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M&A negotiations with limited information: how do opaque firms buy and get bought?

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Abstract

We model theoretically and quantify empirically the impact of informational frictions on managerial decisions in the context of mergers and acquisitions. In particular, we focus on how bid premiums and methods of payment are affected by the bidder and target firms' degrees of opacity. To this end, we model the negotiation between bidder and target as a signaling game with two-sided private information. We then empirically test the model's predictions concerning the effects of target and bidder opacity on the simultaneous determination of the method of payment and the bid premium, by conditioning cross-sectionally on the basis of firms' stock trading properties, which we interpret as representative of individual firm opacity. Consistently with the predictions of our model, we find, by studying a sample of bids by and for U.S. publicly listed firms over the period 1985 – 2014, that both the likelihood of a stock bid and the bid premium increase with the opacity of the target, while the opacity of the bidder is related to lower bid premiums.

JEL classification: G34, G14

Keywords: Asymmetric information, mergers and acquisitions, method of payment, bid premium

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1. Introduction

The consequences of informational frictions on corporate activities have been documented in various contexts, from a firm’s underpricing in initial public offerings (e.g. Beatty and Ritter, 1986) to its cost of capital (e.g. Easley and O’Hara, 2005) or discount in private equity negotiations (e.g. Hertzels and Smith, 1993). However, the relationship between asymmetric information and bidding behavior in mergers and acquisitions (M&As) needs further investigation.¹ A rich collection of anecdotal evidence suggests information asymmetry between target and bidder shareholders indeed results in frictions in the market for corporate control. In many cases, bidders eventually regret their *ex post* overpaid acquisitions and, on several occasions, bid valuation by targets with limited information has been so contentious as to end up in court.

Deal success clearly hinges on how much is paid and how.² In this paper, we model the negotiation between a bidder and a target as a signaling game with private information on both sides and we examine a sample of M&A bids by and for U.S. publicly listed firms over the period 1985 – 2014 to study the relations between three variables: the method of payment, the bid (acquisition) premium, and firm individual opacity (a measure of how hard it is for third parties to evaluate the firm’s true value based on publicly available information and thus a proxy of how limited is the information available to a counterparty in a transaction³). In doing so, we assess the strategic rationale of the observed bidding behavior and the efficiency of the market for corporate control.

¹ Halebian, Devers, McNamara, Carpenter, and Davison (2009) provide a comprehensive review of empirical findings on managerial behavior related to M&As from research in management, economics, and finance.

² For a more detailed discussion see, for example, Cording, Christmann, and Bourgeois Iii (2002), Antoniou, Arbour, and Zhao (2008), and Gillis (2009).

³ We consider opacity a firm characteristic and, in particular, we define as more opaque a firm whose valuation depends to a greater extent on unobservables (e.g. an R&D based company rather than a company reluctant to disclose information). Then, the informational asymmetry between two firms in a transaction is determined by their individual opacity or, in other words, by how limited is the information of each counterparty.

In particular, with asymmetrically informed counterparties, we expect firms' individual opacity to be an important driver of the simultaneous determination of both the bid premium and the method of payment. Since the probability of bid success increases with the value of the offer, but is accompanied by overpayment costs, bidders face an evident trade-off between the likelihood of overpaying and that of missing potential synergistic opportunities if their bid is rejected. Both these costs depend on the extent to which counterparties are privately informed and, most importantly, vary with bid premiums and across methods of payment. We then hypothesize that the informational structure of the deal affects how much is offered and how.

The theoretical underpinnings for our research are provided by the models of M&A under asymmetric information of Hansen (1987), Stultz (1988), Fishman (1989), Eckbo, Giammarino, and Heinkel (1990), and Rhodes-Kropf and Viswanathan (2004). These models show, on the grounds of alternative motivations, how the presence of informational asymmetries may have a significant impact on bid characteristics. Our aim in this paper is to unify the different views from these analyses under a novel theoretical framework. To this end, we propose a stylized bargaining game with asymmetric information on both sides, according to which the characteristics of actual bids will depend on the intensity and interaction of the informational gaps between counterparties, which originate from target and bidder opacity.

Our investigation of the choice of the method of payment and the expected bid premium for different degrees of opacity of bidder and target firms contributes to the M&A literature in several dimensions.

First, while definitely stylized, our model allows us to capture all the main features of the strategic interaction between a privately informed bidder and a privately informed target, in which the former simultaneously chooses the method of payment and the amount to be paid. By so doing, we depart from many existing studies - theoretical and empirical - on the determinants of bid premiums, which consider the method of payment to be predetermined with respect to the amount offered. This allows us to show how bid features

may depend not only on observable characteristics of the involved parties (e.g. firm size, deal materiality, ...) but also on each party's beliefs about the opponent's true value and, therefore, on how firms reason about each other's characteristics and actions, when precise information about the former is not available. Moreover, even under simplifying assumptions and unlike most previous work, our model gives rise to different kinds of equilibria under different parametric configurations. We are thus able to highlight the double channel through which opacity affects bids characteristics: on the one hand, different levels of opacity are associated with different kinds of equilibria (i.e. with different links between bidder characteristics and chosen method of payment); on the other hand, within each kind of equilibrium, opacity impacts directly on the average bid premium.

Second, by testing our hypotheses jointly and directly, our analysis departs from existing empirical studies which have so far typically focused on either the bidder or target side and, regarding the method of payment, have mainly drawn indirect inferences based on cumulative abnormal returns upon the announcement of a bid.⁴ Indeed, Moeller, Schlingemann, and Stultz (2007) find that if stock is used as the exchange currency, abnormal returns to bidders are negatively related to their own extent of private information; Officer, Poulsen, and Stegemoeller (2009) report higher announcement returns for bidders using stock to acquire targets that are difficult to value. To the best of our knowledge, the only paper that presents a direct and joint test of the implications of both target and bidder private information on the choice of the method of payment is by Chemmanur, Paeglis, and Simonyan (2009). Still, the hypotheses they test do not coincide with the testable predictions that result from our theoretical model, which also includes the simultaneous determination of the bid premium. Analogously, existing studies so far have explored the relation between the bid premium and asymmetric informa-

⁴ For example, Travlos (1987), Amihud, Lev, and Travlos (1990), Brown and Ryngaert (1991), and Servaes (1991) report significantly lower returns for bidders using stock instead of cash around the announcement date. Similarly, Franks, Harris, and Mayer (1988) reveal that targets' returns are higher if they are offered cash instead of stock.

tion, typically from just the bidder’s perspective.⁵ Indeed, Cheng, Li, and Tong (2008) and Chatterjee, John, and Yan (2012) test how the opacity of target firms affects bid premiums, drawing on theories of overpricing due to divergence of opinion (e.g. Chen, Hong, and Stein, 2002; Diether, Malloy, and Scherbina, 2002; Miller, 1977). In this respect, we extend their analysis by also taking into consideration the opacity of the bidder.

Third, to the best of our knowledge, studies on M&As have only so far measured firm-specific opacity, the cross-sectional conditioning variable, on the basis of ex ante firm characteristics. For example, Chemmanur et al. (2009) employ the number of analysts following a firm, the dispersion of their earnings per share (EPS) forecasts, and their forecast errors, while Chatterjee et al. (2012) use the dispersion of analysts’ EPS forecasts, the breadth of mutual fund ownership, and idiosyncratic volatility. In this respect, we further contribute to the field of M&A by proposing instead to capture firm-specific opacity from a firm’s equity trading properties, forming an index on the basis of the first principal component of several proxies for adverse selection risk from the literature on market microstructure, as in Bharath, Pasquariello, and Wu (2009). Market microstructure measures of information asymmetry, and of adverse selection risk in particular, are in fact designed to capture investors’ perception of the informational advantage held by firm insiders. For the sake of our analysis, then, they provide us a more direct representation of the informational gaps between counterparts in a transaction than ex-ante firm characteristics.

Our empirical analysis first documents that the opacity faced by the bidder in assessing the value of the target is a significant driver of the choice of the method of payment. Indeed, consistent with the predictions of our model, the likelihood of a stock bid increases with the opacity of the target. The

⁵ For example, Koeplin, Sarin, and Shapiro (2005) document that private firms are acquired at an average 20% – 30% discount relative to acquisition multiples (earnings) of similar publicly traded firms. The authors argue that the discount may partly be risk compensation to the bidder for adversely selecting a potential Akerlof lemon target under asymmetric information. However, for public targets, Fuller, Netter, and Stegemoller (2002) and Officer (2007) find a lower price is paid for targets whose stock is less liquid.

latter is indeed positively correlated with the likelihood that the bidder offer stock independently of its own value, so to alleviate overpayment concerns. We do not find evidence on the use of cash bids as a signaling device to deter potential competitors' bids for more opaque targets, as do Chemmanur et al. (2009), but, in line with the same preemptive bidding rationale and with Chatterjee et al. (2012), we find instead target opacity to be associated with higher bid premiums, as predicted by our model. Our analysis then documents that the opacity of the bidder is related to lower premiums, consistent with the fact that bidding firms take advantage of targets' impaired ability to assess their value when conditions are such that bidders with different values do not use separate means of payments. Other results are discussed in greater detail in Section 3.

The rest of the paper is organized as follows. Section 2 describes the model for the choice of the method of payment and the bid premium and formulates testable hypotheses concerning the impact of firm opacity on observable bid characteristics. Section 3 introduces the sample, describes the methodology, the index of firm opacity and presents the results, comparing the empirical findings with the theoretical predictions. Section 4 concludes the paper and introduces potential developments for further research.

2. The Model

To guide the construction of the relevant empirical hypotheses, we model the negotiations between a bidder and a target in the context of a two-stage Bayesian game. In particular, we consider a framework in which a bidder takes advantage of synergistic opportunities upon the acquisition of a target. The informational structure of the interaction is characterized by asymmetric information about the true, unobservable value of the counterpart and, consequently, the potential benefits from the transaction, with each firm being privately informed about its own stand-alone value. For both bidder and target, market values may not reflect the true value of the firm. The

extent of uncertainty outsiders encounter in assessing the other firm’s value, i.e. opacity, captures partially unobservable firm-specific characteristics.

Wealth-maximizing counterparties negotiate, comparing their expected wealth gain conditional on alternative methods of payment and different bid premiums on the basis of the information they possess. We do not consider bids that combine stock and cash payment. A target firm satisfies its incentive constraint by accepting only bids in excess of its true value. When cash is offered, the value of the offer is independent of the true value of the target and the bidder bears the entire cost of overpayment. The probability of bid success and expected overpayment costs increase in the value of the bid (and the premium) and depend only on the value of the target. On the other hand, in the case of a stock bid, the target is offered shares of the combined firm at some exchange ratio and needs to judge the value of the bid (and the premium) on the basis of its limited information. The terms of the offer are contingent and overpayment costs are reduced, since the target eventually shares gains and losses from the deal. However, the probability of bid success and expected overpayment costs depend not only on the value of the target, as in the case of a cash offer, but also on the target’s assessment of the value of the combined firm. Stock offers then provide additional flexibility to satisfy the incentive constraints imposed by the presence of private information, but also entail additional informational costs.

2.1. *Ingredients*

We model the interactive situation between a generic bidder and its⁶ target by a two-stage Bayesian game with two-sided asymmetric information. Such a game can be represented as

$$G = \left\langle \{B, T\}, M, \{Y, N\}, (\Theta_i, p^i, u_i)_{i \in \{B, T\}} \right\rangle. \quad (1)$$

⁶ Both players are firms and will therefore be referred to by the neutral pronoun ‘it’. Each firm acts as a single decision maker and we shall then talk, for instance, about ‘a firm’s actions’, ‘a firm’s behavior’, ...

$\{B, T\}$ is the set of players, containing one bidder and one target. The rôle of player B in this model is to submit an *offer* directed to player T . An offer is an agreement specifying

- a method of payment, cash (C) or stock (S);
- if the method of payment is cash, an amount $c \in \mathbb{R}_+$ to be transferred from the bidder to the target;
- if the method of payment is stock, a participation share (or fraction) $f \in [0, 1]$ to be awarded by the bidder to the target.

Thus the set of actions available to player B is

$$M := (\{C\} \times \mathbb{R}_+) \cup (\{S\} \times [0, 1]). \quad (2)$$

An action $m \in M$ available to the bidder is also called *message* (whence the choice of the letters m and M). The rôle of player T in this model is to either accept or reject the bidder's offer. Thus its action set is $\{Y, N\}$, where Y denotes acceptance and N denotes rejection of the bidder's offer. An action $r \in \{Y, N\}$ available to the bidder is also called *response* (whence the choice of r to denote it).

Both firms have characteristics which are known to themselves, but unknown to the counterpart; that is, they possess private information. For each firm, each distinct set of characteristics constitutes an information type. In our model, the only relevant unknown characteristic of an agent is its *stand-alone value*, a positive real number summarizing the firm's value before the interaction takes place. We assume that, for each $i \in \{B, T\}$, the set of possible asset values of i is $\Theta_i := \{\underline{\theta}_i, \bar{\theta}_i\}$ where $0 < \underline{\theta}_i < \bar{\theta}_i$. For simplicity, we call these the 'low' and 'high' value (type) of agent i and we denote the difference among them by $V_i := \bar{\theta}_i - \underline{\theta}_i$. For all $i \in \{B, T\}$, $p^i \in (0, 1)$ is agent i 's belief that the opponent's value is $\bar{\theta}_j$.⁷ Such beliefs are commonly

⁷ Thus, for instance, one can see that the expectation of i 's value according to j 's belief is an affine transformation of V_i and, more importantly for our purposes, that the mean square error of i 's value according to j 's belief is a linear transformation of V_i , which justifies our interpreting V_i as a parametric measure of the variability of i 's value.

known by the players.⁸

For each $i \in \{B, T\}$, the payoff function $u_i : M \times \{Y, N\} \times \Theta_B \times \Theta_T \rightarrow \mathbb{R}$ associates with every pair of action profiles and stand-alone values the monetary payoff obtained by i . Both firms are assumed to be risk-neutral.

The structure of the game is as follows. The bidder moves first and proposes an offer $m \in M$. The target observes the offer proposed by B and either accepts it (Y) or rejects it (N). If B 's offer is accepted, the merged firm BT is created. We assume that the value of the merged firm BT , conditional on the stand-alone values of the involved parties, is given by $\theta_B + w(\theta_T)$, where, for all $\theta_T \in \Theta_T$, $w(\theta_T) > \theta_T$. Upon acquisition by the bidder, the value of the target's assets increases. This transformation in values is called *synergy* and we use the same name to denote the intensity of such increase, namely

$$\Delta(\theta_T) := w(\theta_T) - \theta_T. \quad (3)$$

Such synergy is commonly known. For simplicity, we let $W := w(\bar{\theta}_T) - w(\underline{\theta}_T)$. Thus W is the difference in post-merger values between a high- and a low-type target.

We make the following assumptions on our parameters:

- (A1) $W > 0$: synergies preserve the ordering of types so that, *ceteris paribus*, the bidder finds it more convenient to acquire a high-type target than a low-type target;
- (A2) $\frac{\bar{\theta}_T}{\underline{\theta}_T} \geq \frac{\bar{\theta}_B + w(\bar{\theta}_T)}{\underline{\theta}_B + w(\underline{\theta}_T)}$: the ratio among the two possible stand-alone values of the target is larger than the ratio among the values resulting from a 'high-high' and a 'low-low' merge.

⁸ While beliefs are always an element of the players' subjectivity from the modeling point of view, we interpret the values in Θ_i as observable elements which every potential opponent would agree on and, conversely, we interpret p^i as the output of i 's processing of available information: if i 's role were to be played by another agent, the latter might hold a different belief. We will, therefore, sometimes call p^i the "subjective belief" of player i . Still, in our model, the information gathered by i and i 's way to process it are known to i 's opponent, j , and i knows that j knows, and so on, which makes p^i common knowledge.

While assumption (A1) is easy to interpret, assumption (A2) deserves further consideration. Although its function is mainly technical, (A2) simultaneously requires that the variability in stand-alone values is larger for the target than for the bidder (since it implies $\frac{\bar{\theta}_T}{\underline{\theta}_T} \geq \frac{\bar{\theta}_B}{\underline{\theta}_B}$) and yet that such variability in the target's standalone value has sufficiently small impact on the variability of the merged firm's value (the numerator and denominator of the fraction on the right-hand side of the expression are, respectively, the largest and smallest value of a merged firm). In other words, (A2) can be interpreted at one time as an assessment of a more difficult evaluation of the target's value than of the bidder's by a non-informed observer and as a requirement imposing that the post-merger value of low-type targets be relatively large compared to that of high-type targets (a form of 'diminishing returns to scale'). This can be seen by considering the two 'extreme' cases. If one assumes that, for each $i \in \{B, T\}$ and for some $\lambda \in \mathbb{R}_{++}$, $\bar{\theta}_i = (1 + \lambda) \underline{\theta}_i$, assumption (A2) requires that $w(\bar{\theta}_T) \leq (1 + \lambda) w(\underline{\theta}_T)$; if, on the other hand, one assumes that for some $\delta \in \mathbb{R}_{++}$, $w(\bar{\theta}_T) = (1 + \delta) w(\underline{\theta}_T)$, (A2) imposes that $\frac{\bar{\theta}_T}{\underline{\theta}_T} \geq \frac{\bar{\theta}_B}{\underline{\theta}_B}$.

If the bidder proposes a cash offer (C, c) and the target accepts it, then B obtains the value of the merged firm BT and T obtains the amount offered by B in cash:

$$u_B((C, c), Y, \theta_B, \theta_T) = \theta_B + w(\theta_T) - c, \quad (4)$$

$$u_T((C, c), Y, \theta_B, \theta_T) = c. \quad (5)$$

If the bidder proposes a stock offer and the target accepts it, then the two players share the value of the merged firm BT , with a fraction f going to T and the remaining going to B :

$$u_B((S, f), Y, \theta_B, \theta_T) = (1 - f)(\theta_B + w(\theta_T)), \quad (6)$$

$$u_T((S, f), Y, \theta_B, \theta_T) = f(\theta_B + w(\theta_T)). \quad (7)$$

If the bidder proposes an offer $m \in M$ which the target rejects, then both firms retain their stand-alone value, i.e. for each $i \in \{B, T\}$ and every offer $m \in M$, $u_i(m, N, \theta_B, \theta_T) = \theta_i$.

2.2. Opacity and bid premium

We now define the two key variables of our analysis. We call *opacity* of the bidder B the number

$$\sigma_B^2 := p^T (1 - p^T) V_B^2. \quad (8)$$

Similarly, we call opacity of the target T the number

$$\sigma_T^2 := p^B (1 - p^B) W^2. \quad (9)$$

Firm i 's opacity is the variance attributed by j to i 's post-merger value: it measures how hard it is for the opponent to give a precise estimate of i 's future value before the interaction takes place. Opacity increases in the (statistical) range of i 's possible values (V_B for the bidder and W for the target) and decreases with the informativeness of firm j 's beliefs, attaining the minimum value of 0 whenever $p^j \rightarrow \ell \{0, 1\}$ and the maximum value ($\frac{1}{4}V_B^2$ for the bidder and $\frac{1}{4}W^2$ for the target) when $p^j = \frac{1}{2}$.

We call (*relative*) *bid premium* the ratio between the difference in the target's payoff and its stand-alone value (the *absolute bid premium*) and the stand-alone value itself: for every action sequence $(m, r) \in M \times \{Y, N\}$ and every pair of stand-alone values $(\theta_B, \theta_T) \in \Theta_B \times \Theta_T$, the bid premium is

$$\psi(m, r, \theta_B, \theta_T) := \frac{u_T(m, r, \theta_B, \theta_T) - \theta_T}{\theta_T}. \quad (10)$$

The bid premium represents the relative profitability of the acquisition for the current management of the target (its value is 0 in case of a rejection by the target). Because the M&A interaction results in a transfer of wealth from the bidder to the target in exchange for ownership, it is fair to see the bid premium as a price paid by the bidder to the target, although it does not

coincide with the amount of money or the money-value of shares actually transferred. Notice, from (4),(5),(6) and (7), that, for all $m \in M$,

$$u_B(m, Y, \theta_B, \theta_T) = \theta_B + w(\theta_T) - \theta_T[\psi(m, Y, \theta_B, \theta_T) + 1] \quad (11)$$

so that, conditional on accepted offers, expected payoff maximization and expected bid premium minimization yield the same outcome.

2.3. Equilibrium concept

The equilibrium concept we use in this paper is that of *Perfect Bayesian Equilibrium* (see, for instance, Fudenberg and Tirole, 1991).

Definition 1. A *Perfect Bayesian Equilibrium* (PBE) for the game G in (1) is composed of a strategy \mathbf{m}^* of the bidder and an assessment (belief-strategy pair) $(\boldsymbol{\mu}^*, \mathbf{r}^*)$ of the target, where⁹ $\mathbf{m}^* \in M^{\Theta_B}$, $\boldsymbol{\mu}^* \in \Delta(\Theta_B)^M$ and $\mathbf{r}^* \in \{Y, N\}^{\Theta_T \times M}$, such that

1. for every $\theta_B \in \Theta_B$,

$$\mathbf{m}^*(\theta_B) \in \arg \max_{m \in M} \mathbb{E}_{p^B} [u_B(m, \mathbf{r}^*(\theta_T, m), \theta_B, \theta_T)] ; \quad (12)$$

2. for every $m \in M$, $\boldsymbol{\mu}^*(m)$ is obtained from p^T via Bayes' rule, whenever possible;

3. for every $\theta_T \in \Theta_T$ and $m \in M$,

$$\mathbf{r}^*(\theta_T, m) \in \arg \max_{r \in \{Y, N\}} \mathbb{E}_{\boldsymbol{\mu}^*(m)} [u_T(m, r, \theta_B, \theta_T)] . \quad (13)$$

Part (1) of the definition states that, for each type θ_B , action $\mathbf{m}^*(\theta_B)$ maximizes the bidder's expected payoff, given the target's equilibrium response. Randomness in the bidder's payoff is due to the bidder's uncertainty about the target's stand-alone value θ_T .

⁹If X and Y are sets, Y^X denotes the set of functions from X to Y .

Part (3) of the definition similarly requires that, for each message m received by the target, for each type θ_T and given equilibrium beliefs $\boldsymbol{\mu}^*$, the action prescribed by the strategy \mathbf{r}^* upon receiving message m maximizes the type- θ_T target's expected payoff, computed under the equilibrium posterior beliefs $\boldsymbol{\mu}^*(m)$. Randomness in the target's payoff is due to the target's uncertainty about the bidder's stand-alone value θ_B .

Part (2) of the definition requires that the target's posterior beliefs be obtained via Bayesian updating of its prior belief p^T . Whenever the message m sent by the bidder is consistent with the bidder's equilibrium strategy \mathbf{m}^* , this implies¹⁰

$$\boldsymbol{\mu}^*(\bar{\theta}_B | m) = \frac{p^T \mathbf{1}_{\mathbf{m}^*(\bar{\theta}_B)}(m)}{p^T \mathbf{1}_{\mathbf{m}^*(\bar{\theta}_B)}(m) + (1 - p^T) \mathbf{1}_{\mathbf{m}^*(\underline{\theta}_B)}(m)}. \quad (14)$$

If a message is received that is *not* consistent with the bidder's equilibrium strategy, the target can adopt any posterior belief.

From now on, to ease notation we shall write the maximand in (12), given a PBE $(\mathbf{m}^*, (\boldsymbol{\mu}^*, \mathbf{r}^*))$, as

$$U_{\theta_B}^*(m) := \mathbb{E}_{p^B} [u_B(m, \mathbf{r}^*(\theta_T, m), \theta_B, \theta_T)]. \quad (15)$$

Some PBE may be justified by assuming that the target, upon receiving an out-of-equilibrium offer $m \notin \mathbf{m}^*(\Theta_B)$, form posterior beliefs that are incompatible with the target assigning to the bidder the highest degree of strategic sophistication consistent with observed actions (e.g. by assuming that offer m comes with positive probability from a type $\theta_B \in \Theta_B$ for whom m is dominated). To deal with this, we shall make use of two refinements of PBE proposed by Cho and Kreps (1987) and known as the *Equilibrium Dominance Test* (EDT) and the *Intuitive Criterion Test* (ICT). EDT compels us

¹⁰ Here and in what follows, for all $m \in M$ and $\theta_B \in \Theta_B$, we write $\mu(\theta_B | m)$ instead of $\mu(m)(\{\theta_B\})$. Moreover, notice that, since we restrict our attention to pure-strategy equilibria, for each $m \in \mathbf{m}^*(\Theta_B)$, either $\boldsymbol{\mu}^*(\bar{\theta}_B | m) = p^T$ (pooling equilibrium) or $\boldsymbol{\mu}^*(\bar{\theta}_B | m) \in \{0, 1\}$ (separating equilibrium).

to exclude equilibria in which posterior beliefs assign positive probability to the observed message having been sent by a type of bidder for which that message is unequivocally worse than its equilibrium action. ICT excludes equilibria in which the equilibrium message is optimal for some type of bidder only insofar as the latter expects the target to form beliefs which are incompatible with EDT.¹¹ While the application of EDT reduces the set of PBEs in our model by excluding some equilibrium assessments, it turns out that all equilibrium outcomes survive the ICT.

2.4. Cash offers

We first analyze cash offers, i.e. messages $m \in \{C\} \times \mathbb{R}_+$. Notice that the payoff gain that the target can obtain by accepting a cash offer does not depend on the bidder's type. Hence the target's response to a cash offer will not depend on its beliefs about the bidder. It follows that the bidder does not value cash offers as signals of its own type.

Assuming that, when indifferent, a target always accepts the offer, it is easy to see that a cash offer (C, c) is accepted by the target if and only if $c \geq \theta_T$. Thus if $c \geq \bar{\theta}_T$ every type of target will accept the offer; if $\underline{\theta}_T \leq c < \bar{\theta}_T$, only the low-type target will accept the offer; finally, if $c < \underline{\theta}_T$ both types of target will turn the offer down.

As $p^B \in (0, 1)$, cash offers with $c \in (\underline{\theta}_T, \bar{\theta}_T)$ are dominated by $(C, \underline{\theta}_T)$ and cash offers with $c > \bar{\theta}_T$ are dominated by $(C, \bar{\theta}_T)$. Assumption (A1) is then enough to guarantee that, in every PBE where a cash offer is proposed by some type of bidder, such offer is either $(C, \bar{\theta}_T)$ (the “high cash offer”) or $(C, \underline{\theta}_T)$ (the “low cash offer”). For all $\theta_B \in \Theta_B$, the expected payoff obtained by a type- θ_B bidder with each cash offer is

$$\mathbb{E}_{p^B} [u_B((C, \underline{\theta}_T), \mathbf{r}^*(\theta_T, (C, \underline{\theta}_T)), \theta_B, \theta_T)] = \theta_B + (1 - p^B)\Delta(\underline{\theta}_T), \quad (16)$$

¹¹ A more thorough treatment of EDT and ICT for our model, based on Battigalli and Siniscalchi (2002), is given in Appendix 1.

$$\mathbb{E}_{p^B} [u_B((C, \bar{\theta}_T), Y, \theta_B, \theta_T)] = \theta_B - \bar{\theta}_T + \mathbb{E}_{p^B} [w(\theta_T)] , \quad (17)$$

where

$$\mathbf{r}^*(\theta_T, (C, \underline{\theta}_T)) = \begin{cases} Y & \text{if } \theta_T = \underline{\theta}_T \\ N & \text{if } \theta_T = \bar{\theta}_T \end{cases} . \quad (18)$$

Then, given the target's response (18), the bidder will prefer the high cash offer over the low cash offer if and only if

$$p^B \geq \frac{V_T}{V_T + \Delta(\bar{\theta}_T)} =: \pi_C . \quad (19)$$

The number $\pi_C \in (0, 1)$ is called *cash offer threshold*. If the bidder is sufficiently optimistic about the target ($p^B \geq \pi_C$), then it will prefer the high cash offer to the low cash offer: it will have to pay more ($\bar{\theta}_T$), but it will have the target accept for sure and, in its opinion, the target is quite likely to be of the high type. Otherwise ($p^B < \pi_C$) the bidder will prefer the low cash offer, by which he acquires the target only if the latter is of the low type.

(Insert Figure 1 here)

Notice that the cash offer threshold π_C does not depend on the bidder's type θ_B . Although the payoffs are different for the two types of bidder, the fact that the target's response to a cash offer does not depend on the bidder's type makes the bidder's choice between the two cash offers rely exclusively on the target's stand-alone value. This in turn implies that a cash offer cannot be an informative signal about the bidder's type for the target, as anticipated above. Therefore the target will not update its initial belief after observing an *equilibrium* cash offer.

2.5. Stock offers

Consider now stock offers, that is, messages $m \in \{S\} \times [0, 1]$. Let $\mu \in \Delta(\Theta_B)^M$ be the target's belief-updating rule. Upon receiving a stock offer

(S, f) , the target expects to obtain (in case it accepts) a payoff equal to a fraction f of the post-merger value of the new firm BT ,

$$\mathbb{E}_{p_T} [u_T((S, f), Y, \theta_B, \theta_T)] = f (\mathbb{E}_{\mu((S, f))} [\theta_B] + w(\theta_T)) . \quad (20)$$

Hence a type- θ_T target accepts the stock offer (S, f) if and only if

$$f \geq \frac{\theta_T}{\mathbb{E}_{\mu((S, f))} [\theta_B] + w(\theta_T)} . \quad (21)$$

Because of Assumption (A2), the right-hand side of (21) is larger for the type- $\bar{\theta}_T$ target, implying that a high-type target is choosier as far as stock offers are concerned, in the sense that whenever an offer (S, f) is accepted by a high-type target, it will also be accepted by a low-type target.

Unlike cash offers, the value of a stock offer to the target does depend on the latter's belief about the bidder's type, which in turn depends on the target's interpretation of the stock offer as a signal. One could not conclude *a priori* that if a certain type of target would accept the stock offer (S, f) , then it would certainly also accept the stock offer (S, f') with $f' > f$. For some reason, the target might interpret a larger stock offer as a signal of there being a larger chance that the bidder has low type. In order to avoid such situations, we require that, in and out of the equilibrium path, belief updating in our model satisfy the following assumption:

(A3) The function $f \mapsto \mu(\bar{\theta}_B \mid (S, f))$ is continuous and non-decreasing.

Assumption (A3) refines the set of PBEs by requiring that a larger participation share in a stock offer does not induce the target to consider it less likely that the offer originated from a high-type bidder. In other words, the larger the fraction offered, the (weakly) larger the probability that the offer comes from a high-valued bidder.

Assumption (A3) guarantees that, given the updating rule μ , a type- θ_T target will accept any stock offer whose participation share exceeds a certain amount $f^{\theta_T}(\mu)$. Moreover, $f^{\bar{\theta}_T}(\mu) \geq f^{\theta_T}(\mu)$: as expected, high-type targets

are choosier, as it was the case with cash offers. For each $\theta_T \in \Theta_T$, the number $f^{\theta_T}(\mu)$ is determined as the fixed point of the map¹²

$$\Phi^{\theta_T}(f) := \frac{\theta_T}{\mathbb{E}_{\mu((S,f))}[\theta_B] + w(\theta_T)}. \quad (22)$$

We can then write the equilibrium optimal response of a type- θ_T target to stock offers as

$$\mathbf{r}^*(\theta_T, (S, f)) = \begin{cases} Y & \text{if } f \geq f^{\theta_T}(\mu^*) \\ N & \text{if } f < f^{\theta_T}(\mu^*) \end{cases}. \quad (23)$$

Given the equilibrium beliefs μ^* , the expected payoff of a type- θ_B bidder proposing a stock offer (S, f) with $f \geq f^{\bar{\theta}_T}(\mu^*)$ is then

$$(1 - f) (\theta_B + \mathbb{E}_{p^B} [w(\theta_T)]), \quad (24)$$

as the target will always accept such an offer. If the proposed stock offer has $f^{\underline{\theta}_T}(\mu^*) \leq f < f^{\bar{\theta}_T}(\mu^*)$, it will be accepted only by a low-type target and therefore the bidder expects to obtain

$$p^B \theta_B + (1 - p^B) [(1 - f) (\theta_B + w(\underline{\theta}_T))]. \quad (25)$$

Finally, if a stock offer is proposed with $f < f^{\underline{\theta}_T}(\mu^*)$ then no target accepts it and the bidder retains its stand-alone value.

Whenever the offer is bound to be accepted by some type of target, the bidder's payoff is strictly decreasing in f and therefore, given the updating rule μ^* , the bidder will propose either one of the stock offers $(S, f^{\bar{\theta}_T}(\mu^*))$ and $(S, f^{\underline{\theta}_T}(\mu^*))$, respectively called the “*high*” and “*low stock offer*”.

Thus the stock offer proposed by the bidder depends on the bidder's anticipation of the target's reaction, in terms of belief updating, to the bidder's message. In a PBE, the bidder correctly anticipates such reaction, holding a correct belief about the target's updating rule μ^* . For each type θ_B of

¹²The existence and uniqueness of the fixed point is discussed in Appendix 2.

bidder, a special case is what we call “full recognition” stock offers: these are the offers proposed by the type- θ_B bidder who wants to attract a certain type of target anticipating that, upon receiving the offer, the target will be almost sure that the bidder’s type is θ_B . This must be the case, for instance, in any PBE in which a stock offer is proposed by one type of bidder but not by the other (i.e. in all ‘separating’ PBEs).

In Appendix 2 we prove the following

Lemma 2.1. *Under assumptions (A1)-(A3), if all stock offers lead to full recognition, then*

- (a) *for each $p^B \in (0, 1)$, each type θ_B of bidder is indifferent between the low cash offer $(C, \underline{\theta}_T)$ and the low stock offer $(S, f^{\underline{\theta}_T}(\theta_B))$;*
- (b) *for each $p^B \in (0, 1)$, each type θ_B of bidder prefers the high stock offer $(S, f^{\bar{\theta}_T}(\theta_B))$ to the high cash offer $(C, \bar{\theta}_T)$;*
- (c) *for each $\theta_B \in \Theta_B$, there exists a number $\pi_S(\theta_B) \in (0, 1)$ such that a type- θ_B bidder prefers the high stock offer $(S, f^{\bar{\theta}_T}(\theta_B))$ to the low stock offer $(S, f^{\underline{\theta}_T}(\theta_B))$ if and only if $p^B \geq \pi_S(\theta_B)$;*
- (d) $\pi_S(\underline{\theta}_B) < \pi_S(\bar{\theta}_B) < \pi_C$.

(Insert Figure 2 here)

According to Lemma (2.1), the expected payoff from a low full-recognition stock offer coincides with the payoff from the low cash offer, while the high full-recognition stock offer gives a larger payoff than the high cash offer. It follows that, if full recognition were to occur for all types of bidder, no cash offer would ever be the bidder’s unique best choice. The next paragraphs will clarify why this is not the case, justifying the observation of cash offers in the real world.

2.6. Separating equilibria

A PBE strategy for the bidder, \mathbf{m}^* , must prescribe a message to each type of bidder. Because the bidder can have either of two stand-alone values, equilibria can be classified into two categories: those which prescribe the same message to each type of bidder (*pooling equilibria*) and those which don't (*separating equilibria*). Here we analyze the latter.

In a separating equilibrium, the two types of bidder will send different messages. Thus the (Bayesian) target will have no uncertainty about the bidder's type after observing the bidder's offer. In every separating equilibrium, for every $\theta_B \in \Theta_B$,

$$\mu^*(\theta_B \mid \mathbf{m}^*(\theta_B)) = 1. \quad (26)$$

All such equilibria, then, display full recognition: upon observing the bidder's message, the target has no uncertainty about the bidder's stand-alone value.

When a stock offer which is just acceptable for type- θ_T targets is prescribed as the equilibrium message for a type- θ_B bidder in a PBE with full recognition, we abuse notation¹³ and write

$$\mathbf{m}^*(\theta_B) = \left(S, f^{\theta_T}(\theta_B) \right). \quad (27)$$

Thus $f^{\theta_T}(\theta_B)$ is the minimal participation share by which a type- θ_B bidder, which correctly anticipates to be recognized as such, can induce a type- θ_T target to accept its offer. The following fact will prove particularly important.

Lemma 2.2. *Under assumptions (A1)-(A3),*

$$f^{\bar{\theta}_T}(\underline{\theta}_B) > f^{\bar{\theta}_T}(\bar{\theta}_B) \geq f^{\underline{\theta}_T}(\underline{\theta}_B) > f^{\underline{\theta}_T}(\bar{\theta}_B). \quad (28)$$

Each type of bidder has to give up a larger share to convince the high-type

¹³ Here the participation share f implied by the stock offer is made to depend on the bidder's type rather than on its beliefs.

target to accept the offer. Moreover, a low-type bidder will have to promise larger participation than a high-type bidder to induce the same pool of targets to accept its offers, because the merged firm is worth less when the bidder has low type.

As our messages are two-dimensional (they consist of a method of payment and a real number), separating equilibrium candidates can be conveniently divided according to whether both types of bidder choose the same method of payment. As the optimal cash offer does not depend on the bidder's type, there can be no separating equilibrium in which both types of bidder propose a cash offer. Thus a separating equilibrium with common method of payment would need to be one in which both types of bidder propose a stock offer.

But every candidate separating equilibrium with both types of bidder offering stock falls apart as well. Because of the inequalities of Lemma (2.1-d), under full recognition it will never be the case that the high-type bidder prefers the high stock offer while the low-type bidder prefers the low stock offer. Then, by Lemma (2.2), when both types of bidder propose stock offers, the highest participation share is offered by the low-type bidder. The target would then deem it more likely that the bidder type is $\bar{\theta}_B$ after observing a lower stock offer, which contradicts assumption (A3). We make this reasoning rigorous in Lemma (2.1) of Appendix 2.

Inevitably, then, if a separating equilibrium exists, it must prescribe that the two types of bidder use different means of payments. If the high-type bidder were prescribed to offer stock, a stock offer would induce an almost-sure belief that its type is $\bar{\theta}_B$. In this case, though, the low-type bidder would have an incentive to deviate away from its optimal cash offer towards the high-type bidder's equilibrium offer. This excludes the possibility of such an equilibrium configuration, as we explain in Lemma (2.2) of Appendix 2.

We are finally left with the possibility that $\bar{\theta}_B$ proposes a cash offer, and that $\underline{\theta}_B$ proposes a stock offer. Notice in advance that, while a type- $\underline{\theta}_B$ bidder will always prefer a stock offer by which it is recognized as a type- $\bar{\theta}_B$ bidder

to the optimal cash offer, the converse is not true: a type- $\bar{\theta}_B$ bidder will not always profit from abandoning cash in favor of a stock offer by which it could be mistaken for a type- $\underline{\theta}_B$ bidder. This is the reason why, under some conditions, a separating equilibrium in which $\bar{\theta}_B$ offers cash and $\underline{\theta}_B$ offers stock can exist.

Proposition 1. *If*

$$\frac{W\Delta(\bar{\theta}_T)}{V_B(V_T + \Delta(\bar{\theta}_T))} \leq 1 \quad (29)$$

the game G in (1) admits, for all $p^B \in (0, 1)$, a separating equilibrium in which $\mathbf{m}^(\bar{\theta}_B)$ is a cash offer and $\mathbf{m}^*(\underline{\theta}_B)$ is a stock offer. If (29) does not hold, there are $p_+^B, p_-^B \in (0, 1)$ such that $p_+^B > p_-^B$, $\pi_C \in (p_-^B, p_+^B)$ and no separating equilibrium exists if $p^B \in (p_-^B, p_+^B)$.*

(Insert Figure 3 here)

When the low-type bidder is fully recognized, the optimal stock offer provides him with higher expected payoff than the optimal cash offer. Failure to support the separating equilibrium derives from a possible incentive for the high-type bidder to disguise itself as a low-type bidder: this forces the bidder to pay a larger participation share than it would in correspondence of *its* optimal stock offers but, possibly, a smaller overall price than it needs to acquire the target by cash.

2.7. Pooling equilibria

We now turn to the analysis of *pooling equilibria*, which prescribe that $\mathbf{m}^*(\bar{\theta}_B) = \mathbf{m}^*(\underline{\theta}_B) = m^* \in M$. We consider first the case in which both types of bidder post the same cash offer. Notice first that this offer cannot be the high cash offer $(C, \bar{\theta}_T)$. Indeed, independently of the target posterior beliefs, the low-type bidder always prefers the high stock offer to the high cash offer. By the same reasoning, one can exclude that the two types of bidder pool on the best cash offer whenever $p^B > \pi_S(\underline{\theta}_B)$.

The only candidate for an equilibrium message with pooling on a cash offer is, therefore, $\mathbf{m}^* = (C, \underline{\theta}_T)$. For all $p^B \in (0, \pi_S(\underline{\theta}_B)]$, the type- $\bar{\theta}_B$ bidder weakly prefers the low cash offer to its best stock offer. On the other hand, whenever there is a chance that it can be mistaken for a high-type bidder, the low-type bidder will prefer its best stock offer to the low cash offer. We then have to require that the low-type bidder is fully recognized at its low stock offer *and* that it does not want to deviate towards the high stock offer. The last condition requires that $\mu^*(\bar{\theta}_B \mid (S, f^{\bar{\theta}_T}(\mu^*)))$ be small enough. The equilibrium dominance criterion further forces such value to zero.

Proposition 2. *For every $p^B \leq \pi_S(\underline{\theta}_B)$ there exists an equilibrium in which $\mathbf{m}^*(\bar{\theta}_B) = \mathbf{m}^*(\underline{\theta}_B) = (C, \underline{\theta}_T)$.*

Let us finally focus on equilibria in which both types of bidder propose the same stock offer. First notice that, if the equilibrium message is $m^* = (S, f^*)$, then $\mu^*(\bar{\theta}_B \mid (S, f^*)) = p^T$ by Bayes' rule. This excludes the possibility of both types of bidder pooling on a stock offer directed to the low-type target only: since $p^T \in (0, 1)$, the high-type bidder will not enjoy the benefit of full recognition and it will hence prefer to deviate towards the low cash offer. Thus at an equilibrium with pooling on stock offers, both types of bidder will propose the stock offer (S, f^*) with

$$f^* = \frac{\bar{\theta}_T}{\mathbb{E}_{p^T}(\theta_B) + w(\bar{\theta}_T)}. \quad (30)$$

Such an offer can be sustained as an equilibrium message only when the value of the best cash offer is sufficiently small and, at the same time, the prior target's belief that the bidder's type is $\bar{\theta}_B$ is large enough.

Proposition 3. *If*

$$p^T \geq 1 - \frac{W\Delta(\bar{\theta}_T)}{V_B(V_T + \Delta(\bar{\theta}_T))} \quad (31)$$

there exist $p_{++}^B, p_{--}^B \in (0, 1)$ such that $p_{++}^B \geq p_{--}^B$ and the game G in (1) admits a PBE in which $\mathbf{m}^(\bar{\theta}_B) = \mathbf{m}^*(\underline{\theta}_B) = (S, f^*)$, where f^* is given by (30), if and only if $p^B \in [p_{--}^B, p_{++}^B]$.*

It turns out that equilibria with pooling on the stock offer complement separating equilibria whenever the latter fails to exist.

Corollary 1. *If (29) does not hold, then*

$$p_{--}^B \leq p_-^B < p_+^B \leq p_{++}^B \quad (32)$$

In other words, if p^B is such that G does not admit a separating equilibrium, then G admits a pooling equilibrium of the kind described in Proposition (3).

(Insert Figure 4 here)

This result, paired with the previous Propositions, also guarantees that, for all parametric configurations satisfying assumptions (A1) and (A2), our model admits at least one equilibrium and at most two distinct equilibrium outcomes.

2.8. *Opacity, means of payment and the bid premium*

By now we know that three equilibrium configurations can arise in this game: a separating equilibrium in which the high-type bidder offers cash and the low-type bidder offer stock ; a pooling equilibrium in which both types of bidder offer the low cash offer; and a pooling equilibrium in which both types of bidder offer the high cash offer. Our aim is now to inspect the correlation that these equilibrium predictions establish between, on the one side, opacity of either agents and, on the other, the probability of observing a stock offer and the average bid premium paid by the bidder.

Consider a game G as in (1) and let $e^* := (\mathbf{m}^*, (\boldsymbol{\mu}^*, \mathbf{r}^*))$ be a PBE of G . The probability that a transaction occurring under this equilibrium involves a stock offer is

$$\mathbb{P}^S(e^*) := p^T \mathbf{1}_{S \times [0,1]}(\mathbf{m}^*(\bar{\theta}_B)) + (1 - p^T) \mathbf{1}_{S \times [0,1]}(\mathbf{m}^*(\underline{\theta}_B)). \quad (33)$$

If e^* is a pooling equilibrium, one obviously has $\mathbb{P}^S(e^*) \in \{0, 1\}$, the former

case occurring when both types of bidder pool on a cash offer, the latter when both pool on a stock offer. If e^* is a separating equilibrium, the probability of observing a stock offer is the probability that the bidder's type is $\underline{\theta}_B$, which is $1 - p^T$.

Recall now from (10) the definition of the (relative) bid premium. Given an equilibrium e^* , we define the average bid premium associated with e^* as

$$\psi(e^*) = \sum_{(\theta_B, \theta_T) \in \Theta_B \times \Theta_T} \mathbb{P}(\theta_B, \theta_T) \psi(\mathbf{m}^*(\theta_B), \mathbf{r}^*(\theta_T, \mathbf{m}^*(\theta_B)), \theta_B, \theta_T). \quad (34)$$

Here \mathbb{P} is the product probability derived from the priors of each player, which are considered independent.¹⁴ The acceptance of a 'low' offer, be it cash or stock, generates no bid premium, since the type- $\underline{\theta}_T$ target, to which such offer is directed, receives an amount that makes it just indifferent between accepting and rejecting the offer. 'High' offers generate positive bid premiums only when the accepting target has type $\underline{\theta}_T$.

Thus, the average bid premium associated with a cash-pooling equilibrium is 0. Recall that in all equilibria with pooling on the stock offer, the two types of bidder direct their offer to both types of target. The average bid premium associated to a stock -pooling equilibrium e^{SP} will then be

$$\psi(e^{SP}) = (1 - p^B) \left(\frac{\bar{\theta}_T}{\underline{\theta}_T} \cdot \frac{\mathbb{E}_{p^T}[\theta_B] + w(\underline{\theta}_T)}{\mathbb{E}_{p^T}[\theta_B] + w(\bar{\theta}_T)} - 1 \right). \quad (35)$$

Finding average premiums for separating equilibria requires more effort, because the kind of offers proposed depend on p^B . There are three cases: either both types of bidder direct their offer at the low-type target, and no bid premium is paid; or the low-type bidder directs its stock offer to all targets, while the high-type bidder acquires only low-type targets using cash, in which case the average bid premium is

$$\psi(e^{S1}) = (1 - p^B)(1 - p^T) \left(\frac{\bar{\theta}_T}{\underline{\theta}_T} \cdot \frac{\underline{\theta}_B + w(\underline{\theta}_T)}{\underline{\theta}_B + w(\bar{\theta}_T)} - 1 \right); \quad (36)$$

¹⁴ So, for instance, $\mathbb{P}(\bar{\theta}_B, \bar{\theta}_T) = p^T p^B$ and, similarly, $\mathbb{P}(\bar{\theta}_B, \underline{\theta}_T) = p^T(1 - p^B)$ and so on.

or, finally, both bidders aim at every type of target and realize different premiums with their offers of different kind, yielding the average bid premium

$$\psi(e^{S2}) = (1 - p^B) \left\{ p^T \left(\frac{\bar{\theta}_T}{\underline{\theta}_T} - 1 \right) + (1 - p^T) \left(\frac{\bar{\theta}_T}{\underline{\theta}_T} \cdot \frac{\underline{\theta}_B + w(\underline{\theta}_T)}{\underline{\theta}_B + w(\bar{\theta}_T)} - 1 \right) \right\}. \quad (37)$$

One can easily verify that, for all parameter configurations where both a separating equilibrium and a stock pooling equilibrium exist, the latter is associated with larger average bid premiums. The decrease in premiums paid by high-type bidders is more than compensated by the increase in premiums paid by low-type bidders.

Because of the last observation, we can order the three types of equilibria according to the probability that they produce a stock offer and the average bid premium their realization entails. The ordering is the same, in the sense that the stock -pooling equilibrium dominates all others in both dimensions, and so does the separating equilibrium with respect to the cash-pooling equilibrium, which cannot produce a stock offer and requires no bid premiums on the bidder's part.

It therefore turns out that the type of equilibrium the agents find themselves in determines the relationship between parameters and outcomes in this model. In particular, *different degrees of firm opacity are associated to different levels in observable characteristics of the bids only insofar as they affect the likelihood of a certain type of equilibrium arising.*

We simulate several games like G , letting the parametric configurations vary within the ranges that allow our assumptions (A1)-(A3) to hold.¹⁵ For each equilibrium of each simulated game, we compute the probability of observing a stock offer at that equilibrium and the average bid premium. Suppose that the parameters of G are such that two equilibria, e^* and e° , arise. Keeping an agnostic stance on equilibrium selection, in such a case we shall

¹⁵ The numerical exercise generating our results consists of forming a grid of 8^8 parameter configurations, from which we drop configurations that do not satisfy some of our assumptions. We are left with a little less than $6 \cdot 10^6$ games.

associate to the parametric configuration under analysis a probability of observing a stock offer equal to the arithmetic mean of the two probabilities corresponding to the equilibria, that is $\frac{1}{2}\mathbb{P}^S(e^*) + \frac{1}{2}\mathbb{P}^S(e^\circ)$. Analogously, we shall associate to G an average bid premium equal to $\frac{1}{2}\psi(e^*) + \frac{1}{2}\psi(e^\circ)$. We then use these computations to inspect the overall correlations between bidder and target opacity and such observable variables. 1 summarizes the results of this simulation.

(Insert Table 1 here)

First, target opacity (σ_T^2) is positively correlated with the probability of observing a stock offer. Two forces stand behind this result. On the one hand, for each value of W , target opacity is larger when p^B takes on values near $\frac{1}{2}$, which makes the arising of a cash-pooling equilibrium less likely (in Figure 5, the white area is the region where cash-pooling and separating equilibria co-exist). On the other hand, larger values of W and $w(\bar{\theta}_T)$ are associated with smaller values on the right-hand side of condition (31), which makes stock -pooling equilibria more likely to arise (in Figure 5, the darkest area is the region where only the stock -pooling equilibrium exist). Figure 6 shows how the four possible combinations of equilibria (separating and cash-pooling, separating only, separating and stock -pooling and stock -pooling only) are progressively related with higher values of target opacity.

(Insert Figures 5 and 6 here)

Bidder opacity (σ_B^2) is instead negatively correlated with the probability of observing a stock offer. The direction of this relationship, though, is much less intuitive than it was for target opacity. In the context of separating equilibria, the probability of a stock offer decreases with p^T but is unaffected by V_B . Conditional on V_B , bidder opacity is small both when p^T is very small and when it is very large. Consequently, there where a separating equilibrium exists, but stock pooling equilibria do not arise, there is no correlation between bidder opacity and the probability of a stock offer

(see the first panel of Figures 7 and 8). Obviously, within a stock -pooling equilibrium, neither p^T nor V^B influence the probability of a stock offer, which is 1 by definition (for this reason, the third panel of Figures 7 and 8 shows no variation in such probability). Yet larger values of V_B , which are by definition associated with larger values of bidder opacity, make the requirement in condition (31) harder to satisfy, and thus stock -pooling equilibria less likely. On the other hand, the correlation between bidder opacity and existence of stock -pooling equilibria is also affected, and ambiguously so, by the fact that the former is not monotone in p^T while the latter is increasing in this variable. A further confounding factor comes from the distribution of p^B , which can be seen from Figures 7 and 8 to affect the parametric regions where each kind of equilibrium arises. Thus the channel determining correlation between bidder opacity and the likelihood of a stock offer is far from transparent. Our correlation result stems from assuming uniformly distributed beliefs over $(0, 1)$. If the target's belief distribution were chosen to be more optimistic (i.e., if their distribution were skewed to the right), we might observe zero or even positive correlation between bidder opacity and stock offers, because of small bidder opacity being more often paired with separating equilibria where the bidder is largely likely to offer cash.

(Insert Figures 7 and 8) here

As equilibria are ordered similarly in the two dimensions under analysis, one would expect to observe the same pattern when studying the correlation between firm opacity and average bid premiums. Indeed, target opacity turns out to be positively correlated with the average bid premium, precisely because it is associated with a larger likelihood of having a stock pooling equilibrium (Figure 9). That the effect is driven by the presence of pooling on stock is confirmed by the similar result obtained when restricting the correlation analysis to average premiums occurring in stock offers only (Figure 10).

(Insert Figures 9 and 10 here)

The story is different for bidder opacity. The overall correlation between bidder opacity and average premium is positive, but restricting the analysis to stock offer yields negative correlation. Both values are of small magnitudes if compared with the results for target opacity. As we have seen, bidder opacity is overall negatively correlated with the presence of a stock-pooling equilibrium. As the stock-pooling equilibrium carries the highest average bid premium, this channel provides negative correlation between bidder opacity and premiums. Moreover, in stock-pooling equilibria, large values of p^T are associated with larger premiums, reinforcing the negative link between these variables.

In general, larger bidder opacity is correlated with separating equilibria being more likely than stock-pooling equilibria. In those separating equilibria in which the bid premium solely depends on the low-type bidder's stock offer, no clear relationship between average bid premium and bidder opacity can be retrieved: from equation (36) one sees that the premium is highest when p^T is small, but lowest when p^T is large. Wherever this kind of separating equilibrium arises without a stock pooling equilibrium, one expects no correlation between bidder opacity and premiums, both unconditional (Figure 11, panel 1) and conditional on stock offers (Figure 12, panel 2). On the other hand, where these separating equilibria coexist with stock pooling equilibria, such correlation should be unambiguously negative (as it is in the second panel of both Figures 11 and 12). In separating equilibria in which both cash and stock offers yield positive premiums, the average premium is given by equation (37). There premiums coming from stock offers follow the pattern just described, but since cash premiums are larger than stock premiums, the overall correlation between p^T and premiums is positive.

In our simulation, it is this distinction between cash premiums and stock premiums in separating equilibrium that makes overall correlation positive (panels 4-6 in Figure 11) and stock-only correlation negative (panels 4-6 in Figure (12)). Still, theory cannot give sharper indications and the effect remain ambiguous due to the non-linearity of opacity in subjective beliefs. Notice one again that if the belief distribution were skewed to the right,

smaller bidder opacity would be most likely to descend from large values of p^T which entail a larger likelihood of observing high-premium stock pooling equilibria. The resulting correlation, conditional on stock, would then be more clearly negative. It turns out that the assumption of uniform distribution of beliefs used in our simulation is far from unsubstantial. In particular, it deeply affects the results concerning the correlation between bidder opacity and observable variables. As we shall see, these two dimensions are those in which empirical evidence in favor of our model is weaker. Obviously, we cannot map the model's stylized belief structure into the real-world economic agents' beliefs. Still, contrasting simulated results with empirical evidence suggest that beliefs of agents involved in real-world interactions are skewed towards the right, as if a positive selection process had already occurred when the interaction takes place.

2.9. A few hypotheses

Summing up the analysis in the previous section, we can collect the model's main suggestions into four testable predictions on how bidder and target opacity affect the method of payment chosen by the former and the bid premium to be paid by the bidder upon acceptance.

- (i) the likelihood of a stock bid increases with the opacity of the target;
- (ii) the likelihood of a stock bid decreases with the opacity of the bidder;
- (iii) the bid premium increases with the opacity of the target;
- (iv) the bid premium increases with the opacity of the bidder unconditionally, but in stock bids more opaque bidders offer lower premiums.

As we have pointed out before, predictions involving target opacity are not affected by assumptions used to perform simulations, while predictions involving bidder opacity may change, even dramatically, if the distribution of beliefs is not assumed to be uniform.

3. Empirical analysis

Our empirical analysis focuses on bid premiums in regard to how much, as a percentage, is offered for the acquisition of a target in excess of its stand-alone market valuation and on the qualitative dimension of the choice of the method of payment concerning the type of consideration used in the transaction among either cash or stock. For consistency with our model of bidding behavior under asymmetric information, other forms of payment, including mixed cash and stock, are excluded from our analysis. Mixed forms of payment, in particular, cannot be considered a distinct category for the sake of our analysis as there is a great heterogeneity among them depending on the different proportions of cash and stock they involve.

3.1. Data

Data on M&A announcements, as reported on SDC Thomson One Banker, are collected from 1985 to 2014. Both completed and withdrawn bids are considered.¹⁶ We include in the sample only bids in which both the target and bidder firms are U.S. publicly listed non-financial firms.¹⁷ We limit our sample to bids classified as mergers, acquisitions, or acquisitions of a majority interest. We then exclude buybacks, exchange offers, recapitalizations or acquisitions of a partial or remaining interest. These restrictive requirements are expected to result in a sample of transactions for which asymmetric information is a potentially important concern, since a bidder who did not previously own a majority interest in the target is indeed seeking to obtain a majority interest through the transaction.¹⁸ We consider only transactions whose reported value is in excess of \$50 million, adjusted for inflation and expressed as 2014 equivalents. We exclude deals for which consideration is

¹⁶ We believe that firm opacity can result in different distributions of withdrawals across methods of payment. The inclusion of both successful and withdrawn bids then reduces potential concerns of selection bias.

¹⁷ Firms whose main business activity is classified within Standard Industrial Classification (SIC) codes 6000-6999 are considered financial firms.

¹⁸ These requirements are in line with the work of Chemmanur et al. (2009).

not reported as either cash or stock and for which the combined amount of cash and stock accounts for less than 95% of the transaction value. Finally we exclude transactions in which the bidder is a financial sponsor or the target is a subsidiary, a joint venture or government owned.

Our final sample consists of 3141 bids. Still, the number of actual bids used for our analysis is constrained by the availability of the relevant data on bidder and target opacity and other firm-level characteristics. Data on M&A bids and deal characteristics from SDC Thomson One Banker are in fact complemented with firm-level stock market data and financial data from the Center for Research in Security Prices (CRSP) and Compustat databases, respectively. Table 2 presents the complete list of variables used in the analysis that follows, their measurements, and relevant sources.

(Insert Table 2 about here)

Table 3 provides some insights on the composition of the sample. Stock is the most common form of payment and is observed in around 58% of cases, followed by cash, which accounts for almost 42% of observations. Most of the announced bids are unchallenged, are classified as friendly and eventually end up being successfully completed. The sample includes a fair representation of deals that are intended for either business diversification (35%) or specialization (65%), classified on the basis of firms' two-digit SIC codes.¹⁹ Only a few bids are rumored before they are announced or are for targets with a poison pill defensive provision in place or from bidders already owning a significant toehold in the target.

A few differences emerge comparing bid characteristics across cash and stock bids. First, the bid premium varies significantly across methods of payment and is higher, on average, for cash bids. This difference, approximately 10%, is statistically significant at the 1% level in a parametric t-test of the equality of means. In this respect, also Eckbo (2009a) documents that

¹⁹ A similar classification criterion on the basis of the first two digits of firms' SIC codes is adopted by Berger and Ofek (1995).

among deal characteristics expected to affect the bid premium, the method of payment is one of the most important and, in particular, that premiums tend to be higher when cash is used. Then, stock bids are more common when the deal value is large, both in absolute and in relative terms (i.e. with respect to the bidder's market capitalization) as in Hansen (1987), or when the informational costs are lower and targets may thus be more willing to accept stock as a means of exchange, as for example whenever the transaction is friendly. On the contrary, cash bids are instead more common when targets would be less willing to accept stock as a means of exchange, as for example when informational problems are more severe, such as in tender offers, hostile bids and diversifying deals or when poison pills are in place. Moreover, cash bids are also more common when the informational costs for the bidder are lower, because it already has a toehold in the target, or when the transaction is made more complex by competition by a rival bidder. The expected synergies from the transaction of stock and cash bids are not statistically different, on average. Nor the frequency with which a bid is rumored varies significantly across methods of payment. Still, cash bids are more frequently withdrawn and are preceded, on average, by a higher run-up.

(Insert Table 3 about here)

Table 4 summarizes then the firm characteristics of bidders and targets in our sample conditional on the method of payment they self-select into. As expected, bidder size is, on average, considerably larger than the size of targets and the average target involved in a stock bid is significantly larger than the average one that is offered cash. Stock bids usually involve bidders that need to preserve their cash, as they operate with higher cash holdings or have more investment opportunities. The same pattern is observable in the average market-to-book of target firms. Stock bids are targeted to firms with higher market- to-book ratios, consistent with bidders' greater concern of overpayment when market valuations are high relative to book values. Cash bids usually involve instead larger bidders, with better access

to credit, as proxied by their higher leverage and their greater cash flows generating power.

(Insert Table 4 about here)

3.2. Methodology

We implement a multivariate analysis that controls for deal- and firm-specific attributes that, individually or in interaction with firm opacity, are expected to drive the determination of the observed method of payment and the bid premium. In particular, we consider the choice of the method of payment and the level of the bid premium as jointly determined as part of the optimal bidding strategy. As such, they are both endogenous variables, and then, we propose to model their determination in the form of a simultaneous equation system with a dummy variable identifying the method of payment, MP, and the bid premium, PRM, as the two endogenous variables:

$$\begin{aligned} Pr(MP = stock|PRM, X_{MP}) &= \Phi(\gamma_{MP}PRM + \beta_{MP}X_{MP} + \epsilon_{MP}) \\ PRM &= \gamma_{PRM}MP + \beta_{PRM}X_{PRM} + \epsilon_{PRM} \end{aligned} \quad (38)$$

Our approach resembles that used by Boone and Mulherin (2007) in their analysis of wealth effects in auctions versus negotiations and is grounded on the simultaneous equation models with qualitative and continuous dependent variables described by Maddala (1983).²⁰ More specifically, in the first equation the dependent variable is a dummy variable equal to 1 for stock bids, and 0 otherwise. In the second equation, instead, the dependent variable is the percentage amount by which the offering price exceeds target's

²⁰ Other examples of previous applications of simultaneous equation models in similar settings with qualitative dependent variables include Hansen (1986) studying the revenue equivalence of sealed bids versus open auctions, Smith (1987) providing a comparative analysis of the proceeds in competitive versus negotiated securities offerings, Demsetz and Lehn (1985) focusing on the link between a firm performance and its ownership status, Comment and Schwert (1995) and Officer (2003) assessing the wealth effects of respectively poison pills and termination provisions

undisturbed stock price (i.e. four weeks before the announcement).²¹ X_{MP} and X_{PRM} are vectors including the opacity of the bidder, the opacity of the target and the set of control variables respectively related to the choice of the method of payment and the bid premium. Individual effects in isolation would, in fact, fail to take into account that many factors concur to jointly determine the observed method of payment. For example, just considering firm opacity, not only does the method of payment eventually observed depend on the opacity of one counterparty, but rather on the interplay of the - sometimes conflicting - effects of bidder and target opacities. Whether a cash or stock bid is observed, in fact, depends on which effect prevails. Moreover, there are many other factors that together with firms opacity could play a role in the determination of the method of payment, as for example the fact that some bidders might not have enough liquid resources to make a cash bid or may be credit constrained. The set of controls for bid characteristics includes: deal materiality, the target stock price run-up, a dummy variable to identify tender offers, a dummy variable to identify hostile bids, a dummy variable to identify bids involving firms operating in different industries and a dummy variable to identify bids occurring during a merger wave, defined in Harford (2005).²² At the firm level, Fama-French 12-industries dummy variables are used to proxy for common unobserved bidder and target characteristics. Macro variables include Shiller's P/E index and the C&I loan spread that Harford (2005) indicates as two main drivers of M&A activity.

3.3. *Firm opacity*

Unfortunately, opacity, our cross-sectional conditioning variable, is not directly observable. Still, a firm's equity trading properties - and its liquidity in particular - can reflect the nature of the information available to market

²¹ See Eckbo (2009a) for a review of the different proxies for the bid premium used in the literature

²² Specifically, we consider a deal occurring during a merger wave if in the same period we assess an exceptional concentration of merger activity within the industry of either the target, the bidder, or both. Details on the construction of the latter variable are available upon request.

participants on the value of the firm. Based on this premise, we assume that the information asymmetry faced by counterparties in a deal is to some extent correlated with that of other outsiders and we rely on the adverse selection component extracted from existing measures of liquidity to proxy for firm opacity.²³

However, the concept of liquidity is tightly and elusively interconnected to asymmetric information. Indeed, according to Hasbrouck (2009), while liquidity is intended as the ability to trade promptly and with little or no price impact and it is then closely related to the extent of uncertainty over the value of the asset, there is no single measure that captures all of its dimensions. As a consequence, a possible concern is that every single potential proxy of liquidity is driven by adverse selection, but not exclusively so. We then design an index of firm opacity by capturing on the first principal component the common cross-sectional variation of six different constituents: (i) the illiquidity measure of Amihud (2002), (ii) the volume – return autocorrelation of Llorente, Michaely, Saar, and Wang (2002), (iii) the probability of informed trading of Easley, Kiefer, O’Hara, and Paperman (1996), (iv) the adverse selection component of the proportional effective spread of Roll (1984), (v) the reversal coefficient of Pastor and Stambaugh (2003), and (vi) the Amivest liquidity ratio of Cooper, Groth, and Avera (1985) and Amihud, Mendelson, and Lauterbach (1997). The intuition is that combining broader liquidity measures with more informational proxies on their first principal component minimizes the likelihood that these measures are connected to non-informational liquidity. Our approach replicates that of Bharath et al. (2009), who form an index to study the impact of a firm’s private information on capital structure decisions.

Our index is computed for each bidder and each target in the year preceding the bid announcement. Relevant loadings on the individual components

²³ Adverse selection risk is the risk of facing better-informed counterparties when trading a specific stock. It increases with firm opacity. The link between equity trading characteristics and information is indirectly validated by Chae (2005), who documents that measures of market microstructure are significantly affected by announcements of corporate events, including M&As.

of the index are extracted by principal component analysis of our index constituents in each year for all firms with data available from CRSP.²⁴

Specifically, we estimate the first principal component of the correlation matrix of the standardized index constituents and then, for each firm, we form the index of firm opacity by combining our standardized proxies for firm opacity with the corresponding contemporaneous loadings.²⁵ Higher values of the index are associated with higher opacity for the specific firm in the given year. A detailed description of the constituents of our index, how it is constructed, and its main properties is provided in the Appendix, where we also present some robustness tests to validate its use in our empirical analysis. According to our index, the opacity of firm i in year y is computed on the basis of our six index constituents x standardized across all firms in the given year, as

$$Index_{i,y} = \sum_{j=1}^6 w_{j,y} \bar{x}_{i,y} \quad \text{where} \quad w_{j,y} = PC(\bar{x}_{i,y}) \quad (39)$$

Higher values of the index are associated with higher opacity for the specific firm in the given year. In each year, as well as overall, the mean index value across all firms on CRSP is zero by construction. Still, as reported in Table 5 bidders and targets in our sample are on average more transparent than the average firm in CRSP. Moreover, targets tend to be on average relatively more opaque than bidders, consistent with their relative size.

(Insert Table 5 about here)

²⁴ All firms with data available on CRSP are considered in the analysis, since the cross section of firms in our sample of bidders and targets over single years is limited and not homogeneous. The broader scope improves the efficiency of the principal component analysis. On average, 40% of cross-sectional variance is accounted for by the first principal component and in most years only the first eigenvalue is larger than one. Moreover, the elements of the first eigenvector are mostly positive, confirming that each constituent adds positively to the index.

²⁵ Index constituents are standardized across all firms with data available on CRSP in a given year, since a broader scope improves the efficiency of the principal component analysis. The results of the analysis under alternative standardizations at the industry level or across firm size quartiles are available upon request.

3.4. Results

We assess the impact of firm opacity on the simultaneous determination of the bid premium and the method of payment by consistent estimation of our system of equations with a two-stage probit least squares regression analysis. In particular, in the first stage we regress the two dependent variables, the method of payment and the bid premium on their corresponding sets of exogenous variables. Then, in the second stage regressions, we use the fitted values for a given dependent variable as an explanatory variable for the other one. Since the choice of the method of payment is modeled as a probit model, standard errors in the second stage are estimated according to Maddala (1983).²⁶ Identification of the system requires that X_{MP} and X_{PRM} do not coincide. To assure identification, then, the set of regressors for the method of payment X_{MP} will not include the pre-announcement run-up of the stock price of the target that we use to instrument for the bid premium. We consider, in fact, the target's stock price run-up a potential driver of the bid premium while we deem it unrelated to the method of payment. Our intuition is supported by Eckbo (2009b) and Betton, Eckbo, Thompson, and Thorburn (2014) that show how a high pre-announcement run-up is positively associated with a higher bid premium and by the fact that in our sample the relative frequency with which stock and cash bids occur is not affected by the pre-announcement run-up in target stock prices. Univariate tests of equality of means confirm the null hypothesis that the proportion of stock bids does not vary for different levels of run-up, not across subsamples of deals where run-up is above or below its cross-sectional median nor where it is positive or negative. Analogously, the dummy variable that identifies tender offers is excluded from the set of regressors of the bid premium X_{PRM} and used to instrument for the method of payment. We consider, in fact, the decision to realize the transaction by means of a tender offer to be closely tied to the choice of the method of payment, in line with Huang and Walkling (1987) and Berkovitch and Khanna (1991) who show that the likelihood of

²⁶ More specifically, to compute the proper estimates we follow Keshk (2003)

stock bids is lower in tender offers and our summary statistics in Table 3, and mostly unrelated to the level of the bid premium after controlling for the differences across methods of payment.

Table 6 summarizes the coefficients and the corresponding t-statistics (in parenthesis) for the second stage regressions under three alternative model specifications.²⁷ We start with a baseline specification (I) including only the controls at the bid and macro level; then we include an interaction term in the method of payment equation of our second specification (II) to assess the effect of target opacity for different levels of deal materiality, following Hansen (1987); and finally, in our third specification (III) we complete the set of exogenous variables by adding firm level controls.

(Insert Table 6 about here)

Our analysis documents that the opacity faced by the bidder in assessing the value of the target is a significant driver of the choice of the method of payment. Indeed, consistent with the predictions of our model, the likelihood of a stock bid increases with the opacity of the target. The coefficient of target opacity in the equation for the method of payment in our baseline specification (I) is positive, but the magnitude of the effect varies with deal materiality. Indeed, in our model specifications (II) and (III), the interaction term between target opacity and deal materiality, which captures the increasing concern of overpayment as bid size grows, is always positive and significant at the 5% level. This suggests that it is when the transaction is sufficiently material that stock bids are preferred to alleviate the overpayment concerns associated with opaque targets.²⁸ The economic magnitude of this effect is substantial. According to the marginal effects based on our

²⁷ The individual effects of control variables are omitted from the table for the sake of space and are available upon request

²⁸ Analyzing a smaller subsample of deals which does not include observations belonging to the two smallest deciles with respect to deal materiality, i.e. deals for which the target accounts for less than 2.5% of the combined merged entity, leads to equivalent conclusions. The coefficient of target opacity in the equation for the method of payment in our baseline specification (I) is positive and significant at the 1% level. Results are available upon request.

model specification (III), a one standard deviation increase in target opacity would increase, for example, the probability of choosing a stock payment by roughly 2.4% for a deal where the size of the target accounts for one-third of the combined merged entity, i.e. when the bidder is twice as large as the target, or by as much as 5.6% vice-versa.²⁹ This result is in line with the predictions of our model, which are based on the same risk-sharing rationale of Hansen (1987) and in contrast with the use of cash bids as a signaling device to deter potential competitors' bids for more opaque targets, as instead documented by Chemmanur et al. (2009).

We only find weak evidence that the likelihood of a stock bid is overall negatively affected by the opacity of the bidder. Indeed, while this effect is of the expected sign, it does not reach statistical significance at the 10% level in any of our specifications. As mentioned before, the sharp prediction of a negative correlation depends in our model on assumptions about the distribution of prior beliefs. Because different channels display different effects of the components of bidder opacity on the likelihood of a stock offer, the small significance of this correlation as displayed by the data is not surprising and does not invalidate the model's intuition.

We do not find evidence on the use of cash bids as a signaling device to deter potential competitors' bids for more opaque targets, as do Chemmanur et al. (2009), but we find instead, as predicted by our model, that higher bid premiums are associated with target opacity. In this respect, our findings can also be interpreted in light of the preemptive bidding rationale of using cash bids as a signaling device to deter potential competitors' bids for more opaque targets, as suggested by Fishman (1989) and consistent with the evidences provided by Laamanen (2007) and Chatterjee et al. (2012). In particular, in all our model specifications, target opacity is positively related with the level of the bid premium. The corresponding coefficients are always positive and statistically significant at the 1% level. Also this effect

²⁹In particular, the marginal effect of target opacity on the probability of a stock bid is 0.0289, significant at the 10% level, when deal materiality is fixed at 0.33 and equals 0.0313, significant at the 5% level for deal materiality equal to 0.66

is economically relevant as, for example, according to the estimates in our specification (III), for a one standard deviation increase in target opacity the bid premium would increase, on average, by 4.0% in absolute terms. Or, by approximately \$ 44.5 million considering the average target in our sample.³⁰

Our analysis then documents that, after controlling for the method of payment, the opacity of the bidder is related to lower premiums. While this is not direct evidence in favor of our hypothesis that bidder opacity is negatively correlated with premiums conditional on stock offers (something which cannot be tested given our specification), it is consistent with our theoretical model where bidder opacity makes it hard for high-type targets to sustain stock-pooling equilibria, which carry the largest premiums while bidder opacity is associated with higher premiums in separating equilibria through cash offers only. According to the alternative argument of Myers and Majluf (1984) and Rhodes-Kropf and Viswanathan (2004), in fact, when the bidder is opaque, targets are more likely to overestimate synergies and the ensuing increased probability of bid success allows then more opaque bidders to signal their value by offering less at relatively lower cost. In particular, we find, in all our model specifications, that bidder opacity is negatively correlated with the level of the bid premium. The corresponding coefficients are always negative and statistically significant at the 10% level. Also this effect is economically relevant as, for example, according to the estimates in our specification (III), for a one standard deviation increase in bidder opacity the bid premium would decrease, on average, by 2.2% in absolute terms. Or, by approximately \$ 24.5 million considering the average deal in our sample.³¹

Through this conditional effect, bidder opacity then indirectly contributes to the choice of stock as the method of payment since it lowers a bidder's

³⁰ Considering instead the median target size the corresponding increase in the bid premium would be equal to \$ 9 million.

³¹ Considering instead the median target size the corresponding increase in the bid premium would be equal to \$ 5 million.

expectation of a stock bid premium, affecting the gap between the premiums that the bidder anticipates to offer under alternative payment regimes. As a consequence, whether a cash or stock bid is observed depends on which effect prevails. Indeed, a relatively lower anticipated premium under stock payment when a bidder is more opaque would make this type of bid more likely, offsetting the otherwise negative effect of bidder opacity on the use of stock. This indirect contribution of bidder opacity to the choice of the method of payment may then provide an explanation why we only find weak evidence that the likelihood of a stock bid is overall negatively affected by the opacity of the bidder, as predicted by our model.

Evidence of the effect of control variables is generally as expected and in line with Boone, Lie, and Liu (2014). Preference for a stock transaction increases with deal materiality. Consistent with the evidence of Faccio and Masulis (2005), the corresponding coefficient is positive and strongly statistically significant. Analogously, in line with, among others, Schwert (2002) and Faccio and Masulis (2005), a preference for stock bids is found to be significantly higher for deals that involve firms in the same industry. These classes of deals are, in fact, more likely to include transactions in which asymmetric information concerns are lesser and in which the target's shareholders are more likely interested in maintaining a stake in the merged entity. As a consequence, these deals are also associated with significantly lower bid premiums. Then, consistent with McNamara, Halebian, and Dykes (2008), Chidambaran, John, Shangguan, and Vasudevan (2010), and Chatterjee et al. (2012), our analysis suggests a significant preference for stock payments in deals that are part of a merger wave or that occur in periods of strong investment sentiment or low capital liquidity, as proxied respectively by Shiller's P/E index and the C&I Loan spread. The corresponding coefficients are consistently significant. Finally, as expected, run-up is positively and significantly associated with the bid premium, consistent with Betton et al. (2014) and the likelihood of a stock bid is lower in tender offers, consistent with Huang and Walkling (1987) and Berkovitch and Khanna (1991).

4. Conclusion

Our theoretical model and empirical tests show the joint effect of target and bidder opacity on the simultaneous determination of the method of payment and the bid premium in a sample of M&A bids by and for U.S. publicly listed firms over the period 1985-2011. Overall, our results suggest that when targets are more opaque the concern of overpayment leads bidders to select stock bids to benefit from contingent pricing and risk sharing. Bidders then use the bid premium as a signaling device of their valuation of the target, to dominate potential competitors' bids and, in stock bids, to signal their own valuation. Our results are then consistent with bidders determining jointly the bid premium and the method of payment as part of the optimal bidding strategy.

Modeling and testing jointly and directly the impact of both target and bidder opacity on bid characteristics, we are, in fact, able to observe that the preference for stock bids increases with the opacity of the target for bids of substantial materiality, consistent with the adverse selection rationale of Hansen (1987). Moreover, we observe that premiums are higher for cash bids and increase with the opacity of the target but they are also negatively related to bidder opacity. The first results are consistent with arguments by Fishman (1989) and Chatterjee et al. (2012), while the latter support the arguments of Myers and Majluf (1984) and Rhodes-Kropf and Viswanathan (2004).

Our direct investigation of the implications of firm opacity on the realization of an M&A deal sheds light on the rationality of the observed bidding behavior and the efficiency of the market of corporate control by quantifying the impact of the entailed informational frictions on managerial decisions and negotiation. Moreover, it reveals the motives that underlie the prominent role played by financial intermediaries acting as advisors and the continuous effort to design market devices to convey relevant information. In this respect, our results are related to those of Kesner, Shapiro, and Sharma (1994), who take the agency theory perspective and evaluate how the interests of,

respectively, bidders, targets, and their advisors reflect on bidding behavior. Furthermore, our results complement those of Reuer, Tong, and Wu (2012), who document how a target's association with a prominent investment bank, venture capitalist, or alliance partner conveys valuable information and positively affects the bid premium.

A natural extension of the analysis would then be to extend the proposed model for the choice of the method of payment and the bid premium to study the information content of a deal's announcement and show the implications of how much is paid and how for deal success and shareholder value creation. In particular, it would be interesting to look further into the different type and quality of information on the bidder and the target that stock and cash bids respectively convey and, on these premises, shed new light on the role played by the choice of the most appropriate method of payment as a determinant of value creation for shareholders.

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Appendix 1. Equilibrium Refinements

Some PBEs may be sustained only by the target holding an “unreasonable” posterior belief after receiving an out-of-equilibrium message. In particular, we consider it unreasonable, for the target, to assign, upon observing m , positive probability to a type of bidder which is better off with the outcome of its equilibrium action than with any outcome it might receive by choosing to play m , given its assessment of the target’s rationality.

In order to translate this into formal language,³² let us consider a candidate equilibrium *path* $(\mathbf{m}^*, \hat{\mathbf{r}}^*)$. Here $\mathbf{m}^* \in M^{\Theta_B}$ is the bidder’s equilibrium strategy and $\hat{\mathbf{r}}^* \in \{Y, N\}^{\Theta_T \times \mathbf{m}^*(\Theta_B)}$ is the restriction to the domain of equilibrium messages of the target’s equilibrium strategy. Let us also define, given m^* and the prior belief p^T , the set of Bayes*-consistent posterior beliefs (Ba^*) to be the set of beliefs $\boldsymbol{\mu} \in \Delta(\Theta_B)^M$ such that $\boldsymbol{\mu}(m)$ is derived from p^T via Bayes’ rule whenever $m \in \mathbf{m}^*(\Theta_B)$.

We say that the target is *-rational (and denote such event by R_T^*) if, for all $\theta_T \in \Theta_T$ and for all $m \in M$, it chooses an action which is a best reply to m given *some* belief μ consistent with $\mu = \boldsymbol{\mu}(m)$, $\boldsymbol{\mu} \in \text{Ba}^*$. The set of strategies $\mathbf{r} \in \{Y, N\}^{\Theta_T \times M}$ which are compatible with R_T^* is denoted by $r(R_T^*)$. Similarly, we say that the bidder is *-rational (and denote such event by R_B^*) if, for all $\theta_B \in \Theta_B$, the bidder chooses $m(\theta_B)$ to be a best reply to *some* conjecture about the target’s behavior, given that the target will choose $r \in \hat{\mathbf{r}}^*(\Theta_T, m)$ whenever $m \in \mathbf{m}^*(\Theta_B)$.

By definition³³ a candidate equilibrium path cannot be inconsistent with either R_T^* or R_B^* . For an event E and each $i \in \{B, T\}$, let $B_i(E)$ denote the event “player i initially believes E ”. Consider the event $R_B^* \cap B_B(R_T^*)$, which reads “the bidder is *-rational and (initially) believes that the target

³² This appendix is based on the epistemic analysis of forward-induction solution concepts contained in Battigalli and Siniscalchi (2002); see also Battigalli and Siniscalchi (2003) and Battigalli (2006).

³³ In this paper, the reference equilibrium concept is the Perfect Bayesian Equilibrium defined in Definition 1. What follows, though, holds even when the reference equilibrium concept is self-confirming equilibrium; Battigalli and Siniscalchi (2002).

is \ast -rational". Such event constrains the bidder to choose $m(\theta_B)$ taking into account that the target will respond to the message with an action consistent with some strategy in $r(R_T^*)$. Thus, a message m by a type- θ_B bidder is consistent with $R_B^* \cap B_B(R_T^*)$ if and only if there exists a $\tilde{\mathbf{r}} \in r(R_T^*)$ such that

$$m \in \arg \max_{\tilde{m} \in M} \mathbb{E}_{p^B} [u_B(\tilde{m}, \tilde{\mathbf{r}}(\theta_T, \tilde{m}), \theta_B, \theta_T)] \quad (40)$$

If m is an out-of-equilibrium message (i.e. $m \notin \mathbf{m}^*(\Theta_B)$) and there is no such strategy $\tilde{\mathbf{r}}$, it means that the expected payoff obtained by the type- θ_B bidder by playing its equilibrium message $\mathbf{m}^*(\theta_B)$ is strictly larger than what it can obtain by playing m . In this case, we say that m is *equilibrium-dominated*. For each message m , we let $\Theta_B^*(m)$ be the set of types of the bidder for which m is *not* equilibrium-dominated.

For an event E an player $i \in \{B, T\}$, the event $\text{SB}_i(E)$ indicates that player i *strongly believes* E : it initially believes E and keeps doing so throughout the game, as long as what it observes is compatible with E . Consider now the event $R_T^* \cap \text{SB}_T(R_B^* \cap B_B(R_T^*))$: the target is \ast -rational and strongly believes the bidder to be \ast -rational as well as to believe in the target's own \ast -rationality.

On its own, the event $\text{SB}_T(R_B^* \cap B_B(R_T^*))$ implies that the target does not attribute to the type- θ_B bidder the choice of an equilibrium-dominated message. Because Bayes-consistency leaves the target free in forming posterior beliefs after non-equilibrium messages, it might be that a target assigns positive probability to a type-message pair (θ_B, m) such that m is equilibrium-dominated for θ_B .

Definition 2. A PBE $(\mathbf{m}^*, (\boldsymbol{\mu}^*, \mathbf{r}^*))$ fails the Equilibrium Dominance Test (EDT) if there is $m \in M$ such that $\boldsymbol{\mu}^*(\Theta_B^*(m) \mid m) < 1$.

In our paper, it is often the case that many PBEs exist giving rise to the same equilibrium path and differing only in the posterior beliefs. Very often, removal of PBEs that do not pass the EDT ends up in curbing the amount of equilibria who share a given outcome. In other words, for a given equilibrium

path, one can find at least one assessment which sustains such path as the outcome of a PBE which passes the EDT. In general, though, the event $SB_T(R_B^* \cap B_B(R_T^*))$ might make some equilibrium outcomes unsustainable. To see this, define, for all $A \subseteq \Theta_B$,

$$\text{Ba}^*(A) := \{\boldsymbol{\mu} \in \text{Ba}^* : \forall m \in M, \boldsymbol{\mu}(A | m) = 1\} \quad (41)$$

Compatibility with the event $R_T^* \cap SB_T(R_B^* \cap B_B(R_T^*))$ requires that the target's response to message m is a best reply to some posterior beliefs that assigns probability 1 to m having been sent by a type of bidder for which m is not equilibrium dominated. That is, it is required that $\mathbf{r}(\theta, m)$ be a best response to some belief μ such that $\mu = \boldsymbol{\mu}(m)$ and $\boldsymbol{\mu} \in \text{Ba}^*(\Theta_B^*(m))$. As before, then, denote by $r(R_T^* \cap SB_T(R_B^* \cap B_B(R_T^*)))$ the strategies satisfying such requirements.

Finally, consider the event $R_B^* \cap B_B(R_T^* \cap SB_T(R_B^* \cap B_B(R_T^*)))$. Fix a type $\theta_B \in \Theta_B$. A message m by θ_B is *not* compatible with this event if there is another message m' that gives the type- θ_B bidder a larger payoff irrespectively of the target's response to m' , provided such response is consistent with a strategy $\mathbf{r} \in r(R_T^* \cap SB_T(R_B^* \cap B_B(R_T^*)))$. It is possible that some PBE prescribes an equilibrium path in which, for some type θ_B , the type- θ_B bidder is prescribed an equilibrium message that makes the equilibrium path not compatible with $R_B^* \cap B_B(R_T^* \cap SB_T(R_B^* \cap B_B(R_T^*)))$. The following definition parallels the original one of Cho and Kreps (1987).

Definition 3. *A PBE $(\mathbf{m}^*, (\boldsymbol{\mu}^*, \mathbf{r}^*))$ fails the Intuitive Criterion Test (ICT) if there exist $m \in M$ and $\theta_B \in \Theta_B$ such that*

$$U_{\theta_B}^*(\mathbf{m}^*(\theta_B)) < \min_{\mathbf{r} \in r(R_T^* \cap SB_T(R_B^* \cap B_B(R_T^*)))} \mathbb{E}_{p^B} [u_B(m, \mathbf{r}(\theta_T, m), \theta_B, \theta_T)] \quad (42)$$

Thus, an equilibrium fails the ICT test if the message it prescribes to some type of bidder turns out to be worse than some out-of-equilibrium message, once the bidder considers that the target will reply to the latter with a response consistent with the target assigning zero probability to the out-of-

equilibrium message having been sent by a type of bidder for which such message would be equilibrium-dominated.

Appendix 2. Equilibrium Analysis

By the following proposition we identify the minimal stock offers that, given a certain updating rule $\mu \in \Delta(\Theta_B)^M$, are accepted, respectively, by the low-type and the high-type target.

Proposition 4. *For all $\theta_T \in \Theta_T$ and $\mu \in \Delta(\Theta_B)^M$, the map $\Phi^{\theta_T} : [0, 1] \rightarrow \mathbb{R}_+$ defined in (22) has a unique fixed point $f^{\theta_T}(\mu) \in (0, 1)$. Moreover, $f^{\bar{\theta}_T}(\mu) \geq f^{\underline{\theta}_T}(\mu)$.*

Proof. By assumption (A3), $\mu(\bar{\theta}_B | (S, \cdot))$ is continuous and weakly increasing. Then, for all $\theta_T \in \Theta_T$,

$$\Phi^{\theta_T}(\cdot) := \frac{\theta_T}{\mathbb{E}_{\mu(S, \cdot)}[\theta_B] + w(\theta_T)} = \frac{\theta_T}{\mu(\bar{\theta}_B | (S, \cdot))V_B + \underline{\theta}_B + w(\theta_T)}$$

is continuous and weakly decreasing. Moreover, for all $f \in [0, 1]$,

$$\Phi^{\theta_T}(f) = \left[\frac{\theta_T}{\bar{\theta}_B + w(\theta_T)}, \frac{\theta_T}{\underline{\theta}_B + w(\theta_T)} \right] \subset (0, 1).$$

Therefore there exists, for all $\theta_T \in \Theta_T$ and $\mu \in \Delta(\Theta_B)^M$, a unique value $f^{\theta_T}(\mu)$ that solves $f = \Phi^{\theta_T}(f)$. Assumption (A2) implies that, for all $\nu \in \Delta(\Theta_B)$,

$$\frac{\bar{\theta}_T}{\underline{\theta}_T} \geq \frac{\mathbb{E}_\nu[\theta_B] + w(\bar{\theta}_T)}{\mathbb{E}_\nu[\theta_B] + w(\underline{\theta}_T)}, \quad (43)$$

from which it follows that, for all $\mu \in \Delta(\Theta_B)^M$ and all $f \in [0, 1]$, $\Phi^{\bar{\theta}_T}(f) \geq \Phi^{\underline{\theta}_T}(f)$. Then it must be that $f^{\bar{\theta}_T}(\mu) \geq f^{\underline{\theta}_T}(\mu)$. \square

We first prove Lemma (2.2).

Proof of Lemma (2.2). For all $\theta_T \in \Theta_T$, $\frac{\theta_T}{\bar{\theta}_B + w(\theta_T)} < \frac{\theta_T}{\underline{\theta}_B + w(\theta_T)}$, implying

that

$$\forall \theta_T \in \Theta_T \quad , \quad f^{\theta_T}(\underline{\theta}_B) > f^{\theta_T}(\bar{\theta}_B) \quad (44)$$

Then, by (A2),

$$\frac{\bar{\theta}_T}{\underline{\theta}_T} \geq \frac{\bar{\theta}_B + w(\bar{\theta}_T)}{\underline{\theta}_B + w(\underline{\theta}_T)} \implies f^{\bar{\theta}_T}(\bar{\theta}_B) \geq f^{\underline{\theta}_T}(\underline{\theta}_B) \quad (45)$$

Using (44) and (45) we obtain (28). \square

Now we prove Lemma (2.1).

Proof of Lemma (2.1). (a) For all $\theta_B \in \Theta_B$, the participation share constituting the low stock offer is found, by (22), to be

$$f^{\theta_T}(\theta_B) = \frac{\underline{\theta}_T}{\theta_B + w(\underline{\theta}_T)} \quad (46)$$

Using (25), the expected value of such offer to the bidder is

$$\begin{aligned} & p^B \theta_B + (1 - p^B) \left[\left(\frac{\theta_B + \Delta(\underline{\theta}_T)}{\theta_B + w(\underline{\theta}_T)} \right) (\theta_B + w(\underline{\theta}_T)) \right] \\ &= p^B \theta_B + (1 - p^B) (\theta_B + \Delta(\underline{\theta}_T)) \\ &= \theta_B + (1 - p^B) \Delta(\underline{\theta}_T) \end{aligned}$$

which is the expected value of the low cash offer, as in (??).

(b) Similarly, the participation share of the high stock offer is

$$f^{\theta_T}(\theta_B) = \frac{\bar{\theta}_T}{\theta_B + w(\bar{\theta}_T)} \quad (47)$$

and, by (24), the expected value of this offer is

$$\begin{aligned}
& \left(1 - \frac{\bar{\theta}_T}{\theta_B + w(\bar{\theta}_T)}\right) (\theta_B + \mathbb{E}_{p^B} [w(\theta_T)]) \\
&= \theta_B + \mathbb{E}_{p^B} [w(\theta_T)] - \bar{\theta}_T \left(\frac{\theta_B + \mathbb{E}_{p^B} [w(\theta_T)]}{\theta_B + w(\bar{\theta}_T)}\right) \\
&> \theta_B + \mathbb{E}_{p^B} [w(\theta_T)] - \bar{\theta}_T
\end{aligned}$$

the last line being the value of the high cash offer, as in (??). Notice that the values of the two high offers tend to coincide as $p^B \rightarrow 1$.

(c) Notice from formulas (16), (17), (24) and (25), that the expected payoffs from all offers are linear functions of p^B . By part (a) of this Lemma, the payoff from the low stock offer tends, as $p^B \rightarrow 0$, to $\theta_B + \Delta(\underline{\theta}_T)$. The payoff from the high stock offer tends, as $p^B \rightarrow 0$, to $(\theta_B + \Delta(\bar{\theta}_T)) \frac{\theta_B + w(\underline{\theta}_T)}{\theta_B + w(\bar{\theta}_T)}$ which, by assumption (A2), is strictly smaller than $\theta_B + \Delta(\underline{\theta}_T)$. As stated in part (b) of this Lemma, the high stock offer gives the bidder a larger payoff than the high cash offer which, for all $p^B \geq \pi_C$, gives a larger payoff than the low cash offer. This together with the linearity of such payoffs proves part (c) of the Lemma.

(d) Part (c) of this Lemma immediately yields that, for all $\theta_B \in \Theta_B$, $\pi_S(\theta_B) < \pi_C$. Moreover, from (24) one can see that the payoff from the high stock offer grows in p^B at rate $(1 - f^{\bar{\theta}_T}(\theta_B))W$. As $f^{\bar{\theta}_T}(\underline{\theta}_B) > f^{\bar{\theta}_T}(\bar{\theta}_B)$, the slope of the payoff line is smaller for $\underline{\theta}_B$ than for $\bar{\theta}_B$, implying that $\pi_S(\underline{\theta}_B) < \pi_S(\bar{\theta}_B)$. \square

The next Lemma excludes the possibility of an equilibrium where the two types of bidder propose distinct stock offers.

Lemma 2.1. *There is no PBE such that, for all $\theta_B \in \Theta_B$, $\mathbf{m}^*(\theta_B) \in S \times [0, 1]$ and $\mathbf{m}^*(\bar{\theta}_B) \neq \mathbf{m}^*(\underline{\theta}_B)$.*

Proof. Assume, towards a contradiction, that such a PBE existed. By definition, for all $\theta_B \in \Theta_B$, $\mu^*(\theta_B \mid \mathbf{m}^*(\theta_B)) = 1$ (full recognition of the bidder).

As $f \mapsto \boldsymbol{\mu}^*(\bar{\theta}_B | (S, f))$ is required to be increasing by (A3),

$$\boldsymbol{\mu}^*(\bar{\theta}_B | \mathbf{m}^*(\bar{\theta}_B)) = 1 > 0 = \boldsymbol{\mu}^*(\bar{\theta}_B | \mathbf{m}^*(\underline{\theta}_B))$$

implies $\mathbf{m}^*(\bar{\theta}_B) > \mathbf{m}^*(\underline{\theta}_B)$. By Lemma (2.2), this can only happen if $\mathbf{m}^*(\bar{\theta}_B) = f^{\bar{\theta}_T}(\bar{\theta}_B)$ and $\mathbf{m}^*(\underline{\theta}_B) = f^{\underline{\theta}_T}(\underline{\theta}_B)$. This in turn requires $p^B \geq \pi_S(\bar{\theta}_B)$ and $p^B \leq \pi_S(\underline{\theta}_B)$, which is impossible by part (d) of Lemma (2.1). \square

The next lemma excludes the possibility of a PBE where the high-type bidder offers stock and the low-type bidder offers cash.

Lemma 2.2. *There is no PBE such that $\mathbf{m}^*(\underline{\theta}_B) \in C \times \mathbb{R}_+$ and $\mathbf{m}^*(\bar{\theta}_B) \in S \times [0, 1]$.*

Proof. Once again, suppose to have such a PBE. For all $\theta_B \in \Theta_B$ the payoff from a stock offer is decreasing in the participation share f which, in turn, is decreasing in the target's belief that the bidder's type is $\bar{\theta}_B$ at (S, f) . For every $p^B \in (0, 1)$, the best stock offer of a type- $\underline{\theta}_B$ bidder features a participation share that exceeds the one offered by the type- $\bar{\theta}_B$ bidder in equilibrium. Thus, if it deviated to such offer, the type- $\underline{\theta}_B$ bidder would be mistakenly considered a type- $\bar{\theta}_B$ bidder. Its payoff would then be larger than the one it could obtain from the same offer under full recognition, which, in turn, is weakly larger than the payoff from the best cash offer. It follows that such a deviation is always profitable for the type- $\underline{\theta}_B$ bidder and, therefore, that there cannot be any such PBE. \square

We can finally prove the main result on separating equilibria of our model.

Proof of Proposition (1). Fix $p^B \in (0, 1)$ and let, for simplicity, c^* be the best cash offer at p^B . Let also s^* be the best stock offer for a type- $\underline{\theta}_B$ bidder at p^B . We look for an updating rule $\boldsymbol{\mu}^*$ such that $\boldsymbol{\mu}^*$ satisfies (A3) and $(\mathbf{m}^*, (\boldsymbol{\mu}^*, \mathbf{r}^*))$ is a PBE, where $\mathbf{m}^*(\bar{\theta}_B) = c^*$, $\mathbf{m}^*(\underline{\theta}_B) = s^*$ and \mathbf{r}^* is the appropriate response.

A type- $\underline{\theta}_B$ bidder has no incentive to deviate from s^* to c^* as s^* , guaranteeing full recognition, is weakly better than c^* at all $p^B \in (0, 1)$. If s^* is the high stock offer with participation share $f^{\bar{\theta}_T}(\underline{\theta}_B)$, then deviating towards the low stock offer with participation share $f^{\underline{\theta}_T}(\underline{\theta}_B)$ cannot be profitable, since $f^{\underline{\theta}_T}(\underline{\theta}_B) < f^{\bar{\theta}_T}(\underline{\theta}_B)$ and hence the bidder is fully recognized as a low-type at this new offer as well.

However, it might be that, when $p^B < \pi_S(\underline{\theta}_B)$, the type- $\underline{\theta}_B$ bidder has a profitable deviation from $s^* = (S, f^{\underline{\theta}_T}(\underline{\theta}_B))$ to $(S, f^{\bar{\theta}_T}(\boldsymbol{\mu}^*))$. In order to sustain the equilibrium we thus have to guarantee that

$$\underline{\theta}_B + (1 - p^B)\Delta(\underline{\theta}_T) \geq (1 - f^{\bar{\theta}_T}(\boldsymbol{\mu}^*))(\underline{\theta}_B + \mathbb{E}_{p^B}[w(\theta_T)]) \quad (48)$$

Because

$$\underline{\theta}_B + (1 - p^B)\Delta(\underline{\theta}_T) > (1 - f^{\bar{\theta}_T}(\underline{\theta}_B))(\underline{\theta}_B + \mathbb{E}_{p^B}[w(\theta_T)])$$

by construction, we can always specify $\boldsymbol{\mu}^*$ so that it retains full recognition at $f^{\underline{\theta}_T}(\underline{\theta}_B)$ while ensuring that (48) holds. Notice first how (48) requires the equilibrium belief $\boldsymbol{\mu}^*$ *not* to grow too fast in the participation share offered by the bidder: if this were the case, a rather small increase in the offer would be needed for type- $\underline{\theta}_B$ bidder to attract all types of target: in such case, the gains from attracting the high-type targets would surpass the increased costs of a larger participation share. Notice, moreover, that the closer p^B is to zero, the looser is the belief constraint specified by (48), to the point that when $p^B \rightarrow 0$ the constraint is actually moot.

Consider now the high-type bidder. When $p^B \leq \pi_S(\bar{\theta}_B)$, the (low) cash offer is always (weakly) optimal. When $p^B > \pi_S(\bar{\theta}_B)$, the high-type bidder could have a profitable deviation towards the high stock offer, as the payoff it expected from the high stock offer exceeds that expected by the low-type bidder. Under equilibrium beliefs $\boldsymbol{\mu}^*$, the payoff expected by the high-type bidder which is mistaken for a low-type bidder when proposing the high stock offer (1) is smaller than the payoff $\bar{\theta}_B$ would obtain by proposing the high stock offer under full recognition and (2) it increases in p^B at the same

rate as the payoff expected by $\underline{\theta}_B$ when proposing the same offer. Thus its slope is less than the slope of $\bar{\theta}_B$'s full-recognition payoff from the high stock offer. It follows that either (1) there is no value of p^B such that this payoff is larger than the payoff from the (equilibrium) cash offer or (2) there exists an interval $(p_-^B, p_+^B) \subseteq (0, 1)$ such that $\pi_C \in (p_-^B, p_+^B)$ and the high-type bidder prefers to deviate to $(S, f^{\bar{\theta}_T}(\underline{\theta}_B))$ than sticking to its equilibrium cash offer if and only if $p^B \in (p_-^B, p_+^B)$.

Moreover, because of the linearity of payoffs, a necessary and sufficient condition for this *not* to happen is that the payoff from the deviation is not larger than the equilibrium payoff at π^C (which is the value of p^B where the equilibrium payoff is smallest). This is

$$\bar{\theta}_B - \bar{\theta}_T + \mathbb{E}_{\pi_C}[w(\theta_T)] \geq (1 - f^{\bar{\theta}_T}(\underline{\theta}_B)) (\bar{\theta}_B + \mathbb{E}_{\pi_C}[w(\theta_T)]) \quad (49)$$

Using the expression for $f^{\bar{\theta}_T}(\underline{\theta}_B)$ in (47) and the one for π_C from (19) one obtains condition (29). All separating equilibria pass the Intuitive Criterion Test of Definition (3), even though not all of them pass the Equilibrium Dominance Test of Definition (2). Let indeed $p^B \leq \pi_S(\underline{\theta}_B)$, so that $\mathbf{m}^*(\bar{\theta}_B) = (C, \underline{\theta})$ and $\mathbf{m}^*(\underline{\theta}_B) = (S, f^{\underline{\theta}_T}(\underline{\theta}_B))$. Suppose that the out-of-equilibrium message (S, f) , with $f > f^{\underline{\theta}_T}(\underline{\theta}_B)$, is observed by the target. If $f < f^{\bar{\theta}_T}(\bar{\theta}_B)$ and the bidder expects all types of target to accept (S, f) , then such a message might be rationalized as being sent by $\bar{\theta}_B$ with positive probability. On the other hand, if $f \in (f^{\bar{\theta}_T}(\bar{\theta}_B), f^{\bar{\theta}_T}(\underline{\theta}_B))$, this message could only come from the type- $\underline{\theta}_B$ bidder. Equilibrium dominance then requires that, for any such f , $\boldsymbol{\mu}^*(\bar{\theta}_B \mid (S, f)) = 0$. But because we need $\boldsymbol{\mu}^*(\bar{\theta}_B \mid (S, \cdot))$ to be increasing, this implies

$$\forall f \leq f^{\bar{\theta}_T}(\underline{\theta}_B) \quad , \quad \boldsymbol{\mu}^*(\bar{\theta}_B \mid (S, f)) = 0 \quad (50)$$

The restriction thus provided by the application of the EDT, though, does not tamper equilibrium prescriptions: if $\boldsymbol{\mu}^*$ satisfies (50), the incentives to deviate by any type of bidder will be weakened. As equilibrium dominance imposes no restriction on separating equilibria when $p^B > \pi_S(\underline{\theta}_B)$, all such

equilibria survive the Intuitive Criterion Test. \square

We prove here Proposition (2) describing pooling equilibria in which both types of bidder propose a cash offer. We begin by showing that there cannot be such an equilibrium if $p^B > \pi_S(\underline{\theta}_B)$.

Lemma 2.3. *If $p^B > \pi_S(\underline{\theta}_B)$, there is no PBE such that $\mathbf{m}^*(\bar{\theta}_B) = \mathbf{m}^*(\underline{\theta}_B) =: \mathbf{m}^*$ and $\mathbf{m}^* \in C \times \mathbb{R}_+$.*

Proof. Suppose such an equilibrium exists and let $\boldsymbol{\mu}^*$ be the equilibrium beliefs of the target. As $f^{\bar{\theta}_T}(\boldsymbol{\mu}^*) \leq f^{\bar{\theta}_T}(\underline{\theta}_B)$, the type- $\underline{\theta}_B$ bidder finds the high stock offer more convenient under $\boldsymbol{\mu}^*$ than under any updating rule where it is fully recognized. Because the full recognition payoff of the high stock offer is larger, for all $p^B > \pi_S(\underline{\theta}_B)$ than the payoff from the best cash offer, it follows that the type- $\underline{\theta}_B$ bidder always has an incentive to deviate towards the former. Thus this equilibrium cannot exist. \square

Next we show the existence, for all $p^S \leq \pi_S(\underline{\theta}_B)$, of a PBE with both types pooling on the (low) cash offer, thus proving Proposition (2).

Proof of Proposition (2). Let $p^B \leq \pi_S(\bar{\theta}_B)$. Consider the type- $\underline{\theta}_B$ bidder. In order for it not to deviate from the low cash offer to the low stock offer, it is necessary that it finds the two alternatives indifferent, that is, we need to require that it is fully recognized at the low stock offer. This imposes the restriction

$$\forall f \leq f^{\underline{\theta}_T}(\underline{\theta}_B) \quad , \quad \boldsymbol{\mu}^*(\bar{\theta}_B \mid (S, f)) = 0 \quad (51)$$

Condition (48) must also hold in order for the low-type bidder not to wish to deviate to a high stock offer. Under (51) and (48) the high-type bidder has no incentive to deviate to any stock offer. Thus the equilibrium is sustained.

As in the proof of Proposition (1), the Equilibrium Dominance Test requires that full recognition of the low-type bidder extends to all $f \leq f^{\bar{\theta}_T}(\underline{\theta}_B)$. This has no effect on the sustainability of the equilibrium action profile. \square

We complete the analysis of the equilibria of our model by describing those in which the two types of bidder pool on stock offer.

Lemma 2.4. *There is no PBE such that $\mathbf{m}^*(\bar{\theta}_B) = \mathbf{m}^*(\underline{\theta}_B) = (S, f^{\underline{\theta}_T}(\boldsymbol{\mu}^*))$.*

Proof. Consider an equilibrium in which both types of bidder pool on a stock offer (S, f^*) . By Bayes' rule, $\boldsymbol{\mu}^*(\bar{\theta}_T | (S, f^*)) = p^T \in (0, 1)$: since the equilibrium message has no informative content, the target does not update its beliefs upon its reception. It follows that, whatever the pool of targets to which the equilibrium stock offer is directed, this gives the high-type bidder a smaller payoff than the corresponding full-recognition stock offer. In particular, this excludes that such an equilibrium can consist of a low stock offer, since the latter would always turn out to be worse than the low cash offer for the type- $\bar{\theta}_B$ bidder. \square

We now characterize PBEs with pooling on the high stock offer.

Proof of Proposition (3). Consider an equilibrium with $\mathbf{m}^*(\bar{\theta}_B) = \mathbf{m}^*(\underline{\theta}_B) = (S, f^*)$. Because of Bayes' rule, $\boldsymbol{\mu}^*(\bar{\theta}_T | (S, f^*)) = p^T \in (0, 1)$ and the equilibrium payoff to the high-type bidder is less than the payoff from the full-recognition high stock offer. The latter is better than the best cash offer provided $p^B \geq \pi_S(\bar{\theta}_B)$, so that such an equilibrium cannot arise if $p^B < \pi_S(\bar{\theta}_B)$.

Suppose then $p^B \geq \pi_S(\bar{\theta}_B)$. Since this implies $p^B > \pi_S(\underline{\theta}_B)$, the low-type bidder prefers the high stock offer to any cash offer. We need to ensure that the low-type bidder does not prefer the low stock offer to the high stock offer. This could not be the case if this type of bidder were fully recognized but here we cannot exclude that, when receiving the low stock offer, the target gives positive probability to the bidder's type being $\bar{\theta}_B$. Then we need to ensure that

$$(1 - f^*)(\underline{\theta}_B + \mathbb{E}_{p^B} [w(\theta_T)]) \geq p^B \underline{\theta}_B + (1 - p^B)(1 - f^{\underline{\theta}_T}(\boldsymbol{\mu}^*))(\underline{\theta}_B + w(\underline{\theta}_T)) \quad (52)$$

It is easy to see that this equation imposes an upper bound on $\boldsymbol{\mu}^*$ over

$[0, f^*]$. As $\boldsymbol{\mu}^*$ is non-decreasing, this bound is ineffective if (52) is satisfied at $f^{\bar{\theta}_T}(\tilde{\mu})$ for a $\tilde{\mu}$ such that $\tilde{\mu}(\bar{\theta}_T | (S, f^{\bar{\theta}_T}(\tilde{\mu}))) = p^T$.

Consider the type- $\bar{\theta}_T$ bidder. Since $\boldsymbol{\mu}^*$ is non-decreasing, in case the latter proposed the low stock offer $(S, f^{\bar{\theta}_T}(\boldsymbol{\mu}^*))$, the target would associate to the bidder's type being $\bar{\theta}_T$ a probability less than p^T ; this makes the low stock offer less convenient than the low cash offer. Thus we need only compare the equilibrium payoff of $\bar{\theta}_B$ with the one from the best cash offer. Indeed, the high-type bidder might prefer the best cash offer to the high stock offer, given that it is not fully recognized. Type- $\bar{\theta}_B$'s payoff from the equilibrium message is

$$(1 - f^*)(\bar{\theta}_B + \mathbb{E}_{p^B}[w(\theta_T)]) \quad (53)$$

Such payoff is - as usual - linear in p^B and its slope is $(1 - f^*)W$. As $f^* \geq f^{\bar{\theta}_T}(\bar{\theta}_B)$, its slope is less than the one in the full-recognition case. By definition, the full-recognition payoff is larger than the payoff from the best cash offer at all $p^B \in [\pi_S(\bar{\theta}_B), 1)$. Then (S, f^*) will be preferred to the best cash offer on an interval $[p_{-}^B, p_{+}^B] \subset [\pi_S(\bar{\theta}_B), 1)$ provided, similarly to (49), that

$$\bar{\theta}_B - \bar{\theta}_T + \mathbb{E}_{\pi_C}[w(\theta_T)] \leq (1 - f^*)(\bar{\theta}_B + \mathbb{E}_{\pi_C}[w(\theta_T)]) \quad (54)$$

Using (30) for f^* and (19) for π_C , one obtains condition (31). Finally, as in the previous cases, we see that an out-of-equilibrium offer (S, f) with $f \in (f^{\bar{\theta}_T}(\underline{\theta}_B), f^{\bar{\theta}_T}(\underline{\theta}_B))$ can only come from a low-type bidder. Equilibrium Dominance thus restricts beliefs so that

$$\forall f < f^{\bar{\theta}_T}(\bar{\theta}_B) \quad , \quad \boldsymbol{\mu}^*(\bar{\theta}_B | (S, f)) = 0 \quad (55)$$

□

Finally, we show that if a separating equilibrium fails to exist at some $p^B \in (0, 1)$, then a PBE with pooling on stock exists at that p^B .

Proof of Corollary (1). Suppose that p^B is such that the game G does not

admit a separating equilibrium. It must be that the high-type bidder prefers the high stock offer to the best cash offer under full recognition as a low-type bidder. Because the participation share of equivalent (in terms of the pool of target to which they are directed) stock offer is decreasing in the probability assigned by the target to the bidder's type being $\bar{\theta}_B$, the high-type bidder prefers, at p^B , the high stock offer f^* to the best cash offer, provided $\mu^*(\bar{\theta}_B | (S, f^*)) = p^T$. Thus the pooling equilibrium is sustained. \square

Appendix 3. Measuring firm opacity

A potential concern for our analysis is related to the measurement of firm opacity. Our methodology replicates that of Bharath et al. (2009), who form an index on the basis of several measures of adverse selection risk from market microstructure to study the impact of a firm’s private information on capital structure decisions. This section first describes in detail the constituents of our index, how it is constructed, and its main properties. Then, it presents some robustness test to validate its use in our empirical analysis.

Our index constituents include (i) the illiquidity measure of Amihud (2002), (ii) the volume – return autocorrelation of Llorente et al. (2002), (iii) the probability of informed trading of Easley et al. (1996), (iv) the adverse selection component of the proportional effective spread of Roll (1984), (v) the reversal coefficient of Pastor and Stambaugh (2003), and (vi) the Amivest liquidity ratio of Cooper et al. (1985) and Amihud et al. (1997). We estimate these measures for all firms i with price and volume data available from the CRSP in any given year y from 1985 to 2014.

Amihud (2002) illiquidity measure is a market microstructure indicator that is interpreted as representative of the price impact, which is increasing in firm opacity. Price impact, in fact, is a measure designed by Kyle (1985) to capture the permanent component of price change due to trades that move a stock price toward its unobserved fundamental value. Price impact is then higher for firms whose informational gap is larger (i.e., opaque firms), since relatively more information is revealed from trades. Amihud’s illiquidity measure, $ILL_{i,y}$, is computed for all firms in our sample as the daily ratio of the absolute value of the stock return to its dollar volume, averaged over all observations in the year.³⁴

The return – volume coefficient of Llorente et al. (2002) exploits instead the link between volume-return dynamics and speculation. Following their

³⁴ Amihud (2002) shows that this measure is strongly positively related to intra-day estimates of price impact. As suggested by Amihud (2002), we rescale the values by multiplying by 10^6 and, as suggested by Hasbrouck (2009), use a square root transformation.

methodology, for each firm in our sample we estimate the relative importance of information in determining stock return dynamics as the coefficient $c_{2,i,y}$ in the time series regression:

$$r_{i,y,d} = c_{0,i,y} + c_{1,i,y}r_{i,y,d-1} + c_{2,i,y}T_{i,y,d-1}r_{i,y,d-1} + \epsilon_{i,y,d}$$

over all daily observations in a year, where r are daily returns and T is the logarithm of daily turnover (detrended with respect to its mean over the previous 100 observations). The higher the estimated coefficient, the more any stock price change is driven by information and then the more opaque the firm is.

The probability of informed trading of Easley et al. (1996) is an assessment of the likelihood of an informed order. It results from imbalances in the order flow: in principle, in fact, uninformed orders to buy and sell a firm stock occur randomly and therefore imbalances signal informed trading. Then, orders for opaque firms are more clustered and the probability of informed trading for opaque firms is higher. We obtain $PIN_{i,y}$ for firms with stock traded on the NYSE or AMEX between 1985 and 2001 from Easley, Hvidkjaer, and O'Hara (2010).

The adverse selection component of the proportional effective spread of Roll (1984) exploits return autocorrelation to quantify the informational nature of price dynamics. Uninformed trading is associated with the negative autocorrelation of returns, since a variation in stock price is not accompanied by a change in the market expectation of its fundamental value. On the contrary, informed trades determine the positive autocorrelation of returns as the market gradually updates its expectation of a stock's fundamental value. We then estimate the adverse selection component of the proportional effective spread of a firm's stock, filtering its realized returns with a measure of its time-varying expected return according to George, Kaul, and Nimalendran (1991). In particular, $RAD_{i,y}$ is computed as $1 - \pi_{1,i,y}^2$ from the regression:

$$FRS_{i,y,d} = \pi_{0,i,y} + \pi_{1,i,y}RS_{i,y,d} + \epsilon_{i,y,d}$$

over all daily observations in a year, where $RS_{i,y}$ is the proportional effective spread of Roll (1984) calculated on the basis of 60-day rolling autocovariances of returns as

$$RS_{i,y,d} = 200\sqrt{-cov(r_{i,y,d}, r_{i,y,d-1})} \quad \text{if} \quad cov(r_{i,y,d}, r_{i,y,d-1}) < 0$$

$$RS_{i,y,d} = 200\sqrt{cov(r_{i,y,d}, r_{i,y,d-1})} \quad \text{otherwise}$$

and $FRS_{i,y}$ is the filtered proportional effective spread, computed as $RS_{i,y}$ but on the basis of the autocovariances of the residuals from a regression of daily returns on their expected return series (estimated with a market model over observations of the previous year). More opaque firms are characterized by a larger fraction of the proportional effective spread due to adverse selection.

The reversal coefficient of Pastor and Stambaugh (2003) results from the interaction between a stock's return and its lagged order flow. In particular, the intuition is that the greater is the extent of a firm's private information, the lower its stock liquidity and the higher the estimated return reversal for a given dollar volume. Following their methodology, for each firm in our sample we estimate $GAM_{i,y}$ as the coefficient $\gamma_{i,y}$ of the one-period-lagged signed volume in the time series regression of daily excess returns:³⁵

$$r_{i,y,d}^e = \theta_{i,y} + \varphi_{i,y}r_{i,y,d-1} + \gamma_{i,y}V_{i,y,d-1} + \epsilon_{i,y,d}$$

over all daily observations in a year, where $V_{i,y}$ is daily dollar volume signed according to the contemporaneous excess return. The higher the estimated coefficient, the more opaque the firm.

Finally, the Amivest liquidity ratio of Cooper et al. (1985) and Amihud et al. (1997) is used to capture the fact that liquidity mitigates the price impact of large volumes. It is computed for all firms in our sample as the square root of the ratio of a firm's stock daily dollar volume to its absolute return,

³⁵ Excess returns are with respect to the value-weighted market return of all firms on CRSP in the corresponding period.

averaged over all daily observations in a year and preceded by a negative sign. The higher its value, the higher the opacity of the firm.

Table 7 presents summary statistics for all our index constituents and Spearman’s rank correlations among their standardized values for all firms with data available on CRSP in the period between 1985 and 2014. Our estimates are similar to those of Bharath et al. (2009) in a partially overlapping subsample.

(Insert Table 7 about here)

Although all the proposed measures are linked to firm opacity, information is not their only driver. We then isolate the common informational element by estimating the first principal component of the correlation matrix of our standardized index constituents in each year. On average, 40% of cross-sectional variance is accounted for by the first principal component and in most years only the first eigenvalue is larger than one. Moreover, the elements of the first eigenvector are mostly positive and their magnitude is stable over time, confirming that each constituent adds positively to the index.

We form the index of firm opacity by combining standardized index constituents according to the corresponding contemporaneous loadings on the first principal component. According to our index, the opacity of firm i in year y is computed on the basis of our six index constituents x , standardized across all firms in the given year, as

$$Index_{i,y} = \sum_{j=1}^6 w_{j,y} \bar{x}_{i,y} \quad \text{where} \quad w_{j,y} = PC(\bar{x}_{i,y})$$

Higher values of the index are associated with higher opacity for the specific firm in the given year. In each year, as well as overall, the mean index value is zero by construction, the median is slightly negative, and the standard deviation is 1.42.

The literature has linked firm opacity to several firm characteristics. In Ta-

ble 8 we investigate, for all firms with data available on Compustat, the distribution of these information-related characteristics across different classes of opacity formed on the basis of our index. These variables include firm size, capital expenditures, R&D expenses, cash holdings and leverage.

(Insert Table 8 about here)

Not surprisingly, more opaque firms are, on average, smaller, in terms of both total assets and sales. Size follows a steadily decreasing trend as opacity increases. We then observe fewer capital expenditures (Capex) as opacity grows. Interestingly, we find that more opaque firms report, on average, higher levels of R&D expenses (R&D). This evidence is consistent with more innovative firms being inevitably more opaque due to the uncertainty in their future prospects. All these trends support our claim that our index of firm opacity captures the informational dimension at the core of our analysis. Finally we observe that the most opaque firms are on average more leveraged and hoard more cash, consistent with the pecking-order theory of financing.

Appendix 4. Tables and figures

Table 1: Simulations.

<i>Variable 1</i>	<i>Variable 2</i>	<i>Simulated Correlation</i>
Target opacity	Probability of stock offer	0.3021
Bidder opacity	Probability of stock offer	-0.1803
Target opacity	Avg. bid premium	0.1285
Target opacity	Avg. bid premium (stock offers)	0.1239
Bidder opacity	Avg. bid premium	0.0342
Bidder opacity	Avg. bid premium (stock offers)	-0.0415

Table 2: Variables Definition.

This table summarizes the variables used in our empirical analysis, with a brief description and their sources.

<i>Variable</i>	<i>Definition</i>	<i>Source</i>
Panel a. Dependent variables.		
MP	Method of payment: a dummy variable equal to 1 for stock offers and 0 otherwise.	SDC Thomson
PRM	Premium: the percentage amount by which the offering price exceeds target's stock price four weeks before the announcement.	SDC Thomson
Panel b. Firm opacity.		
Bidder Opacity		CRSP
Target Opacity	Index: measured on the basis of the common cross-sectional variation of (i) the illiquidity measure of Amihud (2002), (ii) the volume – return autocorrelation of Llorente et al. (2002), (iii) the probability of informed trading of Easley et al. (1996), (iv) the adverse selection component of the proportional effective spread of Roll (1984), (v) the reversal coefficient of Pastor and Stambaugh (2003), and (vi) the Amivest liquidity ratio of Cooper et al. (1985) and Amihud et al. (1997). The index is formed annually on the basis of the first principal component of the standardized values of these measures (with respect to all firms in CRSP). ³⁶	
Panel c. Controls: deal characteristics.		
Deal Value	Total value of consideration paid by the acquiror, excluding fees and expenses.	SDC Thomson

³⁶ We also compute the index of opacity under alternative standardizations of its components, at the industry level (according to the Fama and French 48-industry classification) or with respect to size. The results of the empirical analysis employing these alternative measures are available upon request.

Deal Materiality	The ratio between the undisturbed market capitalization of the target over the sum of the undisturbed market capitalizations of the bidder and the target 63 days preceding the bid.	CRSP
Run-up	The cumulative return of the target's stock price in the window [-62,-1] with respect to the announcement date.	CRSP and SDC Thomson
Synergies	The market capitalization-weighted average of the bidder's and target's cumulative abnormal returns in the window [-62, 126], as in Bradley, Desai, and Kim (1988)	CRSP and SDC Thomson
Tender Offer	A dummy variable that equals 1 if the bid is reported as a tender offer, 0 otherwise.	SDC Thomson
Diversifying	A dummy variable that equals 1 if the deal involves the bidder and target operating in different two-digit SIC codes, 0 otherwise.	SDC Thomson
Friendly	A dummy variable that equals 1 if the deal is classified as friendly, 0 otherwise.	SDC Thomson
Toehold	A dummy variable that equals 1 if the bidder owns an interest in excess of 5% (threshold for which a bidder has to file a Schedule 13D with the SEC) in the target pre-bid.	SDC Thomson
Hostile	A dummy variable that equals 1 if the deal is classified as hostile, 0 otherwise.	SDC Thomson
Poison Pill	A dummy variable that equals 1 if the target has a poison pill, 0 otherwise.	SDC Thomson
Rumored	A dummy variable that equals 1 if the bid is anticipated by some leakage of information before the announcement according to SDC Thomson One Banker, 0 otherwise.	SDC Thomson
Rivaled	A dummy variable that equals 1 if the bid is challenged by a rival bid, 0 otherwise.	SDC Thomson
Terminated	A dummy variable that equals 1 if the deal has been terminated by the target, 0 otherwise	SDC Thomson
Withdrawn	A dummy variable that equals 1 if the deal has been withdrawn by the bidder, 0 otherwise	SDC Thomson

Panel d. Controls: bidder and target firm characteristics.

Size	The logarithmic transformation of the total assets of the bidder or the target.	Compustat
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Leverage	The bidder's short and long term debt over total assets.	Compustat
Cash Holdings	The bidder's cash holdings over total assets.	Compustat
Cash Flows	The bidder's operating cash flows over total assets.	Compustat
Market-to-Book	The market capitalization over book value of equity of the bidder and the target.	Compustat
Invest. Opp.	Investment opportunities: bidder's capital expenditures and R&D expenses over total assets.	Compustat

Panel e. Controls: institutional and macro environment.

Capital Gain	A dummy variable to identify bids announced from 1989 to 1996, a period of good market performance and a high (28%) tax rate on capital gains.	
Wave	A dummy variable that equals 1 if the deal occurs in a period of exceptional concentration of merger activity, as for Harford (2005), in the industry of either the bidder, the target, or both, and 0 otherwise.	SDC Thomson
Uncertainty	The VIX index.	CBOE
Sentiment	Robert Shiller's cyclically adjusted P/E index.	Prof. R. Shiller
Liquidity	The spread between the average interest rate on Commercial and Industrial Loans and the Fed Funds Rate.	FRED
Credit Spread	The yield spread between 20-year Baa and Aaa corporate bonds	FRED
Term Spread	The yield spread between the 10-year government bond and the 3-month T-Bill	FRED

Table 3: Descriptive Statistics: bid characteristics.

This table reports summary statistics for the bids included in the sample. Means and standard deviations are computed across the entire sample and conditional on the method of payment. In the last column, the result of a parametric t-test of the equivalence of means across methods of payment is presented. Table 2 describes the variables and their sources. The superscripts *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

	All Bids	Cash	Stock	Cash-Stock
	Mean	Mean	Mean	Diff.
	St.Dev.	St.Dev.	St.Dev.	(t-stat)
Deal Value (\$ mil.)	1,589	1,080	1,998	-918***
	6,304	2,110	8,225	(-4.26)
Deal Materiality (%)	18.9	15.8	21.9	-6.1***
	20.1	19.5	20.3	(-6.70)
Premium (%)	43.6	49.1	39.2	9.9***
	38.7	38.4	38.4	(6.44)
Run-up (%)	15.8	17.1	14.7	2.4*
	35.4	33.0	37.3	(1.75)
Synergies (%)	4.4	6.9	2.7	3.6
	57.1	37.8	70.2	(1.46)
Tender Offer (%)	19.6	44.3	1.2	44.1***
	39.7	49.8	10.9	(31.51)
Hostile (%)	4.9	9.5	1.6	7.8***
	21.6	29.3	12.7	(9.09)
Friendly (%)	91.8	85.0	96.6	-11.6***
	27.5	35.7	18.1	(-10.80)
Diversifying (%)	35.3	44.0	29.1	14.9***
	47.8	49.7	45.4	(8.59)
Toehold (%)	4.1	7.3	1.6	5.4***
	19.8	26.0	13.5	(6.89)
Poison Pill (%)	2.1	4.5	0.3	4.2***

	14.2	20.8	5.7	(7.10)
Rumored (%)	3.9	4.4	3.6	0.8
	19.5	20.6	18.6	(1.16)
Rivaled (%)	8.7	14.8	4.4	10.5***
	28.2	35.5	20.4	(9.57)
Withdrawn (%)	15.8	17.1	14.9	2.2*
	36.5	37.7	35.6	(1.66)
Wave (%)	30.3	20.0	31.2	-2.1
	40.0	45.4	46.3	(-1.29)
Number of observations	3,141	1,309	1,832	-
% of observations	100	41.7	58.3	-

Table 4: Descriptive Statistics: bidder and target characteristics.

This table reports summary statistics for the bids included in the sample. Means and standard deviations are computed across the entire sample and conditional on the method of payment. In the last column, the result of a parametric t-test of the equivalence of means across methods of payment is presented. Table 2 describes the variables and their sources. The superscripts *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

	All Bids	Cash	Stock	Cash-Stock
	Mean	Mean	Mean	Diff.
	St.Dev.	St.Dev.	St.Dev.	(t-stat)
Target Market Cap. (\$ mil.)	1,112	689	1,455	-766***
	4,259	1,387	5,571	(-5.02)
Target Market-to-Book	3.44	2.85	4.13	-1.28***
	10.05	10.59	9.34	(-2.81)
Bidder Market Cap. (\$ mil.)	15,893	21,437	10,882	10,591***
	42,588	45,879	38,741	(5.76)
Bidder Market-to-Book	4.03	3.71	4.39	-0.68
	17.97	21.12	13.72	(-0.80)
Bidder Investment Opportunities	0.09	0.08	0.10	-0.02***
	0.11	0.08	0.13	(-3.41)
Bidder Leverage	0.22	0.23	0.20	0.03***
	0.19	0.20	0.19	(2.72)
Bidder Cash Holdings	0.10	0.10	0.11	-0.01**
	0.13	0.11	0.15	(-2.40)
Bidder Cash Flows	0.10	0.13	0.07	0.06***
	0.37	0.43	0.29	(3.79)

Table 5: Descriptive Statistics: bidder and target opacity.

This table reports summary statistics for the index of opacity for the targets and bidders included in our sample. The index is computed as in Bharath et al. (2009). Table 2 describes the variables and their sources.

	Obs.	Mean	St. Dev.	$p - 25^{th}$	Median	$p - 75^{th}$
Targets	2,242	-0.48	0.83	-0.86	-0.49	-0.12
Bidders	2,046	-1.41	1.02	-2.09	-1.27	-0.71
All	4,189	-0.86	1.01	-1.34	-0.72	-0.29

Table 6: Model Estimation.

This table reports the coefficients and t-statistics (in parentheses) for the simultaneous estimation by means of Keshk (2003)'s two-stage probit least squares of our system of equations (38) modeling the method of payment (first column) and the bid premium (second column). Only the estimates of the second stage regressions are reported, first stage regressions are available upon request. In the first equation, the dependent variable, MP, is a dummy variable equal to 1 for stock bids, and 0 otherwise. In the second equation, the dependent variable is the percentage amount by which the offering price exceeds target's stock price four weeks before the announcement. The set of controls for bid characteristics includes: deal materiality, the target's stock price run-up, a dummy variable to identify tender offers, a dummy variable to identify hostile bids and a dummy variable to identify bids involving firms operating in different industries and a dummy variable to identify bids occurring during a merger wave, defined as in Harford (2005). At the firm level, Fama-French 12-industry dummy variables are used to control for bidder characteristics. Macro variables include Shillers P/E index, and the C&I Loan spread. The target stock price run-up is used to instrument for the bid premium and is thus excluded from the controls in the first regression, while the dummy variable to identify tender offers is used to instrument for the method of payment and thus is excluded from the second regression. A description of the variables used in the analysis and the relevant sources is provided in Table 2. The individual effects of control variables are omitted from the table for the sake of space and are available upon request. The superscripts *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

	(I)		(II)		(III)	
	MP	PRM	MP	PRM	MP	PRM
Target Opacity	0.0209 (0.33)	0.0462*** (3.29)	0.0631 (0.82)	0.0462*** (3.29)	-0.1490* (-1.82)	0.0483*** (3.40)
x Materiality	-	-	0.6099** (2.04)	-	0.7798** (2.39)	-
Bidder Opacity	-0.0552 (-0.99)	-0.0212* (-1.73)	-0.0792 (-1.40)	-0.0212* (-1.73)	-0.0913 (-1.54)	-0.0213* (-1.72)
Controls: Bid	Yes	Yes	Yes	Yes	Yes	Yes
Controls: Firm	No	No	No	No	Yes	Yes
Controls: Macro	Yes	Yes	Yes	Yes	Yes	Yes
Nobs	1646	1646	1646	1646	1646	1646

Table 7: Descriptive statistics of index constituents.

This table reports summary statistics for the constituents of our index of firm opacity. ILL is Amihud (2002) illiquidity measure, C2 is the volume-return autocorrelation of Llorente et al. (2002), PIN is the probability of informed trading of Easley et al. (1996), RAD is the adverse selection component of the proportional effective spread of Roll (1984), GAM is the reversal coefficient of Pastor and Stambaugh (2003), and LR is the Amivest liquidity ratio of Cooper et al. (1985) and Amihud et al. (1997). Panel a. presents cross-sectional statistics over the sample period 1985-2014. Panel b. reports the Spearman's rank correlations among the standardized values of the index constituents. The superscript ^a denotes statistical significance at the 1% level.

Panel a.	Obs.	Mean	Median	St. Dev.
ILL	146,882	1.01	0.37	1.68
C2	118,084	0.02	0.02	0.23
PIN	31,103	0.21	0.20	0.08
RAD	146,932	0.37	0.45	0.53
GAM	146,882	0.85	0.04	4.19
LR	146,853	-11.53	-3.09	23.09

Panel b.	ILL	C2	PIN	RAD	GAM	LR
ILL	1					
C2	0.0723 ^a	1				
PIN	0.6955 ^a	0.0111	1			
RAD	-0.2431 ^a	-0.0277 ^a	-0.1548 ^a	1		
GAM	0.8227 ^a	0.0565 ^a	0.5457 ^a	-0.1716 ^a	1	
LR	0.9908 ^a	0.0875 ^a	0.6848 ^a	-0.2419 ^a	0.8247 ^a	1

Table 8: Firm characteristics across levels of firm opacity.

This table reports means for alternative firm characteristics across levels of opacity. Each firm is classified each year on the basis of its index of opacity. Assets and Sales are in millions of dollars and adjusted for inflation; Capex and R&D are, respectively, capital expenditures and R&D expenses, both over total assets; Cash and Lev are, respectively cash holdings and financial debt, both over total assets. Capex, R&D, Cash and Lev are expressed in % terms. Only firms with fiscal year ending in December are considered.

Opacity	Assets	Sales	Capex	R&D	Cash	Lev
Lowest	17,039.28	6,316.26	6.51	5.81	8.88	23.20
2	1,587.28	803.19	6.39	9.43	12.35	21.16
3	676.81	352.27	6.23	11.71	13.00	22.24
4	542.59	175.64	6.01	13.41	12.26	23.04
Highest	164.40	73.75	4.93	12.43	10.74	27.08

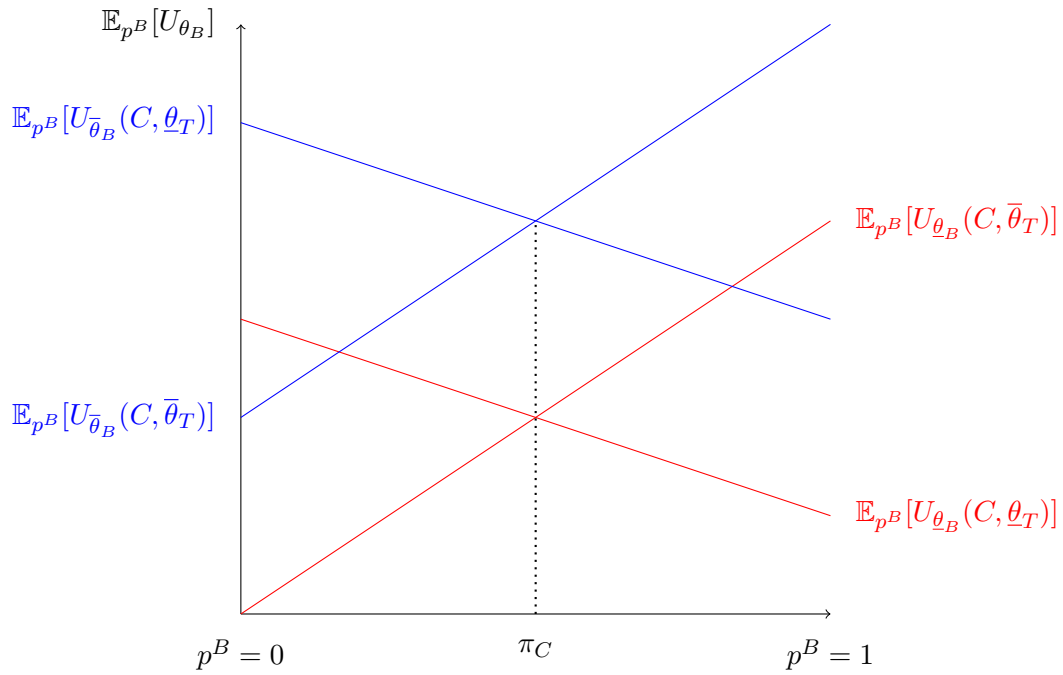


Fig. 1. Expected payoffs from cash offers. Blue lines refer to the type- $\bar{\theta}_B$ bidder, red lines to the type- $\underline{\theta}_B$ bidder. Because the target's decision does not depend on the bidder's value, the bidder's payoff depend only directly on its own type (i.e. through the bidder's assets' contribution to the value of the merged firm). Consequently, type- $\bar{\theta}_B$'s payoffs are vertical translation of type- $\underline{\theta}_B$'s, whence the unique cash offer threshold π_C .

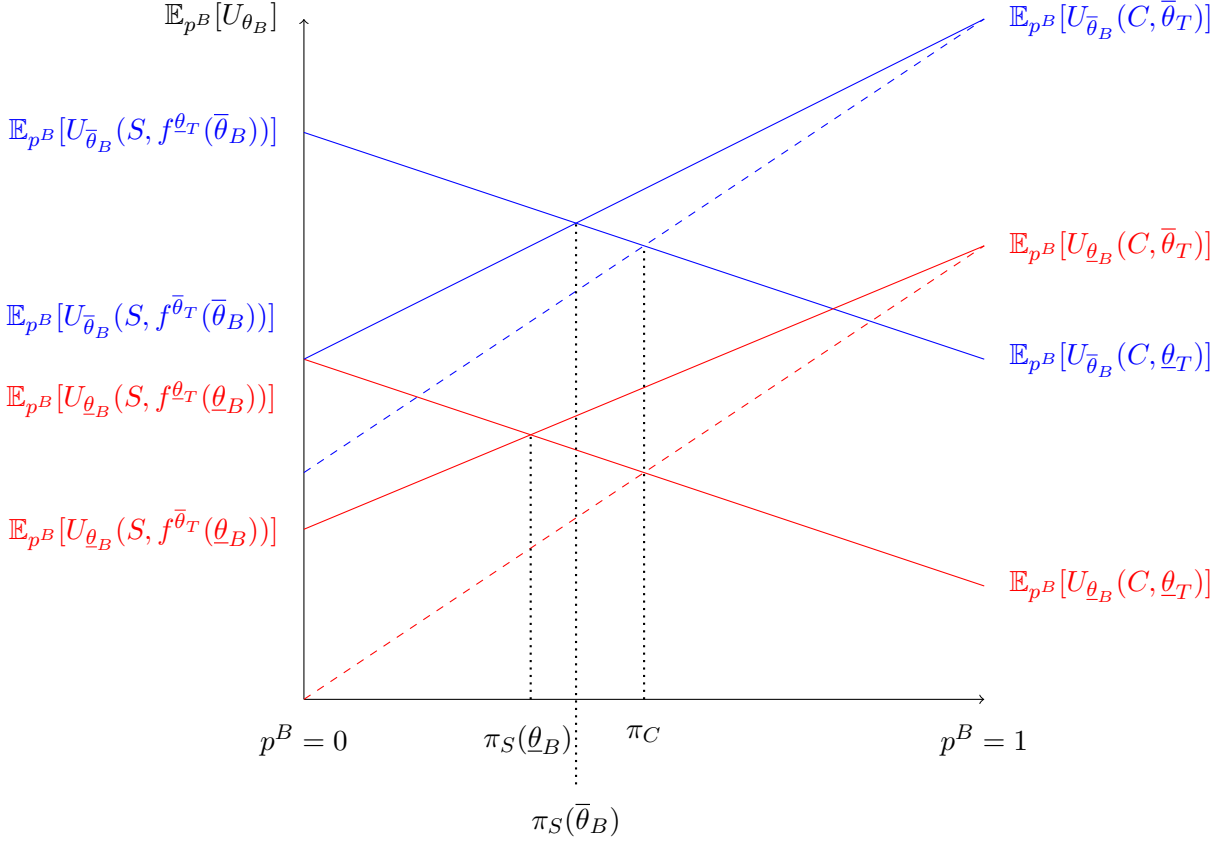


Fig. 2. Expected payoffs from stock offers when both types of bidder are fully recognized. Blue lines refer to the type- $\bar{\theta}_B$ bidder, red lines to the type- $\underline{\theta}_B$ bidder. Dashed lines refer to the payoff accruing to each type of Bidder after a cash offer: only those from a high cash offer are visible in the diagram, as the low cash offer yields the same payoff as the low stock offer. As the payoff from stock offers is influenced by the bidder's value through the target's response as well, there are two distinct thresholds separating the regions where each stock offer is preferred to the other, one for the type- $\bar{\theta}_B$ bidder ($\pi_S(\bar{\theta}_B)$) and one for the type- $\underline{\theta}_B$ bidder ($\pi_S(\underline{\theta}_B)$).

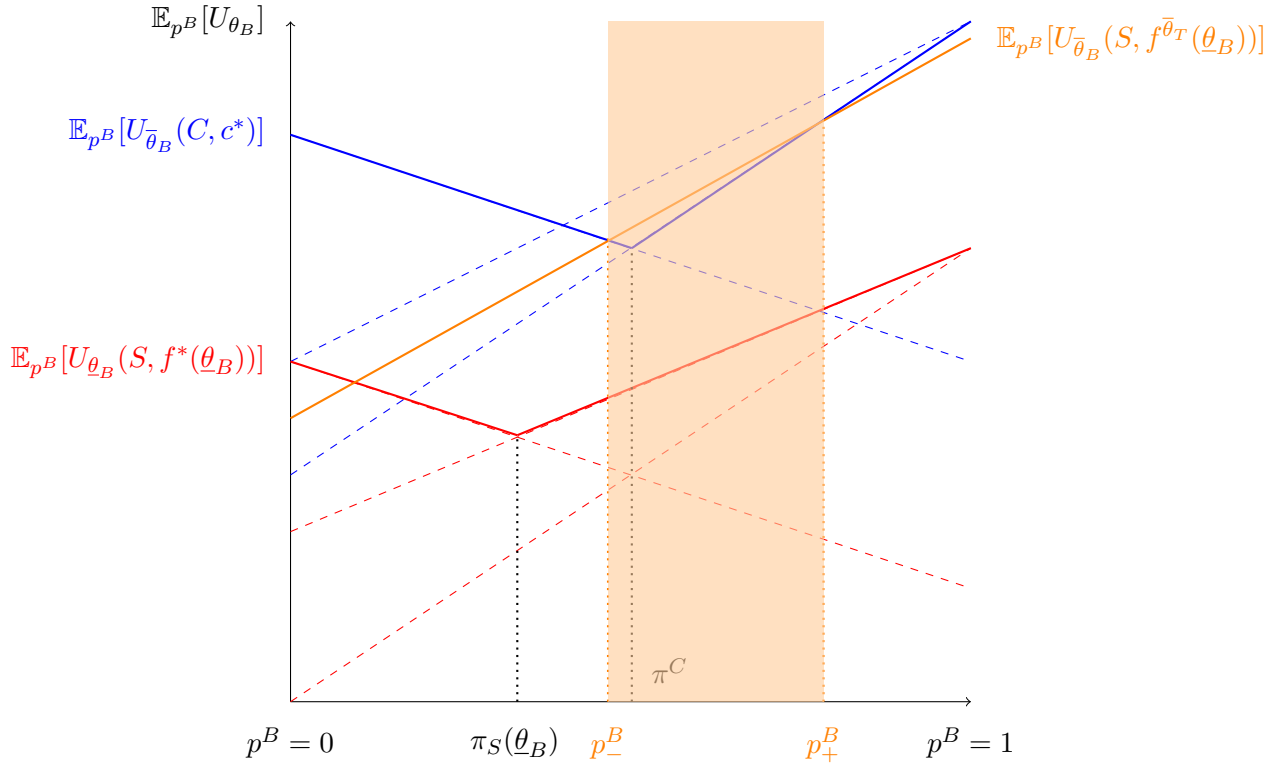


Fig. 3. Separating equilibrium. Equilibrium payoffs for the high- and low-type bidder are represented by the solid blue and red lines, respectively. The shaded region highlights the interval where such separating equilibrium fails to exist, because the high-type bidder prefers to offer the low-type's high stock offer and be recognized as a low type (the payoff from this option is represented by the solid orange line), rather than proposing its best cash offer.

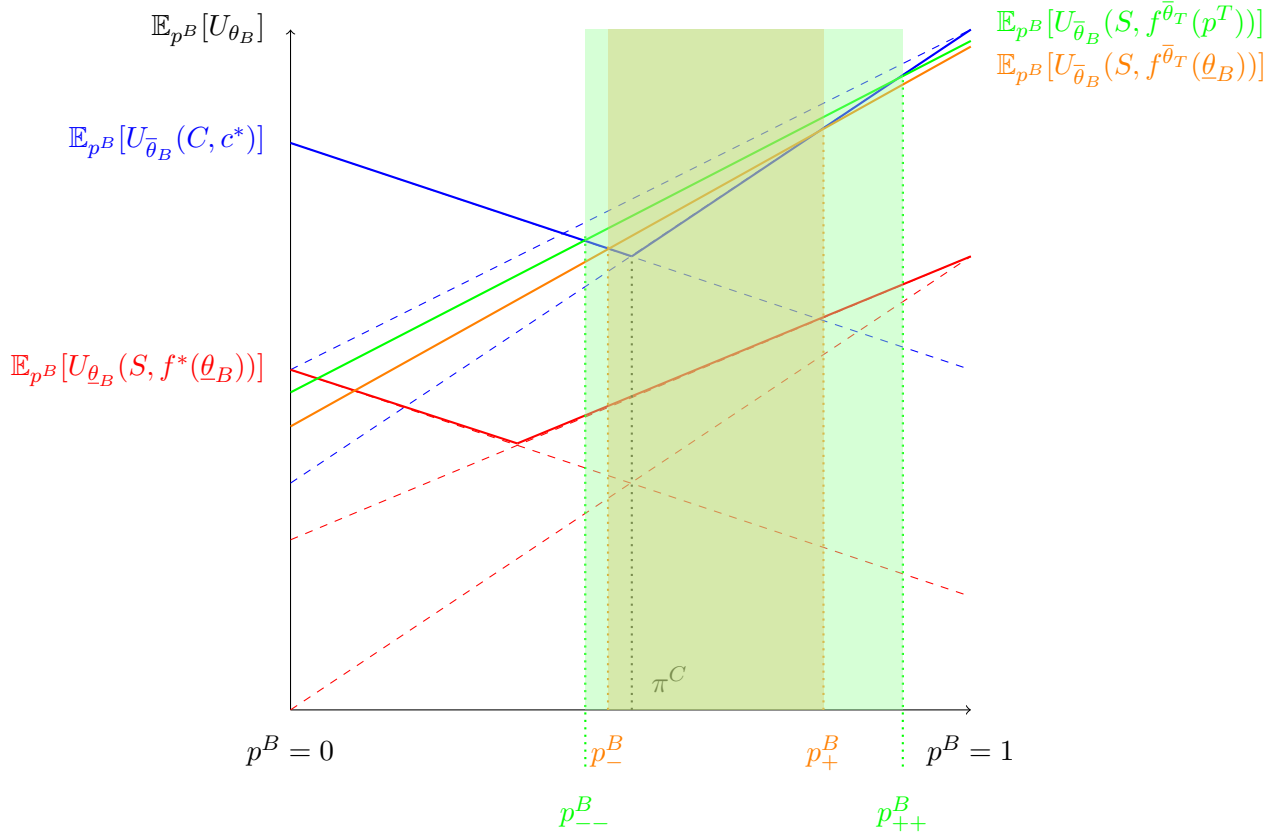


Fig. 4. Stock pooling equilibrium. The solid blue, red and orange lines are as in Figure 3. The solid green line represents the payoff a high-type bidder obtains from proposing the equilibrium offer. The green shaded region represents the interval where the stock pooling equilibrium is sustained. Notice that this interval always includes the one where the separating equilibrium fails to exist.

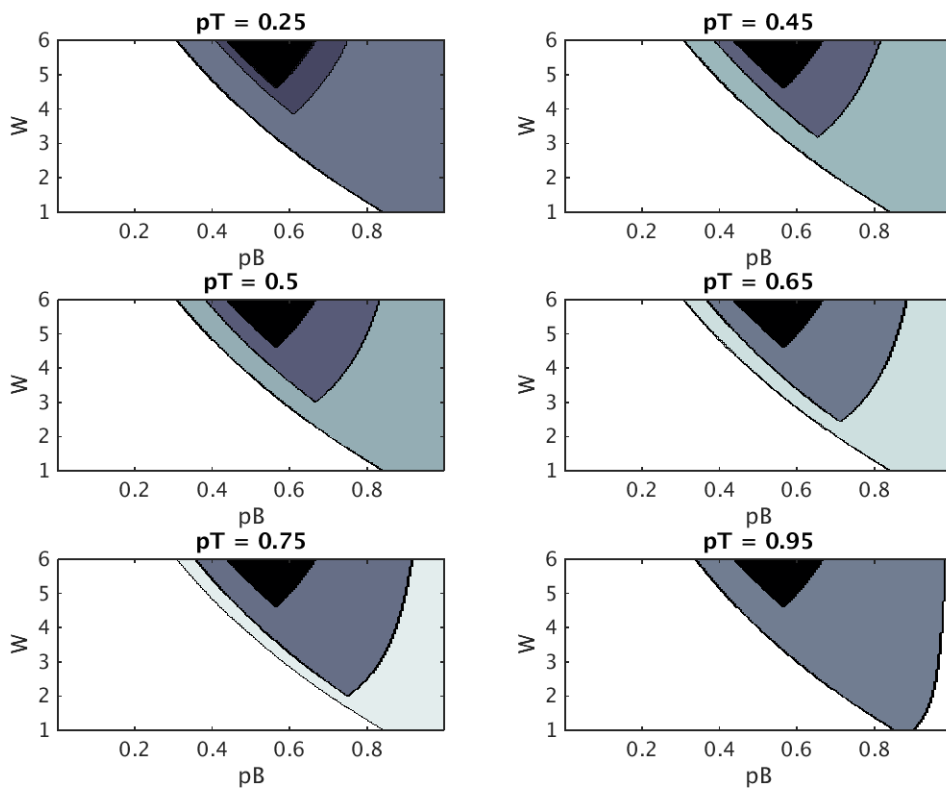


Fig. 5. Probability of observing a stock offer in the (p^B, W) plane, for various values of p^T (darker colors denote larger values).

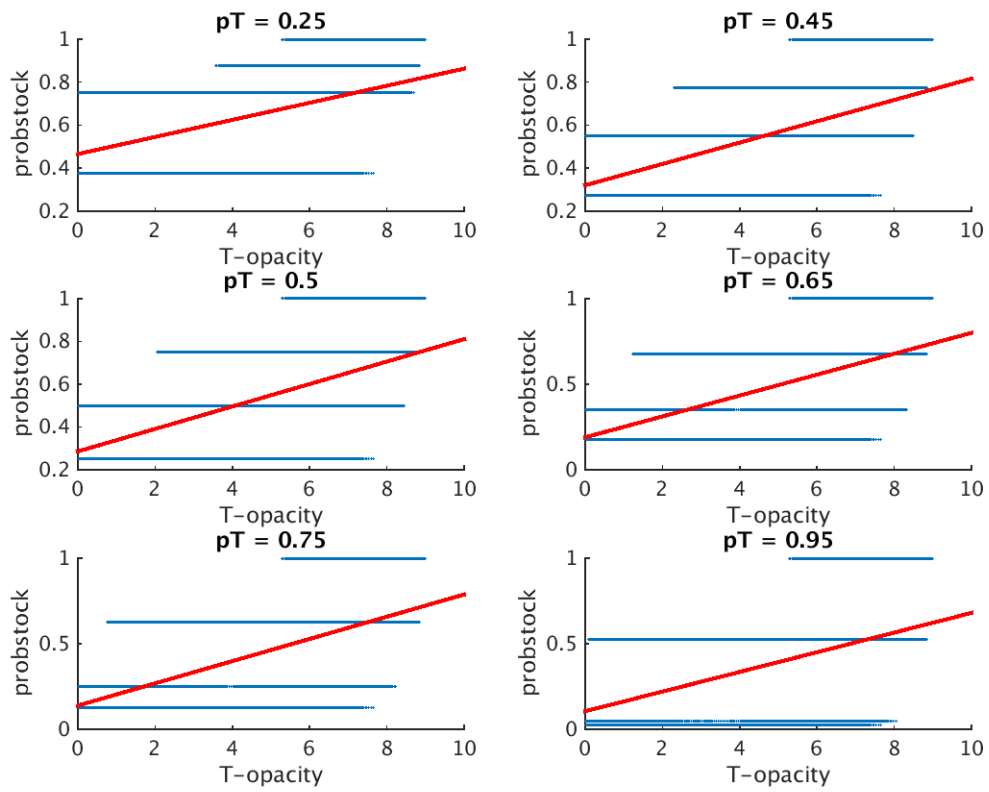


Fig. 6. Correlation between the probability of observing a stock offer and target opacity, for various values of p^T . The least-squares fitting line is drawn in red.

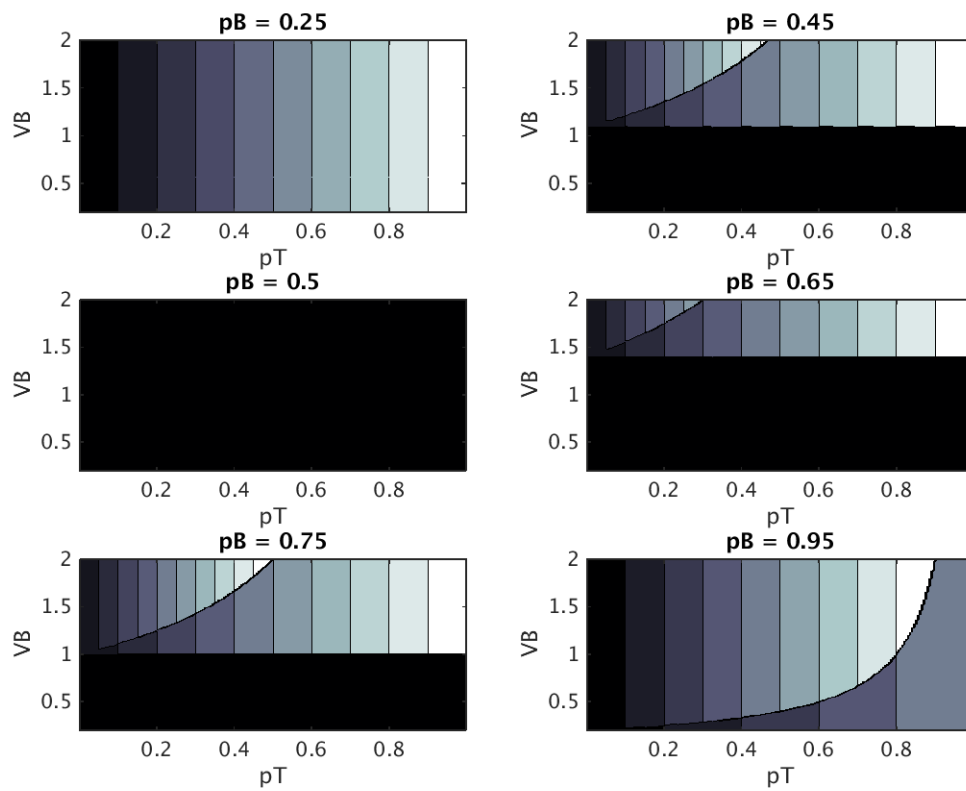


Fig. 7. Probability of observing a stock offer in the (p^T, V_B) plane, for various values of p^T (darker colors denote larger values).

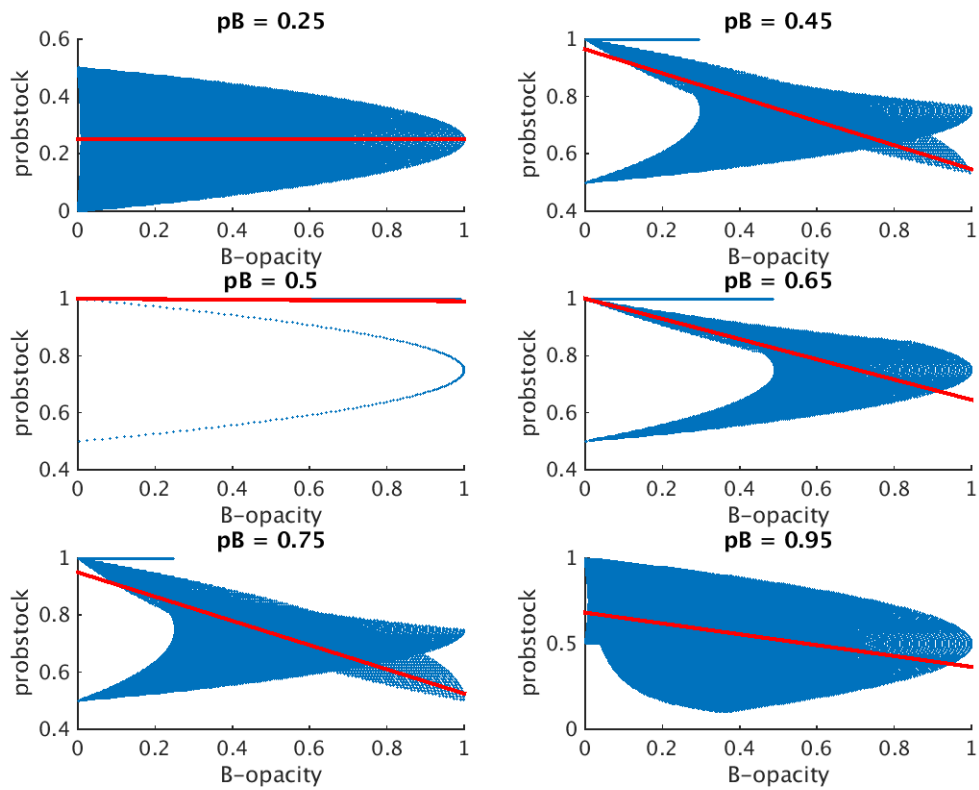


Fig. 8. Correlation between the probability of observing a stock offer and bidder opacity, for various values of p^B . The least-squares fitting line is drawn in red.

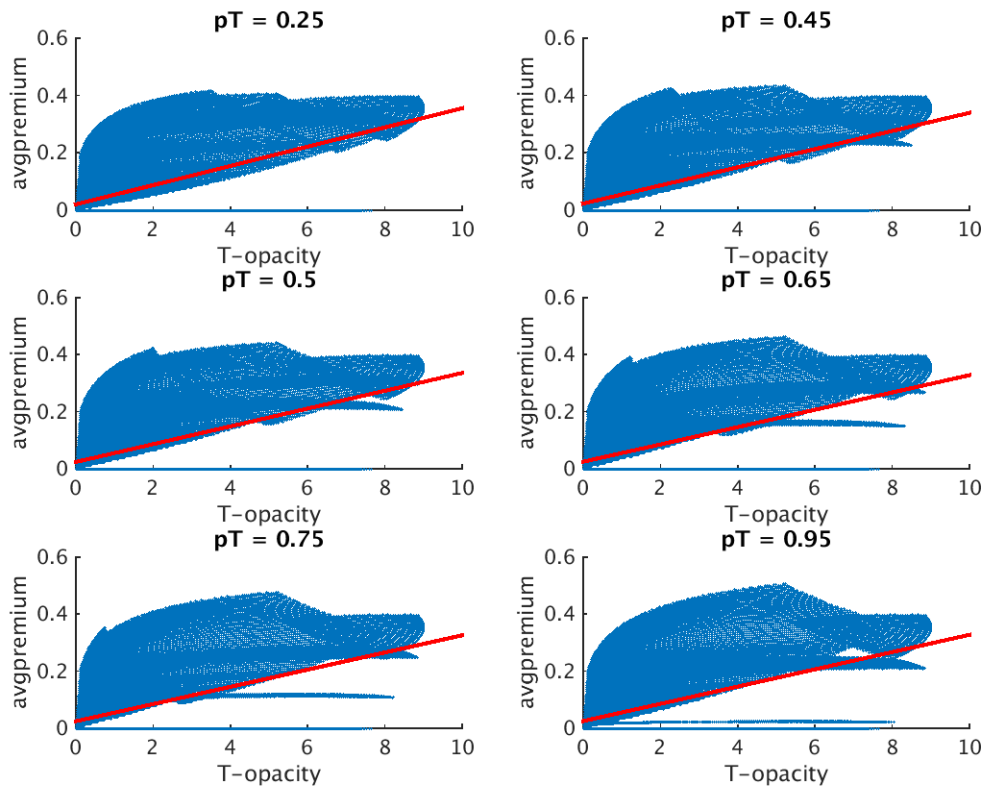


Fig. 9. Correlation between the average bid premium and target opacity, for various values of p^T . The least-squares fitting line is drawn in red.

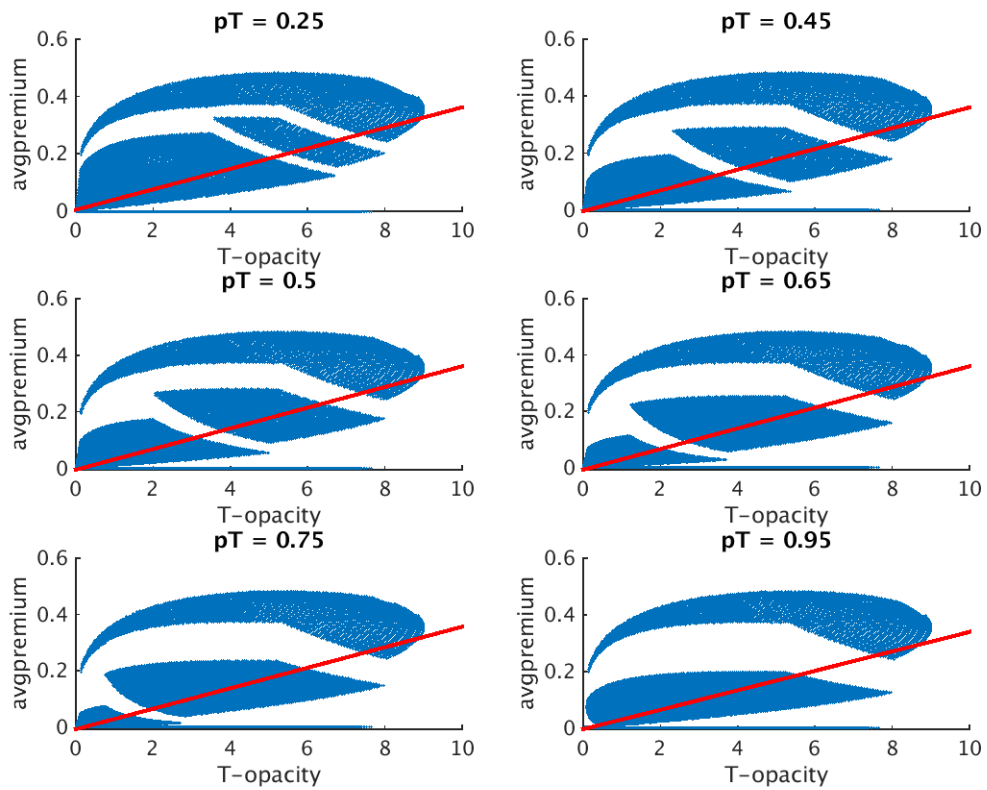


Fig. 10. Correlation between the average bid premium in stock offers and target opacity, for various values of p^T . The least-squares fitting line is drawn in red.

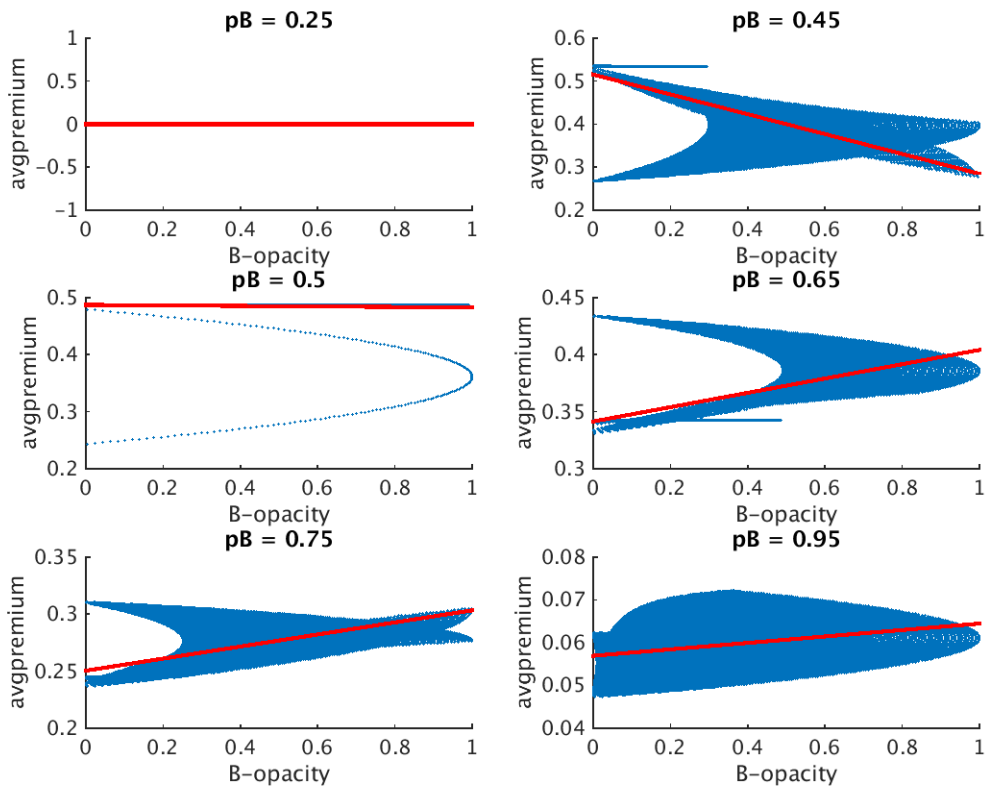


Fig. 11. Correlation between the average bid premium and bidder opacity, for various values of p^B . The least-squares fitting line is drawn in red.

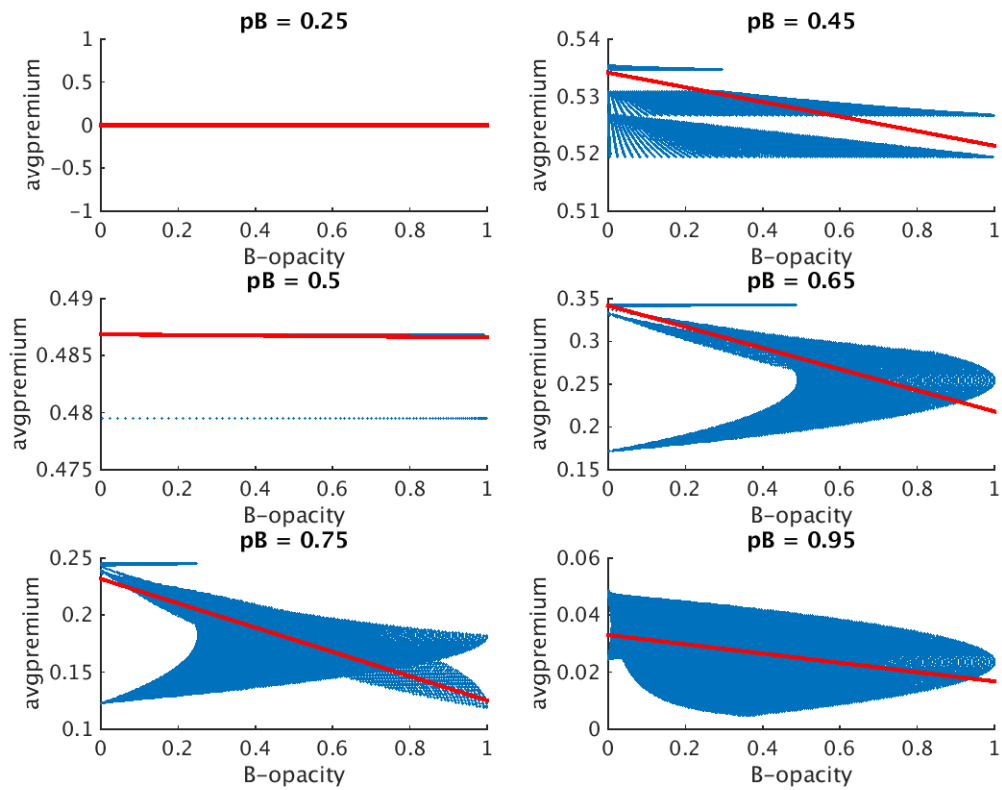


Fig. 12. Correlation between the average bid premium in stock offers and bidder opacity, for various values of p^B . The least-squares fitting line is drawn in red.