Asymmetric Information and the Medium of Exchange in Takeovers: Theory and Tests

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In a model of takeovers under asymmetric information, we identify a separating equilibrium in which the value of the bidder firm is revealed by the mix of cash and securities used as payment for the target. The model predicts that the revealed bidder value is monotonically increasing and convex in the fraction of the total offer that consists of cash. We examine the model restrictions using data from Canada, where mixed offers are both relatively frequent and free of the confounding tax-related options characterizing mixed offers in the United States. We find that the average announcement-month bidder abnormal return in mixed offers is large and significant. However, maximum likelihood estimates of parameters in both linear and nonlinear cross-sectional regressions fail to support the model predictions.

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In perfect markets with symmetrically informed agents, the medium of exchange chosen to accomplish a corporate combination is economically irrelevant; the level and division of the merger-induced gains are the same whether the transaction is executed by means of an all-cash offer or by some combination of cash and securities of the combined firm. However, several recent empirical studies show that takeover premia and merger-induced abnormal returns are systematically related to the payment method. Huang and Walkling (1987), Franks, Harris, and Mayer (1988), and Eckbo and Langohr (1989) show that gains to target firms in the United States, England, and France, respectively, are significantly higher in all-cash offers than in takeovers in which the bidder and target firms exchange common stock.[1] Furthermore, Huang and Walkling conclude that abnormal returns to targets in tender offers are not significantly different from those in mergers once the payment method has been controlled for. Studying merger bids in the United States, Travlos (1987) reports significantly negative two-day announcement-period average abnormal stock returns to bidder firms in all-stock mergers, while the corresponding bidder-firm performance in all-cash mergers is zero or positive.

The previous literature has focused particularly on taxes and information asymmetries to explain these empirical regularities. The tax codes in the countries represented by the above studies generally award a tax-deferred status to a pure exchange merger, while requiring capital-gains taxes to be paid immediately in an all-cash purchase.[2] Thus, it is frequently hypothesized that the bidder must raise the offer premium in an all-cash offer in order to compensate target shareholders for the tax penalty associated with this particular method of payment. However, while tax considerations are certain to play a role in the bidder's choice of payment method, tax arguments do not appear to explain the relatively large premium in all-cash offers. Eckbo and Langohr (1989) find that the value of the option to tender, which is the logical place to look for a tax-related compensation to target shareholders, is as high in all-stock offers as in all-cash offers.[3] Fur-

[1] The impact of the payment method is apparently not restricted to control-oriented takeovers. Eckbo and Langohr (1989) report that targets in minority buyouts realize substantially larger average gains in all-cash buyouts than in all-stock exchange buyouts.

[2] The payment method may also dictate the bidder's accounting treatment of the acquisition, thus affecting depreciation tax shields and accounting-based managerial compensation schemes [see, e.g., Carleton et al. (1983)]. For a general discussion of tax arguments, see Gilson, Scholes, and Wolfson (1988).

[3] With atomistic target shareholders, a necessary condition for an offer to succeed is that the offer price exceed the conditional expected postoffer target share price. The incentive to tender is essentially the premium over this postoffer price. Eckbo and Langohr (1989) use this premium to define the value of the option to tender, and argue that the bidder must include in this premium any required compensation for personal taxes.

thermore, Franks, Harris, and Mayer (1988) report that a superior target performance in all-cash offers is found in U.K. takeovers that took place *before* the introduction of capital-gains taxes on such transactions.

The role of asymmetric information in the choice of the medium of exchange in takeovers has previously been studied by Hansen (1987) and Fishman (1989). They assume two-sided information asymmetry (i.e., the bidder and the target each have private information about their own value). As a result, the division of the merger gains between the parties becomes a function of the size (dollar value) of the bid and of the medium of exchange. To illustrate, a high bid implies a relatively high expected "overpayment cost" to the bidder, since bids are only accepted by targets with values less than or equal to the bid. On the other hand, a low bid reduces the probability that the bid will be successful; unsuccessful bids involve a cost due to the lost synergy gain. Thus, low bids involve a relatively high expected "lost synergy gain" cost.

Furthermore, the medium of exchange affects these costs for the bidder. For example, in an all-cash offer, the bidder bears the entire cost of overpayment, since the payment is independent of the true value of the target ex post. On the other hand, while an all-stock offer means that the bidder shares some of the target mispricing with the target, the bidder may also be issuing its shares at less than true value. Thus, while an all-stock offer can reduce the bidder's overpayment cost, it can also generate a "bidder undervaluation cost."

Hansen (1987) and Fishman (1989) draw on one or more of these costs to construct signaling or sorting equilibria. Hansen (1987) assumes a bidder with monopolistic access to information about the value of the merger. In equilibrium, some bidders present separating all-stock offers while other higher-value bidders present a common all-cash offer. No mixed offers of cash and stock are observed because the bidders are using the foregone synergy cost to signal their value to the target.[4] The primary empirical implication of the model relates the likelihood of the bidder offering all-cash or all-stock to the bidder's and target's debt level and size. Based on a comparison of means across a sample of 46 all-stock and 60 all-cash acquisitions, Hansen (1987) presents some "moderately supportive evidence" (p. 90) for his prediction.

In Fishman (1989) the security offered by the bidder is a debt contract secured by the target's assets, allowing the target to price

[4] Relatively high value bidders present relatively unattractive all-stock offers that have a higher probability of failing. The resulting high expected "lost synergy gain" cost is used to signal so that the bidder's shares are accurately priced. For some high value bidders, however, the cost is not worthwhile, and they "pool" by presenting a common all-cash offer.

this security correctly. Furthermore, Fishman assumes that there is more than one potential bidder. Once an initial bidder identifies a target, rival bidders must incur a cost to acquire information before they can present a bid. Potential rival bidders will incur this cost only if they believe that the initial bidder's valuation of the target is below a critical value. By offering all cash, the initial bidder incurs a relatively high overpayment cost. This signals that his valuation of the target is high, thus deterring competition. Hence, Fishman predicts that all-cash offers will yield a higher bidder abnormal return (as a result of the value of deterrence), and a lower probability of rejection (as a result of less bidder competition). He does not attempt to examine his model empirically.

Our paper has two objectives, one theoretical and one empirical. First, it provides a theoretical explanation for the relation between the *mix* of cash and securities in the offer and the bidder's private information about its value and the value of the synergy, and identifies a fully separating equilibrium in which the bidder's postacquisition value is revealed to the target by the mixed offer selected. The model implies that the offer-induced change in the bidder value is monotonically increasing and convex in the amount of cash used in the offer.[5]

Our second objective is to provide an empirical examination of the valuation effect of the mix of cash and shares used to accomplish the takeover. In the extant empirical literature, mixed offers are treated as an enigma. The sample sizes are generally small,[6] detailed information on the cash–security mix is uniformly absent, and testable hypotheses uniquely addressing mixed offers are not provided. In contrast, our equilibrium framework generates empirical predictions which we examine using data on the mix of cash and stock in a comparatively large sample.

We perform tests on a sample of acquisitions in Canada, because mixed offers in the United States frequently give each target shareholder the option to choose his own mix of cash and stock.[7] These

[5] More recently, and much in the spirit of the first part of our paper, Berkovitch and Narayanan (1989) derive predictions consistent with the use of both cash and stock. In a model with potential competition, they predict that *low-value* firms signal their value through an appropriate all-stock offer, while the high-value firm presents an acceptable offer that includes a positive amount of cash. Also, Brown and Ryngaert (1989) develop an explanation for mixed cash–stock offers based on taxes and one-sided asymmetric information, where the bidder type is unknown but the target type is common knowledge.

[6] For example, there are only seven mixed offers (4 percent of the total sample) in the study by Travlos (1987), 36 (21 percent) in Huang and Walkling (1987), 11 (4 percent) in Eckbo and Langohr (1989), and 20 (7 percent) in Asquith, Bruner, and Mullins (1988).

[7] The U.S. Internal Revenue Service requires that at least 50 percent of the consideration must be paid in the form of voting stock for the takeover to achieve tax-free status [see, e.g., Brealey and Myers (1984, chapter 31)]. As a result, the option in these mixed offers is typically constrained so that the bidder achieves a tax-free status.

tax-related options confound the empirical analysis of the predictions of asymmetric information models. In Canada, however, takeovers receive tax-free status only if 100 percent of the compensation is stock in the bidder firm,[8] and complicating option features are rare.

The rest of the paper is organized as follows. Section 1 introduces our framework and the equilibrium concept employed. We then describe the equilibrium and identify the cross-sectional implications. The sample characteristics and empirical results are discussed in Section 2. Section 3 concludes the paper.

1. The Medium of Exchange under Asymmetric Information

1.1 The model

Consider a bidder with value b who discovers a synergistic opportunity that requires acquisition of another company, the "target." The target has a reservation value t and the synergy, which may be bidder-specific, is worth $s(b)$. We assume that the bidder knows only that the target's reservation value is drawn from a discrete set of possible types contained in the interval $[0, t_b]$ according to the probability function $f(t)$. Similarly, while the bidder knows b, the target knows only that the bidder value is drawn from the interval $[0, b_b]$ according to the probability function $g(b)$. The bidder presents an offer to exchange the target's shares for an amount of cash, c, and some type of security.

This framework follows Hansen (1987) in assuming two-sided asymmetric information and monopolistic access to the synergy by the bidder. We depart, however, by explicitly allowing bidders to select a cash–security mix; this introduces a signaling role for cash that is not present in Hansen's model and leads to the prediction that no two bidder types will present the same offer since they will be able to convey information efficiently to the target through the cash–stock mix selected. We assume that the synergy gain from merging is sufficiently large that the bidder finds it optimal to make a bid that no target will reject. Although foregone synergy costs could be included as an additional signal in this framework, the derived results would then depend, as they do in Hansen (1987), on the particular specification of the relation between the synergy and the bidder's value.

For simplicity, we assume that all agents are risk neutral and that the discount rate is zero. Let t_i refer to a specific target value and

[8] See, e.g., Brealey et al. (1986, chapter 31). This tax feature introduces a discontinuity in the size of the bid for all-stock offers. We avoid dealing with this discontinuity in the test of our model by focusing only on mixed offers. We discuss the implications of this discontinuity in Section 2.2.

assume, for ease of illustration, that $i \in \{l, h\}$. Similarly, let specific bidder values be denoted by b_j, $j \in \{1, 2, 3\}$, and the associated bidder-plus-synergy value by $\Omega_j \equiv b_j + s(b_j)$, where $\Omega_1 < \Omega_2 < \Omega_3$.[9]

The following steps formally outline the chronological structure of the game:

• Bidder type j discovers a synergistic opportunity with a target of unknown type; at this point the bidder knows Ω_j and forms prior beliefs about the target's value:

$$\bar{t} \equiv f(t_l)t_l + f(t_h)t_h.$$

• Bidder j makes an offer (z, c), where c is the cash payment from bidder j to the target shareholders and z is the fraction of the post-merger firm shares to be held by the target shareholders.

• Target shareholders revise their beliefs about Ω_j, and compute the expected payoff from accepting the offer as

$$c + z(t_i + \hat{\Omega}(z, c) - c),$$

where $\hat{\Omega}(z, c)$ is the target's estimate of Ω given that the bidder has offered (z, c).

• Target shareholders accept the offer if the above payoff equals or exceeds t_i, the true target value; otherwise, the target shareholders reject the offer and the synergistic opportunity is lost.

We will require that $z \in [0, 1]$ and $c \in [0, t_h]$, so that the set of actions available to the bidder is defined on the set $[0, 1] \times [0, t_h]$.

We view this model as an extensive form game of incomplete information and employ the sequential equilibrium concept of Kreps and Wilson (1982) to identify equilibria. This concept requires that the target apply Bayes' rule to revise its beliefs about the bidder, having seen (z, c). In cases where Bayes' rule cannot be applied (i.e., an unexpected, zero-probability action by the bidder), a wide range of beliefs is consistent with the sequential equilibrium concept, leading to the existence of a large set of equilibria. We refine the set of equilibria further by using the "intuitive criterion" proposed by Cho and Kreps (1987).

In applying the Cho–Kreps criterion in the context of our problem, we consider possible off-equilibrium-path offers and define the set N of types who would not prefer to make the out-of-equilibrium offer relative to the equilibrium regardless of the target's response. Then,

[9] We choose a model with discrete bidder types, rather than assuming a continuum of types, for two reasons. First, the literature that develops equilibrium concepts for a game-theoretic environment has almost exclusively utilized a discrete-type framework. We will rely on these equilibrium concepts. Second, in this particular application, assuming a continuum of types yields an ordinary differential equation which has no simple solution, so that one cannot obtain a closed-form solution for empirical testing purposes. Thus, we assume discrete bidder types.

an equilibrium is said to *fail* the criterion (and, hence, is supported by unreasonable beliefs) if the following condition holds for some out-of-equilibrium offer: Set D, the complement of N in the set of all possible bidder types, contains at least one type who would prefer to make the out-of-equilibrium offer relative to the equilibrium offer even if the target believed the bidder was the lowest valued type *in the set D*. Thus, an equilibrium consists of a strategy for the bidder, a strategy for the target, and a set of beliefs which satisfy the conditions set out above.

1.2 Equilibrium analysis

In analyzing our problem, we focus on pure strategies and identify equilibria in which the bidder optimally chooses (z, c) offers attractive to *both* low- and high-value targets rather than making offers that the type t_l would accept but that t_h would reject.

Since a high-value target believes that the postacquisition value of the firm is $t_h + \hat{\Omega}(z, c) - c$, in order for it to accept an offer, z and c must satisfy

$$z(t_h + \hat{\Omega}(z, c) - c) + c > t_h. \tag{1}$$

Based on Equation (1) we can fix beliefs and define acceptance curves as the combinations of z and c that satisfy

$$z = \frac{t_h - c}{t_h + \hat{\Omega} - c}. \tag{2}$$

An acceptance curve indicates the minimum value of z that, in conjunction with a payment of c, would be acceptable to the high-value target given that the target believes the bidder is worth $\hat{\Omega}$. Figure 1 depicts the acceptance curve for various beliefs. The curve AB depicts the acceptance curve given that $\hat{\Omega} = \Omega_1$; DB depicts the acceptance curve when $\hat{\Omega} = \Omega_2$; and EB depicts the acceptance curve when $\hat{\Omega} = \Omega_3$. So, for example, the target would accept any offer made by a type-2 bidder that was on or above the curve DB.

A bidder of type j wishes to present an *acceptable* offer that will maximize $(1 - z)\ (\bar{t} + \Omega_j - c)$, the expected value of its residual claim to the combined firm. We can fix the expected value of the bidder's residual claim at some level $\dot{v}$ to define isovalue curves as the combinations of z and c which provide bidder j with a constant level of utility, i.e., which satisfy

$$z = 1 - \frac{\dot{v}}{\bar{t} + \Omega_j - c}. \tag{3}$$

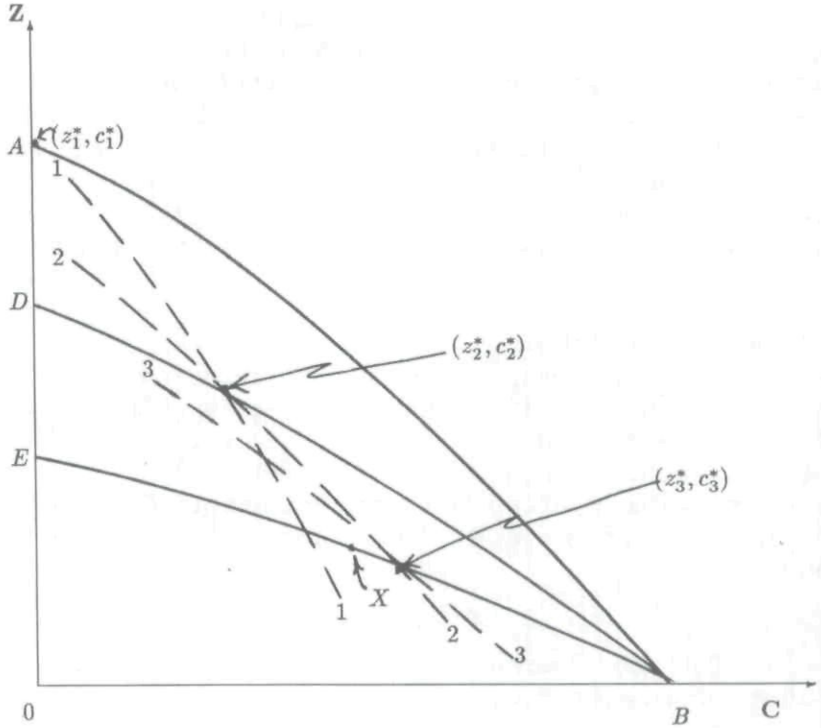

Figure 1
Separating equilibrium
(z_j, c_j) denotes the fraction of the firm and the amount of cash offered to the target by bidder type $j \in \{1, 2, 3\}$. The pair (z_j^*, c_j^*) denotes the equilibrium offer. Curves *AB*, *DB*, and *EB* describe acceptable offers from bidder types 1, 2, and 3. Curves 1–1, 2–2, and 3–3 are isovalue curves for bidder types 1, 2, and 3. The true bidder types, Ω_j, are such that $\Omega_1 < \Omega_2 < \Omega_3$.

The curves 1–1, 2–2, and 3–3 in Figure 1 depict the isovalue curves for bidder 1, 2, and 3, respectively. So, for example, bidder type 2 receives the same postcombination value, v_2, for any (z, c) offer along curve 2–2. Since the value of the residual claim increases with lower values of z and c, the value of $\dot{v}$ represented by the isovalue curves increases for curves located closer to the origin. It can be shown that isovalue curves based on Equation (3) are concave, negatively sloped functions of c; that at any potential offer (z, c) the slope of the isovalue curve is less negative for higher-value bidders; that acceptance curves defined in Equation (2) are concave, negatively sloped functions of c; that at any $c < t_b$ the acceptable value of z is lower for higher values of $\hat{\Omega}$; and that the bidder isovalue curves are more negatively sloped than the target acceptance curves.[10]

[10] This last condition follows from the target's acceptance curve being based on an offer worth t_b when the bidder's valuation of the target is only $\bar{t} < t_b$. To compensate for this expected overpayment,

In equilibrium, the values of z and c must satisfy the constraint (2). Substituting (2) into the bidder's residual claim allows us to restate it as

$$v_j(\hat{\Omega}, c) = \hat{\Omega}\left[\frac{\bar{t} + \Omega_j - c}{t_b + \hat{\Omega} - c}\right]. \tag{4}$$

Hence, in equilibrium, the residual claim of bidder type j is a function of the target's beliefs, $\hat{\Omega}$, and the amount of cash in the offer, c.

Using Equations (2) and (4), and the properties of the isovalue curves, we can describe and analyze the separating equilibrium that forms the basis of our main empirical hypothesis. The following conditions characterize a separating equilibrium for bidders with values $\Omega_1 < \Omega_2 < \Omega_3$ and targets with values t_b and $t_l < t_b$:

- Bidder type 1 offers $c_1^* = 0$.
- All c_j^* for $j > 1$ must satisfy the nonmimicry condition

$$v_j(\hat{\Omega} = \Omega_j, c_j^*) = v_j(\hat{\Omega} = \Omega_{j+1}, c_{j+1}^*), \tag{5}$$

for every adjacent pair Ω_j, Ω_{j+1}, where $\Omega_j < \Omega_{j+1}$.

- All z_j^* satisfy Equation (2).
- Both target types accept equilibrium offers and reject all off-equilibrium-path offers with probability 1 unless they satisfy

$$z \geq \frac{t_i - c}{t_i + \Omega_1 - c}.$$

It is obvious from Figure 1 that $c_3^* > c_2^* > c_1^* = 0$ and that the z_j^* lie on the appropriate acceptance curves for all bidders j. The equilibrium offers are selected from the set of possible offers in the following way. First, we require that the lowest possible bidder type not engage in costly signaling, implying that $c_1^* = 0$.[11] Then, for any two adjacent bidder types j and $j + 1$, $\Omega_j < \Omega_{j+1}$, we take c_j^* as being predetermined and require that c_{j+1}^* satisfy the nonmimicry condition (5). That is, c_{j+1}^* must be such that the lower-value bidder is not better off presenting the higher-value bidder's offer, even if such an offer would mislead the target into believing that the offer had been presented by a higher-value bidder.

The separating equilibrium is summarized in Proposition 1.

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the bidder must achieve a larger drop in z for a given increase in c: The bidder isovalue curves are steeper than the target acceptance curves.

[11] This is a standard requirement of screening models and is also the only strategy consistent with a separating sequential equilibrium in a signaling game. See Cho and Kreps (1987). An all-stock offer minimizes the expected overpayment cost incurred by a bidder making an offer that will only be accepted by targets worth less than what the bid is based upon. Payment in bidder shares forces the target to share in the overpayment cost.

Proposition 1. *Separating strategies, as defined in the text, will form an equilibrium if and only if*

$$f(t_h)s(b_j) \geq (t_h - \bar{t})(1 - z_j^*). \tag{6}$$

The formal proof (available from the authors on request) demonstrates that separating strategies do in fact form a sequential equilibrium. Here we outline the key ideas of the proof. Condition (6) is necessary for bidders not to be better off making an all-cash offer of t_l rather than making this equilibrium offer. That is, the equilibrium we consider requires that all bidder types find it optimal to present bids acceptable to the high-value target. In making this decision, each bidder type compares the payoff from playing the separating strategy given above with the payoff that would result from an all-cash bid for the low-value target. Using Equation (4), the separating strategy ($\hat{\Omega} = \Omega_j$) generates the following expected value of the bidder's residual claim:

$$v_j(\hat{\Omega} = \Omega_j, c) = \Omega_j \frac{\bar{t} + \Omega_j - c}{t_h + \Omega_j - c}. \tag{7}$$

It would be optimal to use all cash if the bid were intended to induce only the low-value target to accept (i.e., $c = t_l$), and this all-cash bid would generate a payoff of

$$f(t_l)(\Omega_j) + f(t_h)b_j. \tag{8}$$

Condition (6) ensures that the payoff in Equation (7) exceeds the payoff in Equation (8).

In showing sufficiency, we first establish that the lowest possible type will not include cash in the offer. Then we demonstrate that the nonmimicry condition (5) also implies that higher bidder types would not want to imitate lower bidder types. This point can be illustrated in Figure 1 by examining the intersection of the isovalue curves for types 1 and 2 at (z_2^*, c_2^*). The fact that the slope of an isovalue curve is less negative for higher values of Ω implies that 2–2 represents higher value than an isovalue curve drawn for type 2 through (z_1^*, c_1^*) and, hence, that type 2 would strictly prefer not to imitate type 1. Thus, there are no incentives for an agent to defect along the equilibrium path.

The equilibrium also requires that off-equilibrium-path offers be rejected, and this in turn imposes a restriction on off-equilibrium-path beliefs: The target must believe the bidder is of low enough value to make rejection an optimal response. Although there is no one widely accepted criterion for evaluating the appropriateness of such restrictions, as indicated earlier, we adopt the intuitive criterion by Cho and Kreps (1987).

To see that in fact the equilibrium identified does satisfy this criterion, consider the offer X in Figure 1. In this case, set N consists of type 1 and set D consists of types 2 and 3, both of whom are better off if X is accepted. However, both 2 and 3 are worse off if the target believes that the offer is from a type-2 bidder, since this would induce rejection. Therefore, the criterion is satisfied.

One important empirical implication of the separating equilibrium is characterized in the following corollary.

Corollary 1. *The value of the bidder's residual claim is increasing with the size of the cash offer.*

Proof. From Equation (4), for a given set of beliefs, the bidder's residual claim is increasing in the bidder's true type. Therefore,

$$v_{j+1}(\Omega_{j+1}, c^*_{j+1}) > v_j(\Omega_{j+1}, c^*_{j+1}).$$

Using the nonmimicry condition (5) to substitute for $v_j(\Omega_{j+1}, c^*_{j+1})$ gives

$$v_{j+1}(\Omega_{j+1}, c^*_{j+1}) > v_j(\Omega_j, c^*_j).$$

Therefore, since $c^*_{j+1} > c^*_j$, the value of the residual claim is increasing in the size of the cash offer. ■

Hence, the separating strategies form an equilibrium with the property that higher bidder types use cash for a larger portion of the transaction. This provides part of the basis of our empirical hypothesis: When a takeover involves a mix of cash and stock, the market revises its valuation of the bidder, awarding higher values to bidders that use more cash.

Further implications of the model which are examined empirically are stated in Proposition 2 and Corollary 2.

Proposition 2. *The value of the bidder's residual claim in the separating equilibrium, $v_j(\Omega_j, c^*_j)$ is a convex function of the amount of cash used, c^*_j.*

The formal proof (available from the authors on request) proceeds by showing (i) $v_j(\Omega_j, c^*_j)$ is convex in Ω_j; and (ii) c^*_j is concave in Ω_j. Under (i) and (ii), Proposition 2 obtains.

To phrase the model results in terms of abnormal returns, define $\bar{v}$ as the preoffer market value of the bidder, including investors' prior beliefs that a bidder might discover a favorable takeover opportunity.

Then, for the purpose of the subsequent empirical tests, Corollary 2 redefines the convexity result of Proposition 2.

Corollary 2. *The abnormal return to the bidder, $v_j(\Omega_j, c_j^*) - \bar{v}$, is a convex function of the fraction of cash used in the offer, $c_j^*/\bar{t}$.*

Because the values $\bar{v}$ and $\bar{t}$ are fixed, the convexity of Proposition 2 goes through in Corollary 2.

It is possible to further sharpen the model's empirical predictions by showing that when any cash is observed in an offer, then bidder-specific valuation information is revealed to the market. First, we can rule out the use of any amount of cash when the value of the bidder is known to the market. The reason for this is that an all-stock offer minimizes the bidder's overpayment to the target and, since the bidder value is known, does so without generating any undervaluation cost to the bidder. Second, we can eliminate the possibility that an equilibrium exists in which all firm types present the same mixed offer. This is stated formally in the following proposition.

Proposition 3. *Strategies in which all bidder types present the same offer are not equilibrium strategies.*

Proof. Suppose that a pooling equilibrium, such as the one illustrated in Figure 2, did exist and that all firms presented the offer P on the acceptance curve FB. For this to be an equilibrium, all off-equilibrium-path offers must be rejected and therefore beliefs must be that off-equilibrium-path offers are presented by bidders of lower-than-average value. However, such off-equilibrium-path beliefs would not satisfy the intuitive criterion. To see this, recall that the acceptance curve for type 3 (EB in Figure 2) lies below the acceptance curve for the pool (FB in Figure 2). Since the isovalue curve for the high-type bidder (3–3 in Figure 2) is flatter than that of the next lowest type (2–2 in Figure 2), there exist offers on the acceptance curve for the high-value bidder (such as point X in Figure 2) which, if accepted, would be preferred to the equilibrium by the high-value bidder but not by the next highest bidder. Hence, in terms of the intuitive criterion, relative to the off-equilibrium-path offer X, the set N consists of types 1 and 2, so that the set D consists of type 3 only. Moreover, type 3 *would* defect to this off-equilibrium-path offer even if the target believed the offer was coming from the lowest valued type in D. Hence the strategies do not satisfy the intuitive criterion. An identical argument rules out partial pools in equilibrium.[12]

[12] In the analysis above, we have restricted c to be nonnegative and less than t_b. Cash bids in excess of t_b can be shown to be dominated by offers of less than t_b. Allowing $c < 0$ shifts the equilibrium

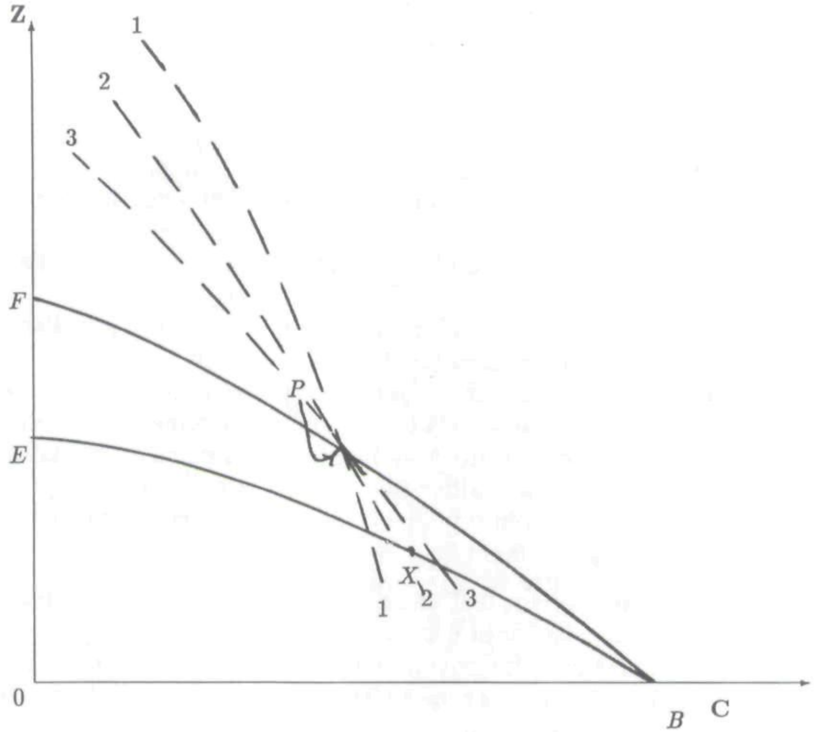

Figure 2
Pooling equilibrium
The point denoted P represents a sequential pooling offer. Point X is an off-equilibrium-path offer that illustrates why this equilibrium does not satisfy the intuitive criterion of Cho and Kreps (1987).

2. Empirical Analysis

2.1 Data and sample characteristics

The sample of acquisitions is selected from the Merger Register compiled by the Department of Consumer and Corporate Affairs.[13] To be included in the sample, it is required that:

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sorting schedule shown in Figure 1 to the left, so that the lowest value bidder (Ω_1) offers $c_1^* = -\Omega_1$ and $z_1^* = 1$, i.e., the bidder demands a cash payment from the target. Higher-value bidders demand less cash, and still higher-value bidders would make a cash payment, as in our model. We could rule out $c < 0$ equilibrium offers by assuming a mass of negative synergy bidders ($\Omega < 0$) at the low end of the Ω distribution. To our knowledge, in the subsequent empirical analysis, the firm making the cash payment is also the firm initiating the transaction, as assumed in our theoretical framework.

[13] The Merger Register contains a total of 9294 merger and acquisition bids announced beween January 1945 and December 1983, of which 7559 were announced after January 1, 1964. The Register records all mergers in industries subject to the 1910 Combines Investigation Act, given the merger is announced in the news media, including newspapers, trade journals, and business magazines in Canada, the United States, and Britain.

1. the merger bid occurred between January 1964 and December 1982[14];

2. at the time of the acquisition, the bidder firm is listed on the Toronto Stock Exchange (TSE);

3. the date of the first press announcement of the acquisition is identified in the Merger Register[15];

4. the acquisition was for a controlling (at least 50 percent) interest in the target[16];

5. the bid was successful (i.e., not rejected by shareholders or later abandoned by managers);

6. sufficient stock return data for TSE-listed bidder firms is available on the University of Laval data tape[17]; and

7. according to information in the corporate database of the *Financial Post* or *Moody's Industrial Manual,* (i) the payment method is either all-cash, all common stock in the bidder firm, or a combination of the two,[18] and (ii) the bidder does not offer target shareholders the option to select, on an individual basis, the preferred combination of stock and cash as payment.[19]

A total of 182 takeovers satisfy the above selection criteria. Table 1 shows the sample distribution by year. In approximately one third (56) of the takeovers, the payment is a combination of cash and common stock in the bidder firm; in 92 cases the offer is all-cash; and there were also 34 all-stock offers which we include for completeness. Thirty-four of the 56 mixed offers took place before 1972, while there apparently was a surge of all-cash offers in the early 1970s.[20]

Table 2 shows the mean and median values of the offer characteristics, classified by the payment method. In the mixed-offer category, the average of the preoffer bidder value $\bar{v}$, measured using total bidder equity value prior to the month of the takeover, is $126 million. Since only 12 of the 56 target firms in the sample of mixed offers are publicly traded, we approximate $\bar{t}$ with $\bar{t}_j \equiv c_j + z_j\bar{v}_j$ (i.e., the sum of the cash payment and the preannouncement market value of the bidder shares

[14] As described below, this time period is primarily dictated by the availability of stock-return data.

[15] The primary newspaper source for the Merger Register is the national *Globe and Mail.*

[16] In 90 percent of the takeovers, the bidder acquired 100 percent of the target.

[17] This tape contains monthly stock returns for approximately 65 percent of all TSE-listed firms, beginning January 1963. The TSE-listed firms excluded by the Laval tape are for the most part stocks with extremely low capitalization ("penny stocks").

[18] This restriction eliminates 52 identified cases where the bidder offered bonds or a combination of bonds, cash and preferred shares.

[19] Restriction (ii) eliminates only four cases from our sample.

[20] We searched newspaper accounts related to the 182 takeovers for information on (i) the presence of multiple, competing bids and (ii) indications that the offers were "hostile" toward incumbent management. None was found.

Table 1
The annual number of successful acquisitions in the sample, classified by the medium of exchange in the transaction, 1964–1982

Year	Total	All-cash offers	All-stock offers	Mixed cash–stock offers
1964	1	1	0	0
1965	2	0	1	1
1966	0	0	0	0
1967	6	4	2	0
1968	19	4	5	10
1969	14	4	4	6
1970	18	2	5	11
1971	23	14	2	7
1972	22	13	5	4
1973	13	11	1	1
1974	7	5	1	1
1975	6	6	0	0
1976	12	8	0	4
1977	3	3	0	0
1978	2	2	0	0
1979	10	4	4	2
1980	8	6	0	2
1981	12	4	4	4
1982	4	1	0	3
1964–1982	182	92	34	56

The sample is drawn from the Merger Register compiled by the Canadian Department of Consumer and Corporate Affairs. A case is included only if the bidder was listed on the Toronto Stock Exchange, if at least 50% of the target shares were acquired, and if details of the payment method are available in the corporate databases of the *Financial Post* or Moody's Corporation.

offered). This value includes any premium paid for the target but excludes the revaluation of the bidder shares due to the offer. The average value of $\bar{t}_j$ is \$32 million and, in the sample of mixed offers, the average target value is 13% of the preoffer equity value of the bidder firm.

Table 2 also shows the average acquisition activity of the bidder firms over years −2 through 0, denoted a_{-2}, where year 0 is the year of the acquisition in the sample. The index counts acquisitions that were announced in major newspapers only, as compiled by Eckbo (1986). For bidder j, the index value is computed as $a_{-2,j} \equiv \frac{1}{6}\sum_{t=-2}^{0} \alpha_{jt}(t+3)$, where α_{jt} is the number of acquisition announcements in year t. Thus, the index is a time-weighted average of the number of acquisition announcements, where the weights are inversely proportional to the distance of year t from year 0.[21] The mean value of a_{-2} is 0.5 for all three categories of takeover bids. Finally, Table 2

[21] To illustrate, if the firm has an equal number of acquisition announcements in each of the index years, then the index value equals the annual number of acquisition announcements. With an uneven distribution of the annual number of acquisition announcements, the index value is greater the more recent the announcements. Thus, the index can be interpreted as firm j's conditional propensity to make an acquisition announcement, given its most recent history of such announcements.

Table 2
Offer characteristics, classified by the method of payment, 1964–1982

Offer characteristic[1]	All-cash offers				All-stock offers				Mixed cash–stock offers			
	Mean	Median	Min.	Max.	Mean	Median	Min.	Max.	Mean	Median	Min.	Max.
$\bar{v}_j$ ($ million)	140.0	32.7	3.5	2390.8	73.9	31.5	0.3	471.8	126.0	22.1	1.2	3550.0
$\bar{t}_j$ ($ million)	30.3	3.1	0.02	1496.4	6.9	2.3	0.09	38.8	32.0	2.7	0.2	790.3
$\bar{t}/\bar{v}_j$ (%)	9.1	8.2	0.2	668.0	9.1	5.5	0.1	902.5	13.5	10.0	0.5	448.2
$a_{-2,j}$	0.5	0.3	0.0	2.7	0.5	0.2	0.0	2.5	0.5	0.3	0.0	2.0
$c_j/\bar{t}_j$ (%)	100.0	100.0	100.0	100.0	0.0	0.0	0.0	0.0	51.0	50.0	8.0	95.0
c_j ($ million)	30.3	3.1	0.2	1496.4	0.0	0.0	0.0	0.0	17.7	1.1	0.5	550.1

[1] Variable definitions: $\bar{v}_j$ = market value of the bidder firm's total equity in the month prior to the month of the takeover; $\bar{t}_j$ = the sum of the cash payment and the preannouncement market value of the bidder shares offered to the target; $a_{-2,j}$ = index of the bidder's acquisition activity over the years −2, −1 and 0, where 0 is the year of the acquisition [for bidder j, the index value is computed as $\frac{1}{6}\sum_{t=-2}^{0} \alpha_{jt}(t+3)$, where α_{jt} is firm j's total acquisition activity in period t as recorded by the Merger Register]; c_j = cash payment to target.

shows the average value of our measure of the cash portion of the total payment to the target, $c/\bar{t}_j$. For mixed offers, the average and median values of the cash portion are 0.51 and 0.50, respectively, ranging from 0.085 to 0.95.

2.2 Average abnormal returns

Our abnormal return estimates are based on monthly stock-return data.[22] The announcement-month abnormal return is estimated directly as the parameter γ_j in the following market model:

$$r_{jt} - r_{ft} = \alpha_j + \beta_j(r_{mt} - r_{ft}) + \gamma_j d_{jt} + e_{jt}, \tag{9}$$

where r_{jt}, r_{ft}, and r_{mt}, respectively, are the continuously compounded rates of return to firm j, the risk-free asset,[23] and the value-weighted market portfolio in month t; d_{jt} is a dummy variable which takes on a value of 1 if month t is the month of the press announcement of the acquisition and 0 otherwise; and e_{jt} is a mean zero-error term assumed normally, identically, and independently distributed. The estimation uses a minimum of 24 and a maximum of 48 observations from the postevent period month 13 through 60, plus month 0.[24]

Table 3 shows the average values of the OLS estimates of the market model parameters α_j and γ_j for the all-cash, all-stock, and mixed cash–stock offers in our sample. While the primary empirical implication of our model is a cross-sectional relation describing mixed offers, it is also of interest to compare the average γ_j across the three offer categories, as is often done in the extant literature. It follows from

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[22] A substantial effort was also invested in collecting and analyzing daily data. A database compiled by the Financial Research Foundation of Canada, and which covers daily stock returns for TSE-listed firms back to 1976, provides information on 48 of the all-cash offers, 11 of the all-stock offers, and 24 of the mixed cash–stock offers in our sample. After an extensive verification of the dividend and stock distribution information on this tape, we estimated abnormal stock returns over the two-day period ending with the day of the press announcement of the acquisition. As reported in an earlier draft, cross-sectional regressions of the type reported below produce largely insignificant results when this two-day abnormal stock return is used as the dependent variable. Given the small sample size, we elected to report the full-sample results based on monthly data only. Of course, monthly data also have the advantage of reflecting any acquisition-related information released to the market several days prior to the newspaper announcement day, which may explain why we in fact obtain more significant abnormal returns with monthly than with daily data.

[23] The risk-free rate is provided by the *Bank of Canada Review*.

[24] In Equation (9), the constant term α_j captures the part of the firm's *expected* return in excess of the risk-free rate that is not due to movements in the market. This "market model" specification is consistent with a world where firms' excess returns are jointly normally distributed, which reasonably characterizes monthly excess returns. Empirically, α_j will also capture any preevent abnormal performance by the bidder firm, which would affect the estimate of γ_j. We avoid this potential problem by using a postevent estimation period. Moreover, the postevent estimation period accounts for any changes in the bidder firm's systematic risk β_j due to the acquisition announcement itself. In an earlier version of this paper we also reported parameter estimates based on the preevent period month −60 through −13. The preevent results were dropped since they produced similar inferences with respect to the empirical validity of our model predictions. Finally, all of the paper's empirical tests were performed based on abnormal *dollar* returns, also without altering the conclusions.

Table 3
Percent announcement-month abnormal stock return γ_j estimated from the market model

$$r_{jt} - r_{ft} = \alpha_j + \beta_j(r_{mt} - r_{ft}) + \gamma_j d_{jt} + e_{jt},$$

where r_{jt}, r_{ft}, and r_{mt} denote the continuously compounded monthly rates of return to bidder j, the riskless asset (Treasury bills), and the value-weighted index of TSE-listed firms, and d_{jt} is a dummy variable that takes on a value of 1 in the announcement month and 0 otherwise

Payment method	Sample size (N)	Average $\hat{\alpha}_j$ (%)[1]	Average $\hat{\gamma}_j$ (%)
All-cash	92	0.87 (1.05; 53.3)	1.43 (1.58; 59.8)
All-stock	34	3.86 (3.80; 76.5)	2.72 (2.02; 58.8)
Cash and stock	56	2.10 (3.21; 71.4)	5.68 (4.18; 66.1)

[1] Z-value and percent positive in parentheses, where $Z = (1/\sqrt{N})\,\Sigma_j(\hat{\gamma}_j/\sigma_{\gamma j}) \overset{as}{\sim} N(0, 1)$, where $\sigma_{\gamma j}$ is the OLS estimate of the standard deviation of γ_j. The estimation period is month 13 through month 60, plus month 0.

the above analysis, however, that this comparison is not straightforward, since the different offer categories arise under different informational regimes. In particular, while mixed offers require the assumption of two-sided information asymmetry, all-stock offers also arise when the bidder value is common knowledge. Moreover, all-cash offers arise only when the target value is common knowledge.

In general, the abnormal return to the bidder firm will consist of two components: (1) *synergy revaluation*—the market's revaluation of the expected synergy gain that is independent of the information provided by the medium of exchange choice; and (ii) *signaling*—the revelation of the bidder's private information concerning the true bidder/synergy value that is conveyed through the medium-of-exchange selection. First, in an all-cash offer there is no signaling, since all-cash offers occur only when the target value is common knowledge and, thus, when there is no overpayment cost. As a result, the abnormal return reflects only component (i). As shown in Table 3, all-cash offers on average lead to a statistically insignificant increase of 1.43% in the bidder's share value over the event month.[25]

Second, all-stock offers occur either when the bidder value is common knowledge, or, in our separating equilibrium, if the bidder is of the lowest value. When the bidder value is common knowledge, the bidder abnormal return reflects the component (i) only, while in the separating equilibrium, component (ii) is also present—with a negative value. Thus, the statistically significant average abnormal

[25] The z-statistics in Table 3 assume cross-sectional independence of the abnormal excess returns in the month of the takeover. This is a reasonable assumption in our sample: multiple events in a given calendar month are rare and never occur in overlapping four-digit SIC industries.

return of 2.72% in all-stock offers reported in Table 3 is a lower bound on the average synergy revaluation gain in this offer category.

Third, bidder abnormal returns in mixed offers consist of both the synergy revaluation component and the signaling component. In Table 3, the average bidder presenting a mixed offer gains a highly significant 5.68% abnormal return over the announcement month. Using the numbers in Table 3 to extract standard errors for the means, the hypothesis that the average abnormal return in mixed offers is the same as in the all-cash or all-stock offers is rejected at the 1% level of significance.[26]

Thus, the evidence in Table 3 indicates that bidder firms presenting mixed offers on average earn the largest announcement-induced abnormal return. The issue remains as to whether the incremental gain in mixed offers represents an average signaling gain or simply a larger average synergy revaluation in this particular offer category. The cross-sectional tests below address this issue directly.

2.3 The econometric model

Propositions and Corollaries 1 and 2 imply that, for takeover j, the abnormal return γ_j to the bidder presenting a mixed cash-stock offer is a monotonically increasing and convex function, h_j, of the cash portion, $c_j/\bar{t}$, of the offer. That is,

$$\gamma_j = h_j(c_j/\bar{t}), \tag{10}$$

where the first and second derivatives of the signaling schedule h_j are positive.

The location and curvature of this signaling schedule depend on the characteristics of the distributions from which the true target and bidder values are drawn. For example, numerical analysis shows that a mean-preserving spread of the distribution of true bidder values shifts the signaling schedule in such a way that it takes a larger value of c_j to create a given value of γ_j. Also, a change in the mean of the bidder or target distributions alters the location of h_j. Thus, cross-sectional tests of Equation (10) require these distributions to be constant across takeovers.

As before, our empirical proxies for the pretakeover bidder and target values $\bar{v}$ and $\bar{t}$ are the preannouncement market value $\bar{v}_j$ and, absent publicly listed targets, the sum of the cash payment and the preannouncement market value of the bidder shares offered, $\bar{t}_j = c_j$

[26] This statement is based on a conventional t-test for the equality of two population means, assuming independent samples and equal true population standard deviations. Also, this statement continues to hold if one restricts the sample period to 1964 through 1972, eliminating from the comparison the post-1972 period, where all-cash offers are relatively frequent. Thus, we have no reason to suspect that the time-series pattern of the different types of offers seen in Table 1 is driving the difference in the abnormal returns in Table 3.

$+ z_j\bar{v}_j$.[27] Furthermore, our proxy for γ_j is the abnormal return parameter estimated from Equation (9), $\hat{\gamma}_j = \ln(v_j/\bar{v}_j)$, where v_j is the postoffer market value of the bidder (net of signaling costs and of market movements over the month of the takeover announcement). With these proxies, our empirical analog to Equation (10) restricts the distributions of true bidder and target values *relative* to $\bar{v}_j$ and $\bar{t}_j$ to be cross-sectionally constant.[28] This yields a cross-sectional regression of the following form:

$$\hat{\gamma}_j = h(c_j/\bar{t}_j) + \epsilon_j, \qquad j = 1, \ldots, N, \tag{11}$$

where the residual ϵ_j reflects measurement error in the abnormal return parameter and is assumed to satisfy

$$E(\epsilon_j) = 0, \quad E(\epsilon_j^2) = \sigma_\epsilon^2, \quad E(\epsilon_j, \epsilon_{j'}) = 0, \qquad j \neq j'.$$

Since our theoretical model does not identify the functional form h, we apply the Box–Cox transformation to the cash portion. A Box–Cox transformation of a variable x, denoted $x^{(\lambda)}$, is defined as[29]

$$x^{(\lambda)} = \begin{cases} (x^\lambda - 1)/\lambda, & \lambda \neq 0, \\ \ln x, & \lambda = 0. \end{cases} \tag{12}$$

When applied to the cash portion, the resulting maximum likelihood estimate of λ will determine the particular functional form of the signaling schedule.

Finally, since the abnormal return is estimated with error, we also include in the statistical model two standardizing variables: the logarithm of the relative size of the target, $\ln(\bar{t}_j/\bar{v}_j)$, and the acquisition propensity index $a_{-2,j}$ defined earlier in Table 2. Inclusion of $\ln(\bar{t}_j/$

[27] Compared to alternative proxies, particularly those based on book values, $\bar{t}_j$ is undoubtedly a relatively precise instrument for $\bar{t}$. Furthermore, because $\partial(c_j/\bar{t}_j)/\partial c_j > 0$, $c_j/\bar{t}_j$ is a valid instrument for the purpose of testing the hypothesis that γ_j is increasing in $c_j/\bar{t}$. On the other hand, while we have proved that γ_j is convex in $c_j/\bar{t}$, no such proof is available for $c_j/\bar{t}_j$. However, numerical analysis shows that γ_j is convex in $c_j/\bar{t}_j$ as well.

[28] To illustrate the nature of this restriction, consider the following distributions of true bidder values in a sample containing two takeovers. In the first takeover, the possible bidder values are 5 and 15, with a prior market value of 10; and, in the other, the values are 50 or 150, with a prior market value of 100. If the high-value bidder reveals its type in both takeovers (by offering a mix of cash and stock), then the resulting abnormal return is ln(3/2) in either case, as required for our cross-sectional analysis. Alternatively, suppose the possible bidder values in the second takeover are 95 and 105—again, with a mean of 100 (a mean-preserving variance reduction). In this case, the distribution of abnormal *dollar* return is cross-sectionally constant, since $v_j - \bar{v}_j = \$5$, for $j = 1, 2$. However, the percentage abnormal return now differs across the two bidders [$\gamma_1 = \ln(3/2)$ and $\gamma_2 = \ln(105/100)$], violating our distributional assumption. To gauge the sensitivity of our empirical results to this issue, all regressions were reestimated with abnormal dollar returns (properly standardized for heteroskedasticity) as dependent variable. These results did not alter any of the paper's conclusions and are therefore not reported.

[29] See, e.g., Judge et al. (1988), pp. 555–563.

Table 4
Maximum-likelihood estimates of coefficients in nonlinear cross-sectional regressions
The dependent variable is the percent merger-induced abnormal return, $\hat{\gamma}_j$. The explanatory variables are the Box–Cox transformation of the cash portion of the payment to the target, $(c_j/\bar{t}_j)^{(\lambda)}$, the log of the relative size of the target, $\ln(\bar{t}_j/\bar{v}_j)$, and the bidder's acquisition propensity, $\alpha_{-2,j}$. Total sample of 56 mixed cash–stock offers, 1964–1982. Asymptotic t-values are in parentheses. The model is

$$\hat{\gamma}_j = \alpha_0 + \alpha_1\left(\frac{c_j}{\bar{t}_j}\right)^{(\lambda)} + \alpha_2 \ln\left(\frac{\bar{t}_j}{\bar{v}_j}\right) + \alpha_3 a_{-2,j} + u_j, \qquad j = 1, \ldots, N.$$

α_0	α_1	λ	α_2	α_3	χ^2-statistic[1]
0.06	0.01	0.22			1.1
(1.51)	(0.15)	(0.07)			
0.09	0.01	0.14	0.01		1.6
(2.46)	(0.10)	(0.06)	(1.10)		
0.09	0.03	0.43	0.02	0.04	1.9
(1.97)	(0.31)	(0.25)	(1.44)	(1.29)	

$\hat{\gamma}_j$ is the estimate of the bidder's abnormal stock return over the announcement month, see Table 3. $\bar{t}_j = c_j + z_j\bar{v}_j$ (i.e., the sum of the cash payment and the preoffer value of the bidder shares offered as payment to the target). The acquisition propensity $a_{-2,j} = \frac{1}{6}\sum_{t=-2}^{0} \alpha_{jt}(t+3)$, where α_{jt} is bidder j's total number of acquisitions in year t relative to the year of the acquisition (year 0).

[1] This statistic equals minus twice the difference between unrestricted log-likelihood and the log-likelihood with the parameters, except the constant, restricted to be zero.

$\bar{v}_j$) reflects our concern that a given merger gain is measured more precisely the larger the relative size of the target.[30] This variable will also reflect any empirical correlation between the payment method and the relative size of the bidder. Inclusion of $a_{-2,j}$ is intended to help control for a possible cross-sectional variation in the degree to which the market anticipates the takeover bid.[31]

The econometric model is then as follows:

$$\hat{\gamma}_j = \alpha_0 + \alpha_1\left(\frac{c_j}{t_j}\right)^{(\lambda)} + \alpha_2 \ln\left(\frac{\bar{t}_j}{\bar{v}_j}\right) + \alpha_3 a_{-2,j} + u_j, \qquad j = 1, \ldots, N. \qquad (13)$$

We use this model to test the hypothesis that $\alpha_1 > 0$ (γ_j increasing in the cash portion) and $\lambda > 1$ (convexity).[32] The parameters are

[30] See, e.g., Jensen and Ruback (1983), p. 20.

[31] Note that since we estimate the return generating process (9) with an unrestricted intercept term, the value of $\hat{\gamma}_j$ is free of an attenuation bias because of partial anticipation of the particular form discussed by Malatesta and Thompson (1985). They assume that the market expects the given firm to acquire targets at a constant rate per unit of time (which can differ across firms). Thus, our acquisition activity index is designed to capture other forms of partial anticipation.

[32] Note that $0 < \partial\bar{t}_j/\partial c_j < 1$, which means that $c_j/\bar{t}_j$, which is our instrument for $c_j/\bar{t}$, understates a given increase in c_j. Since the market reaction captured in $\hat{\gamma}_j$ fully reflects the value of c_j, the estimated value of α_1, therefore, tends to overstate the true covariance between γ_j and the cash proportion $c/\bar{t}$ when the model is true. Numerical examples indicate, however, that this overstatement is on the order of less than 1% and is therefore negligible. Furthermore, if the model is false, then the expected value of α_1 is zero (i.e., unbiased). Thus, the value of α_1 estimated from (13) provides valid statistical inferences with respect to the model's monotonicity prediction.

Table 5
OLS estimates of coefficients in linear cross-sectional regressions

The dependent variable is the percent merger-induced abnormal returns, $\hat{\gamma}_j$. The explanatory variables are the cash portion of the payment to the target, $c_j/\bar{t}_j$, the log of the relative size of the target, $\ln(\bar{t}_j/\bar{v}_j)$, and the bidder's acquisition propensity, a_{-2}. Sample of mixed cash-stock offers, 1964-1982. t-values in parentheses.[1] The model is

$$\hat{\gamma}_j = \delta_0 + \delta_1(c_j/\bar{t}_j) + \delta_2(c_j/\bar{t}_j)^2 + \delta_3 \ln(\bar{t}_j/\bar{v}_j) + \delta_4\alpha_{-2,j} + u_j, \qquad j = 1, \ldots, N.$$

δ_0	δ_1	δ_2	δ_3	δ_4	R^2	F-value
0.04	0.01	0.02			0.04	3.0
(1.90)	(0.05)	(0.05)				
0.03	0.06	−0.01	0.03		0.04	2.4
(1.87)	(0.19)	(−0.02)	(0.92)			
0.04	0.08	−0.04	0.02	0.04	0.04	2.3
(1.96)	(0.29)	(−0.13)	(1.33)	(1.23)		

[1] All variables are defined as in Table 4.

estimated using standard nonlinear maximum-likelihood procedures.[33]

2.4 Parameter estimates

Table 4 shows the parameter estimates and their asymptotic t-values for the full sample of 56 cases. While the constant term is positive and significant (as expected, given the results in Table 3), the values of the χ^2-statistic in Table 4 uniformly indicate that the regressions have little or no explanatory power.[34] With the exception of the constant term, none of the individual coefficients are statistically significant. While the parameters α_1 and λ in the Box-Cox transformation are both of the right sign, the significance levels are too low to conclude reliably in favor of the model. This is true whether or not the standardizing variables $\ln(\bar{t}_j/\bar{v}_j)$ and $\alpha_{-2,j}$ are included in the model.

In Table 4, the Box-Cox transformation lets the data specify the functional form between $\hat{\gamma}_j$ and $c_j/\bar{t}_j$. Table 5 shows results based on the following model, which instead directly imposes a convex (quadratic) functional form on the data:

$$\hat{\gamma}_j = \delta_0 + \delta_1\left(\frac{c_j}{\bar{t}_j}\right) + \delta_2\left(\frac{c_j}{\bar{t}_j}\right)^2 + \delta_3 \ln\left(\frac{\bar{t}_j}{\bar{v}_j}\right) + \delta_4 a_{-2,j} + u_j,$$
$$j = 1, \ldots, N. \tag{14}$$

[33] Eckbo, Maksimovic, and Williams (1990) derive a consistent estimator for cross-sectional regressions of announcement-induced abnormal returns based on discrete, nonrepetitive events. While some of the basic concerns expressed in that paper apply to our regression framework as well, their estimator does not (primarily because of our continuous signal), and is therefore not pursued here.

[34] The hypothesis that the coefficients, except the constant term, are jointly equal to zero at the 10 percent level generates a critical value of 7.8 (with four degrees of freedom) and thus cannot be rejected.

Conditional on this specification, our model predicts that δ_1 and δ_2 are positive.

The regression results in Table 5 fail to support this prediction as well. The coefficient δ_1 is of the right sign but is insignificantly different from zero. Again, inclusion of the standardizing variables does not improve the fit of the model. In sum, the regression results in Tables 4 and 5 provide little support for our signaling framework.[35]

The lack of empirical support may reflect a violation of the theoretical model restrictions or, alternatively, a violation of the assumption that the distributions of true bidder and target values relative to $\bar{v}_j$ and $\bar{t}_j$ are cross-sectionally constant. In the latter case, the sample contains an entire family of signaling schedules b_j, $j = 1, \ldots, N$, and the cross-sectional regression can be viewed as an attempt to estimate the mean parameter values across these N distributions. In this case, and if the parameter values of each signaling schedule are correlated with the choice variable c_j, the parameter estimates reported in Tables 4 and 5 are biased and inconsistent. Unfortunately, one cannot correct for this potential bias since the prior distributions of true bidder and target types are unobservable to the econometrician, a general problem facing empirical tests of asymmetric information models.

3. Conclusions

This paper provides both a theoretical and empirical analysis of the payment method in corporate takeovers. We develop a model which holds that two-sided information asymmetries between the bidder and target firms can lead to an optimal *mix* of cash and stock as payment in the transaction. We identify a separating equilibrium in which the true postacquisition value of the bidder firm is revealed to the target by the composition of the mixed offer, and where this revealed value is increasing and convex in the amount of cash used in the offer.

We examine the model empirically on a sample of 182 Canadian takeovers, of which 56 use a mix of cash and stock as payment method. The average announcement-month abnormal stock return is significantly positive and larger for mixed offers than for either all-stock or all-cash bids. However, there is little or no overall support for our specific model predictions. Maximum-likelihood estimation of par-

[35] All regressions were repeated using weighted least squares, as well as with standardized abnormal returns as dependent variable, without altering any of the conclusions. Furthermore, regressions restricted to the subsample of 34 cases, which took place before 1972, the year capital-gains taxes were introduced in Canada, also do not change the paper's conclusions. We also used a maximum-likelihood procedure to test for a structural shift in the equation, assuming that the time of the structural shift is not known in advance [see, e.g., Judge et al. (1988), pp. 431–433]. No evidence of nonstationarity in the model parameters was uncovered.

ameters in linear and nonlinear cross-sectional regressions fail to reliably support the joint hypothesis of all the model restrictions and the assumption that the sample acquisitions are drawn from the same prior distribution of bidder and target types. This is true whether one lets the data determine the functional form of the relationship between the announcement return and the cash component of the offer (through a Box–Cox transformation), or whether this functional form is prespecified as quadratic.

It is unclear whether the lack of overall support for the empirical hypothesis reflects model error or a violation of the distributional assumption needed to examine the model by means of cross-sectional regressions. The latter ambiguity is inherent in cross-sectional tests of signaling models, where each observation in the cross section in fact may be drawn from a separate distribution of true values (in this case, of bidder and target types). The empirical results of this paper suggest that, absent econometric procedures for handling the critical distributional assumptions underlying asymmetric information models, our empirical knowledge of the relevance of precise model predictions, such as those developed in Section 1, is likely to remain sparse.

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