted for clustering at the firm level. In later tables, we present evidence on corporate responses to exogenous shocks to fragility stemming from financial institution mergers.

4 The Effect of Stock Price Fragility on Cash Holding, Investment and Liquidity Management

The key prediction of our model is that firms facing a greater risk of mispricing in the future, i.e. firms with a more fragile stock price, are likely to hold more cash in order to lower the probability of costly cash shortfalls. Table 2 examines this prediction and reports results from regressions with cash scaled by assets as the dependent variable and a set of controls in addition to firm and year-industry fixed effects. In line with common practice, we use one lag of the explanatory variables in the regressions to alleviate concerns related to that corporate policies are determined jointly.

As predicted by the model the coefficient on fragility is positive and statistically significant at the 1% level of significance in the baseline specification in Column (1). The point estimate indicates that a one standard deviation increase in fragility is associated with an increase in *Cash* by 1.02% when set in relation to mean cash holdings (.22) or by 1.71% when set in relation to the median cash holdings (.13).

While a precautionary motive for cash holdings has been documented in many other studies, see e.g. Bates et al. (2009) or Almeida et al. (2014), we identify that firms respond to risk from the financial markets - specifically the composition of their institutional investors. Thus, we highlight a distinct channel of risk and one that is increasing over time. The regressions control for a number of other factors that are common in cash holding regressions and broadly conform to expectations. For instance, we confirm well established results that larger firms on average hold less cash (see e.g. Bates et al. (2009)).

[Table 2 about here]

The period of study, 2001 to 2017 includes the financial crisis and it may be of interest to examine whether these turbulent years are driving the estimated relations. Column (2) therefore report results of cash holding when the financial crisis years 2008 and 2009 are excluded. A comparison with Column (1) shows that the estimated coefficients are little changed if we consider this more limited sample period.

While our focus is on precautionary cash levels, we recognize that our measure of cash may be distorted by the large levels of cash held by some multinational corporations for tax motivated reasons (see e.g. Faulkender et al. (2018)). Excluding firms which hold cash for both precautionary and tax reasons should provide a cleaner measure of precautionary cash responses. In line with expectations, the point estimates on stock price fragility are substantially higher for this group. Column (3) excludes multinational

corporations and as seen by a comparison with Column (1) point estimates are greater for domestic firms.

Another potential concern is that the results might merely reflect current misvaluation, rather than expectations of scope for future misvaluation. To allay such concerns we first note that Greenwood and Thesmar (2011) and Ben-David et al. (2017) establish that greater stock fragility for a firm strongly predicts volatility and that the Greenwood and Thesmar (2011) measure of fragility is a measure of sensitivity to shocks and not directly related to current over- or undervaluation. However, as a robustness exercise, we may want to control for the current level of misvaluation. As discussed by Derrien et al. (2013), many of the measures used rely on the relation between market value and accounting value of a firm as measured by market-to-book or (Tobin's) Q.[7] Regression analysis of for instance capital investment on market-to-book (or Q) have been used to examine the feedback effect of stock market valuation on corporate policy, either by using "raw" market-to-book measures or by in addition estimating a valuation based on fundamentals (see e.g. Baker et al. (2003) for early influential work highlighting the importance of a feedback effect or Edmans et al. (2012) for the latter approach).

To explore concerns related to current misvaluation, we note that in regressions with firm fixed effects an overvalued stock is likely to be associated with a temporarily high market-to-book ratio and vice versa for an undervalued stock.[8] Based on this reasoning Column (4) of Table 2 reports the same regression specification as in the baseline of Column (1) but also includes the market-to-book value. In line with e.g. Bates et al. (2009), we find that the market-to-book value is positively associated with cash holding. Of key interest for our present purposes however is that the estimated coefficient on stock fragility is essentially the same as in the benchmark regression reported in Column (1). Thus, controlling for a measure that is highly likely to be correlated with current misvaluation does not affect the economic or statistical significance of stock price fragility on cash holding. We interpret this as further support for the notion that expectations of future stock fragility have an incremental impact on corporate policy.

Given the inherently forward-looking nature of management responses to stock price

[7]It seems almost tautological that this would be the way to measure misvaluation but other measures are possible - one may argue that realized excess returns for a stock in future periods implies that it is undervalued today, see e.g. Baker et al. (2003) or Polk and Sapienza (2008).

[8]Without further assumptions we can not of course ascribe all the effect of an increase in market-to-book ratios to overvaluation - successful implementation of a new strategy would raise the market-to-book ratio and may or may not be accompanied by an overvaluation. However, on average we do not expect overvaluation to be associated with falling market-to-book values (or vice versa) and the expected correlation between market-to-book values and overvaluation is expected to be positive.

fragility in our model, one could hypothesize that cash holdings might adjust in the same quarter that fragility changes. Column (5) therefore presents a specification where the current level of fragility is included and as seen the relation is of similar economic and statistical significance.

Finally we note that much of the literature uses the standard deviation of earnings or of cash flows to capture the motivation for precautionary cash holding (often averaged at the industry level as in Opler et al. (1999) or Bates et al. (2009)). As seen in Column (6) we confirm that earnings volatility is positively associated with cash holding and again the estimated effect of stock price fragility on cash holding is stable. The specification in Column (6) also provides an opportunity to compare the quantitative impact of the two motivations for precautionary cash holding. In this specification a one standard deviation increase in stock price fragility is associated with increased cash holdings by 1.04% (when evaluated at the mean cash holding). For comparison, a one standard deviation increase in earnings volatility is associated with increased cash holdings by 2.19% (when evaluated at the mean cash holding). That the effect of stock price fragility on cash holding is about half as large as the effect of a leading motivation for precautionary cash holding underscores that the effect of within firm changes in fragility on cash holding is non-trivial and supports the notion that stock price fragility is something managers pay attention to when they set corporate policies.

Risk of Misvaluation and External Financing Needs

In our model, a firm holds a cash buffer to avoid having to raise funds in a future situation when a cash shortfall coincides with an undervalued stock. The mechanism in the model therefore suggests some conditions under which the motivation to hold a cash buffer should be especially strong. Much of the variation in cash holding will be captured by the year-industry and firm fixed effects, but here we delve further into variation across firms and time. Table 3 reports how firms adjust cash when fragility is interacted with proxies for the expected cost of non-fundamental price shocks.

First, the cost of equity misvaluation is expected to be higher for firms with more limited access to the capital markets. In the spirit of Gilchrist and Himmelberg (1995) and Almeida et al. (2004), Column (1) examines the impact of fragility for unrated firms and Column (2) focuses on smaller firms (defined as those with total assets in the bottom three quartiles). As seen the interaction terms between fragility and the proxies for weaker access to capital markets are positive and a higher potential cost of misvaluation

is associated with a greater precautionary cash response to changing fragility.

Furthermore, the probability of a shortfall in cash holdings should be greater in more volatile product markets (Froot et al. (1993)). Column (3) examines the effect of earnings volatility where *High earnings volatility* is an indicator equal to one if the firm observation is in the top quartile of prior quarter earnings volatility (defined by the rolling 12-quarter standard deviation). As in the model, the combined effects of greater scope for cash shortfalls and greater scope for misvaluation associate with greater cash buffers.

[Table 3 about here]

Finally, the expected cost of misvaluation should be a function of the ease with which the market corrects misvaluation and the cost of misvalued equity (both in alternative access to capital and in the cost of foregone projects). Columns (4) and (5) focus on the potential for misvaluation with two proxies for stock price uncertainty (Zhang (2006)). Column (4) examines the effect of prior price volatility where *High stock volatility* is an indicator equal to one if the firm observation is in the top quartile of prior quarter stock price movement (quarter high price minus quarter low, scaled by the quarter low price). In Column (5), high VIX periods (top quartile) are used to represent aggregate uncertainty. Both uncertainty proxies load positively when interacted with *Fragility*, indicating a stronger precautionary cash response in cases with higher initial potential for equity misvaluation.

All the interaction effects suggested by theory are thus positive and statistically significant. A one standard deviation increase in the stock price fragility is associated with an increase in cash holding for the firms in the respective category of interest that ranges from 1.2% (for small firms) to 1.5% (for firms with high stock price volatility).

The Effect of Fragility on Investment and Liquidity Choices

The model focuses on precautionary cash holding in response to greater scope for costly cash shortfalls as a result of a more fragile stock price. The logic of the model also implies that greater fragility should be associated with less investment and more conservative liquidity management. We explore these dimensions in Table 4 and Column (1) presents a benchmark specification of capital expenditure on the same explanatory variables as in the cash holding regressions. As seen, higher stock price fragility is associated with less investment. The specification in Column (1) implies that if fragility increases by one standard deviation capital expenditure/assets decreases by -.0003. While this may seem

like a tiny effect we note that average investment rate is also low at .012. A one standard deviation increase in fragility thus decreases capital investment by around 2.1% when set in relation to the mean investment level. Also note that investment is skewed with a long upper tail and if we instead relate the change to the median investment level (.007) a one standard deviation increase in fragility corresponds to a fall in capital investment of 3.9%.

[Table 4 about here]

Column (2) presents results from a regression with R&D expenditures as a measure of investment with quantitatively similar effects. The literature on the effect of uncertainty on investment is very large, reflecting both the importance of the subject, the many different potential sources of uncertainty and the theoretical possibility of both negative and positive relationships (see e.g. Bernanke (1983), Caballero (1991), Leahy and Whited (1996)). Many share a prior that higher uncertainty lowers investment and in this sense the results are not surprising. Note however that the source of uncertainty here is very specific and novel. Firms adjust investment in response to higher uncertainty regarding firm-specific but non-fundamental price movements.

Columns (3) and (4) explore aspects of financial flexibility - using financial policies to ensure cost-efficient access to capital in a wide range of states of the world (see e.g. Denis (2011), Almeida et al. (2014)). Payout policy is one such component and in line with expectations Column (3) shows that higher fragility is associated with lower payouts. We expect firms faced with higher risk to payout less to shareholders and keep more financial muscle in the firm - a prediction that is borne out for other sources of risk in e.g. Hoberg and Prabhala (2008), Bonaimé et al. (2013) or Hoberg et al. (2014). Another aspect of financial flexibility that we explore concerns debt maturity. Shorter debt maturity exposes the firm to refinancing risk to a greater extent and our prior is that firms that are faced with a greater stock price fragility have a lower share of short-term debt. Previous evidence consistent with an important role of refinancing risk come from e.g. Harford et al. (2014). Column (4) shows that higher fragility is associated with less short term debt.

5 Asset Management Mergers as Natural Experiments

The BlackRock-BGI merger

The preceding analysis has shown that firms hold more cash and make other precautionary adjustments as the risk of future non-fundamental price shocks increases. The feedback effect creates a real cost to changes in ownership concentration. Combined, this supports the risk management hypothesis laid out in the model where managers recognize that greater fragility raises the probability of misvaluation and therefore adopt more cautious policies.

A concern with this evidence, however, is that changes in fragility are not exogenous and may be correlated with future investment or liquidity management changes. For example, trading frenzies, which have been shown to affect real corporate outcomes (Goldstein et al. (2013)), may be based in concerns about future cash flows or mutual fund outflows may be driven by macroeconomic factors. To address this, we first use the merger of BlackRock and Barclays Global Investors (BGI) as an exogenous shock to stock price fragility. The two institutional investors merged in 2009 with the announcement in June and the deal was completed in December. The merger followed an offer by CVC Capital to purchase the iShares piece of BGI earlier in 2009 which contained a 'go-shop' provision. This event is advantageous relative to other ownership shocks, such as index reconstitutions, because the level of institutional ownership is unchanged by the event. Rather, the merger only affects the ownership concentration.

Tables 5, 6, and 7 present the empirical evidence on this natural experiment. Given that the merger occurred in 2009, we limit the analysis to the 2008–2010 period. Treated firms are identified as those held by both Blackrock and BGI at the end of 2008 (before the merger announcement, and preceding the CVC offer) and thus are exposed to an ownership concentration shock (*Merger Treatment*). As pre-merger ownership is not randomly assigned, we restrict our control group to firms that are held by one of the firms thus mitigating the potential differences between the treated and control groups. The merger has two important event dates – the announcement and the deal completion. The merger was announced in June 2009 and the variable *Merger Treatment* takes the value 1 for firms treated firms for periods after the second quarter of 2009 and 0 otherwise. The merger was cleared by the European Commission in September 2009 and then completed in December 2009. As the mechanism that we focus on concerns expectations, the date

when the proposed merger became publicly known is the natural event date but results are robust to other choices of the treatment period. In Table 5, we present evidence that the BlackRock-BGI merger raised the Greenwood and Thesmar measure of stock price fragility and this effect is robust across different assumptions regarding the timing of events. Further, it is robust to the measure of treatment - a dummy variable for treated firms as well as the post-merger Herfindahl measure of change in ownership concentration (LEVEL), where the pre-merger Herfindahl is normalized to one. All merger treatment specifications are positively associated with higher stock price fragility.

[Table 5 about here]

Having established that the merger affected fragility we now turn to the effect of the merger on cash holding and investment. In Table 6, we see that the *Merger Treatment* raises cash holdings.[9] That is, firms which experience a shock to their ownership concentration due to the BlackRock-BGI merger respond to this increased future exposure to non-fundamental price shocks. As in earlier tables, we control for firm size, market leverage, operating cash flow, fixed assets, and inventory in the panel regressions with both year-industry and firm fixed effects. In Column (1) we see that increased stock price fragility as a result of the BlackRock-BGI merger leads to increased cash holding and the effect is statistically significant at the 1% level. Treated firms on average raise their mean cash holding by more than one percentage point - set in relation to the overall mean for these years the change implies that cash holding as a share of assets increases from around .20 to .21. To evaluate this impact one may for instance compare to the quantitative effects in one of the semimal papers on precautionary cash holding where Bates et al. (2009, p. 2011) state that "... we infer that the average cash ratio increased by 2.1 percentage points from the 1980s to 2006 because of the increase in cash flow volatility [which more than doubled during this time, from 7% to 16.3%]." In light of this our estimate of a more than 1 percentage point increase as a result of the BlackRock-BGI merger clearly points to a substantial effect of stock price fragility on cash holding.

Since the level of treatment differs across different firms, we split the sample according to whether the firms are above or below the median increase in ownership concentration in Columns (2) and (3). Effects are economically and statistically significant for both groups but in line with predictions the effect is stronger for the firms with an above median increase in ownership concentration. Columns (4)-(6) report the corresponding

[9]For simplicity, we report the baseline treatment dummy variable from Column (1) of Table 5.

regressions for a sample that excludes multinational corporations. Results are similar but concentrated in the high treatment group.

[Table 6 about here]

Our evidence that firms respond to changes in stock fragility, and in particular the effect in association with the BlackRock-BGI merger, are complementary to Massa et al. (2018) who establish that *other funds* responded to increased ownership concentration in connection with the BlackRock-BGI merger by lowering exposure to affected stocks and in particular this holds for open-ended funds. The authors note that, "a change in *expected* future fragility will lead to strategic reactions by the fund managers even *before* any fund experiences a liquidity shock of any kind that would lead to a negative impact for some of the stocks held in the portfolio" Massa et al. (2018, p. 2). While that paper documents spillovers within the asset management industry, we show the corporate ramifications.

In Table 7 we explore the effect on investment, payouts and short term debt of the BlackRock-BGI merger. We see that the results are consistent with a causal effect of higher fragility on investments (in capital expenditure and R&D) and payout. With the exception of ST Debt, the effects are statistically significant and quantitatively non-trivial. For instance the coefficient on $CapEx/Assets$ of -0.001 can be set in relation to median $CapEx/Assets$ of 0.007.

[Table 7 about here]

Other Asset Management Mergers as Natural Experiments

The size of the BlackRock-BGI merger makes it an attractive candidate for examining the effect of exogenous changes in ownership concentration on company policies. Based on the previous literature, let us highlight two potential issues surrounding the use of the BlackRock-BGI merger as a natural experiment. First, as discussed in the introduction, an active debate concerns the effects of changes in the degree of common ownership on product market competition and the mechanisms at play (see e.g. Azar et al. (2018a, Section V)). However, this does not affect this research as the hypothesized mechanism investigated here does not rely on fund managers steering firms towards taking other firms' profits into account, but instead relies on greater financial fragility leading to more precautionary behavior.

A second potential concern is that the BlackRock-BGI merger occurred during the great recession - a period of great turbulence where finding firms that act as controls in a difference-in-difference estimation can be challenging. Lewellen and Lowry (2019) examine a broad range of asset management mergers and focus on various measures of return on assets to explore the effects of common ownership. They find that the effects of asset management mergers on return on assets are driven by mergers that occurred during the financial crisis of 2008-2009.

Starting with the Lewellen and Lowry (2019) list of financial institution mergers from 1980 and 2015, we examine the impact on stock price fragility of the eight mergers which occur during our sample period but outside of the financial crisis years 2008 and 2009. As with BlackRock-BGI, we define a firm as treated by the merger if it is held by both the merging parties prior to the merger and as controls we use firms that are only held by one of the merging parties pre-merger. Unlike BlackRock-BGI which involved substantial increases in ownership concentration for the bulk of the treated firms and treated more than 2,000 firms in the sample, these are mostly smaller mergers both in impact and scope. Two of the mergers, Bank of America-Fleet (BoA-Fleet), announced in October 2003, and JP Morgan-Bank One (JPM-BankOne), announced in January 2004, stand out as the largest. Each of these mergers each treated around 1,400 firms.[10] The Bank of America-Fleet merger created an approximately 470 billion combined assets under management and JP Morgan-Bank One created a domestic assets under management (AUM) pool of approximately 250 billion. For comparison, the Blackrock-BGI merger results in a combined 2.8 trillion AUM. Table 8 presents the effects of these mergers on the Greenwood and Thesmar measure of stock price fragility (see the online appendix for the (lack of) effect on stock price fragility of the other financial institution mergers during our sample period).

[Table 8 about here]

Since the BoA-Fleet and JPM-BankOne mergers are close in time and many of the treated firms are the same, we first create separate treatment variables for each of these two mergers based on the respective announcement quarter and then combine the treatment variables such that we use a dummy that takes the value of one if the firm is treated in at least one of these two mergers. Firms that are only held by one of the merging parties

[10]The other mergers mostly treat many fewer firms: Wells Fargo-Strong affected around 800 firms in sample, First Union Wachovia and Morgan Stanley-Frontpoint around 300 and the remaining each fewer than 100 firms. For example, the Goldman-Level merger treats 62 firms.

in each of the two mergers serve as controls.[11]

[Table 9 about here]

Table 9 presents the results from regressions that examine the treatment effect of BoA-Fleet and JPM-BankOne mergers. Column (1) reports the baseline regression and the treatment effect is positive and statistically significant. The coefficient estimate is lower than the estimated treatment effect of the BlackRock-BGI merger, a finding which is consistent with that the current mergers were associated with a much less pronounced increase in fragility. Being treated with the merger is associated with a .4 percentage point increase in cash holding. For a firm with mean level of cash holding in this sample it correspond to an increase from a cash/assets ratio of 22.2% to 22.6%. Since these smaller mergers result in a more limited change in ownership concentration, there is less variation in treatment than with the Blackrock event. Therefore, instead of splitting the sample by change in ownership concentration, Columns (2) and (3) split the sample by the share of institutional ownership (above or below 50%, which as seen by the number of observations is close to the sample median). The effect is markedly stronger in firms with a higher share of institutional ownership, a finding in line with expectations. Columns (4)-(6) report the corresponding regressions for a sample that excludes multinational corporations. The merger impact is limited to firms with a high share of institutional ownership. Table IA.3 in the online appendix presents results of these mergers on investment, payout and short term debt. Effects are quantitatively small and not statistically significant.

Summing up, we find that exogenous changes in ownership concentration support the notion that there is a causal effect from stock price fragility on cash holding. The results are strongest for BlackRock-BGI which is intuitively appealing since its size dwarfs the other asset management mergers that occur in sample. For the other asset management mergers in sample that have a statistically significant effect on fragility we also document a statistically significant though less quantitatively important effect on cash, as would be expected from Warusawitharana and Whited (2015) which finds cash responds more than investment.

[11]Thus, for instance a firm that is held by both Bank of America and Fleet Boston will be assigned the value one from Q4 2003 onward. Firms that were only held by one of the Bank of America and Fleet Boston but by both of JPMorgan Chase and Bank One will be assigned the value one from Q1 2004 onward.

6 An Examination of Alternative Mechanisms

Is it the Bank Lending Channel?

Our model relies on the potential for non-fundamental equity shocks and firms adjusting their behavior in order to lower the probability of a future cash shortfall. Another conceivable mechanism would be that banks required higher interest rates for firms with a more fragile stock price. If common ownership increases equity co-movement (Anton and Polk (2014)), and it is more costly for a bank to lend to firms with higher aggregate risk (Acharya et al. (2013)), then the composition of institutional investors could affect a firm both via potential equity misvaluation as well as a bank lending channel. Acharya et al. (2013) highlights how a firm's aggregate risk affects the bank's ability to diversify the loan risk which, in turn, should affect the cost or availability of credit. Moreover, Acharya et al. (2013) demonstrates that firm credit should be affected during times of heightened aggregate uncertainty or when the firm poses a larger risk to the bank.

To explore whether the bank lending channel confounds our results, Columns (1) and (2) of Table 10 first examine the interest paid by firms on loan deals, separating drawn and undrawn commitments under these deals, during high VIX periods (top quartile of periods in terms of the VIX). In periods of high aggregate risk, larger firms (top quartile of assets) are likely to be an especially high concern to lenders if they have a fragile stock price. As seen, interest rate spreads (over LIBOR) increase for larger firms as fragility increases. Table A.1 in the appendix shows that there is no significant relation in low VIX periods.

[Table 10 about here]

Having established that large firms with fragile stock price can pay higher interest rates during high VIX periods, we next explore whether this explains the relationship between fragility and precautionary corporate behavior. If it is the bank lending channel, the corporate responses to fragility should be concentrated in large firms during high VIX periods. Columns (3) and (4) report the corresponding results for cash holding and investment. As seen, the coefficient estimates do not support the hypothesis that the bank lending channel is the main mechanism behind the cash holding and investment results. Interactions are not statistically significant and furthermore the sign on the coefficient on cash holding is the opposite of what we would expect if the bank lending channel were the main conduit.

Is it Declining Competition?

An alternative hypothesis is that changes in the competitive landscape lead firms to increase cash and reduce investment. Gutierrez and Philippon (2017) find that industry concentration and common ownership associate with lower investment. While the relationship between common ownership and competition is widely debated (as noted in the Introduction), Table 11 shows that the baseline results are robust to the role of industry competition. Columns (1) and (3) evaluate the impact of within firm changes in fragility on cash holding controlling for the level of industry concentration using the Hoberg and Phillips (2016) textual analysis based TNIC3 HHI measure for the full sample as well as when MNCs are excluded. In Columns (2) and (4), the baseline analysis is repeated excluding observations with a TNIC3 HHI measure above the sample mean. Columns (5) and (6) report the corresponding regressions with our measure of capital expenditure as dependent variable. Controlling for changes in competition or excluding observations in more concentrated industries has no impact on our findings.

[Table 11 about here]

7 Conclusions

As equity holdings are increasingly concentrated in a limited number of institutional investors (Lewellen and Lewellen, 2018), there is a question of whether the resulting stock price fragility documented by Greenwood and Thesmar (2011) creates a salient risk to corporations. This paper documents a link between the risk of non-fundamental price shocks and precautionary corporate behavior. In doing so, we document a cost to changes in the composition of institutional investors. We motivate the empirical analysis with a model which highlights the growing benefit of precautionary savings as stock fragility - the risk of future misvaluation - increases. The empirical evidence supports the predictions from the model. Broadly speaking, greater financial fragility lowers investment and leads firms to hold more cash. Not only are the findings are both statistically and economically significant, the BlackRock-BGI merger provides a natural experiment which supports a causal interpretation of the evidence. While that merger was a salient event, the finding of significant effects in smaller mergers as well as the full sample indicates that firms monitor their exposure to non-fundamental price shocks and adjust their liquidity management to hedge the risk of future misvaluation.

In the current paper we have examined the implications of one mechanism that makes a firm's stock more susceptible to future swings in valuation that are unrelated to firm fundamentals. There are also other such mechanisms that would be of interest to study in future work. For instance, while a larger share of foreign owners may bring additional capital or other benefits, it may also make a firm's stock more vulnerable to various global shocks. This is a concern in particular for developing markets and would be interesting to investigate, even if the evidence in Bena et al. (2017) suggest that the balance of effects from foreign ownership on investment is positive. It also would be valuable to investigate whether firms attempt to manage their stock fragility through PIPES or increasing inside ownership. We leave these topics for future research.

References

Acharya, V. A., Almeida, H., and Campello, M. (2013). Aggregate risk and the choice between cash and lines of credit. *The Journal of Finance*, 68(5):2059–2116.

Almeida, H., Campello, M., Cunha, I., and Weisbach, M. S. (2014). Corporate liquidity management: A conceptual framework and survey. *Annu. Rev. Financ. Econ.*, 6(1):135–162.

Almeida, H., Campello, M., and Weisbach, M. (2004). The cash flow sensitivity of cash. *The Journal of Finance*, 59(4):1777–1804.

Anton, M. and Polk, C. (2014). Connected stocks. *The Journal of Finance*, 69(3):1099–1127.

Azar, J., Schmalz, M. C., and Tecu, I. (2018a). Anticompetitive effects of common ownership. *The Journal of Finance*, 73(4):1513–1565.

Azar, J., Schmalz, M. C., and Tecu, I. (2018b). Reply to:'common ownership does not have anti-competitive effects in the airline industry'. *Available at SSRN 3168095*.

Baker, M., Stein, J. C., and Wurgler, J. (2003). When does the market matter? Stock prices and the investment of equity-dependent firms. *The Quarterly Journal of Economics*, 118(3):969–1005.

Baker, S. R., Bloom, N., and Davis, S. J. (2016). Measuring economic policy uncertainty. *The Quarterly Journal of Economics*, 131(4):1593–1636.

Balakrishnan, K., Billings, M. B., Kelly, B., and Ljungqvist, A. (2014). Shaping liquidity: On the causal effects of voluntary disclosure. *The Journal of Finance*, 69(5):2237–2278.

Bates, T. W., Kahle, K. M., and Stulz, R. M. (2009). Why do US firms hold so much more cash than they used to? *The Journal of Finance*, 64(5):1985–2021.

Becker, B. and Ivashina, V. (2015). Reaching for yield in the bond market. *The Journal of Finance*, 70(5):1863–1902.

Ben-David, I., Franzoni, F., Moussawi, R., and Sedunov, J. (2017). The granular nature of large institutional investors. *NBER Working Paper No. 22247*.

Bena, J., Ferreira, M. A., Matos, P., and Pires, P. (2017). Are foreign investors locusts? The long-term effects of foreign institutional ownership. *Journal of Financial Economics*, 126(1):122–146.

Berger, E. (2019). Selection bias in mutual fund flow-induced fire sales: Causes and consequences. *Available at SSRN 3011027*.

Bernanke, B. S. (1983). Irreversibility, uncertainty, and cyclical investment. *The Quarterly Journal of Economics*, 98(1):85–106.

Bian, J., He, Z., Shue, K., and Zhou, H. (2018). Leverage-induced fire sales and stock market crashes. *NBER Working Paper No. 25040*.

Bonaimé, A. A., Hankins, K. W., and Harford, J. (2013). Financial flexibility, risk management, and payout choice. *The Review of Financial Studies*, 27(4):1074–1101.

Bond, P., Edmans, A., and Goldstein, I. (2012). The real effects of financial markets. *Annu. Rev. Financ. Econ.*, 4(1):339–360.

Brunnermeier, M. K. and Oehmke, M. (2013). Predatory short selling. *Review of Finance*, 18(6):2153–2195.

Caballero, R. J. (1991). On the sign of the investment-uncertainty relationship. *The American Economic Review*, 81(1):279–288.

Chen, Q., Goldstein, I., and Jiang, W. (2006). Price informativeness and investment sensitivity to stock price. *The Review of Financial Studies*, 20(3):619–650.

Coval, J. and Stafford, E. (2007). Asset fire sales (and purchases) in equity markets. *Journal of Financial Economics*, 86(2):479–512.

Denis, D. J. (2011). Financial flexibility and corporate liquidity. *Journal of Corporate Finance*, 17(3):667–674.

Dennis, P. J., Gerardi, K., and Schenone, C. (2018). Common ownership does not have anti-competitive effects in the airline industry. *Available at SSRN 3063465*.

Derrien, F., Kecskés, A., and Thesmar, D. (2013). Investor horizons and corporate policies. *Journal of Financial and Quantitative Analysis*, 48(6):1755–1780.

Dessaint, O., Foucault, T., Frésard, L., and Matray, A. (2019a). Noisy stock prices and corporate investment. *Review of Financial Studies, forthcoming*.

Dessaint, O., Olivier, J., Otto, C. A., and Thesmar, D. (2019b). CAPM-based company (mis) valuations. *Rotman School of Management Working Paper*, (3050928).

Dong, M., Hirshleifer, D., Richardson, S., and Teoh, S. H. (2006). Does investor misvaluation drive the takeover market? *The Journal of Finance*, 61(2):725–762.

Edmans, A., Goldstein, I., and Jiang, W. (2012). The real effects of financial markets: The impact of prices on takeovers. *The Journal of Finance*, 67(3):933–971.

Faulkender, M. W., Hankins, K. W., and Petersen, M. A. (2018). Understanding the rise in corporate cash: Precautionary savings or foreign taxes. *The Review of Financial Studies*.

Foucault, T. and Fresard, L. (2014). Learning from peers' stock prices and corporate investment. *Journal of Financial Economics*, 111(3):554–577.

Froot, K. A., Scharfstein, D. S., and Stein, J. C. (1993). Risk management: Coordinating corporate investment and financing policies. *The Journal of Finance*, 48:1629–1658.

Gilchrist, S. and Himmelberg, C. P. (1995). Evidence on the role of cash flow for investment. *Journal of Monetary Economics*, 36:541–572.

Goldstein, I. and Guembel, A. (2008). Manipulation and the allocational role of prices. *The Review of Economic Studies*, 75(1):133–164.

Goldstein, I., Ozdenoren, E., and Yuan, K. (2013). Trading frenzies and their impact on real investment. *Journal of Financial Economics*, 109(2):566–582.

Gredil, O., Kapadia, N., and Lee, J. H. (2019). Do rating agencies deserve some credit? Evidence from transitory shocks to credit risk. *Available at SSRN 2998242*.

Greenwood, R. and Thesmar, D. (2011). Stock price fragility. *Journal of Financial Economics*, 102(3):471–490.

Gutierrez, G. and Philippon, T. (2017). Declining competition and investment in the U.S. *Brookings Papers on Economic Activity*, pages 89–190.

Harford, J., Klasa, S., and Maxwell, W. F. (2014). Refinancing risk and cash holdings. *The Journal of Finance*, 69(3):975–1012.

Hau, H. and Lai, S. (2013). Real effects of stock underpricing. *Journal of Financial Economics*, 108(2):392–408.

Hoberg, G. and Phillips, G. (2016). Text-based network industries and endogenous product differentiation. *Journal of Political Economy*, 124(5):1423–1465.

Hoberg, G., Phillips, G., and Prabhala, N. (2014). Product market threats, payouts, and financial flexibility. *The Journal of Finance*, 69(1):293–324.

Hoberg, G. and Prabhala, N. R. (2008). Disappearing dividends, catering, and risk. *The Review of Financial Studies*, 22(1):79–116.

Ivashina, V. and Scharfstein, D. (2010). Bank lending during the financial crisis of 2008. *Journal of Financial Economics*, 97(3):319–338.

Jurado, K., Ludvigson, S. C., and Ng, S. (2015). Measuring uncertainty. *American Economic Review*, 105(3):1177–1216.

Khan, M., Kogan, L., and Serafeim, G. (2012). Mutual fund trading pressure: Firm-level stock price impact and timing of SEOs. *The Journal of Finance*, 67(4):1371–1395.

Koch, A., Ruenzi, S., and Starks, L. (2016). Commonality in liquidity: a demand-side explanation. *The Review of Financial Studies*, 29(8):1943–1974.

Leahy, J. V. and Whited, T. M. (1996). The effect of uncertainty on investment: Some stylized facts. *Journal of Money, Credit, and Banking*, 28(1).

Lewellen, J. and Lewellen, K. (2018). Institutional investors and corporate governance: The incentive to be engaged. *Available at SSRN 3265761*.

Lewellen, K. and Lowry, M. (2019). Does common ownership really increase firm coordination? *Available at SSRN 3336343*.

Luo, Y. (2005). Do insiders learn from outsiders? Evidence from mergers and acquisitions. *The Journal of Finance*, 60(4):1951–1982.

Massa, M., Schumacher, D., and Wang, Y. (2018). Who is afraid of BlackRock? *INSEAD Working paper 2015/60*.

Opler, T., Pinkowitz, L., Stulz, R., and Williamson, R. (1999). The determinants and implications of corporate cash holdings. *Journal of Financial Economics*, 52(1):3–46.

Pástor, L. and Veronesi, P. (2005). Rational IPO waves. *The Journal of Finance*, 60(4):1713–1757.

Peek, J. and Rosengren, E. S. (2000). Collateral damage: Effects of the Japanese bank crisis on real activity in the United States. *American Economic Review*, 90(1):30–45.

Polk, C. and Sapienza, P. (2008). The stock market and corporate investment: A test of catering theory. *The Review of Financial Studies*, 22(1):187–217.

Riddick, L. A. and Whited, T. M. (2009). The corporate propensity to save. *The Journal of Finance*, 64(4):1729–1766.

Stein, J. C. (1996). Rational capital budgeting in an irrational world. *Journal of Business*, 69(4).

Wardlaw, M. (2020). Measuring mutual fund flow pressure as shock to stock returns. *Journal of Finance, forthcoming*.

Warusawitharana, M. and Whited, T. M. (2015). Equity Market Misvaluation, Financing, and Investment. *The Review of Financial Studies*, 29:603–654.

Xiao, S. C. (2018). The real effects of noise trading on firm performance. *SSRN Working paper No. 3199126*.

Zhang, X. F. (2006). Information uncertainty and stock returns. *The Journal of Finance*, 61:105–137.

Table 1: Summary Statistics (2001-2017)

	Mean	Sd	P50	N
Cash/Assets	0.194	0.221	0.105	137,208
CapEx/Assets	0.013	0.018	0.007	136,798
R&D/Assets	0.025	0.034	0.014	73,902
Payout/Assets	0.007	0.016	0.000	127,422
ST Debt/Assets	0.041	0.078	0.008	136,271
Fragility ($\times$1000)	0.023	0.039	0.007	137,208
Ln(Assets)	6.083	2.018	6.029	137,208
MktLev	0.197	0.210	0.134	137,208
OperCashFlow	0.009	0.053	0.020	137,208
FixedAssets	0.245	0.224	0.169	137,208
Inventory	0.124	0.139	0.083	137,208
Earnings volatility	0.027	0.052	0.011	137,011

Summary statistics for variables as used in regressions. Greenwood and Thesmar's stock price fragility measure as well as additional firm-level control variables. The data is quarterly from 2001 - 2017 and the sample excludes utilities, financial firms, and SIC 9000 codes. We require positive book equity and positive sales. Variables that are reported as year-to-date are transformed to quarterly flow variables based on the fiscal year-end and generally scaled by book value of assets. Variables used as explanatory variables are lagged one quarter in regressions. All variables are winsorized at the 1st and 99th percentiles.

Table 2: Stock Fragility and Cash Holding

	(1) Cash/Assets	(2) Cash/Assets	(3) Cash/Assets	(4) Cash/Assets	(5) Cash/Assets	(6) Cash/Assets
Fragility	56.544***	54.703**	79.032***	59.835***		57.598***
	(19.630)	(21.701)	(25.860)	(19.697)		(19.620)
Market-to-Book				0.009***		
				(0.001)		
Fragility (current)					64.748***	
					(19.606)	
Earnings volatility						0.086***
						(0.019)
Ln(Assets)	-0.039***	-0.038***	-0.028***	-0.036***	-0.039***	-0.038***
	(0.003)	(0.003)	(0.004)	(0.003)	(0.003)	(0.003)
MktLev	-0.093***	-0.104***	-0.087***	-0.075***	-0.091***	-0.095***
	(0.006)	(0.007)	(0.007)	(0.006)	(0.006)	(0.006)
OperCashFlow	-0.065**	-0.084***	-0.084***	-0.066***	-0.062**	-0.056**
	(0.026)	(0.028)	(0.032)	(0.025)	(0.027)	(0.026)
FixedAssets	-0.419***	-0.421***	-0.403***	-0.414***	-0.423***	-0.418***
	(0.017)	(0.018)	(0.021)	(0.017)	(0.017)	(0.017)
Inventory	-0.557***	-0.557***	-0.523***	-0.557***	-0.558***	-0.555***
	(0.025)	(0.026)	(0.034)	(0.025)	(0.025)	(0.025)
Sample	ALL	NO CRISIS	DROP MNC	ALL	ALL	ALL
Year-Industry FE	YES	YES	YES	YES	YES	YES
Firm FE	YES	YES	YES	YES	YES	YES
Adj. R2	0.858	0.861	0.875	0.860	0.859	0.859
Observations	137,208	120,030	69,429	137,146	135,026	137,009

Panel regression of cash holding on Greenwood and Thesmar's stock price fragility measure as well as additional firm-level control variables. The regressions include both firm and year-industry (SIC3) fixed effects and the standard errors are adjusted for clustering at the firm level. The data is quarterly from 2001 - 2017. Column (2) excludes fiscal years 2008 and 2009 and (3) excludes multinational corporations. Explanatory variables are lagged one quarter unless otherwise noted. Statistical significance at the 1, 5, or 10% levels is reported as ***, **, *, respectively.

Table 3: Stock Fragility and Cash. The Expected Cost of Misvaluation

	(1) Cash	(2) Cash	(3) Cash	(4) Cash	(5) Cash
No bond rating x Frag.	75.852**				
	(35.081)				
Small x Frag.		74.200**			
		(33.979)			
High earnings vol. x Frag.			73.501**		
			(33.292)		
High stock vol. x Frag.				56.189**	
				(22.849)	
High VIX period x Frag.					40.148**
					(17.359)
No bond rating	-0.000				
	(0.005)				
Small		-0.000			
		(0.004)			
High earnings vol.			0.004**		
			(0.002)		
High stock vol.				0.001	
				(0.001)	
High VIX period					0.000
					(0.001)
Fragility	1.938	0.100	42.292**	45.330**	41.082**
	(26.034)	(26.892)	(19.642)	(19.983)	(20.705)
Year-Industry FE	YES	YES	YES	YES	YES
Firm FE	YES	YES	YES	YES	YES
Adj. R2	0.858	0.858	0.859	0.858	0.859
Observations	137,208	137,208	137,009	137,208	137,208

Panel regression of cash scaled assets on Greenwood and Thesmar's stock price fragility measure. The regressions include both firm and year-industry (SIC3) fixed effects as well as additional (unreported) controls: Ln(Assets), MktLev, OperCashFlow, FixedAssets and Inventory. Standard errors are adjusted for clustering at the firm level. High earnings volatility, High stock volatility, High VIX period are dummy variables that take the value 1 for the top quartile while Small are defined as firms not in the top quartile by assets. Statistical significance at the 1, 5, or 10% levels is reported as ***, **, *, respectively

Table 4: Stock Fragility, Investments and Liquidity Management

	(1) CapEx/Assets	(2) R&D/Assets	(3) Payout/Assets	(4) ST Debt/Assets
Fragility	-6.802***	-5.875*	-5.822**	-33.363***
	(2.201)	(3.484)	(2.537)	(9.689)
Ln(Assets)	0.000	-0.009***	0.001***	-0.007***
	(0.000)	(0.001)	(0.000)	(0.001)
MktLev	-0.018***	-0.004***	-0.014***	0.127***
	(0.001)	(0.001)	(0.001)	(0.005)
OperCashFlow	0.012***	-0.106***	0.012***	-0.049***
	(0.002)	(0.007)	(0.002)	(0.009)
FixedAssets	0.003*	0.016***	-0.005***	0.017**
	(0.002)	(0.003)	(0.001)	(0.008)
Inventory	0.002	-0.005	-0.008***	0.091***
	(0.002)	(0.005)	(0.001)	(0.011)
Year-Industry FE	YES	YES	YES	YES
Firm FE	YES	YES	YES	YES
Adj. R2	0.551	0.806	0.308	0.556
Observations	136,796	73,800	127,374	136,269

Panel regression of investment and liquidity decisions on Greenwood and Thesmar's stock price fragility measure as well as additional firm-level control variables. The regressions include both firm and year-industry (SIC3) fixed effects and the standard errors are adjusted for clustering at the firm level. The data is quarterly from 2001 - 2017. Statistical significance at the 1, 5, or 10% levels is reported as ***, **, *, respectively.

Table 5: Effect of BlockRock-BGI Merger on Fragility: Treatment Definition

	(1) Fragility	(2) Fragility	(3) Fragility	(4) Fragility
Merger Treatment	0.002**			
	(0.001)			
Merger Treatment		0.001**		
		(0.001)		
Merger Treatment			0.002***	
			(0.001)	
Merger Treatment				0.001**
				(0.001)
Inst Ownership	0.015***	0.015***	0.015***	0.015***
	(0.005)	(0.005)	(0.005)	(0.005)
Ln(Assets)	0.003	0.003	0.003	0.003
	(0.002)	(0.002)	(0.002)	(0.002)
MktLev	-0.000	-0.000	0.001	-0.000
	(0.003)	(0.003)	(0.003)	(0.003)
OperCashFlow	-0.023***	-0.023***	-0.023***	-0.023***
	(0.006)	(0.006)	(0.006)	(0.006)
FixedAssets	0.019**	0.019**	0.019**	0.019**
	(0.008)	(0.008)	(0.008)	(0.008)
Inventory	-0.008	-0.009	-0.007	-0.008
	(0.008)	(0.008)	(0.008)	(0.008)
Firm FE	YES	YES	YES	YES
Pre	2008 Q4	2009 Q2	2008 Q4	2009 Q2
Post	2009 Q3	2009 Q3	2009 Q3	2009 Q3
Treatment	DUMMY	DUMMY	LEVEL	LEVEL
Adj. R2	0.803	0.803	0.803	0.803
Observations	19,329	19,329	19,246	19,309

Panel regression with Greenwood and Thesmar's stock price fragility ($\times$ 1000) measure as dependent variable. The merger treatments differ by pre and post period and treatment variable as described at bottom of the table. The regressions include firm fixed effects and the standard errors are adjusted for clustering at the firm level. The data is quarterly from 2008-2010 with the exclusion of utilities, financial firms, and SIC 9000 codes. Statistical significance at the 1, 5, or 10% levels is reported as ***, **, *, respectively.

Table 6: Effect of Exogenous Shock to Fragility (BlackRock-BGI Merger) on Cash Holding

	All firms			No MNC		
	(1) All	(2) High Treat	(3) Low Treat	(4) All	(5) High Treat	(6) Low Treat
Merger Treatment	0.012***	0.014***	0.010***	0.007**	0.014***	0.003
	(0.002)	(0.002)	(0.003)	(0.003)	(0.004)	(0.004)
Ln(Assets)	-0.037***	-0.043***	-0.033***	-0.017*	-0.016	-0.015
	(0.007)	(0.012)	(0.009)	(0.009)	(0.017)	(0.011)
MktLev	0.004	0.025**	-0.003	-0.014	0.017	-0.020*
	(0.007)	(0.012)	(0.009)	(0.011)	(0.023)	(0.012)
OperCashFlow	0.072***	0.131***	0.048*	0.085***	0.190***	0.052*
	(0.024)	(0.044)	(0.029)	(0.028)	(0.060)	(0.031)
FixedAssets	-0.399***	-0.403***	-0.400***	-0.388***	-0.434***	-0.377***
	(0.035)	(0.054)	(0.047)	(0.051)	(0.087)	(0.063)
Inventory	-0.417***	-0.477***	-0.398***	-0.300***	-0.279**	-0.291***
	(0.033)	(0.065)	(0.038)	(0.045)	(0.122)	(0.047)
Year-Industry FE	YES	YES	YES	YES	YES	YES
Firm FE	YES	YES	YES	YES	YES	YES
Adj. R2	0.929	0.916	0.935	0.940	0.933	0.943
Observations	21,333	8,558	12,774	9,868	2,786	7,082

Panel regression of cash holding on Blackrock-BGI treatment indicator as well as additional firm-level control variables. The regressions include firm fixed effects and the standard errors are adjusted for clustering at the firm level. The data is quarterly from 2008-2010. Merger Treatment equals one if the stock was jointly held by Blackrock and BGI in 2008 Q4 (robust to 2009 Q2 joint holding, the time of announcement). The treatment period is 2009 Q3 - 2010 Q4 (again, based on announcement, but robust to just post-merger 2010 treatment period). High and Low Treat defined as above or below the median for change in ownership concentration as a result of the merger. Columns (4)-(6) exclude multinational corporations from the sample. Statistical significance at the 1, 5, or 10% levels is reported as ***, **, *, respectively.

Table 7: Effect of Exogenous Shock to Fragility (BlackRock-BGI Merger) on Investment and Liquidity Management

	(1) CapEx/Assets	(2) R&D/Assets	(3) Payout/Assets	(4) ST Debt/Assets
Merger Treatment	-0.001***	-0.001**	-0.001***	-0.002
	(0.000)	(0.000)	(0.000)	(0.001)
Ln(Assets)	-0.001	-0.013***	0.003***	-0.002
	(0.001)	(0.002)	(0.001)	(0.004)
MktLev	-0.018***	-0.001	-0.013***	0.088***
	(0.002)	(0.002)	(0.001)	(0.009)
OperCashFlow	0.009**	-0.041***	-0.002	-0.050**
	(0.004)	(0.009)	(0.003)	(0.021)
FixedAssets	-0.035***	-0.002	-0.027***	-0.027*
	(0.008)	(0.008)	(0.004)	(0.016)
Inventory	0.006	-0.011	-0.017***	0.099***
	(0.004)	(0.008)	(0.004)	(0.023)
Year-Industry FE	YES	YES	YES	YES
Firm FE	YES	YES	YES	YES
Adj. R2	0.587	0.886	0.351	0.691
Observations	21,304	11,351	20,133	21,171

Panel regression of investment and liquidity management decisions on Blackrock-BGI treatment indicator as well as additional firm-level control variables. The regressions include both firm and year-industry (SIC3) fixed effects and the standard errors are adjusted for clustering at the firm level. The data is quarterly from 2008-2010. Merger Treatment equals one if the stock was jointly held by Blackrock and BGI in 2008 Q4 (robust to 2009 Q2 joint holding, the time of announcement). The treatment period is 2009 Q3 - 2010 Q4 (again, based on announcement, but robust to just post-merger 2010 treatment period). Statistical significance at the 1, 5, or 10% levels is reported as ***, **, *, respectively.

Table 8: Effect of Other Mergers (Outside Financial Crisis) on Fragility

	(1) BoA-Fleet	(2) JPM-BankOne
Merger Treatment	0.002***	0.002***
	(0.000)	(0.000)
Inst Ownership	0.018***	0.019***
	(0.002)	(0.002)
Ln(Assets)	-0.001	-0.001
	(0.001)	(0.001)
MktLev	0.006***	0.004*
	(0.002)	(0.002)
OperCashFlow	-0.008	-0.009
	(0.006)	(0.006)
FixedAssets	0.009**	0.001
	(0.004)	(0.005)
Inventory	-0.008	0.006
	(0.006)	(0.007)
Firm FE	YES	YES
Adj. R2	0.813	0.798
Observations	18,369	17,153

Panel regression with Greenwood and Thesmar's stock price fragility ($\times$ 1000) measure as dependent variable. Merger treatment defined by four quarters pre- and post announcement quarter. The regressions include firm fixed effects and the standard errors are adjusted for clustering at the firm level. The data is quarterly. Statistical significance at the 1, 5, or 10% levels is reported as ***, **, *, respectively.

Table 9: Exogenous Shock to Fragility (Bank of America-Fleet and JP Morgan-Bank One) on Cash Holding

	All firms			No MNC		
	(1) All	(2) High IO	(3) Low IO	(4) All	(5) High IO	(6) Low IO
Merger Treatment	0.004*	0.009***	0.001	-0.002	0.006*	-0.005
	(0.002)	(0.002)	(0.006)	(0.003)	(0.003)	(0.009)
Ln(Assets)	-0.018**	-0.045***	-0.003	-0.009	-0.017	-0.001
	(0.009)	(0.012)	(0.011)	(0.011)	(0.016)	(0.012)
MktLev	-0.060***	-0.045***	-0.060***	-0.052***	-0.033	-0.045***
	(0.011)	(0.016)	(0.014)	(0.014)	(0.023)	(0.017)
OperCashFlow	0.069*	0.050	0.033	0.033	0.121	0.005
	(0.040)	(0.070)	(0.044)	(0.046)	(0.085)	(0.050)
FixedAssets	-0.435***	-0.379***	-0.434***	-0.438***	-0.356***	-0.442***
	(0.035)	(0.055)	(0.046)	(0.043)	(0.072)	(0.053)
Inventory	-0.382***	-0.301***	-0.388***	-0.334***	-0.180***	-0.351***
	(0.045)	(0.051)	(0.062)	(0.053)	(0.063)	(0.070)
Year-Industry FE	YES	YES	YES	YES	YES	YES
Firm FE	YES	YES	YES	YES	YES	YES
Adj. R2	0.939	0.941	0.938	0.940	0.943	0.938
Observations	19,039	9,616	9,121	11,204	4,357	6,611

Panel regression of cash holding indicator variable for merger treatment as well as additional firm-level control variables. The regressions include firm fixed effects and the standard errors are adjusted for clustering at the firm level. The data is quarterly from Q4 2002 until Q4 2004. High and Low IO defined as observations with more or less than 50% institutional ownership. Merger Treatment defined by announcement (2003 Q4 for Bank of America-Fleet and Q1 2004 JP Morgan-Bank One). Statistical significance at the 1, 5, or 10% levels is reported as ***, **, *, respectively.

Table 10: The Bank Lending Channel: Interest Spreads, Cash and Investment during High VIX Periods

	Interest spreads		Cash and investment	
	(1) Drawn	(2) Undrawn	(3) Cash/Assets	(4) CapEx/Assets
Large x Frag.	121250.236*	28825.397**	-71.097	-2.651
	(73115.603)	(13370.413)	(51.421)	(5.853)
Fragility	-81571.354*	-22988.342***	94.736***	-0.484
	(48276.055)	(7865.987)	(35.404)	(3.462)
Large	4.950	0.232	0.007	0.001
	(6.880)	(1.281)	(0.006)	(0.001)
Year-Industry FE	YES	YES	YES	YES
Firm FE	YES	YES	YES	YES
Adj. R2	0.711	0.739	0.878	0.556
Observations	19,227	17,756	32,199	32,045

Columns (1) and (2): Panel regression of allindrawn (total (fees and interests) annual spread paid over LIBOR for each dollar drawn) and allindundrawn (the same for for each dollar available under a commitment) on fragility and (unreported) control variables. Large is an indicator that the firm is in the top quartile of assets. Columns (3) and (4): Panel regressions of cash holding and capital expenditure on fragility and (unreported) control variables. The regressions include both firm and year-industry (SIC3) fixed effects and the standard errors are adjusted for clustering at the firm level. The controls Ln(Assets), MktLev, OperCashFlow, FixedAssets and Inventory. VIX is defined as High if the average VIX is in the top quartile across all years. Statistical significance at the 1, 5, or 10% levels is reported as ***, **, *, respectively.

Table 11: Declining Competition: Cash Holding and Investment

	Cash/Assets		Cash/Assets: No MNC		CapEx/Assets	
	(1) All	(2) Low HHI	(3) All	(4) Low HHI	(5) All	(6) Low HHI
Fragility	46.64**	49.97*	70.55**	62.81**	-4.786**	-6.700**
	(2.17)	(1.96)	(2.47)	(2.02)	(-2.00)	(-2.34)
Ln(Assets)	-0.0378***	-0.0382***	-0.0233***	-0.0228***	-0.000515**	-0.000399
	(-11.80)	(-10.25)	(-4.99)	(-4.50)	(-2.15)	(-1.39)
MktLev	-0.0973***	-0.0912***	-0.0953***	-0.0857***	-0.0149***	-0.0170***
	(-14.62)	(-11.37)	(-11.55)	(-8.97)	(-18.55)	(-16.03)
OperCashFlow	-0.0636**	-0.0602**	-0.0808**	-0.0615*	0.00779***	0.00724***
	(-2.42)	(-2.16)	(-2.53)	(-1.93)	(3.94)	(3.28)
FixedAssets	-0.418***	-0.428***	-0.398***	-0.405***	0.00443**	0.00278
	(-22.41)	(-20.00)	(-17.07)	(-15.75)	(2.21)	(1.16)
Inventory	-0.551***	-0.578***	-0.519***	-0.530***	-0.00102	0.00110
	(-22.07)	(-18.89)	(-16.32)	(-13.02)	(-0.58)	(0.50)
TNIC HHI	0.00383		0.0112*		-0.000338	
	(0.95)		(1.79)		(-1.00)	
Year-Industry FE	YES	YES	YES	YES	YES	YES
Firm FE	YES	YES	YES	YES	YES	YES
Adj. R2	0.865	0.875	0.885	0.896	0.574	0.608
Observations	133,389	98,600	66,088	49,400	133,033	98,348

Panel regression of cash holding (Columns (1)-(4) and investment (Columns (5)-(6)) on Greenwood and Thesmar's stock price fragility measure as well as additional firm-level control variables. The regressions include both firm and year-industry fixed effects and the standard errors are adjusted for clustering at the firm level. The data is quarterly. TNIC HHI is the Hoberg and Phillips (2016) measure of industry concentration and Low HHI is defined as below the sample mean. Statistical significance at the 1, 5, or 10% levels is reported as ***, **, *, respectively.

Table A.1: The Bank Lending Channel: Interest Spreads, Cash and Investment during Low VIX Periods

	Interest spreads		Cash and investment	
	(1) Drawn	(2) Undrawn	(3) Cash/Assets	(4) CapEx/Assets
Large x Frag.	81065.405*	9354.014	-47.195	2.003
	(47361.527)	(8024.859)	(40.100)	(4.564)
Fragility	-46032.961	-6767.982	46.278*	-5.964*
	(30632.361)	(5008.961)	(28.051)	(3.046)
Large	-3.294	-0.776	-0.003	-0.000
	(4.746)	(0.791)	(0.004)	(0.000)
Year-Industry FE	YES	YES	YES	YES
Firm FE	YES	YES	YES	YES
Adj. R2	0.695	0.743	0.864	0.588
Observations	61,571	57,727	104,418	104,147

Columns (1) and (2): Panel regression of allindrawn (total (fees and interests) annual spread paid over LIBOR for each dollar drawn) and allindundrawn (the same for for each dollar available under a commitment) on fragility and (unreported) control variables. Large is an indicator that the firm is in the top quartile of assets. Columns (3) and (4): Panel regressions of cash holding and capital expenditure on fragility and (unreported) control variables. The regressions include both firm and year-industry (SIC3) fixed effects and the standard errors are adjusted for clustering at the firm level. The controls Ln(Assets), MktLev, OperCashFlow, FixedAssets and Inventory. VIX is defined as Low if the average VIX is in the bottom three quartiles across all years. Statistical significance at the 1, 5, or 10% levels is reported as ***, **, *, respectively.

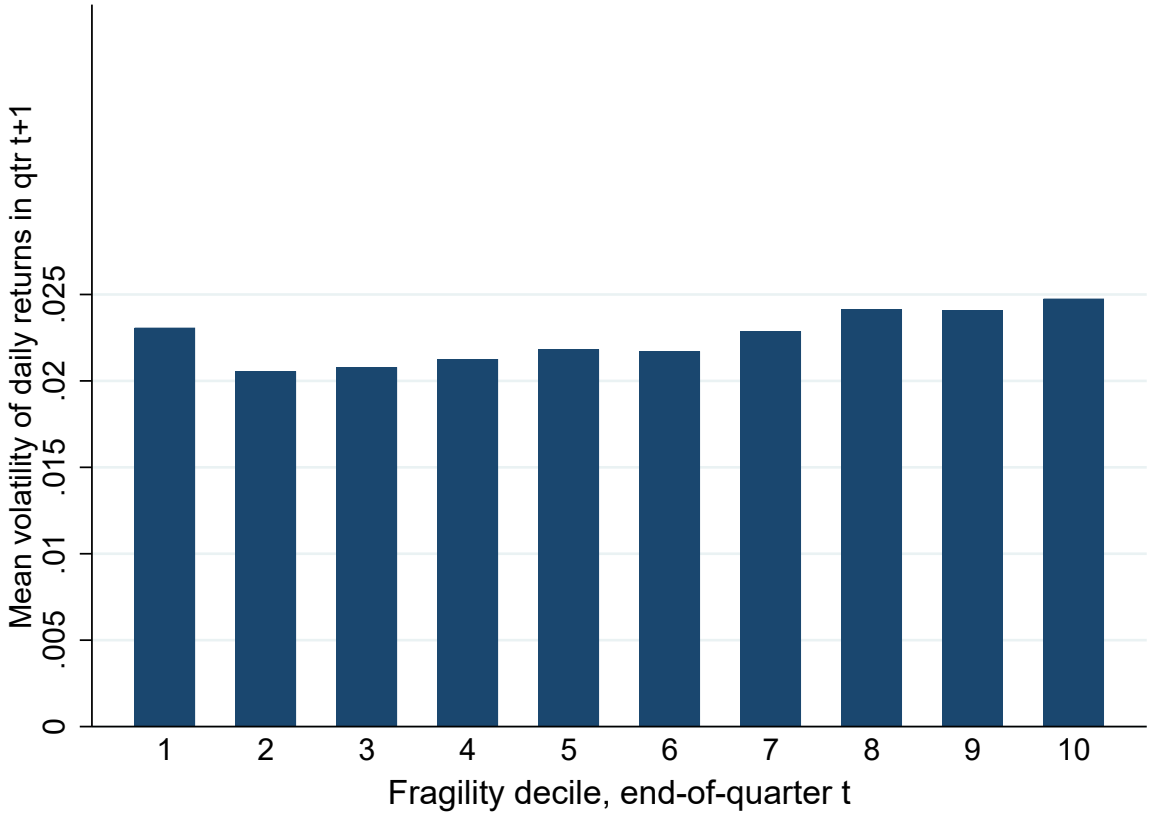
Online Appendix

(1) Stock fragility and stock price volatility

The forward looking, precautionary, behavior that the current paper examines relies on an expectation on the part of firms that a higher stock price fragility is associated with a more volatile stock price. The seminal article by Greenwood and Thesmar (2011) documents this relation for 1990-2007, limiting their sample to firms in decile five or above in terms of market capitalization on the NYSE. Similarly Ben-David et al. (2017) document a robust positive relation between the Greenwood and Thesmar measure of stock price fragility and volatility for the universe of CRSP stocks 1980-2016. Both of these papers use quarterly data (as do we) and focus on daily volatility averaged over the quarter. Greenwood and Thesmar (2011) consider both total return volatility and various specifications of excess returns. Ben-David et al. (2017) consider total returns volatility and control for a number of other factors, in particular the share owned by the largest institutional investors.

A first relevant question is whether our fragility results match up well with those of Greenwood and Thesmar. Figure 2 in Greenwood and Thesmar (2011) present the mean volatility of daily returns for firms against the fragility decile (with sample set to the the top 5 deciles by market capitalization) for 1989 to 2007. We present the corresponding graph for our sample period, 2001 to 2016 in Figure IA.1. Despite the difference in sample period this figures is very similar to Figure 2 in Greenwood and Thesmar (2011), both qualitatively and quantitatively.

Figure IA.1: A comparison with Greenwood and Thesmar: Stock price volatility and fragility 2001-2016



Daily return volatility (average by quarter) on deciles by Greenwood and Thesmar's stock price fragility. Sample restricted to firms in decile 5 or above by market capitalization. Data for 2001-2016.

While Greenwood and Thesmar (2011) focus only on the largest firms later applications of their index, such as Ben-David et al. (2017) and Massa et al. (2018), do not impose such size cut-offs. In the raw data the correlation between fragility and volatility is negative for smaller firms - partly reflecting that stock prices of smaller firms tend to be more volatile at the same time as institional ownership and fragility tend to be lower for these firms. Table IA.1 presents a regression analysis of the relation between daily stock price volatility and fragility, controlling for (the natural log of) market capitalization, ownership by 13-F institutions and the inverse of price in addition to firm fixed effects and year×quarter fixed effects. Column (1) presents the results for the full sample and while the point estimate on fragility is positive it is imprecisely estimated and we can not reject the hypothesis that the coefficient equals zero (t-stat of 1.11). However, Greenwood and Thesmar (2011) note that in their model fragility is proportional to variance of returns

and hence the *square root of fragility* should be proportional to the standard deviation of returns. In their regressions they therefore include the square root of fragility rather than fragility in levels. In Column (2) we therefore include the square root of fragility and the results indicate a statistically significant positive relation between fragility and stock price volatility. We expect a stronger positive relation for firms that are larger and with higher institutional ownership. To explore these dimensions Column (3) restricts the sample to observations with at least 20% ownership share of 13-F institutions, Column (4) excludes microcap firms with less than 100 million in market capitalization and Column (5) considers the top five deciles by market capitalization. In sum, the current sample lines up well with previous evidence in that there is a positive relation between stock price fragility and volatility of returns.

Table IA.1: Return Volatility and Fragility

	(1) All firms	(2) All firms	(3) Inst own>0.2	(4) MarketCap>100	(5) Top 5 deciles
Fragility	3.122				
	(2.416)				
sqrt(Fragility)		0.078**	0.100***	0.121***	0.158***
		(0.033)	(0.032)	(0.029)	(0.039)
Ln(MarketCap)	-0.004***	-0.004***	-0.003***	-0.002***	-0.001***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
1/price	0.008***	0.008***	0.014***	0.018***	0.022***
	(0.001)	(0.001)	(0.001)	(0.002)	(0.007)
Year-Quarter FE	YES	YES	YES	YES	YES
Firm FE	YES	YES	YES	YES	YES
Inst. Own. quantiles	YES	YES	YES	YES	YES
Adj. R2	0.537	0.537	0.596	0.579	0.673
Observations	163,639	163,639	135,961	122,766	47,506

Panel regression of daily return volatility (average by quarter) on Greenwood and Thesmar's stock price fragility measure as well (natural log of) market capitalization, 1/stock price and dummy variables for quantiles of institutional ownership (13-F) as well as firm fixed effects, year×quarter fixed effects. Standard errors are adjusted for clustering at the firm level. Beyond the fragility measure, the data is quarterly Compustat from 2001 - 2016 with the exclusion of utilities, financial firms, and SIC 9000 codes. We require positive book equity and positive sales. Column (3) restricts sample to firms with at least 20% institutional ownership (13-F), Column (4) to firms with market capitalization above 100 million USD and Column (5) to firms in decile 5 or above by market capitalization. Statistical significance at the 1, 5, or 10% levels is reported as ***, **, *, respectively.

(2) Mergers Outside of Financial Crisis - Additional results

Table IA.2: Effect of Smaller Mergers (Outside Financial Crisis) on Fragility

	(1) FirstUn-Wachovia	(2) Goldman-Ayco	(3) BoA-Fleet	(4) JPM-BankOne	(5) Wells F-Strong	(6) Transam-Westcap	(7) Morgan S-Frontp	(8) Goldman-Level
Merger Treatment	0.000	-0.002	0.002***	0.002***	0.001	-0.001	-0.001	0.004*
	(.)	(0.001)	(0.000)	(0.000)	(0.001)	(0.001)	(0.001)	(0.002)
Inst Ownership	0.020***	0.015***	0.018***	0.019***	0.020***	0.024***	0.020***	0.016***
	(0.004)	(0.002)	(0.002)	(0.002)	(0.002)	(0.003)	(0.002)	(0.002)
Ln(Assets)	0.002	0.001	-0.001	-0.001	-0.002*	0.001	-0.000	0.002*
	(0.002)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
MktLev	-0.005	0.004*	0.006***	0.004*	0.005**	0.012**	0.020***	-0.004*
	(0.004)	(0.002)	(0.002)	(0.002)	(0.002)	(0.005)	(0.003)	(0.002)
OperCashFlow	0.023**	0.001	-0.008	-0.009	-0.007	-0.019	-0.012*	-0.020***
	(0.009)	(0.006)	(0.006)	(0.006)	(0.006)	(0.015)	(0.006)	(0.006)
FixedAssets	0.001	0.006	0.009**	0.001	0.002	-0.002	0.002	0.013**
	(0.008)	(0.004)	(0.004)	(0.005)	(0.005)	(0.009)	(0.005)	(0.006)
Inventory	-0.016*	-0.004	-0.008	0.006	0.006	0.020	0.012*	-0.008
	(0.009)	(0.006)	(0.006)	(0.007)	(0.006)	(0.012)	(0.006)	(0.007)
Firm FE	YES	YES	YES	YES	YES	YES	YES	YES
Adj. R2	0.893	0.815	0.813	0.798	0.805	0.793	0.823	0.825
Observations	6,218	17,578	18,369	17,153	17,901	6,757	18,228	16,919

Panel regression with Greenwood and Thesmar's stock price fragility ($\times$ 1000) measure as dependent variable. List of mergers from Lewellen and Lowry (2019). Merger treatment defined by four quarters pre- and post announcement quarter. The regressions include firm fixed effects and the standard errors are adjusted for clustering at the firm level. The data is quarterly Compustat with the exclusion of utilities, financial firms, and SIC 9000 codes. Statistical significance at the 1, 5, or 10% levels is reported as ***, **, *, respectively.

Table IA.3: Effect of Other Mergers (Outside Financial Crisis) on Investment and Liquidity Management

	(1) CapEx/Assets	(2) R&D/Assets	(3) Payout/Assets	(4) ST Debt/Assets
Merger Treatment	0.000	0.000	0.000	0.001
	(0.000)	(0.001)	(0.000)	(0.001)
Ln(Assets)	-0.001	-0.015***	0.003***	-0.008***
	(0.002)	(0.002)	(0.001)	(0.003)
MktLev	-0.016***	0.002	-0.011***	0.092***
	(0.003)	(0.003)	(0.002)	(0.011)
OperCashFlow	-0.002	-0.062***	-0.010**	-0.070***
	(0.004)	(0.013)	(0.005)	(0.018)
FixedAssets	-0.051***	0.000	-0.010***	0.029*
	(0.014)	(0.009)	(0.004)	(0.017)
Inventory	0.009	-0.008	-0.015***	0.058**
	(0.005)	(0.007)	(0.005)	(0.023)
Year-Industry FE	YES	YES	YES	YES
Firm FE	YES	YES	YES	YES
Adj. R2	0.498	0.842	0.308	0.707
Observations	18,941	10,063	16,967	18,916

Panel regression of corporate investment decisions and liquidity management on indicator and merger treatment as well as additional firm-level control variables. The regressions include firm fixed effects, year fixed effects, and the standard errors are adjusted for clustering at the firm level. The data is quarterly Compustat from Q4 2002 until Q4 2004 with the exclusion of utilities, financial firms, and SIC 9000 codes. Merger Treatment defined by announcement (2003 Q4 for Bank of America-Fleet and Q1 2004 JP Morgan-Bank One). Statistical significance at the 1, 5, or 10% levels is reported as ***, **, *, respectively.