The Real Effects of Financial Markets: The Impact of Prices on Takeovers*

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Abstract

This paper provides evidence of the real effects of financial markets. Using mutual fund redemptions as an instrument for price changes, we identify a strong effect of market prices on takeover activity (the "trigger effect"). An inter-quartile decrease in valuation leads to a 7 percentage point increase in acquisition likelihood, relative to a 6% unconditional takeover probability. Instrumentation addresses the fact that prices are endogenous and increase in anticipation of a takeover (the "anticipation effect.") Our results overturn prior literature which found a weak relation between prices and takeovers without instrumentation. They imply that financial markets may impose discipline on managers by triggering takeover threats, but the anticipation effect hinders this process. More generally, they demonstrate the bi-directional relationship between asset prices and corporate finance – prices both affect and reflect real decisions.

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Does a low market valuation make a firm a takeover target? In theory, acquirers can profit from taking over a firm, whose market value is low relative to its peers, and restore it to its potential. Indeed, in practice, acquirers and other investors track a firm's valuation multiples for indication on the potential for acquisition, and managers strive to maintain high market valuation to prevent a hostile takeover. Understanding whether such a link exists is important because, if so, it suggests that the market provides a powerful disciplining device to alleviate managerial agency problems (see Marris (1964), Manne (1965) and Jensen (1993)). Empirical studies on takeovers, however, fail to systematically uncover a meaningful relationship between market valuations and takeover probabilities. While Cremers, Nair, and John (2009) and Bates, Becher, and Lemmon (2008) find a negative, but economically insignificant, relation between takeover likelihood and Tobin's Q, Palepu (1986) and Ambrose and Megginson (1992) uncover no link, and Rhodes-Kropf, Robinson, and Viswanathan (2005) document that target market-to-book ratios are in fact higher than in control firms. Relatedly, Agrawal and Jaffe (2003) find that targets do not exhibit inferior prior stock performance than peer firms.

We argue that there is a fundamental challenge in finding a relation between market prices and takeover activity in the data, because the relationship is inherently bi-directional. While markets may exhibit a *trigger effect*, in which a low valuation induces a takeover attempt, there is also an *anticipation effect*, in which forward-looking market prices are inflated by the probability of a future takeover. Estimating the underlying trigger effect must account for the anticipation effect. Even if a low valuation attracts an acquisition, a high valuation may indicate that the market believes an acquisition is probable, thus attenuating any relationship between valuation and takeover probability found in the data. In this paper, we attempt to identify these two effects separately. We call the combination of these effects the *feedback loop*.

Disentangling the trigger effect from the anticipation effect requires an instrumental variable: a variable that directly affects the market price, but affects takeover probability only via its effect on the market price. Conceptually, this is a difficult problem: any variable that is directly associated with the firm's characteristics or its management would not qualify as an instrument since it is directly related to both the price and the probability of a takeover. Hence we seek a variable that causes mispricing, i.e., one that changes the price, but not due to issues related to the firm's fundamentals.

Friction-driven mispricing events have been the subject of a large recent literature in finance, summarized by Duffie (2010) in his presidential address to the American Finance Association. Building on this literature, we construct a measure of price pressure induced by mutual funds not due to informational reasons, but due to flows they face from investors. The idea follows from Coval and Stafford (2007), who document that large flows by mutual fund investors lead prices of stocks held by the funds to shift away from fundamental value for prolonged periods of time. While Coval and Stafford (2007) investigate actual trades executed by mutual funds, this is not a valid instrument in our context as funds may be trading deliberately based on private information on a firm's likely takeover potential. We instead study mutual funds' hypothetical trades mechanically induced by flows by their own investors. We argue that fund investors' decisions to accumulate or divest mutual fund shares are unlikely to be directly correlated with the takeover prospects of individual firms held by the fund. An investor, who wishes to speculate on the takeover likelihood of an individual firm, will trade the stock of that firm, rather than a mutual fund share.[1] Hence, investor flows lead to price pressure that may affect the probability of a takeover, but are not directly related to this probability. We find that our measure causes significant price changes, followed by slow reversal that ends with full correction only after two years on average. Using this as an instrument for the market price, we are able to find a strong negative relation between market prices and takeover probabilities.

Prior literature studies the effect of raw valuations (such as price-to-earnings or market-to-book ratios) on takeover likelihood. However, a low raw valuation may not indicate underperformance and thus the need for a corrective action, as it may be driven by irremediably low quality – for example, because the firm is mature and in a competitive industry. We thus construct a "discount" measure of the difference between a firm's current valuation and its potential value under full efficiency. This discount measures the value that an acquirer can create by restoring a firm to its potential, and thus has a theoretical link to the likelihood that a firm becomes targeted by a bidder. We estimate the potential value using the values of other firms in the industry or with similar basic fundamentals. Without accounting for the fact that prices reflect takeover likelihood,

[1] Importantly, we exclude mutual funds that concentrate on a specific industry to assure that investors' flows are not driven by a takeover wave among many firms held by the fund.

an inter-quartile change in the discount is associated with a 1 percentage point increase in takeover probability. Our main contribution is in showing that, by accounting for the anticipation effect by instrumenting the discount with mutual fund investors' flows, the trigger effect rises substantially to 7 percentage points. This is both statistically significant and economically important compared to the 6.2% unconditional probability that a given firm receives a takeover bid in a particular year. Using this analysis, we can also estimate the magnitude of the anticipation effect. An inter-quartile change in shocks to takeover probability is associated with a 3.9 percentage point decrease in the discount on average, versus a mean discount of $18-28\%$.

These findings have a number of implications for takeover markets. First and foremost, the trigger effect implies that financial markets are not just a side show. They have a real effect on corporate events, such as takeovers, and thus on firm value. In that, our paper adds to existing evidence on the real effect of financial markets, such as Baker, Stein, and Wurgler (2003) and Chen, Goldstein, and Jiang (2007).[2] While these previous papers identified the real effect via comparative statics (showing that the sensitivity of real decisions to prices increases in some firm characteristic that is hypothesized to augment the importance of prices), our paper identifies it directly. It is the first to use an instrumental variable to capture the effect of exogenous price changes on corporate events.

There are a number of reasons for why market prices may have real effects. First, decision makers may learn from market prices to guide their actions – see, for example, the models of Fishman and Hagerty (1992), Dow and Gorton (1997), and Goldstein and Guembel (2008). In a takeover context, the argument is more intricate. For prices to affect takeover likelihood (rather than just the price paid in a takeover), there must be an asymmetry in learning between the acquirer and the target's shareholders. For example, suppose that target shareholders learn the firm's true value from the market price and thus demand a takeover price that is closely linked to the market price (e.g. a certain premium above market price),[3] but the acquirer has additional information on the potential value that can be achieved under his management and so the value of the target to him is less sensitive to the market price. Then, a decrease in target valuation will increase the potential

[2] For an early discussion, see Morck, Shleifer, and Vishny (1990).

[3] Schwert (1996) provides related evidence, finding that the offer price increases almost dollar-for-dollar with the target's pre-bid runup. He argues that the higher offer price may be justified by the target's greater perceived value based on new information from the runup. He does not explore the effect on takeover probability.

gain for the acquirer and thus the likelihood of a bid. Note that the possibility of asymmetric learning has not been incorporated yet into the theoretical takeover literature. Our empirical findings thus call for modification of existing takeover theories. Second, market participants may anchor on the price, as in Baker, Pan, and Wurgler (2009). For example, practitioners currently study premia to the market price in related past deals to estimate an appropriate premium to offer in the current transaction (known as "precedent transactions analysis").

Interestingly, the active role of financial markets implies that any factor that influences prices can also influence takeover activity (and other real actions). Therefore, mispricing (e.g. due to market frictions or investor errors) can have real consequences by impacting takeovers. Hence, our paper is related to the behavioral corporate finance literature (surveyed by Baker, Ruback, and Wurgler (2007)). In particular, Dong, Hirshleifer, Richardson, and Teoh (2006) use a firm's multiple as an indicator for mispricing and link it to takeover activity. Unlike us, they do not model the relationship between prices and takeovers as a simultaneous system or use an instrumental variable to identify the effect of exogenous price changes, but instead focus on the equilibrium correlation between the multiples and takeovers. Note that, in the behavioral corporate finance literature, temporary overvaluation often improves a firm's fundamental value as it allows managers to raise capital or undertake acquisitions at favorable prices (e.g. Stein (1996), Shleifer and Vishny (2003)). Here, it can reduce fundamental value by deterring value-creating takeovers.

Second, regarding the anticipation effect, our results demonstrate the illusory content of stock prices. While researchers typically use valuation measures to proxy for management performance, a firm's stock price may not reveal the full extent of its agency problems, as it may also incorporate the expected correction of these problems via a takeover. Our results thus challenge the common practice of using Tobin's Q or stock price performance to measure management quality. By breaking the correlation between market valuations and takeover activity into trigger and anticipation effects, our analysis enables us to ascertain the extent to which future expected takeovers are priced in. In that, our paper is related to Song and Walkling (2000), who find an increase in firms' stock prices following the acquisition of their rivals and attribute this to the increased expectation that they will be taken over themselves. Other papers have analyzed the effect of takeover anticipation on stock returns rather than valuations. Hackbarth and Morellec (2008) and Cremers, Nair, and John

(2009) show that anticipated takeovers affect the correlation of a stock's return with the market return and hence have an effect on the discount rate. Prabhala (1997) and Li and Prabhala (2007) note that takeover anticipation will affect the market return to merger announcements.

Third, considering the full feedback loop, our results suggest that the anticipation effect might be an impediment to takeovers – the anticipation of a takeover boosts prices, deterring the acquisition of underperforming firms. Moreover, it may also allow managers to underperform in the first place since they are less fearful of disciplinary acquisitions.[4] Indeed, many practitioners believe that the anticipation effect has significant effects on real-life takeover activity. A December 22, 2005 *Wall Street Journal* article claims that this has been a major problem in the U.S. banking industry: "takeover potential raises [the] value of small financial institutions, making them harder to acquire." This may have had severe consequences, as small banks remained stand-alone and were less able to withstand the recent financial crisis. Many commentators believe that the same phenomenon recently occurred in the U.K. water industry. For example, an October 13, 2006 article in *This Is Money* notes that "there are concerns that the race for control of [water] assets has overheated valuations, adding to speculation that the [merger] bubble is about to burst." Essentially, in these cases and others, the belief of an upcoming takeover becomes self-defeating. This effect is reminiscent of the free-rider problem in the theoretical model of Grossman and Hart (1980), although the market price plays no role in coordinating expectations in their setting. Equilibrium outcomes in settings where the combination of the trigger effect and anticipation effect becomes self-defeating have been analyzed by Bond, Goldstein, and Prescott (2010).

This self-defeating nature of takeover expectations sheds new light on other important real-world phenomena. First, it suggests why merger waves endogenously die out. If a recent spate of mergers leads the market to predict future acquisitions, this causes valuations to rise (anticipation effect), dissuading further acquisition attempts. Second, it provides a rationale for the practice of CEOs publicly expressing concerns about an upcoming takeover. Such statements act as a takeover defense, as they inflate the price, which in turn deters the takeover from occurring.

In addition, our paper has a number of wider implications outside the takeover market. The

[4] Brealey, Myers, and Allen (2008) note that "the most important effect of acquisitions may be felt by the managers of companies that are *not* taken over. Perhaps the threat of takeover spurs the whole of corporate America to try harder."

feedback loop may apply to other corrective actions, such as CEO replacement, shareholder activism and regulatory intervention. Low valuations trigger intervention, but market anticipation causes prices to rise, which in turn may deter the correction from occurring. Bradley, Brav, Goldstein, and Jiang (2010) show that the discount at which a closed-end fund is traded affects and reflects the probability of activism at the same time. Separately, while many existing papers use raw valuation or profitability to measure management quality or agency problems, this paper's approach of measuring them using a discount to potential value and purging them of anticipation can be applied to a range of other settings.

More broadly, our results contribute to the growing literature that analyzes the link between financial markets and corporate events. While corporate finance typically studies the effect of prices on firm actions and asset pricing examines the reverse relation, our paper analyzes the full feedback loop – the simultaneous, two-way interaction between prices and corporate actions that combines the trigger and anticipation effects. One important strand of this literature concerns the link between financial market efficiency and real efficiency. While most existing research suggests that the former is beneficial for the latter[5], our results point to an intriguing disadvantage of forward-looking prices – they may deter the very actions that they anticipate.

The remainder of the paper is organized as follows. Section 1 specifies the model that we use for the empirical analysis. In Section 2, we describe our data and variable construction. Section 3 presents the empirical results on the feedback loop. In Section 4, we consider some extensions and robustness tests. Section 5 concludes.

1 Model Specification

1.1 Firm Valuation and Discount

A number of earlier papers have studied the effect of raw valuations on takeover probability. By contrast, our key explanatory variable is the "discount" at which a firm trades relative to its maximum potential value absent managerial inefficiency and mispricing, which we call the "frontier value". Theoretically, it is this variable that will drive a firm's likelihood of becoming a takeover

[5] See, e.g., Fishman and Hagerty (1992), Holmstrom and Tirole (1993), Subrahmanyam and Titman (1999), Dow, Goldstein, and Guembel (2008), Admati and Pfleiderer (2009), and Edmans (2009).

target, as it measures the potential gain from an acquisition.

Under some circumstances, the frontier value is well-defined. For example, in closed-end funds, it is the net asset value (NAV). The discount can then be simply calculated as the difference between the NAV and the market price. Indeed, Bradley, Brav, Goldstein, and Jiang (2010) find that activist shareholders are more likely to target closed-end funds that are trading at deep discounts. Analogously, the market value of regular corporations can deviate from their potential value owing to agency problems and/or mispricing, and this might make the corporation a takeover target.

For a regular corporation, the frontier value cannot be observed and must be estimated. This is done by observing the valuation of "successful" firms with similar fundamentals. Specifically, let X be a vector of variables that represent firm fundamentals that determine potential value: $V^* = f(X)$. Since V^* represents the potential value after the acquirer has corrected managerial inefficiencies, the X variables should consist of firm characteristics that bidders are unlikely to change upon takeover.

If the set of value-relevant variables X is exhaustive, and if there is no noise or mispricing in valuation, then the maximum valuation commanded among the group of peer firms that share the same fundamentals can be perceived as the "potential" of all other firms. However, a particular firm could have an abnormally high valuation owing to luck, misvaluation, or idiosyncratic features (such as unique core competencies) if X is not fully exhaustive of all value-relevant fundamental variables. For example, a rival search engine is unlikely to command the valuation of Google even if it is efficiently run. Therefore, setting the potential value to the maximum value among peers would erroneously assume that this high valuation was achievable for all firms, and overestimate the discount.

An improved specification is to set the potential value to a high-percentile, rather than the maximum, valuation of peer firms. We define "successful" firms as those that command valuations at the $(1-\alpha)$th percentile or higher among peer firms, where $0 < \alpha < \frac{1}{2}$. A firm valued at below the $(1-\alpha)$th percentile is thus classified as operating below potential value. When $\alpha = 0$, the benchmark is the maximum valuation among peers; when $\alpha = \frac{1}{2}$, the benchmark becomes the median (we require $\alpha < \frac{1}{2}$ to reflect the fact that a successful firm should be above median).

We now discuss the choices for X variables and the parameter α, starting with the former. In our first approach, X includes only a firm's industry affiliation. Acquirers are unlikely to change the target's sector and instead typically aim to restore its value to that commanded by successful firms in the same sector, so the industry affiliation easily satisfies the requirement for a valid X variable. In using the industry benchmark, we follow other papers in the takeover literature (see, e.g., Rhodes-Kropf, Robinson, and Viswanathan (2005)) as well as practitioners. For example, "comparable companies analysis" compares a firm's valuation to its industry peers, and is often used by practitioners to identify undervalued companies that might be suitable takeover targets. The potential concern is that an industry benchmark ignores other determinants of the potential value. For example, small and growing firms are likely to command higher valuations than larger, mature peers. Also, this approach implicitly assumes that a particular industry cannot be systematically over- or undervalued, contrary to evidence (Hoberg and Phillips (2010)).

We therefore also employ a second approach, using firm characteristics as X variables.[6] We take two steps to reduce the concern that the estimated frontier value can be affected by the acquirer. First, following Habib and Ljungqvist (2005), who also estimate a frontier value, we choose variables that are unlikely to be radically transformed by an acquirer. For example, both a firm's market share and financial policies (such as dividend payout) affect its actual valuation. However, only the former affects its frontier valuation: it is difficult to transform market share immediately, but financial policies can be quickly reversed. The X variables we use are firm size, firm age, asset intensity, R&D intensity, market share, growth opportunities, and business cyclicality. These variables are further motivated in Section 2.2 as well as in Habib and Ljungqvist (2005).

Second, we recognize that firm characteristics are not completely exogenous and that acquirers may be able to change them within a modest range. We therefore do not use the raw measures of these variables (except for age, which is fully exogenous) but their tercile ranks. This specification allows for bidders to change the value of these fundamentals within a given tercile, but not to alter it sufficiently to move it into a different tercile. Since an acquirer may be able to change the tercile of a firm that is currently close to the cutoffs, we exclude such firms from a sensitivity analysis in Section 4.

Indeed, existing research finds that takeover gains typically stem from correcting underperfor-

[6] We do not use industry affiliation in conjunction with firm characteristics, as we wish to allow particular industries to be over- or undervalued.

mance given a set of fundamentals, rather than changing the fundamentals themselves. For the typical M&A deal, one cannot observe whether the target's fundamentals change since they are consolidated with the acquirer, but this is possible in LBOs since the target continues to be reported independently. Muscarella and Vetsuypens (1990) find that the sales (one of our X variables) of LBO targets change at a similar rate to non-targets, and Smith (1990) documents no significant difference in the rate of change in R&D (a second X variable). Relatedly, many papers find that the bulk of value creation from LBOs is due to improvements in efficiency. This literature is surveyed by Eckbo and Thorburn (2008); we briefly mention the key papers here. Kaplan (1989), Smith (1990), and Muscarella and Vetsuypens (1990) find improvements in accounting performance; Smith (1990) show that these arise from superior working capital management and Muscarella and Vetsuypens (1990) demonstrate that they stem from cutting expenses rather than increasing revenues. Using plant-level data, Lichtenberg and Siegel (1990) document significant increases in productivity; the case study of Baker and Wruck (1989) finds improved incentives, monitoring and working capital management.

In summary, there is a trade-off between the two approaches. The advantage of the second approach is that a more extensive list of variables will provide a more accurate assessment of the true potential value. The disadvantage is that some of the added X variables may not be completely outside the acquirer's control. This concern does not arise under the first approach, where the only X variable is the industry affiliation. As we describe later, our results turn out to be slightly stronger under the industry approach.

The remaining specification issue is the choice of α. Here, again, there is a trade-off. A low α may overweight abnormal observations; a high α may underestimate the potential value and thus the occurrence of discounts. We calibrate α from the empirical facts documented by prior literature. According to Andrade, Mitchell, and Stafford (2001), the median takeover premium was $37 - 39$ percent during the 1980-2002 period; Jensen and Ruback (1983) documented similar magnitudes in an earlier period. Since bidder returns are close to zero on average (Jensen and Ruback (1983), Betton, Eckbo, and Thorburn (2008)), the target captures almost the entire value gains from the takeover. Therefore, on average, the takeover premium represents the potential for value improvement at the target. We thus calibrate the $(1 - \alpha)$th percentile (i.e. the expected post-takeover value) to capture the value of the median target firm (pre-takeover) plus the median takeover premium (38%).[7] Specifically, we pool all firms within a given SIC three-digit industry across all years and subtract year fixed effects. We then add 38% to the pre-acquisition equity value of each firm that was a takeover target and rank each target's cum-premium value within its industry peers. We find that, after including the premium, the median ranking of targets in our sample is at the 77th percentile of the respective industry. Rounding to the nearest decile, this corresponds to an α of 20%. In other words, about 80% (20%) of the firms are traded at a discount (premium) in a given year. This choice of α is also supported by evidence from closed-end funds, a setting in which the discount can be precisely measured. Bradley, Brav, Goldstein, and Jiang (2010) find that, on average, about 20% (80%) of closed-end funds trade at a premium (discount) to NAV. In Section 4, we vary α across the range of $[0.10, 0.30]$, and find that our results are not sensitive to the choice of α within this region.

Once X and α are chosen, and given observed valuations V, the potential value can be estimated using the quantile regression method pioneered by Koenker and Bassett (1978):

$$V = X\beta + \varepsilon, \text{ where } Quantile_{1-\alpha}(\varepsilon) = 0, \tag{1}$$

ε is a disturbance term, and $X\beta$ is the potential value. More specifically, with actual data $\{V_{i,t}, X_{i,t}\}$, and for a given α, we estimate $\widehat{\beta}$ in (1) via the least absolute deviation (LAD) method:

$$\min_{\widehat{\beta}\in\mathcal{B}} \frac{1}{n}\left\{ \sum_{V_{i,t}>f(X_{i,t};\widehat{\beta})} (1-\alpha)\left|V_{i,t} - f(X_{i,t};\widehat{\beta})\right| + \sum_{V_{i,t}\le f(X_{i,t};\widehat{\beta})} \alpha\left|V_{i,t} - f(X_{i,t};\widehat{\beta})\right| \right\}, \tag{2}$$
$$s.t. f(X_{i,t};\widehat{\beta}) \ge 0,$$

where $f(X_{i,t};\widehat{\beta})$ is the estimated maximum potential value. Note that (2) holds regardless of the distribution of ε (or its empirical analog $V_{i,t} - f(X_{i,t};\widehat{\beta})$), and so we do not require any assumptions for the disturbance term, except for its value at the $(1-\alpha)$th percentile. The added non-negativity

[7] Arguably, the takeover premium might include synergy as well as efficiency gains. According to Betton, Eckbo, and Thorburn (2008), same-industry takeovers (where synergies are most likely) do not involve higher takeover premia; and hostile takeovers (which are less likely to be synergy-driven) do not feature lower premia. Therefore, valuation-driven takeovers likely exhibit similar premia to takeovers in general.

constraint $f(X_{i,t};\widehat{\beta}) \geq 0$ (which reflects limited liability) is a minor variation to the original model of Koenker and Bassett (1978). It is addressed by the censored least absolute deviation (CLAD) method of Powell (1984). Obviously, this estimation is simple under the first approach where there is a single X variable, the industry affiliation. In this case, the frontier value is simply the 80th percentile firm in the industry.

Having estimated $\widehat{\beta}$, the empirical analog to $Discount = (V^* - V)/V^*$ is

$$\left(X_{i,t}\widehat{\beta} - V_{i,t}\right)/X_{i,t}\widehat{\beta}. \tag{3}$$

Our estimation of the potential value is a form of the stochastic frontier method proposed by Aigner, Lovell, and Schmidt (1977), analyzed by Kumbhakar and Lovell (2000). A different form of stochastic frontier analysis has been used in finance by Hunt-McCool, Koh, and Francis (1996) and Habib and Ljungqvist (2005). Our specification (1) makes no parametric assumptions regarding ε and thus accommodates skewness, heteroskedasticity and within-cluster correlation, all of which are common features in finance panel data.

Note that our discount measure provides a "floor" estimate for the potential increase in value due to a takeover. This is because it captures the discount in the valuation of the firm as a standalone entity relative to its peers, and deliberately does not take into account any synergies with specific acquirers. This is because our goal is to study the effect of prices on takeover activity, and more generally the importance of financial markets for real decisions. If synergies are the primary motive for mergers and/or financial markets are a side show, our *Discount* measure (which ignores acquirer-specific synergies and captures only managerial inefficiency and mispricing) should have no explanatory power. By contrast, we find that standalone *Discount* does attract takeovers.[8]

1.2 Interaction of Takeover and Discount

Our goal is to estimate the bi-directional relationship between takeover likelihood and value discounts. We will show that accounting for the anticipation effect (from the takeover likelihood to the

[8] Note that, to the extent that other peer firms have already merged and achieved synergies, our measure does capture these potential synergies. The synergies that our measure does not capture are those that are not reflected in the current value of comparable firms and are specific to a combination with a particular acquirer.

discount) is crucial in quantifying the trigger effect (from the discount to the takeover likelihood).

For illustrative purposes, we start with a benchmark model without the anticipation effect, i.e., where market valuations do not incorporate the possibility of future takeovers. We use $Discount^0$ to denote the "underlying" discount that would exist in such a world. In this benchmark model, the system can be written as:

$$Discount^0 = \gamma_0 X + \gamma_1 Z_1 + \gamma_2 Z_2 + \eta, \tag{4}$$

$$Takeover^* = \mu_1 Discount^0 + \mu_2 X + \mu_3 Z_1 + \xi, \tag{5}$$

$$Takeover = \begin{cases} 1, \text{ if } Takeover^* > 0, \\ 0, \text{ otherwise,} \end{cases} \tag{6}$$

$$corr(\eta, \xi) = 0. \tag{7}$$

$Takeover^*$ is the latent variable for the propensity of a takeover bid, and $Takeover$ is the corresponding observed binary outcome. Since $corr(\eta, \xi) = 0$, the two equations can be separately estimated using a linear regression model and a binary response regression model, respectively.

We classify determinants of the discount into two groups. Z_1 is a vector of variables that affect both the discount and the probability of takeovers. These include variables that capture managerial agency problems, as they affect operational inefficiency and are likely also correlated with takeover resistance. Z_2 is a variable that represents market frictions that affect the stock price, but have no independent effect on takeover probability other than through the price. The distinction between Z_1 and Z_2 variables will become important when we incorporate the anticipation effect and require instruments.

Since the discount is calculated using tercile ranks of X (except *Age* which enters with its full value), it is not orthogonal to the raw values of X and so X (except *Age*) appears in (4). We also allow the X variables to enter the $Takeover$ equation directly as certain firm characteristics may make an acquisition easier to execute. For example, small acquisitions are easier to finance and less likely to violate antitrust hurdles (Palepu (1986) and Mikkelson and Partch (1989)). In addition, it is easier to raise debt to finance targets with steady cash flows, high asset tangibility and in non-cyclical businesses. All variables are described in Section 2.2.

Allowing for the anticipation effect, the equations above become interdependent. Specifically, if the market rationally anticipates the probability of a takeover, the observed discount (*Discount*) will shrink below the underlying $Discount^0$ as modeled by (4). Then, (4) and (5) should be remodeled as:

$$Discount = \gamma_0 X + \gamma_1 Z_1 + \gamma_2 Z_2 + \delta\xi + \eta', \tag{8}$$

$$Takeover^* = \mu_1 Discount + \mu_2 X + \mu_3 Z_1 + \xi. \tag{9}$$

η in (4) becomes $\delta\xi + \eta'$ in (8), where $\delta\xi$ represents the shrinkage from the anticipation effect, i.e., δ is expected to be negative. As a result, we have

$$\begin{aligned} \rho &= corr(\eta, \xi) = corr(\delta\xi + \eta', \xi) = \delta\sigma_\xi^2 \\ &< 0 \text{ if } \delta < 0, \end{aligned} \tag{10}$$

hence the simultaneity of the system. Note that since $\rho < 0$, the endogeneity acts in the opposite direction from the true μ_1 and using equation (9) alone will underestimate μ_1. In other words, empiricists might estimate a low μ_1 simply because a low discount is observed when the market anticipates a takeover. The only way to uncover the true μ_1 is by using an instrumental variable Z_2 that has a direct effect on *Discount*, but only affects $Takeover^*$ via its effect on *Discount*.

The system cannot be estimated using conventional two-stage least squares because the observed variable *Takeover* is a binary variable. Our estimation follows Rivers and Vuong (1988) and adopts the maximum likelihood method. We estimate (9) as the main equation, using the reduced form of (8) as an input to the main equation, and instrumenting the endogenous variable *Discount* by the Z_2 variable. Later, we back out the relation from *Takeover* shocks to *Discount* in (8) from the estimation (see Section 3.2) .

The intuition of the estimation is as follows. Suppose we obtain the residual discount, $\widetilde{Discount}$, from the linear regression as specified in (8):

$$\widetilde{Discount} = Discount - \widehat{\gamma}_0 X - \widehat{\gamma}_1 Z_1 - \widehat{\gamma}_2 Z_2. \tag{11}$$

$\widetilde{Discount}$ is thus the empirical analog of the sum of two components: the anticipation effect ($\delta\xi$) and an unmodeled residual disturbance (η'). The power of the test rests on the explanatory power of X, Z_1 and Z_2 so that, within $\widetilde{Discount}$, the unmodeled residual η' (which is not correlated with any other variables in the model) does not dominate the anticipation effect $\delta\xi$. The residual in (9), ξ, can be expressed as a linear function of $\widetilde{Discount}$ as follows:

$$\xi = \lambda \widetilde{Discount} + \xi'. \tag{12}$$

Substituting (12) into (9) yields:

$$Takeover^* = \mu_1 Discount + \mu_2 X + \mu_3 Z_1 + \underbrace{\lambda \widetilde{Discount} + \xi'}_{=\xi}. \tag{13}$$

By adding the projected residual, $\widetilde{Discount}$, as a control function (or "auxiliary" regressor) in equation (13), it absorbs the correlation between the error term and the *Discount* regressor. Therefore, the resulting residual ξ' is now a well-behaved disturbance that is uncorrelated with all other regressors in the *Takeover* equation, including *Discount*. As a result, (13) resembles a regular probit specification except that $\widetilde{Discount}$, which is not a natural covariate, needs to be integrated out in order to obtain coefficients on observable variables. Equation (20) in Appendix A.2 presents the full likelihood function.

2 Data and Variable Description

2.1 Data

We obtain data on mergers and acquisitions (M&A) from Securities Data Company (SDC), for 1980-2007. Since we are assuming a sufficient change-of-control that the acquirer is able to improve the target's efficiency, we use SDC's "Form of the Deal" variable to exclude transactions classified as acquisitions of partial stakes, minority squeeze-outs, buybacks, recapitalizations, and exchange offers. We also delete transactions where the bidder had a stake exceeding 50% before the acquisition, or a final holding of under 50%. This leaves us with 13,196 deals. As we require the target's valuation, we drop all transactions for which the target does not have stock return data on CRSP and basic accounting data from Compustat. We also exclude all financial (SIC code 6000-6999) and utilities (SIC code 4000-4949) firms from the sample, because takeovers are highly regulated in these industries. These restrictions bring the final sample down to 6,555 deals. From this list we construct the variable $Takeover$, a dummy variable that equals 1 if the firm receives a takeover bid in a particular calendar year. The universe of potential targets is all non-financial and non-utility firms that have the necessary CRSP and Compustat data.

Table 1, Panel A provides a full definition of all the independent variables used in our analysis; summary statistics are in Panel B. All of our accounting variables are obtained from Compustat; we obtain additional variables from CRSP, Thomson Reuters, and SDC as detailed below. All variables from Compustat are calculated for the fiscal year ending the year before the $Takeover$ dummy; the others are calculated for the prior calendar year. All potentially unbounded numbers are winsorized at the 1% and 99% levels.

[Insert Table 1 here]

2.2 Variable Description

The construction of the *Discount* variable relies on the choice of a valuation metric to determine V and a set of fundamental variables that can be used to predict the frontier value. Our primary valuation measure is Q, the ratio of enterprise value (debt plus market equity) to book value (debt plus book equity), as it is the most widely used valuation metric in the finance literature. We also use a secondary measure, $EV/Ebitda$, the ratio of enterprise value to earnings before interest, tax, depreciation and amortization, because most takeovers are driven by the acquirer's desire to access the target cash flows rather than liquidate target assets. In addition, this variable is frequently used by M&A practitioners. Negative values for these observations are coded as missing.

The rationale behind the choice of X variables was described in Section 1.1. In our first specification, the only X variable is a firm's industry affiliation as classified by the SIC three-digit code. Therefore, the frontier value is the 80th percentile valuation of a given industry. To construct this measure, we first pool observations from all years for a given industry, filter out year fixed effects from the valuation measures, retrieve the 80th percentile value, and then add back the year fixed effects.[9] Finally, we calculate *Discount* as in (3), i.e. it is the shortfall of actual from potential valuation, scaled by the latter.

In the second specification, we use firm-specific characteristics that are unlikely to be substantially changed by the acquirer. We first include *Age*, the firm's age (defined as the number of years since a firm's first appearance in CRSP), as this is a characteristic that an acquirer cannot change. Given potential non-linearities (the effect of *Age* on growth opportunities and thus firm value is likely to be greatest for young firms), we also include the square of *Age*. We use *Sales* (in ranks) as a measure of firm size, which likely impacts the frontier valuation as it proxies for growth opportunities and diminishing returns to scale.[10] Size is primarily determined by factors outside the acquirer's control such as firm history. *Growth* (3-year sales growth) and *MktShr* (market share in the SIC 3-digit industry) are likely to be positively correlated with valuation and are also a function of firm history. *R&D* (the ratio of R&D to sales) may affect valuation as it is correlated with growth opportunities, and *BetaAsset* (the firm's unlevered market beta) captures business cyclicality which affects the cost of capital. Both are affected by a firm's industry, which is unlikely to be changed by the acquirer. We also employ *ATO* (asset turnover, the ratio of sales to total assets), as this is primarily determined by the asset intensity or the importance of tangible assets in the firm's industry. A high proportion of intangible assets is likely to be associated with a low book value and thus a high Q.

As stated previously, since an acquirer can alter these X variables to a degree, we only use their tercile ranks among all Compustat firms in a given year (except for *Age*, where we use the continuous variable as it is strictly exogenous). Our methodology thus allows companies to change the fundamentals within tercile ranges, but not significantly enough to transform the firm into a different tercile. For example, an acquirer of a retail company is unlikely to increase R&D in the target company to the level of pharmaceutical companies, and vice versa. We estimate the frontier values based on firm-specific characteristics using the censored quantile regression technique as specified in (1) and (2), and construct *Discount* accordingly.

[9] We pool observations from all years for a given industry (while adjusting for year fixed effects) in order to have a large sample to form accurate percentile estimates. On average, there are 26 observations in an industry-year, and 693 observations in an industry across all years from 1980-2006.

[10] We use *Sales* rather than market capitalization as our measure of size, since the latter is correlated with our dependent variables.

The combination of two valuation metrics and two frontier value specifications yields four *Discount* measures. Their summary statistics are reported in Table 1, Panel B. The 20th percentile values are close to zero by construction, and the mean is $18 - 28\%$.[11] In addition to being necessary to estimate the trigger effect, the "underlying" discount is of independent interest as it measures the potential increase in social welfare from a disciplinary takeover. Figure 1 plots two graphs. The first is the time series of the aggregate discount values using the industry frontier value specification, where each year observation is obtained as the equal-weighted average across all firms during that year. The second is the empirical frequency of takeovers during the sample period, which ranges from about 3% to above 8% annually. The aggregate discount and takeover levels tend to move in the same direction, except for 2002-2003 when the market crash both depressed valuations and reduced firms' ability to finance acquisitions.

[Insert Figure 1 here.]

As specified in (4), there are three sets of variables that explain the cross-sectional variation in *Discount*. The first group is the firm fundamental variables X. The second group is our Z_1 variables, which measure firm characteristics or policies that affect both the valuation discount and also the takeover likelihood, either through proxying for managerial entrenchment (thus deterring takeovers), or affecting the ease of takeover execution. *Leverage* (net debt / book assets) and *Payout* (dividends plus repurchases divided by net income) both reduce the free cash available to managers and therefore are likely to lessen discounts. In addition, both variables are correlated with business maturity and thus cash flow stability, which facilitates financing of the takeover. As an external governance measure we include $HHISIC3$, the Herfindahl index of all firms' sales within the firm's primary 3-digit SIC, to capture the degree of product market competition and antitrust concerns which may impede acquisition.[12] We also construct the Herfindahl index of the firm's sales by business segment, $HHIFirm$, as a measure of diversification. Diversification may proxy for an

[11] The mean value is slightly higher than the 16% found by Habib and Ljungqvist (2005) using a different (parametric) methodology and a larger set of X variables. As we discuss in the text, we are intentionally being stringent on the criteria for X variables, to ensure that the determinants of the frontier are largely beyond the control of managers and potential acquirers.

[12] Industry concentration could also be a fundamental variable, as industry competitiveness can affect firm profitability. We follow Habib and Ljungqvist (2005) and include it in the category of agency variables. Giroud and Mueller (2010) show that product market competition can discipline management and render corporate governance unimportant.

empire-building manager and thus increase the discount; it may also directly deter takeovers since it complicates target integration. Institutional shareholder monitoring is an internal governance mechanism that is likely associated with a lower discount. In addition, institutional ownership concentration also facilitates coordination among shareholders, thus reducing the Grossman and Hart (1980) free-rider problem in takeovers. Indeed, Mikkelson and Partch (1989) and Shivdasani (1993) find that block ownership increases the probability of a takeover attempt. We construct *Inst* to be the total percentage ownership by institutions from Thomson Reuters.[13] We also add *Amihud*, the Amihud (2002) illiquidity measure. Although not a measure of agency costs, we classify it as a Z_1 variable as it impacts both *Discount* and *Takeover*. Illiquidity directly affects takeover likelihood as it deters toehold accumulation, which in turn affects takeover success rates (Betton and Eckbo (2000)). In addition, it causes firms to trade at a discount (Amihud (2002)).

Finally, the Z_2 variable affects *Discount*, but has no effect on takeover probability other than through its impact on the discount. We therefore seek a variable that affects the price due to market frictions and is unrelated to firm fundamentals and managerial resistance. Our chosen instrument is *MFFlow*, the price pressure created by mutual fund trading, which is not induced by information, but rather by investor flows. Appendix A.1 describes the construction of this variable in detail. We assume that following investor outflows (inflows), a mutual fund will be pressured to sell (buy) shares in proportion to its current holdings. Hence, for each stock, this measure is the hypothetical net buying by all mutual funds in response to net flows in each period. Since order imbalances affect stock prices (see, e.g. Sias, Starks, and Titman (2006) and Coval and Stafford (2007)), *MFFlow* is negatively correlated with *Discount*.

An important feature of our *MFFlow* measure is that it is constructed not using mutual funds' actual purchases and sales (as in Sias, Starks, and Titman (2006) and Coval and Stafford

[13] We do not use the Gompers, Ishii, and Metrick (2003) shareholder rights measure or the Bebchuk, Cohen, and Ferrell (2009) entrenchment index as additional corporate governance variables as they substantially reduce our sample size, and skew the sample towards large firms. Since large firms are less likely to be taken over, the sample becomes unrepresentative of the universe of takeover targets. Panel A of Table IA1 in the Internet Appendix shows that, in the subsamples in which they are available, the entrenchment index is uncorrelated with takeover probability. The shareholder rights index is uncorrelated with the takeover probability using the *EV/Ebitda* valuation measure. While it is positively correlated with takeover probability using the Q measure, *Discount* retains its significance. Panel B shows that both indices are positively correlated with *Discount*, suggesting that worse governed firms command lower valuations, consistent with Gompers, Ishii, and Metrick (2003) and Bebchuk, Cohen, and Ferrell (2009). Bates, Becher, and Lemmon (2008) also find that the Gompers, Ishii, and Metrick (2003) antitakeover measures do not reduce the likelihood of takeover (and in some cases are positively correlated with takeover probability.)

(2007)), but using hypothetical orders projected from their previously disclosed portfolio. Therefore, $MFFlow$ does not reflect mutual funds' discretionary trades possibly based on changes in their views of a stock's takeover vulnerability. Rather, this measure captures the expansion or contraction of a fund's existing positions that is mechanically induced by investor inflows to and outflows from the fund. Such flows are in turn unlikely to be driven by investors' views on the takeover likelihood of an individual firm held by the fund, since these views would be expressed through direct trading of the stock. Hence, $MFFlow$ satisfies the econometric requirement of being correlated with the discount, but not directly with the probability of a takeover.

A potential concern is that some funds' prior holdings may reflect stock pickings that successfully anticipate future takeovers, and that investors' decisions on outflows and inflows are affected by this. Any such effect should, however, attenuate our findings. Funds skilled in identifying takeover targets should attract inflows due to their superior performance. Such inflows will inflate the price of the firms in their portfolio (which may have been selected by the fund owing to their underlying takeover vulnerability) and reduce their likelihood of acquisition. Separately, it is possible that mutual funds specializing in a particular industry experience flows that are correlated with shocks to both the valuation and takeover activities in the industry. For example, the bursting of the technology bubble sparked both sector consolidation and outflows from technology mutual funds. To mitigate this concern, we exclude these sector mutual funds in constructing the $MFFlow$ measure.[14] In addition, we use year fixed effects to control for any aggregate shocks to both takeover activity and fund flows in a particular year.

Figure 2 illustrates the magnitude and persistence of the stock price effect of mechanically-driven mutual fund redemptions. Following Coval and Stafford (2007), we define an "event" as a firm-month where $MFFlow$ falls below the 10th percentile value of the full sample. We then trace out the cumulative average abnormal returns ($CAAR$) over the CRSP equal-weighted index from 12 months before the event to 24 months after. (There are three event months because holdings are only recorded at the quarterly level, while returns are recorded at a monthly frequency). Figure 2 shows that the price pressure effects are both significant in magnitude and long-lasting, persisting for over a year. Equally importantly, they are temporary rather than fundamental, with the price

[14] These funds represent 8.5% of all funds in our sample, and 8.7% of the aggregate flows (in unsigned absolute magnitude) to and from equity mutual funds. Results are unchanged when including these funds.

recovering by the end of the 24th month. This is a similar duration effect to that found by Coval and Stafford (2007).

[Insert Figure 2 here.]

3 Empirical Results

3.1 Determinants of Discount and Takeover Without Feedback

As a first step and for comparison with later results, we estimate (4) and (5) without incorporating the anticipation effect. In this setting, the two equations are estimated separately. Table 2 reports the determinants of $Discount$ and $Takeover$, for all four measures of $Discount$.

[Insert Table 2 here.]

We describe first the results in Panel B, which tabulates the determinants of $Discount$. Both high leverage and high payout should mitigate the agency problem of free cash flow and reduce the discount. Our empirical results are consistent with this hypothesis for $Leverage$, although the results for $Payout$ are more mixed. Firms with more concentrated businesses (high $HHIFirm$) are associated with a lower discount, consistent with the large literature on the diversification discount. Industry concentration (proxied by $HHISIC3$) has a negative effect on $Discount$, indicating that the benefits from market power outweigh the lack of product market discipline. Some variables, such as $Inst$, have different effects on $Discount$ depending on whether the frontier is industry- or firm-specific. This dichotomy implies that stocks with high institutional ownership tend to have high valuations relative to their fundamental variables, but low valuations relative to other firms in the same industry. Finally, consistent with Amihud (2002), illiquidity increases the discount. Our instrument, $MFFlow$, is significantly associated with lower discounts across all four specifications.

We now turn to the $Takeover$ equation in Panel A, which illustrates the responsiveness of the probability of acquisition to $Discount$. In terms of marginal probabilities, a one percentage point increase in $Discount$ is associated with a $1-3$ basis point (i.e. a 0.01-0.03 percentage point) increase in takeover probability, and an inter-quartile change in $Discount$ is associated with a $0.4-1.6$ percentage point increase, out of an unconditional probability of 6.2 percent. While a number of prior papers found no relationship between takeovers and raw valuation, this coefficient is highly statistically significant. The result is consistent with the hypothesis that the discount to potential value, rather than raw valuation, motivates acquisitions.[15] Nevertheless, the economic magnitude is modest, especially when using $EV/Ebitda$. This is because the observed discount is shrunk by the prospects of a takeover. Such an anticipation effect attenuates the relation between takeover and valuation. The next section shows that, when feedback is controlled for, the economic significance rises substantially.

3.2 Determinants of Takeover and Discount With Feedback

3.2.1 The Trigger Effect

We now analyze the simultaneous system of (8) and (9). We first investigate the effect of the underlying discount, $Discount^0$, on takeover probability that would prevail if the former did not anticipate the latter, i.e. we estimate the trigger effect, controlling for the anticipation effect. It therefore measures the "true" importance of the discount for takeover attractiveness. The results are reported in Table 3.

[Insert Table 3 here.]

Compared to estimates in Table 2, the coefficients on *Discount* are orders of magnitude higher in all four specifications. Table 3 shows that a one percentage point increase in *Discount* would lead to a statistically significant $12 - 16$ basis point increase in $Takeover$ probability if *Discount* did not shrink in anticipation of a takeover. An inter-quartile change in *Discount* is associated with a $5.7 - 7.6$ percentage point increase in $Takeover$ probability, economically significant compared to an unconditional probability of 6.2 percent. The sensitivity is higher using the *Discount* measure derived from industry-specific value frontiers, indicating that acquirers are more attracted to firms with low valuations compared to their industry peers.

The table also presents the results of two Wald tests. The first is a Stock and Yogo (2005) weak instrument test, which rejects the hypothesis that the instruments are weak. The second evaluates

[15] Replacing *Discount* with raw valuation leads to an inter-quartile response of 0.04 (using $EV/Ebitda$) and 0.65 (using Q) percentage points in takeover frequency. Both values, though significant in our large sample, are considerably lower than those using *Discount*. This economically insignificant coefficient is consistent with prior empirical findings.

the exogeneity of the system, i.e. whether *Discount* is exogenous to shocks in *Takeover*. The null is rejected at less than the 1% level in all four specifications. The second test result, combined with the difference in the *Discount* coefficient between Tables 2 and 3, highlights the need to control for the anticipation effect when estimating the trigger effect. Doing so shows that prices are a far more important driver of takeover activities than implied by the equilibrium correlation between the two variables.

3.2.2 The Anticipation Effect

While Table 3 quantifies the trigger effect, we now tackle the reverse question of estimating the anticipation effect – how much the discount shrinks due to the market's anticipation of likely takeovers. Put differently, we wish to measure the "overvaluation" relative to current fundamentals, agency costs and market frictions that is caused by takeover expectations.

Empirically, one way to quantify the anticipation component in *Discount* is to estimate the effect of takeover vulnerability (i.e., $Takeover^*$) on *Discount*, controlling for other determinants. Identification of such an effect would require an instrumental variable that impacts $Takeover^*$ but does not affect *Discount* directly. We are not able to find firm-specific variables that satisfy this exclusion restriction. Valid instruments could come from the "supply side," such as capital inflows to buyout funds or interest rates that proxy for the ease of financing. However, such instruments suffer from low power because they fail to generate variation in the cross-section.

We therefore adopt a different approach. We identify the effect of the shocks to takeover vulnerability (i.e., the δ term in equation (8)) on *Discount* by utilizing the intermediate and final outputs from estimating equation (9). The anticipation coefficient δ is a linear projection of the residual discount (defined in (11)) on ξ, the residual in the takeover equation. We can therefore construct a $\widehat{\delta}$ estimate by regressing the empirical analog of residual discount ($\widetilde{Discount}$) on the empirical analog of ξ ($\widehat{\xi}$). The empirical analog $\widetilde{Discount}$ is readily available from (11). For the empirical analog $\widehat{\xi}$, we adopt the "generalized residual" for discrete response models as proposed by Gourieroux, Monfort, Renault, and Trognon (1987):

$$\widehat{\xi} = \frac{\left[Takeover - \widehat{\Pr}\left(Takeover\right)\right] \widehat{\Pr}'\left(Takeover\right)}{\widehat{\Pr}\left(Takeover\right)\left[1 - \widehat{\Pr}\left(Takeover\right)\right]},$$

where $\widehat{\Pr}\left(Takeover\right)$ and $\widehat{\Pr}'\left(Takeover\right)$ represent the estimated probability and density (derivative of probability) of $Takeover$, respectively. Assuming that error disturbances are drawn from normal distributions, the above expression becomes

$$\begin{aligned} \widehat{\xi} &= \frac{\left[Takeover - \Phi\left(\widehat{u}\right)\right]\phi\left(\widehat{u}\right)}{\Phi\left(\widehat{u}\right)\left[1-\Phi\left(\widehat{u}\right)\right]}, \\ \text{where } \widehat{u} &= \widehat{\mu}_1 Discount + \widehat{\mu}_2 X + \widehat{\mu}_3 Z_1, \end{aligned} \tag{14}$$

where Φ and ϕ represent the cumulative distribution function and the density function of the standard normal distribution, respectively.

The results from all four specifications are reported in Table 4. Our estimates for the anticipation coefficient δ are uniformly negative and highly statistically significant. The economic magnitude of the coefficients is not readily interpretable because ξ is a shock to the propensity of takeover which does not have a natural unit. However, we can calculate the estimated discount shrinkage due to a one standard deviation change in the takeover propensity. These calibrated marginal effects are reported below the coefficients in Table 4.

[Insert Table 4 here.]

Table 4 indicates that if a firm's takeover likelihood rises, exogenously, from the 25th to the 75th percentile value, *Discount* shrinks by an average of 3.9 percentage points. Such a magnitude is economically plausible and significant given the average discount level of $18\% - 28\%$.

4 Additional Analyses

4.1 Discount, Takeover Premium, and Acquirer Return

In equilibrium, we would expect our discount measure to be positively correlated with the premium paid to the target, as well as with the acquirer return. A higher discount implies greater gains from a corrective takeover. Thus, as long as the target has some bargaining power, it should capture a proportion of these gains in the form of a higher premium. Similarly, as long as the acquirer has some bargaining power, it should also realize a higher gain when the discount is higher.

As is standard in the literature, we calculate *Premium* as the percentage increase in the target's stock price over the $[-60, 0]$ window relative to the announcement date,[16] and *AcquirerRET* as the $[-1, +1]$ percentage increase in the acquirer's stock price. We find that both are positively and significantly correlated with *Discount*: averaging across all four *Discount* measures, the correlation coefficients are 7.2% and 1.8%, respectively. By the same logic, a measure of total return from the acquisition ($TotalRET = Premium + AcquirerRET$) should also be positively correlated with the discount. Indeed, the average correlation coefficient is 7.4%.

To further explore the relation between *Discount* and the three measures of acquisition return, we run regressions of these measures on *Discount*, controlling for other determinants of these measures. The regressions appear in Table IA2 in the Internet Appendix. The relationship between *Discount* and both *Premium* and *AcquirerRET* retains its significance in all specifications after the addition of controls. Importantly, while the relationship between *Premium* and *Discount* remains highly significant, it is still far from one. This suggests that the acquirer does indeed enjoy part of the gains from buying a discounted target, and is thus consistent with our main result that acquirers are more likely to target discounted firms. The relationship between *Discount* and *AcquirerRET* remains significant in the *EV/Ebitda* specifications. In the Q regressions, the association is positive but not statistically significant, perhaps because measures of acquirer return are known in the literature to be noisy.[17]

[16] The results are qualitatively similar using alternative windows (such as $[-40, 0]$) or using the actual premium paid. The latter is available on a smaller subsample as transaction terms are often missing.

[17] There are a number of challenges with measuring acquirer returns accurately. First, there is significant long-run drift after an M&A announcement (Agrawal, Jaffe, and Mandelker (1992)). This means that the event-study reactions capture only a small proportion of the overall effect and leads to substantial attenuation. Moreover, the drift in M&A is more problematic than for other corporate events, as it has no discernible relation to the initial

4.2 Financially-Driven Takeovers

The results thus far have documented that takeovers in general are driven by low target valuations. However, certain acquisitions are motivated by other factors, such as synergies or empire building. As such, the trigger effect should be stronger among takeovers that are particularly likely to be valuation-driven. We classify these "financially-driven takeovers" as acquisitions that are either leveraged buyouts or undertaken by financial sponsors. Such acquisitions are typically motivated by underperforming current management or market undervaluation, both of which manifest themselves in low market prices. There are a number of reasons for these different motives. First, the aforementioned synergy and empire-building motives for standard acquisitions do not exist to the same degree for LBOs: targets typically remain standalone, and LBO managers are compensated by carried interest above a threshold rate of return. By contrast, for regular corporations, Bebchuk and Grinstein (2009) find a significant link between firm expansion and CEO pay. Second, the LBO structure was designed precisely to correct agency problems. The high debt (compared to standard M&A deals) imposes discipline on the manager by forcing him to disgorge excess cash, and concentrates his equity stake to provide incentives (see, e.g., Jensen (1989) and Jensen (1993)). Third, the literature summarized on p9 systematically finds that LBO gains arise from correcting underperformance.

We repeat the trigger effect analysis of Table 3 removing all non-financially-driven takeovers from the sample and report the results in Table 5, Panel A. Indeed, the effect of *Discount* becomes stronger relative to the smaller unconditional probability. An inter-quartile change in *Discount* is associated with a 2.2% increase in the probability of a financially-driven takeover. The full-sample probability of such a takeover is 1.3%, compared to the 6.2% probability of any takeover. In addition, we repeat the anticipation effect analysis of Table 4 and report the results in Table 5, Panel B. An inter-quartile change in shocks to takeover probability leads to a 4.1 percentage point shrinkage in the discount.

event-study reaction. Second, the M&A announcement only reflects the value creation that was unanticipated by the market. A deal could destroy substantial value but only have a mild reaction because the market expected the firm to make a value-destructive deal, e.g. because it was sitting on a pile of cash. Third, the M&A announcement return implicitly assumes that the counterfactual if the deal had not been undertaken is zero (Prabhala (1997) and Li and Prabhala (2007)), which may not be the case. For example, the counterfactual return could be negative because the stock was overvalued, or the acquirer not buying the target would have allowed a rival to do so.

[Insert Table 5 here.]

4.3 Robustness Checks

In this section, we report results from further robustness checks. First, we check the sensitivity of our results to the choice of $\alpha = 0.20$ as our default percentile for frontier values. As discussed earlier, such a choice reflects the trade-off between reducing the influence of outliers and not underestimating potential values. Higher α values are associated with lower aggregate values of *Discount*. Table IA3 of the Internet Appendix indicates that the correlation of *Discount* estimates based on different quantile restrictions around $\alpha = 0.20$ (our default value) is extremely high (above 0.89). Since our analysis is driven by the relative ranking (rather than the absolute level) of *Discount*, it is not surprising then that our results for various α values in the range of $[0.1, 0.3]$ are similar to those reported in Tables 2-4. These results are available upon request.

Second, we estimated the firm-specific frontier using tercile ranks rather than raw measures of the X variables, to allow for bidders to change these variables within a given tercile. However, for firms already close to the tercile cutoffs, it is easier for bidders to move them into a different tercile. We therefore rerun the analyses excluding firms within 2.5% in ranking from any tercile thresholds. Table IA4 of the Internet Appendix shows that the results are just as strong as in the full sample in Table 3, with an inter-quartile response of $6.0 - 7.8\%$ compared to an unconditional takeover probability of around 6% for this subsample. A related concern is that, in merger waves (which may be driven by regulatory changes), fundamentals may be particularly likely to change. Table IA5 of the Internet Appendix removes both aggregate merger waves (in Panel A) and industry merger waves (in Panel B) and finds that the results are little changed.

Finally, our analysis focuses on bids announced rather than completed, since the target's valuation is likely to have greatest effect on an acquirer's decision to bid. Whether the takeover is subsequently completed often depends on factors unrelated to valuation, e.g. antitrust concerns. Nevertheless, we have re-run the data defining takeover as completed deals (which is 76.5% of deals in our sample) and tabulate the equivalent of Table 3 in Table IA6 of the Internet Appendix. The results are qualitatively similar.

5 Conclusion

This paper provides evidence on the real effect of financial markets. Using non-fundamental shocks to market prices – occurring due to non-discretionary trades by mutual funds who face liquidation pressure from investors' outflows – as an instrumental variable, we show that market prices affect takeover activity. A non-fundamental decrease in the stock price creates a profit opportunity for acquirers, and increases the probability that the firm will be taken over. Using an instrument for price changes is necessary for identifying this effect since market prices are endogenous and reflect the likelihood of an upcoming acquisition. This may explain the weak relationship between prices and takeover activity found by prior literature. By modeling the relationship between prices and takeovers as a simultaneous system that accounts for anticipation, and identifying using an instrument, we find a significantly stronger effect of prices on takeovers than previous research.

Our findings have a number of implications for the takeover market. They imply a double-edged sword for the disciplinary effect of takeover threat. The trigger effect suggests that managerial underperformance increases takeover vulnerability to a much greater extent than previously documented. However, the anticipation effect reduces the sensitivity of takeovers to a firm's underlying inefficiency. More generally, the importance of market prices suggests that they are not simply a side-show but affect real economic activity: temporary mispricing can have real consequences by impacting takeover probability.

While our paper identifies that market prices have an effect on takeover probability, it is silent on the mechanism behind this effect. It is plausible that market prices have an effect because agents try to learn from them, and as a result rely on them when making various decisions. In the context of takeovers, a possible mechanism is that target shareholders use the market price to update their view about the value of the firm. Hence, they demand a price that is related to the market price. Then, acquirers, who know more about the potential value under their management, identify a profit opportunity when the price goes down, and are more likely to launch a bid for the firm. Interestingly, traditional takeover theories do not incorporate such asymmetric information and learning from prices. In a framework with symmetric information, if there is free-riding by target shareholders (as in Grossman and Hart (1980)), the bidder must pay the potential value V^* regardless of the current price, because target shareholders have full bargaining power. Even if the bidder has some bargaining power, it should bargain with the target over the underlying $Discount^0$, rather than the observed $Discount$, since it is the former that represents the potential fundamental value that can be created. Regardless of the source of a high market valuation, it has no effect on takeover likelihood if viewed symmetrically by the bidder and the target. If high valuation is due to positive news about fundamentals (as in Schwert (1996)), both the bidder and target will agree that a higher takeover price is warranted. Since the superior fundamentals also increase the target's value to the acquirer, the bidder is fully willing to pay the higher price and so the target's attractiveness is unchanged. If high valuation is instead due to mispricing, both the bidder and target will agree that it should not lead to a high takeover price, and so again takeover likelihood is unaffected. Our findings thus suggest the need for new takeover theories to explain why market prices should impact acquisition likelihood.

There are many other settings in which the interaction between the financial market and the real economy is important. These include the impact of market prices on investment decisions, CEO replacement, and other real activities. It is typically difficult to identify a real effect of the financial market, since even if there is correlation between prices and real activity, it may be driven by an omitted variable that affects both. We are able to identify the active role of the financial market by exploring the effects of non-fundamental changes in the price which are not directly correlated with real activity. This insight can be used to explore the empirical relation between financial markets and real activities in these other settings.

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A Appendix

A.1 Data

This section details the calculation of the mutual fund price pressure variable. We obtain quarterly data on mutual fund holdings from CDA Spectrum / Thomson and mutual fund flows from CRSP. We remove funds that specialize in a single industry, and calculate

$$Outflow_{j,t} = -F_{j,t}/TA_{j,t-1}$$

where j $(= 1, ..., m)$ indexes mutual funds, and t represents one quarter. $F_{j,t}$ is the total inflow experienced by find j in quarter t, and $TA_{j,t-1}$ is fund j's total assets at the end of the previous quarter. We then construct

$$MFFlow_{i,t} = \sum_{j=1}^{m} \frac{F_{j,t} s_{i,j,t-1}}{VOL_{i,t}}.$$

for each stock-quarter pair, where i $(= 1, ..., n)$ indexes stocks, and the summation is only over funds j for which $Outflow_{j,t} \geq 5\%$. $VOL_{i,t}$ is total dollar trading volume of stock i in quarter t, and

$$s_{i,j,t} = \frac{SHARES_{i,j,t} \times PRC_{i,t}}{TA_{j,t-1}}$$

is the dollar value of fund j's holdings of stock i, as a proportion of fund j's total assets at the end of the previous quarter. Substitution gives our mutual fund price pressure measure as

$$MFFlow_{i,t} = \sum_{j=1}^{m} \frac{F_{j,t} \times SHARES_{i,j,t-1} \times PRC_{i,t-1}}{TA_{j,t-1} \times VOL_{i,t}},$$

where the summation is only over funds j for which $Outflow_{j,t} \geq 5\%$.

A.2 Estimation Procedures

This section derives the FIML likelihood function for equation (9). The likelihood of an individual takeover in our simultaneous equation model is as follows, omitting the i, t subscripts for brevity:

$$L = g(Takeover = 1, Discount)^{Takeover} g(Takeover = 0, Discount)^{1-Takeover},$$

where the joint density function g is

$$g(Takeover = 1, Discount) = \int_{-\mu_1 Discount - \mu_2 X - \mu_3 Z_1}^{\infty} f(\xi, \eta)\, d\xi, \tag{18}$$

and

$$g(Takeover = 0, Discount) = \int_{-\infty}^{-\mu_1 Discount - \mu_2 X - \mu_3 Z_1} f(\xi, \eta)\, d\xi, \tag{19}$$

where $f(\xi, \eta)$ is the bivariate density function (assumed to be normal for estimation purposes), and can be expressed as the product of a conditional distribution and a marginal distribution:

$$f(\xi, \eta) = f(\xi|\eta)\, f(\eta).$$

The conditional distribution $f(\xi|\eta)$ is normal with mean $\rho_{\xi,\eta}\eta/\sigma_\eta$ and variance $1 - \rho^2_{\xi,\eta}$, where ρ and σ are the standard notations for correlation coefficient and standard deviation. Therefore the joint density function of (18), assuming all variables are jointly normal, can be rewritten as

$$g(Takeover = 1, Discount) = \Phi\left(\frac{\mu_1 Discount + \mu_2 X + \mu_3 Z_1 + \rho_{\xi,\eta}\eta/\sigma_\eta}{\sqrt{1 - \rho^2_{\xi,\eta}}}\right) \phi\left(\frac{\eta}{\sigma_\eta}\right),$$

and Φ, ϕ are the cumulative probability and density functions of the standard normal distribution. Equation (19) can be rewritten analogously. Combining all equations, we arrive at the log likelihood for a takeover on a firm-year observation:

$$l_{i,t} = Takeover_{i,t} \ln\left[\Phi\left(u_{i,t-1}\right)\right] + \left(1 - Takeover_{i,t}\right) \ln\left[1 - \Phi\left(u_{i,t-1}\right)\right] - \ln(\sigma_\eta) - \frac{\eta^2}{2\sigma^2_\eta}, \tag{20}$$

where

$$
\begin{aligned}
u &= \frac{\mu_1 Discount + \mu_2 X + \mu_3 Z_1 + \rho_{\xi,\eta}\eta/\sigma_\eta}{\sqrt{1-\rho^2_{\xi,\eta}}}, \\
\eta &= Discount - \gamma_1 Z_1 - \gamma_2 Z_2.
\end{aligned}
$$

The estimation methodology is FIML. It is "full information" because it employs the full information about the joint distribution of $f(\xi,\eta)$, by using the conditional distribution $f(\xi|\eta)$ and the marginal distribution $f(\eta)$ simultaneously. Second, it is a "maximum likelihood" estimator and thus provides the most efficient estimates (i.e., attains the Cramer-Rao bound) as long as the model is correctly specified.

Figure 1. Time Series of Aggregate Discounts and Takeover Activities

This figure plots the time series (1980-2006) of the aggregate *Discount* (the left axis), and the empirical frequency of takeovers (the right axis).

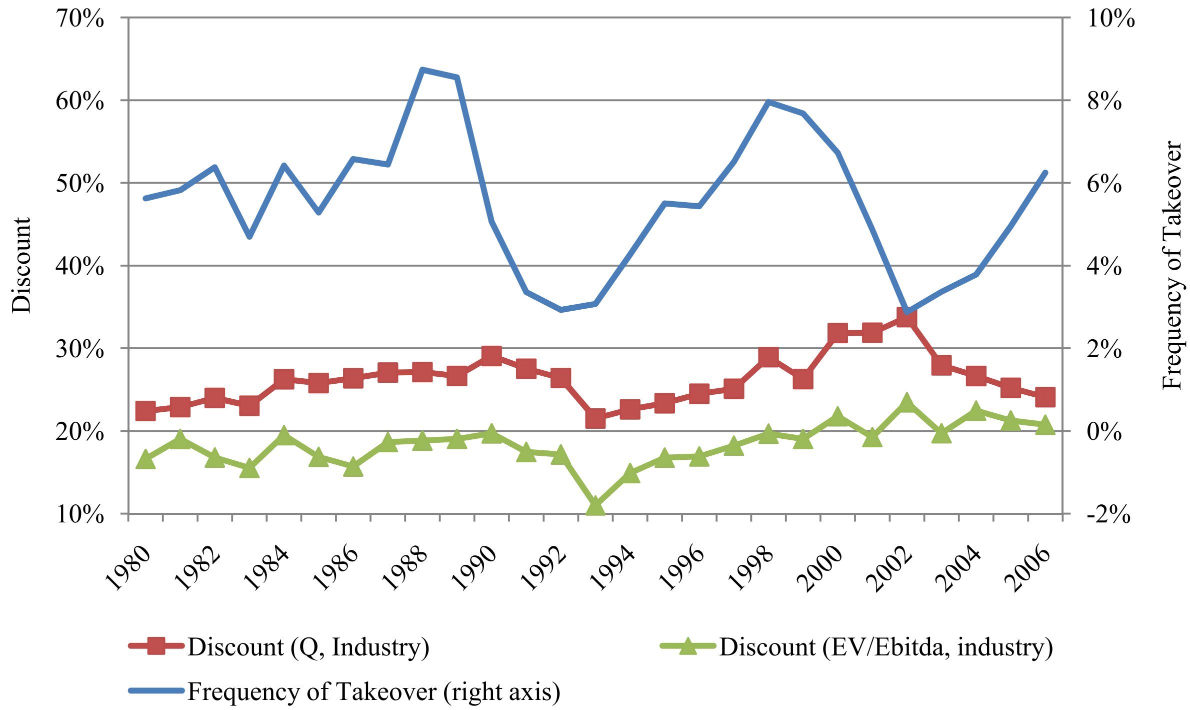

Figure 2. Effect of Mutual Fund Outflows on Stock Returns

This figure plots the monthly cumulative average abnormal returns (CAAR) of stocks around the event months, where an event is defined as a firm-month observation where *MFFlow* falls below the 10th percentile value of the full sample. CAAR is computed over the benchmark of the CRSP equal-weighted index from 12 months before the event to 24 months after. (There are three event months because holdings are only recorded at the quarterly level, while returns are recorded at a monthly frequency).

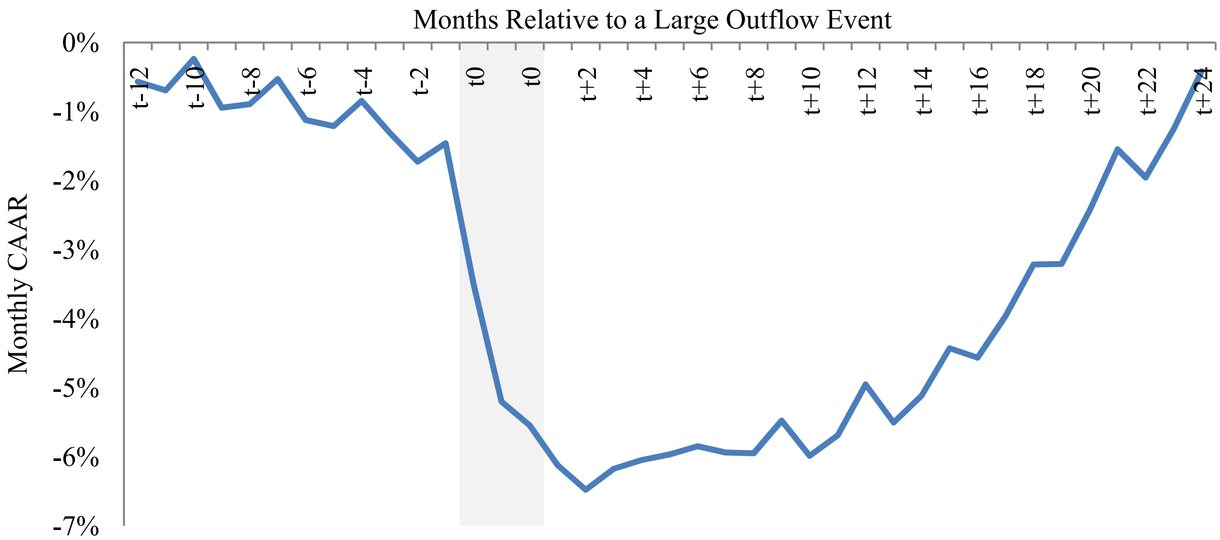

Table 1. Summary of Variables

This table summarizes the main variables used. All data are obtained from Compustat unless otherwise stated. "data" numbers refer to the line items from Compustat.

Panel A: Data Definitions

	Definition
Discount Variables (*Discount*)	
Discount (Industry: EV/Ebitda)	Value discount relative to industry frontier, using EV/Ebitda as the valuation metric
Discount (Industry: Q)	Value discount relative to industry frontier, using *Q* as the valuation metric
Discount (Firm: EV/Ebitda)	Value discount relative to firm-specific frontier, using EV/Ebitda as the valuation metric
Discount (Firm: Q)	Value discount relative to firm-specific frontier, using EV/Ebitda as the valuation metric
Fundamental Variables (*X*)	
Age	Firm age, calculated as years from first appearance in CRSP
ATO	Asset turnover. Sales (data12) / Assets (data6)
BetaAsset	*Beta* on the market factor in a Fama-French three-factor model using daily data from CRSP, and then unlevered
Growth	Average sales growth during past (up to) three years
MktShr	Sales / Total sales in SIC 3-digit industry
R&D	R&D expense (data46) / Sales (data12). Zero if missing
SalesRank	Rank of sales (data12) among all Compustat firms in a given year, ranging from 0 to 1
Variables Affecting Discount and Takeover Probability (Z_1)	
Amihud	Illiquidity measure per Amihud (2002). Yearly average of the square root of (Price×Vol)/|Return|
	Daily observations with a zero return are removed. Coded as missing if < 30 observations in a year. From CRSP
HHIFirm	Herfindahl index of firm's sales in different business segments
HHISIC3	Herfindahl index of sales by all firms in SIC 3-digit industry
Inst	% of shares outstanding held by institutions. From Thomson Financial
Leverage	(Debt (data9 + data34) - Cash (data1)) / Assets
Payout	(Dividends (data21) + Repurchases (data115)) / Net Income (data18). 0 if numerator is zero or missing;
	1 if numerator > 0 and denominator = 0
Variables Affecting Discount (Z_2)	
MFFlow	Mutual fund price pressure. From Thomson Reuters mutual fund holdings database. See Appendix A for further details

Panel B: Summary Statistics

Name	# obs	Mean	Std. Dev.	Percentiles				
				5th	25th	50th	75th	95th
Age	118,942	11.48	13.03	1	3	7	15	37
ATO	118,942	1.21	0.82	0.17	0.63	1.08	1.59	2.79
Amihud	101,026	0.77	1.11	0.02	0.11	0.35	0.93	3.05
BetaAssets	117,211	0.69	0.41	0.09	0.38	0.65	0.95	1.45
Discount (Industry: EV/Ebitda)	92,116	0.18	0.48	-1.05	0.10	0.38	0.57	0.76
Discount (Industry: Q)	116,543	0.24	0.47	-0.90	0.09	0.37	0.57	0.77
Discount (Firm: EV/Ebitda)	92,141	0.27	0.48	-1.03	0.11	0.41	0.61	0.79
Discount (Firm: Q)	116,567	0.28	0.46	-0.92	0.11	0.41	0.60	0.77
EV/Ebitda	92,141	15.95	28.05	3.76	6.12	8.70	13.77	47.05
Growth (%)	118,942	30.4%	80.0%	-17.8%	1.3%	11.4%	28.3%	127.5%
HHIFirm	118,942	0.85	0.24	0.35	0.66	1.00	1.00	1.00
HHISIC3	118,942	0.19	0.16	0.06	0.09	0.14	0.25	0.50
Inst (%)	118,942	27.9%	26.7%	0.0%	4.1%	19.8%	46.8%	80.4%
Leverage (%)	118,942	8.8%	34.6%	-56.5%	-11.7%	12.5%	31.8%	60.5%
MFFlow	118,942	-0.30	0.92	-1.45	-0.20	0.00	0.00	0.00
MktShr (%)	118,942	5.1%	12.8%	0.0%	0.1%	0.5%	3.3%	27.4%
Payout (%)	118,942	38.1%	77.4%	0.0%	0.0%	0.0%	50.3%	137.0%
Q	116,567	2.33	2.55	0.67	1.04	1.51	2.51	6.75
R&D (%)	118,942	19.0%	114.4%	0.0%	0.0%	0.0%	4.7%	38.2%
Sales (Log)	118,942	4.68	2.38	0.69	3.13	4.68	6.27	8.66

Table 2. Determinants of Discount and Takeover without Feedback

This table reports the results from estimating equations (4) and (5) separately. All variables are defined in Table 1. The dependent variable in Panel A is *Takeover*, and that in Panel B is *Discount*. In the regressions with industry-specific frontiers, all non-dummy regressors are industry-adjusted. The firm-specific frontier is formed by a quantile (at the 80th percentile) regression of valuation measures on *SalesRank*, *R&D*, *ATO*, *MktShr*, *Growth*, *BetaAsset* (all expressed in tercile ranks), *Age* and Age^2. Year fixed effects are used in all specifications, but unreported. All standard errors are adjusted for heteroskedasticity and within-cluster correlation. In Panel A, they are clustered at the firm level; in Panel B, they are double-clustered at the year and the firm level. The column dPr/dX gives the marginal effect on takeover probability of a one unit (or 100 percentage points) change in each regressor. The bottom row of the table reports the number of observations, the pseudo R^2, and the all-sample frequency of the dependent variable being one. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels.

Panel A: Determinants of Takeover

	Dependent Variable = Takeover											
	Discount = Discount(Q)						Discount = Discount(EV/Ebitda)					
	Industry-Specific Frontier			Firm-Specific Frontier			Industry-Specific Frontier			Firm-Specific Frontier		
	Coef	t-stat	dPr/dX	Coef	t-stat	dPr/dX	Coef	t-stat	dPr/dX	Coef	t-stat	dPr/dX
Discount	**0.282*** **	15.34	3.28%	**0.128*** **	7.99	1.51%	**0.116*** **	6.66	1.37%	**0.070*** **	4.30	0.84%
(effect of inter-quartile change)			*1.58%*			*0.74%*			*0.65%*			*0.41%*
SalesRank	**0.065**	1.42	0.76%	**0.114** **	2.51	1.35%	**-0.065**	-1.21	-0.76%	**-0.022**	-0.42	-0.26%
R&D	**-0.020*** **	-2.71	-0.23%	**-0.018** **	-2.51	-0.21%	**0.145**	1.15	1.71%	**0.158**	1.26	1.86%
ATO	**0.023** **	2.44	0.27%	**0.014**	1.47	0.16%	**-0.005**	-0.42	-0.05%	**0.003**	0.26	0.03%
MktShr	**-0.233*** **	-3.19	-2.71%	**-0.273*** **	-3.70	-3.22%	**-0.275*** **	-3.59	-3.24%	**-0.279*** **	-3.63	-3.29%
Growth	**0.004**	0.47	-0.05%	**-0.007**	-0.80	-0.08%	**-0.004**	-0.29	-0.05%	**-0.007**	-0.51	-0.08%
BetaAsset	**-0.054*** **	-2.78	-0.63%	**-0.123*** **	-6.40	-1.45%	**-0.112*** **	-4.98	-1.31%	**-0.121*** **	-5.38	-1.43%
Leverage	**0.030**	1.23	0.35%	**0.012**	0.51	0.14%	**0.112*** **	3.65	1.32%	**0.105*** **	3.44	1.24%
Payout	**-0.000**	-0.01	-0.00%	**0.004**	0.47	0.05%	**0.006**	0.67	0.07%	**0.005**	0.55	0.06%
HHIFirm	**0.230*** **	7.19	2.67%	**0.233*** **	7.28	2.75%	**0.175*** **	5.13	2.06%	**0.180*** **	5.26	2.12%
Inst	**0.100*** **	2.53	1.16%	**0.090** **	2.28	1.06%	**0.069**	1.61	0.82%	**0.077***	1.79	0.91%
HHISIC3	**-0.082**	-1.53	-0.95%	**-0.091***	-1.71	-1.07%	**-0.063**	-1.03	-0.74%	**-0.072**	-1.19	-0.85%
Amihud	**-0.034*** **	-4.05	-0.39%	**-0.023*** **	-2.84	-0.27%	**-0.027*** **	-2.62	-0.32%	**-0.026** **	-2.54	-0.31%
# obs, pseudo- R^2, and all-sample frequency	100,160	0.019	6.18%	100,166	0.015	6.18%	79,100	0.018	6.24%	79,103	0.017	6.24%

Panel B: Determinants of Discount

Discount	Discount(Q)		Discount(EV/Ebitda)	
Frontier	Industry	Firm	Industry	Firm
Sales	0.2818***	0.1185***	0.3419***	-0.0840***
	[13.34]	[5.27]	[15.48]	[-3.77]
R&D	-0.0097***	-0.0348***	-0.7116***	-1.3508***
	[-3.81]	[-12.73]	[-11.82]	[-19.57]
ATO	-0.0662***	-0.0627***	0.0441***	-0.0337***
	[-15.84]	[-14.62]	[9.96]	[-7.64]
MktShr	-0.2317***	-0.1519***	-0.0494*	-0.0085
	[-7.42]	[-4.64]	[-1.82]	[-0.31]
Growth	-0.0531***	-0.0258***	-0.0696***	-0.0677***
	[-17.48]	[-8.67]	[-14.02]	[-13.29]
BetaAsset	-0.2253***	0.0680***	-0.0577***	0.0364***
	[-38.61]	[11.24]	[-8.26]	[5.29]
Leverage	-0.0583***	0.0141	-0.0689***	-0.0220*
	[-5.63]	[1.22]	[-5.39]	[-1.69]
Payout	0.0206***	0.0107***	-0.0236***	-0.0195***
	[9.71]	[4.51]	[-9.40]	[-7.68]
HHIFirm	-0.0591***	-0.1401***	-0.0093	-0.0764***
	[-4.74]	[-11.64]	[-0.74]	[-6.32]
Inst	-0.1028***	-0.1379***	0.0235	-0.0553***
	[-6.41]	[-8.07]	[1.47]	[-3.36]
HHISIC3	-0.0759***	-0.0372*	-0.1105***	-0.0579***
	[-3.40]	[-1.74]	[-4.84]	[-2.72]
Amihud	0.0838***	0.0869***	0.0253***	0.0261***
	[32.84]	[32.27]	[6.88]	[7.40]
MFFlow	-0.0139***	-0.0193***	-0.0103***	-0.0161***
	[-8.43]	[-10.13]	[-4.63]	[-7.13]
Constant	0.4649***	0.3268***	0.1037***	0.4618***
	[25.72]	[18.82]	[4.96]	[23.44]
R-squared	0.126	0.098	0.064	0.081
# Observations	100,160	100,166	79,100	79,103

Table 3. Effects of Discount on Takeover with Feedback

This table reports the results from estimating equation (9) in the (8)-(9) joint system. All variables are defined in Table 1. The dependent variable is *Takeover*. In the regressions with industry-specific frontiers, all non-dummy regressors are industry-adjusted. All standard errors are adjusted for heteroskedasticity and correlation clustered at the firm level. The column dPr/dX gives the marginal effect on takeover probability of a one unit (or 100 percentage points) change in each regressor. Year fixed effects are used in all specifications, but unreported. The bottom of the table reports the number of observations, the pseudo R^2, and the all-sample frequency of the dependent variable being one. Also reported are the test for weak instruments (which rejects the null that the instrumental variable is weak at any significance level higher than the indicated p-value) and the Wald test for the exogeneity of the system (which rejects the null that the joint system could be reduced to two independent equations at any significance level higher than the indicated p-value). *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels.

	Dependent Variable = Takeover											
	Discount = Discount(Q)						Discount = Discount(EV/Ebitda)					
	Industry-Specific Frontier			Firm-Specific Frontier			Industry-Specific Frontier			Firm-Specific Frontier		
	Coef	t-stat	dPr/dX	Coef	t-stat	dPr/dX	Coef	t-stat	dPr/dX	Coef	t-stat	dPr/dX
Discount	**1.371*****	4.24	15.66%	**0.989*****	3.67	11.58%	**1.512*****	4.51	15.87%	**1.101*****	3.64	12.64%
(effect of inter-quartile change)			*7.55%*			*5.65%*			*7.48%*			*6.25%*
Sales	**-0.259****	-2.31	-2.96%	**0.002**	0.02	0.02%	**-0.536*****	-4.34	-5.62%	**0.069**	1.17	0.79%
R&D	**-0.006**	-0.73	-0.07%	**0.014**	1.13	0.17%	**1.138*****	4.28	11.95%	**1.567*****	3.61	17.90%
ATO	**0.094*****	4.09	1.07%	**0.0667*****	3.51	0.78%	**-0.067*****	-3.72	-0.70%	**0.0372****	2.51	0.43%
MktShr	**0.058**	0.47	0.66%	**-0.115**	-1.23	-1.35%	**-0.135**	-1.52	-1.42%	**-0.231*****	-2.96	-2.64%
Growth	**0.064*****	3.19	0.73%	**0.017**	1.49	0.20%	**0.097*****	3.00	0.53%	**0.066****	2.58	0.22%
BetaAsset	**0.208****	2.47	2.37%	**-0.170*****	-7.65	-1.99%	**0.000**	0.00	0.00%	**-0.141*****	-6.66	-1.61%
Leverage	**0.094*****	3.10	1.07%	**0.001**	0.04	0.01%	**0.187*****	6.16	1.96%	**0.119*****	4.03	1.36%
Payout	**0.023****	-2.16	-0.26%	**-0.006**	-0.66	-0.07%	**0.038*****	3.58	0.40%	**0.025****	2.49	0.28%
HHIFirm	**0.271*****	8.53	3.10%	**0.340*****	8.11	3.98%	**0.148*****	3.94	1.55%	**0.239*****	6.90	2.73%
Inst	**0.196*****	4.16	2.24%	**0.195*****	3.87	2.28%	**0.012**	0.27	0.12%	**0.117*****	2.74	1.33%
HHISIC3	**0.008**	0.12	0.08%	**-0.057**	-1.07	-0.67%	**0.105**	1.41	1.11%	**-0.007**	-0.12	-0.09%
Amihud	**-0.124*****	-4.50	-1.42%	**-0.097*****	-4.03	-1.14%	**-0.057*****	-5.29	-0.60%	**-0.050*****	-4.39	-0.57%

# obs, pseudo- R^2, and all-sample frequency	100,160	0.020	6.18%	100,166	0.015	6.18%	79,100	0.018	6.24%	79,103	0.017	6.24%
Weak instrument tests												
F(1, #obs) and p-val		95.38	0.00		167.15	0.00		38.00	0.00		91.39	0.00
Exogeneity tests												
Wald (chi2 and p-val)		7.71	0.01		8.21	0.00		7.93	0.01		8.04	0.01

Table 4. The Feedback Effect from Takeover to Discount

This table reports the estimation of the system (8)-(9) through a regression of residual *Discount* from equation (11) on shocks to *Takeover* from equation (14). Also reported are the changes in the residual *Discount* for one standard deviation change in the shocks to *Takeover*. All standard errors are adjusted for heteroskedasticity and correlation double-clustered at the year and the firm level, as well as the variation from the first-stage estimation. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels.

Residual Discount	Discount(Q)		Discount(EV/Ebitda)	
Frontier	Industry	Firm	Industry	Firm
ξ (shocks in Takeover*)	-0.163	-0.140	-0.266	-0.193
	[-32.40]	[-18.66]	[-32.92]	[-33.96]
(Effect of inter-quartile change)	-3.08%	-1.98%	-7.27%	-3.32%
Observations	100,160	100,166	79,100	79,103
R-squared	0.040	0.046	0.109	0.048

Table 5. Financially-Driven Takeovers

This table repeats the analyses in Table 3 (Panel A) and Table 4 (Panel B) but only studies takeovers that are either leveraged buyouts and/or undertaken by financial sponsors. All other takeovers are removed from the sample. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels.

Panel A: Effect of Discount on Takeover with Feedback

Discount	Discount(Q)		Discount(EV/Ebitda)	
Frontier	Industry	Firm	Industry	Firm
Discount	1.4807***	1.4135***	1.4710***	1.4475***
	[3.96]	[4.06]	[3.45]	[3.60]
(dPr/dX)	4.76%	4.32%	4.69%	4.51%
(Effect of inter-quartile change)	2.29%	2.11%	2.21%	2.23%
Sales	-0.3762***	-0.1775*	-0.5229***	0.0188
	[-3.05]	[-1.88]	[-3.21]	[0.24]
R&D	0.0194*	0.0555***	0.1000	1.0936
	[1.81]	[3.65]	[0.16]	[1.36]
ATO	0.1457***	0.1352***	-0.0196	0.0953***
	[6.28]	[6.37]	[-0.62]	[6.26]
MktShr	0.1870	0.0981	-0.0511	-0.0914
	[1.22]	[0.74]	[-0.44]	[-0.83]
Growth	0.0879***	0.0501***	0.0707*	0.0737*
	[3.72]	[3.25]	[1.67]	[1.81]
BetaAsset	0.0937	-0.3201***	-0.1183	-0.2656***
	[0.79]	[-10.43]	[-1.61]	[-6.58]
Leverage	0.1410***	0.0338	0.2136***	0.1509***
	[3.25]	[0.82]	[4.37]	[3.10]
Payout	-0.0088	0.0016	0.0502***	0.0435***
	[-0.54]	[0.12]	[3.72]	[3.56]
HHIFirm	0.1260**	0.2579***	0.0606	0.1685***
	[2.33]	[3.72]	[1.24]	[2.88]
Inst	0.4694***	0.5494***	0.2342***	0.4546***
	[8.03]	[8.13]	[2.61]	[7.23]
HHISIC3	0.0961	-0.0309	0.1020	-0.0413
	[1.13]	[-0.42]	[1.03]	[-0.51]
Amihud	-0.1335***	-0.1318***	-0.0306*	-0.0340*
	[-4.08]	[-4.23]	[-1.67]	[-1.88]
Constant	-2.6582***	-2.3820***	-1.9900***	-2.4652***
	[-33.31]	[-16.89]	[-6.75]	[-15.95]
Probability of takeover	1.38%	1.38%	1.45%	1.45%
Observations	94,802	94,808	74,901	74,904
Pseudo R-squared	0.037	0.032	0.041	0.040
Exogeneity tests				
Wald chi2 statistic	6.14	7.95	4.56	5.36
p-value	0.01	0.00	0.03	0.02

Panel B: The Feedback Effect from Takeover to Discount

Residual Discount	Discount(Q)		Discount(EV/Ebitda)	
Frontier	Industry	Firm	Industry	Firm
ξ (shocks in Takeover*)	-0.272	-0.343	-0.375	-0.381
	-12.73	-15.39	-11.27	-12.24
(Effect of inter-quartile change)	2.64%	3.98%	4.80%	5.02%
Observations	94,802	94,808	74,901	74,904
R-squared	3.59%	5.80%	6.55%	6.98%