

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 5 percentage point decrease in the discount, while an inter-quartile change in the discount leads to a 3-4 percentage point increase 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 many existing papers, here financial efficiency reduces real efficiency, since forward-looking prices may deter the very actions that 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

It is commonly believed that the market for corporate control imposes discipline on firm managers. The mechanism often proposed is that a decrease in a firm's share price makes the firm an attractive target for takeover, which is aimed at bringing the firm back to its potential value. Indeed, Marris (1964), Manne (1965), Rappaport (1986) and Jensen (1993) argue that a well-functioning takeover market can have substantial benefits for the efficiency of the overall economy.

The market for corporate control is complicated by the dual relation between market prices and takeover activities. On the one hand, a low market valuation may increase the potential for profit from a takeover and trigger a takeover attempt. We call this the "trigger effect" from prices to takeovers. On the other hand, since markets are forward-looking, the anticipated future takeover is reflected in the current valuation. This "anticipation effect" acts to inflate firm value, which may prevent the takeover attempt from being triggered. Prior analysis of the takeover market focuses on one of these two effects. In this paper, we attempt to analyze the simultaneous, two-way interaction between prices and takeovers – the combination of the trigger and anticipation effects – which we call the "feedback loop."

Understanding the feedback loop is key to understanding the workings of the takeover market. First, if the anticipation effect is a significant impediment to takeovers, substantial value destruction may remain uncorrected. 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 by Ian McDonald 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. Our paper empirically documents the dual role of prices in the takeover market.

Second, consideration of the feedback loop can help us understand the surprising apparent lack of correlation between valuations and takeover activity. While acquirers, investment bank advisors, and the media frequently motivate acquisitions on the basis of low target valuations, empirical studies on takeovers fail to uncover this relation. For example, Palepu (1986) and Ambrose and Megginson (1992) both find that takeover likelihood is related neither to market-to-book nor to 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. These results may suggest that mergers are not primarily motivated by the desire to discipline underperforming targets (as advocated by Marris (1964), Manne (1965), Rappaport (1986) and Jensen (1993)) but instead by other reasons such as synergies or empire building – thus, the market for corporate control does not correct inefficiencies. We posit that this apparent inconsistency with stated practice and disciplinary motives arises because the valuation itself endogenously reflects the takeover likelihood. A high valuation may signal that the market believes an acquisition is probable, thus attenuating any relationship between valuation and takeover probability. In our terminology, estimation of the trigger effect must control for the anticipation effect. Correct estimation of the dual relation between market valuations and takeover probabilities has the potential to uncover the true underlying relation, and also to provide a more accurate measure of the effect of other variables on market prices and takeover likelihoods.

There are two main challenges in the estimation we conduct in this paper. The first challenge 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 highly competitive industry. Then, there is no scope for value creation through a takeover. The theoretical basis for the importance of raw valuations is therefore unclear. We instead argue that the relevant driver is not a firm’s raw valuation, but its “discount” from maximum potential value under full efficiency.¹ This discount measures

¹Note that the existence of discounts does not imply market inefficiency. Firms that suffer agency problems are fairly valued at a discount to maximum potential value, so there is no arbitrage opportunity for a passive investor. Activist investors indeed target firms that are underachieving their potential.

the value that can be created by restoring a firm to its potential value through a disciplinary acquisition, and thus the target’s attractiveness to a bidder. Our empirical strategy therefore starts by using techniques from stochastic frontier theory (Aigner, Lovell, and Schmidt (1977)) to estimate this discount.²

In addition to its theoretical correctness described above, 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. We therefore use variables that reflect financial market frictions, since they affect the discount but have no direct effect on takeover attractiveness. 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.³ The main variable we use in this category captures price pressure due to mutual fund trades mechanically induced by investor inflows or redemptions (as in Coval and Stafford (2006)). 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 mutual fund inflows are significantly negatively correlated with the discount. Similar logic motivates our use of 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,

²Hunt-McCool, Koh, and Francis (1996) and Habib and Ljungqvist (2005) are examples of other applications of the stochastic frontier analysis to financial economics. The former use it to calculate a measure of pre-market underpricing and the latter focus on how the firm’s valuation discount is affected by managerial incentives. As we explain later, however, our motivation and specification are quite different from both of these earlier papers.

³The 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.

while 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 a 0.6 – 1.1 percentage point increase in takeover probability. Controlling for the anticipation effect, the trigger effect rises to 2.9 to 4.2 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 and disciplinary motives for acquisitions, 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. An inter-quartile change in takeover probability is associated with a 5 percentage point decrease in the discount, versus a mean discount of 20–24%. The equity of a firm at the 95th percentile of takeover vulnerability is overvalued by 13 percent, compared to a hypothetical state of no takeover anticipation.

Our results shed new light on various issues related to acquisitions. First, they suggest a significant impediment to the market for corporate control. Marris (1964), Manne (1965), Rappaport (1986) and Jensen (1993) argue that highly inefficient firms are ripe candidates for takeovers, owing to the large value creation potential. However, the very firms that would benefit most from disciplinary action are also those whose prices will be most inflated by market anticipation – thus deterring the acquisitions from actually occurring.

A second important issue is the emergence and cessation of merger waves. A number of existing papers analyze the causes of merger 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 anticipate future acquisitions; this causes valuations to rise, which in turn deters future bids from occurring. 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. In our model, takeovers arise from the potential to correct target inefficiencies and lead to increases in total surplus. 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. Healy and Ruback (1992) find that industry-adjusted operating performance improves after a merger. While they analyze the combined entity, McGuckin and Nguyen (1995) and Schoar (2002) use plant-level data to show that it is the target plants that experience productivity increases. Supporting the hypothesis that acquisitions increase social welfare, a number of studies document that combined shareholder returns are significantly positive (see Jensen and Ruback (1983) and Andrade, Mitchell, and Stafford (2001) for surveys of the evidence), and that these gains do not come at the expense of other stakeholders (see the summary of Jarrell, Brickley, and Netter (1988)). In Hackbarth and Morellec (2007), stock prices also reflect the probability of a takeover. Their theoretical paper focuses on the effect of mergers on the betas of acquirers and targets, rather than their incorporation into target price levels.

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 latter⁴, our results point to an intriguing disadvantage of forward-looking prices – they may deter the very actions that they anticipate. 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, and generates implications for the efficiency of the market for corporate control.

Finally, our method enables us to uncover that prices reflect the probability of takeovers. It is natural to conjecture that they would also reflect the probability of other corrective actions, such as CEO replacement. Given that such corrective actions are likely to be affected by the price – since

⁴See: Fishman and Hagerty (1992), Khanna, Slezak, and Bradley (1994), Dow and Gorton (1997), Subrahmanyam and Titman (1999), Fulghieri and Lukin (2001), Goldstein and Guembel (2008), Dow, Goldstein, and Guembel (2008), Admati and Pfleiderer (2008), Edmans (2008) and Edmans and Manso (2008).

the price reveals information that is useful to the decision on a corrective action – these settings will also be plagued by a feedback loop that requires careful econometric analysis. An advantage of the takeover setting is that market values affect takeovers mostly through the prices that raiders will have to pay for the target’s shares. This justifies the assumption that the source of the discount – whether market frictions or agency problems – does not matter for the takeover incentive and renders our instrumental variable valid. This may not be the case in other settings where the feedback loop between market prices and corrective actions result from information conveyed by the market price.⁵

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 value under full efficiency and zero market frictions. 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 both valuation and takeover probability directly, and thus not satisfy the exclusion restriction. This issue is discussed in more detail in Section 2.2.

Under some circumstances, such as in closed-end funds, the discount is well defined and can be calculated as the difference between the market price and the net asset value (NAV) per share. Bradley, Brav, Goldstein, and Jiang (2007) find that activist shareholders are more likely to target closed-end funds that are trading at deep discounts. In a similar vein, regular corporations are

⁵See Bond, Goldstein, and Prescott (2008) for an equilibrium analysis of a feedback loop between market prices and corrective actions due to learning.

also closed-end entities whose market value can deviate from its maximum potential, and such inefficiency can be alleviated by disciplinary takeovers. Unlike in closed-end funds, the discount cannot be observed directly. Therefore, the first step of our analysis is to construct this discount variable for each individual firm at each time period.

Let X be a vector of variables that represent a firm’s fundamentals, including those related to its production function, investment opportunity set and competitive environment. The firm’s maximum potential value (under zero agency costs or market frictions) can be expressed as a function $V^* = f(X; \beta)$, where β is a vector of parameters. For example, V^* will be higher if the firm is in a growing industry. By definition, the firm’s actual value, V , satisfies the following inequality:

$$V \leq f(X; \beta). \tag{1}$$

For any given valuation measure V , the above system could be estimated using a standard linear programming technique to minimize a “loss function,” such as the absolute distance between the actual and potential valuation. However, this method is problematic since it requires (1) to hold for all firms, i.e. it strictly forces all observed valuations to be below the frontier. It is therefore highly sensitive to noise stemming from “luck”, misvaluation or measurement error, or idiosyncratic features such as unique core competencies. For example, if a single firm is overvalued due to mispricing, or justifiably richly valued owing to inimitable management talent or first-mover advantage, this method would erroneously assume that this high valuation was achievable for all firms. The frontier, and thus discounts, would be significantly overestimated. Separately, measurement error will arise if X is not fully exhaustive of all value-relevant fundamental variables, and so the inequality of (1) will be violated for some observations. The estimation process should allow for such violations.

An improved specification allows the valuation frontier to be stochastic, thus removing the effect of outliers and accounting for noise (see Aigner, Lovell, and Schmidt (1977) for a survey of the estimation of stochastic frontiers). As a result, (1) can be relaxed to

$$V \leq f(X; \beta), \text{ with probability } 1 - \alpha, \text{ where } 0 \leq \alpha \leq \frac{1}{2}. \tag{2}$$

When $\alpha = 0$, (2) is reduced to (1); when $\alpha = \frac{1}{2}$, $f(X; \beta)$ becomes the standard median, rather than the frontier function. $\alpha > 0$ incorporates the fact that (1) will be violated for some observations.

The optimal choice of α reflects the trade-off between two factors. A low α may overweight extreme observations; a high α may underestimate the occurrence of discounts.⁶

Specifically, α provides *Discount* estimates for individual firms relative to firms whose valuations are at the $(1 - \alpha)$ th percentile conditional on the X variables. Ideally, we would like to treat α as an additional parameter to be estimated by the data, but this is not possible without knowledge of the distribution of potential firm values. In our baseline analysis, we assume α to be 20%. We motivate such a choice as follows. First, a natural starting point for determining the value of α is data from closed-end funds, since the discount can be precisely measured in this setting. Bradley, Brav, Goldstein, and Jiang (2007) find that, on average, about 20% of the closed-end funds trade at a premium. Analogously, we assume that valuations are below their potential level in 80% of all firm-year observations. We acknowledge that regular firms are different from closed-end funds, and so the appropriate α in our setting may be somewhat different. Second, we cross-check the resulting estimates of value discounts among takeover targets with related empirical facts. Based on $\alpha = 20\%$, the average value discount among targets is estimated to be 30% – 32%, very much in line with the average takeover premium documented by Jensen and Ruback (1983) and Andrade, Mitchell, and Stafford (2001). To the extent that both the discount and takeover premium reflect the potential of value improvement for the target upon takeover, the consistency suggests that the actual value of α is likely to be in the neighborhood of 20%. Further, we conduct sensitivity analyses by varying α across the range of $[0.10, 0.30]$, and find that our results are not sensitive to variation of α in this reasonable range.

The inequality (2) can be expressed as an equality by adding a disturbance term ε :

$$V = f(X; \beta) + \varepsilon, \text{ where } \text{quantile}_{1-\alpha}(\varepsilon) = 0. \quad (3)$$

In turn, $\text{quantile}_{1-\alpha}(\varepsilon)$ is the solution to ξ in the following equation (see, e.g., Koenker and Bassett (1978)):

$$\min_{\xi} E_{\varepsilon > \xi} [(1 - \alpha)|\varepsilon - \xi|] + E_{\varepsilon \leq \xi} (\alpha|\varepsilon - \xi|). \quad (4)$$

⁶Almost all estimation methods require some parametric assumptions. For example, the OLS estimation assumes that the error disturbances have a zero mean value; and the probit estimation assumes that a positive discrete response occurs when the underlying propensity score is greater than zero. Later in this section we describe how our methodology requires fewer parametric assumptions than other implementations of stochastic frontier analysis.

To estimate (3) with actual data $\{V_{i,t}, X_{i,t}\}$, the objective function over the estimated $\hat{\beta}$ can be obtained by translating (4) into empirical analogs and using the identifying assumption $quantile_{1-\alpha}(\varepsilon) = 0$:

$$\min_{\hat{\beta} \in \mathcal{B}} \frac{1}{n} \left\{ \sum_{V_{i,t} > f(X_{i,t}; \hat{\beta})} (1 - \alpha) |V_{i,t} - f(X_{i,t}; \hat{\beta})| + \sum_{V_{i,t} \leq f(X_{i,t}; \hat{\beta})} \alpha |V_{i,t} - f(X_{i,t}; \hat{\beta})| \right\}, \quad (5)$$

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

Note that equations (4) and (5) hold regardless of the distribution of ε (or its empirical analog $V_{i,t} - f(X_{i,t}; \hat{\beta})$), and so we do not require any assumptions for the disturbance term, except for its value at the α th percentile. We estimate $\hat{\beta}$ using the least absolute deviation (LAD) method (also known as the quantile regression technique) which takes into account this constraint, and employ quadratic functions of X for $f(X_{i,t}; \hat{\beta})$. To further account for the non-negativity constraint $f(X_{i,t}; \hat{\beta}) \geq 0$ (which reflects limited liability), we use the censored least absolute deviation (CLAD) method as proposed by Powell (1984).

Our key empirical measure is the firm's percentage discount to its maximum potential value V^* , defined by $Discount = (V^* - V) / V^*$. The empirical analog to $Discount$ is

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

The estimation procedure described above is semi-parametric in nature. On the one hand, the estimation relies on the parametric functional form of $f(\cdot)$ (which we assume to be quadratic); on the other hand, the estimation of (5) is consistent under any assumptions about the distributions of ε , except its location at quantile $(1 - \alpha)$.

An alternative method is proposed by Aigner, Lovell, and Schmidt (1977), analyzed by Kumbhakar and Lovell (2000), and used in Hunt-McCool, Koh, and Francis (1996) and Habib and Ljungqvist (2005). This method expresses the stochastic frontier as

$$V = f(X; \beta) + \varepsilon,$$

where

$$\varepsilon = u + v. \quad (6)$$

While our method is nonparametric about ε , (6) is a parametric method and thus requires assumptions about the shape of the distribution of ε . The random variable ε is comprised of two components. The first, u , is a symmetric random disturbance that captures the combined effect of missing fundamental variables, luck, and misvaluation. The second, v , represents the (negative of the) valuation discount, and is thus one sided ($v \leq 0$). The usual procedure is to assume that u and v respectively follow normal and lower-half normal (or negative exponential) distributions, and obtain $\hat{\beta}$ using the maximum likelihood estimation (MLE) method. We conducted simulations and found that the method in (6) is not suitable for our particular context. Specifically, since v is lower-half normal, it aims to capture any left skewness in the data. If the valuation frontier is right-skewed, then there is no left skewness for v to absorb. \hat{v} thus frequently equals its corner value of zero, and is thus severely underestimated. Given that most financial variables exhibit skewness, we choose the specification in (5).⁷ Further, since (5) makes no parametric assumptions regarding the disturbance term, it accommodates heteroskedasticity and within-cluster correlation, both 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 should 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 $Discount^0$ to denote the “underlying”

⁷Indeed, estimating (6) using MLE on our sample data results in $\sigma_v \rightarrow 0$, i.e. the error disturbance v is degenerate. As a result, the MLE estimation collapses to the OLS estimation. Theoretically, one could account for skewness by allowing u to be skewed. However, the appropriate correction would require us to know the “natural” skewness of the valuation frontier (i.e. the distribution of maximum potential firm values), but we can only observe actual valuations (which incorporate the discount). It is therefore not possible to “correct” the parametric method for skewness, and so we use a semi-parametric method.

discount that would exist in such a world. In this benchmark model, the system can be written as:

$$Discount^0 = \gamma_1 Z_1 + \gamma_2 Z_2 + \eta, \quad (7)$$

$$Takeover^* = \mu_1 Discount^0 + \mu_2 X + \mu_3 Z_1 + \xi, \quad (8)$$

$$Takeover = \begin{cases} 1, & \text{if } Takeover^* > 0, \\ 0, & \text{otherwise,} \end{cases} \quad (9)$$

$$corr(\eta, \xi) = 0. \quad (10)$$

$Takeover^*$ is the latent variable for the propensity of a takeover bid, and $Takeover$ is the corresponding observed variable. Given that $corr(\eta, \xi) = 0$, 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 a direct effect on takeover probability. Such variables represent firm characteristics or market frictions that reduce the stock price, but 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 reason why Z_2 is excluded from equation (8) is that it does not affect the likelihood of acquisition except via its effect on the discount. Z_2 is irrelevant once the discount is controlled for, since the level of the discount is a "sufficient statistic" for the profit opportunity from acquisition. We take a stand that the *source* of the profits is unimportant – potential acquirers are not concerned by the fraction of the discount that results from market frictions, as opposed to managerial agency. Conditional upon a successful takeover, Z_1 and Z_2 are thus symmetric. The difference between these variables is that, before an acquisition, Z_1 may be correlated with entrenchment and thus the likelihood of a successful takeover in the first place. This distinction will become important when we incorporate the anticipation effect and require instruments.

Fundamental variables X do not appear in equation (7) because by construction, $Discount$ is net of the effect of the fundamentals which determine the frontier level. However, we allow X 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; indeed, Palepu (1986) and Mikkelsen and Partch (1989) find that smaller firms are likelier targets. 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, *Discount* will shrink - i.e. the actual *Discount* will be lower than the underlying *Discount*⁰ as modeled by (7). Specifically, (7) and (8) should be remodeled as:

$$Discount = \gamma_1 Z_1 + \gamma_2 Z_2 + \delta \xi + \eta', \quad (11)$$

$$Takeover^* = \mu_1 Discount + \mu_2 X + \mu_3 Z_1 + \xi. \quad (12)$$

η in (7) is replaced by $\delta \xi + \eta'$ in (11) owing to the anticipation effect. Since positive shocks to takeover probability will shrink the discount, δ should be negative. As a result, we have

$$\begin{aligned} \rho &= corr(\eta, \xi) = corr(\delta \xi + \eta', \xi) = \delta \sigma_\xi^2 \\ &< 0, \text{ if } \delta < 0, \end{aligned} \quad (13)$$

hence the simultaneity of the system.

The system of (11) and (12) is reminiscent of the supply-demand curve identification. In (12), we wish to identify the slope of the demand curve for targets, i.e. the effect of changes in valuation on the quantity demanded, holding the “supply” curve (discount formation) constant. When the price of takeover targets rises (i.e. the discount falls), the quantity demanded of targets should decline. The true μ_1 in (12) should be positive (the trigger effect). However, tracing out this demand curve is complex as the discount will be affected by an upward shift in (rather than movement along) the demand curve. We therefore require a supply shifter that affects the price without altering the demand curve. (13) illustrates the likely outcome of weak (or no) instrumentation: since $\rho < 0$, the endogeneity acts in the opposite direction from the true μ_1 and using equation (12) alone will underestimate μ_1 .

The system (11) and (12) cannot be estimated using conventional two-stage least squares because equation (12) is nonlinear. We focus on (12) as the main equation, and use a reduced form

of (11) as an input to the main equation. We will back out the structural parameters in (11) from the estimation, as described in Section 3.4.

In order to estimate (12) allowing for the endogeneity of *Discount*, we use the probit version of the instrumental variables method. *Discount* is instrumented by Z_2 , a vector of market friction variables that affect valuation but do not affect takeover resistance or the value after a successful takeover. They therefore affect the takeover likelihood only through their impact on *Discount*. The likelihood function of the probit model with an endogenous continuous variable is given in equation (21) in Appendix A.2.

The intuition of the estimation procedure is as follows. In equation (11), *Discount* is the sum of two components, $Discount^0$ and $\delta\xi$. The first component $Discount^0$ is the underlying discount that would prevail if prices did not anticipate takeover activity. The second component $\delta\xi$ represents the shrinkage of discount that results from the anticipation effect. The individual components $Discount^0$ and $\delta\xi$ are not directly measurable. However, $Discount^0$ can be modeled as a function of covariates (Z_1 and Z_2) plus an error disturbance. Therefore:

$$\begin{aligned}
 Discount &= Discount^0 + \delta\xi & (14) \\
 &= [\gamma_1 Z_1 + \gamma_2 Z_2 + \eta'] + \delta\xi \\
 &= \underbrace{Discount}_{\gamma_1 Z_1 + \gamma_2 Z_2} + \underbrace{Discount}_{\eta' + \delta\xi}.
 \end{aligned}$$

In the re-grouping in the above equation, the first component $\widehat{Discount}$ is a function of observable variables (Z_1 and Z_2). Z_1 is controlled for in the *Takeover** equation, and Z_2 does not directly affect *Takeover**. Therefore $\widehat{Discount}$ is free from the anticipation effect, i.e. uncorrelated with the shocks in *Takeover** (ξ). The second component $\widetilde{Discount}$ contains both the anticipation effect ($\delta\xi$) and unmodeled residual disturbances (η'). The power of the test rests on the ability of Z_1 and Z_2 in explaining $Discount^0$ so that the unmodeled residual (η' , uncorrelated with all other variables in the system) does not dominate the price anticipation part ($\delta\xi$) of the $\widetilde{Discount}$ component.

We cannot estimate equation (12) via standard procedures (such as probit) as the error term ξ is correlated the regressor *Discount*, owing to its correlation with the error term $\delta\xi + \eta'$ in equation (11). We address this problem by using the control function methodology. Specifically, we project

the residual in (12) ξ , on the estimated residual in equation (11), $\widetilde{Discount}$:

$$\xi = \lambda \widetilde{Discount} + \xi', \quad (15)$$

where the empirical analog to $\widetilde{Discount}$ is:

$$\widetilde{Discount} = Discount - \hat{\gamma}_1 Z_1 - \hat{\gamma}_2 Z_2. \quad (16)$$

Substituting (15) into (12) yields:

$$Takeover^* = \mu_1 Discount + \mu_2 X + \mu_3 Z_1 + \lambda \widetilde{Discount} + \xi'. \quad (17)$$

The first-stage regression, (15), orthogonalizes the residual ξ with respect to the residual η ($= \delta\xi + \eta'$). Therefore, by adding the projected residual, $\widetilde{Discount}$, as a control function or an “auxiliary” regressor in equation (17), it absorbs the correlation between the error terms.⁸ Therefore, the resulting residual ξ' is a well-behaved error disturbance that is uncorrelated with all other regressors in the *Takeover* equation, including *Discount*. Probit estimation can now be applied. We require a more complex estimation procedure because $\widetilde{Discount}$ is an auxiliary regressor rather than a natural covariate. The likelihood function derived in (21) integrates out $\widetilde{Discount}$ and is expressed only in terms of observable covariates.

We previously motivated the use of *Discount*, rather than *V*, as the key explanatory variable on theoretical grounds – value creation potential depends on the firm’s discount to maximum potential value, rather than its raw value. Having laid out the empirical model we can now explain how econometric reasons also justify the use of *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

⁸Essentially, the control function approach treats endogeneity similar to an omitted variables bias. In the absence of instrumentation, the residual is correlated with one or more covariates. Incorporating the auxiliary regressor absorbs this correlation, similar to the inclusion of an omitted variable.

from the buyer’s viewpoint. Unlike the discount, valuation is not a “sufficient statistic” for the profitability of a takeover: the *source* of a low valuation matters. Z_2 therefore affects takeover probability even holding V constant, violating the exclusion restriction. By contrast, Z_2 has no independent effect on takeover probability controlling for *Discount* because the level of *Discount* is a sufficient statistic for the profitability of a disciplinary takeover where low valuation resulting from weak fundamentals is filtered out.

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 data from Compustat. We also exclude all financial (SIC 6000-6999) and utilities (SIC 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 provides a full definition of all the independent variables used in our analysis and Appendix A.1 details the calculation of the more complex regressors. All of our accounting variables are obtained from Compustat; we obtain additional variables from Execucomp, Compact Disclosure, 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. Table 1, Panel A lists the description of the main variables used in this

paper.

[Insert Table 1, Panel A here.]

Our X variables are fundamentals that affect a firm's maximum potential value, such as those related to its production function, investment opportunity set and competitive environment. Many of these variables are also motivated in Habib and Ljungqvist (2005). To ensure stationarity, all X variables are expressed in ratios or ranks. Firm characteristics, such as accounting profitability, are frequently the joint outcome of firm potential and managerial ability – for example, a moderate net income margin may reflect an efficient manager achieving the highest feasible profitability at a mediocre firm, or an inefficient manager failing to achieve the firm's high profit potential. In selecting our X variables, we choose those that most likely reflect the firm's inherent characteristics rather than managerial choices. We are not claiming (or requiring) that these X variables are entirely exogenous. Instead, we only assume that takeover activity is primarily motivated by the desire to improve firm value given these variables, rather than to change these fundamentals.

We use *Sales* (the rank of sales among all firms in a year) as a measure of firm size, which likely impacts the frontier valuation as it proxies for growth opportunities and diminishing returns to scale.⁹ Moreover, size is primarily determined by factors outside the manager's control such as firm age and random productivity shocks (e.g. Luttmer (2007)). *Growth* (3-year sales growth) and *MktShr* (market share) are likely to be positively correlated with valuation and also a function of firm age. *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) affects the cost of capital. Both variables are determined primarily by a firm's industry and age, and thus less affected by managerial decisions. Our chosen profitability measure is *GPM* (gross profit margin, (1 - cost of goods sold) / sales). The direct cost of sales largely depends on demand/supply conditions in input industries. Managerial efficiency will likely affect costs lower down the income statement (such as excessive wages), and therefore we do not include measures such as operating or net income margin in X . We also employ *ATO* (asset turnover, the ratio of sales to total assets), as this is primarily determined by the importance of tangible assets in the firm's industry. Finally, we measure a firm's

⁹We use *Sales* rather than market capitalization as our measure of size, since the latter is correlated with our dependent variables.

diversification ($HHIFirm$, the Herfindahl index of the firm's sales by business segment). Diversified firms typically trade at a discount, but diversification may be required in certain industries – for example, backward integration may be necessary to secure an input supply.

As mentioned above, we take a stand that takeovers are primarily motivated by the potential to improve firm performance given fundamentals X (for example by increasing operational efficiency, reducing excessive wages, and paying out free cash) rather than changing the fundamentals or business strategy. This view is supported by empirical evidence. For example, McGuckin and Nguyen (1995) and Schoar (2002) show that targets experience productivity increases at the plant level post acquisition. In a similar vein, Brav and Thomas (2008) show that activist hedge funds that take significant positions in target companies generate gains for shareholders by squeezing excess cash out of the firm (through cutting administrative expenses, CEO pay and inefficient investment, and forcing payouts), improving governance, and spurring asset reallocation. Their effect on product market strategy and the R&D process is limited.

Our Z_1 variables measure firm characteristics or policies that may affect both the valuation discount and 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 variables are highly correlated with the maturity of business and thus the steadiness of cash flows, an attractive characteristic for acquirers as it facilitates financing. 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.¹⁰ 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)

¹⁰Industry 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.

and Shivdasani (1993) find that block ownership increases the probability of a takeover attempt. We construct *INST* to be the total percentage ownership by institutions, from Thomson Financial. We also add *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)).

Additional agency variables are available on a subsample of the data and included in Z_1 . *Insider* is the total percentage equity ownership by directors and officers, from Compact Disclosure. *WPS* is the CEO’s wealth-performance sensitivity, which measures the manager’s incentives stemming from options as well as stock. We use the Edmans, Gabaix, and Landier (2008) measure of *WPS* (the dollar change in CEO wealth for a one percentage point increase in firm returns, divided by the CEO’s annual wage) as it is independent of firm size and thus comparable across firms, in contrast to alternative measures. Finally, *Gindex*, the governance measure from Gompers, Ishii, and Metrick (2003), is inversely related to shareholder rights. Strong governance plausibly reduces *Discount* and takeover resistance. Approximately 20 – 25 percent of the observations have non-missing values on these three additional agency variables. Large firms and firms with high institutional ownership are over-represented in this subsample.

The Z_2 variables affect *Discount*, but have no effect on takeover probability other than through their impact on the discount. We therefore use variables that affect the price due to market frictions and are unrelated to firm fundamentals and managerial resistance. Our leading variable is *MFFlow*, the price pressure created by mutual fund buying and selling in response to investor flows (as in Coval and Stafford (2006)). In building this measure, 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.¹¹ 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. Approximately 8.5% of all equity mutual funds in our sample are sector funds, and they represent 8.7% of the aggregate flows (in unsigned absolute magnitude) to and from equity mutual funds. In a sensitivity check, we exclude these sector mutual funds in constructing the *MFFlow* measure.

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 *SPIIdx*) 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

¹¹This is an unlikely scenario since it requires that mutual funds be able to predict takeovers more than a year in advance (the combination of a one-quarter lag in using previously disclosed holdings and a one-year lag of the regressors in the *Takeover* equation). We are not aware of any empirical evidence that mutual funds are successful in predicting takeovers. This is not surprising given that takeovers bear very weak correlations with observable variables.

than through their effect on *Discount*.¹² Analyst coverage may also proxy for firm characteristics that facilitate takeovers: high coverage is associated with high trading liquidity and more sophisticated investors. Therefore, it is important that we include direct controls for these two characteristics, *Amihud* and *Inst*.

3.2 Value Discount

We use two measures of valuation: Q and $EV/Ebitda$. The former is the ratio of enterprise value (debt plus market equity) to book value (debt plus book equity) and is the most widely used valuation metric in the finance literature. The latter is also relevant in our setting because most takeovers are driven by the acquirer's desire to access the target cash flows rather than liquidate target assets. This is consistent with its frequent use by M&A practitioners.¹³ Negative values for these observations are coded as missing.

Table 1, Panel B reports summary statistics for all the explanatory variables and valuation measures used.

[Insert Table 1, Panel B here.]

We estimate (5) using the censored least absolute deviation method introduced by Powell (1984). Table 2 Panel A displays the frontier estimation. All standard errors adjust for heteroskedasticity and correlation of error disturbances clustered at the firm level.¹⁴

[Insert Table 2, Panel A here.]

¹²In theory, target analysts could initiate coverage on bidders after the acquisition. However, since bidders are typically much larger than targets and size is strongly correlated with coverage, it is rare that an analyst will cover the target but not the bidder. In addition, acquiring a covered target is an expensive way of increasing coverage, rendering it an unlikely takeover motive.

¹³An additional reason for emphasizing $EV/Ebitda$ is the prevalent (albeit theoretically dubious) goal among the investment banks to undertake earnings-accretive acquisitions. Under this goal, the target's cash flows are more important than its book assets.

¹⁴To our knowledge, no existing programming packages have the option to estimate clustered standard errors for CLAD using analytical formulas. Bootstrap options are available in some packages, such as Stata. The analytical formula is derived in Appendix A.2.

Most variables have the expected signs. Large firms (proxied by *Sales*) tend to have lower potential values, perhaps because growth opportunities are lower. High-tech (*RND*¹⁵), high growth (*Growth*) and high market power (*MktShr*, insignificant) firms are associated with high potential valuations. Business concentration within the firm (*HHIFirm*, insignificant) is associated with higher frontiers, consistent with the diversification discount documented by Lang and Stulz (1994), Berger and Ofek (1995) and Servaes (1996). Asset turnover (*ATO*) captures the asset intensity of a firm’s business, and has different effects depending on the valuation proxy. High asset intensity (inverse of asset turnover) is associated with a high potential EBITDA multiple, but with a low *Q*. The latter likely occurs because assets appear in the numerator of *ATO* and in the denominator of *Q*, which introduces a mechanical negative relation. Product-level gross profitability (*GPM*) exhibits a similar ambiguity: it is negatively correlated with *EV/Ebitda*, while positively correlated with *Q*. There is likely a mechanical relation between the numerator of *GPM* and the denominator of *EV/Ebitda*. Finally, a firm’s exposure to market risk (*BetaAsset*) is associated with an (insignificantly) lower potential EBITDA multiple, but with a higher *Q*. On the one hand, beta may be an indirect proxy for growth opportunities, and therefore could be positively correlated with valuations. On the other hand, a high beta implies a higher cost of capital, which in turn reduces the valuation of a given EBITDA stream. For comparison, Table 2 also reports the results of a standard OLS regression of actual (not potential) valuations on fundamentals. The difference in coefficients implies that our method has identified a valuation frontier that is distinct from actual valuations.

After analyzing the effects of fundamental variables on potential valuation, we construct *Discount* as the shortfall of actual from potential valuation, scaled by the latter. The summary statistics of the two *Discount* variables are reported in Table 1. The 20th percentile values are zero by construction. The mean is 20 – 24%, moderately higher than the 16% found by Habib and Ljungqvist (2005) using a different (parametric) methodology. If our list of fundamental variables is not exhaustive, then missing variables could lead to over-estimated discount levels. Since our analysis is

¹⁵Firm observations without reported R&D are coded as zero *RND*. The coefficient on *RND* (as well as other coefficients) is not affected by adding a dummy regressor for missing *RND* values. Given that our goal is to predict a firm’s potential value given its fundamental variables, we choose not to include the artificial regressor for missing *RND* values.

driven by the relative ranking (rather than the absolute level) of *Discount*, an over-estimation in the average discount has little effect on our results. Table 2 Panel B indicates that the correlation of *Discount* estimates based on different quantile restrictions around $\alpha = 0.20$ (our default value) is extremely high (above 0.9). Our results are qualitatively unchanged for various α values subject to (2).

[Insert Table 2, Panel B here.]

Finally, Figure 1 gives an overview of the time series of detrended aggregate discounts (equal-weighted average over all firms in a year) and takeover activity from 1980 to 2006. The aggregate discount and takeover levels tend to move in the same direction, except for the 2002-2003 period when the market crash both led to low valuations and reduced firms' ability to finance acquisitions.

[Insert Figure 1 here.]

3.3 Determinants of Takeover and Discount Without Feedback

As a first step and a comparison for later results, we estimate (7) and (8) without incorporating the anticipation effect. In this setting, the two equations are estimated separately. Table 3 reports the determinants of *Discount* and *Takeover*, using both the full sample and the subsample where compensation, inside ownership and governance variables are available.

[Insert Table 3 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 except that *Payout* is positively correlated with the *Q* discount. This may be because a high payout ratio proxies for firm maturity and thus low growth opportunities which affect *Q* more than *EV/Ebitda*. In the subsample for which executive compensation data is available, wealth-performance sensitivity is strongly negatively correlated with the discount, and insider ownership exhibits a weak negative association. Both effects are consistent with standard agency theory, e.g. Jensen and Meckling (1976). 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. Consistent with Amihud (2002), liquidity reduces the discount. Finally, the *Gindex* governance measure is uncorrelated with *Discount*. Our primary instrumental variable, *MFFlow*, is significantly associated with lower discounts in both the full sample and subsample, and for both measures of valuation. Analyst coverage has the expected significant negative sign in two of the four specifications, and is insignificant in the others. Index inclusion generally reduces the discount in the full sample, but the coefficients become less negative in the subsample with executive compensation. This subsample is predominantly comprised of large firms.

We now turn to the *Takeover* equation in Panel A, which shows that the probability of acquisition is responsive to *Discount*. A one percentage point increase in *Discount* is associated with a 1 – 2 basis point (i.e. a 0.01-0.02 percentage point) increase in takeover probability, and an inter-quartile change in *Discount* is associated with a 0.59 (using *EV/Ebitda*) to 1.05 (using *Q*) 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 discount to potential value, rather than raw valuation, motivates acquisitions.¹⁶ However, the economic magnitude is modest at best (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 (11) and (12). 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, and the extent to which takeovers are motivated by the intent to discipline inefficiency. Results are reported in Table

¹⁶Replacing *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).

4.

[Insert Table 4 here.]

Compared to estimates in Table 3, the coefficients on *Discount* are several orders of magnitude higher. Table 4 shows that, in the full sample, a one percentage point increase in *Discount* would lead to a statistically significant 5 – 9 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 2.9 to 4.2 percentage points increase in *Takeover* probability, economically significant compared to an unconditional probability of 6.2 percent. Results on subsamples with governance data are qualitatively similar. In the *EV/Ebitda* regression, the coefficient for a one percentage point increase in *Discount* rises to 13 basis points, although it falls to 4 basis points in the *Q* regression.¹⁷

The MLE method further provides an estimation of ρ in equation (13), which is -0.22 (using *Q*) and -0.17 (using *EV/Ebitda*). Both estimates are of the expected sign. A test of the null hypothesis $H_0 : \rho = 0$ evaluates the exogeneity of *Discount* to shocks in *Takeover*. Based on the *Q* discount, the system strongly rejects exogeneity of *Discount* (t -statistic = -2.63). In the *EV/Ebitda* regression, the t -statistic (-1.46) falls short of conventional significance levels. Nevertheless, in all four specifications in Table 4, the coefficient on *Discount* increases multiple times from their corresponding values in Table 3, indicating that takeover anticipation is an important determinant of firm valuations.

While Table 4 quantified the trigger effect, controlling for the anticipation 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 which is caused by takeover expectations.

Empirically, quantifying the anticipation component in *Discount* amounts to estimating δ in equation (11). Estimating (11) 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

¹⁷If merging parties recognized that the target’s value was inflated by the anticipation effect, they would reduce the takeover premium accordingly. Thus, the anticipation effect would not affect takeover probability. Our results are thus consistent with ?, who finds that acquisition premiums are uncorrelated with the pre-bid runup.

interest rate levels and term structure (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 in uncovering a negative relation between the firm-level *Discount* and the underlying *Takeover* probability.

We therefore approach the problem by utilizing the intermediate and final outputs from estimating equation (12). Note that the price anticipation coefficient δ is a linear projection of $\widetilde{Discount}$ (defined in (16)) on ξ , the shrinkage in discount due to a one unit change in shocks to takeover propensity. We can therefore construct a $\widehat{\delta}$ estimate. The empirical analog of $\widetilde{Discount}$ is readily available from (16). For the empirical analog of $\widehat{\xi}$, we adopt the “generalized residual” for discrete response models as proposed by Gourieroux, Monfort, Renault, and Trognon (1987):

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

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

$$\widehat{\xi} = \frac{[Takeover - \Phi(\widehat{u})] \phi(\widehat{u})}{\Phi(\widehat{u}) [1 - \Phi(\widehat{u})]}, \quad (18)$$

where $\widehat{u} = \widehat{\mu}_1 Discount + \widehat{\mu}_2 X + \widehat{\mu}_3 Z_1,$

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

Finally, the parameter $\widehat{\delta}$ is obtained by regressing $\widetilde{Discount}$ on $\widehat{\xi}$. The procedure is made possible only by simultaneous estimation of equations (11) and (12) 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 (7) to (10)), then $\widetilde{Discount}$ and $\widehat{\xi}$ would be uncorrelated by construction, due to mis-specification.

[Insert Table 5 here.]

The results from all four specifications are reported in Table 5. The coefficients on $\widehat{\xi}$ are uniformly negative and highly statistically significant. The economic magnitude of the coefficients

is not readily interpretable because ξ is a shock to the propensity of takeover which does not have a natural unit. However, we can calculate the estimated discount shrinkage due to a one standard deviation change in the takeover propensity. These calibrated marginal effects are reported below the coefficients in Table 5. If a firm's takeover likelihood rises, exogenously, by one standard deviation from the mean, *Discount* shrinks by 3.3 – 3.7 percentage points. Such a magnitude is economically plausible and significant given the average discount level of 20% – 24%. An inter-quartile change in takeover probability (corresponding to a 1.37 standard deviation change in a normal distribution) is associated with a 4.5 – 5.1 percentage point variation in the discount. The equity of a firm at the 95th percentile of takeover vulnerability is overvalued by 12.9 to 14.5 percentage points, compared to a hypothetical state in which its valuation did not reflect such takeover vulnerability.¹⁸

Taken together, our results in Tables 4-5 provide evidence of both channels of the feedback loop. Table 5 shows that takeover expectations reduce value discounts: the anticipation effect. Table 4 demonstrates that lower values in turn deter takeovers, by reducing a bidder's potential profit from an acquisition: the trigger effect. Overall, the feedback loop represents a potentially significant impediment to the market for corporate control. Not only may it 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.

The source of the feedback loop is the forward-looking nature of market valuations. The majority of existing papers on the connection between financial market efficiency and real economic activity conclude that the former is beneficial for the latter. By contrast, our results suggest an intriguing disadvantage of forward-looking prices: they may deter the very corrective actions that they anticipate. While the above implication concerns economy-wide market efficiency, our results also contrast existing research on the effect of firm-level valuations. In our paper, overvaluation (with respect to fundamentals) due to the anticipation effect can reduce the firm's underlying value by deterring corrective actions and weakening the trigger effect (see also Grossman and Hart (1980)). This also contrasts with some results in the behavioral corporate finance literature (e.g.

¹⁸Note that we cannot interpret the difference as relative to another firm whose takeover vulnerability is near zero, due to the endogeneity of takeover vulnerability owing to unobserved heterogeneity.

Stein (1996)), where increased financial market valuations boost real values. In addition, our results imply that the anticipation effect may be a powerful takeover defense. Increasing market awareness that one's firm is a likely acquisition target may deter the takeover from actually occurring – an example of a “self-destroying prophecy.”

An alternative explanation to the shrinkage in *Discount* is that the threat of a takeover forces the managers to adopt actions that increase the value of the firm. While this disciplinary effect can also be viewed as part of the feedback loop (valuations affect takeover vulnerability, which in turn changes valuations), it is distinct from the effect described above since the shrinkage in discount in this case reflects actual changes in fundamental value rather than takeover anticipation. If this is the driving force that causes the negative δ in equation (11), 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). Overall, we conclude that the effect of takeover intensity on the discount mostly reflects market anticipation rather than underlying increases in firm value.

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 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. It also suggests that a firm may be able to defend against a takeover by making the market aware that it is a potential target. Finally, the feedback loop offers a novel 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, there are many existing models in which real decisions are driven by market values. Our results provide empirical motivation for extending these theories to incorporate the price's anticipation of these future actions.

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A Appendix

A.1 Data

This section details the calculation of the more complex variables employed, and describes the merging process used to link the different datasets used in the paper.

Mutual Fund Price Pressure (*MFFlow*)

Following Coval and Stafford (2006), we calculate a measure of price pressure based in mutual fund flows. We obtain quarterly data on mutual fund flows from Thomson Financial and construct

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

for each stock-quarter pair, where i ($= 1, \dots, n$) indexes stocks, j ($= 1, \dots, m$) 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

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

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

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

Wealth-Performance Sensitivity (*WPS*)

Our wealth-performance sensitivity measure is taken from Edmans, Gabaix, and Landier (2008) and calculated as:

$$WPS = \frac{\Delta \$\text{Wealth}}{\Delta \% \text{Firm Return}} \frac{1}{\$ \text{Wage}}.$$

The first term is the CEO's effective dollar equity holdings, after converting options to effective equity equivalents based on their deltas. This measure is used by Hall and Liebman (1998); Edmans,

Gabaix, and Landier (2008) show that scaling by the wage leads to a measure independent of firm size and thus comparable across firms.

To calculate WPS , we obtain the portfolio of a CEO's stock and options from Execucomp. We use the Black-Scholes formula to calculate the delta of each option. All of the data required in the Black-Scholes formula is available for new option grants. For previously granted options, the strike price and time to maturity are not provided in Execucomp and we estimate them using the methodology of Core and Guay (2002) with a few minor modifications used in Edmans, Gabaix, and Landier (2008). We sum the deltas of all shares and options held by the CEO to give the delta of the CEO's overall portfolio, $\frac{\Delta\$Wealth}{\Delta\$Firm\ Return}$. We multiply this by the firm's enterprise value and divide it by his annual flow compensation (Execucomp variable `tdc1`) to obtain WPS . A more detailed description of this calculation is given in the Appendix of Edmans, Gabaix, and Landier (2008).

A.2 Estimation Procedures

This section derives the FIML likelihood function for equation (12). The likelihood of an individual takeover in our simultaneous equation model is as follows, omitting the i, t subscripts for brevity:

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

where the joint density function g is

$$g(\textit{Takeover} = 1, \textit{Discount}) = \int_{-\mu_1 \textit{Discount} - \mu_2 X - \mu_3 Z_1}^{\infty} f(\xi, \eta) d\xi, \quad (19)$$

and

$$g(\textit{Takeover} = 0, \textit{Discount}) = \int_{-\infty}^{-\mu_1 \textit{Discount} - \mu_2 X - \mu_3 Z_1} f(\xi, \eta) d\xi, \quad (20)$$

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

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

The conditional distribution $f(\xi|\eta)$ is normal with mean $\rho_{\xi,\eta}\eta/\sigma_\eta$ and variance $1 - \rho_{\xi,\eta}^2$, where ρ and σ are the standard notations for correlation coefficient and standard deviation. Therefore the

joint density function of (19), assuming all variables are jointly normal, can be rewritten as

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

and Φ , ϕ are the cumulative probability and density functions of the standard normal distribution. Equation (20) could be rewritten analogously. Combining all equations, we arrive at the log likelihood for a takeover on a firm-year observation:

$$l_{i,t} = \textit{Takeover}_{i,t} \ln [\Phi (u_{i,t-1})] + (1 - \textit{Takeover}_{i,t}) \ln [1 - \Phi (u_{i,t-1})] - \ln(\sigma_\eta) - \frac{\eta^2}{2\sigma_\eta^2}, \quad (21)$$

where

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

$$\eta = \textit{Discount} - \gamma_1 Z_1 - \gamma_2 Z_2.$$

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

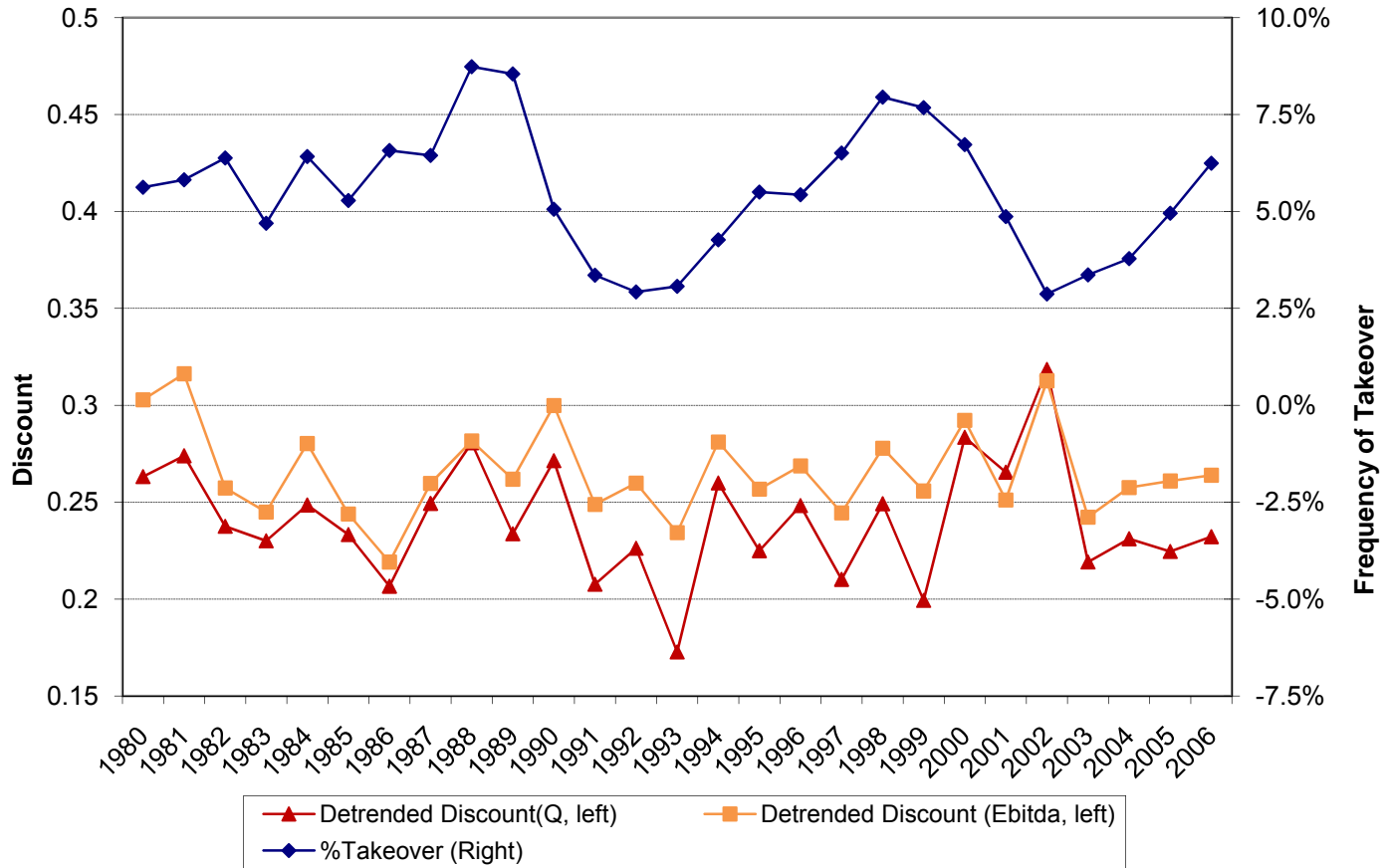


Table 1. Summary of Variables

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

Panel 1: Data Definitions

	Definition
<u>Fundamental Variables (X)</u>	
ATO	Asset turnover. Sales (data12) / Assets (data6)
BetaAssets	<i>Beta</i> on the market factor in a Fama-French three-factor model using daily data from CRSP, and then unlevered
Financial	Dummy variable for whether firm is in the financial industry (SIC 6000-6999)
GPM	Gross profit margin. 1 - Cost of Goods Sold (data41) / Sales (data12)
Growth	Average sales growth during past (up to three) years
HHIFirm	Herfindahl index of firm's sales in different business segments
MktShr	Sales / Total sales in SIC 3-digit industry
RND	R&D expense (data46) / Sales (data12). Zero if missing
Sales	Log of Sales (data12)
Utility	Dummy variable for whether firm is in the utility industry (SIC 4000-4949)
<u>Variables Affecting Discount and Takeover Probability (Z_1)</u>	
Amihud	Illiquidity measure per Amihud (2002). Yearly average of the square root of (Price×Vol)/ Return Daily observations with a zero return are removed. Coded as missing if < 30 observations in a year. From CRSP
Gindex	The Gompers, Ishii, and Metrick (2003) index for shareholder rights
HHISIC3	Herfindahl index of sales by all firms in SIC 3-digit industry
Insider	% of shares outstanding held by directors and officers. Missing values are imputed from firm sales and CRSP age. From Compact Disclosure
Inst	% of shares outstanding held by institutions. From Thomson Financial
Leverage	(Debt (data9 + data34) - Cash (data1)) / Assets.
Payout	(Dividends (data21) + Repurchases (data115)) / Net Income (data18). 0 if numerator is zero or missing; 1 if numerator > 0 and denominator = 0
WPS	CEO's wealth-performance sensitivity as measured by $((\Delta\$Wealth)/(\Delta\%Firm\ Return))/(1/(\$Wage))$ From Execucomp. See Appendix A for further details

Variables Affecting Discount (Z_2)

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

Panel B: Summary Statistics

Name	# obs	Mean	Std. Dev.	Percentiles				
				5th	25th	50th	75th	95th
ATO	118,942	1.21	0.82	0.17	0.63	1.08	1.59	2.79
Amihud	101,026	0.77	1.11	0.02	0.11	0.35	0.93	3.05
Analyst	118,942	1.06	1.16	0.00	0.00	0.69	2.08	3.18
BetaAssets	117,211	0.69	0.41	0.09	0.38	0.65	0.95	1.45
Discount (EV/Ebitda)	92,022	0.20	0.79	-1.05	0.10	0.40	0.59	0.77
Discount (Q)	116,377	0.24	0.65	-0.74	0.10	0.37	0.56	0.76
EV/Ebitda	92,116	15.95	28.05	3.76	6.12	8.70	13.77	47.05
Gindex	40,995	8.68	2.72	4.00	7.00	9.00	11.00	13.00
GPM (%)	118,942	22.5%	91.4%	-2.5%	20.7%	32.7%	48.1%	75.2%
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
Insider (%)	118,942	24.7%	11.8%	3.8%	16.6%	26.5%	32.6%	39.1%
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	116,543	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 (\$m)	118,942	0.52	0.28	0.07	0.28	0.52	0.75	0.95
WPS	20,203	40.46	125.66	0.77	3.67	7.66	18.91	172.06

Table 2. Estimating Value Discounts

Panel A: Estimation of valuation frontier

This table reports the estimation of the valuation frontier using the Powell (1984) CLAD method. All fundamental variables (defined in Table 1) as well as their squared terms enter the regression. As a comparison, we also report the coefficient estimates using the OLS method. All standard errors are adjusted for heteroskedasticity and correlation clustered at the firm level. The Discount is calculated as (predicted valuation - actual valuation)/predicted valuation, the distribution of which is listed in Table 1. The 20th percentile Discount value is zero by construction.

Est. Method Dep. Var.	CLAD ($\alpha = 0.20$)				OLS			
	Q		EV/Ebitda		Q		EV/Ebitda	
	Coef	t-stat	Coef	t-stat	Coef	t-stat	Coef	t-stat
CNST	1.596***	8.86	43.774***	22.01	0.725***	6.50	41.767***	41.09
Sales	-0.059***	-15.35	-0.491***	-11.54	-0.053***	-24.95	-0.316***	-16.44
RND	0.073***	16.47	0.842***	9.58	0.041***	22.52	0.907***	30.92
ATO	0.520***	6.74	-12.244***	-14.34	0.869***	18.27	-14.425***	-30.32
GPM	0.516***	5.98	-30.413***	-8.38	0.514***	10.64	-37.905***	-19.11
MktShr	0.311	0.83	4.052	1.40	0.050	0.21	2.791*	1.82
Growth	1.261***	15.70	-0.295	-0.32	1.286***	26.58	0.874*	1.80
FirmHHI	0.607	1.31	5.872	1.53	0.864***	3.00	4.019**	2.08
BetaAsset	0.552***	5.19	-0.994	-0.89	0.843***	14.26	0.324	0.55
Sales^2	0.000***	14.03	0.003***	8.18	0.000***	23.61	0.001***	9.19
RND^2	0.000***	-11.59	0.003	1.02	0.000***	-15.34	-0.005***	-8.94
ATO^2	-0.073***	-2.90	2.798***	11.38	-0.161***	-11.41	3.239***	25.58
GPM^2	2.068***	14.28	26.973***	6.02	1.381***	18.81	25.701***	11.29
MktShr^2	-0.303	-0.68	-3.816	-0.95	-0.097	-0.35	-2.774	-1.23
Growth^2	-0.246***	-5.16	5.252***	6.00	-0.367***	-14.10	1.718***	6.13
FirmHHI^2	-0.164	-0.50	-2.510	-0.91	-0.391*	-1.93	-2.059	-1.48
BetaAsset^2	0.624***	8.21	3.253***	4.56	0.125***	3.15	1.892***	5.26
# obs and R ²	116,383	0.239	92,012	0.184	116,383	0.261	93,093	0.205

Panel B: Correlations of discount estimates using different quantile restrictions

This table reports the correlation among six discount estimates, by a combination of two valuation measures (Q or EV/Ebitda) and three quantile restrictions ($\alpha = 0.3, 0.2, 0.1$).

Quantile restrictions:	Valuation measure = Q			Valuation measure = EV/Ebitda		
	$\alpha = 0.3$	$\alpha = 0.2$	$\alpha = 0.1$	$\alpha = 0.3$	$\alpha = 0.2$	$\alpha = 0.1$
Q($\alpha = 0.3$)	1.00					
Q($\alpha = 0.2$)	0.99	1.00				
Q($\alpha = 0.1$)	0.97	0.99	1.00			
EV/Ebitda($\alpha = 0.3$)	0.42	0.42	0.42	1.00		
EV/Ebitda($\alpha = 0.2$)	0.42	0.44	0.45	0.99	1.00	
EV/Ebitda($\alpha = 0.1$)	0.40	0.43	0.45	0.91	0.97	1.00

Table 3. Determinants of Discount and Takeover without Feedback

This table reports the results from estimating equations (8) and (9) separately. The dependent variable in Panel A is Takeover, and that in Panel B is Discount. The Discount variable is constructed using EV/Ebitda and Q as the valuation variables. 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 1 (= 100%) change in each regressor.

Panel A: Determinants of Takeover

	Dependent Variable = Takeover											
	Discount = Discount(Q)						Discount = Discount(EV/Ebitda)					
	Coef	t-stat	dPr/dX	Coef	t-stat	dPr/dX	Coef	t-stat	dPr/dX	Coef	t-stat	dPr/dX
Discount	0.191***	11.13	2.28%	0.194***	4.52	1.73%	0.097***	5.67	1.18%	0.063	1.40	0.56%
Sales	0.073	1.66	0.88%	-0.120	-0.77	-1.07%	-0.030	-0.59	-0.37%	-0.110	-0.64	-0.97%
R&D	-0.003	-0.26	-0.03%	-0.029	-0.54	-0.26%	-0.086	-0.65	-1.05%	-0.058	-0.23	-0.51%
ATO	0.020**	2.16	0.24%	-0.036	-1.30	-0.33%	0.016	1.41	0.19%	-0.042	-1.39	-0.37%
GPM	0.040***	3.08	0.48%	0.039	0.57	0.35%	0.135***	2.78	1.64%	0.114	1.03	1.00%
MktShr	-0.284***	-3.84	-3.41%	-0.266	-1.65	-2.37%	-0.278***	-3.64	-3.38%	-0.252	-1.52	-2.23%
Growth	-0.008	-0.92	-0.09%	-0.041	-0.79	-0.36%	-0.005	-0.35	-0.06%	-0.052	-0.80	-0.46%
HHIFirm	0.198***	6.25	2.37%	0.210***	3.06	1.87%	0.154***	4.56	1.87%	0.183**	2.61	1.62%
BetaAsset	-0.111***	-5.96	-1.33%	-0.185***	-3.25	-1.65%	-0.094***	-4.31	-1.14%	-0.189***	-3.16	-1.67%
Leverage	0.055**	2.28	0.66%	0.067	0.87	0.60%	0.134***	4.42	1.63%	0.122	1.47	1.08%
Payout	0.005	0.59	0.06%	0.048***	2.93	0.42%	0.009	1.05	0.11%	0.040**	2.39	0.36%
Inst	0.080**	2.28	0.95%	0.316***	3.26	2.82%	0.037	0.99	0.45%	0.360***	3.51	3.19%
HHISIC3	-0.114**	-2.18	-1.36%	-0.220	-1.34	-1.97%	-0.105*	-1.78	-1.28%	-0.279	-1.67	-2.46%
Amihud	-0.042***	-5.27	-0.51%	-0.190	-0.95	-1.69%	-0.047***	-4.71	-0.57%	-0.261	-1.14	-2.31%
Insider	--	--	--	0.195	1.28	1.74%	--	--	--	0.301*	1.93	2.66%
WPS	--	--	--	-0.033*	-1.72	-0.29%	--	--	--	-0.039**	-2.03	-0.34%
Gindex	--	--	--	0.008	1.17	0.07%	--	--	--	0.005	0.73	0.04%
Cnst	-1.722***	-41.80	--	-1.858***	-10.05	--	-1.643***	-30.71	--	-1.851***	-8.66	--
# obs and R ²	100,166	0.008	6.18%	19,164	0.015	4.40%	79,102	0.005	6.24%	18,060	0.014	4.34%

Panel B: Determinants of Discount

Dep. Var.	Discount(Q)				Discount(EV/Ebitda)			
	Coef	t-stat	Coef	t-stat	Coef	t-stat	Coef	t-stat
Leverage	-0.076***	-8.83	0.113***	4.10	-0.029**	-2.61	0.089***	3.65
Payout	0.019***	8.37	-0.008	-1.67	-0.019***	-7.19	-0.016***	-3.45
INST	-0.059***	-3.73	0.018	0.45	-0.094***	-5.68	0.033	0.89
HHISIC3	-0.076***	-3.93	-0.173***	-3.40	-0.028	-1.32	-0.186***	-3.86
AmihudI2	0.062***	27.40	0.320***	5.24	0.028***	9.00	0.194***	3.08
Analyst	-0.001	-0.34	-0.033***	-3.42	-0.020***	-5.46	0.001	0.05
MFFlow	-1.187***	-9.78	-0.784***	-3.64	-0.567***	-4.40	-0.518**	-2.46
SPIIdx	-0.017**	-2.07	0.123***	8.10	0.012	1.40	0.070***	4.47
Nasdaq	-0.005	-0.78	0.046***	2.77	-0.031***	-4.36	-0.021	-1.33
Insider	--	--	-0.061	-0.95	--	--	-0.060	-1.12
WPS	--	--	-0.055***	-7.89	--	--	-0.040***	-6.02
Gindex	--	--	-0.001	-0.19	--	--	0.003	1.25
Cnst	0.263***	30.27	0.125**	2.45	0.335***	34.52	0.104**	2.14
# obs and R ²	100,189	0.041	19,171	0.063	79,125	0.019	18,067	0.038

Table 4. Effects of Discount on Takeover with Feedback

This table reports the results from estimating equations (12) in the (12)-(13) 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 1 (= 100%) change in each regressor.

	Dependent Variable: Takeover											
	Discount = Discount(Q)						Discount = Discount(EV/Ebitda)					
	Coef	t-stat	dPr/dX	Coef	t-stat	dPr/dX	Coef	t-stat	dPr/dX	Coef	t-stat	dPr/dX
Discount	0.721***	3.70	9.18%	0.458*	1.70	4.16%	0.468*	1.87	5.88%	1.135***	2.80	13.27%
Sales	-0.046	-0.72	-0.50%	-0.193	-1.08	-1.75%	-0.074	-1.26	-0.93%	-0.493**	-2.15	-5.77%
R&D	-0.011	-1.05	-0.14%	-0.034	-0.63	-0.31%	-0.143	-1.04	-1.79%	-0.801**	-2.14	-9.37%
ATO	0.048***	3.41	0.60%	-0.017	-0.47	-0.15%	0.017	1.52	0.22%	0.045	0.95	0.52%
GPM	0.038***	3.00	0.48%	0.057	0.80	0.52%	0.095*	1.69	1.19%	0.252**	2.05	2.95%
MktShr	-0.284***	-3.80	-3.56%	-0.260	-1.59	-2.36%	-0.293***	-3.86	-3.68%	-0.276*	-1.73	-3.23%
Growth	-0.019*	-1.99	-0.24%	-0.048	-0.93	-0.44%	-0.017	-1.09	-0.21%	-0.088	-1.41	-1.03%
HHIFirm	0.171***	5.08	2.14%	0.191***	2.68	1.74%	0.142***	4.06	1.78%	0.061	0.71	0.71%
BetaAsset	-0.165***	-6.19	-2.10%	-0.250***	-2.93	-2.27%	-0.110***	-4.56	-1.38%	-0.328***	-4.50	-3.84%
Leverage	0.078***	3.08	0.99%	0.016	0.18	0.15%	0.128***	4.16	1.60%	-0.068	-0.62	-0.79%
Payout	-0.005	-0.57	-0.06%	0.046***	2.84	0.42%	0.015	1.56	0.18%	0.045***	2.84	0.53%
INST	0.183***	3.52	2.72%	0.301***	3.02	2.73%	0.103*	1.79	1.29%	0.244**	2.03	2.85%
HHISIC3	-0.084	-1.57	1.36%	-0.196	-1.18	-1.78%	-0.101*	-1.71	-1.27%	-0.125	-0.73	-1.47%
Amihud	-0.089***	-4.80	-1.11%	-0.361	-1.30	-3.28%	-0.065***	-4.35	-0.81%	-0.756**	-2.53	-8.85%
Insider	--	--	--	0.195	1.27	1.77%	--	--	--	0.259*	1.68	3.03%
WPS	--	--	--	-0.017	-0.68	-0.15%	--	--	--	0.011	0.43	0.13%
Gindex	--	--	--	0.007	1.08	0.07%	--	--	--	-0.002	-0.27	-0.02%
Cnst	-1.732***	-40.53	--	-1.763***	-7.95	--	-1.666***	-31.34	--	-1.314***	-3.66	--
# obs	100,166		19,164			79,102			18,060			
ρ and t-stat	-0.22		-2.63		-0.11		-0.99		-0.17		-1.46	

Table 5. The Feedback Effect from Takeover to Discount

This table reports the estimation of the system (12)-(13) through a regression of residual Discount from equation (16) on shocks in Takeover from equation (18). Also reported are the changes in the residual discount for one standard deviation change in the shocks in Takeover. All standard errors are adjusted at the firm level.

Dep. Var.	η (residual Discount(Q))				η (residual Discount(EV/Ebitda))			
	Coef	t-stat	Coef	t-stat	Coef	t-stat	Coef	t-stat
ξ (shocks in Takeover*)	-0.074***	-26.71	-0.039***	-5.57	-0.066***	-18.92	-0.169	-20.96
(Effect of one std. dev. change)	-0.037		-0.018		-0.033		-0.075	
Cnst	-0.001	-0.49	-0.062***	-8.06	-0.001	-0.24	-0.057	-8.2
# obs and R ²	100,166	0.008	19,164	0.002	79,102	0.005	18,060	0.032