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, where acquisition likelihoods and target valuations simultaneously interact. We find that a firm’s discount to its maximum potential value significantly attracts takeovers (the “trigger effect”) – but market expectations of an acquisition cause the discount to shrink (the “anticipation effect”), reducing the probability that the bid actually occurs. An inter-quartile change in takeover probability leads to a 4 percentage point decrease in the discount, while an inter-quartile change in the discount leads to an average increase of 4 percentage points in acquisition likelihood. This feedback loop reduces the effectiveness of takeovers in correcting managerial failure, and may explain previous findings on the insignificance of raw valuations for takeover probability. In contrast to common wisdom, here financial efficiency reduces real efficiency, since forward-looking prices deter the actions they anticipate.

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

JEL Classification: G34, G14, C14, C34

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1 Introduction

The interaction between financial markets and corporate finance stands at the core of financial economics. This interaction consists of a dual relation, where market prices both affect and reflect corporate events. The relationship is particularly delicate for corrective actions triggered by asset prices. On the one hand, a low market valuation may imply significant agency problems, and trigger intervention – such as a takeover, shareholder activism, or CEO replacement – that is aimed at restoring the firm to its potential value. We call this the trigger effect from prices to corrective actions. On the other hand, since markets are forward-looking, the anticipated future intervention is reflected in the current valuation. This anticipation effect acts to inflate firm value, which may prevent the needed corrective action from being triggered.

Corporate finance typically studies the effect of prices on firm actions; asset pricing examines the reverse relation. This paper provides an empirical analysis of the simultaneous, two-way interaction between prices and corporate events – the combination of the trigger and anticipation effects – which we call the feedback loop. We analyze the importance and implications of this feedback loop in the context of the market for corporate control, estimating a system of equations where market valuations affect and reflect takeover likelihood at the same time.

We choose to study takeovers as they are arguably the most powerful corrective action that can be undertaken. In particular, understanding the feedback loop is key to understanding the relationship between a firm’s market valuation and its takeover vulnerability. This relationship is critical in assessing the effect of the market for corporate control on the efficiency of the overall economy. Marris (1964), Manne (1965), Rappaport (1986) and Jensen (1993) argue that takeovers can play a major role in improving efficiency by correcting managerial agency – not only can disciplinary acquisitions overturn value destruction in companies that are already underperforming, but also the mere threat of a takeover can be a powerful deterrent to rent extraction in the first place. For takeovers to discipline management, it must be that lowly-valued firms are more likely to be acquired. In practice, acquirers, investment bank advisors, and the media indeed frequently motivate acquisitions on the basis of low target valuations.

However, empirical studies on takeovers fail to uncover a systematic negative relationship between valuation and takeover probability. While Cremers, Nair, and John (2008) and Bates, Becher,
and Lemmon (2008) find a negative relationship between takeover likelihood and Q, Palepu (1986) and Ambrose and Megginson (1992) both find no relationship with either market-to-book or price-to-earnings ratios, and Rhodes-Kropf, Robinson, and Viswanathan (2005) document that target market-to-book ratios are in fact higher than in control firms. Such findings suggest that managerial discipline is not a first-order motive for takeovers, and that other factors (e.g. synergies, hubris, or empire-building) are more important. Existing theoretical models also do not predict that market prices affect takeover likelihood. In Grossman and Hart (1980), the acquirer must pay the full post-restructuring value of the target; even if the acquirer has bargaining power, he may bargain with the target only over the underlying efficiency gains and so the market price is an irrelevant “sideshow.” For example, if the target is overpriced due to the anticipation effect or irrationality, and both bidder and target agree on the mispricing, it will not affect the offer price. Moreover, even if the offer price is affected, takeover likelihood may not be. Schwert (1996) finds that the offer price increases dollar-for-dollar with the target’s pre-bid runup. His explanation is that the runup reflects positive new information about the target being released into the market. Therefore, the higher offer price is fully justified by the greater estimated value of the target, and so the attractiveness of the takeover is unaffected. This is consistent with rational asset pricing theory, where highly valued stocks are equally as attractive as lowly valued stocks.

Building on prior findings that prices incorporate takeover expectations (e.g. Schipper and Thompson (1983), Song and Walkling (2000) and Cremers, Nair, and John (2008)), we argue that estimating the underlying trigger effect must account for the anticipation effect. A high valuation may signal that the market believes an acquisition is probable, thus attenuating any relationship between valuation and takeover probability. Controlling for the anticipation effect has the potential to uncover the true relationship between market prices and takeover likelihoods, and also to provide a more accurate measure of the effect of other factors on these two variables.

There are two main challenges for our estimation. The first involves identifying the appropriate measure of market valuation. Previous papers investigate the effect of raw valuations on takeover likelihood, assuming that a low price signals managerial inefficiency and thus high potential benefits from corrective action. However, a low valuation may be consistent with efficient current management and result from the firm being of irremediably low quality – for example, because it is in a
declining and competitive industry. Then, there is no scope for value creation through a takeover. The theoretical basis for the importance of raw valuations for takeover attractiveness is therefore unclear. We posit that the relevant driver is not a firm’s raw valuation, but its “discount” from maximum potential value under full efficiency (also referred to as X-inefficiency). This discount measures the value a bidder can create by restoring a firm to its potential value through a disciplinary acquisition. Our empirical strategy therefore starts by using quantile regression techniques to measure the maximum potential value based on peer firms in the same industry or with similar characteristics, thus allowing us to estimate the discount.

In addition to the above theoretical justification, we also use the discount as our key valuation metric as we are able to find instruments for this measure, which are necessary to identify our system of simultaneous equations. Indeed, finding instrumental variables represents our second main empirical challenge. We require a variable that affects the discount, but does not impact takeover likelihood except for via its effect on the discount. Financial market frictions satisfy these requirements. The level of the discount is a “sufficient statistic” for the profit opportunity from a disciplinary acquisition. The source of the profits is unimportant conditional on the success of a takeover, and so potential acquirers are not concerned by the fraction of the discount that results from market frictions, as opposed to managerial inefficiency. Our main instrument captures price pressure from mutual fund trades mechanically induced by investor inflows or redemptions (as in Coval and Stafford (2007)). 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. Indeed, we find that net mutual fund inflows are significantly negatively correlated with the discount. 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.

Overall, our structural estimation allows us to demonstrate empirically that prices both affect and reflect the probability of a takeover. Indeed, a high discount is likely to trigger a takeover, while

\[1\] The exclusion restriction would be violated if we used raw valuations instead of discounts. 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.
at the same time the anticipation of a takeover shrinks the discount. Without accounting for the fact that prices reflect takeover likelihood, an inter-quartile change in the discount is associated with about a 1 percentage point increase in takeover probability. Controlling for the anticipation effect, the trigger effect rises to an average of 4 percentage points. This is both statistically significant and economically important compared to the 6.2% unconditional probability of a takeover. Hence, consistent with stated practice, but in contrast to earlier academic studies, we find that valuation does indeed 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 takeover probability is associated with an average 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 about 7 – 12 percent, compared to a hypothetical state of no takeover anticipation.

These findings have a number of implications for the takeover market. The underlying negative relationship between takeovers and valuations implies that disciplinary motives are indeed an important driver of acquisitions, supporting the view of Marris (1964), Manne (1965), Rappaport (1986) and Jensen (1993). It also suggests the need for new takeover theories where the market price is not just a sideshow but has real effects on takeover attempts. Such a theory would require the market price not only to affect the offer price, but also in a manner that is viewed asymmetrically by the bidder and target which means that the acquisition no longer takes place.

More generally, by showing that prices in general matter (through using an instrument for prices in the takeover likelihood regression), we demonstrate that any factor that influence prices can also influence takeover activity. For example, mispricing of targets due to investor irrationality can have real consequences by deterring takeover attempts and allowing substantial value destruction to remain uncorrected. (In standard frameworks, both the bidder and target would agree that the target is mispriced, and so the market price would not affect the offer price). This result builds on results in the behavioral corporate finance literature that the stock market affects real decisions: see Morck, Shleifer, and Vishny (1990) and the survey of Baker, Ruback, and Wurgler (2007). Similarly, mispricing due to the anticipation effect can be a significant impediment to takeovers – the anticipation of a takeover boosts prices, deterring the acquisition from actually
occurring. Indeed, as well as being academically intriguing, many practitioners believe that this mechanism has significant effects on real-life takeover activity. A December 22, 2005 *Wall Street Journal* article claims that this has been a major problem in the U.S. banking industry, noting that “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. This idea is reminiscent of the free-rider problem pointed out in the theoretical model of Grossman and Hart (1980), although the market price plays no role in coordinating expectations in their setting.

The feedback loop has implications for the cessation of merger waves. 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. A recent spate of mergers leads the market to predict future acquisitions. This causes valuations to rise (anticipation effect), which in turn deters future bids from occurring (trigger effect). A related topic is takeover defenses. The anticipation effect suggests that an effective takeover defense is to alert the market to the possibility of an upcoming takeover. This can inflate valuations, thus discouraging acquisition attempts. Indeed, conversations with industry practitioners suggest that this is an occasional practice among likely takeover targets.

Our paper builds on a large literature that attempts to identify the motivation for takeovers and their effect on social welfare. While many motives for takeovers exist (e.g. acquirer-specific synergies, hubris and empire-building), here takeovers arise from the potential to correct target inefficiencies. Consistent with this view, Lang, Stulz, and Walkling (1989) document that value creation in tender offers is higher if the target has a low Q ratio; Servaes (1991) shows that this result also holds for mergers. Moreover, Lang, Stulz, and Walkling (1989) find that target Q ratios were significantly higher five years before the tender offer, which suggests that their low valuations reflect
discounts to potential value, rather than irremediably weak fundamentals. Wang and Xie (2008) show that value creation in M&A is greater if a well-governed acquirer buys a poorly-governed target, consistent with disciplinary motives. Healy and Ruback (1992) find that industry-adjusted operating performance improves after a merger. While they analyze the combined entity, McGuckin and Nguyen (1995), Maksimovic and Phillips (2001) and Schoar (2002) use plant-level data to show that it is the target plants that experience productivity increases.

A number of papers have studied one component of the feedback loop in isolation. Palepu (1986), Ambrose and Megginson (1992), Cremers, Nair, and John (2008), Rhodes-Kropf, Robinson, and Viswanathan (2005) and Bates, Becher, and Lemmon (2008) find mixed results on the trigger effect without controlling for feedback. Turning to the anticipation effect, Song and Waling (2000) show that rivals of acquisition targets earn abnormal returns because of the increased probability that they will become targets themselves. Cremers, Nair, and John (2008) demonstrate that target valuations reflect not only the expected takeover premium but also its correlation with macroeconomic factors. Schipper and Thompson (1983) find that acquirers’ stock prices incorporate the expected value created from future merger programs. Hackbarth and Morellec (2008) present theory and evidence that stock prices reflect the probability of a takeover. Prabhala (1997) examines the effect of anticipation on cross-sectional regressions of announcement returns on firm characteristics, and Li and Prabhala (2007) note that takeover anticipation will affect the market return to merger announcements. Our paper considers the entire feedback loop, i.e. simultaneously estimates both the trigger and anticipation effects. Specifically, prior findings on the anticipation effect show that we cannot estimate the trigger effect by a simple regression of takeover likelihood on valuation, and motivate the structural approach that we use in this paper.

In addition to its implications for the takeover market, our paper also contributes to the growing literature that analyzes the link between financial market efficiency and real economic activity. While most existing research suggests that the former is beneficial for the latter\(^2\), our results point to an intriguing disadvantage of forward-looking prices – they may deter the very actions that they anticipate. This is related to the theoretical analysis in Bond, Goldstein, and Prescott (2008) on a

feedback loop between market prices and corrective actions. Empirically, the only explicit analysis is conducted by Bradley, Brav, Goldstein, and Jiang (2007). They show that the discount at which a closed-end fund is traded affects and reflects the probability of activism at the same time. Our paper considers the broader setting of takeovers, studying the relationship between acquisitions and market prices, and developing implications for the efficiency of the market for corporate control.

The remainder of the paper is organized as follows. Section 2 specifies the model that we use for the empirical analysis. In Section 3, we describe our data and variable construction and present our results on the feedback loop. Section 4 concludes.

2 Model Specification

2.1 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.” 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 Section 1. The second is 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 valuation, and thus not satisfy the exclusion restriction. This issue is discussed in more detail in Section 2.2.

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 showing that takeovers correct managerial discipline and are thus induced by low target prices. Synergistic acquisitions may occur even if the target is at its maximum standalone value, i.e. there may be no trigger effect. Therefore, if all takeovers are motivated by synergies (or other non-disciplinary reasons, such as hubris or empire-building), then the discount to frontier value would not matter.

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 market price and the NAV. Indeed, Bradley, Brav, Goldstein, and Jiang (2007) 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. A natural starting point is to observe the valuation of “successful” firms with similar fundamentals. More specifically, let $X$ be a vector of variables that represent firms’ fundamentals that determine the potential value: $V^* = f(X)$. Because $V^*$ represents the potential value free from managerial inefficiencies, the $X$ variables should be firm characteristics that are mostly out of control of the managers and that the 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. 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 over-estimate discounts for other firms.

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 within the peer group 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). The optimal choice of $\alpha$ reflects the trade-off between two factors. A low $\alpha$ may overweight abnormal observations; a high $\alpha$ may underestimate the potential value and thus the occurrence of discounts.

We now discuss the choices for $X$ variables and the parameter $\alpha$. Our first approach for $X$ is to use a firm’s industry affiliation. If a firm suffers from significant agency problems, it should trade
at a discount relative to its industry peers. Moreover, since acquirers are unlikely to change the
target’s industry, their goal is often to restore its value to that commanded by successful firms in
the same industry. Indeed, the industry benchmark is commonly used in the takeover literature
(see, e.g., Rhodes-Kropf, Robinson, and Viswanathan (2005)), as well as by practitioners.\(^3\)

However, the use of an industry benchmark has two main shortcomings. First, it forces all firms
in the same industry to have the same frontier values, which implicitly assumes that a particular
industry cannot be systematically over- or undervalued, contrary to empirical evidence (e.g., Hoberg
and Phillips (2008)). Second, it assumes that industry is the only determinant of frontier valuation,
and thus all firms within the same industry could achieve the same value under full efficiency. In
reality, there are likely to be many other determinants of potential values. For example, small and
growing firms are likely to command higher valuations than larger, mature peers.

We therefore also employ a second approach, using firm-level characteristics as \(X\) variables.
When using firm characteristics, we must be particularly careful to employ only those unlikely
to be changed by the acquirer. 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 relatively quickly reversed. Therefore, we classify the first type of variables as determinants
of the potential value and the second type as the determinants of the discount, since they may
proxy for agency problems. Our choice of \(X\) variables are firm size, firm age, asset intensity, R&D
intensity, market share, growth opportunities, and business cyclicality. These variables are further
motivated in Section 3.2 as well as in Habib and Ljungqvist (2005), who also estimate a frontier
value. While an acquirer’s scope for changing these variables is much smaller than for financial
policies, these variables are not completely exogenous since bidders 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. We note that a bidder may be able to change the tercile of a firm

\(^3\)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.
currently close to the cutoffs. In Section 3.6 we exclude such firms from our analysis.

The remaining specification issue is the choice of \( \alpha \). We calibrate \( \alpha \) from the empirical facts documented by prior literature. According to Andrade, Mitchell, and Stafford (2001), the median (average) 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 (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 be the median percentile of target valuation after adding in the takeover premium (median of 38 percent) to the stock price.\(^4\) We add 38% to the pre-acquisition equity value of each target and then rank each target within firm observations belonging to the SIC three-digit industry from the full sample period, after subtracting year fixed effects. We find that the median percentile ranking of all targets (cum-premium) in our sample is 77%. Rounding to the nearest decile, this corresponds to an \( \alpha \) of 20%. In other words, if we assume that the the cum-premium target valuation represents its maximum potential value, then about 80% (20%) of the firms are traded at a discount (premium) in a given year.\(^5\) In Section 3.6, we vary \( \alpha \) across the range of \([0.10, 0.30]\), and find that our results are not sensitive to the choice of \( \alpha \) within this region.

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

\[
V = X \beta + \varepsilon, \text{ where } \text{Quantile}_{1-\alpha}(\varepsilon) = 0
\]

and \( \varepsilon \) is a disturbance term. More specifically, with actual data \( \{V_{i,t}, X_{i,t}\} \), and for a given \( \alpha \), we

\(^4\)We add a 38% takeover premium to the pre-acquisition value, rather than using the actual acquisition price, as the latter is missing for many transactions. 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.

\(^5\)This choice of \( \alpha \) is also supported by evidence from the closed-end funds, a setting in which the discount can be precisely measured. Bradley, Brav, Goldstein, and Jiang (2007) find that, on average, about 20% (80%) of closed-end funds trade at a premium (discount) to NAV.
estimate $\tilde{\beta}$ in (1) via the least absolute deviation (LAD) method:

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

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

where $f(X_{i,t}; \tilde{\beta})$ is the estimated maximum potential value. Note that (2) holds regardless of the distribution of $\varepsilon$ (or its empirical analog $V_{i,t} - f(X_{i,t}; \tilde{\beta})$), and so we do not require any assumptions for the disturbance term, except for its value at the $\alpha$th percentile. The added non-negativity constraint $f(X_{i,t}; \tilde{\beta}) \geq 0$ (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 $\tilde{\beta}$, the empirical analog to $\text{Discount} = (V^* - V) / V^*$ is

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

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

2.2 Interaction of Takeover and Discount

As previously discussed, there is a bi-directional relationship between takeover likelihood and value discounts. While a high discount may attract a takeover, the expectation of a takeover will cause the discount to shrink and so a simple estimate of the takeover-to-discount sensitivity will underestimate the true, underlying relationship.

To illustrate the importance of accounting for the anticipation effect when quantifying the trigger effect, we start with a simple analysis of a benchmark model where market valuations do not incorporate the possibility of future takeovers. We use $\text{Discount}^0$ to denote the “underlying”
discount that would exist in such a world. In this benchmark model, the system can be written as:

\[
Discount^0 = \gamma_0 X + \gamma_1 Z_1 + \gamma_2 Z_2 + \eta, \quad (4)
\]

\[
Takeover^* = \mu_1 Discount^0 + \mu_2 X + \mu_3 Z_1 + \xi, \quad (5)
\]

\[
Takeover = \begin{cases} 1, & \text{if } Takeover^* > 0, \\ 0, & \text{otherwise}, \end{cases} \quad (6)
\]

\[
corr(\eta, \xi) = 0. \quad (7)
\]

\(Takeover^*\) 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. Managerial agency variables are one example: they cause inefficiencies and increase the discount, and also may be correlated with managerial entrenchment and resistance to takeovers. The second group, \(Z_2\), only affects the discount and has no direct effect on takeover probability. Such variables represent firm characteristics or market frictions that reduce the stock price but that are not related to takeover resistance. Moreover, they disappear or become irrelevant after the firm is taken over and therefore do not affect the maximum value post-acquisition, \(f(X; \beta)\). For example, price pressure caused by mutual fund selling reduces current valuation but does not affect the target’s fundamental worth to a potential acquirer. 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 \(X\), it is not orthogonal to the raw values of \(X\) and so \(X\) 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.

In the presence of a feedback loop, the two 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). Specifically, (4) and (5) should be
remodeled as:

\[
\text{Discount} = \gamma_0 X + \gamma_1 Z_1 + \gamma_2 Z_2 + \delta \xi + \eta', \quad (8)
\]
\[
\text{Takeover}^* = \mu_1 \text{Discount} + \mu_2 X + \mu_3 Z_1 + \xi. \quad (9)
\]

\(\eta\) in (4) is replaced by \(\delta \xi + \eta'\) in (8), where the additional component \(\delta \xi\) represents the shrinkage from the anticipation effect. Since positive shocks to takeover probability will shrink the discount, \(\delta\) should be negative. As a result, we have

\[
\rho = \text{corr}(\eta, \xi) = \text{corr}(\delta \xi + \eta', \xi) = \delta \sigma^2_{\xi}
\]

\[
< 0 \text{ if } \delta < 0,
\]

hence the simultaneity of the system. As the error term \(\xi\) is now correlated with the regressor \(\text{Discount}\), owing to its correlation with the error term \(\delta \xi + \eta'\) in equation (8), we cannot estimate (9) via standard procedures such as probit. Since \(\rho < 0\), the endogeneity acts in the opposite direction from the true \(\mu_1\) and using equation (9) alone will underestimate \(\mu_1\).

The system (8) and (9) cannot be estimated using conventional two-stage least squares because equation (9) is nonlinear. We focus on (9) as the main equation, and use a reduced form of (8) as an input to the main equation. We will back out the structural parameters in (8) from the estimation, as later described in Section 3.4.

The system of (9) is estimated simultaneously using the maximum likelihood method, where the endogenous variable \(\text{Discount}\) is instrumented by the \(Z_2\) variables. The intuition of the estimation is as follows. Suppose we obtain the residual discount, \(\tilde{\text{Discount}}\), from the linear regression as specified in (8):

\[
\tilde{\text{Discount}} = \text{Discount} - \tilde{\gamma}_0 X - \tilde{\gamma}_1 Z_1 - \tilde{\gamma}_2 Z_2. \quad (11)
\]

\(\tilde{\text{Discount}}\) is thus the empirical analog of the sum of two parts: the anticipation effect (\(\delta \xi\)) and an unmodeled residual disturbance (\(\eta'\)). The power of the test rests on the explanatory power of \(X\), \(Z_1\) and \(Z_2\) so that within \(\tilde{\text{Discount}}\) the unmodeled residual \(\eta'\) does not dominate the anticipation effect \(\delta \xi\). Moreover, the residual in (9), \(\xi\), can be expressed as a linear function of \(\tilde{\text{Discount}}\) as follows:

\[
\xi = \lambda \tilde{\text{Discount}} + \xi'. \quad (12)
\]
Substituting (12) into (9) yields:

\[
\text{Takeover}^* = \mu_1 \text{Discount} + \mu_2 X + \mu_3 Z_1 + \lambda \text{Discount} + \xi'.
\]

By adding the projected residual, \(\text{Discount}\), as a control function (or “auxiliary” regressor) in equation (13), the resulting residual \(\xi'\) is now a well-behaved disturbance that is uncorrelated with all other regressors in the \(\text{Takeover}\) equation, including \(\text{Discount}\). As a result, (13) resembles a regular probit specification except that \(\text{Discount}\), 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.

We previously motivated the use of \(\text{Discount}\), rather than \(V\), as the key explanatory variable on theoretical grounds – value creation potential depends on the firm’s discount, rather than its raw value. Having laid out the empirical model, we can now explain how econometric reasons also justify the use of \(\text{Discount}\). If \(V\) was used as the explanatory variable, the \(Z_2\) variables would affect takeover likelihood directly, in addition to their indirect effect through \(V\). 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), and so 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 \(\text{Discount}\), because the level of \(\text{Discount}\) is a sufficient statistic for the profitability of a disciplinary takeover. Regardless of whether \(\text{Discount}\) stems from mispricing or agency problems, it can be corrected by acquisition.
3 Empirical Results

3.1 Data and Sample Description

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 date 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 and Execucomp 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]

3.2 Variable Selection

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 2.1. 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. $^6$ We add the year fixed effects to the pooled 80th percentile values of individual industries to obtain industry-year specific frontier values. 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 rely on firm-specific characteristics that are unlikely to be changed by the acquirer. 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. $^7$ Moreover, size is primarily determined by factors outside the manager’s control such as history and random productivity shocks (e.g. Luttmer (2007)). $Age$ is the firm’s age (from CRSP) which is unchangeable; we also include the square of age. $Growth$ (3-year sales growth) and $MktShr$ (market share) are likely to be positively correlated with valuation and also a function of firm history. $RND$ (the ratio of R&D to sales) may affect valuation as it is correlated with growth opportunities, and $BetaAssets$ (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. Finally, 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. The frontier values based on these firm-specific fundamental variables are estimated using the censored quantile regression technique as specified in (1) and (2), and $Discount$ is constructed accordingly.

$^6$We pool observations from all years for a given SIC three-digit industry (with year fixed effects adjustment) 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.

$^7$We use $Sales$ rather than market capitalization as our measure of size, since the latter is correlated with our dependent variables.
As stated previously, since a bidder can alter these $X$ variables to a degree, we only use their tercile ranks among all Compustat firms in a given year (except for Age, where we use the continuous variable as it is 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.

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 $18 - 28\%$. 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 being a correctable action (which attracts takeovers), 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

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8The 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.

9If the full information contained by the firm-specific $X$ variables were used in the frontier estimation, then Discount should be orthogonal to the $X$ variables. However, since we only use the tercile rank information of these $X$ variables, we allow the $X$ variables to enter the Discount equation as control variables.
variables are correlated with the maturity of the business and thus the stability of cash flows, which facilitates financing of the takeover. As an external governance measure we include HHISIC3, the Herfindahl index of all firms’ sales within the firm’s primary 3-digit SIC, to capture the degree of product market competition and antitrust concerns which may impede acquisition.\footnote{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.} 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 may 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, Mikkelsen and Partch (1989) and Shivdasani (1993) find that block ownership increases the probability of a takeover attempt. We construct \emph{Inst} to be the total percentage ownership by institutions from Thomson Financial.\footnote{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.)} We also add \emph{Amihud}, the Amihud (2002) illiquidity measure. Although this is 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 \emph{MFFlow}, the price pressure created by mutual fund buying and selling in response to investor flows (as in Coval and Stafford (2007)). Appendix A.1 describes its construction in detail. We
assume that following outflows from (inflows to) a mutual fund, it will be pressured to sell (buy) shares in proportion to its current holdings. Hence, for each stock, this measure is the hypothetical net buying by all mutual funds in response to net flows in each period. Since order imbalances affect stock prices (see, e.g. Sias, Starks, and Titman (2006)), $MFFlow$ is negatively correlated with $Discount$.

An important feature of $MFFlow$ is that it is not constructed using mutual funds’ actual purchases and sales, 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 such 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 were 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 3.6 we exclude these sector mutual funds in constructing the $MFFlow$ measure, and find that our results are unchanged.

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.\footnote{Note that our analyst measure is only the number of analysts covering the stock; we do not use their actual forecasts since these 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 \textit{Inst}.} Note that our analyst measure is only the number of analysts covering the stock; we do not use their actual forecasts since these 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 \textit{Inst}.

### 3.3 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.

\[\text{Insert Table 2 here.}\]

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)
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 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.\footnote{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 $Discount$, consistent with the findings of Palepu (1986), Ambrose and Megginson (1992) and Rhodes-Kropf, Robinson, and Viswanathan (2005).} However, the economic magnitude is modest, especially when using $EV/Ebitda$. This is because the observed discounts are shrunk by the anticipation effect. The next section shows that, when feedback is controlled for, the economic significance rises substantially.

### 3.4 Determinants of Takeover and Discount With Feedback

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. 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 several orders of magnitude higher in all four specifications. Table 3 shows that, in the full sample, a one percentage point increase in $Discount$ would lead to a statistically significant $3 - 10$ 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 finds that the instruments are strongly significant. 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. These results indicate that the anticipation effect must be controlled for when estimating the trigger effect. Doing so uncovers that firm valuation is a far more important motivation for takeover activities than implied by the equilibrium correlation between the two variables.

While Table 3 quantified 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 $\delta$ 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 $\delta$ is a linear projection of Discount (defined in (11)) on $\xi$, the shrinkage in discount due to a one unit change in shocks to takeover propensity. We can therefore construct a $\hat{\delta}$ estimate. The empirical analog of Discount is readily available from (11). For the empirical analog of $\hat{\xi}$, we adopt the “generalized residual” for discrete response models as proposed by Gourieroux, Monfort, Renault, and Trognon (1987):

$$\hat{\xi} = \frac{[\text{Takeover} - \hat{\Pr}(\text{Takeover})] \hat{\Pr}'(\text{Takeover})}{\hat{\Pr}(\text{Takeover}) [1 - \hat{\Pr}(\text{Takeover})]} ,$$
where \( \Pr (\text{Takeover}) \) and \( \Pr' (\text{Takeover}) \) represent the estimated probability and density (derivative of probability) of \( \text{Takeover} \), respectively. Assuming that error disturbances are drawn from normal distributions, the above expression becomes

\[
\hat{\xi} = \frac{[\text{Takeover} - \Phi (\hat{u})] \phi (\hat{u})}{\Phi (\hat{u}) [1 - \Phi (\hat{u})]},
\]

where \( \hat{u} = \mu_1 \text{Discount} + \mu_2 X + \mu_3 Z_1 \),

where \( \Phi \) and \( \phi \) represent the cumulative distribution function and the density function of the standard normal distribution.

Finally, the parameter \( \hat{\delta} \) is obtained by regressing \( \text{Discount} \) on \( \hat{\xi} \). The procedure is made possible only by simultaneous estimation of equations (8) and (9) that incorporates the correlation between the error disturbances from the two equations. If the two equations were estimated as separate and exogenous processes (as modeled by equations (4) to (7)), then \( \text{Discount} \) and \( \hat{\xi} \) would be uncorrelated by construction, due to mis-specification.

The results from all four specifications are reported in Table 4. The coefficients on \( \hat{\xi} \) are uniformly negative and highly statistically significant. The economic magnitude of the coefficients is not readily interpretable because \( \xi \) 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. According to our model specification, \( \eta = \delta \xi + \eta' \), where \( E (\eta') = 0 \). Therefore, the intercepts in Table 4 should be close to zero, which also serves as an informal specification test. Indeed, three out of the four intercept estimates in Table 4 are statistically zero. The significant intercept in the specification with \( \text{EV}/\text{Ebitda} \) valuation and industry-specific frontier suggests potential mis-specification with this \( \text{Discount} \) variable, and so we will not use information from this column for our inference.

[Insert Table 4 here.]

Table 4 indicates that if a firm’s takeover likelihood rises, exogenously, by one standard deviation from the mean, \( \text{Discount} \) shrinks by 2 – 3 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.\footnote{Note that we cannot interpret the difference as relative to another firm whose takeover vulnerability is near zero, since these firms will differ on other dimensions.}

Taken together, our results in Tables 3-4 provide evidence of both channels of the feedback loop. Table 4 shows that takeover expectations reduce value discounts: the anticipation effect. Table 3 demonstrates that lower discounts in turn deter takeovers, by reducing a bidder’s potential profit from an acquisition: the trigger effect. The combination of these findings have several implications for the market for corporate control. We start with the trigger effect. The finding that low valuations attract takeovers suggests that many mergers are motivated by the desire to correct managerial failure, rather than synergies, hubris or entrenchment. However, while this finding supports the (unmodeled) managerial discipline theories of Marris (1964), Manne (1965), Rappaport (1986) and Jensen (1993), the importance of market prices is a theoretical puzzle. Even in a framework in which takeovers are motivated by target inefficiency, it is not clear why the market price should matter – if there is free-riding by target shareholders (as in Grossman and Hart (1980)), the bidder must pay $V$ regardless of the current price; 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 creation of fundamental value. The trigger effect can also not be explained by mispricing viewed symmetrically by the bidder and target, nor by the revelation of new information (as in Schwert (1996)) as this would would augment not only the offer price but also the target’s value to the acquirer, and thus have no effect on takeover attractiveness. Our findings thus suggests the need for new takeover theories to explain why market prices should matter for 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) and Cremers, Nair, and John (2008) 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 currently overvalued. By finding evidence on both channels of the feedback loop, we show that mispricing due to takeover
anticipation may deter 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.

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 $\delta$ 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). In addition, our interpretation that the negative effect of takeover likelihood on the discount is caused by the anticipation effect, rather than actual increases in firm value, is consistent with existing evidence that prices incorporate takeover expectations, e.g. Song and Walkling (2000), Schipper and Thompson (1983) and Cremers, Nair, and John (2008).

Considering the entire feedback loop also has implications for takeover defenses and merger waves. First, 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. Indeed, conversations with industry practitioners suggest that this is an occasional practice among likely takeover targets. Second, the feedback loop demonstrates how merger waves can be endogenously self-defeating. When takeover activity is high, market valuations anticipate potential future acquisitions. This causes prices to rise, thus deterring the takeovers from actually occurring and causing the merger wave to end. As noted in Section 1, this phenomenon is currently believed to be halting the recent spate of mergers in the U.K. water industry.

Our instrumental variables technique uses market frictions as an instrument for prices, to identify a relationship between prices in general and takeover likelihood. It thus shows that any factor that affects market prices can affect acquisition probabilities. Therefore, the negative trigger effect extends to other forms of mispricing than takeover anticipation – target overvaluation that results from market irrationality may also impede acquisitions. Our results therefore contribute to the behavioral corporate finance literature (surveyed by Baker, Ruback, and Wurgler (2007)), which
demonstrates the real effects of mispricing.

3.5 Financially-Driven Takeovers

The results thus far have documented that takeovers in general are driven by low target valuations, and so managerial discipline is an important motive for takeovers. However, many acquisitions are primarily driven by other reasons such as synergies or empire building. As such, the trigger effect should be stronger among takeovers that are particularly likely to be motivated by target valuations. We define these “financially-driven takeovers” as acquisitions that are either leveraged buyouts or undertaken by financial sponsors. Such acquisitions are typically driven by underperforming current management or market undervaluation, both of which manifest 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 much smaller unconditional probability. An inter-quartile change in Discount is associated with a 0.4 – 2.0% increase in takeover probability, compared to a 1.3% full-sample probability of a financially driven takeover (down from 6.2% for of all takeovers.)

[Insert Table 5 here.]

3.6 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 \( \alpha \) 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). Our results for various \( \alpha \) values in the range of \([0.1, 0.3]\) are similar to those reported in Tables 2-4. Since our analysis is driven by the relative ranking (rather than the absolute level) of Discount, it is logical that small changes in the estimation of the average discount has little effect on our results. They are untabulated to conserve space, but available from the authors upon request.
Second, as noted in Section 3.2, 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 may be possible for bidders to move them into a different tercile. We therefore rerun the analyses excluding firms within 2.5% in ranking from any tercile percentiles. Panel B of Table 6 shows that the results are slightly stronger than the full sample, with an inter-quartile response of 7.6% compared to an unconditional takeover probability of 5.4% for this subsample.

4 Conclusion

This paper provides evidence of the feedback loop – the dual relationship between financial markets and corporate events. Our chosen corporate event is acquisitions, owing to their importance for the efficiency of the overall economy. Previous papers found that raw valuation has little effect on takeover probability, suggesting that takeovers are not motivated by the disciplinary reasons advocated by Marris (1964), Manne (1965), Rappaport (1986) and Jensen (1993). We posited 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 a firm’s 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 used 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 of corrective action causes the discount to shrink (the anticipation effect). Controlling for the anticipation effect yields coefficient estimates for the trigger effect that are several orders of magnitude higher than in the absence of instrumentation.

Our findings have a number of implications for the efficiency of the market for corporate control. We show that market valuations are not a sideshow but affect takeover activity. Therefore, any factor that inflates market prices will hinder takeovers – mispricing has real effects. In particular, 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 may deter the very actions that they anticipate. The anticipation effect also suggests that a firm may be able to defend against a takeover by making the market aware that it is a potential target. Moreover, the feedback loop offers an explanation for merger waves: recent acquisitions cause the market to price in the possibility of future acquisitions, thus deterring them from actually occurring.

In addition, our paper suggests potential avenues for future research. On the empirical side, it implies that the discount is the appropriate measure of valuation in a disciplinary takeover context. While existing papers have investigated the link between overall value creation and the target’s raw valuation (e.g. Lang, Stulz, and Walkling (1989) and Servaes (1991)), we would expect to see even stronger relations with the target’s discount. Similarly, the predictive power of the discount for future takeovers may imply a profitable trading strategy. 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 current valuations matter.
References


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

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

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

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

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

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

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 \( \rho_{\xi,\eta}/\sigma_\eta \) and variance \( 1 - \rho_{\xi,\eta}^2 \), where \( \rho \) and \( \sigma \) 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

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

and \( \Phi, \phi \) are the cumulative probability and density functions of the standard normal distribution. Equation (16) could be rewritten analogously. Combining all equations, we arrive at the log likelihood for a takeover on a firm-year observation:

\[
l_{i,t} = \text{Takeover}_{i,t} \ln \left[ \Phi \left( u_{i,t-1} \right) \right] + (1 - \text{Takeover}_{i,t}) \ln \left[ 1 - \Phi \left( u_{i,t-1} \right) \right] - \ln(\sigma_\eta) - \frac{\eta^2}{2\sigma_\eta^2}, \tag{17}
\]

where

\[
u = \frac{\mu_1 \text{Discount} + \mu_2 X + \mu_3 Z_1 + \rho_{\xi,\eta} \eta/\sigma_\eta}{\sqrt{1 - \rho_{\xi,\eta}^2}},
\]

\[
\eta = \text{Discount} - \gamma_1 Z_1 - \gamma_2 Z_2.
\]
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

<table>
<thead>
<tr>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Fundamental Variables (X)</strong></td>
</tr>
<tr>
<td>Age</td>
</tr>
<tr>
<td>ATO</td>
</tr>
<tr>
<td>Beta Assets</td>
</tr>
<tr>
<td>Growth</td>
</tr>
<tr>
<td>MktShr</td>
</tr>
<tr>
<td>RND</td>
</tr>
<tr>
<td>Sales</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Variables Affecting Discount and Takeover Probability (Z₁)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amihud</td>
</tr>
<tr>
<td>Daily observations with a zero return are removed. Coded as missing if &lt; 30 observations in a year. From CRSP</td>
</tr>
<tr>
<td>HHIFirm</td>
</tr>
<tr>
<td>HHISIC3</td>
</tr>
<tr>
<td>Inst</td>
</tr>
<tr>
<td>Leverage</td>
</tr>
<tr>
<td>Payout</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Variables Affecting Discount (Z₂)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Analyst</td>
</tr>
<tr>
<td>MFFlow</td>
</tr>
<tr>
<td>Nasdaq</td>
</tr>
<tr>
<td>SPIidx</td>
</tr>
</tbody>
</table>
Panel B: Summary Statistics

<table>
<thead>
<tr>
<th>Name</th>
<th># obs</th>
<th>Mean</th>
<th>Std. Dev.</th>
<th>5th</th>
<th>25th</th>
<th>50th</th>
<th>75th</th>
<th>95th</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>118,942</td>
<td>16.6</td>
<td>11.9</td>
<td>2</td>
<td>7</td>
<td>13</td>
<td>26</td>
<td>34</td>
</tr>
<tr>
<td>ATO</td>
<td>118,942</td>
<td>1.21</td>
<td>0.82</td>
<td>0.17</td>
<td>0.63</td>
<td>1.08</td>
<td>1.59</td>
<td>2.79</td>
</tr>
<tr>
<td>Amihud</td>
<td>101,026</td>
<td>0.77</td>
<td>1.11</td>
<td>0.02</td>
<td>0.11</td>
<td>0.35</td>
<td>0.93</td>
<td>3.05</td>
</tr>
<tr>
<td>Analyst (log)</td>
<td>118,942</td>
<td>1.06</td>
<td>1.16</td>
<td>0.00</td>
<td>0.00</td>
<td>0.69</td>
<td>2.08</td>
<td>3.18</td>
</tr>
<tr>
<td>BetaAssets</td>
<td>117,211</td>
<td>0.69</td>
<td>0.41</td>
<td>0.09</td>
<td>0.38</td>
<td>0.65</td>
<td>0.95</td>
<td>1.45</td>
</tr>
<tr>
<td>Discount (Industry: EV/Ebitda)</td>
<td>92,116</td>
<td>0.18</td>
<td>0.48</td>
<td>-1.05</td>
<td>0.10</td>
<td>0.38</td>
<td>0.57</td>
<td>0.76</td>
</tr>
<tr>
<td>Discount (Industry: Q)</td>
<td>116,543</td>
<td>0.24</td>
<td>0.47</td>
<td>-0.90</td>
<td>0.09</td>
<td>0.37</td>
<td>0.57</td>
<td>0.77</td>
</tr>
<tr>
<td>Discount (Firm: EV/Ebitda)</td>
<td>92,141</td>
<td>0.27</td>
<td>0.48</td>
<td>-1.03</td>
<td>0.11</td>
<td>0.41</td>
<td>0.61</td>
<td>0.79</td>
</tr>
<tr>
<td>Discount (Firm: Q)</td>
<td>116,567</td>
<td>0.28</td>
<td>0.46</td>
<td>-0.92</td>
<td>0.11</td>
<td>0.41</td>
<td>0.60</td>
<td>0.77</td>
</tr>
<tr>
<td>EV/Ebitda</td>
<td>92,141</td>
<td>15.95</td>
<td>28.05</td>
<td>3.76</td>
<td>6.12</td>
<td>8.70</td>
<td>13.77</td>
<td>47.05</td>
</tr>
</tbody>
</table>
| 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 |
| RND(%)                      | 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. 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

<table>
<thead>
<tr>
<th></th>
<th>Industry-Specific Frontier</th>
<th>Firm-Specific Frontier</th>
<th>Industry-Specific Frontier</th>
<th>Firm-Specific Frontier</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Coef</td>
<td>t-stat</td>
<td>dPr/dX</td>
<td>Coef</td>
</tr>
<tr>
<td>Discount (effect of inter-quartile change)</td>
<td>0.287***</td>
<td>15.21</td>
<td>3.34%</td>
<td>0.128***</td>
</tr>
<tr>
<td>Discount (effect of inter-quartile change)</td>
<td>1.61%</td>
<td>0.74%</td>
<td>0.60%</td>
<td>0.41%</td>
</tr>
<tr>
<td>Sales</td>
<td>-0.011</td>
<td>-0.24</td>
<td>-0.12%</td>
<td>0.114**</td>
</tr>
<tr>
<td>R&amp;D</td>
<td>0.022</td>
<td>0.52</td>
<td>0.25%</td>
<td>-0.018**</td>
</tr>
<tr>
<td>ATO</td>
<td>0.074***</td>
<td>6.02</td>
<td>0.87%</td>
<td>0.014</td>
</tr>
<tr>
<td>MktShr</td>
<td>-0.355***</td>
<td>-4.36</td>
<td>-4.13%</td>
<td>-0.273***</td>
</tr>
<tr>
<td>Growth</td>
<td>-0.015</td>
<td>-1.34</td>
<td>-0.17%</td>
<td>-0.007</td>
</tr>
<tr>
<td>BetaAsset</td>
<td>-0.022</td>
<td>-1.10</td>
<td>-0.26%</td>
<td>-0.123***</td>
</tr>
<tr>
<td>Leverage</td>
<td>0.083**</td>
<td>2.22</td>
<td>0.97%</td>
<td>0.012</td>
</tr>
<tr>
<td>Payout</td>
<td>-0.031</td>
<td>-0.17</td>
<td>-0.37%</td>
<td>0.004</td>
</tr>
<tr>
<td>HHI&gt;Firm</td>
<td>0.177***</td>
<td>5.56</td>
<td>2.06%</td>
<td>0.233***</td>
</tr>
<tr>
<td>Inst</td>
<td>0.167***</td>
<td>4.15</td>
<td>1.94%</td>
<td>0.090**</td>
</tr>
<tr>
<td>HHISIC3</td>
<td>-0.071</td>
<td>-1.45</td>
<td>-0.83%</td>
<td>-0.091*</td>
</tr>
<tr>
<td>Amihud</td>
<td>-0.036***</td>
<td>-4.37</td>
<td>-0.42%</td>
<td>-0.023***</td>
</tr>
</tbody>
</table>

# obs and R² 99,658 0.019 6.18% 99,658 0.015 6.18% 99,658 0.018 6.24% 99,658 0.017 6.24%
## Panel B: Determinants of Discount

<table>
<thead>
<tr>
<th>Dep. Var.</th>
<th>Discount(Q)</th>
<th>Discount(EV/Ebitda)</th>
<th>Industry-Specific Frontier</th>
<th>Firm-Specific Frontier</th>
<th>Industry-Specific Frontier</th>
<th>Firm-Specific Frontier</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Coef</td>
<td>t-stat</td>
<td>Coef</td>
<td>t-stat</td>
<td>Coef</td>
<td>t-stat</td>
</tr>
<tr>
<td>Sales</td>
<td>0.669***</td>
<td>23.09</td>
<td>0.317***</td>
<td>8.41</td>
<td>0.557***</td>
<td>14.40</td>
</tr>
<tr>
<td>R&amp;D</td>
<td>-0.220***</td>
<td>-5.57</td>
<td>-0.032***</td>
<td>-7.00</td>
<td>-0.700***</td>
<td>-8.31</td>
</tr>
<tr>
<td>ATO</td>
<td>-0.119***</td>
<td>-15.64</td>
<td>-0.082***</td>
<td>-13.78</td>
<td>0.125***</td>
<td>17.68</td>
</tr>
<tr>
<td>MktShr</td>
<td>-0.193***</td>
<td>-6.09</td>
<td>-0.113***</td>
<td>-3.36</td>
<td>-0.064**</td>
<td>-2.36</td>
</tr>
<tr>
<td>Growth</td>
<td>-0.080***</td>
<td>-10.21</td>
<td>-0.026***</td>
<td>-4.88</td>
<td>-0.063***</td>
<td>-7.84</td>
</tr>
<tr>
<td>BetaAsset</td>
<td>-0.261***</td>
<td>-19.47</td>
<td>0.089***</td>
<td>6.43</td>
<td>-0.124***</td>
<td>-9.93</td>
</tr>
<tr>
<td>Leverage</td>
<td>-0.104***</td>
<td>-3.98</td>
<td>-0.006**</td>
<td>-0.22</td>
<td>-0.228***</td>
<td>-8.53</td>
</tr>
<tr>
<td>Payout</td>
<td>0.397***</td>
<td>4.25</td>
<td>0.012**</td>
<td>2.28</td>
<td>1.154***</td>
<td>15.34</td>
</tr>
<tr>
<td>HHI Firm</td>
<td>-0.069***</td>
<td>-5.26</td>
<td>-0.124***</td>
<td>-9.75</td>
<td>0.007</td>
<td>0.57</td>
</tr>
<tr>
<td>Inst</td>
<td>-0.002</td>
<td>-0.09</td>
<td>-0.007</td>
<td>-0.20</td>
<td>0.088***</td>
<td>4.82</td>
</tr>
<tr>
<td>HHISIC3</td>
<td>-0.058**</td>
<td>-2.28</td>
<td>-0.076***</td>
<td>-2.81</td>
<td>0.011</td>
<td>0.43</td>
</tr>
<tr>
<td>AmihudI2</td>
<td>0.092**</td>
<td>27.86</td>
<td>0.085***</td>
<td>17.39</td>
<td>0.033***</td>
<td>7.67</td>
</tr>
<tr>
<td>MFFlow</td>
<td>-2.119***</td>
<td>-3.88</td>
<td>-1.015**</td>
<td>-2.60</td>
<td>-0.403**</td>
<td>-2.05</td>
</tr>
<tr>
<td>Analyst</td>
<td>-0.009***</td>
<td>-8.77</td>
<td>-0.061***</td>
<td>-6.97</td>
<td>-0.004***</td>
<td>-4.24</td>
</tr>
<tr>
<td>SPIdx</td>
<td>-0.087***</td>
<td>-6.49</td>
<td>-0.062***</td>
<td>-4.37</td>
<td>-0.019*</td>
<td>-1.71</td>
</tr>
<tr>
<td>Nasdaq</td>
<td>0.033***</td>
<td>3.25</td>
<td>0.023**</td>
<td>2.23</td>
<td>-0.012</td>
<td>-0.91</td>
</tr>
</tbody>
</table>

# 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

Year dummies are included but not reported
In column (1) and (3), all non-dummy regressors are expressed as industry-adjusted standard errors are doubly clustered
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.

<table>
<thead>
<tr>
<th></th>
<th>Industry-Specific Frontier</th>
<th>Firm-Specific Frontier</th>
<th>Industry-Specific Frontier</th>
<th>Firm-Specific Frontier</th>
</tr>
</thead>
<tbody>
<tr>
<td>Discount</td>
<td>0.558***</td>
<td>0.489***</td>
<td>1.119***</td>
<td>0.270</td>
</tr>
<tr>
<td>(effect of inter-quartile change)</td>
<td>3.25%</td>
<td>2.97%</td>
<td>7.09%</td>
<td>1.64%</td>
</tr>
<tr>
<td>Sales</td>
<td>-0.149**</td>
<td>0.031</td>
<td>-0.494***</td>
<td>-0.051</td>
</tr>
<tr>
<td>R&amp;D</td>
<td>0.054</td>
<td>-0.006</td>
<td>1.043***</td>
<td>0.406</td>
</tr>
<tr>
<td>ATO</td>
<td>0.098***</td>
<td>0.041***</td>
<td>-0.119***</td>
<td>0.014</td>
</tr>
<tr>
<td>MktShr</td>
<td>-0.263***</td>
<td>-0.201***</td>
<td>-0.205**</td>
<td>-0.264***</td>
</tr>
<tr>
<td>Growth</td>
<td>0.012</td>
<td>0.009</td>
<td>0.040*</td>
<td>0.018</td>
</tr>
<tr>
<td>BetaAsset</td>
<td>0.034</td>
<td>-0.122***</td>
<td>0.054</td>
<td>-0.099***</td>
</tr>
<tr>
<td>Leverage</td>
<td>0.088**</td>
<td>0.034</td>
<td>0.322***</td>
<td>0.134***</td>
</tr>
<tr>
<td>Payout</td>
<td>0.012</td>
<td>0.003</td>
<td>-1.197***</td>
<td>0.013</td>
</tr>
<tr>
<td>HHIFirm</td>
<td>0.194***</td>
<td>0.283***</td>
<td>0.095***</td>
<td>0.187***</td>
</tr>
<tr>
<td>Inst</td>
<td>0.165***</td>
<td>0.145***</td>
<td>-0.011</td>
<td>0.086</td>
</tr>
<tr>
<td>HHISIC3</td>
<td>-0.086*</td>
<td>-0.129**</td>
<td>-0.127**</td>
<td>-0.108*</td>
</tr>
<tr>
<td>Amihud</td>
<td>-0.075***</td>
<td>-0.069***</td>
<td>-0.058***</td>
<td>-0.052***</td>
</tr>
</tbody>
</table>

|                |                          |                        |                          |                        |
| # obs          | 99,658                   | 100,166                | 78,772                   | 79,103                 |
| Weak instrument tests | F(4, #obs) and p-val | 193.46                  | 127.53                   | 29.49                   | 46.87                   |
| Exogeneity tests | Wald (chi2 and p-val) | 8.80                    | 6.88                     | 6.008                   | 0.34                    |

* = 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 in Takeover from equation (14). Also reported are the changes in the residual discount for one standard deviation change in the shocks in 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.

<table>
<thead>
<tr>
<th>Dep. Var.</th>
<th>η (residual Discount(Q))</th>
<th>η (residual Discount(EV/Ebitda))</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Industry-Specific Frontier</td>
<td>Firm-Specific Frontier</td>
</tr>
<tr>
<td></td>
<td>Coef</td>
<td>t-stat</td>
</tr>
<tr>
<td>ξ (shocks in Takeover*) (Effect of one standard deviation)</td>
<td>-0.036***</td>
<td>-9.50</td>
</tr>
<tr>
<td>Cnst</td>
<td>0.000</td>
<td>-0.09</td>
</tr>
<tr>
<td># obs and R²</td>
<td>99,658</td>
<td>0.002</td>
</tr>
</tbody>
</table>
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 \( d\Pr/dX \) 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.

<table>
<thead>
<tr>
<th>Dependent Variable: Financially Driven Takeover</th>
<th>Discount = Discount(Q)</th>
<th>Discount = Discount(EV/Ebitda)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Industry-Specific Frontier</td>
<td>Firm-Specific Frontier</td>
</tr>
<tr>
<td>Discount</td>
<td>Coef</td>
<td>t-stat</td>
</tr>
<tr>
<td>(effect of inter-quartile change)</td>
<td>1.10%</td>
<td>1.71%</td>
</tr>
<tr>
<td>Discount</td>
<td>0.684***</td>
<td>4.30</td>
</tr>
<tr>
<td>Sales</td>
<td>-0.487***</td>
<td>-4.23</td>
</tr>
<tr>
<td>R&amp;D</td>
<td>0.188**</td>
<td>2.50</td>
</tr>
<tr>
<td>ATO</td>
<td>0.146***</td>
<td>5.88</td>
</tr>
<tr>
<td>MktShr</td>
<td>0.037</td>
<td>0.29</td>
</tr>
<tr>
<td>Growth</td>
<td>0.028</td>
<td>1.26</td>
</tr>
<tr>
<td>BetaAsset</td>
<td>-0.010</td>
<td>-0.19</td>
</tr>
<tr>
<td>Leverage</td>
<td>0.284***</td>
<td>4.49</td>
</tr>
<tr>
<td>Payout</td>
<td>1.420***</td>
<td>5.18</td>
</tr>
<tr>
<td>HHI Firm</td>
<td>-0.001</td>
<td>-0.03</td>
</tr>
<tr>
<td>Inst</td>
<td>0.410***</td>
<td>5.46</td>
</tr>
<tr>
<td>HHISIC3</td>
<td>0.048</td>
<td>0.63</td>
</tr>
<tr>
<td>Amihud</td>
<td>-0.082***</td>
<td>-4.01</td>
</tr>
<tr>
<td># obs &amp; Uncond. Pr.</td>
<td>99,658</td>
<td>1.31%</td>
</tr>
<tr>
<td>Wald (chi2 and p-val)</td>
<td>5.76</td>
<td>0.02</td>
</tr>
</tbody>
</table>
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

<table>
<thead>
<tr>
<th>Valuation measure = Q</th>
<th>Valuation measure = EV/Ebitda</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Quantile restrictions:</strong></td>
<td><strong>α = 0.3</strong></td>
</tr>
<tr>
<td>Q(α = 0.3)</td>
<td>1.00</td>
</tr>
<tr>
<td>Q(α = 0.2)</td>
<td>0.98</td>
</tr>
<tr>
<td>Q(α = 0.1)</td>
<td>0.93</td>
</tr>
</tbody>
</table>

Firm-Specific Frontier

<table>
<thead>
<tr>
<th>Valuation measure = Q</th>
<th>Valuation measure = EV/Ebitda</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Quantile restrictions:</strong></td>
<td><strong>α = 0.3</strong></td>
</tr>
<tr>
<td>Q(α = 0.3)</td>
<td>1.00</td>
</tr>
<tr>
<td>Q(α = 0.2)</td>
<td>1.00</td>
</tr>
<tr>
<td>Q(α = 0.1)</td>
<td>0.98</td>
</tr>
</tbody>
</table>
Panel B: Effects of discount on takeovers excluding sector-specific funds, and firms close to the tercile cutoffs

<table>
<thead>
<tr>
<th></th>
<th>Industry-Specific Frontier</th>
<th>Firm-Specific Frontier</th>
<th>Excluding Firms close to Tercile Cutoffs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Discount</td>
<td><strong>0.599</strong>* 6.90 7.27%</td>
<td><strong>0.566</strong>* 6.00 7.14%</td>
<td><strong>0.607</strong>* 4.91 7.59%</td>
</tr>
<tr>
<td></td>
<td>(effect of inter-quartile change)</td>
<td>4.81%</td>
<td>3.48%</td>
</tr>
<tr>
<td>Sales</td>
<td>-<strong>0.172</strong>* -2.69 -2.09%</td>
<td><strong>0.016</strong> 3.5 0.21%</td>
<td>-<strong>0.005</strong> -0.08 -0.06%</td>
</tr>
<tr>
<td>R&amp;D</td>
<td><strong>0.062</strong> 1.41 0.75%</td>
<td>-<strong>0.003</strong> -0.41 -0.04%</td>
<td><strong>0.001</strong> 0.09 0.01%</td>
</tr>
<tr>
<td>ATO</td>
<td><strong>0.101</strong>* 6.95 1.23%</td>
<td><strong>0.046</strong>* 4.08 0.58%</td>
<td><strong>0.062</strong>* 4.23 0.77%</td>
</tr>
<tr>
<td>MktShr</td>
<td>-<strong>0.249</strong>* -2.86 -3.03%</td>
<td>-<strong>0.188</strong> -2.48 -2.37%</td>
<td>-<strong>0.137</strong> -1.38 -1.71%</td>
</tr>
<tr>
<td>Growth</td>
<td><strong>0.015</strong> 1.17 0.18%</td>
<td><strong>0.011</strong> 1.28 0.14%</td>
<td><strong>0.022</strong> 2.20 0.28%</td>
</tr>
<tr>
<td>BetaAsset</td>
<td><strong>0.046</strong> 1.48 0.56%</td>
<td>-<strong>0.127</strong>* -6.61 -1.60%</td>
<td>-<strong>0.120</strong>* -4.88 -1.49%</td>
</tr>
<tr>
<td>Leverage</td>
<td><strong>0.090</strong> 2.41 1.10%</td>
<td><strong>0.033</strong> 1.39 0.42%</td>
<td><strong>0.035</strong> 1.14 0.44%</td>
</tr>
<tr>
<td>Payout</td>
<td><strong>0.000</strong> 0.00 0.0%</td>
<td><strong>0.001</strong> 0.18 0.02%</td>
<td><strong>0.007</strong> 0.65 0.09%</td>
</tr>
<tr>
<td>HHIFirm</td>
<td><strong>0.197</strong>* 6.13 2.39%</td>
<td><strong>0.295</strong>* 8.52 3.71%</td>
<td><strong>0.266</strong>* 5.76 3.32%</td>
</tr>
<tr>
<td>Inst</td>
<td><strong>0.171</strong>* 4.16 2.08%</td>
<td><strong>0.158</strong>* 4.03 2.00%</td>
<td><strong>0.163</strong>* 3.13 2.03%</td>
</tr>
<tr>
<td>HHISIC3</td>
<td>-<strong>0.084</strong> -1.76 -1.02%</td>
<td>-<strong>0.128</strong> -2.47 -1.62%</td>
<td>-<strong>0.108</strong> -1.55 -1.35%</td>
</tr>
<tr>
<td>Amihud</td>
<td>-<strong>0.079</strong>* -6.98 -0.95%</td>
<td>-<strong>0.076</strong>* -6.75 -0.96%</td>
<td>-<strong>0.073</strong>* -5.07 -0.91%</td>
</tr>
</tbody>
</table>

# obs | 99,658 | 100,166 | 54,688
Wald (chi2 and p-val) | 13.86 0.00 | 22.33 0.00 | 14.58 0.00