Takeover Activity and Target Valuations: Feedback Loops in Financial Markets *

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Abstract

Asset prices both affect and reflect real decisions. This paper provides evidence of this two-way relationship in the takeover market. We find that a firm's discount to its potential value significantly attracts takeovers (the "trigger effect") – but market expectations of an acquisition cause the discount to shrink (the "anticipation effect"). By controlling for the simultaneous anticipation effect, we document a markedly stronger trigger effect from prices to takeover probabilities than prior literature – an inter-quartile change in the discount leads to a 4 percentage point increase in acquisition likelihood (compared to a 6% unconditional takeover probability). This implies that financial markets may discipline managerial agency by triggering takeover threats, but the anticipation effect reduces the effectiveness of this process.

Keywords: Takeovers, mergers and acquisitions, market valuation, feedback effects, financial and real efficiency, merger waves.

JEL Classification: G34, G14, C14, C34

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Does a low market valuation make a firm a takeover target? Early thought on the market for corporate control ascribes an important role for stock prices. The argument, going back to Marris (1964) and Manne (1965), is that a firm's low valuation relative to its peers suggests internal managerial problems. An acquirer can then take over the firm, correct its problems, and earn a profit by restoring the firm's value to its potential. This logic is also consistent with common practice, as 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. Indeed, understanding whether such a link exists is important because, if so, it suggests that takeover threat is a powerful disciplining device to alleviate managerial agency problems.[1]

Despite this logic, empirical studies on takeovers fail to systematically uncover a meaningful relationship between market valuations and takeover probabilities. While Cremers, Nair, and John (2008) 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.

We argue that there is a fundamental challenge in finding such a relation in the data, because the relationship between market prices and corporate events goes in two directions. 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*.

We begin our estimation by constructing measures of a firm's "discount" from maximum potential value under full efficiency (also referred to as X-inefficiency). While previous papers investigate the effect of raw valuations (such as price-to-earnings or market-to-book ratios) on takeover likeli-

[1] 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."

hood, we argue that the discount, rather than raw valuation, is the relevant measure, as it captures the value a bidder can create by restoring a firm to its potential value through an acquisition. 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, asset-intensive and in a competitive industry. Our estimation uses quantile regression techniques to measure the maximum potential value based on successful peer firms in the same industry or with similar characteristics.

Equipped with our discount measures, we move on to estimate a system of equations where discount and takeover likelihood are jointly determined. The key challenge in estimating this system is finding instrumental variables that affect the discount, but do not directly affect the likelihood of a takeover conditional upon the discount. A high discount can occur for two main reasons – the firm is underperforming owing to agency problems, or it is undervalued due to mispricing. While agency problems are likely correlated with managerial entrenchment and thus takeover likelihood, mispricing variables such as financial market frictions do satisfy the exclusion restriction. The discount is a "sufficient statistic" for the value that an acquirer can extract via a takeover: conditional upon the discount, the acquirer is unconcerned with whether it results from agency problems or financial frictions. Hence, frictions have no independent effect on takeover attractiveness other than through the discount.[2] Our main instrument captures price pressure from mutual fund trades mechanically induced by investor inflows or redemptions, motivated by Coval and Stafford (2007) who find that such flows affect prices. An investor's decision to accumulate or divest mutual fund shares is not driven by her views on the takeover likelihood of individual stocks held by the fund. However, her actions induce the fund to expand or contract its existing positions, generating price pressure on the stocks held that is uncorrelated with their takeover likelihood. Similar logic motivates our use of S&P index inclusion and analyst coverage as additional instruments: they only impact takeover attractiveness through their effect on the discount.

Our structural estimation, controlling for feedback, allows us to be the first study to demonstrate that prices have a statistically and economically significant effect on takeover probability.

[2] Note that the exclusion restriction would be violated if we used raw valuations instead of discounts as our dependent variable. Conditional on the raw valuation, the existence of a negative market friction suggests that firm value would be higher in the absence of the friction, and therefore renders the firm a more attractive takeover target.

Without accounting for the fact that prices reflect takeover likelihood, an inter-quartile change in the discount is associated with a 1 percentage point increase in takeover probability.[3] Controlling for the anticipation effect, the trigger effect rises substantially to 4 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. Hence, in contrast to earlier academic studies, we find that valuation does indeed strongly affect takeovers – when valuation is measured as a discount to potential value and purged of the anticipation effect. We also find that takeover anticipation has a significant impact on valuations. A one standard deviation change in shocks to takeover probability is associated with a 3.5 percentage point decrease in the discount, versus a mean discount of $18 - 28\%$. As a result of the anticipation effect, the equity of a firm at the 95th percentile of takeover vulnerability is "overvalued" by $7 - 12$ percent, compared to a hypothetical state of no takeover anticipation.

These findings have a number of implications for takeover markets. First, considering the trigger effect, our results imply that financial markets impose discipline on managers through affecting acquisition likelihood. Since low market prices attract takeovers, and since managerial underperformance reduces market prices, managers must exert effort and refrain from private benefits and pet projects to avoid being taken over.[4] While this active role of the financial market in disciplining managers has been noted by Marris (1964), Manne (1965), Rappaport (1986) and Jensen (1993), it has not been part of formal models of takeovers. For example, in Grossman and Hart (1980), the acquirer must pay the full post-restructuring value of the target irrespective of the market price. Hence, our findings call for new takeover theories where the market price is not simply a side-show but has a real effect on takeover probability and thus on firm value.[5] This effect may arise if the

[3] This effect is significantly smaller if we analyze raw valuations instead of discounts.

[4] Our result that managerial inefficiency triggers acquisitions is consistent with evidence that value creation in takeovers is increasing in target agency problems, as measured by a low Q (Lang, Stulz, and Walkling (1989) and Servaes (1991)) or weak governance (Wang and Xie (2008)). These papers do not study the link between managerial agency problems and takeover likelihood.

[5] The idea that the bid price is affected by the market price is strongly supported by Schwert (1996), who finds 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.

market price contains new information that agents are attempting to learn (as in Chen, Goldstein, and Jiang (2007))[6], or if market participants anchor on the price. Interestingly, this active role of financial markets implies that any factor that influences prices can also influence takeover activity. Therefore, mispricing (e.g. due to market frictions or investor errors) can have real consequences by impacting takeovers. This is in the spirit of findings in the behavioral corporate finance literature (surveyed by Baker, Ruback, and Wurgler (2007)), although the direction of the effect is different. In that literature, temporary overvaluation 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 reduces fundamental value as it may deter desirable actions.

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 takeover. 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. Song and Walkling (2000) argue that the increase in firms' stock prices following the acquisition of their rivals is a result of the anticipation effect – the market increases its expectation that they will be taken over themselves. Other papers have analyzed the effect of takeover anticipation on stock returns. Hackbarth and Morellec (2008) and Cremers, Nair, and John (2008) 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 can be a significant impediment to takeovers – the anticipation of a takeover boosts prices, deterring the acquisition from actually occurring. Therefore, it may both deter value-enhancing takeovers of firms that are already underperforming, and give allow managers to shirk in the first place since they are less fearful of disciplinary acquisitions. Indeed, as well as being academically intriguing, many practitioners believe that the anticipation effect has significant effects on real-life takeover activity.

[6] Note that a learning model will have to feature asymmetry betweeen the bidder and target.

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." 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. The self-defeating nature of takeovers 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 (2009).

This self-defeating nature of takeover expectations can shed new light on other important real-world phenomena. First, it offers an explanation for why takeovers of public targets create significantly less value for acquirers than private acquisitions (see, e.g. Chang (1998)). There is no anticipation effect for private targets, and thus no deterrence of value-creating deals. Second, 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. A third is the practice of publicly expressing concerns about an upcoming takeover as a takeover defense: these concerns inflates the price, which in turn deters the takeover from occurring. Indeed, conversations with industry practitioners suggest that this is an occasional practice among likely takeover targets.

In addition, our paper has a number of wider implications outside the takeover market. The 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 (2009) 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 can be applied to a range of other settings.[7]

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[8], 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 under full efficiency and zero market frictions, which we call the "frontier value."[9] This is for two reasons. The first is theoretical – it is the discount that measures potential value creation and thus target attractiveness, as explained in the introduction. The second is

[7] Hunt-McCool, Koh, and Francis (1996) and Habib and Ljungqvist (2005) also estimate a potential value within a finance setting. As discussed in Section 1.1, our specification and application are different from theirs.

[8] See, e.g., Fishman and Hagerty (1992), Holmstrom and Tirole (1993), Dow and Gorton (1997), Subrahmanyam and Titman (1999), Fulghieri and Lukin (2001), Goldstein and Guembel (2008), Dow, Goldstein, and Guembel (2008), Admati and Pfleiderer (2008), Edmans (2008), Edmans and Manso (2008), and Gorton, Huang, and Kang (2008).

[9] Note that the frontier value is a standalone concept, i.e. it does not take into account any synergies with specific acquirers. This is because our focus is on takeovers that correct managerial discipline and are thus induced by low valuations compared to standalone potential value. If synergies are the major driver of mergers, our standalone discount measure will be insignificant.

econometric: we are able to identify instruments that affect the discount but do not affect takeover likelihood conditional upon the discount. However, such variables would impact the takeover probability directly conditional on raw valuation, and thus fail the exclusion restriction. This issue is discussed in more detail in Section 1.2.

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 (2009) 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 such inefficiency can be alleviated by disciplinary takeovers.

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 firms' 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 be 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 fundamental characteristics 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 the rival firm 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 hence 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. The choice of X variables involves a tradeoff. On the one hand, a more extensive list of variables will provide a more accurate assessment of the true potential value. On the other hand, extending the list of X variables runs the risk of including variables that are not outside the acquirer's control.

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 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.[10] The disadvantage 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 empirical evidence (Hoberg and Phillips (2009)).

We therefore also employ a second approach, using firm characteristics as X variables.[11] 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 a bidder. For example, both a firm's market share and financial policies (such as dividend payout) affect its actual valuation. However, only the 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 bidders

[10] 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.

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

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. The specification therefore 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 a bidder may be able to change the tercile of a firm that is currently close to the cutoffs, we exclude such firms from our analysis in Section 4.

The remaining specification issue is the choice of α. Here, again, there is a tradeoff. 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%).[12] 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.[13] 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.

[12] 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.

[13] 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 (2009) find that, on average, about 20% (80%) of closed-end funds trade at a premium (discount) to NAV.

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):

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

and ε is a disturbance term. 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:

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

$$s.t. f(X_{i,t};\widehat{\beta}) \geq 0,$$

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 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).

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).[14] Our specification (1) makes no parametric assumptions regarding

[14] This alternative method expresses the stochastic frontier as $V = f(X;\beta) + \varepsilon$, where $\varepsilon = u + v$. It is a parametric method that assumes that ε is comprised of two components. The first, u, is a symmetric random disturbance that captures the combined effect of missing fundamental variables, luck, and misvaluation. The second, v, represents the (negative of the) valuation discount, and is thus one sided ($v \leq 0$). The usual procedure is to assume that u and v respectively follow normal and lower-half normal distributions, and obtain $\widehat{\beta}$ using maximum likelihood estimation. We conducted simulations and found that this method is not suitable for our context. Specifically, since v is lower-half normal, it aims to capture any left skewness in the data. If the valuation frontier is right-skewed, then there is no left skewness for v to absorb. $\widehat{v}$ thus frequently equals its corner value of zero, and is thus severely underestimated. Given that most financial variables exhibit skewness, we choose the specification in (2).

ε and thus accommodates skewness, heteroskedasticity and within-cluster correlation, all of which are common features in finance panel data.

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 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 vector of variables that represent firm characteristics or 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 conditional on value discounts. 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:

$$\begin{aligned} Discount &= \gamma_0 X + \gamma_1 Z_1 + \gamma_2 Z_2 + \delta\xi + \eta', && (8) \\ Takeover^* &= \mu_1 Discount + \mu_2 X + \mu_3 Z_1 + \xi. && (9) \end{aligned}$$

η in (4) is replaced by $\delta\xi + \eta'$ 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

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

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.

The system cannot be estimated using conventional two-stage least squares because the observed variable $Takeover$ is a binary variable, and thus does not exhibit a linear relation with its determinants. Our estimation follows Rivers and Vuong (1988) and uses the maximum likelihood method. We estimate (9) as the main equation, using a reduced form of (8) as an input to the main equation, and instrumenting the endogenous variable $Discount$ by the Z_2 variables. Later, we back out the structural parameters 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' 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 (17) in Appendix A.2 presents the full likelihood function.

Finally, having laid out the empirical model, we can now explain how econometric reasons justify the use of *Discount* instead of V (raw valuation), in addition to the theoretical arguments discussed in the introduction. Consider two firms with the same low V. In one firm, the low V results from weak fundamentals; in the second, it is caused by market frictions. The firm suffering from market frictions will be a more attractive takeover target since its low V does not represent deficiencies in any area that matters to the acquirer (it is automatically reversed upon acquisition); therefore it is underpriced from the buyer's viewpoint. Unlike the discount, valuation is not a "sufficient statistic" for the profitability of a takeover: the *source* of a low valuation matters. Z_2 therefore affects takeover probability even holding V constant, violating the exclusion restriction. By contrast, Z_2 has no independent effect on takeover probability controlling for *Discount*, because the level of *Discount* is a sufficient statistic for the profitability of a disciplinary takeover. Regardless of whether *Discount* stems from mispricing or agency problems, it can be corrected by acquisition.

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.

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 Financial 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 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.[15] 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) and the square of *Age*, characteristics that an acquirer cannot change. We use *Sales* as a measure of firm size, which likely impacts the frontier valuation as it proxies for growth opportunities and diminishing returns to scale.[16] 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 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 a bidder can alter these X variables to a degree, we only use their

[15] 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.

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

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.

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 $18-28\%$.[17] 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 the time series of the aggregate discount values (using the industry frontier value specification), together with the empirical frequency of takeovers during the sample period. 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. Our Z_1 variables 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

[17] 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. We err on the conservative side regarding the inclusion of firm characteristics in the frontier estimation, to ensure that the determinants of the frontier are largely beyond the control of managers and potential acquirers.

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.[18] 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 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 Financial.[19] 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)).

The Z_2 variables affect *Discount*, but have no effect on takeover probability other than through their impact on the discount. We therefore use variables that affect the price due to market frictions and are unrelated to firm fundamentals and managerial resistance. Our leading variable is $MFFlow$, the price pressure created by mutual fund buying and selling in response to investor flows. Appendix A.1 describes its construction 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

[18] 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 (2008) show that product market competition can discipline management and render corporate governance unimportant.

[19] We do not use the Gompers, Ishii, and Metrick (2003) shareholder rights measure as an additional corporate governance variable as it substantially reduces our sample size. Moreover, in the subsample in which it is available, it is uncorrelated with both the discount and takeover probability. 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.)

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 Coval and Stafford (2007)), but using hypothetical orders projected from their previously disclosed portfolio. Therefore, $MFFlow$ does not reflect mutual funds' discretionary trades 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 would, 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. As a sensitivity check, in Section 4 we exclude these sector mutual funds in constructing the $MFFlow$ measure, and find that our results are unchanged. In addition, we use year fixed effects to control for any aggregate shocks to both takeover activity and fund flows in a particular year.

In a similar vein, equity analyst coverage (Doukas, Kim, and Pantzalis (2005)) and index inclusion can increase investor demand and thus valuations. We therefore include dummy variables for NASDAQ and S&P inclusion ($NASDAQ$ and $SPIdx$) and the log of (one plus) the number of IBES analysts covering the firm ($Analyst$). Since the target will no longer be traded after a successful takeover, nor receive independent coverage, these features will become irrelevant post-acquisition.

Therefore, the acquirer should not display any significant preferences for these characteristics other than through their effect on *Discount*.[20] Note that we only use the number of analysts covering the stock and not their actual forecasts, since the latter may be affected by their views on the firm's takeover likelihood. Even if the number of analysts does not directly affect takeover likelihood, it may be correlated with firm characteristics that facilitate takeovers: high coverage is associated with high trading liquidity and more sophisticated investors. Therefore, it is important that we include direct controls for these two characteristics, *Amihud* and *Inst*.

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. Finally, consistent with Amihud (2002), illiquidity increases the discount. Our primary instrumental variable, $MFFlow$, is significantly associated with lower discounts across all four specifications. Analyst coverage (*Analyst*) has the expected significant negative sign. Index inclusion ($SPIdx$)

[20] In theory, target analysts could initiate coverage on bidders after the acquisition. However, since bidders are typically much larger than targets and size is strongly correlated with coverage (Hong, Lim, and Stein (2000)), it is rare that an analyst will cover the target but not the bidder. In addition, acquiring a covered target is an expensive way of increasing coverge, rendering it an unlikely takeover motive.

generally reduces the discount. Firms listed on Nasdaq (*Nasdaq*) tend to have higher discounts when calculated using Q, but lower discounts using $EV/Ebitda$.

We now turn to the *Takeover* equation in Panel A, which illustrates the responsiveness of the probability of acquisition to *Discount*. 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.[21] However, 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, in the full sample, a one percentage point increase in

[21] 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.

Discount would lead to a statistically significant $3-11$ 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 1.6 to 7.1 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 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 three of the 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 uncovers that the value discount is a far more important motivation for 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, quantifying the anticipation component in *Discount* amounts to estimating δ in equation (8). Estimating (8) directly is difficult because we lack firm-specific instruments that predict *Takeover* but do not affect *Discount* directly. Variables from the takeover side, such as interest rates (to proxy for the ease of financing) or capital flows to buyout funds, satisfy the exclusion restriction. However, they are not firm-specific and only vary over the time series, and thus have low power.

We therefore approach the problem by utilizing the intermediate and final outputs from estimating equation (9). The anticipation coefficient δ is a linear projection of the residual discount $\widetilde{Discount}$ (defined in (11)) on $\widehat{\xi}$, the estimated residual in the takeover equation. We can therefore construct a $\widehat{\delta}$ estimate by regressing $\widetilde{Discount}$ on $\widehat{\xi}$. The empirical analog of $\widetilde{Discount}$ is readily available from (11). For the empirical analog of $\widehat{\xi}$, 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, by one standard deviation from the mean, *Discount* shrinks by $3 - 4$ percentage points. Such a magnitude is economically plausible and significant given the average discount level of $18\% - 28\%$. The equity of a firm at the 95th percentile of takeover vulnerability is overvalued by 7.2 to 11.6 percentage points, compared to a hypothetical state in which its valuation did not reflect such takeover vulnerability.

3.2.3 Discussion

Taken together, our results in Tables 3-4 provide evidence of both channels of the feedback loop. Table 3 demonstrates that lower discounts in turn deter takeovers, by reducing a bidder's potential profit from an acquisition: the trigger effect. Table 4 shows that takeover expectations reduce value discounts: the anticipation effect. The combination of these findings have several implications for the market for corporate control.

The finding that low valuations increase the likelihood of acquisition suggests that managerial underperformance increases takeover vulnerability, and thus takeover threat imposes discipline on managers. However, while this finding supports the (unmodeled) managerial discipline arguments of Marris (1964), Manne (1965), Rappaport (1986) and Jensen (1993), the importance of market prices is a theoretical puzzle. In a framework with symmetric information, if there is free-riding by target shareholders (as in Grossman and Hart (1980)), the bidder must pay 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.

Moreover, the existence of the trigger effect means that the anticipation effect may be a significant impediment to the market for corporate control. Song and Walkling (2000) previously found that target prices are inflated by takeover expectations. However, in the absence of a trigger effect, such anticipation has no effect on actual takeovers, since market prices are irrelevant: both parties will agree that target stock is priced above standalone fundamentals, and thus a lower premium is warranted. By finding evidence on both channels of the feedback loop, we show that takeover anticipation deters acquisitions. This has important implications for economic efficiency – not only may the anticipation effect deter value-enhancing takeovers of firms that are already underperforming, but also it may give managers freedom to act inefficiently in the first place since they are less fearful of disciplinary acquisitions. More generally, it suggests that financial market efficiency may reduce real efficiency, contrary to common wisdom and conclusions from most existing research – forward-looking prices may deter the very actions that they anticipate.

An alternative explanation to the shrinkage in *Discount* is that takeover threat forces the managers to adopt actions that increase the value of the firm. If fundamental changes are the cause of the negative δ in equation (8), then discounts should not rebound when takeover intensities wane. This is in contrast with existing findings that stock prices of target companies drop significantly after cancellation of takeover bids (see Jarrell, Brickley, and Netter (1988) for a survey of the evidence).

Considering the entire feedback loop also has implications for takeover defenses, merger waves, and differences in returns to acquisitions of public and private targets. First, while the anticipation effect deters desirable takeovers of public targets, it does not apply to acquisitions of private firms. This is consistent with the higher returns to private takeovers, as found by Chang (1998). Second, it suggests that a potential takeover defense is to alert the market to the possibility of an upcoming takeover. Via the anticipation effect, this can inflate valuations; combined with the trigger effect, the high prices discourage acquisition attempts. Third, the feedback loop demonstrates how merger waves can be endogenously self-defeating. A number of existing papers analyze the causes of waves; for example, Rhodes-Kropf and Viswanathan (2004) and Shleifer and Vishny (2003) posit that they are driven by high market valuations. Such a framework implies that merger waves are only halted when the initial cause disappears, for exogenous reasons. This paper proposes an endogenous reason for why merger waves eventually end. When takeover activity is high, market valuations anticipate future acquisitions. This causes prices to rise, thus deterring the takeovers from actually occurring and causing the merger wave to abate. As noted in the Introduction, this phenomenon is believed to have ended the spate of mergers in the U.K. water industry that occurred around 2003-6.

Our instrumental variables technique uses market frictions as an instrument for prices to identify a relationship between prices in general and takeover likelihood. We thus show that any factor that affects market prices can affect acquisition probabilities. Our results therefore contribute to the behavioral corporate finance literature (surveyed by Baker, Ruback, and Wurgler (2007)), which demonstrates that mispricing can have real consequences.

4 Additional Analyses

4.1 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. We repeat the analysis in Table 3 for this subset of takeovers and report the results in Table 5. Indeed, the effect of *Discount* becomes stronger relative to the smaller unconditional probability. An inter-quartile change in *Discount* is associated with a $0.4 - 2.0\%$ increase in the probability of a financially-driven takeover. The full-sample probability of such a takeover is 1.3%, which is a subset of the 6.2% probability of any takeover.

[Insert Table 5 here.]

4.2 Robustness Checks

In this section, we report results from further robustness checks; some of the results are not tabulated for brevity. First, we check the sensitivity of our results to the choice of $\alpha = 0.20$ as our default percentile for frontier values. As we 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*. Panel A of Table 6 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 untabulated to conserve space, but available from the authors upon request.

[Insert Table 6 here.]

Second, as noted in Section 2.2, mutual funds that specialize in a particular industry may experience flows correlated with shocks to both industry valuations and takeover activities. We therefore rerun the analyses excluding these sector funds, which 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. Panel B of Table 6 presents the results for the Q specifications (the results for $EV/Ebitda$ are similar but omitted for brevity). The coefficient estimates are slightly higher than in Table 3. An inter-quartile change in the discount leads to a $3.5 - 4.8\%$ increase in takeover likelihood.

Finally, 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. Panel B of Table 6 shows that the results are, if anything, stronger than the full sample in Table 3, with an inter-quartile response of 7.6% compared to an unconditional takeover probability of 5.4% for this subsample.

5 Conclusion

This paper provides evidence of the feedback loop – the dual relationship between financial markets and corporate events. We choose acquisitions as the corporate event for two main reasons: first, they are arguably the most powerful corrective action available and second, analyzing takeovers allows us to reassess the relationship between prices and takeovers, and thus the extent to which takeover threat exerts discipline on managers. Previous papers found mixed evidence on the link between valuation and takeover likelihood. We posit that this insignificance resulted from two reasons. First, in a forward-looking market, the valuation itself endogenously reflects the market's expectation of a takeover. Second, the appropriate valuation measure for takeover likelihood is not a firm's raw value but its discount to its maximum potential value under full efficiency, as this captures the potential profit opportunity from a disciplinary acquisition.

After constructing a measure of each firm's value discount, we use a system of simultaneous equations to identify empirically both channels of the feedback loop. A high discount indeed invites takeovers (the trigger effect) but market anticipation causes the discount to shrink (the anticipation effect). Controlling for the anticipation effect yields coefficient estimates for the trigger effect that are orders of magnitude higher than in the absence of instrumentation.

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 economically significant 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. Not only will this reduce the likelihood that currently inefficient firms will be acquired, but also it may encourage managers to pursue private objectives rather than maximize shareholder value, since the threat of a disciplinary takeover is weakened. This negative impact of the anticipation effect suggests that, in contrast to most existing research, financial efficiency may hinder real efficiency, since forward-looking prices deter the very actions that they anticipate. The self-defeating nature of takeover expectations has implications for merger waves, expressing concerns about a potential bid as a takeover defense, and differential returns to acquisitions of public and private targets. Moreover, 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.

Finally, our paper suggests potential avenues for future research. On the empirical side, our methodology can be used to study many other situations where markets affect and reflect corporate events. These include the decision to replace a CEO and shareholder activism. It also suggests that agency problems should be measured using discounts to potential value, rather than raw valuations. On the theoretical side, the effect of market prices on takeover probability poses a puzzle, since most existing models predict that they should play no role. Our results suggest an open question for future research – the development of theories that explain why market valuations matter.

References

Admati, Anat, and Paul Pfleiderer, 2008, The "Wall Street Walk" and shareholder activism: Exit as a form of voice, *Review of Financial Studies* forthcoming.

Aigner, Dennis, C.A. Knox Lovell, and Peter Schmidt, 1977, Formulation and estimation of stochastic frontier production function models, *Journal of Econometrics* 6, 11–37.

Ambrose, Brent, and William Megginson, 1992, The role of asset structure, ownership structure, and takeover defenses in determining acquisition likelihood, *Journal of Financial and Quantitative Analysis* 27, 575–589.

Amihud, Yakov, 2002, Illiquidity and stock returns: cross-section and time-series effects, *Journal of Financial Markets* 5, 31–56.

Andrade, Gregor, Mark Mitchell, and Erik Stafford, 2001, New evidence and perspectives on mergers, *Journal of Economic Perspectives* 15, 103–120.

Baker, Malcolm, Richard Ruback, and Jeffrey Wurgler, 2007, Behavioral corporate finance: A survey, in Espen Eckbo, ed.: *Handbook of Corporate Finance: Empirical Corporate Finance* (Elsevier/North Holland: New York).

Bates, Thomas, David Becher, and Michael Lemmon, 2008, Board classification and managerial entrenchment: Evidence from the market for corporate control, *Journal of Financial Economics* 87, 656–677.

Betton, Sandra, and Espen Eckbo, 2000, Toeholds, bid-jumps, and expected payoffs in takeovers, *Review of Financial Studies* 13, 841–882.

——— , and Karin Thorburn, 2008, Corporate takeovers, in Espen Eckbo, ed.: *Handbook of Corporate Finance: Empirical Corporate Finance* (Elsevier/North Holland: New York).

Bond, Philip, Itay Goldstein, and Edward Simpson Prescott, 2009, Market-based corrective actions, *Review of Financial Studies* forthcoming.

Bradley, Michael, Alon Brav, Itay Goldstein, and Wei Jiang, 2009, Activist arbitrage: A study of open-ending attempts of closed-end funds, *Journal of Financial Economics* forthcoming.

Brealey, Richard, Stewart Myers, and Franklin Allen, 2008, *Principles of Corporate Finance* (McGraw-Hill: New York, NY).

Chang, Saeyoung, 1998, Takeovers of privately held targets, methods of payment, and bidder returns, *Journal of Finance* 53, 773–784.

Chen, Qi, Itay Goldstein, and Wei Jiang, 2007, Price informativeness and investment sensitivity to stock price, *Review of Financial Studies* 20, 619–650.

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

Cremers, Martijn, Vinay Nair, and Kose John, 2008, Takeovers and the cross-section of returns, *Review of Financial Studies* forthcoming.

Doukas, John, Chansong Kim, and Christos Pantzalis, 2005, The two faces of analyst coverage, *Financial Management* 34, 99–125.

Dow, James, Itay Goldstein, and Alexander Guembel, 2008, Incentives for information production in markets where prices affect real investment, Working paper, London Business School, Wharton School, and Oxford University.

Dow, James, and Gary Gorton, 1997, Stock market efficiency and economic efficiency: Is there a connection?, *Journal of Finance* 52, 1087–1129.

Edmans, Alex, 2008, Blockholder trading, market efficiency, and managerial myopia, *Journal of Finance* forthcoming.

———, and Gustavo Manso, 2008, Governance through exit and voice: A theory of multiple blockholders, Working paper, Wharton School and MIT Sloan School of Management.

Fishman, Michael, and Kathleen Hagerty, 1992, Insider trading and the efficiency of stock prices, *RAND Journal of Economics* 23, 106–122.

Fulghieri, Paolo, and Dimitry Lukin, 2001, Information production, dilution costs, and optimal security design, *Journal of Financial Economics* 61, 3–42.

Giroud, Xavier, and Holger Mueller, 2008, Does corporate governance matter in competitive industries?, *Journal of Financial Economics* forthcoming.

Goldstein, Itay, and Alexander Guembel, 2008, Manipulation and the allocational role of prices, *Review of Economic Studies* 75, 133–164.

Gompers, Paul, Joy Ishii, and Andrew Metrick, 2003, Corporate governance and equity prices, *Quarterly Journal of Economics* 118, 107–155.

Gorton, Gary, Lixin Huang, and Qiang Kang, 2008, Informed trading in the stock market and CEO turnover, Working paper, Yale University.

Gourieroux, Christian, Alain Monfort, Eric Renault, and Alain Trognon, 1987, Generalized residuals, *Journal of Econometrics* 34, 4–32.

Grossman, Sanford, and Oliver Hart, 1980, Takeover bids, the free-rider problem, and the theory of the corporation, *The Bell Journal of Economics* 11, 42–64.

Habib, Michel, and Alexander Ljungqvist, 2005, Firm value and managerial incentives: A stochastic frontier approach, *Journal of Business* 78, 2053–2094.

Hackbarth, Dirk, and Erwan Morellec, 2008, Stock returns in mergers and acquisitions, *Journal of Finance* 63, 1213–1252.

Hoberg, Gerard, and Gordon Phillips, 2009, Real and financial industry booms and busts, *Journal of Finance* forthcoming.

Holmstrom, Bengt, and Jean Tirole, 1993, Market liquidity and performance monitoring, *Journal of Political Economy* 101, 678–709.

Hong, Harrison, Terence Lim, and Jeremy Stein, 2000, Bad news travels slowly: Size, analyst coverage, and the profitability of momentum strategies, *Journal of Finance* 55, 265–295.

Hunt-McCool, Janet, Samuel Koh, and Bill Francis, 1996, Testing for deliberate underpricing in the IPO premarket: A stochastic frontier approach, *Review of Financial Studies* 9, 1251–1269.

Jarrell, Gregg, James Brickley, and Jeffry Netter, 1988, The market for corporate control: The empirical evidence since 1980, *Journal of Economics Perspectives* 2, 49–68.

Jensen, Michael, 1993, The modern industrial revolution, exit, and the failure of internal control systems, *Journal of Finance* 48, 831–880.

——— , and Richard Ruback, 1983, The market for corporate control: The scientific evidence, *Journal of Financial Economics* 11, 5–50.

Koenker, Roger, and Gilbert Bassett, 1978, Regression quantiles, *Econometrica* 46, 33–50.

Kumbhakar, Subal, and Knox Lovell, 2000, *Stochastic Frontier Analysis* (Cambridge University Press: Cambridge, MA).

Lang, Larry, René Stulz, and Ralph Walkling, 1989, Managerial performance, tobin's Q, and the gains from successful tender offers, *Journal of Financial Economics* 24, 137–154.

Li, Kai, and N. R. Prabhala, 2007, Self-selection models in corporate finance, in Espen Eckbo, ed.: *Handbook of Corporate Finance: Empirical Corporate Finance* (Elsevier/North Holland: New York).

Manne, Henry, 1965, Mergers and the market for corporate control, *Journal of Political Economy* 73, 110–120.

Marris, Robin, 1964, *The Economic Theory of Managerial Capitalism* (Macmillan: London).

Mikkelson, Wayne, and Megan Partch, 1989, Managers' voting rights and corporate control, *Journal of Financial Economics* 25, 263–290.

Palepu, Krishna, 1986, Predicting takeover targets: A methodological and empirical analysis, *Journal of Accounting and Economics* 8, 3–35.

Powell, James, 1984, Least absolute deviations estimation for the censored regression model, *Journal of Econometrics* 25, 303–325.

Prabhala, N. R., 1997, Conditional methods in event-studies and an equilibrium justification for using standard event-study methods, *Review of Financial Studies* 10, 1–38.

Rappaport, Alfred, 1986, *Creating Shareholder Value: The New Standard for Business Performance* (Free Press: New York).

Rhodes-Kropf, Matthew, David Robinson, and S. Viswanathan, 2005, Valuation waves and merger activity: The empirical evidence, *Journal of Financial Economics* 77, 561–603.

Rhodes-Kropf, Matthew, and S. Viswanathan, 2004, Market valuation and merger waves, *Journal of Finance* 59, 2685–2718.

Rivers, Douglas, and Quang Vuong, 1988, Limited information estimators and exogeneity tests for simultaneous probit models, *Journal of Econometrics* 39, 347–366.

Schwert, G. William, 1996, Markup pricing in mergers and acquisitions, *Journal of Financial Economics* 41, 153–192.

Servaes, Henri, 1991, Tobin's Q and the gains from takeovers, *Journal of Finance* 46, 409–419.

Shivdasani, Anil, 1993, Board composition, ownership structure, and hostile takeovers, *Journal of Accounting and Economics* 16, 167–198.

Shleifer, Andrei, and Robert Vishny, 2003, Stock market driven acquisitions, *Journal of Financial Economics* 70, 295–311.

Sias, Richard, Laura Starks, and Sheridan Titman, 2006, Changes in institutional ownership and stock returns: Assessment and methodology, *Journal of Business* 79, 2869–2910.

Song, Moon, and Ralph Walkling, 2000, Abnormal returns to rivals of acquisition targets: A test of the "acquisition probability hypothesis", *Journal of Financial Economics* 55, 143–171.

Stein, Jeremy, 1996, Rational capital budgeting in an irrational world, *Journal of Business* 69, 429–455.

Stock, James, and Motohiro Yogo, 2005, Testing for weak instruments in linear iv regression, in James Stock, and Donald Andrews, ed.: *Identification and Inference for Econometric Models: A Festschrift in Honor of Thomas Rothenberg* (Cambridge University Press: Cambridge).

Subrahmanyam, Avindhar, and Sheridan Titman, 1999, The going-public decision and the development of financial markets, *Journal of Finance* 54, 1045–1082.

Wang, Cong, and Fei Xie, 2008, Corporate governance transfer and synergistic gains from mergers and acquisitions, *Review of Financial Studies* forthcoming.

A Appendix

A.1 Data

This section details the calculation of the mutual fund price pressure variable. We obtain quarterly data on mutual fund flows from Thomson Financial and construct

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

for each stock-quarter pair, where i $(= 1, ..., n)$ indexes stocks, j $(= 1, ..., m)$ indexes mutual funds, and t represents one quarter. $F_{j,t}$ is the total outflow experienced by find j in quarter t, $MV_{i,t}$ is the market value of stock i in quarter t $(PRC^{*}_{i,t} \times SHROUT_{i,t})$, and

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

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

$$MFFlow_{i,t} = \sum_{j=1}^{m} \frac{F_{j,t} SHARES_{i,j,t-1}}{TA_{j,t-1} SHROUT_{i,t-1}}.$$

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

$$g(Takeover = 1, Discount) = \int_{-\mu_1 Discount - \mu_2 X - \mu_3 Z_1}^{\infty} f(\xi, \eta) \, d\xi, \tag{15}$$

and

$$g(Takeover = 0, Discount) = \int_{-\infty}^{-\mu_1 Discount - \mu_2 X - \mu_3 Z_1} f(\xi, \eta) \, d\xi, \tag{16}$$

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 (15), 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 (16) can be rewritten analogously. Combining all equations, we arrive at the log likelihood for a takeover on a firm-year observation:

$$l_{i,t} = Takeover_{i,t} \ln\left[\Phi\left(u_{i,t-1}\right)\right] + \left(1 - Takeover_{i,t}\right)\ln\left[1 - \Phi\left(u_{i,t-1}\right)\right] - \ln(\sigma_\eta) - \frac{\eta^2}{2\sigma^2_\eta}, \quad (17)$$

where

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

Figure 1. Time Series of Aggregate Discounts and Takeover Activities (1980-2006)

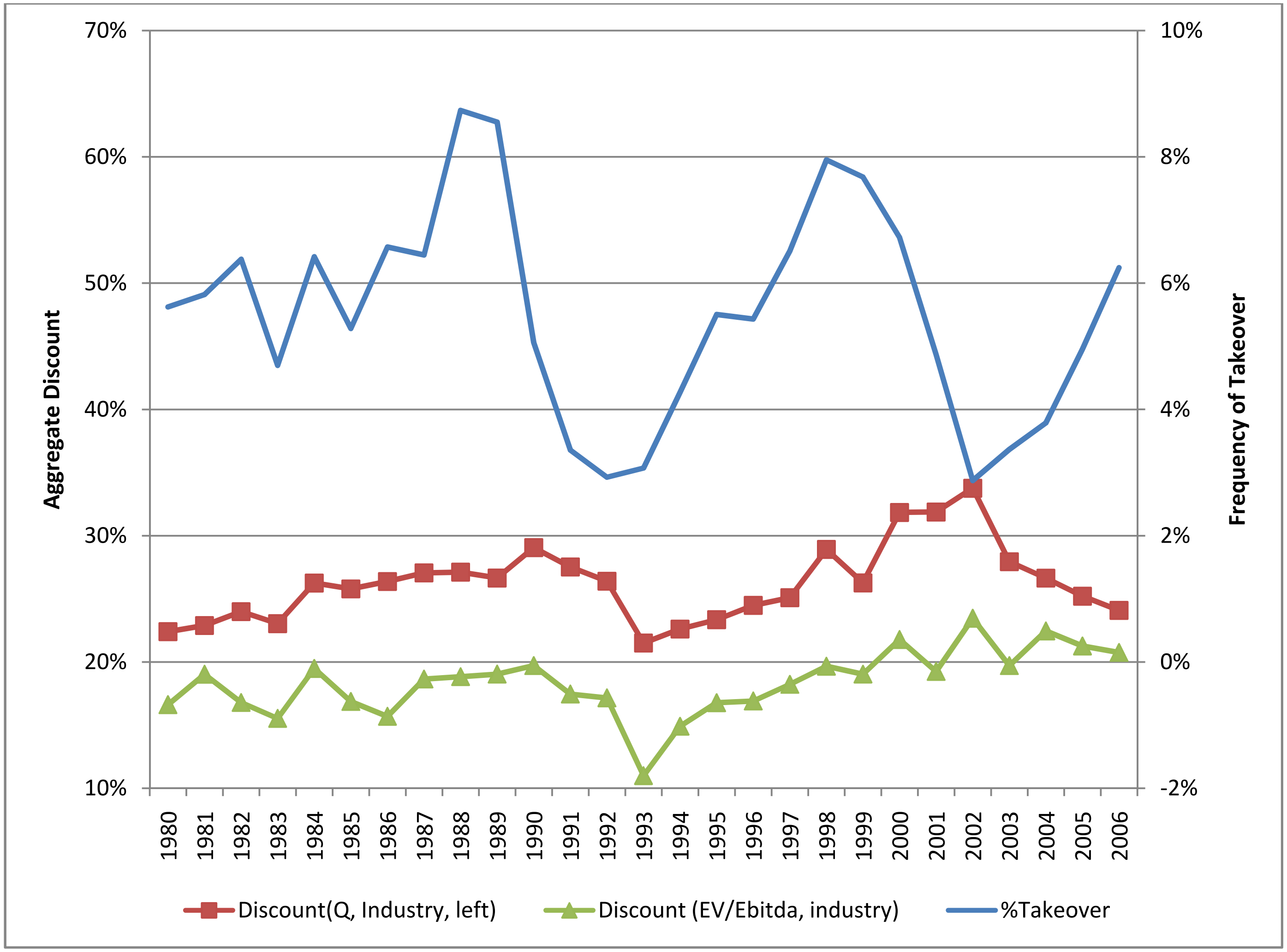

Table 1. Summary of Variables

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
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
Sales	Log of Sales (data12)
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)	
Analyst	Log of (1+# analysts) covering the firm. From IBES
MFFlow	Mutual fund price pressure. From Thomson Financial. See Appendix A for further details
Nasdaq	Dummy variable for Nasdaq inclusion. From CRSP
SPIdx	Dummy variable for inclusion in any S&P stock index

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
Analyst (log)	118,942	1.06	1.16	0.00	0.00	0.69	2.08	3.18
BetaAsset	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	2.88	11.97	-1.42	0.00	0.00	1.41	12.77
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. The dependent variable in Panel A is Discount, and that in Panel B is Takeover. The Discount variable is constructed using EV/Ebitda and Q as the valuation variables, and industry- and firm-specific frontier values. In the regressions with industry-specific frontiers, all non-dummy regressors are industry-adjusted. The firm-specific frontier is a quantile regression of valuation measures on *Sales, 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. In columns (1) and (3), all non-dummy regessors are expressed as industry-adjusted. All standard errors are adjusted for heteroskedasticity and correlation 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%) change in each regressor.

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	**0.287*****	15.21	3.34%	**0.128*****	7.99	1.51%	**0.108*****	5.98	1.28%	**0.071*****	4.30	0.84%
(effect of inter-quartile change)			*1.61%*			*0.74%*			*0.60%*			*0.41%*
Sales	**-0.011**	-0.24	-0.12%	**0.114****	2.51	1.35%	**0.038**	0.74	0.45%	**-0.022**	-0.42	-0.26%
R&D	**0.022**	0.52	0.25%	**-0.018****	-2.51	-0.21%	**0.358*****	2.79	4.22%	**0.158**	1.26	1.86%
ATO	**0.074*****	6.02	0.87%	**0.014**	1.47	0.16%	**0.026***	1.80	0.31%	**0.003**	0.26	0.03%
MktShr	**-0.355*****	-4.36	-4.13%	**-0.273*****	-3.70	-3.22%	**-0.437*****	-5.11	-5.15%	**-0.279*****	-3.63	-3.29%
Growth	**-0.015**	-1.34	-0.17%	**-0.007**	-0.80	-0.08%	**-0.045****	-2.52	-0.53%	**-0.007**	-0.51	-0.08%
BetaAsset	**-0.022**	-1.10	-0.26%	**-0.123*****	-6.40	-1.45%	**-0.086*****	-3.75	-1.01%	**-0.121*****	-5.38	-1.43%
Leverage	**0.083****	2.22	0.97%	**0.012**	0.51	0.14%	**0.162*****	3.61	1.91%	**0.105*****	3.44	1.24%
Payout	**-0.031**	-0.17	-0.37%	**0.004**	0.47	0.05%	**-0.111**	-0.55	-1.31%	**0.005**	0.55	0.06%
HHIFirm	**0.177*****	5.56	2.06%	**0.233*****	7.28	2.75%	**0.129*****	3.81	1.52%	**0.180*****	5.26	2.12%
Inst	**0.167*****	4.15	1.94%	**0.090****	2.28	1.06%	**0.066**	1.48	0.77%	**0.077***	1.79	0.91%
HHISIC3	**-0.071**	-1.45	-0.83%	**-0.091***	-1.71	-1.07%	**-0.079**	-1.43	-0.93%	**-0.072**	-1.19	-0.85%
Amihud	**-0.036*****	-4.37	-0.42%	**-0.023*****	-2.84	-0.27%	**-0.017***	-1.68	-0.20%	**-0.026****	-2.54	-0.31%
# obs, R^2, uncond. pr.	99,658	0.019	6.18%	100,166	0.015	6.18%	78,772	0.018	6.24%	79,103	0.017	6.24%

Panel B: Determinants of Discount

Dep. Var.	Discount(Q)				Discount(EV/Ebitda)			
	Industry-Specific Frontier		Firm-Specific Frontier		Industry-Specific Frontier		Firm-Specific Frontier	
	Coef	t-stat	Coef	t-stat	Coef	t-stat	Coef	t-stat
Sales	**0.669*** **	23.09	**0.317*** **	8.41	**0.557*** **	14.40	**-0.041**	-0.61
R&D	**-0.220*** **	-5.57	**-0.032*** **	-7.00	**-0.700*** **	-8.31	**-1.292*** **	-10.89
ATO	**-0.119*** **	-15.64	**-0.082*** **	-13.78	**0.125*** **	17.68	**-0.038*** **	-5.10
MktShr	**-0.193*** **	-6.09	**-0.113*** **	-3.36	**-0.064** **	-2.36	**-0.013**	-0.46
Growth	**-0.080*** **	-10.21	**-0.026*** **	-4.88	**-0.063*** **	-7.84	**-0.065*** **	-10.64
BetaAsset	**-0.261*** **	-19.47	**0.089*** **	6.43	**-0.124*** **	-9.93	**0.045*** **	2.77
Leverage	**-0.104*** **	-3.98	**-0.006**	-0.22	**-0.228*** **	-8.53	**-0.033**	-1.22
Payout	**0.397*** **	4.25	**0.012** **	2.28	**1.154*** **	15.34	**-0.021*** **	-4.26
HHIFirm	**-0.069*** **	-5.26	**-0.124*** **	-9.75	**0.007**	0.57	**-0.055*** **	-3.69
Inst	**-0.002**	-0.09	**-0.007**	-0.20	**0.088*** **	4.82	**-0.010**	-0.24
HHISIC3	**-0.058** **	-2.28	**-0.076*** **	-2.81	**0.011**	0.43	**-0.069*** **	-2.94
Amihud	**0.092*** **	27.86	**0.085*** **	17.39	**0.033*** **	7.67	**0.022*** **	3.64
MFFlow	**-2.119*** **	-3.88	**-1.015** **	-2.60	**-0.403** **	-2.05	**-0.362**	-1.09
Analyst	**-0.009*** **	-8.77	**-0.061*** **	-6.97	**-0.004*** **	-4.24	**-0.034*** **	-2.71
SPIdx	**-0.087*** **	-6.49	**-0.062*** **	-4.37	**-0.019* **	-1.71	**0.020** **	2.15
Nasdaq	**0.033*** **	3.25	**0.023** **	2.23	**-0.012**	-0.91	**-0.027** **	-2.05
# obs and R^2	99,658	0.217	100,166	0.112	78,772	0.140	79,103	0.085

* = significant at the 10% level, ** = significant at the 5% level, *** = significant at the 1% level

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 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%) change in each regressor. Also reported are Wald tests for weak instruments and the exogeneity of the system. Year fixed effects are used in all specifications, but unreported.

	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	**0.558*** **	5.87	6.74%	**0.489*** **	3.47	6.08%	**1.119*** **	6.06	15.02%	**0.270**	0.79	3.32%
(effect of inter-quartile change)			*3.25%*			*2.97%*			*7.09%*			*1.64%*
Sales	**-0.149** **	-2.22	-1.80%	**0.031**	0.62	0.39%	**-0.494*** **	-4.43	-6.63%	**-0.051**	-0.99	-0.62%
R&D	**0.054**	1.21	0.66%	**-0.006**	-0.70	-0.08%	**1.043*** **	6.13	13.99%	**0.406**	0.84	4.99%
ATO	**0.098*** **	6.49	1.18%	**0.041*** **	3.11	0.51%	**-0.119*** **	-4.18	-1.60%	**0.014**	0.86	0.17%
MktShr	**-0.263*** **	-2.97	-3.17%	**-0.201** **	-2.56	-2.50%	**-0.205** **	-2.23	-2.75%	**-0.264*** **	-3.41	-3.24%
Growth	**0.012**	0.90	0.14%	**0.009**	0.97	0.11%	**0.040* **	1.90	0.53%	**0.018**	0.66	0.22%
BetaAsset	**0.034**	1.05	0.41%	**-0.122*** **	-5.96	-1.52%	**0.054**	1.45	0.72%	**-0.099*** **	-3.49	-1.22%
Leverage	**0.088** **	2.33	1.06%	**0.034**	1.44	0.43%	**0.322*** **	5.80	4.32%	**0.134*** **	4.40	1.65%
Payout	**0.012**	0.06	0.15%	**0.003**	0.31	0.03%	**-1.197*** **	-4.16	-16.06%	**0.013**	1.23	0.16%
HHIFirm	**0.194*** **	6.01	2.34%	**0.283*** **	7.50	3.52%	**0.095*** **	2.97	1.28%	**0.187*** **	4.40	2.30%
Inst	**0.165*** **	3.98	1.99%	**0.145*** **	3.21	1.80%	**-0.011**	-0.25	-0.14%	**0.086**	1.06	1.06%
HHISIC3	**-0.086* **	-1.79	-1.04%	**-0.129** **	-2.48	-1.60%	**-0.127** **	-2.37	-1.71%	**-0.108* **	-1.81	-1.32%
Amihud	**-0.075*** **	-6.31	-0.90%	**-0.069*** **	-4.81	-0.86%	**-0.058*** **	-5.80	-0.78%	**-0.052*** **	-3.96	-0.63%
# obs, uncond. pr.		99,658	6.18%		100,166	6.18%		78,772	6.24%		79,103	6.24%
Weak instrument tests												
F(4, #obs) and p-val		193.46	0.00		127.53	0.00		29.49	0.00		46.87	0.00
Exogeneity tests												
Wald (chi2 and p-val)		8.80	0.00		6.88	0.01		26.90	0.00		0.34	0.56

* = significant at the 10% level, ** = significant at the 5% level, *** = significant at the 1% level

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.

Dep. Var.	η (residual Discount(Q))				η (residual Discount(EV/Ebitda))			
	Industry-Specific Frontier		Firm-Specific Frontier		Industry-Specific Frontier		Firm-Specific Frontier	
	Coef	t-stat	Coef	t-stat	Coef	t-stat	Coef	t-stat
ξ (shocks in Takeover*)	**-0.036*** **	-9.50	**-0.058*** **	-12.43	**-0.145*** **	-13.13	**-0.037*** **	-8.45
(Effect of one standard deviation)	**-0.018**		**-0.029**		**-0.073**		**-0.019**	
Cnst	**0.000**	-0.09	**-0.001**	-0.14	**-0.015*** **	-4.39	**0.000**	-0.02
# obs and R^2	99,658	0.002	100,166	0.005	78,772	0.064	79,103	0.002

Table 5. Effects of Discount on Financially-Driven Takeovers With Feedback

This table reports the results from estimating equations (9) in the (8)-(9) joint system, for all takeovers that are either leveraged buyouts and/or undertaken by financial sponsors. 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%) change in each regressor. The Wald test examines the exogeneity of the system. Year fixed effects are used in all specifications, but unreported.

	Dependent Variable: Financially Driven 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	**0.684*** **	4.30	2.27%	**1.122*** **	6.66	3.50%	**1.199*** **	3.81	4.21%	**0.283**	0.52	0.93%
(effect of inter-quartile change)			*1.10%*			*1.71%*			*1.98%*			*0.46%*
Sales	**-0.487*** **	-4.23	-1.62%	**-0.202*** **	-2.65	-0.63%	**-0.759*** **	-4.50	-2.66%	**-0.183**	-1.49	-0.60%
R&D	**0.188** **	2.50	0.63%	**0.046*** **	4.05	0.14%	**1.227*** **	4.73	4.31%	**-0.714**	-0.75	-2.34%
ATO	**0.146*** **	5.88	0.49%	**0.127*** **	7.63	0.40%	**-0.083**	-1.62	-0.29%	**0.073*** **	3.23	0.24%
MktShr	**0.037**	0.29	0.12%	**0.058**	0.52	0.18%	**0.041**	0.35	0.15%	**-0.135**	-1.11	-0.44%
Growth	**0.028**	1.26	0.09%	**0.042*** **	2.95	0.13%	**-0.031**	-0.67	-0.11%	**-0.022**	-0.47	-0.07%
BetaAsset	**-0.010**	-0.19	-0.03%	**-0.325*** **	-10.65	-1.01%	**-0.006**	-0.08	-0.02%	**-0.280*** **	-5.99	-0.92%
Leverage	**0.284*** **	4.49	0.94%	**0.042**	1.04	0.13%	**0.505*** **	6.37	1.77%	**0.140** **	2.49	0.46%
Payout	**1.420*** **	5.18	4.72%	**0.008**	0.65	0.02%	**-0.198**	-0.35	-0.70%	**0.028**	1.52	0.09%
HHIFirm	**-0.001**	-0.03	0.00%	**0.197*** **	3.66	0.61%	**-0.028**	-0.55	-0.10%	**0.046**	0.63	0.15%
Inst	**0.410*** **	5.46	1.36%	**0.597*** **	9.98	1.86%	**0.197** **	2.58	0.69%	**0.523*** **	3.62	1.71%
HHISIC3	**0.048**	0.63	0.16%	**-0.030**	-0.38	-0.09%	**-0.049**	-0.62	-0.17%	**-0.071**	-0.76	-0.23%
Amihud	**-0.082*** **	-4.01	-0.27%	**-0.113*** **	-5.98	-0.35%	**-0.041** **	-2.25	-0.14%	**-0.011**	-0.47	-0.04%
# obs & Uncond. Pr.		99,658	1.31%		100,166	1.31%		78,772	1.37%		79,103	1.37%
Wald (chi2 and p-val)		5.76	0.02		27.09	0.00		8.00	0.00		0.08	0.78

Table 6: Robustness Checks

This table reports the results of two robustness checks. Panel A illustrates the correlations between the discount estimates using different quantile restrictions. Panel B estimates the effect of discount on takeover (with feedback) excluding sector-specific funds, and firms within 2.5% of the tercile cutoffs.

Panel A: Correlations of discount estimates using different quantile restrictions

Industry-Specific Frontier

	Valuation measure = Q			Valuation measure = EV/Ebitda		
Quantile restrictions:	α = 0.3	α = 0.2	α = 0.1	α = 0.3	α = 0.2	α = 0.1
Q(α = 0.3)	1.00					
Q(α = 0.2)	0.98	1.00				
Q(α = 0.1)	0.93	0.97	1.00			
EV/Ebitda(α = 0.3)	0.32	0.33	0.31	1.00		
EV/Ebitda(α = 0.2)	0.30	0.31	0.31	0.98	1.00	
EV/Ebitda(α = 0.1)	0.26	0.28	0.29	0.89	0.95	1.00

Firm-Specific Frontier

	Valuation measure = Q			Valuation measure = EV/Ebitda		
Quantile restrictions:	α = 0.3	α = 0.2	α = 0.1	α = 0.3	α = 0.2	α = 0.1
Q(α = 0.3)	1.00					
Q(α = 0.2)	1.00	1.00				
Q(α = 0.1)	0.98	0.99	1.00			
EV/Ebitda(α = 0.3)	0.28	0.27	0.26	1.00		
EV/Ebitda(α = 0.2)	0.29	0.29	0.28	0.99	1.00	
EV/Ebitda(α = 0.1)	0.30	0.30	0.31	0.94	0.97	1.00

Panel B: Effects of discount on takeovers excluding sector-specific funds, and firms close to the tercile cutoffs

	Dependent Variable: Takeover. Discount = Discount(Q)								
	Excluding Sector Funds from MFFlow						Excluding Firms close to Tercile Cutoffs		
	Industry-Specific Frontier			Firm-Specific Frontier			Firm-Specific Frontier		
	Coef	t-stat	dPr/dX	Coef	t-stat	dPr/dX	Coef	t-stat	dPr/dX
Discount	**0.599*** **	6.90	7.27%	**0.566*** **	6.00	7.14%	**0.607*** **	4.91	7.59%
(effect of inter-quartile change)			*4.81%*			*3.48%*			*3.70%*
Sales	**-0.172*** **	-2.69	-2.09%	**0.016**	0.35	0.21%	**-0.005**	-0.08	-0.06%
R&D	**0.062**	1.41	0.75%	**-0.003**	-0.41	-0.04%	**0.001**	0.09	0.01%
ATO	**0.101*** **	6.95	1.23%	**0.046*** **	4.08	0.58%	**0.062*** **	4.23	0.77%
MktShr	**-0.249*** **	-2.86	-3.03%	**-0.188** **	-2.48	-2.37%	**-0.137**	-1.38	-1.71%
Growth	**0.015**	1.17	0.18%	**0.011**	1.28	0.14%	**0.022** **	2.20	0.28%
BetaAsset	**0.046**	1.48	0.56%	**-0.127*** **	-6.61	-1.60%	**-0.120*** **	-4.88	-1.49%
Leverage	**0.090** **	2.41	1.10%	**0.033**	1.39	0.42%	**0.035**	1.14	0.44%
Payout	**0.000**	0.00	0.00%	**0.001**	0.18	0.02%	**0.007**	0.65	0.09%
HHIFirm	**0.197*** **	6.13	2.39%	**0.295*** **	8.52	3.71%	**0.266*** **	5.76	3.32%
Inst	**0.171*** **	4.16	2.08%	**0.158*** **	4.03	2.00%	**0.163*** **	3.13	2.03%
HHISIC3	**-0.084* **	-1.76	-1.02%	**-0.128** **	-2.47	-1.62%	**-0.108**	-1.55	-1.35%
Amihud	**-0.079*** **	-6.98	-0.95%	**-0.076*** **	-6.75	-0.96%	**-0.073*** **	-5.07	-0.91%
# obs		99,658			100,166			54,688	
Wald (chi2 and p-val)		13.86	0.00		22.33	0.00		14.58	0.00