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Financing bidders in takeover contests ☆

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ABSTRACT

This paper argues that endogenizing how acquirers finance their cash bids is just as important for understanding bidding in takeovers as endogenizing acquirers' payment method choice. The paper shows that acquirers finance their cash bids with equity only if they lack access to competitive financing. This leads to underbidding and lower takeover premiums. Conversely, acquirers with access to competitive financing use debt and overbid. Endogenizing the payment method reveals that security (e.g., stock) bids carry lower premiums than cash bids, backed by competitive financing. These insights find empirical support and could help explain existing evidence, which contradicts prior theory.

1. Introduction

Takeovers are important events in firms' corporate histories, and the takeover premium is usually among the most contested and important issues for both acquirers and targets. Financial economists have analyzed this issue extensively, and what seems clear is that bidder financing and the payment method should be a first-order determinant of these premiums and of bidding in general (Betton, Eckbo, and Thorburn, 2008). However, established stylized facts seem to contradict some of the main insights from the prior theoretical literature. For example, this literature predicts that acquirers are more aggressive when bidding in equity (stock), less aggressive when bidding in debt, and least aggressive when bidding in cash (Hansen, 1985, DeMarzo, Kremer, and Skrzypacz, 2005). However, these predictions find no empirical support: Takeover premiums are higher when the method of payment is cash than equity (Betton, Eckbo, and Thorburn, 2008). There is also no empirical support when extending the predictions to how external financing affects bidding in cash: Premiums are higher when cash bids are financed with debt than with equity.[1]

This paper seeks to provide an explanation for this contradictory evidence by addressing several open questions in the context of acquirers choosing to bid in cash. One such question is how bidding in takeovers changes if acquirers are

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cash-constrained and the financing for their cash bids is determined endogenously. For example, how would different types of financing affect bidding, efficiency, and takeover premiums? Would the type of financing differ for acquirers that may not be able to raise financing in a competitive market, such as small, medium-sized, and private acquirers? And if acquirers could offer equity as an acquisition currency, to what extent would such a bid be an attractive alternative to making a cash bid financed externally?

This paper shows that bidders that pay in cash use equity financing only when they do not have access to competitive financing. In such cases, financiers seek to make a profit, and bidders pass on the higher financing cost by bidding less than they would have if not cash-constrained. Indeed, acquiring firms, especially if they are young or small, often do not have access to a competitive market, which affects not only the terms of their financing, but also its type. For example, in a recent bidding war against Twitter, UberMedia, a small private high-tech company, financed its losing bid for TweetDeck by approaching equity financiers. In contrast, in the multibillion-dollar bidding war between BHP Billiton and Xstrata for WMC Resources, the two mining giants used debt financing. For cases such as these, in which acquirers have access to competitive financing, the paper predicts that financing cash bids with debt is optimal but that it leads to overbidding. Thus, this paper has implications for why an acquirer, such as UberMedia, uses equity, while BHP Billiton uses debt financing, and how this affects takeover premiums and under- and overbidding. Analyzing in addition whether bidding would have been different had it been in equity rather than in cash, the paper shows that bidding in securities is more expensive for acquirers than financing cash bids externally, resulting in lower takeover prices.

The paper develops a model in which cash-constrained bidder-managers (henceforth “bidders”) secure external financing to bid for a firm in a cash auction. If a bidder wins the takeover contest, he repays the financier out of the eventually realized cash flows. The main frictions are that bidders are privately informed about the profitability of this firm under their management—i.e., their ability to generate synergies and cash flows and, hence, their “valuation” —and that they may or may not be able to raise financing at competitive terms. The model also discusses the acquirer's choice between bidding in cash or securities. Bringing the model's predictions to the data shows that they find preliminary empirical support.

The paper makes three contributions. First, it bridges the gap between the literature on bidding in securities (e.g., DeMarzo, Kremer, and Skrzypacz, 2005) and the standard corporate finance literature that analyzes financing investments under information asymmetry (e.g., Nachman and Noe, 1994). This results in an intuitive extension showing that, when bidding adapts to financing, debt financing minimizes bidders' incentives both to mislead financiers about their ability to generate cash flows (their types) and to distort their bids. The opposite insight holds for levered equity financing.[2] The limit of this intuitive extension, however, is that it says nothing about takeover prices. Indeed, since bidding adapts to financing, whether equity or debt financing results in higher takeover prices depends on the endogenously determined financing terms. In deciding these terms, one must take into account that expensive financing would depress bidding and, thus, the acquirer's probability of winning the takeover contest. Another complication in this setting is that contracts could specify different types of financing (e.g., debt, equity, etc.) for different cash payments and that contracts could feature cross-subsidization across takeover payments—i.e., a bidder could agree to expensive financing for some takeover payments in exchange for cheap financing for other payments.

The second contribution is to show that by analyzing the strategic interaction between bidders and financiers, one obtains a markedly different relation between financing contracts and takeover prices than could be expected from the literature on bidding in securities.[3]

A bidder who does not have access to competitive external financing—e.g., a small private firm such as UberMedia—will finance his cash bid with levered equity. In the presence of information asymmetry, a financier offering such financing can extract a higher repayment for any takeover bid. An important feature of this setting is that the financier makes a profit not only at the acquirer's, but also at the target's, expense. A strong financier sets a high financing cost, which induces the bidder to make a *lower* cash bid than when he is not cash-constrained (underbidding). This leads to a lower takeover price.[4]

This result is overturned in a competitive market for capital, in which bidders have more bargaining power than financiers. Payments are then financed with debt. An interesting insight is that financing contracts feature cross-subsidization across payments, and not, as is standard, across types (e.g., Nachman and Noe, 1994). That is, while financing for low payments will be expensive in order to prevent mimicking by bidders with lower valuations, this will be offset by cheaper financing for higher payments. This cheaper financing leads to *higher* cash bids than when bidders are not cash-constrained (overbidding).

To summarize, compared to when cash bids are internally financed, debt-financed cash bids are higher and there is overbidding. Conversely, equity-financed cash bids are lower and there is underbidding. This result is markedly different from its counterpart in the literature on bidding with securities, in which seller revenues are highest for levered equity, lower for debt, and lowest for cash bids.

The third contribution is to suggest why the predictions in the literature on bidding in securities find no empirical support even in studies testing the effect of the method of payment on takeover prices. The approach lies in endogenizing how

[2] Levered equity is the mirror image of debt. It is a claim on all cash flows above a threshold. Levered equity and debt are the most and least information sensitive securities, respectively.

[3] In the literature on bidding in securities, bidding in more-information-sensitive securities leads to higher prices. The intuition for this result follows that of Milgrom and Weber's (1982) Linkage Principle.

[4] To address the trade-off that such underbidding reduces the bidder's probability of winning and, thus, his own probability of making a profit, a strong financier will make financing disproportionately more expensive for low cash payments, which are more likely to remain affordable. A bidder with low valuation would, thus, be especially hurt from not being able to raise competitive financing.

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external financing interacts with the ability to bid not only in cash, but also in securities. The main insight is that the value a seller attributes to a security bid is at most as high as the cash bid the same bidder would have made if not cash-constrained. Thus, the takeover premiums for security bids, such as bids in equity, will appear lower than for debt-financed cash bids in the data. Intuitively, the seller will treat security bids in such a way that she does not miss out on potentially more valuable cash bids. Another implication of this treatment is that acquirers would bid in securities, such as equity, only if they cannot raise financing externally and bid in cash.

These results give rise to a rich set of empirical implications that the paper supports with some preliminary empirical evidence. One implication is that bidders' ease of access to the capital markets determines the relation between the choice of financing for cash bids and takeover premiums. Indeed, analyzing externally financed cash bids, the paper shows that takeover premiums are five to eight percent lower when cash bids are not financed with debt. This is 20% of the average takeover premium. Equally important is that the results can lead to a better understanding of acquirers' capital structure decisions. The predictions, which are also supported with empirical tests, are that smaller or start-up firms or firms in countries with less-developed capital markets will finance their cash bids in takeovers with equity.[5] Conversely, larger or more-established firms and firms in countries with more-competitive capital markets will use debt financing. Furthermore, the paper argues and supports empirically that abnormal announcement returns to bidders are lower when they finance their cash bids with equity. Other implications derived from the model concern why takeover premiums for equity bids are lower than for cash bids (Betton, Eckbo, and Thorburn, 2008) and why mostly small acquirers, likely to be financially constrained, make such bids (Eckbo, Makaew, and Thorburn, 2014). Furthermore, the paper discusses participation in takeovers and the lack of evidence for fire sales in bankruptcy auctions (Baird and Rasmussen, 2003; Hotchkiss and Mooradian, 1998).[6]

This paper is closely related to two strands in the literature. The first strand explicitly considers the strategic interaction of bidding and borrowing from an outside financier but does not discuss optimal contracts. The most notable contributions are Liu (2012), who discusses takeovers in which bidding can affect the subsequent pricing of equity sold to finance the bid; and Rhodes-Kropf and Viswanathan (2005), who analyze the existence of an efficient equilibrium in a competitive market when bidders are asymmetric.

The second closely related strand focuses on how bidding in securities affects bidding behavior in auctions (Skrzypacz, 2013). Hansen (1985) is the first to illustrate that bidding in securities, instead of in cash, can increase the seller's revenue, and Rhodes-Kropf and Viswanathan (2000) and DeMarzo, Kremer, and Skrzypacz (2005) have extended and generalized this idea. Also closely related is the contribution of Board (2007), in which bidders can default on their cash bids, making the cash bids equivalent to bidding in debt.

The present paper combines these two strands. The complication comes from the fact that, in practice, bidders choose from a much richer set of contracts, and different bidders can be financed differently—e.g., because they have different access to competitive financing. Deriving the optimal contract allows us to analyze how bidders pass on their cost of financing; how this affects under- and overbidding and takeover prices; how this interacts with bidding and the choice between bidding in cash or in securities; and how this explains takeover premiums, including why security bids do not lead to higher premiums. Thus, the paper addresses a number of open questions from both a theoretical and an empirical perspective.

The paper also relates to the sizeable literature on the method of payment in takeovers, which has investigated the choice between cash and equity in the context of taxes (e.g., Gilson, Scholes, and Wolfson, 1988); information asymmetry between bidders and the seller (e.g., Eckbo, Giammarino, and Heinkel, 1990); capital structure and corporate control motives (e.g., Faccio and Masulis, 2005); timing considerations (Gorbenko and Malenko, 2014b); and behavioral motives (e.g., Rhodes-Kropf and Viswanathan, 2004). The contribution to this literature is to suggest a more differentiated view on bidding in cash, as the way that cash bids are financed is just as important as the method of payment. Furthermore, by endogenizing the choice of the method of payment, this paper could help explain the contradictory evidence on how the seller, bidders, and financiers gain from takeovers.[7]

The paper proceeds as follows. Section 2 introduces the model. Section 3 describes how financing affects bidding. Section 4 endogenizes financing and describes its effect on takeover prices. Section 5 discusses the model's empirical implications and shows supportive empirical evidence, and Section 6 concludes. All proofs are contained in the Appendix.

2. Model

The model has three time periods. At $t=1$, $N \geq 2$ bidder-managers, "bidders," secure financing from an outside financier to participate in the takeover of a firm, which is sold off by a seller (she) fully as a going concern. For simplicity, it is assumed that the only asset of the target firm is a project that generates stochastic cash flows in the future. At $t=2$, an all-cash auction takes place. A bidder who must make a payment raises the money according to

[5] Some investors, such as banks, are restricted in the type of securities they can offer. If they can offer only debt, they will choose the most information-sensitive type.

[6] Anecdotal evidence of contested (externally financed) acquisitions of firms in bankruptcy is abundant: CenterSpan, a small start-up, bought Scour Inc. for $9 million with private equity financing. Illustrative is also that large deals, such as Sungard's $850 million cash bid for Comdisco and Columbia Sussex's $2.7 billion bid for Aztar, were, instead, financed with debt. There were more than three bidders in all these contests.

[7] This paper also relates to the optimal security design literature, such as Nachman and Noe (1994) and DeMarzo and Duffie (1999). One main difference from these papers is that financing affects bidding and, thus, how much capital needs to be raised. Another difference is the focus on a non-competitive market for capital. As a result, a bidder issues levered equity, and not debt, if he is locked in to a financier. This insight relates the paper to Inderst and Vladimirov (2015), who show that firms' choice of how to build up financial flexibility differs starkly depending on whether they expect to face financiers with a strong or weak bargaining position in new financing rounds.

the contract signed at $t=1$. Finally, at $t=3$, the firm's cash flows are realized, and the bidder repays his financier. All parties are risk-neutral and there is no discounting.

The firm generates stochastic cash flows X, which are verifiable at $t=3$. The distribution of X depends on the winning bidder's type $\theta \in \{\underline{\theta}, \ldots, \overline{\theta}\}$. One can think of θ as the bidder's ability to generate cash flows, which reflects the potential for synergies and his ability as a manager. Conditional on θ, the density of X, $g(x|\theta)$, has full support $[0, \infty)$. It is assumed that the conditional cumulative distribution functions satisfy the strict monotone likelihood ratio property (SMLRP)

$$\frac{g(x|\theta)}{g(x|\theta')} > \frac{g(x'|\theta)}{g(x'|\theta')} \quad \text{for } \theta > \theta', x > x', \tag{1}$$

where, for simplicity, the conditional density $g(x|\theta)$ is assumed to be continuously differentiable in x, and $G(\cdot)$ is the cumulative density function.

Each bidder privately learns his type θ at $t=1$ before the contract is signed. What is commonly known is that θ is independently drawn from the prior probability distribution $\pi = \{\pi_{\underline{\theta}}, \ldots, \pi_{\overline{\theta}}\}$, with $\pi_{\theta'}$ being the prior probability that the realization of the bidder's type is θ'. Bidders, furthermore, have liquid assets in place, w, which they use to co-finance their bids.[8] Finally, the analysis assumes that the financier observes the payment in the auction, but not the individual bids. The seller has no private information, and her outside option is zero. Section 4.5 discusses the robustness of the results when most of these assumptions are relaxed.

External financing: To secure financing for his bid, a bidder negotiates a security R. It may be conditioned on the cash flows X realized by the asset and the payment $y \in \mathbb{R}_+$ to the seller at $t=2$. The analysis considers both the case when bidders face a non-competitive and when they face a competitive market for capital, so that the resulting security design problem will be to maximize the financier's or the bidders' ex ante expected payoff, respectively. It is assumed that only bidders who make a payment to the seller raise money from the financier at $t=2$ and that there is no fine for not raising financing. By standard security design arguments, $R(x,\cdot)$ and $x - R(x,\cdot)$ are non-decreasing in x and $0 \le R(x,\cdot) \le x$ (e.g., Nachman and Noe, 1994; DeMarzo and Duffie, 1999).[9] It is straightforward to show that the expected payoff of a security that satisfies these "feasibility" conditions increases in the bidder's type.

Lemma 1. For any given contract $R(x,\cdot)$, the expected security payments $\int_X R(x,\cdot)\, dG(x|\theta)$ and $\int_X (x - R(x,\cdot))\, dG(x|\theta)$ increase in θ.

In what follows, the focus is on the second-price auction (SPA). This seems reasonable, as in the baseline setting the SPA is strategically equivalent to an ascending (English) auction in which bids are raised continuously until only one bidder remains.[10] This is a standard way of modeling takeover contests (e.g., Povel and Singh, 2010).

Furthermore, though the main text focuses on takeovers in which there are multiple bidders and their number is known, the results in what follows are more general. It is straightforward to extend the setting to one in which the number of potential competing acquirers is uncertain. Given that most takeovers involve multiple bidders even if only one eventually becomes public knowledge (Boone and Mulherin, 2007; Gorbenko and Malenko, 2014a), it also seems safe to assume that most acquirers do not exclude the possibility of potential competition when deciding how to bid. Furthermore, note that though the paper's focus is on takeovers, almost any auction for a valuable enough asset will feature budget-constrained bidders raising external financing backed by the asset being sold—e.g., spectrum auctions and privatizations.

3. Bidding with external financing

By defining how much a bidder must repay for any given cash payment in the takeover, the dependence of the financing contract R on y essentially captures its terms of financing. Before endogenizing how these contracts are optimally designed at the initial stage $t=1$, the analysis needs to address more generally how external financing affects bidding at $t=2$. In particular, for a given financing contract R, the acquirer's problem is to choose the bid $\beta_i(\theta_i)$ that maximizes his expected payoff

$$\max_b \mathrm{E}_{\theta_{-i}}\left[\left(\int_X [x - R(x, y(b, \beta_{-i}(\theta_{-i})))]\, dG(x|\theta_i) - w\right) P(b, \beta_{-i}(\theta_{-i}))\right], \tag{2}$$

where $\mathrm{E}_{\theta_{-i}}$ is the expectation about the types of the remaining $N-1$ bidders; y is the second-highest bid among the choice b and the bids $\beta_{-i}(\theta_{-i})$ of all other bidders; and P is the allocation rule stating that bidder θ_i wins the takeover (i.e., $P=1$) if he offers the highest bid and loses otherwise (i.e., $P=0$). If multiple bidders make the highest bid, P is determined by some tie-breaking rule. It is implicitly assumed that the bidder co-invests all his cash w (which is still insufficient to cover the takeover payment), but Section 4.4 shows that this is without loss of generality.

[8] The bulk of the related literature assumes that w is the same for all bidders (e.g., DeMarzo, Kremer, and Skrzypacz, 2005; Axelson, 2007; Board, 2007; Gorbenko and Malenko, 2011), but this is not very consequential for the results in this paper. If w is heterogeneous, the bidder with the highest valuation may not win the auction (e.g., Rhodes-Kropf and Viswanathan, 2005). However, auctions will be inefficient even if w is the same when different bidders have different financing contracts. See Section 4.5.

[9] The monotonicity assumptions make sure that no party prefers a lower cash flow state. The lower and upper bounds for R are limited liability assumptions for the bidder and the financier. Note that limited liability implies that debt and levered equity will be the most "extreme" shapes of security contracts (explained below). However, it does not change the qualitative nature of the results below—i.e., how bidders and financiers decide about financing contracts.

[10] With cash bids and private values, the second-highest bid in an SPA and the highest losing bid in an English auction are the same and summarize the same information. Thus, contracting is affected in the same way. However, the strategic equivalence may fail if the auction involves both cash and securities, as discussed in Section 4.3. The equivalence may also fail if bidders try to signal their valuations by making very high opening bids at the expense of possibly forgoing a lower takeover payment (Liu, 2012). Financial contracting would also matter in such an equilibrium, however, as it would affect the opening bids.

The standard way to derive the bidding strategy in a second-price auction is simple: The offer should be such that the sum of the acquirer's payments is equal to his valuation of the target if he ends up paying his own bid. Indeed, if the financing contract is such that bidder θ_i's expected repayment to the financier increases in the amount $y-w$ he raises, $\beta_i(\theta_i)$ solves

$$\int_X R(x, \beta_i(\theta_i))\, dG(x|\theta_i) + w = \int_X x\, dG(x|\theta_i). \tag{3}$$

The intuition is that increasing the probability of winning by offering a higher payment makes no sense, as the bidder would make a loss in the additional instances of winning. Offering less is also suboptimal, as it decreases the bidder's probability of winning in cases in which he could have still made a profit.

A similar intuition applies even if the payment to the financier is not continuously increasing in the amount raised by the bidder.[11] Specifically, suppose that for some contract R and type θ_i, the set of takeover payments y for which the bidder's overall payment is equal to, at most, his valuation is not connected—i.e.,

$$\int_X R(x, y)\, dG(x|\theta_i) + w \le \int_X x\, dG(x|\theta_i) \tag{4}$$

holds, for example, for $y \in [0, y']$ and $y \in [y'', y''']$ where $y' < y''$. Using the same arguments as above, one can argue that the bid that maximizes the bidder's payoff (2) is either y' or y'''. The choice between y' and y''' depends on the probability distribution of the second-highest bid and the probabilities of winning. More generally, if $B_i(\theta_i)$ contains the highest payments in each disconnected subset for which (4) is satisfied (in the example $B_i(\theta_i) = \{y', y'''\}$), then:

Lemma 2. (i) *In the equilibrium in weakly undominated strategies of the second-price cash auction, the bid that maximizes the acquirer's profit in Eq.* (2) *satisfies* $\beta_i(\theta_i) \in B_i(\theta_i)$. (ii) *If the expected repayment to the financier is continuously increasing in* y, *the bidder's equilibrium bidding strategy is given by Eq.* (3).

While Lemma 2 does not explicitly derive the acquirer's bidding strategy, several implications seem clear. The bidder always adjusts his cash bid β to the financing contract R. Furthermore, the probabilities of winning affect bidding both directly (if B is not a singleton) and indirectly over the design of the financing contract R.

3.1. Passing on financing cost

To illustrate Lemma 2 and, in particular, how the cost of financing affects bidding, consider the following simple example in which the financing contract is assumed exogenously, so that the financier might or might not be making a profit. It illustrates in a stark way how bidders adjust their cash bids to the cost of financing so that this cost might affect the seller more than it affects the bidder himself. Note that the treatment of financing contracts as exogenous in this and the preceding subsection is key, as understanding the channels through which on- or off-equilibrium financing affects bidding is the basis for endogenizing financing contracts in the following section.

Example: Suppose that there are only two states of the world at $t=3$ with $X = \{x, x+\Delta x\}$, where $x, \Delta x > 0$. The bidder's type $\theta \in (0,1]$ is his probability of being in the high cash flow state. Assuming that the bidder defaults in the low cash flow state (a sufficient condition for this is that $w < \underline{\theta}\Delta x$), the state-dependent payoffs of the debt contract are $R = \{x, (1+r(y))(y-w)\}$, where $r(y)$ is the interest rate demanded by the financier. This interest rate can depend on the takeover payment y, but (as noted above) at this stage, it is not yet important whether it arises from an equilibrium financing game. Suppose that the expected repayment to the financier is continuously increasing in the takeover payment y. Then, the bidding strategy is given by (3), and it solves

$$x + \theta_i\left[(1+r(\beta_i(\theta_i)))(\beta_i(\theta_i)-w) - x\right] = (x+\theta_i\Delta x) - w$$
$$\Rightarrow \beta_i(\theta_i) = w + \frac{1}{1+r(\beta_i(\theta_i))}\left(x+\Delta x - \frac{w}{\theta_i}\right). \tag{5}$$

Suppose, now, that all bidders are financed with the same financing contract. Let $\tilde{\pi}_t$ be the probability that the highest bidder among the other $N-1$ bidders is of type t and that type θ_i wins the auction. Since the payment y in an SPA is the second-highest bid and (when all bidders use the same financing contract) higher types make higher cash bids, the bidder's expected payoff is:

$$\sum_{t=\underline{\theta}}^{\theta_i}\left(x+\theta_i\Delta x - w - x - \theta_i\left[(1+r(\beta(t)))\frac{x+\Delta x-\frac{w}{t}}{1+r(\beta(t))} - x\right]\right)\tilde{\pi}_t$$
$$= w\sum_{t=\underline{\theta}}^{\theta_i}\left(\frac{\theta_i - t}{t}\right)\tilde{\pi}_t, \tag{6}$$

which is independent of the interest rate $r(y)$.

The main insight from this example is the extreme extent to which bidders adjust their bidding strategy to pass on increases in the interest rate to the seller in the form of lower cash bids. Lemma 2 is key to analyzing the effects on the bidders' expected payoffs. It shows that the expected debt repayment, when the bidder actually has to pay his cash bid, has to be the *same* regardless of how the interest rate is set (cf. (3)). For this reason, bidders must adjust their bids when the interest rate changes.

In the special case in which all bidders use the same financing contract, ranking cash bids leads to the same allocation rule (probability of winning) as ranking the debt repayments that correspond to these bids. Thus, in this example of debt financing, the bidder's optimization problem could be rewritten as choosing the maximum debt repayment that he is willing to make and then "reverse engineering" the financing contract to derive the cash bid that corresponds to this debt payment. This makes the bidder's problem the same as in a security-bid auction, in which bidders compete by offering the seller a debt claim, backed by the target's cash flows, instead of offering cash bids financed externally (as in the present model). Thus, the bidder's expected payoff is also the same as in a security-bid

[11] While such a situation will not arise in equilibrium, it is not inconceivable. If R stipulates different types of financing contracts for different payments y, it could be that the expected repayment is increasing in y for some types, but not for others.

auction, implying that it does not depend on r. This intuition holds generally when all bidders are financed with the same type-independent contracts (i.e., contracts that do not discriminate among different types θ) and when the security type (e.g., debt, equity, etc.) is independent of the payment y. As argued next, this result points to the limits of extending the results from the literature on bidding in securities to externally financed takeovers and to the pitfalls of assuming that financing is exogenous.

Proposition 1. (i) *Bidders pass on changes in their cost of financing to the seller by adjusting their cash bid.* (ii) *Bidders fully pass on such changes—i.e., their expected payoff for a given security type is always the same—in the special case in which all bidders are financed with the same contract, stipulating that all types are financed with the same type of security for all potential payments y, and for which the bidders' expected repayment increases in the amount raised from the financier.*

3.2. Effect of financing contracts on incentives and bidding

The limitation of Proposition 1 is that it says nothing about how contracting affects takeover prices and the probabilities of winning, let alone how it arises endogenously in externally financed takeovers. Indeed, to assume that external financing affects bidding in cash similarly to the way security design affects bidding in securities would require not only that the many conditions of Proposition 1 (ii) are satisfied, but also that financiers always make zero profit. In this case, assuming that the type of financing is exogenous, the seller's revenue would be highest for levered equity, lower for debt financing, and lowest when bidders are not cash-constrained. The intuition behind this "naive" extension is that a security payment that has an *expected value* of \$100 to a low type has a higher expected value for a higher type. Therefore, when he has the same financing contract, the high type ends up paying more than the lower type's valuation in the SPA. If the financier makes zero profit, the fact that the auction extracts more rent from the bidder implies a higher revenue for the seller. This effect is stronger, the more the payment (i.e., financing contract) depends on the bidder's true type.[12]

However, in practice, different bidders could use different financing contracts, and some financiers could seek to make a profit. Thus, for example, two debt contracts that stipulate a repayment of \$120 to the financier cannot be treated as equivalent since bidding and raising \$100 at a 20% interest rate is clearly different from bidding and raising \$120 at a zero percent cost. Moreover, the type of security could depend on the amount that bidders need to raise, and high types could try to obtain cheaper financing contracts than low types. Furthermore, the strategic game between bidders and financiers could imply that a contract that leaves the bidder with a lower expected payoff does not necessarily translate into a higher price paid in the takeover.

The natural first step to address these issues is to combine what is already known from the literature on bidding in securities and the standard corporate finance literature and to extend it as much as possible to externally financed takeovers in which contracts could be more complex. However, one of the complications that arises when optimally designing financing contracts and verifying that they can be supported in the joint equilibrium of the bidding and the financing game is that a bidder could now deviate along two dimensions: along the security contract and along the cash bid. Specifically, regardless of whether the objective is to maximize the bidders' or the financier's profits, the financing contract of a type θ_i' should be such that he has no incentive to deviate to the security contract $\widehat{R}$, issued in equilibrium by some other type $\widehat{\theta}_i$, and then to bid as a potentially different type θ_i''

$$\mathrm{E}_{\theta_{-i}}\left[\left(\int_X \left[x - R(x, y(\theta_i', \theta_{-i}))\right] dG(x|\theta_i') - w\right) P(\theta_i', \theta_{-i})\right] \\ \geq \mathrm{E}_{\theta_{-i}}\left[\left(\int_X \left[x - \widehat{R}\left(x, y(\theta_i'', \theta_{-i})\right)\right] dG(x|\theta_i') - w\right) P(\theta_i'', \theta_{-i})\right], \tag{7}$$

where the takeover payment $y(\beta_i(\theta_i), \beta_{-i}(\theta_{-i}))$ and allocation rule $P(\beta_i(\theta_i), \beta_{-i}(\theta_{-i}))$ in what follows are written as $y(\theta_i, \theta_{-i})$ and $P(\theta_i, \theta_{-i})$. Note that this notation is used for brevity only and, in particular, that it conceals the dependence on the financing contracts, which can be different for different bidders.

The fact that the bidder can deviate along two dimensions is further related to the fact that financing contracts could potentially feature two types of cross-subsidization: across types and across payments. While the first dimension is standard in the context of pooling contracts (e.g., Nachman and Noe, 1994), the second dimension needs clarification. It could emerge if a bidder signed a financing contract that is expensive for some payments in the takeover, but that compensates for this with cheaper financing for other payments. Such cross-subsidization could distort bidding relative to when the bidder is not cash-constrained, but it may be instrumental in minimizing mimicking incentives. The following result serves as a basis for the next section, which analyzes how such distortions can be minimized and how they can be used to the bidder's or the financier's advantage.

Proposition 2. Financing all potential payments in the takeover with debt minimizes the incentives of low types to take the financing contract of higher types and to bid as a different (lower or higher) type. The opposite holds for levered equity financing. This holds regardless of the other bidders' financing contracts.

The intuition behind Proposition 2 borrows from the fact that the value of a debt contract is least sensitive to a bidder's ability to generate cash flows (his type). This makes debt financing the most expensive contract for lower types to mimic, regardless of the bids for which they end up raising financing. This property helps to minimize mispricing of the financing contract for any

[12] More formally, DeMarzo, Kremer, and Skrzypacz's (2005) reasoning is based on Milgrom and Weber's (1982) Linkage Principle: The more strongly a bidder's payment depends on his true type, the higher his expected payment in an auction will be. Since, in this setting, a bidder's expected payment to the financier is more sensitive to his ability to generate cash flows for levered equity than for debt, we have a similar result.

given payment y. A natural implication of this result, used in Section 4.2, will be that the need for distortions to prevent mimicking, such as cross-subsidization across payments, could be made minimal for debt. These implications are important, as mispricing of the financing contract is the main reason why a bidder bids differently than when he is not cash-constrained (even if outside financiers make zero profits).

Exactly the opposite intuition holds for the security for which mimicking is least costly. That security is levered equity, and its shape is the mirror image of that of debt (i.e., it looks like a call option). Recall that an important property of such financing is that levered equity, being most sensitive to the bidder's ability to generate cash flows, is the most expensive security for a high type when he has the same financing contract as a low type and raises the cash bid of such a type.

Despite the intuitive appeal of Proposition 2, its critical limitation is that it has nothing to say about the seller's, bidders', or financier's payoffs. In particular, one difficulty when analyzing the strategic interaction between bidding and the optimal design of financing contracts is that a change in the bidder's expected payoff could reflect a change in the payment to the financier or the seller, which also resonates in the probabilities of winning. This is the main focus of the next section.

4. Raising financing

This section contains the main results of the paper. It solves for the optimal financing contract by looking, in turn, at the cases in which a bidder faces an uncompetitive (Section 4.1) and a competitive market for capital (Section 4.2). In addition, it considers the case in which the bidder can choose whether to bid in cash or in securities (Section 4.3). More-balanced distributions of bargaining power are discussed in Section 4.5.

4.1. Raising financing in a non-competitive market for capital

Suppose that at least one bidder does not have access to a competitive market for capital, which is modeled by allowing the financier to make a take-it-or-leave-it offer to this bidder. While this situation for the bidder is assumed exogenously, one way to endogenize such a setting would be to add an *additional* layer of information asymmetry between an incumbent and outside financiers. Then, a refusal to provide financing could make it impossible for the bidder to raise cash elsewhere, as it sends a negative signal about his type (e.g., Rajan, 1992). As argued in more detail in Section 5, this case may be more relevant for younger, smaller, or private firms, as well as firms that have no established track record. It may also be more relevant for firms in countries with less-developed capital markets and in downturns of the business cycle, when financing is generally harder to obtain.

The objective of the financier who is facing such a bidder is to offer a contract R that maximizes his expected payoff

$$\max \mathrm{E}_{\theta_i,\theta_{-i}}\left[\left(\int_X [R(x,y(\theta_i,\theta_{-i}))-(y(\theta_i,\theta_{-i})-w)]\; dG(x|\theta_i)\right)P(\theta_i,\theta_{-i})\right], \tag{8}$$

where $\mathrm{E}_{\theta_i,\theta_{-i}}[\cdot]$ is the expectation operator over all possible realizations of the types of the N bidders, and where the other $N-1$ bidders could be financed by different financiers. The financier chooses the contract, taking into account how it affects bidding and, thus, the takeover payment y and the allocation rule P, and subject to the restrictions that it satisfies incentive compatibility (7), feasibility, and individual rationality for the bidder types θ_i he wants to finance

$$\mathrm{E}_{\theta_{-i}}\left[\left(\int_X [x-R(x,y(\theta_i,\theta_{-i}))-w]\; dG(x|\theta_i)\right)P(\theta_i,\theta_{-i})\right]\geq 0. \tag{9}$$

The financier has two tools at his disposal. He can choose the type of financing contract R (e.g., debt, equity, menus of securities) for every given payment y and, having chosen the type, he can choose the cost of this contract—i.e., how R depends on y (e.g., the interest rate that fixes the overall debt repayment). The main insight in what follows is that with these two different tools, the financier can achieve his objective in two different ways. Specifically, the strategic interaction between financing and bidding allows the financier to make a profit not only at the bidder's (i.e., acquirer's) expense, but also at the seller's (i.e., the target's).

First, by optimally choosing the type of security contract, the financier can maximize the profit he makes at the bidder's expense. From the financier's point of view, the most attractive type of financing leaves the bidder with the lowest possible payoff for any given cash bid that this bidder is rationally prepared to offer. Proposition 2 already suggests that levered equity is potentially the most expensive form of financing to the bidder, and this is, indeed, what the financier will offer. An interesting property of the optimal contract is its simplicity. Rather than offering a menu of contracts to the bidder, offering just one contract maximizes the financier's profit.

The intuition for offering the bidder levered equity financing for all payments at terms independent of his type is as follows: On the one hand, only high types make higher cash bids. Thus, despite offering the same contract to all types, the financier is able to extract surplus in a targeted fashion from higher types, as only such types make higher payments. On the other hand, offering the same contract for lower payments (made by both high and low types) automatically prevents mimicking for such payments, while extracting the maximum surplus from all these types. In such cases, levered equity is the most expensive form of financing for high types when they raise financing for bids lower than their own (cf. discussion following Proposition 2).

Second, by choosing the financing cost of the levered equity contract, the financier can choose how much surplus to extract from the seller since bidders pass on increases in the cost of financing to the seller by adjusting their cash bids (cf. Proposition 1 and the Example). However, given that the other bidders could be financed differently—e.g., at competitive terms—this comes at the expense of a lower probability of winning. Trading off these effects, the best strategy for the financier is to offer a financing contract inducing, at most, the same cash bid β_C as that of an unconstrained bidder. Intuitively, inducing a cash bid higher than β_C would mean that the financier is subsidizing and, thus, making a loss on all bids $\beta > \beta_C$.[13] The financing offered by the financier will, thus, induce bids $\beta \le \beta_C$. In particular, financing will be disproportionately more expensive for lower payments since the bidder is more likely to be able to afford them despite the more expensive financing terms (i.e., his type is sufficiently high). In contrast, it is never optimal to induce a payment lower than β_C for the highest type—i.e., it will hold $\beta(\overline{\theta}) = \beta_C(\overline{\theta})$. Otherwise, the financier could profitably deviate by modifying the initial contract so that it stipulates the same repayment for $y \in [\beta(\overline{\theta}), \beta_C(\overline{\theta})]$. The only change with this deviation is that type $\overline{\theta}$ would be able to bid $\beta_C(\overline{\theta})$. This makes the financier better off, as his expected payoff would be unchanged for payments $y \le \beta(\overline{\theta})$, while he would be making a profit on the additional payments $y \in (\beta(\overline{\theta}), \beta_C(\overline{\theta})]$ that type $\overline{\theta}$ would now be able to afford.

Proposition 3. (i) *If the financier controls the terms of financing, he offers levered equity financing for all payments.* (ii) *The contract is disproportionately more expensive for low payments, and there is underbidding compared to when the bidder is not cash-constrained*: $\beta(\theta) \le \beta_C(\theta)$, *with the inequality being strict for low types and weak for the highest type*.

Part (ii) of the proposition implies that the financing contract can effectively exclude the bidder from bidding if his type is very low. This is reminiscent of the rent-extraction efficiency trade-off in monopoly pricing problems, but a novel feature here is that the bidder can adapt to the financing contract by choosing how much to bid.

4.2. Raising financing in a competitive market for capital

Consider, next, the case in which the bidders can raise financing at competitive terms. Analogous to the case in the previous subsection, this case is modeled by stipulating that bidders make a take-it-or-leave-it offer to the financier at $t=1$. A bidder of type θ_i chooses R to maximize

$$\max \mathrm{E}_{\theta_{-i}}\left[\left(\int_X \left[x - R\big(x, y(\theta_i, \theta_{-i})\big) - w\right] \, dG(x|\theta_i)\right) P(\theta_i, \theta_{-i})\right], \tag{10}$$

taking into account how R affects bidding and, thus, the takeover payment y and the allocation rule P, and subject to the restrictions that the contract satisfies incentive compatibility (7), feasibility, and individual rationality for the financier

$$\mathrm{E}_{\theta_i, \theta_{-i}}\left[\left(\int_X \left[R\big(x, y(\theta_i, \theta_{-i})\big) - \big(y(\theta_i, \theta_{-i}) - w\big)\right] \, dG(x|\theta_i)\right) P(\theta_i, \theta_{-i})\right] \ge 0. \tag{11}$$

Moreover, this is a game of signaling, as bidders are privately informed about their types; thus, they also need to take into account how their offer and their bidding behavior affect the financiers' beliefs. In particular, what makes this setting different from prior models of optimal security design is that bidding and, thus, the amount raised from the financier at $t=2$ adapts to the financing contract.

An equilibrium candidate of the financing game is a quintuple of functions (R, ϕ, μ, d, β): $R(X,y)$ is the security that the bidder offers for every cash payment y; ϕ is the financier's updated belief at $t=1$, which maps the proposed security contract into the set of probability distributions over the type set $\theta \in \{\underline{\theta}, \ldots, \overline{\theta}\}$; μ is the financier's interim belief at $t=2$, which maps the observed auction payment y over the same type set. Focusing on pure strategies, the financier's action is the binary choice $d: R(\cdot) \to \{Y, N\}$, where $d = Y$ corresponds to accepting and $d = N$ to rejecting the offer. Finally, $\beta(\theta): (R(\cdot), d) \to \mathbb{R}_+$ is the bidder's equilibrium bidding strategy. As is standard, the equilibrium concept is that of Perfect Bayesian Equilibrium. To rule out equilibria supported by arbitrary off-equilibrium beliefs, it is required that the financier places probability zero on the deviation coming from a type whose expected deviation payoff (conditional on acceptance, $d = Y$) is weakly lower than on the equilibrium path.[14] This requirement follows the logic of the Intuitive Criterion of Cho and Kreps (1987).[15]

In the resulting equilibrium of the signaling game, bidders offer contracts stipulating debt financing for all payments. Proposition 2 already suggests the intuition. Debt is the cheapest security, as it maximally relaxes the upward incentive constraints and minimizes mispricing of the financing contract. As a result, an equilibrium with non-debt securities cannot be supported. This argument is sketched in more detail below.

First, an interesting characteristic that any equilibrium candidate in this setting must satisfy is that it cannot feature cross-subsidization across types. Otherwise, a bidder-type θ'' who, when suffering from such cross-subsidization offers $\beta(\theta'')$, could offer an alternative contract that benefits him but does not benefit higher or lower types. Specifically, type θ'' could offer to be subject to slightly better terms for the highest takeover payment he is willing to offer (which low types would not make), but more expensive financing for high takeover payments $y > \beta(\theta'')$ that he is not willing to offer anyway. Such a deviation would be successful: Lower types who do not bid as high as $\beta(\theta'')$ would be indifferent to this deviation, while high types would be hurt from the more expensive financing for the high takeover payments. Thus, since with cross-subsidization across types the financier makes a profit on the deviating type θ'', there is scope for constructing the deviation such that the financier at least breaks even for any refined beliefs (excluding the types who do not benefit from this deviation).

Second, the debt equilibrium features cross-subsidization across payments for every type. Specifically, every bidder-type offers a contract for which the financier breaks even for his type. This contract stipulates expensive financing terms for low takeover payments, deterring mimicking by lower types, in exchange for cheaper financing terms for higher takeover payments. When competing bidders are not cash-constrained or also have

[13] Throughout the text, the subscripts of β and θ are omitted if this does not lead to confusion.

[14] Note that the best response of the financier in this setting is either to accept or reject, $d = \{Y, N\}$, and bidders' payoffs are zero for $d = N$.

[15] The Intuitive Criterion is a weaker refinement than D1, which has been used extensively in the security-design literature (e.g., Nachman and Noe, 1994; DeMarzo and Duffie, 1999).

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access to competitive financing, this cheaper financing induces a higher cash bid than when the bidder is not cash-constrained.[16] Thus, it holds that $\beta(\theta) \geq \beta_C(\theta)$, with the inequality being strict for all $\theta > \underline{\theta}$. The resulting bidding strategy is unique.

The specific advantage of debt over other security types is that, by relaxing the incentive constraints, it minimizes the necessity for cross-subsidization across payments. This gives the bidder the additional flexibility to offer financing contracts that are less expensive for him for lower payments and for which he could optimally offer a lower cash bid, while still preventing mimicking by lower types. This additional flexibility of debt financing is the reason why non-debt contracts cannot be sustained as an equilibrium, while beliefs that support debt as an equilibrium can easily be found.

Proposition 4. (i) *In the refined equilibrium of the financing game, bidders issue debt contracts, which separate their types. The bidding strategy is unique.* (ii) *If competing bidders have access to competitive financing or are not cash-constrained, a bidder raising debt financing overbids compared to when he is not cash-constrained*: $\beta(\theta) \geq \beta_C(\theta)$ *with the inequality being strict for all* $\theta > \underline{\theta}$.

An interesting aspect of Proposition 4 is that every bidder-type bears ex ante the cost of his own overbidding: The cheap financing for high takeover payments, which leads to higher bids, is offset by more expensive financing for lower takeover payments. Intuitively, such financing contracts are optimal for the bidder as cross-subsidizing his own payments is preferable to cross-subsidizing other types' payments. This effect from endogenizing contracting differentiates this paper from prior explanations of overbidding in the context of external financing, such as expropriation of existing debt holders (Chowdhry and Nanda, 1993) and receiving a financing subsidy from the seller (Povel and Singh, 2010).

By endogenizing the financing contracts, Propositions 3 and 4 may help explain why the effect of financing on takeover prices could follow, in practice, a markedly different pattern from that in the literature on bidding in securities (DeMarzo, Kremer, and Skrzypacz, 2005). As noted above, in this literature, the seller's revenue is highest for levered equity, lower for bidding in debt, and lowest for bidding in cash. Instead, by endogenizing how financing contracts depend on financiers' bargaining power, the main result here (illustrated in Fig. 1) is that:

Proposition 5 (*Ranking of takeover prices*). *Acquirers financing their cash bids with debt bid higher than when they are not cash-constrained. Conversely, they bid lower when financing their cash bids with levered equity*.

4.3. Choice of method of payment

So far, the analysis has considered raising financing only from an outside financier. However, the seller could also offer financing. In practice, this is often the case. Any form of bidding in securities, such as bidding in equity, is a form of seller financing. In such cases, the value that the seller attaches to security bids implicitly defines the financing terms and, thus, bidding aggressiveness. Yet an important difference between formal seller financing and bidding in securities is that formal financing binds the seller to the stipulated financing terms, while such a commitment would not be possible with security bids. Thus, the question that arises is how the financing terms implied by the seller's treatment of security bids would affect takeover premiums and the bidders' choice between bidding in cash or in securities.

What is known from the previous literature is that the seller's revenue is maximized when security bids are in levered equity (DeMarzo, Kremer, and Skrzypacz, 2005). To induce all bidders to bid in levered equity instead of raising external financing for cash bids, the seller could try to *commit* to treat levered equity bids so favorably that outside financiers would never break even for the effectively implied terms of seller financing. The seller would benefit from such a commitment, as bidders pass on the benefit of cheap financing in their bids (Proposition 1). More importantly, for such cheap financing terms, even bidders who are not cash-constrained would be effectively forced to bid in levered equity to be able to compete with the inflated value attributed to the levered equity bids.

Such a commitment is not ex post feasible, however. To see this, suppose that the seller treats a bid in levered equity with a value of ψ as having a value of $c > \psi$. Clearly, if an alternative bid with a true value between ψ and c were to emerge, it would make the seller strictly better off; thus, it would not be credible to treat the security bid as having the inflated value of c.

Consider, now, the ascending English auction in which bidding proceeds as follows: The cash price is increased until only one bidder is left. To stay in the bidding race, a security bidder must increase his security bid until the seller agrees that it is equal to the latest-announced cash price.[17] The insights from the preceding paragraph have two related implications. First, the value that the seller attaches to a bidder's maximum security bid will be at most the same as the maximum cash bid that this bidder would make if he were not cash-constrained. Ex post, this reduces the risk of not selling for the bid with the highest value. Second, not having to worry about competing with inflated security bids, a bidder who can bid in cash by raising external financing will do so before resorting to bidding in securities. The reason is that, in order not to miss out on more-valuable cash bids, the seller effectively undervalues

[16] Note that a competing bidder of the same type who does not have access to competitive financing would offer less than $\beta_C(\theta)$. This could make it optimal to use the cheaper financing for lower payments than $\beta_C(\theta)$ and, as a result, to not bid more than $\beta_C(\theta)$.

[17] The equivalence between an English auction and the SPA breaks down when the seller needs to compare cash to security bids. To see this, observe that (contrary to an English auction), in the equilibrium of an SPA, the seller would be able to infer the bidder's type from his security bid. However, if the highest bid is in a security, the seller would maximize her revenue by claiming that this bid has the same value as the highest cash bid. If, instead, the highest bid is in cash, the seller would claim that a competing security bid is equal to the highest cash bid. Thus, regardless of whether he bids in cash or in a security, the winning bidder will end up paying his bid, making an auction with cash and security bids effectively resemble a first-price auction (FPA). For these reasons, this section focuses on the English auction, as takeover contests in practice more closely resemble an English auction than an FPA.

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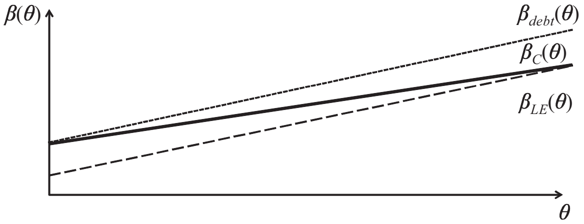

Fig. 1. Bidding when external financing is endogenous. Debt-financed bids $\beta_{debt}(\theta)$ are represented by the dotted line. Levered equity-financed bids $\beta_{LE}(\theta)$ are represented by the dashed line. The solid line represents the bids $\beta_C(\theta)$ of bidders who are not cash-constrained.

security bids. This treatment makes bidding in securities more expensive than bidding in cash financed externally in a competitive market. Even if a bidder is facing a strong external financier, this financier could offer better financing terms than those of the seller, while still making a profit.

Proposition 6. (i) *The cash equivalent that the seller attributes to a bidder's maximum security bid is, at most, equal to his maximum bid in an auction in which he is not cash-constrained.* (ii) *Bidders choose to bid in securities only if they have no access to external financing.*

In the context of Fig. 1, this would imply that the value that the seller attaches to a bidder's maximum security bid would, at most, coincide with curve β_C, which lies below curve β_{debt}, characterizing premiums when bidders have access to competitive external financing. Thus, an important implication of these results is that the takeover premium for cash bids when the winning bidder has access to competitive financing is higher than when this bidder bids in securities, such as equity.

Corollary 1. When acquirers have access to competitive external financing, takeover premiums for cash deals should be higher than for equity deals.

Finally, it should be noted that the seller's revenue is jointly determined by the takeover premium and by whether she effectively undervalues the bidder with her treatment of security bids. Thus, the higher takeover premium extracted from the winning bidder when he pays with an externally financed cash bid does not necessarily imply that the seller's overall revenue is higher. This also depends on the highest losing bid. To illustrate this, using the notation from Fig. 1, observe that the seller is better off if the *winning* bidder—of, say, type θ'—uses external debt financing if the highest losing bid y (regardless of how it is financed) is between $\beta_C(\theta')$ and $\beta_{debt}(\theta')$. In such cases, the winning bidder's financing contract leads him to overpay, as his takeover payment is $y > \beta_C(\theta')$. The seller gains from this overpayment, as it comes ex post at the expense of external financiers. If, instead, the second-highest bid is $y < \beta_C(\theta')$, the seller's revenue is higher if the winning bidder pays in a security. This results from the fact that the seller attaches lower values to security bids than they are actually worth. Thus, when the highest losing bidder drops out at y, the winning bidder's last security bid to stay in the bidding race is actually worth more than y.

4.4. *Discussion of cash constraint*

The bidder's expected payoff from a takeover depends not only on his type of financing, but also on how cash-constrained he is. Decreasing the bidder's co-investment increases the amount he needs to raise from outside financiers to make such a payment. As the example in Section 3 shows, this has a non-trivial effect on his equilibrium cash bids and his expected payoffs (cf. (5) and (6)). Among the insights from the following analysis is that the initial assumption that the bidder co-invests all his cash w is, indeed, without loss of generality.

Proposition 7. (i) *In equilibrium, the bidder co-invests all his available cash w.* (ii) *Bidders' equilibrium expected payoffs increase in their co-investment w.*

Co-financing a higher portion of his cash bid makes the bidder less dependent on outside financing and, thus, less subject to the potential mispricing connected with such financing. An intuitive way to think about this is to compare the effect to that of security design on the bidder's payoff. Similar to the effect of debt financing, a higher cash co-investment reduces the dependence of the bidder's overall payment in the auction on his ability to generate cash flows. Thus, co-investing a higher proportion of the cash payment helps relax the bidder's incentive constraint and reduces the cost of separation in the joint equilibrium of the bidding and the financing game.

Along the lines of Proposition 4, this insight implies that in the only equilibrium in a competitive market from which no type has an incentive to deviate, the bidder must co-invest all his cash w. A higher cash participation reduces the need for cross-subsidization across payments, giving the bidder additional flexibility to optimally make lower bids (closer to β_C). Similarly, if the bargaining power is in the financier's hands and the bidder can choose how much he wants to co-invest, co-investing all available cash is optimal for all types, as it minimizes the reliance on expensive outside financing.

The preceding analysis assumes, for tractability, that bidders have the same cash holdings w. Suppose, instead, that cash holdings are heterogeneous but uncorrelated with the bidders' types (as in Che and Gale, 1998). Then, the above results would remain valid, as the financier would not be able to infer the bidder's type from his cash participation. Clearly, the auction could now be inefficient, but note that it is also inefficient when bidders have different access to financing. Just as above, co-investing all cash remains optimal for every bidder. Separation with financing contracts could be easier to implement if cash holdings are correlated with the bidders' types. In particular, if there is a positive correlation, high types could separate by raising less external financing for any given cash bid. Overall, however, the bidders' and the financiers' preferences regarding optimal security design remain the same.

4.5. *Discussion of other assumptions and extensions*

Sections 4.1 and 4.2 discuss the extreme cases in which either the bidder or the financier makes a take-it-or-leave-it offer. Naturally, this is a very stylized way to model access to competitive financing, and one could also think of cases in which the bargaining power is split more evenly between the two parties. Analyzing a bargaining game with asymmetric information is complex. The main problem is that in the presence of incomplete information, there is no generally accepted solution concept, such as Nash bargaining, and the bargaining outcome depends strongly on the underlying assumptions about the bargaining process. Still, the way that financial contracting affects bidders' incentives in a bargaining game would be related to that described in the analysis above. Specifically, whether the party making the offers in a bargaining game would be able to extract a higher surplus and whether it would attempt to discriminate among different bidder-types by inefficient delay would depend on the bidder's incentive constraints. One of the complications when solving such a setting arises from the fact that both parties' expected payoffs depend on the bidder's ability to generate cash flows (his type). Formalizing such an extension goes beyond the scope of this paper, but a possible way to approach it could be to build on the insights of Deneckere and Liang (2006) and Fuchs and Skrzypacz (2013).[18]

One could also extend the model along other dimensions. First, one could address the timing assumptions. It is straightforward to show that the qualitative insights remain valid even if the financing contract is signed after the auction in $t=2$. They also hold if cash is raised before the takeover, and the unused portion is returned after y becomes known. Second, it should be noted that financial contracting affects a bidder's behavior in a number of ways beyond the ones analyzed in this paper. A typical example is that it also affects effort incentives and, thus, can either ameliorate or contribute to moral hazard problems. In particular, a bidder-manager's incentive to exert effort is lower if his participation on the upside is not sufficiently high (as in the case with levered equity). Since these effects are not specific to this setting, they are not pursued further here (see, e.g., Kogan and Morgan, 2010; Cong, 2014).[19] Finally, it was claimed above that the results of the paper also extend to a setting in which a bidder is uncertain about the number of potential competing acquirers. The necessary modification in such a case is that bidding and financing contracts should take into account the probabilities of facing any given number of competing bidders. See Harstad, Kagel, and Levin (1990) for a related discussion in the context of the first-price auction.

[18] These papers show that even if the uninformed party (here, the financier) cannot commit to a single take-it-or-leave-it offer, this party might still be able to extract a profit and there could be inefficient delay in bargaining. Based on the insights from these papers and Proposition 2, it seems likely that the financier would still prefer to offer levered equity financing, as it makes it easier to extract rent from the bidder even without price-discriminating through delay.

[19] The model can also be extended to include reserve prices and to address non-private values. Another interesting issue is how the seller may endogenously choose from among different auction formats. In particular, the seller's revenue is higher in an SPA when the market for capital is competitive, while it is higher in a first-price auction when financing is not competitive. A discussion of these results is available on request.

5. Empirical implications and evidence

5.1. Empirical implications

One of the main contributions of this paper is to explain takeover prices by accounting for the endogeneity of the financing decision. The first set of predictions, therefore, focuses on how acquirers raise financing to finance takeover bids. Proposition 3 implies that firms that have limited access to capital markets or that are locked into a relationship with a financier—e.g., smaller or private firms, as in the examples of UberMedia or CenterSpan discussed in the Introduction—will issue more-information-sensitive securities, such as equity. If their financier, e.g., their house-bank, is exogenously restricted to offering debt, financing will be in the form of the most information-sensitive debt, such as non-recourse loans.[20] In contrast, Proposition 4 implies that larger firms—as in the examples of BHP Billiton, Sungard, and Columbia Sussex—should finance their takeovers by issuing the least-information-sensitive debt. More broadly, the model predicts that bidders who are unable to raise debt may still be able to raise equity financing. As Proposition 3 shows, this will allow the financiers to extract a higher return on each dollar invested.

Implication 1. Firms with limited access to capital markets—typically smaller, private, or start-up firms—will finance their cash bids by issuing more-information-sensitive securities, such as equity. In contrast, firms with easier access to capital markets—typically established or larger firms—will issue debt.

The next section provides preliminary evidence in support of Implication 1 by empirically analyzing how bidders finance their cash bids. It tests whether variables that could proxy for the firm's ease of access to capital—such as its size, the availability of a rating, and its public or private status—are economically and statistically significant after controlling for standard measures affecting its debt capacity (e.g., share of fixed assets, indebtedness, and profitability).

To the extent that access to competitive financing is more difficult in economies with less-developed capital markets, related to Implication 1, one could also expect:

Implication 2. A consequence of a lower supply of competitive financing and less-developed capital markets is a higher demand by financiers for more-information-sensitive securities.

The main implications of this paper concern how takeover prices depend on the endogeneity of the financing decision. Failing to consider this endogeneity and adopting the predictions from the literature on bidding in securities would imply that takeover premiums should be highest for equity, lower for debt, and lowest when bidders are not cash-constrained. In contrast, one of the paper's novel predictions, tested empirically in the next

[20] Non-recourse loans are more-information-sensitive, as they are collateralized only by the asset the firm is bidding for, and not by the firm's existing assets, as is the case with more standard loans. A stricter interpretation of a levered equity contract would be that the bidder himself is bought by some strong financier who then lets him bid on his behalf while paying him a "wage," which has priority relative to the financier's claim in the case of default.

section, is that the endogeneity of the financing decision would predict the following pattern in the data:

Implication 3. Takeover premiums in takeovers paid in cash are highest when bidders finance their payments with debt, lower when bidders are not cash-constrained, and lowest when bidders use equity-like financing.

A closely related issue is the model's implications for bidders' expected payoffs. Propositions 3 and 4 imply that a bidder who raises equity to finance his cash bid in a takeover should experience lower abnormal returns upon announcing the financing and the takeover decision than a bidder who secures debt financing.

Implication 4. Bidders' abnormal returns surrounding takeover announcements should be higher for cash bids financed with debt than for cash bids financed with equity.

Furthermore, since the choice of the method of payment in takeovers is also endogenous, Proposition 6 predicts:

Implication 5. (i) *Takeover premiums are lower when the method of payment is equity than when the payment is in cash and bidders have access to competitive external financing.* (ii) *Acquirers who bid in equity are likely to be facing more restricted access to competitive financing.*

Part (ii) of Implication 5 could help explain Eckbo, Makaew, and Thorburn's (2014) finding that acquirers paying with stock tend to be small, non-dividend-paying growth companies. Part (i) is based on Proposition 6: Bidding in equity is essentially equivalent to raising financing from the seller at terms that are determined by the value she attaches to the security bids. Since this value is lower than the cash bid that the same bidder would have made if he were externally financed in a competitive market, this should lead to lower takeover premiums for equity deals. This insight finds support in the empirical findings of Betton, Eckbo, and Thorburn (2008), which contradict the predictions from the literature on bidding in securities that premiums should be higher for equity than for cash deals (DeMarzo, Kremer, and Skrzypacz, 2005).[21]

Another factor that determines takeover prices is the extent to which bidders are cash-constrained. As discussed following Proposition 7, the aggressiveness of bidders increases in their cash constraint.

Implication 6. When cash-constrained bidders have access to competitive (*debt*) *financing, their bidding aggressiveness increases in their cash constraint.*

Implication 6 refers only to takeovers in which acquirers are cash-constrained. The reason is that, absent such a constraint, it is well known that other issues become relevant, such as Jensen's (1986) argument that managers could waste money on unprofitable investments. The confounding effect of such agency problems would, therefore, make it difficult to test Proposition 7 by comparing acquirers that are cash-constrained with those that are not.

Participation in takeovers has not been modeled explicitly above, but it is straightforward to sketch how such a discussion could be incorporated. Consider an extension of the baseline setting in which the acquirer has a positive outside option—e.g., an alternative investment opportunity available at $t=1$ that is mutually exclusive with the takeover. Thus, the acquirer must choose the investment opportunity with the higher expected payoff.[22] When establishing such a comparison, Propositions 3 and 4 imply that the acquirer's expected payoff from participating in the takeover depends more on whether he has access to debt (i.e., competitive) financing than on the cost of debt (which, in a competitive market, is likely to be similar to that of competing bidders), as this cost is largely passed on to the seller:

Implication 7. Participation in takeovers depends more on whether bidders have access to debt financing than on the cost of debt.

The insight that bidders largely pass on the cost of financing could help explain why participation in bankruptcy auctions is high, despite the fear of many scholars and practitioners that the high financing cost could lead to insufficient competition, allocative inefficiencies, and fire-sales (e.g., Shleifer and Vishny, 1992; Hart, 2000). Indeed, while bankrupt assets are often sold at a discount—indicating that acquirers pass on their financing costs—participation and efficiency do not seem to be a big issue. Recent evidence shows that more than a third of bankruptcy auctions involve multiple bidders (Hotchkiss and Mooradian, 1998; Baird and Rasmussen, 2003). In Sweden, where there is a mandatory bankruptcy auction procedure, the figure is 63% (Eckbo and Thorburn, 2008). Moreover, the post-bankruptcy operating performance is on par with that of industry rivals.

5.2. Empirical evidence

This section performs several tests of the model's main predictions. Similar to related theoretical papers (e.g., Morellec and Zhdanov, 2008), the objective is not to provide a full-fledged empirical analysis establishing causality, but only to present some preliminary empirical evidence that supports the model's implications.

5.2.1. Data and summary statistics

The data source is the Worldwide Mergers and Acquisition Database of Thomson One (formerly SDC Platinum), spanning the period from January 1980 to June 2014. The

[21] The predictions for target abnormal returns are less clear-cut. First, these returns should reflect the seller's overall revenue and not only the takeover premium. As noted following Corollary 1, whether the seller's revenue is lower or higher in a security bid auction depends on the level of the second-highest bid. Second, an equity bidder winning the takeover could be evidence of less aggressive competition due to bidders facing difficulties raising competitive external financing (cf. Implication 7). For these reasons, the overall relation between the method of payment and target abnormal returns is ambiguous. See Malmendier, Moretti, and Peters (2012) and Malmendier, Opp, and Saidi (2015) for recent empirical evidence.

[22] While this assumption is not without loss, it is realistic to assume that managers rarely undertake two major investments at the same time. Furthermore, introducing a positive discount factor would create urgency to undertake the alternative investment opportunity at $t=1$, as opposed to waiting to see whether the takeover attempt would succeed.

sample is created by applying the following data filters: (1) At least part of the deal is paid in cash, and there is information about the source of financing of the cash bid; (2) the deal types include tender offers, exchange offers, self-tenders, and leveraged buyouts; (3) the acquirer owns more than 50% after the acquisition; (4) the acquirer's financial information, including that of private acquirers, is available; (5) financial firms (Standard Industry Classification (SIC) codes 6000 to 6999) and regulated firms (SIC codes 4900 to 4999) are excluded; and (6) countries with fewer than five observations are excluded. Stock price data are obtained from Thomson Financial's Datastream. The final sample consists of 9,648 deals from 44 countries, with U.S. firms constituting close to 40% of the sample. As motivated in Section 2, the empirical tests below do not have to be restricted to takeovers with more than one publicly known bidder.

Table 1 presents summary statistics of the sample. It reports means, medians, standard deviations, and the number of observations for all variables used in the empirical analysis. All variable definitions are provided in Table A1 in the Appendix. Panel A of Table 1 presents characteristics of the acquirers in the sample, in particular, acquirer size (total assets), leverage (liabilities over assets), tangibility (property plant and equipment over total assets: PPE/TA), and profitability (earnings before interest and taxes over sales: EBIT/Sales; and earnings before interests, taxes, depreciation, and amortization over total assets: EBITDA/TA). The consumer price index is used to express total assets in constant dollars (base 1980). The evidence shows that the average acquirer is a large public firm with a leverage ratio exceeding 50% and over a quarter of the balance sheet represented by fixed assets. However, consistent with previous studies, there is large variation. For example, the medium firm is more profitable and significantly smaller by a factor of ten. The three-day bidder cumulative abnormal returns (CAR) in Panel A are calculated for the event window (−1,1) using market model parameters over the 200-day period from event day −210 to event day −11 and home-market index returns as benchmarks. The resulting average bidder CAR in Table 1 is 1%, which is consistent with the average bidder CARs on cash bids documented in the literature (Betton, Eckbo, and Thorburn, 2008).

Panel B reports various deal characteristics, such as the fraction of pure cash bids and bids that are financed with 100% internally generated cash. It also reports the takeover premium, which is calculated as the natural logarithm of the final offer price divided by the stock price 42 days prior to the takeover announcement. By definition, this premium can be calculated only for public targets, which represent about one fifth of the sample. The average premium in the sample equals 39%. This is slightly lower than the premium in Betton, Eckbo, and Thorburn's (2008) sample, which spans 1980–2002. Given that premiums for cash bids, which are the primary focus of this study, have been typically shown to be higher than for equity bids, this implies that premiums may have declined in the last decade.

Finally, Table 1, Panel C provides summary statistics on the different financing sources for the cash bids in the sample. Note that the different funding sources are not mutually exclusive and hence do not add up to one. For example, the table shows that 20% of the acquirers use a common stock issue to pay for cash deals, while 21% use a line of credit. Taking into account that firms often use a combination of different sources (e.g., corporate funds, a credit line, and new borrowing), cash bids have been financed with debt in 57%, and with equity in 21%, of the cases. There are no data in Thomson One on what fraction of the cash bid is financed internally and what fraction comes from which financing source, making it difficult to test Implication 6.

5.2.2. *Choice of financing*

The model's first set of predictions states that acquirers raise equity financing when they do not have access to competitive financing and use debt financing otherwise. Table 2 addresses these predictions by presenting logit regressions that explain whether an acquirer finances a deal with a non-debt instrument. The dependent variable is a dummy variable, taking the value of one if a cash payment is financed by issuing common stock, preferred stock, a rights issue, or mezzanine financing. Including mezzanine financing in this category is inconsequential, as the fraction of deals using such financing is close to zero (Table 1, Panel C). The regressions in Models (1) through (3) are estimated using the full sample, while those in Models (4) and (5) use U.S. firms only. Model (6) is estimated for deals for which the presence of multiple bidders is publicly observed.

When testing Implication 1, the main independent variables of interest are the acquirers' size (total assets), age, public or private status, and whether they have a credit rating. These variables are used as proxies for a bidder's access to a competitive market for capital (e.g., Hadlock and Pierce, 2010). To test for the effect of size, for each country, the sample is split into quintiles based on acquirers' total assets. The lowest quintile is denoted with q1 and the highest with q5. The acquirers are then grouped according to the respective quintiles.[23] The regressions that are restricted to U.S. firms use the logarithm of assets as a proxy for firm size and, in addition, control for Hadlock and Pierce's (2010) index of financial constraints (available only for U.S. firms).

To provide supportive evidence for Implication 2, the regressions control for two types of variables. First, including country fixed effects controls for an acquirer's country of incorporation, where the assumption is that there is a greater supply of competitive financing in the U.S. Second, the regressions include a dummy that equals one if the economy in which the acquirer is incorporated is in a recession in the quarter of the deal announcement. Following Erel, Brandon, Kim, and Weisbach (2012), the regressions include an alternative dummy that equals one if the economy is in a low-growth phase (defined as GDP growth below the 25th percentile since 1971). Following the same paper, another considered alternative is a dummy that captures whether banks tighten lending standards according to the “Senior

[23] Note that classifying acquirers into quintiles depending on their relative size within their country avoids that an acquirer that is considered small in one country may be considered relatively larger in a different country. In Model (6), quintiles 3 and 4 predict failure—i.e., debt financing—almost perfectly. The model, thus, tests the effect of quintiles 1 and 2 against the rest. The results are robust to using the logarithm of assets as a proxy for size in the full sample (see Model (3)).

Table 1
Descriptive statistics.
The sample consists of takeovers in which the price is paid at least partially in cash and there is information about the source of financing for the cash bids. The data source is Thomson One, and the sample period is 1980–2014. The deal types include tender offers, exchange offers, self-tenders, and leveraged buyouts, and it is required that acquirers own more than 50% after the acquisition. Financial firms (SIC codes 6000 to 6999), regulated firms (SIC codes 4900 to 4999), and acquisitions from countries with fewer than five observations are excluded. Panel A provides summary statistics for the acquirers' characteristics. The calculated variables are from the last 12 months prior to the takeover. Panel B provides summary statistics for key deal characteristics, and Panel C summarizes the use of different financing sources for the acquirers' cash bids. The percentages do not add up to one, as some deals use several financing sources (e.g., borrowing and line of credit). For indicator variables, the table presents only the mean and the number of observations. All variable definitions are in Table A1.

Panel A: Acquirer characteristics	Mean	Median	Sd.	N
Acquirer total assets	1283	125	6930	9648
TL/TA	0.54	0.50	1.65	9207
PPE/TA	0.28	0.22	0.24	9107
EBITDA/TA	0.08	0.12	1.24	9136
EBIT/ Sales	−0.14	0.09	6.18	8993
HP index of fin. constr. (U.S. only)	−3.33	−3.36	0.91	3799
Private acquirer	0.01			9648
Panel B: Deal characteristics	Mean	Median	Sd.	N
Takeover premium	0.39	0.36	0.50	1826
Bidder CAR(−1,+1)	0.01	0.00	0.07	9282
Pure cash bid	0.62			9648
Bid 100% internally financed	0.29			9648
Horizontal merger	0.56			9648
Acquirer has toehold	0.12			9648
Acquirer has rating	0.23			9648
Hostile bid	0.01			9648
Private target	0.43			9648

Panel C: Percentage of deals using given type of financing			
Debt	*57%*	*Non-debt*	*21%*
Borrowing	33%	Common stock issue	20%
Line of credit	21%	Rights issue	4%
Debt issue	8%	Preferred stock issue	1%
Bridge loans	3%	Mezzanine financing	0%
Foreign lenders	3%		
Junk bond issue	0%	Corporate funds	51%

Loan Officer Opinion Survey on Bank Lending Practices" by the Federal Reserve (available for the U.S. only).

The results in Table 2 show that small firms, private firms, and firms that do not have a rating are significantly more likely to use non-debt financing for their cash bids. The economic magnitude is large. For example, the marginal effects reported in Models (1) and (2) imply that the probability of using non-debt financing is 20% higher for acquirers in the smallest than in the largest quintile.[24] Furthermore, U.S. private acquirers (Models (4) and (5)) are 10% more likely to use non-debt financing and, across the board, rated firms are 2–5% less likely to use non-debt financing. The results are robust after controlling for acquirers' debt capacity. Thus, to the extent that size, private status, and having a rating are good proxies for an acquirer's ease of access to competitive financing, the data suggest that the lack of such access reduces an acquirer's ability to issue debt and forces him to finance his cash bids in takeovers with non-debt instruments. There is support also for Implication 2. Compared to the U.S., the country fixed effects coefficients (not reported) imply that in all other 37 countries for which there are sufficient data, acquirers are more likely to use non-debt financing. The effect is significant in 29 of these countries, including in developed countries such as the UK, Canada, and Australia. The evidence that firms use non-debt financing in economic downturns is weaker, though Model (2) shows that acquirers are more likely to use non-debt financing in times of low GDP growth.

5.2.3. Takeover premiums

Two of the main implications of the theoretical analysis are that takeover premiums are lower when bidders raise non-debt financing to pay their cash bids (Implication 3), and possibly also when the payment method includes equity (Implication 5). Thus, adding an outside financier starkly differentiates the predictions of this paper's theory from those in the prior theoretical literature.

Table 3 presents preliminary supportive evidence. The dependent variable in the reported regressions is the takeover premium, and the main independent variable of interest is non-debt—i.e., whether the acquirer has used non-debt financing for his cash bid. The regressions also include control variables that have been shown to be related to the takeover premium in the prior literature.

[24] In terms of odds ratios, acquirers in the smallest quintile are four times more likely to use non-debt financing. Martynova and Renneboog (2009) find similar results for a sample of European acquirers.

Table 2
Determinants of the use of non-debt financing for cash bids.

The table presents the marginal effects of logit regressions analyzing the determinants of the use of non-debt financing for cash bids. The dependent variable is Non-debt, which is a dummy variable equal to one if the acquirer uses common stock, preferred stock, a rights issue, or mezzanine financing to finance his cash payment. All variable definitions are in Table A1. The regressions in Models (1)–(3) use the full sample, Models (4) and (5) use only deals with U.S. acquirers, and Model (6) uses only deals in which multiple bidders are publicly observed. *Z*-statistics based on standard errors clustered by country and industry are presented in parentheses. ***, **, and * indicate significance at the 1%, 5%, and 10% level, respectively.

	Dependent variable: Non-debt					
	All countries			U.S. only		Mult. obs. bidders
	(1)	(2)	(3)	(4)	(5)	(6)
q1 (lowest size quintile)	0.217***	0.217***				0.206**
	(7.59)	(7.66)				(2.56)
q2	0.130***	0.129***				0.224***
	(4.92)	(4.94)				(3.29)
q3	0.107***	0.107***				
	(4.81)	(4.81)				
q4	0.057**	0.056**				
	(2.57)	(2.54)				
ln(Acquirer total assets)			−0.035***	−0.013*		
			(−8.08)	(−1.85)		
Age	0.000	0.000	0.000	−0.001		0.001
	(0.02)	(0.05)	(−0.35)	(−0.93)		(0.39)
HP index of fin. constr.					0.033**	
					(2.48)	
Acquirer has rating	−0.046**	−0.047***	−0.034*	−0.024**	−0.024*	−0.068
	(−2.55)	(−2.58)	(−1.95)	(−1.97)	(−1.86)	(−0.96)
Private acquirer	0.017	0.020	0.003	0.107***	0.113***	0.259***
	(0.23)	(0.27)	(0.04)	(2.87)	(2.94)	(3.16)
Recession	0.009					0.091
	(0.67)					(1.23)
Low growth		0.040***		0.005		
		(2.83)		(0.36)		
Weak credit growth					−0.0082	
					(−0.56)	
Multiple observed bidders	−0.118***	−0.117***	−0.133***	−0.126**	−0.082	
	(−2.60)	(−2.60)	(−3.19)	(−1.97)	(−1.30)	
EBIT/Sales	−0.001	−0.001	−0.001	0.003**	0.003**	0.197
	(−0.97)	(−0.92)	(−1.05)	(2.23)	(2.10)	(0.61)
EBITDA/TA	−0.107**	−0.106**	−0.092*	−0.053	−0.044	−0.092
	(−2.16)	(−2.14)	(−1.88)	(−0.70)	(−0.55)	(−0.15)
TL/TA	0.056***	0.056***	0.033**	0.043**	0.041**	0.494***
	(3.20)	(3.25)	(2.34)	(2.25)	(2.07)	(3.54)
PPE/TA	0.007	0.010	−0.056*	−0.018	−0.0175	−0.122*
	(0.25)	(0.33)	(−1.91)	(−0.56)	(−0.53)	(−1.65)
Country fixed effects	YES	YES	YES	NO	NO	YES
Industry fixed effects	YES	YES	YES	YES	YES	YES
Year fixed effects	NO	NO	YES	NO	NO	NO
N	6248	6248	6247	2742	2571	138
Pseudo R-squared	0.184	0.185	0.226	0.047	0.044	0.558

The regression in Model (1) is estimated using the full sample, while those in Models (2) and (3) using only U.S. acquirers and deals with multiple publicly observed bidders, respectively.

The regression estimates in Models (1) and (2) show that non-debt financing for cash bids is associated with a 5–8% lower takeover premium; this effect is statistically significant at the 1% and the 5% level respectively. The economic significance is also very large: these results show that the acquirer's source of financing can explain up to 20% of the mean premium in takeovers paid in cash (cf. Table 1). Furthermore, supporting Implication 5, the premiums for pure cash deals are significantly higher than those for deals involving equity payments. The coefficients on the control variables are in line with the existing literature (Betton, Eckbo, and Thorburn, 2008). For example, targets with a higher increase in the stock price in the 41 days preceding the announcement (runup) and targets that have adopted a poison pill enjoy higher premiums. In contrast, acquirers with a toehold pay lower premiums.

5.2.4. *Bidder returns*

The final set of results in Table 4 takes the bidders' perspective and tests the prediction of Implication 4 that bidder announcement returns are lower when cash bids are not financed with debt. The dependent variable in these regressions is the cumulative abnormal return to the bidder in the (−1,1) event window surrounding the takeover announcement.

Table 3
Determinants of target takeover premium.

The table provides ordinary least squares (OLS) regressions analyzing the determinants of the takeover premium. The dependent variable is the natural logarithm of the takeover premium, defined as the final offer price divided by the price 42 days prior to the announcement. All variable definitions are in Table A1. The regression in Model (1) uses the full sample, Model (2) uses only deals with U.S. acquirers, and Model (3) uses only deals in which multiple bidders are publicly observed. *T*-statistics based on standard errors clustered by country and industry are presented in parentheses. ***, **, and * indicate significance at the 1%, 5%, and 10% level, respectively.

	Dependent variable: Takeover premium		
	All countries (1)	U.S. only (2)	Mult. obs. bidders (3)
Non-debt	−0.052***	−0.082**	0.042
	(−2.99)	(−2.45)	(0.51)
Pure cash bid	0.027*	0.031	0.117*
	(1.76)	(1.27)	(1.83)
Bid 100% internally financed	0.005	−0.009	−0.062
	(0.33)	(−0.33)	(−0.89)
Acquirer has toehold	−0.063***	−0.047	−0.015
	(−3.14)	(−1.45)	(−0.27)
Hostile bid	0.019	0.037	−0.068
	(0.85)	(0.77)	(−1.09)
Poison pill	0.096**	0.082	0.085
	(2.12)	(1.46)	(1.00)
Runup	0.496***	0.530***	0.773***
	(10.14)	(8.56)	(8.68)
Horizontal merger	0.002	0.008	0.044
	(0.17)	(0.64)	(0.90)
Multiple observed bidders	0.076***	0.053	
	(2.77)	(1.15)	
q1 (lowest size quintile)	−0.001		0.261***
	(−0.03)		(2.71)
q2	0.031		0.017
	(1.01)		(0.17)
q3	−0.031*		−0.063
	(−1.85)		(−0.96)
q4	−0.035**		−0.126*
	(−2.39)		(−1.91)
ln(Acquirer total assets)		0.004	
		(0.60)	
Private acquirer	−0.020	0.001	−0.143
	(−0.28)	(0.01)	(−0.97)
Country fixed effects	YES	NO	YES
Industry fixed effects	YES	YES	YES
Year fixed effects	YES	YES	YES
N	1622	885	160
Adjusted R-squared	0.443	0.445	0.620

The main result is that, consistent with Implication 4, the market reacts significantly worse to takeovers in which the cash bid is not financed with debt. In such cases, the abnormal returns to bidders are between 40 and 70 basis points lower, and even lower in publicly contested deals. This difference is economically significant, as it accounts for more than half of the average bidder CARs in Table 1.[25] The remaining results are in line with the prior literature: the CARs are lower for hostile bids, when there are multiple publicly observed bidders, and for large acquirers that do not use external financing. The latter finding is in line with the predictions of the prior literature that, when a cash constraint is completely absent, acquirers might start wasting money on unprofitable investments (Jensen, 1986).

6. Conclusion

Financing is a critical aspect when a bidder's free cash on hand is insufficient to pay for his bid in large-scale auctions. This paper endogenizes the financing choice and its interaction with the bidding process in contested takeovers. Thus, it addresses a gap in the literature by connecting the literature on bidding with securities with the literature on bidding in takeovers, in which the type of external financing for bidders is assumed exogenously. On the one hand, the novel implications of the model provide for a better understanding of takeover prices when taking into account the endogeneity of the financing decision. In particular, the results could help explain existing empirical evidence that seems at odds with prior theory. On the other hand, the results could also help explain capital structure decisions of acquirers with restricted access to competitive financing, such as small, private, or young firms.

The analysis shows that financiers have a significant effect on bidding, not only through the cost of financing (e.g., interest rate on debt), but also through the type of financing (e.g., debt, equity, menus of securities). Taking into account that financing is endogenous, the main result is that financial contracting depends on whether bidders can finance their bids in a competitive market for capital. If a bidder cannot raise financing at competitive terms—e.g., because he is locked in to a financier—he raises financing by selling equity-like securities. This type of financing allows financiers to charge a higher price on any given cash bid that a bidder is rationally prepared to offer. In contrast, if bidders can finance their cash bids in a competitive market for capital, they issue debt. This is the cheapest financing contract from their perspective, as it allows them to bid less aggressively in the joint equilibrium of the bidding and the financing game.

The effect of these financing choices on takeover prices is as follows. Compared to when cash bids are internally financed, debt-financed cash bids are higher and there is overbidding. Conversely, equity-financed cash bids are lower and there is underbidding. This result highlights the importance of endogenizing the financing decisions. Specifically, adopting the results from the literature on bidding in securities would predict, instead, the lowest prices when bidders are not cash-constrained, higher prices for debt, and even higher prices for equity financing.

An extension of the model considers endogenizing the choice of the method of payment. The main insight is that bidders would choose to bid in equity only when they have difficulties raising external financing. Equity bids, which are a form of seller financing, are expensive for bidders, making

[25] Using a sample of 623 firms announcing a takeover in 1984–1998, Schlingemann (2004) finds that firms issuing equity in the year preceding the announcement have higher abnormal returns. Using, instead, information on the source of funds for cash bids, which is by now available in

(*footnote continued*)
SDC, all the results in Table 4 are robust also when restricting attention only to U.S. deals in 1984–1998.

Table 4
Determinants of bidder abnormal returns.

The table provides OLS regressions analyzing the determinants of the three-day bidder cumulative abnormal returns. The dependent variable is the bidder CARs measured in the event window (−1,1) with market model parameters over the estimation window (−210, −11) and home-market index returns as benchmarks. All variable definitions are in Table A1. The regression in Model (1) uses the full sample, Model (2) uses only deals with U.S. acquirers, and Model (3) uses only deals in which multiple bidders are publicly observed. *T*-statistics based on standard errors clustered by country and industry are presented in parentheses. ***, **, and * indicate significance at the 1%, 5%, and 10% level, respectively.

	Dependent variable: Bidder CAR (−1,+1)		
	All countries (1)	U.S. only (2)	Mult. obs. bidders (3)
Non-debt	−0.004**	−0.007**	−0.032*
	(−2.08)	(−2.17)	(−1.79)
Pure cash bid	0.001	−0.001	−0.007
	(0.26)	(−0.30)	(−0.78)
Bid 100% internally financed	−0.007***	−0.004**	0.007
	(−5.50)	(−2.27)	(0.67)
Acquirer has toehold	−0.002	−0.001	0.016*
	(−1.08)	(−0.30)	(1.69)
Hostile bid	−0.019***	−0.010***	−0.017
	(−3.94)	(−2.76)	(−1.52)
Poison pill	0.022***	0.017**	0.080***
	(2.69)	(2.28)	(3.78)
Horizontal merger	0.001	0.000	−0.005
	(0.59)	(−0.05)	(−0.53)
Multiple observed bidders	−0.010***	−0.007	
	(−2.65)	(−1.47)	
q1 (lowest size quintile)	0.018***		0.030
	(7.93)		(1.51)
q2	0.011***		−0.008
	(5.61)		(−0.56)
q3	0.007***		0.024**
	(3.52)		(2.47)
q4	0.003		−0.002
	(1.57)		(−0.25)
ln(Acquirer total assets)		−0.005***	
		(−7.53)	
Private target	0.000	−0.003*	−0.018
	(−0.22)	(−1.85)	(−0.66)
Country fixed effects	YES	NO	YES
Industry fixed effects	YES	YES	YES
Year fixed effects	YES	YES	YES
N	9260	3634	210
Adjusted R-squared	0.023	0.029	0.207

takeover premiums actually lower than when bidders are not cash-constrained. In such cases, when the seller agrees to accept security bids, her benefit does not come from a higher takeover premium, but from effectively undervaluing the acquirer's shares, allowing her to obtain a larger claim on the cash flows of the newly combined firm.

Overall, the analysis highlights that endogenizing the choice of financing for cash bids is just as important as the method of payment in takeovers. Preliminary empirical results show that firms with more restricted access to competitive financing—such as smaller firms, firms in countries with less-developed capital markets, and private firms—are more likely to finance their cash bids by issuing equity. Given that the evidence shows that such acquirers tend to bid 5–8% less than acquirers financed with debt, it seems that bidding distortions and welfare loss are potentially significant. Future research might address how acquirers actively try to circumvent bidding inefficiencies resulting from financing frictions—e.g., by optimally timing their initial bids or by hoarding cash.

Appendix A. Omitted Proofs

Proof of Lemma 1. Let $\theta' > \theta$. Since R is a non-decreasing function on a compact set, it is differentiable almost everywhere and $R'(X,\cdot) \geq 0$. A straightforward implication of SMLRP is that $G(X|\theta')$ dominates $G(X|\theta)$ in terms of first-order stochastic dominance. Thus, it holds

$$\int_X R(x,\cdot)\left(g(x|\theta') - g(x|\theta)\right)\,dx = -\int_X R'(x,\cdot)\left(G(x|\theta') - G(x|\theta)\right)\,dx > 0,$$

where the equality follows from integration by parts. The result for the bidder's claim can be shown analogously.□

Proof of Lemma 2. The bidder's expected payoff for a takeover payment y is

$$\int_X x\,dG(x|\theta_i) + (y-w) - y - \int_X R(x,y)\,dG(x|\theta_i),$$

where the first term is the bidder's expected valuation of the asset. The second and the third terms say that, upon winning, the bidder must raise the money he does not have to pay his bid and then pay it to the seller. Finally, the last term stands for the expected security payment to the financier. In what follows, it is assumed that when the bidder is indifferent between two bids, he makes the higher bid.

(i) Suppose that the expected repayment to the financier, holding R, is not continuously increasing in y and that $B_i(\theta_i)$ is not empty (else, the bidder never makes a bid). Consider a bid $b \notin B_i(\theta_i)$ for which $\int_X R(x,b))\,dG(x|\theta_i) + w > \int_X x\,dG(x|\theta_i)$. Let y' be the highest element of $B_i(\theta_i)$ which is smaller than b. In such case, by bidding y' instead of b the bidder increases his expected payoff as the only situations he eliminates are ones in which he expects to make a loss. Instead, if $b \notin B_i(\theta_i)$ and $\int_X R(x,b)\,dG(x|\theta_i) + w \leq \int_X x\,dG(x|\theta_i)$, let y' be the smallest element of $B_i(\theta_i)$ which is larger than b. Then, bidding y' increases the bidder's expected payoff as it increases his probability of winning in states for which he still makes a profit (without adding states for which he does not). Thus, bidding $b \notin B_i(\theta_i)$ could not have been optimal, and the bidder chooses $b \in B_i(\theta_i)$, which maximizes his expected payoff taking into account the associated probabilities of winning and the distribution of the second-highest bid.[26]

(ii) Consider type θ_i and suppose that the expected repayment to the financier, holding R, is continuously increasing in y. It holds

$$y'' > y' \Longleftrightarrow \int_X R(x,y'')\,dG(x|\theta) \geq \int_X R(x,y')\,dG(x|\theta), \qquad \text{(A.1)}$$

implying that $B_i(\theta_i)$ is a singleton and that the standard characterization of the SPA applies (Krishna, 2002): For every type θ_i, it is a weakly dominant strategy to submit a cash bid for which he would just break even conditionally on paying this bid—i.e., $\beta_i(\theta_i)$ solves (3).□

[26] Introducing a fine for not raising financing would induce the bidder to bid more than his valuation. As in most related papers, such a fine and how it is optimally set is not modeled, however.

Table A1
Variable definitions.
The table describes the variables used in the empirical analysis in alphabetical order.

Variable	Definition
Acquirer has rating	Equals one if the acquirer has a rating
Acquirer has toehold	Equals one if the acquirer already has a stake in the target
Acquirer total assets	The acquirer's total assets in 1980 million USD, where the inflation adjustment is made using the consumer price index at the end of the respective year
Age	The acquirer's age in years, capped at 37 years.
Bid 100% internally financed	Equals one if the whole cash offer is financed with internally generated cash
Bidder CAR($-1,+1$)	"Three-day bidder cumulative abnormal returns (CAR) calculated for the event window (-1,1) using market model parameters over the 200-day period from event day -210 to event day -11 and home-market index returns as benchmarks"
Corporate funds	Equals one if the cash bid is paid at least partially with internally generated cash
Debt	Equals one if the acquirer finances the cash bid with debt financing, defined as borrowing, bridge loan, line of credit, debt or junk bond issue, or foreign lending
EBIT/ Sales	The acquirer's EBIT over sales for the last 12 months (LTM) ending on the date of the most current financial information prior to the announcement
EBITDA/TA	The acquirer's EBITDA over total assets in the LTM
Horizontal merger	Equals one if the acquirer and the target are within the same two-digit SIC code
Hostile bid	Equals one if the acquirer makes a hostile bid.
HP index of fin. constr.	"Hadlock and Pierce's (2010) index of financial constraints, defined as $-0.737\text{Size}+0.043\text{Size}^2-0.04\text{Age}$, where Size is defined as ln(Acquirer total assets), which is capped at the (log of) \$4.5 billion"
ln(Acquirer total assets)	The natural logarithm of Acquirer total assets (in 1980 mUSD)
Low growth	Equals one if the gross domestic product (GDP) growth in the quarter of the takeover is below the 25th percentile since 1971
Multiple observed bidders	Equals one if there are multiple publicly observed bidders
Non-debt	Equals one if the acquirer finances the cash bid with non-debt financing, defined as a common stock, a preferred stock, or a rights issue, or mezzanine financing
Poison pill	Equals one if the target has adopted a poison pill
PPE/TA	The acquirer's ratio of property, plant, and equipment to total assets in the LTM
Private acquirer	Equals one if the acquirer is a private firm
Private target	Equals one if the target is a private firm
Pure cash bid	Equals one if the acquirer makes a pure cash offer
q1–q5	Equal one if the acquirer is in the respective size quintile where q1 is the lowest quintile
Recession	Equals one if the takeover takes place in a recession according to the Organisation for Economic Co-operation and Development(OECD) definition
Runup	The cumulative return of the target's stock in the 41 days preceding the announcement
Takeover premium	The takeover premium calculated as the natural logarithm of the final offer price over the price 42 days prior to the announcement
TL/TA	The acquirer's total liabilities over total assets in the LTM
Weak credit growth	Equals one if banks tighten their lending standards to large and medium-sized firms according to the "Senior Loan Officer Opinion Survey on Bank Lending Practices" by the Federal Reserve

Proof of Proposition 1. (ii) The proof shows that in the special case in which all types and all bidders are financed with the same contract, and the security type is the same for all potential payments y, the bidders' payoffs are the same as in a security-bid auction. In the equilibrium of the bidding game, if all types θ_{-i} report truthfully, bidder θ_i also reports truthfully.[27] Hence, for every realization of types, $\beta_i(\theta_i)$ satisfies

$$\theta_i \in \arg\max_{\hat{\theta}_i} \mathrm{E}_{\theta_{-i}}\left[\begin{array}{c} \left(\int_X \left(x - R\left(x, y(\beta_i(\hat{\theta}_i), \beta_{-i}(\theta_{-i}))\right)\right) \mathrm{d}G(x|\theta_i) - w\right) \\ \times P(\beta_i(\hat{\theta}_i), \beta_{-i}(\theta_{-i})) \end{array} \right]. \tag{A.2}$$

The key step now is to rewrite the above problem as one of choosing the optimal expected security payment instead of the cash bid β. This will relate the problem to that in the literature on bidding in securities.

Precisely, to make the analysis more tractable, this literature has restricted attention to bidding in securities which can be ranked independent of the bidder's type. Let s_R denote the "order" of a security as defined in DeMarzo, Kremer, and Skrzypacz (2005) (and so we write $R(x, s_R)$). For example, bidding in debt corresponds to bidding with the promised debt repayment. In this case, the order s_R corresponds to this repayment. Similarly, the order s_R corresponds to the offered equity share when bidding in equity, and it is the strike price in the case of call and put options.

Observe now that when R increases in y for all types, there is a one-to-one correspondence between the payment $y(\theta_i, \theta_{-i})$ and the order of the security corresponding to this payment $s_R(y(\theta_i, \theta_{-i}))$ (Lemma 2), so we can write for simplicity $s_R(\theta_i, \theta_{-i})$. Furthermore, when all types and all bidders are financed with the same contract, ranking cash bids is equivalent to ranking security bids: $P(s_R(\theta_i, \theta_{-i})) = P(\beta_i(\theta_i), \beta_{-i}(\theta_{-i}))$. This implies that (A.2) can be restated as

$$\theta_i \in \arg\max_{\hat{\theta}_i} \mathrm{E}_{\theta_{-i}}\left[\left(\left(\int_X \left(x - R\left(x, s_R(\hat{\theta}_i, \theta_{-i})\right)\right)dG(x|\theta_i) - w\right) P(s_R(\hat{\theta}_i, \theta_{-i}))\right].$$

This is, however, the same problem that bidders solve in a security-bid auction. Hence, when all types and all bidders

[27] Using the Revelation Principle, we could model the bidding game as a message game. Note also that the proof applies to a wider set of auction formats, such as the first-price-auction.

are financed with the same type of contract for all payments whose expected payoff is increasing in y, the bidders' expected security repayments (and, thus, payoffs) are also the same as in such an auction. Thus, in this special case, any change in the cost of financing for a given security type (e.g., debt, equity) is fully passed on to the seller.□

Proof of Proposition 2. In what follows, $P(\beta_i(\theta_i), \beta_{-i}(\theta_{-i}))$ and $y(\beta_i(\theta_i), \beta_{-i}(\theta_{-i}))$ are written for brevity as $P(\theta_i, \theta_{-i})$ and $y(\theta_i, \theta_{-i})$, but it should be kept in mind that P and y depend on the financing contracts used by the bidders. The proof shows only the claim for debt financing. The opposite claim for levered equity financing can be shown following similar steps.

Observe, first, that the equilibrium bidding strategy described in Lemma 2 implies that even if different types sign the same financing contract at $t=1$, they separate with their bids at $t=2$ (though the financier observes only the second-highest bid). By stating and reformulating the incentive constraint, it is shown in what follows that debt financing most easily implements such interim separation by reducing the ex ante incentives to deviate to the financing contract and bidding strategies of other types.

Step 1. *Reformulating the incentive constraint*: Suppose that bidders sign non-debt, possibly type- and payment-dependent contracts. It is convenient to define

$$v(y,\theta_i) := \int_X R(x,y)\, dG(x|\theta_i) - (y-w) \tag{A.3}$$

as the type-dependent difference between the true expected value of R in $t=2$ and the amount raised from the financier when the bidder follows his prescribed equilibrium strategy. This "mispricing" difference reflects the financiers's interim gain/loss at $t=2$ from providing financing for y. One can now reformulate the incentive constraints (7) for type θ_i' who considers deviating to security contract $\widehat{R}$, issued in equilibrium by type $\widehat{\theta}_i$, and then bidding as some higher type θ_i'' (i.e., $\beta_i(\theta_i'') > \beta_i(\theta_i')$) as

$$\begin{aligned} &\mathrm{E}_{\theta_{-i}}\left[\left(\int_X \left[\widehat{R}(x, y(\theta_i',\theta_{-i})) - R(x, y(\theta_i',\theta_{-i}))\right] dG(x|\theta_i')\right) P(\theta_i',\theta_{-i})|A\right] \\ &\quad \geq \mathrm{E}_{\theta_{-i}}\left[\left(\int_X \left[x - \widehat{R}\left(x, y(\theta_i'',\theta_{-i})\right)\right] dG(x|\theta_i') - w\right) P(\theta_i'',\theta_{-i})\Big|B\right], \end{aligned} \tag{A.4}$$

where the sets A and B contain the realizations of θ_{-i} such that the second-highest bid is below $\beta_i(\theta_i')$ and between $\left[\beta_i(\theta_i'), \beta_i\left(\theta_i''\right)\right]$, respectively. The incentive constraint when θ_i'' is a lower type (i.e., $\beta_i\left(\theta_i''\right) < \beta_i(\theta_i')$) is

$$\begin{aligned} &\mathrm{E}_{\theta_{-i}}\left[\left(\int_X \left[\widehat{R}(x, y(\theta_i',\theta_{-i})) - R(x, y(\theta_i',\theta_{-i}))\right] dG(x|\theta_i')\right) P(\theta_i',\theta_{-i})|A'\right] \\ &\quad \geq -\mathrm{E}_{\theta_{-i}}\left[\left(\int_X [x - R(x, y(\theta_i',\theta_{-i}))]\, dG(x|\theta_i') - w\right) P(\theta_i',\theta_{-i})|B'\right], \end{aligned} \tag{A.5}$$

where the sets A' and B' contain the realizations of θ_{-i} such that the second-highest bid is below $\beta_i\left(\theta_i''\right)$ and between $\left[\beta_i\left(\theta_i''\right), \beta_i(\theta_i')\right]$, respectively. Note that we have used that in regions A and A' the cash payment and the allocation rule are the same as without deviation—i.e., $y(\theta_i',\theta_{-i}) = y(\theta_i'',\theta_{-i})$ and $P(\theta_i',\theta_{-i}) = P(\theta_i'',\theta_{-i})$ for $\theta_{-i} \in A$ and $\theta_{-i} \in A'$.

Using (A.3) to plug in for $R(\cdot)$ and $\widehat{R}(\cdot)$, the integral inside the expectation operator in the first line of (A.4) can be rewritten as

$$v(y,\widehat{\theta}_i) - v(y,\theta_i') - \int_X \widehat{R}(x, y(\theta_i',\theta_{-i}))\left(dG(x|\widehat{\theta}_i) - dG(x|\theta_i')\right)$$

for any given y. Analogously rewriting the second line, the incentive constraint (A.4) can be stated only in terms of $\widehat{R}$, y, and the "mispricing" terms $v(y,\cdot)$ in the proposed equilibrium:

$$\begin{aligned} &\mathrm{E}_{\theta_{-i}}\Big[-\left(\int_X \widehat{R}(x, y(\theta_i',\theta_{-i}))\left(dG(x|\widehat{\theta}_i) - dG(x|\theta_i')\right)\right. \\ &\qquad \left. + v(y(\theta_i',\theta_{-i}),\widehat{\theta}_i) - v(y(\theta_i',\theta_{-i}),\theta_i')\right) P(\theta_i',\theta_{-i})|A\Big] \\ &\quad \geq \mathrm{E}_{\theta_{-i}}\Big[\Big(\left(\int_X \widehat{R}\left(x, y(\theta_i'',\theta_{-i})\right)\right)\left(dG(x|\widehat{\theta}_i) - dG(x|\theta_i')\right) \\ &\qquad + \int_X x\, dG(x|\theta_i') - y(\theta_i'',\theta_{-i}) - v(y(\theta_i'',\theta_{-i}),\widehat{\theta}_i)\Big) P(\theta_i'',\theta_{-i})\Big|B\Big] \end{aligned} \tag{A.6}$$

and (A.5) can be similarly stated as

$$\begin{aligned} &\mathrm{E}_{\theta_{-i}}\Big[-\left(\int_X \widehat{R}(x, y(\theta_i',\theta_{-i}))\left(dG(x|\widehat{\theta}_i) - dG(x|\theta_i')\right)\right. \\ &\qquad \left. + v(y(\theta_i',\theta_{-i}),\widehat{\theta}_i) - v(y(\theta_i',\theta_{-i}),\theta_i')\right) P(\theta_i',\theta_{-i})|A\Big] \\ &\geq \mathrm{E}_{\theta_{-i}}\left[\left(v(y(\theta_i',\theta_{-i}),\theta_i) + y(\theta_i',\theta_{-i}) - \int_X x\, dG(x|\theta_i')\right) P(\theta_i',\theta_{-i})|B\right]. \end{aligned} \tag{A.7}$$

Step 2. *Financing all payments with debt relaxes the upward incentive constraints regardless of bidding*: Suppose that $\widehat{R}$ (used by type $\widehat{\theta}_i$) is not debt for some payment $y=y'$. Construct instead a financing contract $\tilde{R}$, which is debt for y' and otherwise identical to $\widehat{R}$ for all other payments. Furthermore, $\tilde{R}$ is such that type $\widehat{\theta}_i$ is indifferent between $\widehat{R}$ and $\tilde{R}$ for every y:

$$\int_X \widehat{R}(x,y)\, dG(x|\widehat{\theta}_i) = \int_X \tilde{R}(x,y)\, dG(x|\widehat{\theta}_i) = y - w + v(y,\widehat{\theta}_i).$$

Observe now that for payment y', an important property of the debt security $\tilde{R}$ is that it crosses the non-debt security $\widehat{R}$ in X exactly once from above for some $\widehat{x} > 0$. Hence, $\tilde{R} \geq \widehat{R}$ for $x < \widehat{x}$ with the inequality being strict at least for some x and vice versa otherwise. Using this, we obtain

$$\begin{aligned} &\int_0^{\widehat{x}} \left(\widehat{R}(x,y) - \tilde{R}(x,y)\right) dG(x|\theta_i') + \int_{\widehat{x}}^{\infty} \left(\widehat{R}(x,y) - \tilde{R}(x,y))\right) dG(x|\theta_i') \\ &\quad = \int_0^{\widehat{x}} \left(\widehat{R}(x,y) - \tilde{R}(x,y)\right) \frac{g(x|\theta_i')}{g(x|\widehat{\theta}_i)}\, dG(x|\widehat{\theta}_i) \\ &\qquad + \int_{\widehat{x}}^{\infty} \left(\widehat{R}(x,y) - \tilde{R}(x,y)\right) \frac{g(x|\theta_i')}{g(x|\widehat{\theta}_i)}\, dG(x|\widehat{\theta}_i) \\ &\quad < \frac{g(\widehat{x}|\theta_i')}{g(\widehat{x}|\widehat{\theta}_i)} \left(\int_0^{\widehat{x}} \left(\widehat{R}(x,y) - \tilde{R}(x,y)\right) dG(x|\widehat{\theta}_i)\right. \\ &\qquad \left. + \int_{\widehat{x}}^{\infty} \left(\widehat{R}(x,y) - \tilde{R}(x,y)\right) dG(x|\widehat{\theta}_i)\right) = 0. \end{aligned}$$

where the inequality follows by SMLRP for any $\theta_i' < \widehat{\theta}_i$, implying that

$$\int_X \widehat{R}(x,y)\left(dG(x|\widehat{\theta}_i)-dG(x|\theta_i')\right) > \int_X \tilde{R}(x,y)\left(dG(x|\widehat{\theta}_i)-dG(x|\theta_i')\right).$$

Applying this to the incentive constraints in Step 1, we see that for any given y and $v(y,\theta)$, debt relaxes the "upward" incentive constraints requiring that a bidder should have no incentive to deviate to the *financing contract* of a higher type ($\widehat{\theta}_i > \theta_i'$) and bidding as a potentially different type $\theta_i'' \neq \theta_i'$ (regardless of whether lower or higher, cf. (A.6) and (A.7)).□

Proof of Proposition 3. The proof proceeds in two steps. It shows, first, that for any *given* bidding strategy $\beta(\theta)$ a bidder should rationally be induced to follow, the financier maximizes his profit by offering the bidder, regardless of his type, a single contract that stipulates levered equity financing for all payments. Step 2 shows then that it is optimal to make financing disproportionately more expensive for lower payments. Recall, in what follows, that the subscripts of β and θ are omitted for notational simplicity, but that this does *not* imply that bidders are symmetric and that they have the same access to competitive financing.

Step 1. *Optimality of levered equity*: Take the lowest type and suppose that this type is financed with contract $R_{\underline{\theta}}(X,\beta(\underline{\theta}))$. It is optimal for the financier to extract all surplus from type $\underline{\theta}$ by stipulating that $\int_X R_{\underline{\theta}}(x,y)\, dG(x|\underline{\theta}) + w = \int_X x\, dG(x|\underline{\theta})$ for all $y \leq \beta(\underline{\theta})$. Thus, the lowest type always makes zero profit.[28]

Let the next higher type be θ'. Consider the contract offered to type θ' for payments $y > \beta(\underline{\theta})$. The best the financier could do is to extract all surplus from type θ' for $y \in (\beta(\underline{\theta}), \beta(\theta')]$, whatever bidding strategy $\beta(\theta')$ the contract should induce from this type. Similarly to above, extracting all surplus is feasible by stipulating the same repayment $R_{\theta'}(X,y)$ for all payments $y \in (\beta(\underline{\theta}), \beta(\theta')]$. Note that since type θ' is making a zero profit on these payments, it must be made sure that he has no incentive to mimic the contract of type $\underline{\theta}$. By arguments analogous to Step 2 in Proposition 2, it can be shown that this is easiest to achieve by financing type $\underline{\theta}$ with levered equity for $y \leq \beta(\underline{\theta})$. Thereby, it should hold $\int_X (x - R_{\theta'}(x,y) - w)\, dG(x|\theta') \geq \int_X \left(x - R_{\underline{\theta}}(x,y) - w\right) dG(x|\theta')$, and where by optimality for the financier, this incentive constraint should hold with equality. This requirement could be ensured by financing both types with the same levered equity contract for $y \leq \beta(\underline{\theta})$—i.e., $R_{\theta'}(X,y) = R_{\underline{\theta}}(X,y)$—which also ensures that type $\underline{\theta}$ (who makes a zero profit) does not mimic type θ'. Thus, levered equity is the most expensive financing contract for type θ' when effectively pooled with type $\underline{\theta}$ for payments $y \leq \beta(\underline{\theta})$.

Consider the next higher type θ''. Analogously to above, the financier will extract the full surplus from type θ'' for payments $y \in (\beta(\theta'), \beta(\theta'')]$. Again, to make sure that θ'' does not mimic θ', type θ''s contract should be levered equity, and it is optimal to stipulate the same contract for both types for payments $y \leq \beta(\theta')$. Repeating this argument for all types yields the result.

Step 2. *Bidding strategies*: Let $\beta_C(\theta)$ be the cash bid of a non-constrained bidder, where it holds $\beta_C(\theta) = \int_X x\, dG(x|\theta)$. Note that it is never optimal for the financier to induce a bidding strategy $\beta(\theta) > \beta_C(\theta)$, as he would make a loss for all payments $y \in (\beta_C(\theta), \beta(\theta)]$.

We show, next, that $\beta\left(\overline{\theta}\right) = \beta_C\left(\overline{\theta}\right)$. Suppose to the contrary that $\beta\left(\overline{\theta}\right) < \beta_C\left(\overline{\theta}\right)$ for a levered equity contract $R(X,y)$ (offered to all types). Construct an alternative financing contract $\tilde{R}(X,y)$ which is identical to $R(X,y)$ for $y \leq \beta\left(\overline{\theta}\right)$—i.e., all types $\theta < \overline{\theta}$ make the same bids as before—but stipulates the same repayment to the financier for all payments $y \in [\beta\left(\overline{\theta}\right), \beta_C\left(\overline{\theta}\right)]$. This makes it optimal for type $\overline{\theta}$ to bid $\beta_C\left(\overline{\theta}\right)$. The financier now extracts the same surplus on all types for $y \leq \beta\left(\overline{\theta}\right)$, but discretely increases the probability of winning of type $\overline{\theta}$, thereby making additional profits whenever $y \in (\beta\left(\overline{\theta}\right), \beta_C\left(\overline{\theta}\right)]$. Thus, offering a contract for which $\beta\left(\overline{\theta}\right) < \beta_C\left(\overline{\theta}\right)$ could not have been optimal.

We show, finally, that $\beta(\underline{\theta}) < \beta_C(\underline{\theta})$. If $\beta_C(\underline{\theta})$ is the lowest competing bid that could be expected, both type $\underline{\theta}$ and the financier make zero profit for $\beta(\underline{\theta}) = \beta_C(\underline{\theta})$.[29] Thus, the financier strictly benefits from making $R(X, \beta_C(\underline{\theta}))$ more expensive, which allows him to extract a higher profit on all higher types $(\underline{\theta}, \overline{\theta}]$ (who have the same contract for $\beta(\underline{\theta})$ by Step 1). The exact trade-off between rent extraction and efficiency (i.e., effectively excluding low types from bidding by providing too expensive financing) depends on the distribution of θ and the expectation over the financing contracts of the competing bidders.□

Proof of Proposition 4. The proof proceeds in three steps. Step 1 shows that the only candidate for an equilibrium of the signaling game is financing all payments with debt, and it features no cross-subsidization across types. Step 2 constructs a fully separating debt contract schedule for every type, and Step 3 shows that this debt financing strategy can be supported as an equilibrium.

Step 1. Observe first that an equilibrium with cross-subsidization across types does not survive the equilibrium refinement discussed above. Take two adjacent types $\theta'' > \theta'$ and suppose that, due to being financed with the same contract R, type θ'' cross-subsidizes θ' or a lower type. Thus, the financier (who in expectation breaks even) makes ex post a profit on types θ''. From Lemma 2, it must

[28] If $\underline{\theta}$ is not the lowest type that receives financing, replace $\underline{\theta}$ with that type. Recall that it is assumed that if the bidder is indifferent between two cash bids, he makes the higher one.

[29] Note that making the argument for this case is sufficient: In this case the incentives of the financier to offer a contract for which $\beta(\underline{\theta}) = \beta_C(\underline{\theta})$ are maximal as otherwise this type will be effectively excluded from bidding.

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be that $\beta\left(\theta''\right) \geq \beta(\theta')$ with the inequality being strict if $\int_X R(x,y)\, dG(x|\cdot)$ is continuously increasing at $y=\beta(\theta')$. Suppose that this is, indeed, the case and $\beta\left(\theta''\right) > \beta(\theta')$.[30] Construct now a deviation contract with the following properties: (i) It is identical to R for all payments $y \leq \beta(\theta')$; (ii) while still increasing in y, it stipulates a marginally lower repayment than R for $\beta\left(\theta''\right)$ and (infinitely) higher repayments for $y > \beta\left(\theta''\right)$.[31] Thus, the deviation contract is such that only types $[\theta'', \theta''')$ (who would then optimally bid $\beta\left(\theta''\right)$ with the deviation contract) have a strictly higher deviation payoff conditional on acceptance $(d=Y)$ than on the equilibrium path. By the stipulated equilibrium refinement, the financier should, therefore, place probability one on the deviation coming from $[\theta'', \theta''')$. The claim follows now by observing that the deviation can be constructed such that the financier at least breaks even when accepting for *any* beliefs over this set of types. This follows from the fact that the financier makes an expected profit on type θ'' when he is financed with R, implying that there is scope for offering cheaper financing for $\beta\left(\theta''\right)$ such that the financier at least breaks even for this type. But by Lemma 1 he would then also at least break even for the higher types (θ'', θ''').

We show, next, that a non-debt contract will also not survive as an equilibrium. Take the highest type θ'' who offers a contract that is non-debt for at least some payments. From the previous paragraph, the financier must break even for this type. From Proposition 2, by offering a debt contract for which he has the same expected payments for all y, type θ'' would be deviating to a contract that is less attractive for all lower types than their equilibrium contracts. But, since the upward incentive constraint is relaxed, this also gives the bidder the additional flexibility to offer an alternative deviation debt contract, which is still unattractive for lower types, but stipulates different repayments (potentially lower for some y, while higher for others) and make type θ'' strictly better off. In particular, type θ'' has the option to offer a deviation contract with the following properties: (i) While still being worse for lower types than their equilibrium contract, it stipulates weakly lower debt repayments for at least some $y < \beta\left(\theta''\right)$, in exchange for higher repayments for y closer to (and potentially equal) to $\beta\left(\theta''\right)$, and (infinitely) higher repayments for $y > \beta\left(\theta''\right)$. Thus, (conditional on acceptance) the deviation contract yields a higher expected payoff than on the equilibrium path only for types $[\theta'', \theta''')$ (who then bid at most $\beta(\theta'')$), and the financier's refined beliefs should place probability one on the deviation coming from $[\theta'', \theta''')$. (ii) The financier at least breaks even for beliefs placing probability one on type θ'' and, therefore, by Lemma 1 for *any* beliefs over $[\theta'', \theta''')$. Thus, the only equilibrium candidate is with debt financing. As illustrated next, by allowing for lower cross-subsidization across payments, debt financing gives the bidder the flexibility to offer contracts which allow him to *optimally* make also lower cash bids,[32] while enjoying cheaper financing for lower takeover payments.

Step 2: Given the insights from Step 1, the proof constructs now a separating equilibrium in which all types offer contracts, stipulating a debt repayment for every y, and satisfying the financier's ex ante participation constraint

$$E_{\theta_{-i}}\left[\int_X \left(R(x, y(\theta_i, \theta_{-i})) - y(\theta_i, \theta_{-i}) + w\right)\, dG(x|\theta_i) P(\theta_i, \theta_{-i})\right] = 0 \quad \text{for every } \theta_i. \tag{A.8}$$

Consider the following separating financing strategies where bidders offer debt for all payments. Suppose that type $\underline{\theta}$ offers a debt contract $R_{\underline{\theta}}(X,y)$ for which the financier breaks even for $y \leq \beta(\underline{\theta})$ where, as shown below, type $\underline{\theta}$ offers $\beta(\underline{\theta}) = \beta_C(\underline{\theta})$. If there are multiple such debt contracts, consider only those that maximize type $\underline{\theta}$'s expected payoff.

Let the next higher type be θ'. Clearly, offering a debt contract that stipulates that the financier at most breaks even in expectation for type θ' if $y \leq \beta(\underline{\theta})$ is not incentive-compatible, as this contract will be mimicked by type $\underline{\theta}$. However, for any other debt financing contract type θ' would in expectation be repaying more than he has borrowed for $y \leq \beta(\underline{\theta})$ (Lemma 1). Thus, for the financier to break even ex ante, it must be that the financier agrees not to break even for some payments higher than $\beta(\underline{\theta})$. From all debt contracts that satisfy these requirements, consider only those that maximize type θ''s expected payoff. Note that if competing bidders also have access to competitive financing or are not cash-constrained, the next higher bid made by the bidder cannot be $\beta_C(\theta')$. Given the cheaper financing for the next higher payment, Lemma 2 implies that types θ' would actually like to bid $\beta(\theta') > \beta_C(\theta')$.

Consider the next higher type θ''. Analogous to above, the debt-contract terms for type θ'' for payments $y \leq \beta(\theta')$ must be the same or worse than those for type θ', as otherwise θ' would mimic θ''. To compensate the bidder for this, the financier accepts a lower debt repayment (than needed to break even) for payments higher than $\beta(\theta')$ (so that if all bidders have access to competitive financing or are not cash-constrained, it will hold again that $\beta(\theta'') > \beta_C(\theta'')$). Consider again only the debt contracts that maximize type θ'''s expected payoff. Repeating this argument for all types generates all incentive-compatible

[30] If not, the same argument as below can be made by offering a deviation contract which is identical to R for $y \leq \beta(\theta')$ and continuously increasing at $\beta(\theta')$. Furthermore, if it is type θ' who subsidizes θ'', the argument below can again be modified by deviating to a contract which is identical to R for $y < \beta(\theta')$, marginally cheaper for $\beta(\theta')$, and infinitely more expensive for $y > \beta(\theta')$.

[31] For this to be true for all types, we could take the deviation contract to be the same security type as R for all y.

[32] Note that by Lemma 2, more expensive financing for $\beta\left(\theta''\right)$ will induce the bidder to bid lower.

separating (debt) contracts that maximize the bidder's expected payoff. Let Ω denote the set of these contracts. Since, by construction, the bidder is indifferent among all contracts in this set, it can be assumed that he chooses each of these contracts with equal probability.

Finally, observe that the cash bids must be the same for all contracts in Ω. Let $H(y)$ be the probability that the second-highest bid is y. If type $\widehat{\theta}$ is indifferent between R and $\widehat{R}$ (where $R, \widehat{R} \in \Omega$) with respective bidding strategies $\beta(\widehat{\theta})$ and $\widehat{\beta}(\widehat{\theta})$, the financier's participation constraint (A.8) can be rewritten as

$$\begin{aligned}
0 = & \sum_{y=\underline{b}}^{\beta(\widehat{\theta})} \int_X (x-y)\, dG(x|\widehat{\theta})H(y) \\
& - \sum_{y=\underline{b}}^{\beta(\widehat{\theta})} \int_X (x - R(x,y) - w)\, dG(x|\widehat{\theta})H(y) \\
= & \sum_{y=\underline{b}}^{\widehat{\beta}(\widehat{\theta})} \int_X (x-y)\, dG(x|\widehat{\theta})H(y) \\
& - \sum_{y=\underline{b}}^{\widehat{\beta}(\widehat{\theta})} \int_X \left(x - \widehat{R}(x,y) - w\right) dG(x|\widehat{\theta})H(y) \\
= & \sum_{y=\underline{b}}^{\widehat{\beta}(\widehat{\theta})} \int_X (\widehat{R}(x,y) - y + w)\, dG(x|\widehat{\theta})H(y) \quad \text{only if } \beta(\widehat{\theta}) = \widehat{\beta}(\widehat{\theta}),
\end{aligned}$$

where $\underline{b}$ is the lowest expected cash bid. Furthermore, a straightforward modification of this argument (omitted for brevity) shows that type $\underline{\theta}$ is better off with a security R which induces him to bid $\beta_C(\underline{\theta})$ than with security $\tilde{R}$ which induces him to bid $\beta(\underline{\theta}) \neq \beta_C(\underline{\theta})$, where the financier breaks even for both R and $\tilde{R}$. Since offering a financing contract for which the financier breaks even for all $y \leq \beta_C(\underline{\theta})$ and that induces type $\underline{\theta}$ to offer $\beta_C(\underline{\theta})$ can always be supported, it must be that $\beta(\underline{\theta}) = \beta_C(\underline{\theta})$.

Step 3: One can now argue that there is no profitable deviation from the financing strategy in Step 2. Suppose that the financier observes a deviation to a contract that is not in Ω and that (if accepted) makes at least one type better off than on the equilibrium path. Let type θ' be the lowest type who is strictly better off deviating (conditional on acceptance).[33] Suppose that for beliefs placing probability one on that type, the financier would at least break even. However, by construction of Ω, contracts for which types $\theta < \theta'$ are better off with their equilibrium contracts, which maximize type θ''s payoff and for which the financier at least breaks even for beliefs placing probability one on that type, must already be contained in Ω. Thus, it cannot be that the financier breaks even, making rejection a best response for beliefs consistent with the stipulated equilibrium refinement.□

Proof of Proposition 6. As explained in the main text, this section only focuses on the ascending English auction (cf. footnote 17). The proof proceeds in two steps. It discusses, first, how the seller will treat security bids and then discusses how bidders will choose between cash and security bids.

Step 1. *Evaluating security bids in an English auction*: The maximum security bid $\tilde{R}$ a bidder of type $\tilde{\theta}$ would make in an English auction is the one for which he would just break even

$$\int_X \tilde{R}(x)\, dG(x|\tilde{\theta}) + w = \int_X x\, dG(x|\tilde{\theta}). \tag{A.9}$$

Suppose that the seller treated every security bid as if it were the highest bid that the respective bidder were willing to make. Then, if the seller observes security bid $\tilde{R}$ she would treat it as if it were coming from type $\tilde{\theta}$. Regardless of the type of security used, such treatment attributes the following value to this security bid:

$$c(\tilde{R}) := \int_X \tilde{R}(x)\, dG(x|\tilde{\theta}) + w = \int_X x\, dG(x|\tilde{\theta}),$$

which is the same value as $\tilde{\theta}$'s *maximum* cash bid in an auction in which he is not cash-constrained ($\beta_C(\tilde{\theta}) = \int_X x\, dG(x|\tilde{\theta})$). Thus, given such a treatment, the last remaining cash or security bid in an English auction would also be the one with the highest value.

It remains to argue that the seller will ex post attribute at most a value $c(\tilde{R})$ to a security bid $\tilde{R}$. This follows from two observations. First, if all competing bidders drop out at $c(\tilde{R})$, the security bid still wins the auction so there is no need to claim that it is worth more.[34] Second, if the security bidder who offers $\tilde{R}$ drops out as the price increases above $c(\tilde{R})$, then treating him as type $\tilde{\theta}$ is actually a fair treatment. This prevents this bidder from overbidding, the cost of which would have been borne by the seller by accepting a security bid worth less than a competing bid she could have obtained. Thus, absent a contract, the seller cannot commit to treating security bid $\tilde{R}$ as having a higher value than $c(\tilde{R})$.

Step 2. *Choosing between cash and security bids*: There are three cases to consider. First, a bidder who is not cash-constrained or has access to a competitive market for capital will bid in cash. To see this, observe from Step 1 that the maximum value the seller attributes to a security bid undervalues the bidder's type for every payment (except possibly his maximum bid). Thus, even if the bidder bids in debt for which the effect of such undervaluation is smallest (Proposition 2), it would be still larger for every payment than when the bidder raises debt financing as described in Proposition 4. Thus, since the outside option of bidding in securities would never be binding, Proposition 4 extends also to when bidders can choose to bid in securities. Second, a bidder who has no access to external financing has no option but to bid in securities. Third, suppose that a bidder faces a strong financier. Given that the bidder can choose now between bidding in securities and external financing, the financier has no choice but to offer weakly better terms than those implied by bidding in securities. Thereby, the best he can do is offer financing that keeps the bidder at his reservation value of bidding in

[33] If all types strictly benefit, take $\theta' = \underline{\theta}$, and it is clear that the financier will reject the deviation for out-of-equilibrium beliefs placing probability one on type $\underline{\theta}$.

[34] If anything, the seller would have an incentive to claim that it is worth less to make the security bidder increase his bid even more (though this should be traded off against the risk of the bidder dropping out).

securities for all his potential types. This can easily be achieved by offering the same financing terms as those effectively implied by the way the seller treats security bids, which would still lead to positive profits. Analogous to a tie-breaking argument, the strong financier can ensure that the bidder takes his offer with probability one.□

Proof of Proposition 7. The proof is a modification of Proposition 2.

Step 1 *Reformulating the incentive constraint*: Using the same notation as in Proposition 2, one can state the incentive constraint for type θ_i' who in equilibrium is financed with R with co-investment w', but considers deviating to security contract $\widehat{R}$ with co-investment $\widehat{w}$, issued in equilibrium by type $\widehat{\theta}_i$, and then bidding as some higher type θ_i'' as

$$E_{\theta_{-i}}\left[\left(\int_X\left[\widehat{R}(x,y(\theta_i',\theta_{-i}))-R(x,y(\theta_i',\theta_{-i}))+\widehat{w}-w'\right]dG(x|\theta_i')\right)P(\theta_i',\theta_{-i})|A\right]$$
$$\geq E_{\theta_{-i}}\left[\left(\int_X\left[x-\widehat{R}\left(x,y(\theta_i'',\theta_{-i})\right)\right]dG(x|\theta_i')-\widehat{w}\right)P(\theta_i'',\theta_{-i})\Big|B\right].$$

Using (A.3) to plug in for $R(\cdot)$ and $\widehat{R}(\cdot)$, the incentive constraint can be stated only in terms of $\widehat{R}$, y, and the "mispricing" terms $v(y,\cdot)$. It is straightforward to show that it has exactly the same form as (A.6). Similarly, it can be shown that the incentive constraint that θ_i' should not bid as a lower type takes exactly the same form as (A.7).

Step 2 *Fully co-investing all cash w maximally relaxes the "upward" incentive constraint*: The argument is made with debt financing, as Proposition 2 shows that such financing maximally relaxes this constraint holding w fixed. Suppose that a bidder is financed with debt for all payments y, but that for some payment y' he does not co-invest his full cash $\widehat{w}<w$. Let his equilibrium financing contract be $\widehat{R}$. Construct instead a financing contract $\tilde{R}$, which is identical to $\widehat{R}$ for all other payments except that the bidder co-invests w at y'. Furthermore, $\tilde{R}$ is such that type $\widehat{\theta}_i$ is indifferent between $\widehat{R}$ and $\tilde{R}$ for every y:

$$\int_X\widehat{R}(x,y)\,dG(x|\widehat{\theta}_i)+\widehat{w}=\int_X\tilde{R}(x,y)\,dG(x|\widehat{\theta}_i)+w=y+v(y,\widehat{\theta}_i).$$

Observe now that for payment y', security $\tilde{R}$ strictly crosses $\widehat{R}$ in X exactly once from above for some $\widehat{x}>0$. Precisely, $\tilde{R}+w>\widehat{R}+\widehat{w}$ for $x<\widehat{x}$ and $\tilde{R}+w<\widehat{R}+\widehat{w}$ for $x<\widehat{x}$. Using this, we obtain

$$\int_0^{\widehat{x}}\left(\widehat{R}(x,y)-\tilde{R}(x,y)\right)dG(x\Big|\theta_i')+\int_{\widehat{x}}^{\infty}\left(\widehat{R}(x,y)-\tilde{R}(x,y))\right)dG(x|\theta_i')+\widehat{w}-w$$
$$<\frac{g(\widehat{x}|\theta_i')}{g(\widehat{x}|\widehat{\theta}_i)}\left(\int_0^{\widehat{x}}\left(\widehat{R}(x,y)-\tilde{R}(x,y)\right)dG(x|\widehat{\theta}_i)\right.$$
$$\left.+\int_{\widehat{x}}^{\infty}\left(\widehat{R}(x,y)-\tilde{R}(x,y)\right)dG(x|\widehat{\theta}_i)+\widehat{w}-w\right)$$
$$=0,$$

where the inequality follows by SMLRP for any $\theta_i'<\widehat{\theta}_i$, implying that

$$\int_X\widehat{R}(x,y)\left(dG(x|\widehat{\theta}_i)-dG(x|\theta_i')\right)$$
$$>\int_X\tilde{R}(x,y)\left(dG(x|\widehat{\theta}_i)-dG(x|\theta_i')\right).$$

Applying this to the incentive constraint in Step 1, we see that for any given y and $v(y,\theta)$, fully co-investing all cash w relaxes the "upward" incentive constraint requiring that a bidder should have no incentive to deviate to the financing contract of a higher type ($\widehat{\theta}_i>\theta_i'$) and bid as a different type $\theta''\neq\theta'$ (cf. (A.6)).

The rest of the proof is straightforward. The complete argument for a competitive market for capital is an extension of Proposition 4. For an uncompetitive market for capital, the bidder is weakly better off investing all cash as this minimizes the reliance on costly outside financing.□

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