LBO Financing

Finance Working Paper N° 698/2020
September 2023

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ECGI Working Paper Series in Finance

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We thank Franklin Allen, Ulf Axelson, Patrick Bolton, Jason Donaldson, Martin Oehmke, Thomas Geelen, Elu von Thadden, and seminar participants at Lausanne, LSE, the Stockholm School of Economics, the HEC-McGill Winter Finance Workshop, the Cambridge Corporate Finance Symposium, the Global Corporate Governance Colloquium, the WFA Meetings, and ESSFM for helpful comments. An earlier version of the paper circulated under the title ”The Social Value of Debt in the Market for Corporate Control”. Burkart acknowledges financial support from the ESRC via Research Grant ES/S016686/1.

Abstract

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Keywords: Leveraged buyouts, bootstrap acquisitions, tender offers, free-rider problem, debt overhang, private equity, free cash flow theory

JEL Classifications: G34, G32

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LBO Financing*

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September 7, 2023

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"Leverage" refers to the fact that the company being purchased is forced to pay for... its own acquisition... If this sounds like an odd arrangement, that's because it is. (Kosman 2012, para.8).

1 Introduction

The rise of leveraged buyouts (LBOs) in the 1980s and subsequently of private equity (PE) firms marks a watershed in the history of corporate governance. In his famous treatise on the eclipse of the public corporation, Jensen (1989) advocates for LBOs as a remedy to the agency problem arising from the separation of ownership and control in the "conventional... model of corporate governance—dispersed public ownership, professional managers without substantial equity holdings, a board of directors dominated by management-appointed outsiders" (p.62). Such an LBO basically reunifies control and ownership to improve incentives.[1] A model of this view should have three elements: initially dispersed ownership, scope for ownership consolidation to improve incentives, and buyout debt. While these elements have been studied before, a theory that encompasses all three of them is missing from the large literature on takeovers.[2] The present paper fills this gap and provides such a unified framework.

A framework that unifies these elements does more than replicate known insights. Our model predicts LBO traits that prior theories cannot fully capture but are pertinent to the debate about LBO debt, which has been ongoing even as PE established itself as a mainstay of corporate governance. As in the past, the main critique is that debt finance is used excessively in order to appropriate rents from other stakeholders

[1] The corporate governance view of LBOs dominates the retrospectives in Jensen (1988), Shleifer and Vishny (1990), Holmstrom and Kaplan (2001), and Kaplan and Stromberg (2009). It does not apply to buyouts of (closely held) private targets for which the motivations range from succession issues to improving access to external financing. Buyouts have indeed remarkably different effects on public and private targets (e.g., Davis et al. 2021).

[2] The exception is a model extension in Müller and Panunzi (2003). We pinpoint our contribution in our related literature discussion in Section 2, and in much more detail, in Section G of the Internet Appendix.

(e.g., Shleifer and Summers 1988). Such criticism has not waned with the growth of the PE industry. On the contrary, there are now concerns about the aggregate risk of excessive LBO debts as well (Kosman 2009).[3]

The persistence of this criticism is, in part, owed to the fact that some of the most controversial traits of LBO transactions are not adequately accounted for in existing theories. The present paper provides an efficiency rationale for precisely those traits. Before describing our theory we discuss the main (corporate governance) theories of LBO debt and their limitations.

Incentive-benefit theory. The basic theory—debt imposes discipline on managers and raises incentives to create value (Jensen 1986; Innes 1990)—has the caveat that debt plays no role apart from optimizing managerial incentives: It does not require takeovers to be levered, as the debt can in principle be raised after (or in management buyouts even prior to) the takeover. The reason is that the postulated benefit of debt applies to capital structure and financing in general, that is, also outside of takeovers. Nor for the same reason does it require that the debt is bootstrapped—a practice we elaborate on below. Leveraging the takeover could be a matter of convenience, but if so, it should exhibit patterns similar to corporate leverage outside of takeovers; this lacks support in the data (Axelson et al. 2013). In this vein, incentive-benefit theory cannot by itself explain why buyout leverage is much higher than corporate leverage at large.[4]

This is by no means a refutal of the point that debt finance has incentive benefits, but the limitation of the theory with regard to takeovers justifies second-guessing the

[3]By some estimates, PE funds in the U.S. managed almost $7 trillion in assets in 2018, and there are sectors (e.g., retail) in which nearly all recent bankruptcies involve PE-owned firms (Appelbaum and Batt 2018; Scigliuzzo et al. 2019). This has prompted renewed calls for regulation, reminiscent of similar efforts in the 1980s, one example being the "Stop Wall Street Looting Act" sponsored by U.S. Senator Elizabeth Warren (https://www.congress.gov/bill/116th-congress/senate-bill/2155).

[4]This caveat of the incentive-benefit theory motivates alternative theories of debt levels in LBOs based on factors beyond the individual control transaction, such as the financing structure of private equity funds (Axelson et al. 2009) or the reputation of "repeat" acquirers (like private equity funds) vis-à-vis lenders (Malenko and Malenko 2015). In contrast, our theory of buyout leverage remains focused on determinants at the individual-transaction level.

manner in which and the *extent* to which debt is raised in buyouts. In LBOs, bidders get funding by indebting targets. Kosman (2009) likens this so-called bootstrapping to mortgage loans, except "while we pay our mortgages, PE firms had the companies they bought take the loans, making *them* responsible for repayment" (p.3). In recent congressional testimony Eileen Appelbaum[5] sums up why the practice is contentious (America for Sale? An Examination of the Practices of Private Funds 2019, p.4):

> [I]t is the company, not the PE fund that owns it, that is obligated to repay this debt ... The [PE] firm will lose at most its equity investment in the portfolio company, and often this has already been repaid via fees the PE firm collects from the company. The PE firm has little to no skin in the game; it's the company, its workers, suppliers, creditors and customers that the use of leverage (high debt) has put at risk.

She criticizes that bootstrapping limits bidders' liability with respect to the debt. This poses a conundrum for incentive-benefit theory, as limited liability undermines incentives in standard principal-agent theory. Deal-by-deal debt at the PE fund level or in intermediate holding companies[6] would give PE firms, in Appelbaum's words, more "skin in the game." This puts bootstrapping at odds with the incentive-benefit explanation.[7]

Relatedly, she notes that, net of fees received (often at or shortly after the deal),

[5] Appelbaum is co-director of the Center for Economic Policy Research (CEPR) and co-author of *Private Equity at Work: When Wall Street Manages Main Street*, which was a finalist in 2016 for the Academy of Management's George R. Terry Book Award.

[6] In general, buyout debt can be held at the level of PE funds (FundCo debt), at target companies (OpCo debt), or at intermediate holding companies (HoldCo debt). LBO debt traditionally refers to OpCo debt. The use of HoldCo and FundCo debt has increased over time (Brown et al. 2021). Note that HoldCo debt allows separation of fund-level capital structure from deal-level capital structures. Therefore deal-by-deal financing does not require bootstrapping; multi-pronged holding structures can make debts deal-specific without bootstrapping targets.

[7] This is by no means a claim that PE firms lack any source of incentives. Equity exposures aside, there are also reputation and relational incentives, i.e., "skin in the game" by way of human capital. Appelbaum's reservation is rather that bootstrapping *per se* appears to have no incentive benefits, and concerningly, perhaps the opposite. This begs the question what benefit it has and whether it is related to the unusually high leverage.

PE firms' financing contributions are small or even negative.[8] This is also difficult to square with standard incentive theory where wealth constraints bind in equilibrium; rather than cash out early, bidders would reduce outside funding. Cashing out seems dubious, too, from an incentives point of view.

Since the incentive-benefit theory offers no efficiency rationale for bootstrapping, nor for why the resultant leverage is so high and fees are paid out upfront, it struggles to put to rest suspicions that directly leveraging targets somehow benefits bidders at the expense of other stakeholders, as hinted in the quote (or the moniker "raiders").

Rent-extraction theory. In Müller and Panunzi (2004), bootstrapping plays such a role. They explicitly model dispersed target ownership and the resultant free-riding behavior *in* the buyout process, and show that bidders can overcome this problem by extracting takeover gains from target shareholders via bootstrapping. Bootstrapping hence has social value in that it facilitates takeovers (i.e., on the "extensive margin"). Nonetheless, this theory—on its own—has three caveats.

First, the theory actually corroborates policy concerns. Conditional on a takeover (i.e., on the "intensive margin"), bootstrapping is at best a pure redistribution; given bankruptcy costs or externalities, it induces too much leverage.[9] This warrants a cap on bootstrapping, which does not conflict with incentive-benefit theory, as the latter does not require bootstrapping.

Second, a theory equating buyout debt to bidder profits squares poorly with the fact that LBOs seem to mainly benefit target shareholders (e.g., Jarrell et al. 1988). This caveat is also orthogonal to incentive-benefit theory. If anything, explaining low bidder profits in highly leveraged bootstrap deals is even harder if debt also improves incentives.

Third, the theory predicts reduced bootstrapping once bidders compete. Müller

[8] Indeed the term bootstrapping comes from "pulling oneself up by one's bootstraps," a metaphor for succeeding with few means and little help. The term is used for LBOs precisely because the LBO structure allows bidders to acquire targets with little to no capital of their own.

[9] See Section VI.B in Müller and Panunzi (2004).

and Panunzi (2004) themselves conclude therefore that this theory can explain bootstrapping but not the high debt levels in LBOs.[10] Empirically, the increase in bidder competition in the late 1980s did not reduce buyout leverage (Kaplan and Stein 1993; Andrade and Kaplan 1998; Holmstrom and Kaplan 2001).

In sum, neither the incentive-benefit nor the rent-extraction theories on their own rationalize bootstrapping in a way that fits the empirics well or quells the criticism.

A unified theory. We show that merging the two strands of theory yields a stronger justification of bootstrapping, produces new effects, and matches the evidence better. We add to Grossman and Hart (1980)'s model a stage in which the bidder chooses her financing (as in Müller and Panunzi 2004) and a stage in which incentives to improve the firm's value depend on its capital structure (as in Burkart et al. 1998).

This unified framework is able to tie up the loose ends and generates the following predictions: the incentive benefit of debt requires bootstrapping and cannot be replicated outside the takeover; the optimal financial structure entails that bidders cash out upfront (e.g., through fees); takeover debt can mainly *benefit* target shareholders although bidders use it to extract gains; and bidding competition entails *more* debt. Thus, bootstrapping, excessive debt, and upfront bidder payouts—with nevertheless *high* takeover premia—arise jointly as an optimal structure that is Pareto-improving (on the extensive and intensive margins).

The mechanisms underlying these results are new as they are driven by trilateral interactions of financing, moral hazard, and free-riding behavior that are not in effect when incentive benefits and rent extraction are analyzed separately:

1. **Ownership-debt link**. While bootstrapped debt lets bidders extract rents, lenders' debt supply depends on the value they expect to be created. Therefore, bidders can only raise debt to the extent that they increase their own incentives by buying larger stakes, which they are reluctant to do without debt due to the

[10] We elaborate on their conclusion in Section 2 and in Section G of the Internet Appendix.

free-rider problem. Thus *bootstrapping drives value creation through ownership concentration*. (Proposition 1).

2. **Sharing rule**. Moral hazard imposes a debt constraint: The wedge between debt and firm value must be large enough (i.e., equity must be sufficiently in the money) to avoid debt overhang. This wedge is the post-takeover share value that the free-riding target shareholders extract through the takeover premium. Under common model specifications of the moral hazard problem, the financing constraint is such that *bootstrapping divides the marginal gains from improved incentives to mutual benefit*—despite free-riding behavior (Proposition 2).

3. **Upfront fees**. The tension between endogenous value creation and free-riding is that bidders, on the one hand, maximize the value of their shares for a given financial structure, but on the other hand, seek to minimize the expected share value due to the free-rider problem. The solution is to profit via "upfront fees" instead of "equity gains." *The optimal financing structure that implements this solution mirrors a compensation contract whereby financiers give bidders equity incentives and a fixed fee to improve the firm, with the fee being financed by debt that reduces future free cash flow to equity* (Proposition 3).[11]

4. **Competition and debt**. Takeover debt raises the maximum value a bidder is willing to generate by enabling her to extract part of it. But because free-riding shareholders share in the gains, her profit-maximizing bid does not exhaust her capacity to use debt and thus is not the socially most efficient bid she can make. *Competition forces bidders to submit more efficient bids using higher debt levels* (Propositions 4 and 5).

[11] That upfront payouts are funded by using debt to reduce future free cash flow resonates with the free cash flow theory. In buyout models with moral hazard but without free-riding, upfront payouts to agents who subsequently manage the firm are inefficient (for incentive reasons) and redundant for allocating rents (as that is achieved directly via price bargaining). In buyout models with free-riding but without moral hazard, upfront payouts shift rents but have no (positive) effect on efficiency.

The key takeaway is that a theory that accounts for the dual problem of dispersed ownership—lack of incentives *and* free-riding behavior—predicts the most distinctive and controversial traits of buyout financing. This theory shares the classic prediction that buyout leverage leads to stronger incentives to improve firm value, but its unique prediction is that the debt has to be bootstrapped and exceed funding needs for bidders to implement stronger post-buyout incentives. In short, it predicts *bootstrapping with excessive leverage* as incentive-efficient.

Indeed, while these traits are typically cast in a negative light because of potential adverse effects, our theory provides countervailing efficiency arguments in their favor. These arguments are void outside of buyouts and thus identify a social benefit of debt unique to the market for corporate control. Though, they pertain only to disciplinary LBOs, which reverse the separation of ownership from control in public firms. Hence leverage should be less extreme in buyouts that do not serve to reunify ownership and control, such as those of private targets.[12]

2 Related Literature

As we have already discussed, our paper connects two literatures on buyouts: one on incentive benefits of debt (e.g., Jensen 1986; Innes 1990) and the other on free-riding (e.g., Grossman and Hart 1980; Burkart et al. 1998; Müller and Panunzi 2004). This section elaborates on how the insights stemming from this connection make separate, distinct contributions to each of those literatures.

Contribution to the incentive theory of buyouts. The rent-extraction motive

[12] One rationale for bootstrapping private targets is that the buyout firm (e.g., due to borrower reputation) relaxes targets' capital constraints (Boucly et al. 2011; Chung 2011; Cohn et al. 2020). The point is then to increase target leverage. But this does not require that leverage is "excessive." Indeed, Applebaum's testimony cited above also says, "smaller PE funds typically acquire small and medium-sized enterprises that can benefit from the *access to financing* and improvements in operations and business strategy that private equity firms can provide. *These PE funds use relatively low levels of debt...*" (America for Sale? An Examination of the Practices of Private Funds 2019, p.3, emphasis added). Along this vein our theory suggests that time variation in average buyout leverage may reflect variation in the public-vs.-private composition of buyout targets.

introduced by free-riding behavior generates a different incentive benefit of debt than standard theory, one operating through potential agency *costs* of debt: to avoid debt overhang while extracting rents through debt, the bidder must buy a larger stake to improve her incentives. In our model this is embodied in an equilibrium relation that maps sustainable debt levels to required equity stakes. Intuitively, it strikes a balance between improving *and* "raiding" a target. Empirically, it links buyout debt levels to the insiders' post-buyout equity stakes (and incentives).[13]

The rent-extraction motive for debt can also explain differences between buyout leverage and corporate leverage. The incentive-benefit theory explains debt (whether in buyouts or standard corporate finance) as implementing the second-best outcome under wealth constraints (e.g., Innes 1990). In such models, wealth constraints bind: bidders would use as little outside funding as needed (i.e., exhaust their own funds).

If added to our model, wealth constraints are slack, since the rent-extraction debt level exceeds the need for outside funds: the outside investors supply more cash than is paid to target shareholders, the surplus being extracted by bidders.[14] This upfront payout is not a "free lunch." It is (as the remainder of the external funds) contingent on bidders taking equity positions that incentivize them to improve value; their rents are returns to *human* capital.[15]

Last, a core aspect of our theory is that the benefits of debt require bootstrapping and cannot be replicated through a recapitalization before or after the takeover. This reflects a key difference to incentive-benefit theory: The driver of leverage is a friction in the buyout process itself.

The above features make our theory compatible with the possibility that optimal buyout financing differs and deviates significantly from the optimal capital structure

[13]This describes a causal effect, not a cross-sectional correlation, as elaborated on in Section 4.1.

[14]In our model, bidders are capable of establishing the first-best post-takeover incentive structure by self-financing the entire takeover. This is by no means to argue against the empirical relevance of limited bidder wealth but to cleanly identify the driving forces in our model and afterward highlight that the buyouts in equilibrium (more than) finance "themselves."

[15]Kaplan and Stein (1993) note that incumbent managers that stay on usually cash out some pre-buyout holdings even as their percentage stake in the (more levered) post-buyout equity rises.

the target's industry.[16]

Contribution to the literature on tender offers. Mechanisms whereby bidders exclude free-riding target shareholders from part of the value improvement play a key role in this literature.[17] Such *exclusion mechanisms* are no panacea, however. Their Achilles heel is that, while enabling bids, they hurt target shareholders conditional on a bid. Thus, target shareholders generally prefer to limit exclusion even if such limits deter some takeovers.[18]

We identify an exception to this rule. Takeover debt requires lender participation. In the presence of moral hazard, this creates financing constraints that interact with the free-rider problem in two crucial ways: First, lenders push bidders to consolidate equity as commitment to generate sufficient value (which addresses the Berle-Means problem). Second, the endogenous debt constraint limits to what extent bidders can exclude target shareholders, acting de facto like a sharing rule (which addresses the Grossman-Hart problem).

Together these effects amount to buyout debt *inducing aggregate gains* and *splitting those gains to mutual benefit* even conditional on a bid. Target shareholders then oppose limiting this exclusion device, making it a "silver bullet" against the free-rider problem.

Relation to Müller and Panunzi (2003, 2004). Müller and Panunzi were first to

[16] Otherwise, there is a salient tension when arguing that the high buyout leverage represents the optimal capital structure for a target (even though significantly raising the risk of financial distress) despite the much lower leverage ratio in the target's industry. This tension is, for instance, palpable in Andrade and Kaplan (1998, notably Sections II and VI.B). Most targets (manage to) reduce their debt in the years following the buyout (see, e.g., Brown et al. 2021).

[17] This is true of the literature on investor activism as well. In the tender offer literature, the main exclusion mechanisms are dilution (Grossman and Hart 1980), toeholds (Shleifer and Vishny 1986), and debt (Müller and Panunzi 2004). Freeze-out mergers offer an alternative (Yarrow 1985; Amihud et al. 2004), but this mechanism is not robust to legal or strategic uncertainty (Müller and Panunzi 2004; Dalkir, Dalkir, and Levit 2019). The various mechanisms are functionally equivalent in basic tender offer games (Müller and Panunzi 2004; Burkart and Lee 2015). In the activism literature, the exclusion mechanism is anonymous trading in the presence of noise traders.

[18] This rent-efficiency trade-off appears in many guises, e.g., in disclosure laws that limit toehold acquisition, minority shareholder protection laws to restrict dilution, dissenters' rights that weaken freeze-outs, and supermajority voting rules that force bidders to acquire more shares.

identify takeover debt as a solution to the free-rider problem. Their published article (Müller and Panunzi 2004) derives this insight in a framework without moral hazard, where bootstrapping enables bidders to extract rents to recoup a fixed takeover cost, thereby facilitating a buyout. While this is a socially positive effect of bootstrapping on the "extensive margin," the article also elaborates on the caveat that leveraging a buyout to extract rents is undesirable on the "intensive margin;" conditional on the takeover, debt is (1) a zero-sum transfer *at best*, (2) harmful to target shareholders, and hence (3) used less when several bidders compete. Due to these intensive-margin effects (1)-(3), Müller and Panunzi (2004) summarize the overall takeaway as follows (p.1220):

> "[A] minimal amount of debt equal to the raider's transaction cost might be sufficient to ensure that the takeover takes place. Indeed, if debt is costly and the raider's profit is limited due to bidding competition, it is precisely this minimal amount of debt that is optimal. Hence, while our model provides a role for debt in takeovers, it cannot explain LBO-style debt levels."

The closing paragraph of the above article refers to a model extension with moral hazard in the working paper version (Müller and Panunzi 2003), framing as the central added insight that moral hazard decreases the bidder's debt capacity.[19] All else equal, this seems to reinforce the idea that this theory cannot account for LBO-style debt levels.

However, a vital point missing in the analysis of Müller and Panunzi (2003) is that neither effects (1)-(3) nor the consequent prediction of a "minimal amount of debt" remain robust. Establishing this, which is the purpose of our paper, matters for two reasons. First, it shows that bootstrapping and the resultant leverage can be Pareto-

[19] Cf. the last paragraph of Section VII in Müller and Panunzi (2004) and the first paragraph of Section 6 in Müller and Panunzi (2003). Section G of our Internet Appendix discusses their model extension, including (a) the different focus of their analysis and (b) the novelty of our central results (Propositions 1 to 5), which have no counterparts in Müller and Panunzi (2003)'s analysis.

improving *on the intensive margin* when buyouts serve to improve incentives. So, the implications of bootstrapping for efficiency, surplus division, and bidder competition are the *opposite* of those in the model without moral hazard.

Second, and more importantly, it shows that a theory combining free-riding and moral hazard *can* explain the distinctive traits of LBO financing—bootstrapping, excessive debt, upfront payouts—better than theories based on either of those frictions alone. Thus, the novelty of our paper is to show that unifying these principal strands of the existing literature leads to interaction effects that yield a more comprehensive characterization of LBO financing, notably its (still) most controversial traits. In the unified theory, those traits in fact turn out to be the hallmarks of incentive-improving financing structures.

Other papers. Burkart, Gromb, Müller, and Panunzi (2014) examine how investor protection laws impact (the financing of) tender offers by wealth-constrained bidders. Axelson, Stromberg, and Weisbach (2009) study optimal contracts between PE firms and passive capital providers (limited partners). Malenko and Malenko (2015) offer a theory of buyout leverage based on PE firms' reputational concerns vis-à-vis lenders. The latter two papers propose alternative explanations for high buyout leverage. The main difference to our theory is that their predictions speak to neither bootstrapping nor upfront cash-outs, and apply equally to public and private targets.[20] Last there is a literature studying the role of debt in bidding contests, which we discuss in Section 4.4.

3 Incentives, Free-riding, and Buyout Financing

We present a tender offer model with financing in which the source of takeover gains is an improvement in incentives, while the distribution of the gains is subject to free-

[20]The root of these differences is that these theories focus on frictions between acquirers and their financiers, while our theory focuses on frictions in the acquisition itself. In Axelson, Stromberg, and Weisbach (2009), buyout debt is issued "deal by deal," but this does not equate to bootstrapping.

riding behavior. It is the first model in the tradition of Grossman and Hart (1980) in which debt and (outside) equity financing both play a critical role.

3.1 Model

Source of takeover gains. A widely held firm ("target") faces a potential acquirer ("bidder"). If the bidder gains control, she generates a value improvement $V(e)$ over the firm's status quo value, which is normalized to 0. Generating value requires effort $e \in \mathbb{R}_0^+$, which imposes a private cost $C(e)$ on the bidder. The premise is that current shareholders, being dispersed, lack the incentives to exercise control and bring about such improvements themselves (the Berle-Means problem).

We assume a linear value improvement function, $V(e) = \theta e$, where $\theta > 0$ is the marginal return to effort. The cost function is twice differentiable, strictly increasing, and strictly convex, i.e., $C'(e) > 0$ and $C''(e) > 0$ for all $e \geqslant 0$. We further assume $C(0) = 0$, $\lim_{e\to 0} C'(e) = 0$, and $\lim_{e\to\infty} C'(e) = +\infty$ to restrict attention to strictly positive but finite post-takeover values. While V and C are commonly known, effort e is unobservable.[21]

The post-takeover moral hazard could alternatively be modeled as private benefit extraction (as in Burkart et al. 1998), with more effort mapping into less extraction.[22] Our results also apply to pre-takeover efforts before or during the preparation of the bid (such as assessing target suitability and potential improvements) as long as effort is unobservable.[23]

[21] Assuming linear V is without loss of generality in that all results can be translated to concave V. Suppose $V : [0, +\infty) \to \mathbb{R}$ is a twice differentiable, strictly increasing, and concave function. The game we consider is isomorphic to a game in which the bidder, instead of choosing e, chooses y where $\theta y = V(e)$. In the latter game, the bidder's post-takeover objective function is $\alpha[\theta y - D]^+ - C(V^{-1}(\theta y))$, where V^{-1} denotes the inverse function of V. Since the inverse of a strictly increasing, strictly concave function is a strictly increasing, strictly convex function, the composition $C \circ V^{-1}$ satisfies the assumptions postulated for C in our model.

[22] A model with private benefit extraction, where insiders misuse cash flow rather than pay it out, would be more akin to free cash flow theory. The main insights would obtain in such a model too, but the presence of a second source of gains (private benefits) makes for a less parsimonious analysis.

[23] The one-to-one mapping of e to realized V allows for indirect contracting on e in the model. We ignore this possibility and view modeling deterministic V as a simplification. The issue is less salient

Division of takeover gains. To gain control, the bidder must purchase at least half of the target shares by way of a tender offer. The incumbent management is assumed to be unwilling or unable to counterbid; alternatively, it may be part of the investor group that makes the offer to buy out the current shareholders.

Each target shareholder is non-pivotal for the takeover outcome. The consequent free-riding behavior frustrates the takeover unless the bidder has means to "exclude" the target shareholders from part of the takeover gain (the Grossman-Hart problem). We focus on the exclusion mechanism identified by Müller and Panunzi (2004): debt collateralized with target assets. Since debt is senior, shareholders are excluded from future cash flow pledged to the lenders, while the bidder extracts the present value of those cash flows in the form of a loan prior to the bid.

Specifically, the bidder is wealth-unconstrained but can nonetheless raise outside funding for the bid in the form of debt and equity. She can choose to pledge a fraction $(1-\gamma) \in [0,1]$ of the cash flow from the acquired target shares to outside investors in exchange for some amount F^E of equity financing. Similarly, she can promise outside creditors a debt repayment $D \geqslant 0$ in exchange for some amount F^D of debt financing. We abstract from exclusion mechanisms other than debt. So a profitable bid requires $F^D > 0$ and that the debt is raised by *bootstrapping*. It is without loss of generality to ignore "non-bootstrapped" debt in our model. We will use the terms "takeover debt" and "bootstrapping" interchangeably.

We assume risk-neutrality and zero discount rates for all agents.

Sequence of events. Our model has three stages. In stage 1, the bidder makes a take-it-or-leave-it cash bid to acquire target shares at a price p per share and chooses how to finance the bid. The financing is publicly observable. The bid is conditional, that is, it becomes void if less than half of the shares are tendered.

if e denotes effort to identify value improvements and devise restructuring plans while or prior to arranging bids or if V is modeled as a random variable whose distribution depends on e. The latter is the case in the model extension of Section 6 in Müller and Panunzi (2003), which is discussed in detail in Section G of our Internet Appendix.

In stage 2, target shareholders non-cooperatively decide whether to tender their shares. The shareholders are homogeneous and atomistic such that no one is pivotal. Specifically, we assume a unit mass of shares dispersed among an infinite number of shareholders whose individual holdings are equal and indivisible.[24] Shareholder i's tendering strategy maps the offer terms into a probability that she tenders her shares, $\beta_i : (\gamma, D, p) \to [0, 1]$. It is without loss of generality to focus on symmetric strategies and drop index i. So, by the law of large numbers, β shares are traded in a successful bid.

In stage 3, if less than half the shares are tendered, the takeover fails. Otherwise, the bidder pays βp for the fraction β of shares tendered and obtains control. Net of the fraction γ financed by outside investors, the bidder then owns the "inside" equity stake $\alpha \equiv \gamma\beta$, and chooses her effort level $e \geqslant 0$ to maximize her post-takeover payoff $U(\alpha, D, e)$. So, her post-takeover strategy is a function $e : (\alpha, D) \to \mathbb{R}^+$. Finally, the firm value and all payoffs are realized (see Figure 1).

Interpretation. An LBO is carried out by a group of investors that may comprise incumbent management and a PE firm, or a consortium of PE firms. These investors take large equity positions in the target and active roles in management or the board (Kaplan and Stromberg 2009, p.130f).[25] They are represented by the "bidder" in our model, whose (cost of) effort hence represents (opportunity costs of) time and effort provided by PE firms, directors, and managers.

PE firms raise equity funding for the buyouts through PE funds. This funding is typically provided by institutional investors, such as pension funds, endowments, and insurance companies (Kaplan and Stromberg 2009, p.123f). These so-called *limited partners*—unlike the PE firms who are known as *general partners*—do not take on an

[24] These assumptions are standard in tender offer models exploring the free-rider problem. If they are relaxed, Grossman and Hart (1980)'s result that target shareholders get all the gains in security benefits is weakened (Holmström and Nalebuff 1992).

[25] For PE firms, part of the equity exposure comes from the "carried interest" they earn when their funds perform well. Our model abstracts from this compensation feature.

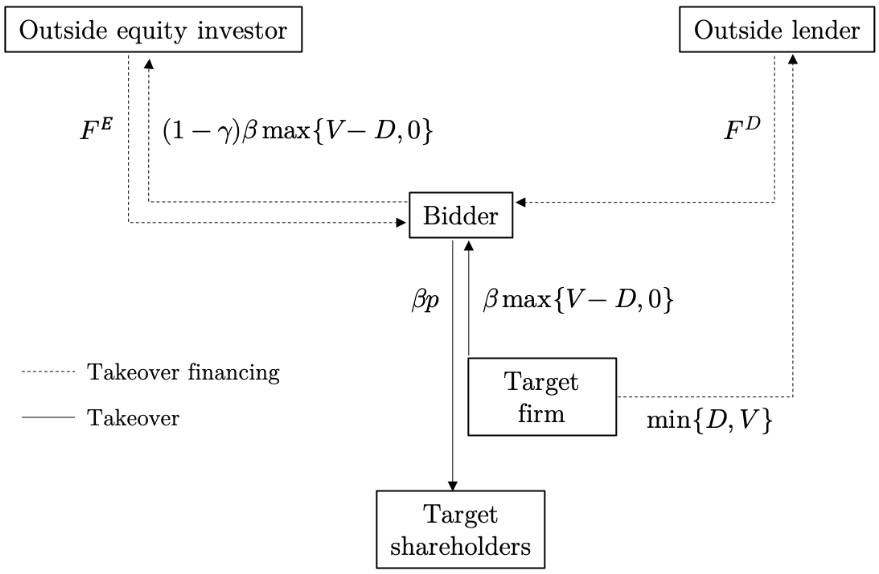

Figure 1: This summarizes the payments vis-à-vis a successful bidder in our model. Consider a management buyout as illustration: Incumbent managers and a buyout firm together are the "bidder," limited partners in the buyout fund are the "outside equity investor," and bondholders or a loan syndicate are the "outside lender." Debt funds being disbursed to the bidder but repaid directly by the target firm is the key effect of bootstrapping.

active role in post-buyout firms. They are the "outside equity investor" in our model.

When a specific buyout deal materializes, PE firms contribute some of the capital from the PE funds as equity to finance the buyout. This equity financing is further complemented with debt financing. The debt makes up the lion's share of the funds, covering 60 to 90 percent of the buyout value (Kaplan and Stromberg 2009, p.124f). The parties providing the debt funding are the "outside lender" in our model.

Unlike the equity, the debt is raised at *deal* (rather than fund) level. This allows it to be collateralized by the assets of the *target firm* through a bootstrap acquisition. In a first step, a shell company is created and funded from the aforementioned sources of buyout financing to bid for a majority of the target shares. If the bid is successful, the second step is to merge the target with the shell company such that the former's assets are matched with the latter's debt. Consequently, all equity investors receive, in our model notation, parts of $[V(e)-D]^+$. Without the second step, shell company shareholders and target shareholders would instead receive $[\beta V(e) - D]^+$ and $(1 - \beta)V(e)$, respectively.

The equity stake of the *active* investor group in the merged company is a function of the fraction $1 - \gamma$ of outside equity financing and the equity share β tendered by the original target shareholders: $\alpha = \gamma\beta$. With the sole exception of $\alpha = 1$, for every $\alpha < 1$, the roles of β and γ are somewhat interchangeable; though, a given γ imposes a lower bound on α, namely $\alpha \geqslant \gamma/2$, as a successful takeover requires $\beta \geqslant 1/2$.[26] With $\gamma \in [0, 1]$, the bidder can implement any $\alpha \in [0, 1]$. In going-private buyouts, initial shareholders are bought out ($\beta = 1$); in cash-outs, selling shareholders retain shares in the post-takeover firm ($\beta < 1$). The various cases are subsumed in our model, but distinguishing them is not important as only α matters for our results.

Our model allows buyouts with $\alpha \to 0$, which will be optimal if $D \to 0$. It also allows α to be fully optimized at the deal level, while it is in practice set partly by the

[26]This is why constructing α from γ and β matters. Without γ, α has a lower bound of $1/2$. This is counterfactual, and creates a kink at $1/2$ and non-monotonicity, making the model less tractable.

PE funds' financial structure. These modeling choices are a matter of convenience. Empirically, the median equity stake of the post-takeover management team is about 16 percent (Kaplan and Stromberg 2009), which excludes the PE firm's equity stake and carried interest. Our model prediction that low debt pushes the optimal α (and so the value improvement) to 0 is best interpreted to the effect that a buyout without debt is not lucrative.

Optimality of debt. We should stress what feature of debt makes its use optimal in our model. In the second step of the bootstrap acquisition, the merger, it reduces the target's expected share value from $V(e)$ to $[V(e) - D]^+$ by virtue of taking priority over equity.[27] In effect, this rolls part of the debt burden otherwise borne only by the bidder and her equity co-investors onto target minority shareholders. This dilution of the claims of those shareholders who retained shares in the first step, the tender offer, overcomes the free-rider problem.

However, this is not the only way through which merger terms can dilute minority shareholders. Suppose $D = 0$, and as before, let $1 - \beta$ denote minority shareholders' target equity stake after the tender offer. The minority shareholders would be diluted in any merger in which they are paid a combination of stock and post-merger equity worth less than $(1-\beta)V(e)$, such as in a freeze-out merger in which they are paid cash below that amount.

Crucially, minority shareholders can challenge the merger terms. Under Delaware law, their strongest legal recourse is a rescission remedy, as a result of which they may be paid rescissory damages up to the post-merger share value $(1-\beta)V(e)$. As Müller and Panunzi (2004) show, this legal risk at the merger stage, however small, restores the free-rider problem at the tender offer stage.

[27]This dilution-by-priority effect of debt has also been highlighted in the literature on bargaining between firms and unions (e.g., Bronars and Deere 1991; Perotti and Spier 1993). Note that priority is necessary and sufficient for debt to play this role, which is a less demanding requirement than that outside debt optimize the performance-sensitivity or information-sensitivity of insider claims, as is the requirement in classic models of debt optimality with moral hazard or asymmetric information.

This legal caveat lacks bite, however, in the case of takeover debt. There minority shareholders' merger payoff *is* the post-merger value $(1-\beta)[V(e)-D]^+$ of their stake, and so weakly exceeds the potential payout from a legal challenge.[28] This makes debt "the best known 'legal form of dilution'" (Müller and Panunzi 2004, p.1244), and in this particular sense, optimal in our setting.[29]

Understanding the role of debt matters for interpreting implications of our model. For example, results on the social value of takeover debt hold insofar as other dilution mechanisms are lacking, and are weakened when they are not.[30] In the same vein, the prediction of "excessive" leverage does not apply if bidders do not rely on dilution to extract takeover gains. So, leverage should be less excessive for private targets where price bargaining allocates gains and debt would play only its classic incentive role.

3.2 Equilibrium

We solve the model by backward induction in three subsections corresponding to the stages of the game. We focus on the bidder's post-takeover stake α and takeover debt D, which characterize the post-takeover ownership and capital structure. Unlike in a standard financing model, there are no wealth constraints that call for outside funds. All effects are purely driven by the interaction between financing choices, tendering decisions, and effort choice.

[28] In another important legal respect, the dilution methods do not differ: The law seeks to protect minority shareholders from being made *worse* off by the overall takeover (tender offer plus merger). This can be ensured under either dilution method as long as the takeover raises firm value. Sections IV and V in Müller and Panunzi (2004) discuss the legal nuances in great detail.

[29] Notice that the admissible range of rescissory damages is the root of this difference. This implies that, if one wanted to allow for dilutive stock-for-stock mergers or freeze-out mergers to be immune from the legal risk, the scope for rescissory damages would have to be restricted—a non-trivial issue. This legal angle also suggests that our results may hold when incumbent management negotiates a merger with the bidder that could be legally challenged by dispersed shareholders afterwards (which would amount to "ex post" free-riding). In such a model, bootstrapped debt allows bidders to profit while reducing the difference between bid price and post-takeover share value, which in turn reduces the potential risk from a rescission remedy. Looking at such an alternative model, although it would also be based on (ex post) free-riding, is beyond the scope of this paper.

[30] Though on this point our model also implies that, whereas target shareholders generally *want to restrict* other dilution mechanisms, this is not necessarily true for takeover debt.

3.2.1 Value creation

After a successful bid, the bidder's equity stake is α and the target firm assumes the acquisition debt (of face value) D. The bidder then chooses effort e to maximize the value of her equity stake in the levered firm net of private effort costs, $U(\alpha, D, e) \equiv \alpha[V(e) - D]^+ - C(e)$.

This objective function is not globally concave in e. Let e_D satisfy $V(e_D) = D$. For $e \in [0, e_D)$, equity is "out of the money" because $V(e) < D$, and so $U(\alpha, D, e) = -C(e)$ which is strictly decreasing in e. For $e \geqslant e_D$, $U(\alpha, D, e) = \alpha[V(e) - D] - C(e)$ since equity is "in the money." Under our assumptions about V and C, this is strictly concave and the first-order condition, $\alpha V'(e) = C'(e)$, has a unique, strictly positive solution, hereafter denoted by $e^+(\alpha)$.

Because $U(\alpha, D, e)$ is not globally concave, $e^+(\alpha)$ need not be a global optimum. Specifically, given that $\frac{\partial U}{\partial e} < 0$ for $e \in [0, e_D)$, it is possible that $U(\alpha, D, e^+(\alpha)) < 0$. If so, the bidder's optimal effort is $e = 0$. To summarize the above arguments:

Lemma 1. *The bidder's optimal effort is* $e^*(\alpha, D) = e^+(\alpha) > 0$ *if*

$$\alpha[V(e^+(\alpha)) - D] - C(e^+(\alpha)) \geqslant 0 \tag{1}$$

where $e^+(\alpha)$ *is the solution to*

$$\alpha V'(e^+(\alpha)) = C'(e^+(\alpha)) \tag{2}$$

Otherwise, she makes no effort to improve target firm value, i.e., $e^*(\alpha, D) = 0$.

Lemma 1 replicates established wisdom within our takeover setting. Outside debt can lead to a debt overhang that undermines a (controlling) shareholder's incentives to improve firm value (Myers 1977). Here, this occurs when condition (1) is violated. Value creation incentives also decrease with the fraction of equity that is dispersedly held (Berle and Means 1932; Jensen and Meckling 1976). Firm value thus increases in ownership concentration: Conditional on (1), optimal effort $e^+(\alpha)$ and resultant firm value $V(e^+(\alpha))$ increase in α (by the envelope theorem).

The novel element of Lemma 1 is that these two effects interact in condition (1). Whether a debt overhang problem emerges depends not only on the debt level D but also on the level of ownership concentration α. The intuition is simple: The bidder's incentives derive from a *levered* equity *stake* $\alpha[V(e^+(\alpha)) - D]$. While D lowers the total value of equity, α determines the bidder's share of that total value. As a result, the firm can have more debt without undermining the bidder's incentives if the latter owns more equity. This interaction between α and D is crucial for our results.

3.2.2 Tendering decisions

As Lemma 1 indicates, the first-best structure is fully concentrated ownership and no debt, i.e., $(\alpha, D) = (1, 0)$.[31] An ideal market for corporate control would restore this structure. We discuss next how free-riding behavior by dispersed target shareholders distorts bidders' preferences regarding α and D.

Suppose target shareholders face a cash bid p (partially) financed with debt D. Being non-pivotal, an individual shareholder i tenders only if $p \geqslant V(e^*(\hat{\alpha}_i, D))$ where $\hat{\alpha}_i$ denotes i's belief about the bidder's post-takeover equity stake. Because tendering decisions depend on individual beliefs, no dominant strategy equilibrium exists. In a rational expectations equilibrium, beliefs are consistent with the outcome, so shareholders tender only if

$$p \geqslant [V(e^*(\alpha, D)) - D]^+. \tag{3}$$

That is, target shareholders tender their shares only if they extract (at least) the full increase in share value that the bidder will generate. This is known as the free-rider condition.

[31] This is the only structure that leads to the first-best outcome for every admissible specification of V and C. For any $D > 0$, there exist admissible V and C such that (1) is violated.

Previous work has analyzed two special cases of (3). Müller and Panunzi (2004) study a model with exogenous post-takeover values where (3) becomes $p \geqslant (V - D)^+$ and show that the bidder maximizes D. Burkart, Gromb, and Panunzi (1998) study a model with endogenous post-takeover values but without debt where (3) reduces to $p \geqslant V(e^*(\alpha, 0))$, and show that the bidder minimizes α. These results, as explained in the papers, share a common logic: the bidder aims to reduce the right-hand side of (3), i.e., the post-takeover share value that target shareholders extract via the price. As we shall see, a model in which D and α are jointly chosen generates novel effects, and overturns some of the key predictions of the aforementioned papers.

Before we characterize the stage-2 subgame equilibrium, note that (3) is merely a necessary condition for a successful bid; a failed bid, in which an insufficient number of shares is tendered, can always be supported as a self-fulfilling equilibrium outcome. To focus on the interesting case, we assume that shareholders always tender when the free-rider condition is weakly satisfied, thereby selecting the Pareto-dominant success equilibrium whenever it exists.

Denote the post-takeover share value that the bidder will create for a given stake α and debt D by $E(\alpha, D)$ and her *equilibrium* post-takeover equity stake by $\alpha^*(p, D)$. Since a successful bid implies that $\beta \in [1/2, 1]$ shares are tendered, the bidder's post-takeover stake α lies in the interval $[\gamma/2, \gamma]$ for a given outside equity financing share $1 - \gamma$. Hence, the post-takeover share value must lie between $E(\gamma/2, D)$ and $E(\gamma, D)$. In the subsequent lemma, we omit describing the subgame equilibrium for bids that can be ruled out a priori: bids that fail for any set of beliefs ($p < E(\gamma/2, D)$) and bids that could be undercut without affecting any other decision ($p > E(\gamma, D)$).

Lemma 2. *Any bid $p \in [E(\gamma/2, D), E(\gamma, D)]$ succeeds, and $\alpha^*(p, D) = \alpha_p$ where α_p satisfies $p = E(\alpha_p, D)$.*

Proof. For every $p \in [E(\gamma/2, D), E(\gamma, D)]$, there exists a unique $\alpha_p \in [\gamma/2, \gamma]$ such that $E(\alpha_p, D) = p$. Every shareholder tenders for $\hat{\alpha}_i < \alpha_p$, retains her shares for $\hat{\alpha} > \alpha_p$, and is indifferent between tendering and retaining for $\hat{\alpha} = \alpha_p$. $\square$

Target shareholders are willing to sell shares until the post-takeover share value, which increases with the bidder stake, matches the bid price. As in Burkart, Gromb, and Panunzi (1998), supply is hence upward-sloping: the fraction of shares tendered increases with the price. In equilibrium, the bidder ends up with the stake for which the free-rider condition (3) holds with equality.[32]

3.2.3 Bid and financing

The bidder's ex ante profit is $\alpha E(\alpha_p, D) - \beta p - C(e) + F^E + F^D$. It comprises the value of the equity stake she expects to acquire, less takeover payment and effort cost, and outside funds she raises for the bid. She maximizes this by choosing the bid p, outside equity financing $\{\gamma, F^E\}$, and debt financing $\{D, F^D\}$ subject to (1), (2), (3), and the following participation constraints: Outside equity investors demand

$$F^E \leqslant \beta(1 - \gamma) E(\alpha_p, D). \tag{4}$$

Outside lenders demand $F^D \leqslant \min[D, V(e)]$. Since debt overhang constraint (1) requires $V(e) > D$, this reduces to

$$F^D \leqslant D. \tag{5}$$

We assume perfect competition among outside financiers such that they merely break even. Hence, (4) and (5) hold with equality. Substituting these binding participation constraints in the bidder's ex ante profit yields $\beta[E(\alpha, D) - p] - C(e) + D$.

Recall from Lemma 2 that free-rider condition (3) is endogenously binding; target shareholders will tender shares such that $E(\alpha_p, D) = p$. Recall further from Lemma

[32] Though the outcome is pinned down, the equilibrium strategy profile is not necessarily unique. The outcome obtains when each shareholder tenders with probability $\beta_p \equiv \alpha_p/\gamma$, but also when mass β_p of shareholders tenders while all others keep their shares.

1 that, conditional on (1), post-takeover effort is $e^+(\alpha)$, which satisfies (2). To demarcate the new element of our analysis from existing results, we first state how these constraints—binding free-rider condition (3) and first-order condition (2) for effort—affect the bidder. Plugging these constraints into her ex ante profit gives

$$D - C(e^+(\alpha)). \tag{6}$$

This replicates the known insights that debt D enables the bidder to extract private gains and that a larger equity stake α is unattractive because it induces her to incur higher effort costs, while all gains in share value accrue to target shareholders. This also shows that the bidder's ex ante problem essentially reduces to choosing the post-takeover ownership and capital structure (α, D).[33]

The new element is the joint restriction that debt overhang constraint (1) imposes on D and α. This constraint cannot be slack at the optimum. Otherwise, the bidder could lower α while preserving D. This would increase her profit, as (6) shows. Using the binding constraint (1) to replace D in (6) collapses the bidder's stage-0 choices to a univariate optimization problem:

$$\max_{\alpha \in [1/2, 1]} \mathcal{W}(\alpha) - \frac{C(e^+(\alpha))}{\alpha}. \tag{P}$$

where $\mathcal{W}(\alpha) \equiv V(e^+(\alpha)) - C(e^+(\alpha))$ is the total surplus created by the takeover. In Section 4, we use this representation of the problem to elucidate the role of debt. We conclude this section by establishing equilibrium existence (though not uniqueness).

Lemma 3. *If the bidder's profit under (P) is negative, she makes no bid. Otherwise, she succeeds with a bid such that (1)-(5) bind and α solves (P).*

[33]This is why it is without loss of generality to abstract from cash-equity bids and restricted bids. The same objective function obtains (i) for cash-equity bids with $1 - \alpha$ being the fraction of post-takeover equity offered to target shareholders as payment combined with cash or (ii) for cash bids in which the number of shares the bidder offers to acquire is restricted to α.

Proof. The objective function is continuous in α and its domain is compact. Hence there exists an $\alpha \in [1/2, 1]$ that solves (P). If the profit under this solution is positive, the bidder makes a successful bid. Otherwise, she abstains from a takeover. □

4 The Paradoxical Benefits of Bootstrapping

This section presents our main results. It is worth reiterating that the bidder faces no wealth constraint in our model; she is capable of implementing the first-best outcome by fully self-financing the bid. Frictions in the buyout process keep her from doing so. Our results concern how financing affects this process—not only post-buyout capital structure—making this a theory of *buyout* debt.[34]

To make statements about the causal effect of bootstrapping, several results use a thought experiment: removing an *exogenous* cap on bootstrapped debt (Propositions 1, 2, and 5).[35] The main normative insight is that such a restriction is inefficient even though bootstrapping is a rent extraction strategy. The positive predictions are that buyout debt is bootstrapped, "excessive," and beneficial not just to bidders by way of upfront fees but likely also to target shareholders via large takeover premiums.

4.1 Ownership-debt relationship

We first study how bootstrapping affects total surplus $\mathcal{W}(\alpha) = V(e^+(\alpha)) - C(e^+(\alpha))$. While this expression depends only on the bidder's post-takeover equity stake α, the latter is linked to debt D through debt overhang constraint (1). This constraint binds

[34] It is also worth stressing that, although Section 6 in Müller and Panunzi (2003) explores a model with free-riding and moral hazard, *none* of our main results (Propositions 1 to 5) have counterparts in their analysis (see Section G of our Internet Appendix).

[35] We do not present comparative statics with respect to (parameters of) V or C. The equilibrium debt levels and division of gains between bidder and target shareholders depend on the curvatures of V and C in non-trivial ways. Consequently, these comparative statics generate no clear-cut results. So, though we can offer clean statements about *causal effects* of bootstrapping, clean statements do not exist for *cross-sectional correlations* between takeover debt and other observables (such as, e.g., bid premia or upfront fees) driven by variation in V or C across deals in the data. Internet Appendix F illustrates this using an example that parametrizes V as a power function.

in equilibrium, yielding

$$D = V(e^+(\alpha)) - \frac{C(e^+(\alpha))}{\alpha}. \tag{1*}$$

As shown in the proof of the next result, (1*) defines D as a monotonically increasing function of α. The intuition behind this *ownership-debt function* is that to avoid debt overhang, a higher debt level D requires a larger bidder stake α.[36] The latter, in turn, leads to a higher surplus $\mathcal{W}(\alpha)$.

To state this formally, imagine a hypothetical exogenous limit $\bar{D}$ on the amount of debt that can be bootstrapped for a bid. We interpret how removing the limit affects $\mathcal{W}(\alpha)$ as the causal effect of bootstrapping on takeover surplus.

Proposition 1. *Bootstrapping increases takeover surplus.*

Proof. Section A of the Appendix. □

This result is not obvious as the primary purpose of bootstrapping is to shift rents from target shareholders to bidders. In Müller and Panunzi (2004), conditional on a bid, bootstrapping is a pure transfer, and inefficient for exogenous bankruptcy costs. Interacting the free-rider problem and the incentive problem is crucial to Proposition 1.

On the equity side, the fact that owning a larger stake creates stronger incentives to create value is a *dis*incentive to buy shares when faced with the free-rider problem. While the bidder is more incentivized to provide effort when acquiring a larger stake, target shareholders appropriate the added value through the bid price. All else equal, the bidder hence prefers low α.

On the debt side, lenders' supply of funds depends on the value they expect to be created. To obtain more debt, the bidder must commit to create more value. A larger

[36] The inverse interpretation is that takeover debt makes bidders willing to buy larger stakes. We primarily use the first interpretation in light of the bidder's profit function (6), whereby she would at the margin want to increase D and decrease α (were it not for debt overhang constraint (1*)).

stake provides that commitment, as reflected in the ownership-debt function. If debt is used, the demand for commitment prevails over her preference for low α. A cap on takeover debt would impede this indirect benefit of bootstrapping on incentives.

This qualifies the prediction in Burkart, Gromb, and Panunzi (1998) that bidders buy as little equity as possible when value creation is endogenous; indeed, our model would generate $\alpha \to 0$ without debt, which is counterfactual. Instead, Proposition 1 reflects a mechanism whereby bootstrapping drives equity consolidation.

After leveraged buyouts, managers own more equity and active owners dominate boards (Kaplan 1989). According to our theory, lenders' willingness to provide debt depends on how much "skin in the game" such active owners will assume in the firm. We are unaware of evidence that speaks directly to this mechanism.[37] However, there is evidence in another context consistent with it. Anderson, Mansi, and Reeb (2003) report that founding family ownership in large public firms is related to lower costs of debt, suggesting reduced debt-equity conflicts as a reason. Lagaras and Tsoutsoura (2015) report similar effects from a natural experiment. They also document that for 17% of the family firms, creditors explicitly require that the founding family maintain a certain percentage of ownership or control.[38]

4.2 Debt (constraints) as sharing rule

We now study how the surplus $\mathcal{W}(\alpha)$ is split between bidder and target shareholders. The ownership-debt function (1*) pins the equity value down as a wedge that must be kept between firm value and debt to avoid debt overhang: $V(e^+(\alpha)) - D = \frac{C(e^+(\alpha))}{\alpha}$.

[37]Note again that this is a *causal* statement: for a *given* buyout, lenders will provide less financing if insider equity is *exogenously* reduced. This does not imply a positive correlation between buyout debt and post-buyout inside ownership in a cross-section of buyouts due to, possibly unobserved, differences in V and C across deals (cf. our earlier footnote 35).

[38]These studies suggest that family ownership makes it easier for a firm to raise (more) debt. The part of the intuition behind Proposition 1 missing in their empirical setting is that the bidders in our model have strong incentives to lever up: they need debt to extract takeover gains.

This reveals that the bidder's profit in (P),

$$\mathcal{W}(\alpha) - \frac{C(e^+(\alpha))}{\alpha},$$

equals total surplus less the wedge that target shareholders extract through the price. How the wedge varies with α determines how increases in $\mathcal{W}(\alpha)$ are divided.

There are two opposing effects. Holding the numerator fixed, $\frac{C(e^+(\alpha))}{\alpha}$ decreases in α. This reflects that blockholder incentives depend on equity concentration and total equity value: active shareholders with larger stakes can dilute total equity value more without creating debt overhang problems.

However, holding the denominator fixed, $\frac{C(e^+(\alpha))}{\alpha}$ increases in α through $C(e^+(\alpha))$. That is, the increase in equilibrium effort moderates dilution. If the bidder acquires a larger equity stake as an incentive to improve firm value more, any parallel increase in debt must not undermine the required higher effort.

Target shareholders benefit from bootstrapping when the latter effect dominates. This requires equilibrium effort $e^+(\alpha)$ to be sufficiently elastic, which in turn requires that cost function C is not *too* convex. Our next result identifies a sufficient condition for this to be the case, while considering how target shareholders would be affected by the removal of a hypothetical exogenous limit $\bar{D}$ on bootstrapped debt.

Proposition 2. *Bootstrapping increases takeover premia if C is log-concave.*

Proof. Section B of the Appendix. □

In Müller and Panunzi (2004), bootstrapped debt lowers takeover premia and target shareholders can benefit from restrictions on bootstrapping (or buyout leverage). This reflects a rather general point in the theory of tender offers: target shareholders prefer limits to exclusion even if that deters some potential bids. To our knowledge, Proposition 2 represents the only exception to this rule. Under the stated condition, target shareholders do not want *any* restriction on bootstrapping or takeover debt.[39]

More than of theoretical interest, Proposition 2 squares the idea of bootstrapping as rent extraction with empirically high target returns in LBOs (e.g., Jensen 1988). (Appendix D.1 has examples of V and C functions where high leverage ratios benefit target shareholders.) In Section 4.4, we show that bidding competition reinforces the positive link between bootstrapping and target returns.

Like Proposition 1, Proposition 2 is a consequence of endogenous value creation. The crux is that the incentive problem constrains debt—but this plays a different role than in standard financing theories where the constraint measures up against a need for outside funds. Here it determines what a bidder can extract from the takeover, or conversely, has to leave on the table for free-riding target shareholders, for a given α. Intriguingly, the incentive constraints on D impose a "sharing rule" for the incentive gains from α such that bootstrapping can be Pareto-improving.

4.3 Upfront fees and (bidder) compensation structure

We trace through what channel the bidder extracts her share of the surplus $\mathcal{W}$. This is not obvious since target shareholders receive the full increase in share value, $V-D$, on any shares they retain or sell. (Outside investors merely break even.) How can the bidder make a profit if target shareholders get the full appreciation on all sold shares? The only possibility is that she does not fully pay for her stake out of her own pocket.

The bidder's financing contribution is $I_B \equiv \beta(V-D)-F^E-F^D$, where $\beta(V-D)$ is the total takeover payment, F^E is outside equity funding, and F^D is debt funding. By (4) and (5), which are binding in equilibrium, $F^E = \beta(1-\gamma)(V-D)$ and $F^D = D$. Netting out outside equity, we get $I_B = \alpha(V-D)-D$, where $\alpha(V-D)$ is the value of

[39] The condition (log-concavity) is not very restrictive and met by, among others, power functions $C(e) = \frac{c}{n}e^n$ and exponential functions $C(e) = \exp(e)-c$. It is tighter than needed in the sense that target shareholders can benefit even if C is not *globally* log-concave. When C becomes too convex, the limit $e^{+\prime}(\alpha) \to 0$ is a model with exogenous costs and values (Müller and Panunzi 2004). If we allow concave value improvement functions, an analogous condition exists for the concavity of the bidder's post-takeover objective function.

the stake going to the bidder. Indeed, takeover debt D lets her pay less than the value of the stake she gets.

This in itself is still consistent with the bidder contributing, on balance, a positive amount of funding. However, in equilibrium, it turns out that she cashes out upfront, i.e., $I_B < 0$.

Proposition 3. *The bidder's financing contribution is negative.*

Proof. By (1*), $I_B = C(e^+(\alpha)) - D$, which is the negative of bidder profit (6). $\square$

Bidders cannot extract profit through future cash flow to their equity stakes since the value of those cash flows is extracted by the target shareholders via the bid price. Instead, bidders extract it by cashing out upfront—a cash-out financed by taking on debt that decreases the future free cash flow (to equity).

But there is a limit to this extraction mechanism: the equity cannot be diluted to such an extent that a debt overhang arises. The equilibrium level of dilution is such that the incentives to create value are *just* preserved, as captured by the binding debt overhang constraint (1*): $\alpha(V(e^+(\alpha)) - D) = C(e^+(\alpha))$. The constraint shows that, in the optimally structured takeover, the value of the bidder's stake is diluted so as to just cover her effort cost—in fact, inducing that effort is the sole purpose of the stake. The bidder must in equilibrium get that stake *for free* to break even. Thus, for her to find the takeover profitable, outside funding must exceed the acquisition price to also finance upfront payouts to the bidder. That is, she must get upfront payouts to profit from accepting the incentives provided by the equity stake.

Note that the bidder's remuneration consists of two components: (i) target equity that she receives for free, akin to stock compensation, which incentivizes her to incur the effort that outside financiers bank their participation on; and (ii) an upfront cash payment, akin to a fixed salary, that is equal to her equilibrium rent. LBO financing resembles a compensation contract through which the passive LBO (debt and equity) investors "hire" bidders to take over the management of the target firms; and bidders profiting despite contributing no capital is analogous to managers earning returns to human capital.

In Müller and Panunzi (2004)'s model without moral hazard, upfront fees can also be positive, but they only affect surplus distribution. In our model, a limit on upfront fees (like a limit on bootstrapping) reduces a bidder's willingness to adopt incentive-superior financing structures and so the surplus. Thus ex ante payouts play a *positive* incentive role in our theory—in contrast to the negative incentive effect they have in managerial agency theories with moral hazard only.[40]

Empirically, upfront fees are common in leveraged buyouts. Two examples cited in Müller and Panunzi (2004) are the 1986 Revco deal where the upfront fees of \$54.4 million exceeded the acquisition company's equity of \$35 million (Wruck 1997) and the 1989 RJR Nabisco deal where the fees amounted to \$780 million (Burrough and Helyar 1990).[41] Kaplan and Stein (1993) also provide evidence on the magnitude of upfront fees.

4.4 Bidding competition and buyout debt

The last part of our analysis considers two competing bidders who may differ in their value improvement or cost functions. To gain control of the target in this setting, a bidder must outbid her rival with an offer price that satisfies the free-rider condition. We show that (i) bootstrapping raises reservation prices and (ii) the winner's use of takeover debt increases in the loser's reservation price (and hence with competition).

[40] The upfront payouts also imply that any wealth constraints would be slack in our model. Last, note that there is no need for upfront fees to transfer rents in models where prices are negotiated free from the free-rider condition.

[41] Kohlberg Kravis Roberts & Co., the buyout firm behind the deal, was said to have contributed only \$15 million to the deal (Knight 1988).

4.4.1 Bootstrapping increases reservation prices

Without loss of generality, consider bidder 2. As in the setting without competition, if she succeeds, her effort will satisfy first-order condition (2) and target shareholders will tender such that free-rider condition (3) strictly binds (Sections 3.2.1 and 3.2.2). As a result, (6) still applies; bidder 2's profit can be written as $D_2 - C_2(e_2^+(\alpha_2))$.

We can characterize all offers under which bidder 2 would break even by

$$D_2 = C_2(e_2^+(\alpha_2)). \tag{7}$$

By definition, target shareholders receive the whole surplus under a break-even offer; so the break-even prices are equal to $\mathcal{W}_2(\alpha_2)$. As $\mathcal{W}_2(\alpha_2)$ is strictly increasing, bidder 2's reservation price p_2^o is the break-even price under the largest (α_2, D_2) that is both feasible and satisfies (7), hereafter denoted by (α_2^o, D_2^o).

For the causal effect of bootstrapping on bidders' reservation prices, consider the exogenous limit $\bar{D}$. If $\bar{D} < D_2^o$, the limit changes her reservation price from $\mathcal{W}_2(\alpha_2^o)$ to $\mathcal{W}_2(\bar{\alpha}_2)$ where $\bar{\alpha}_2$ solves (7) for $D_2 = \bar{D}$. As α_2 and D_2 are positively linked in (7), the new reservation price is lower, making bidder 2 a "weaker" competitor.

Proposition 4. *Bootstrapping strengthens competition.*

It is worthwhile repeating that neither bidder is wealth-constrained. That is, the role of debt financing here is not that it makes it *possible* to pay more. Rather, its role in break-even condition (7) is to compensate bidder 2 for costs. Being able to recoup costs drives how much value she is *willing* to generate, which in turn determines her reservation price.

4.4.2 Competition increases buyout debt

Without loss of generality, consider bidder 1. To show that she uses more debt under competition, we first show that she does not exhaust her debt capacity otherwise. In the absence of competition, she maximizes (6) subject to (1*), that is, solves

$$\max_{\alpha_1 \in [0,1]} D_1(\alpha_1) - C(e_1^+(\alpha_1)), \tag{8}$$

where $D_1(\alpha_1)$ is her ownership-debt function, as defined by (1*). Her maximum debt capacity, by contrast, is found by maximizing α_1 subject to $D_1(\alpha_1) - C(e_1^+(\alpha_1)) = 0$ or is the corner value $D_1(1)$. Hence, whenever the solution to (8) involves $\alpha_1^* < 1$ and a strictly positive profit, bidder 1 raises less debt than she *could*. This is, for example, always the case when C is from the class of power functions (see Appendix D.1).[42]

Lemma 4. *Absent competition, bidders do not generally exhaust their debt capacity.*

Intuitively, this is a consequence of Proposition 2: If target shareholders capture part of the incentive gains induced by takeover debt, bidders will generally not max out on debt. This begs the question how they adjust debt in response to competition. Hereafter, assume that bidder 1's bid $(\alpha_1^*, D(\alpha_1^*), p_1^*)$ absent competition is profitable and features $\alpha_1^* < 1$, so she has unused debt capacity.

Without loss of generality, let bidder 1 have the higher reservation price and win. Under competition, her optimal bid meets four conditions: debt overhang constraint (1), first-order condition (2) for effort, free-rider condition (3), and furthermore the competition constraint:

$$p_1 \geqslant \overline{p}_2 \tag{9}$$

We assume $\overline{p}_2 > p_1^*$, so competition is effective.

Suppose her optimal bid just matches bidder 2's reservation price, so (9) binds.[43] Focusing on interior solutions, where bidder 1 gets $\alpha_1 < 1$ shares, recall from Lemma

[42] In incentive models with wealth constraints (e.g., Innes 1990), the insider always ends up with all the equity ($\alpha = 1$). In those models, swapping outside debt for outside equity raises incentives and pledgeable income; this is always feasible and profitable. For real-world LBOs by PE firms, it is safe to claim that $\alpha < 1$ due to the large capital contributions of limited partners.

[43] Since the objective function in (P) can be non-monotonic in α, it is possible that bidder 1 wants to pay *strictly* more than $\overline{p}_2$. The arguments that follow in the text can also be applied to such cases with $\overline{p}_2$ replaced by $\overline{p}_2^+ = \overline{p}_2 + \Delta$ for some $\Delta > 0$.

2 that free-rider condition (3), endogenously, binds. (We cover corner solutions in the proof of the next result.) Substituting (2) and a binding (9) into a binding (3) yields

$$D_1 = V(e_1^{+}(\alpha_1)) - \overline{p}_2. \tag{10}$$

This identifies (α_1, D_1) that take into account all optimality conditions except for (1). With target shareholders' payoff fixed at $\overline{p}_2$, bidder 1's profit subject to (10) is

$$\mathcal{W}_1(\alpha_1) - \overline{p}_2.$$

As this strictly increases in α_1, bidder 1 should match $\overline{p}_2$ with the highest α_1 subject to (10) and (1). Intuitively, if limiting target shareholders to $\overline{p}_2$ ((9)), she optimally maximizes surplus under the other constraints. This requires increasing α to improve incentives to create value ((2)) and increasing D to keep post-takeover share value at $\overline{p}_2$ (due to (3))—until further increases are infeasible due to debt constraints ((1)) or because the corner solution is reached ($\alpha_1 = 1$).

This reasoning leads to the next result which, in keeping with the language used in Proposition 4, refers to an increase in $\overline{p}_2$ as "stronger" competition.

Proposition 5. *Stronger competition increases bootstrapping and takeover surplus.*

Proof. Section C of the Appendix. □

Both parts of Proposition 5 are novel. In Müller and Panunzi (2004), where post-takeover values are exogenous, competition curbs bootstrapping. In incentive models with wealth constraints, competition increases bidders' need for outside funds, which pushes them further *away* from first-best incentives. In our model, bidders generally do not increase their own incentives as much as feasible due to the free-rider problem. Competition pushes them *toward* first-best incentives, and as they create more value, they also extract more through debt.

The effect of competition on profits is the conventional one: The added constraint (9) lowers bidder profits. Given takeover surplus increases, target shareholders gain. Proposition 5 thus reconciles bidding competition with high takeover leverage as well as high takeover leverage with low bidder returns, in line with the following narrative (Holmstrom and Kaplan 2001, p.128f):

> The leveraged buyout experience was different in the latter half of the 1980s. Roughly one-third of the leveraged buyouts completed after 1985 subsequently defaulted on their debt, some spectacularly...But even for the late 1980s, the evidence is supportive of the efficiency story ...
>
> The likely answer is that the success of the LBOs of the early 1980s attracted entrants and capital... As a result, much of the benefit of the improved discipline, incentives, and governance accrued to the selling shareholders rather than to the post-buyout LBO investors. The combined gains remained positive, but the distribution changed.

At the extreme in our model, if the bidders are equally competitive, the winner raises her maximum feasible debt amount but *all* of the surplus goes to target shareholders —even though the debt serves to dilute the latter.

In sum, in our theory, bootstrapping makes rival bidders more competitive, which forces winners to use more debt, improves efficiency, and benefits target shareholders. These pro-competitive effects contrast with the role of debt in other models of bidder competition. In Chowdhry and Nanda (1993), debt funding serves to *deter* rivals. In DeMarzo, Kremer, and Skrzypacz (2005), which expands on results in Hansen (1985) and Rhodes-Kropf and Viswanathan (2000), competing bidders prefer debt to equity funding (or equivalently, paying in cash rather than in stock) because doing so *lowers* the seller's expected revenue.

5 Conclusion

The question of why firms use debt and how much they should use is one of the classic questions in finance. Much is by now understood, but the question still sparks debate in areas where leverage seems "excessive," such as in LBOs. During the buyout wave in the 1980s, then-SEC Chairman Alan Greenspan cautioned in U.S. Senate hearings (Leveraged Buyouts and Corporate Debt 1989, p.17),

> [T]he extent of the leverage involved is worrisome, in the sense that while one may say the restructuring is a plus, how it is financed is a different question and something which I find disturbing . . . If, for example, all of this restructuring were done with equity, rather than leveraged buyouts, I frankly would feel considerably more comfortable.

The prevailing narrative is that buyout debt optimizes the incentives with which the target is managed after the buyout. While persuasive, this leaves some questions open: If implementing optimal capital structure, why are leverage ratios in buyouts so much *higher* than in firms, sometimes reaching 90 percent of total capital? If debt serves to discipline and incentivize those taking control of the post-buyout firm, why do PE firms structure it in such a manner as to *eschew* liability ("bootstrapping")? These questions stir the perennial criticism that the debt also plays a less benign role. With PE activity expanding, such criticism is resurfacing (Kosman 2009; Appelbaum and Batt 2014), echoing Greenspan's unease.

In this paper, we offer answers to these questions by merging the incentive theory of buyouts with the theory on the free-rider problem in takeovers of widely held firms. Our unified theory predicts "*excessive*" levels of debt (beyond financing needs) raised via *bootstrapping*, paired with *upfront payouts* to bidders, as a financial structure that profits bidders *and increases* takeover premia (and in this sense, is Pareto-improving). It is to our knowledge the only theory to fully capture these LBO traits.

Our theory bolsters a prominent line of reasoning in corporate governance theory.

Set against Berle and Means (1932)'s thesis that diffuse owners' free-riding empowers managers, Manne (1965) proposed the most direct remedy: (the threat of) a takeover to reunify ownership and control when warranted. Such takeovers must reconsolidate ownership to *improve incentives* while *overcoming holdout behavior* among dispersed shareholders (Jensen and Meckling 1976; Grossman and Hart 1980). Bootstrapping targets (to such a degree that PE firms cash out early) is, as we show, a buyout design that achieves both objectives simultaneously, immune even to the typical caveat that target shareholders want to limit the means bidders use to extract gains. This makes bootstrapped debt a near-perfect weapon against free-riding—the root cause of weak governance under diffuse ownership—and as such potentially crucial to implementing Manne's idea of disciplinary takeovers.

This is by no means to refute that LBO financing could entail costs, including a higher risk of financial distress or negative externalities on other stakeholders. But it offers efficiency arguments for controversial LBO traits to counterbalance some of the concerns. In fact, we argue that bootstrapping is crucial to a well-functioning market for corporate control, and can explain why buyouts are extremely leveraged based on arguments that unify two canonical strands of takeover theory, and importantly, do not apply to capital structure choice outside of takeovers.

Appendix

A Proof of Proposition 1

The proof is composed of two lemmas. One establishes that a binding debt overhang constraint entails a positive relationship between α and D. The other shows that the debt overhang constraint binds in equilibrium also when an exogenous cap $\bar{D}$ limits the bidder's choice of D.

Lemma A.1. *A binding debt overhang constraint defines D as a strictly increasing function of α.*

Proof. As per (1*), define $D(\alpha) \equiv V(e^+(\alpha)) - \frac{C(e^+(\alpha))}{\alpha}$. We have:

$$\begin{aligned} D'(\alpha) &= V'(e^+(\alpha))e^{+\prime}(\alpha) + \frac{1}{\alpha^2}C(e^+(\alpha)) - \frac{1}{\alpha}C'(e^+(\alpha))e^{+\prime}(\alpha) \\ &= \big(V'(e^+(\alpha)) - \frac{1}{\alpha}C'(e^+(\alpha))\big)e^{+\prime}(\alpha) + \frac{1}{\alpha^2}C(e^+(\alpha)) \\ &= \frac{1}{\alpha^2}C(e^+(\alpha)) > 0. \end{aligned}$$

The third equality holds because $\alpha V'(e^+(\alpha)) - C'(e^+(\alpha)) = 0$ by (2). The fact that $D(\alpha)$ is strictly increasing implies the same for its inverse function. □

Let $\overline{D}$ be an *exogenous* upper bound on debt, that is, the bidder is only allowed to issue $D \in [0, \overline{D}]$. Let (α^*, D^*) denote the optimal post-takeover bidder stake α^* and debt level D^* in the absence of the exogenous upper bound on D.

Since the exogenous debt limit is non-binding for $\overline{D} > D^*$, we restrict attention to $\overline{D} \leqslant D^*$. The next lemma shows that the debt overhang constraint is *always* binding in equilibrium even when there is an exogenous cap on debt.

Lemma A.2. *In equilibrium, the bidder chooses (α, D) such that $D \leqslant \overline{D}$ and $\alpha D = \alpha V(e(\alpha)) - C(e(\alpha))$.*

Proof. First suppose $D < \overline{D}$. By the endogenous debt overhang constraint, $\alpha D \leqslant \alpha V(e(\alpha)) - C(e(\alpha))$. If $\alpha D < \alpha V(e(\alpha)) - C(e(\alpha))$, the bidder can increase D by some $\varepsilon > 0$ so that $D + \varepsilon < \overline{D}$ and $\alpha(D+\varepsilon) < \alpha V(e(\alpha)) - C(e(\alpha))$, which strictly increases the bidder's profit. Thus, this yields a contradiction.

Now suppose $D = \overline{D}$ but $D < \bar{D}(\alpha)$ where, for said α, $\bar{D}(\alpha) = V(e(\alpha)) - \frac{C(e(\alpha))}{\alpha}$ is the *endogenous* debt capacity where the debt overhang constraint would be binding. Since $\bar{D}'(\alpha) > 0$ by Lemma A.1 and $D < \bar{D}(\alpha)$, there is an $\varepsilon > 0$ such that $\alpha' = \alpha - \varepsilon$ satisfies $D < \bar{D}(\alpha') = V(e(\alpha')) - \frac{C(e(\alpha'))}{\alpha'}$. Because $C(e(\alpha))$ is increasing in α, it then follows that $D - C(e(\alpha')) > D - C(e(\alpha))$, so the bidder obtains a strictly higher profit. Thus, this too leads to a contradiction. $\square$

Lemma A.2 implies that the imposition of a binding exogenous cap $\bar{D}$ causes the debt overhang constraint (1*) to be binding at some lower level of debt $D \leqslant \bar{D} < D^*$. Lemma A.1 consequently implies that the imposition of D leads to a smaller bidder stake α. We will use these lemmas also in the proof of Proposition 2.

To conclude this proof, note that $\mathcal{W}(\alpha)$ is strictly increasing in α. By lowering α, the imposition of a binding exogenous cap hence reduces takeover surplus. ■

B Proof of Proposition 2

For reference, we state a result from one variable calculus (e.g., Rudin 1964, p. 114):

Lemma B.1. *Let $f : (0, +\infty) \to \mathbb{R}$ be a differentiable function such that $f'(x) > 0$ for all $x \in (0, +\infty)$. Then f is strictly increasing on $(0, +\infty)$ and has a differentiable inverse function g with*

$$g'(f(x)) = \frac{1}{f'(x)}$$

for all $x \in (0, +\infty)$. If $f : (0, +\infty) \to \mathbb{R}$ is twice differentiable and such that $f''(x) > 0$ for all $x \in (0, +\infty)$ then its inverse g is also twice differentiable and we *have*

$$g''(f(x)) = -\frac{f''(x)}{(f'(x))^3}$$

for all $x \in (0, +\infty)$.

We turn to the main proof. As in the proof of Proposition 1, suppose the bidder may issue $D \in [0, \overline{D}]$ where $\overline{D}$ is an exogenous limit. We restrict attention to $\overline{D} \leqslant D^*$ where D^* is the optimal debt level in the absence of the limit, that is, to cases where the limit matters.

We know that debt overhang constraint (1) binds in equilibrium with or without a limit on D and that such a limit causes a decrease in the bidder's post-buyout stake α (Lemmas A.1 and A.2 in the proof of Proposition 1). For the current proposition, it hence suffices to establish whether or when target shareholders benefit from larger α, conditional on (1) binding.

As shown in the main text, when (1) binds, target shareholders' payoff is $\frac{C(e^+(\alpha))}{\alpha}$. Target shareholders benefit from larger α if

$$\begin{aligned} \frac{\mathrm{d}}{\mathrm{d}\alpha}\frac{C(e^+(\alpha))}{\alpha} &= \frac{C'(e^+(\alpha))e^{+\prime}(\alpha)}{\alpha} - \frac{C(e^+(\alpha))}{\alpha^2} \\ &= \frac{\theta}{\alpha}\left[\frac{C'(e^+(\alpha))}{C''(e^+(\alpha))} - \frac{C(e^+(\alpha))}{C'(e^+(\alpha))}\right] \geqslant 0. \end{aligned}$$

The second equality above holds by Lemma B.1, whereby if $e^+(\alpha) > 0$, then $e^{+'}(\alpha) = \frac{\theta}{C''(e^+(r))}$. A sufficient condition for the last inequality to hold globally is log-concavity of C, i.e., $C(e)C''(e) \leqslant [C'(e)]^2$ for all $e > 0$.[44]

Finally, we want to verify that there exist log-concave C for which $D^* > 0$, that is, for which the bidder is inclined to use debt (make a bid) such that the exogenous debt limit could be binding. In Appendix D, we show that this is the case, for example, for

[44]Note that $\frac{C(e^+(\alpha))}{\alpha}$ is an average cost per share, but α is not the direct argument in C. If C were a *direct* function of α, a sufficient condition for the average cost to be increasing is that marginal cost exceeds average cost. Log-concavity matters for first-order condition (2) to ensure that $e^+(\alpha)$ is sufficiently elastic with respect to α.

power functions.[45] ■

C Proof of Proposition 5

Interior solution. Note that (10) expresses bidder 1's debt as a strictly increasing function of her equity stake. We denote this function by

$$D_1^c(\alpha_1) \equiv V(e_1^+(\alpha_1)) - \overline{p}_2.$$

It represents (α_1, D_1) that take into account all optimality conditions except (1), or more specifically, for which (2) holds and (3) and (9) strictly bind.

Recall that, as per (1*),

$$D_1(\alpha_1) \equiv V_1(e_1^+(\alpha_1)) - \frac{C_1(e_1^+(\alpha_1))}{\alpha_1}$$

represents all (α_1, D_1) for which (1) strictly binds.

As established in the main text, bidder 1 optimally matches bidder 2's reservation price by maximizing α subject to (1) and (10). The solution is the highest α_1 where

$$D_1^c(\alpha_1) \leqslant D_1(\alpha_1),$$

which we hereafter denote by α_1^{**}.

The previous inequality is slack at the single-bidder optimum α_1^*:

$$D_1^c(\alpha_1^*) = V_1(e^+(\alpha_1^*)) - \overline{p}_2 < V_1(e^+(\alpha_1^*)) - p_1^* = D_1(\alpha_1^*),$$

where the inequality follows from $p_1^* = \frac{C_1(e_1^+(\alpha_1^*))}{\alpha_1^*}$ and effective competition ($\overline{p}_2 > p_1^*$).

[45] One can also find conditions under which the bidder's equilibrium profit is globally increasing in α. A sufficient condition for this is that C is log-convex (see Internet Appendix E). That said, *global* conditions on C are much more restrictive than needed for bootstrapping to create Pareto gains. For example, it is simple to construct such a setting with cost functions that have alternating log-convex and log-concave segments.

Thus, $\alpha_1^{**} > \alpha_1^*$. That is, competition increases bidder 1's takeover debt compared to the single-bidder case.

For a given $\overline{p}_2$, suppose $\alpha_1^{**} < 1$. Does bidder 1 use even more takeover debt when bidder 2's reservation price increases to $\overline{p}_2^\epsilon > \overline{p}_2$? One can show that this is the case by relabeling α_1^{**} as α_1^*, $\overline{p}_2$ as p_1^*, and $\overline{p}_2^\epsilon$ as $\overline{p}_2$ and retracing the previous arguments. In doing so, an important observation is that debt overhang constraint (1) binds for any optimal non-corner winning bid; for $\alpha_1^{**} < 1$, $D_1^c(\alpha_1^{**}) = D_1(\alpha_1^{**})$.

Corner solution. Suppose bidder 1 matches bidder 2's reservation price with a bid that leads to $\alpha_1 = 1$. At $\alpha_1 = 1$, the free-rider condition can be slack. Still, as bidder 1 buys all shares at a price equal to $\overline{p}_2$, her profit is $\mathcal{W}(1) - \overline{p}_2$, which is the maximum value of the profit function $\mathcal{W}(\alpha) - \overline{p}_2$ used in the arguments in the text. Thus, the result that bidder 2's presence increases bidder 1's takeover debt, if $\alpha_1^* < 1$, is valid also when the winning bid is a corner solution. Once in the corner solution, bidder 1 can meet further increases in $\overline{p}_2$ by reducing debt but, equivalently, also by raising p_1 without a change in debt.

D Examples with specific functional forms for C

Below we solve our model adopting two specific functional forms for cost function C: power functions and exponential functions.

Power functions serve as an example of log-concave functions for which the bidder uses a strictly positive amount of debt, but not the maximum feasible amount of debt in the absence of competition (i.e., $\alpha^* \in (0, 1)$ while her profit is strictly positive).[46]

Exponential functions serve as an example of log-convex functions, under which the most extreme solution obtains: the bidder takes the largest possible stake $\alpha^* = 1$, maxing out on her potential use of debt even without competition.

Under either class of functions, bootstrapping is Pareto-improving (though in the

[46] These equilibrium properties obtain under all power functions except the linear one.

case of exponential functions, target shareholders gain only weakly).

Example D.1 (Power functions)**.** Let $V(e) \equiv \theta e$ and $C(e) \equiv \frac{c}{n}e^n$ where $\theta > 0$, $c > 0$ and $n \in \mathbb{N}$ are exogenous parameters. These functions satisfy all our assumptions. It can also be shown that they generate unique solutions to (P) (proof available upon request). So, if the bidder's profit is positive under the solution to (P), there exists a unique $\langle D, \alpha, p, e\rangle$ such that $\alpha V'(e) = C'(e)$, $p = V(e) - D$, $\alpha D = \alpha V(e) - C(e)$, and $\alpha \in [1/2, 1]$ satisfying $\alpha \in \{1/2, 1\}$ or the ex ante first-order condition for (P),

$$\frac{1}{\alpha^2}C(e^+(\alpha)) = C'(e^+(\alpha))e^{+\prime}(\alpha). \tag{D.1}$$

The specific functional form allows us to express $\langle D, \alpha, p, e\rangle$ in closed form. The first-order condition for effort $\alpha V'(e) = C'(e)$ yields $e = \left(\frac{\alpha\theta}{c}\right)^{\frac{1}{n-1}}$. The equilibrium stake α solves (D.1). One can show that this condition holds if and only if

$$\theta e^{+\prime}(\alpha)\left(\frac{n-1}{n} - \alpha\right) = 0,$$

which in turn holds if and only if $\alpha = 0$ (since $e^{+\prime}(0) = 0$) or $\alpha = \frac{n-1}{n}$. Of these, only $\alpha = \frac{n-1}{n}$ is admissible as a solution to (P). It is straightforward to verify that

$$D = \frac{(n-1)\theta}{n}\left(\frac{(n-1)\theta}{nc}\right)^{\frac{1}{n-1}}$$

and

$$p = \frac{\theta}{n}\left(\frac{(n-1)\theta}{nc}\right)^{\frac{1}{n-1}}.$$

Furthermore, the bidder's profit under the solution to (P) is positive since

$$\begin{aligned} D - C(e^+(\alpha)) &= \frac{(n-1)\theta}{n}\left(\frac{(n-1)\theta}{nc}\right)^{\frac{1}{n-1}} - \frac{(n-1)\theta}{n^2}\left(\frac{(n-1)\theta}{nc}\right)^{\frac{1}{n-1}} \\ &= \theta\left(\frac{n-1}{n}\right)^2\left(\frac{(n-1)\theta}{nc}\right)^{\frac{1}{n-1}} \geqslant 0. \end{aligned}$$

To sum up, there is a unique equilibrium in which

$$\langle D, \alpha, p, e \rangle = \left\langle \frac{(n-1)\theta}{n} \left(\frac{(n-1)\theta}{nc} \right)^{\frac{1}{n-1}}, \frac{n-1}{n}, \frac{\theta}{n} \left(\frac{(n-1)\theta}{nc} \right)^{\frac{1}{n-1}}, \left(\frac{\frac{n-1}{n}\theta}{c} \right)^{\frac{1}{n-1}} \right\rangle.$$

As power functions are log-concave for all $n \in \mathbb{N}$, (more) debt always increases post-takeover share value and target shareholder wealth (Proposition 2). The equilibrium debt-equity ratio is $D/p = n - 1$. For $n = 5$, the ratio equals 4. $\lhd$

Example D.2 (Exponential functions.)**.** Let $V(e) \equiv \theta e$ and $C(e) \equiv \exp(e)$ with $\theta > \exp(2)$. These functions satisfy all our assumptions, and can be shown to entail unique solutions to (P) (proof available upon request). If the bidder's profit is positive under (P), there is a unique $\langle D, \alpha, p, e \rangle$ such that $\alpha V'(e) = C'(e)$, $p = V(e) - D$, $\alpha D = \alpha V(e) - C(e)$, and $\alpha \in [1/2, 1]$ either satisfying the ex ante first-order condition (D.1) or $\alpha \in \{1/2, 1\}$. The post-takeover first-order condition $\alpha V'(e) = C'(e)$ yields $e^+(\alpha) = \ln(\alpha\theta)$, which is stictly positive given $\alpha\theta > \frac{\exp(2)}{2} > 1$. Substituting $e^+(\alpha)$ into the profit function of (P) yields

$$\theta \ln(\alpha\theta) - (1 + 1/\alpha)\alpha\theta.$$

Differentiating with respect to α yields $\theta(1/\alpha - 1)$, which is strictly positive for all $\alpha \in [1/2, 1)$. Thus, $\alpha = 1$ is the unique solution to (P). It is straightforward to verify that

$$D = \theta \ln(\theta) - \theta$$

and

$$p = \theta.$$

Furthermore, the bidder's profit is

$$D - C(e^+(1)) = \theta(\ln(\theta) - 2),$$

which is positive since $\theta > \exp(2)$ implies $\ln(\theta) > 2$. To summarize, there is a unique equilibrium in which

$$\langle D, \alpha, p, e \rangle = \langle \theta \ln(\theta) - \theta, 1, \theta, \ln(\theta) \rangle .$$

As exponential functions are weakly log-concave, leverage is weakly Pareto-improving. With $\alpha = 1$ in equilibrium, first-best incentives are restored. The equilibrium debt-equity ratio is $D/p = \ln(\theta) - 1$. For example, if $\theta = \exp(5)$, the ratio is 4. $\triangleleft$

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Internet Appendix for "LBO Financing"

E Log-convex cost functions

For reference, we first state the following auxiliary result:

Lemma E.1. *There is a unique differentiable function* $e : [1/2, 1] \to \mathbb{R}_{\geqslant 0}$ *such that* $\alpha V'(e(\alpha)) = C'(e(\alpha))$ *for all* $\alpha \in [1/2, 1]$ *and such that* $e'(\alpha) > 0$ *for all* $\alpha \in (1/2, 1)$.

Proof. Define a function $H : (0, +\infty) \to \mathbb{R}$ by $H(e) = \frac{C'(e)}{\theta}$. Clearly

$$H'(e) = \frac{C''(e)}{\theta} > 0$$

for all $e > 0$ by our assumption that $C''(e) > 0$ for all $e \geqslant 0$. Thus H satisfies the premises of Lemma B.1, and hence there is a differentiable function G such that $G(H(e)) = e$ for all $e > 0$ and $H(G(y)) = y$ for all y in the range of H. From our assumptions $\lim_{e \to 0} C'(e) = 0$ and $\lim_{e \to +\infty} C'(e) = +\infty$ and the fact that H is continuous, it follows that $[1/2, 1]$ is a subset of the range of H, i.e., $[1/2, 1] \subseteq H((0, +\infty))$. Hence we may define $e : [1/2, 1] \to (0, +\infty)$ by $e(\alpha) := G(\alpha)$ for all $\alpha \in [1/2, 1]$. Then $\frac{C'(e(\alpha))}{\theta} = H(e(\alpha)) = H(G(\alpha)) = \alpha$ for all $\alpha \in [1/2, 1]$ and the first part of the claim follows. Let $\alpha \in (1/2, 1)$ and $e > 0$ be such that $H(e) = \alpha$, applying Lemma *B*.1 once again then yields

$$e'(\alpha) = e'(H(e)) = \frac{1}{H'(e)} = \frac{\theta}{C''(e)} > 0.$$

□

We now show that, when cost function C is log-convex, bidder profit is strictly increasing in α, thus leading to the corner solution $\alpha^* = 1$. By Lemma A.1, the debt overhang constraint (1) always binds (even with an exogenous limit on debt). When

(1) binds, the profit is

$$\pi^B(\alpha) \equiv V(e^+(\alpha)) - \left[1 + \frac{1}{r}\right] C(e^+(\alpha))$$

(cf. the objective function in (P)). This is strictly increasing in α if

$$\begin{aligned}
\frac{\mathrm{d}\pi^B(\alpha)}{\mathrm{d}\alpha} &= V'(e^+(\alpha))e^{+\prime}(\alpha) + \frac{1}{\alpha^2}C(e^+(\alpha)) - \frac{1}{\alpha}C'(e^+(\alpha))e^{+\prime}(\alpha) - C'(e^+(\alpha))e^{+\prime}(\alpha) \\
&= \left[V'(e^+(\alpha)) - \frac{1}{\alpha}C'(e^+(\alpha))\right] e^{+\prime}(\alpha) + \frac{1}{\alpha^2}C(e^+(\alpha)) - C'(e^+(\alpha))e^{+\prime}(\alpha) \\
&= \frac{1}{\alpha^2}C(e^+(\alpha)) - C'(e^+(\alpha))e^{+\prime}(\alpha) \\
&= \frac{1}{\alpha^2}C(e^+(\alpha)) - \frac{C'(e^+(\alpha))\theta}{C''(e^+(\alpha))} \\
&= \frac{1}{\alpha^2}C(e^+(\alpha)) - \frac{C'(e^+(\alpha))C'(e^+(\alpha))}{C''(e^+(\alpha))\alpha} \\
&= \frac{1}{\alpha}\left(\frac{C(e^+(\alpha))}{\alpha} - \frac{[C'(e^+(\alpha))]^2}{C''(e^+(\alpha))}\right) > 0
\end{aligned}$$

The second equality is obtained by rearranging terms. The third equality holds since $\alpha V'(e^+(\alpha)) - C'(e^+(\alpha)) = 0$ by (2). The fourth equality follows from Lemma E.1. The fifth equality holds because $\alpha\theta = C'(e^+(\alpha))$ by (2). A sufficient condition for the last inequality to be satisfied globally is that

$$\frac{1}{\alpha}\left(\frac{C(e)}{\alpha} - \frac{[C'(e)]^2}{C''(e)}\right) > \frac{1}{\alpha}\left(C(e) - \frac{[C'(e)]^2}{C''(e)}\right) \geqslant 0$$

for all $e > 0$. The strict inequality holds for all $\alpha < 1$. The last weak inequality holds if C is log-convex, i.e., if $C(e)C''(e) \geqslant [C'(e)]^2$ for all $e > 0$. For example, exponential functions satisfy this property.

F Comparative statics with respect to parameters of V

For reference, we first state the following auxiliary result:

Lemma F.1. *Let $f : (a, b) \to \mathbb{R}$ be a function such that $f(x) = h(x)g(x)$ for all $x \in (a, b)$, where $h(x) > 0$ and $g'(x) < 0$ for all $x \in (a, b)$. Then there is at most one $x \in (a, b)$ such that $f(x) = 0$. Moreover if a point $x \in (a, b)$ such that $f(x) = 0$ exists then $f(y) > 0$ for all $y < x$ and $f(y) < 0$ for all $y > x$.*

Proof. Consider two arbitrary distinct points $x, y \in (a, b)$ with $f(x) = f(y) = 0$. Then $h(x) > 0$ and $h(y) > 0$ implies $g(x) = g(y) = 0$. Since g is differentiable, hence also continuous on $[x, y]$, the mean value theorem (Rudin 1964, Theorem 5.10, p. 108) gives a point z with $x < z < y$ and $g'(z) = 0$. This contradicts $g'(z) < 0$. The second part clearly holds since $g(y) > 0$ for all $y < x$ and $g(y) < 0$ for all $y > x$ and since $h(x)$ is strictly positive. □

We will now provide a comparative statics analysis with respect to the parameters of V in the setting of example D.1. This is for two reasons. First, it showcases a class of cost functions that satisfies the log concavity assumption and hence Proposition 2. Second, it allows us to contrast the *causal* effect of debt, described by Proposition 2, with the "cross-sectional" relationship between takeover debt and target shareholder wealth generated by variation in (fundamentals such as) V in the debt-unconstrained equilibrium.

As in example D.1, $V(e) = \theta e$ and $C(e) = \frac{c}{n} e^n$ with $\theta > 0$, $c > 0$ and $n \geqslant 2$. Consequently, the optimal debt level, target shareholder wealth, and bidder stake as functions of n are:

$$D(n) \equiv \frac{(n-1)\theta}{n} \left(\frac{(n-1)\theta}{nc} \right)^{\frac{1}{n-1}},$$

$$\pi^S(n) \equiv V(e(\alpha)) - D = \frac{\theta}{n} \left(\frac{(n-1)\theta}{nc} \right)^{\frac{1}{n-1}}.$$

$$\alpha(n) \equiv \frac{n-1}{n}$$

One can verify that $C(e)$ is convex and log-concave for all $n \geqslant 2$. Thus, Proposition 2 applies: Takeover debt has a positive causal impact on target shareholder wealth.

As a comparison, we now describe comparative statics of the equilibrium without an exogenous debt limit with respect to n.

Result 1. *Let $V(e) = \theta e$ and $C(e) = \frac{c}{n} e^n$ with $\theta > 0$, $c > 0$ and $n \geqslant 2$.*

a. If $\theta > 2c$, then $\pi^S(n)$ is a decreasing function of n. If $\theta \leqslant 2c$ then there is an n^* such that shareholder wealth $\pi^S(n)$ is increasing in n for $n \leqslant n^*$ and decreasing in n for $n > n^*$.

b. The optimal bidder stake $\alpha(n)$ is an increasing function of n.

c. The optimal debt level $D(n)$ is an increasing function of n whenever $\frac{\theta(n-1)}{cn} \leqslant \mathrm{e}$ where $\mathrm{e} \equiv \sum_{k=0}^{\infty} \frac{1}{k!}$ and a decreasing function of n for all n with $\frac{\theta(n-1)}{cn} > \mathrm{e}$.

Proof. For part a, let $f(x) \equiv \frac{\theta}{x} \left(\frac{(x-1)\theta}{xc} \right)^{\frac{1}{x-1}}$ for all $x \geqslant 2$ and $x \in \mathbb{R}$. Now,

$$f'(x) = \frac{\theta}{x} \left(\frac{(x-1)\theta}{xc} \right)^{\frac{1}{x-1}} \left[-\frac{1}{x} - \frac{1}{(x-1)^2} \log \left(\frac{(x-1)\theta}{xc} \right) + \frac{1}{(x-1)^2 x} \right] =$$

$$\frac{\theta}{x} \left(\frac{(x-1)\theta}{xc} \right)^{\frac{1}{x-1}} \left[\frac{2-x}{(x-1)^2} - \frac{1}{(x-1)^2} \log \left(\frac{(x-1)\theta}{xc} \right) \right] =$$

$$\frac{\theta}{x(x-1)^2} \left(\frac{(x-1)\theta}{xc} \right)^{\frac{1}{x-1}} \left[2 - x - \log \left(\frac{(x-1)\theta}{xc} \right) \right]$$

Denote the last term in brackets as $g(x)$. Then $g'(x) = -1 - \frac{x}{x-1} \frac{1}{x^2} = -1 - \frac{1}{x(x-1)} < 0$. If $\theta \leqslant 2c$ then $g(2) = -\log \left(\frac{\theta}{2c} \right) > 0$ and since $g(x) < 0$ for large x, it follows that there is a unique x^* such that $g(x^*) = 0$. Since $f(x)$ is the product of a strictly positive function and $g(x)$ it follows that $f(x) > 0$ for all $x < x^*$ and $f(x) \leqslant 0$ for all $x \geqslant x^*$. If $\theta > 2c$ then $g(2) \leqslant 0$, and since $g(x)$ is strictly decreasing, it follows that $f(x) < 0$ for all $x \geqslant 2$. Since the factor multiplying $g(x)$ is positive for all $x \geqslant 2$ it follows by Lemma F.1 that there is no more than one point x^* such that

$g(x^*) = 0$. Moreover, by the same lemma, if such a point exists, then $f'(x) > 0$ for all $x < x^*$ and $f'(x) \leqslant 0$ for all $x \geqslant x^*$. Now, if $\theta \leqslant 2c$ then $g(2) = -\log\left(\frac{\theta}{2c}\right) \geqslant 0$ and since $g(x) < 0$ for large x, it follows by the intermediate value theorem (Rudin 1964, Theorem 4.23, p. 93) that there is a x^* such that $g(x^*) = 0$. If $\theta > 2c$ then $g(2) < 0$, and since $g(x)$ is strictly decreasing, it follows that $f'(x) < 0$ for all $x \geqslant 2$.

For part b, note that $\alpha'(n) = \frac{1}{n^2} > 0$ for all $n \geqslant 2$ and $n \in \mathbb{R}$.

For part c, define $h(x) \equiv \frac{\theta(x-1)}{x}\left(\frac{(x-1)\theta}{xc}\right)^{\frac{1}{x-1}}$ for all $x \geqslant 2$ and $x \in \mathbb{R}$. Then

$$h'(x) = \theta\left(\frac{(x-1)\theta}{xc}\right)^{\frac{1}{x-1}}\left[\frac{1}{x(x-1)} - \frac{1}{x(x-1)}\log\left(\frac{(x-1)\theta}{xc}\right)\right].$$

By the last term in brackets, $h'(x) > 0$ if and only if $1 \geqslant \log\left(\frac{(x-1)\theta}{xc}\right)$, which in turn holds if and only if $\mathrm{e} \geqslant \frac{(x-1)\theta}{xc}$. (Note that e denotes Euler's constant $\mathrm{e} \equiv \sum_{k=0}^{\infty}\frac{1}{k!}$, not the bidder's effort.) $\square$

Result 1 illustrates by example that there may well be no clear-cut equilibrium relationship between α, $\pi^S(n)$, and D. Changes in n represent variations in economic fundamentals that are plausibly unobserved in the data. The three parts of the result state that there are parameters such that α is decreasing, $\pi^S(n)$ is increasing, and D is non-monotonic in n—correlations that contrast sharply with the *causal* impact of D on the other two variables (Propositions 1 and 2). This is to say that unobserved confounding factors, as represented by n in our example, can generate correlations in the data that obscure the causal effect of takeover leverage.

G Comparison to Section 6 in Müller and Panunzi (2003)

We now study a variant of our model with a binary value improvement function V, as in Section 6 of Müller and Panunzi (2003). If the bidder gains control, the post-takeover firm value will be $V = v > 0$ with probability $q(e)$ and $V = 0$ with probability $1 - q(e)$, where $e \in \mathbb{R}_0^+$ is the bidder's effort which imposes a private cost $C(e) \geqslant 0$ on her. We assume the success probability function $q(e) = e$, like Müller and Panunzi (2003), but instead of their quadratic cost function $C(e) = \frac{\xi e^2}{2}$, allow for a more general effort cost function $C(e)$ that satisfies $C'(e) \geqslant 0, C''(e) \geqslant 0$ for all $e \geqslant 0$. We also impose Inada-style conditions $C'(0) = 0$ and $\lim_{e \to 1} C'(e) = \infty$ to abstract from corner solutions.[47]

The primary reason for discussing this model variant is to spell out which insights Müller and Panunzi (2003) establish within their analysis of this setting, and thereby to delineate that the results of our paper are novel insights. As a by-product, this also demonstrates that our key results hold in a different model variant.

Remark 1. *A well-known property of financing models with binary v-or-0 outcomes is that debt and equity, or any other financial contract for that matter, are equivalent. The only material contract feature is how the firm value v in the singular success state is split. Whether the sharing rule is defined as an equity share α or a debt claim D is irrelevant; for any equity contract α, there is a payoff-equivalent debt contract D and vice versa.*[48] *In models with only moral hazard, this equivalence renders the choice or distinction between debt and equity immaterial.*

[47] Given our general cost function $C(e)$, assuming a linear $q(e)$ is without loss of generality. We use a general cost function to demonstrate that some predictions of this model variant are particular to the binary outcome structure rather than the quadratic cost function.

[48] Note that this equivalence between a fixed claim and a proportional sharing rule no longer holds when there are multiple "success" states with differing but positive firm values. That is, it is unique to the binary v-or-0 outcome structure.

G.1 Analysis and focus of Section 6 in Müller and Panunzi (2003)

Effort choice. If the bidder gains control, she chooses her effort to solve

$$\max_{e\in[0,1]} q(e)\alpha[v - D]^+ - C(e),$$

where α is her equity stake and D is the firm's debt. Given interior solutions, the optimal effort is pinned down by the first-order condition

$$C'(e) = \alpha[v - D]. \tag{G.1}$$

It is instructive to define $Z \equiv \alpha[v - D]$ to stress that what matters for incentives is only the amount the bidder is paid in the success state, i.e., Z. Any $Z \in [0, v]$ and associated effort level is implementable via infinitely many payoff-equivalent α-D-pairs, including such with only debt or only equity. If moral hazard were the only friction, capital structure would hence be irrelevant (cf. Remark 1).

Let $e(Z)$ denote the effort that solves (G.1). There is an increasing differentiable function f such that $e(Z) = f(Z)$ (given $C''(e) > 0$ and the inverse function lemma).

Tendering decisions. The target shareholders' free-riding behavior equalizes, in equilibrium, the expected post-takeover share value with the bid price:

$$p = f(Z)(v - D) \tag{G.2}$$

where $f(Z)$ is the success probability under the rationally anticipated optimal effort.

Financing choice. The bidder's ex-ante financing problem is to pick p, α, and D to maximize her expected profit $f(Z)D + f(Z)Z - \alpha p - C(f(Z))$, where $f(Z)D$ is the amount of debt funding raised, $f(Z)Z$ is the bidder's expected payoff from the equity stake she gets, αp is the cash paid to target shareholders for α shares acquired, and

$C(f(Z))$ is the bidder's effort cost. Substituting (G.2) for p in the objective yields

$$\begin{aligned} &\underset{\alpha,D}{\text{maximize}} \quad f(Z)D - C(f(Z)) \\ &\text{subject to} \\ &\qquad\qquad \alpha \in [0,1] \\ &\qquad\qquad p = f(Z)(v-D) \end{aligned} \tag{M}$$

As discussed, the impact of the bidder's α-D-choice through $Z \equiv \alpha(V-D)$ on the effort level $f(Z)$ is *per se* irrelevant. However, as the objective in (M) highlights, the bidder gains from raising D (as a consequence of free-rider condition (G.2)). The fact that bootstrapping mitigates the free-rider problem breaks the bidder's indifference between debt and outside equity (that would otherwise obtain in the model) in favor of debt. This leads to the use of (only) debt for outside funding in this setting.

Proposition G.1. *In equilibrium,* $\alpha^* = 1$, $D^* = \frac{v}{2}$, *and* $p^* > 0$.

Proof. Using (G.2) again, this time to replace $f(Z)$, the problem can be rewritten

$$\begin{aligned} &\underset{p,D}{\text{maximize}} \quad \frac{pD}{v-D} - C\left(\frac{p}{v-D}\right) \\ &\text{subject to} \\ &\qquad\qquad \alpha \in [0,1] \\ &\qquad\qquad p = f(Z)(v-D) \end{aligned}$$

Partially differentiating w.r.t. p, D yields

$$\frac{d\Pi}{dp} = \frac{D}{v-D} - C'\left(\frac{p}{v-D}\right)\frac{1}{v-D},$$

and

$$\frac{d\Pi}{dD} = \frac{p}{v-D} + \frac{Dp}{(v-D)^2} + C'\left(\frac{p}{v-D}\right)\frac{p}{(v-D)^2}.$$

The first order condition $\frac{d\Pi}{dp} = 0$ implies

$$C'\left(\frac{p}{v-D}\right) = D \tag{G.3}$$

Inserting this in the partial w.r.t. D gives

$$\frac{d\Pi}{dD} = \frac{p}{v-D} + \frac{2pD}{(v-D)^2} > 0. \tag{G.4}$$

The four conditions (G.1)-(G.4) pin down the optimal financing choice. First, if we rewrite (G.1) as $C'(f(Z)) = Z$, we see that (G.1) and (G.3) imply $f(D) = \frac{p}{v-D}$, or

$$p = f(D)[v-D].$$

Combining the latter equation with (G.2) implies $f(D)[v-D] = f(Z)[v-D]$. Since f is invertible, this implies $D = Z$. As $Z \equiv \alpha[D-v]$, this defines α as an increasing function of D, i.e., $\alpha = \frac{D}{D-v}$. By (G.4), the upper bound $\alpha = 1$ is optimal. If $\alpha = 1$, then $D = \frac{v}{2}$ and $p = f\left(\frac{v}{2}\right)\frac{v}{2} > 0$. □

Müller and Panunzi (2003)'s focus is to compare $D^* = \frac{v}{2}$ and $p^* > 0$ with the outcome in the absence of moral hazard, $D = v$ and $p = 0$. This comparison underlies what Müller and Panunzi (2003, 2004) sum up as the added insight from integrating moral hazard: (a) The potential debt overhang problem *lowers takeover leverage* and (b) less debt, in turn, benefits target shareholders via *larger takeover premia*.[49]

The two observations, (a) and (b), seem to reinforce the takeaway from the basic model without moral hazard that the use of leverage harms target shareholders and that this framework cannot explain "LBO-style debt levels" (Müller and Panunzi 2004, p.1220).

[49] This emphasis is clear in the conclusion of Müller and Panunzi (2004), the opening paragraph of Section 6 in Müller and Panunzi (2003), and the main proposition of their analysis in Section 6 (Müller and Panunzi 2003, Proposition 11): "[T]he raider uses less debt ex ante. This, in turn, raises the takeover premium."

Our paper shows that integrating moral hazard, in fact, *overturns* the above takeaway of Müller and Panunzi (2004). Their takeaway is based on three results in the model without moral hazard: (1) a small debt amount (to cover given takeover costs) is socially optimal, (2) takeover leverage harms target shareholders conditional on a takeover, and (3) bidding competition reduces such leverage. The extended analysis in Müller and Panunzi (2003) does not uncover that including moral hazard upends results (1)-(3) and so their main takeaway. The contribution of our paper is to fill this gap (Propositions 1 to 5 in the four parts of Section 4) and thereby to contend that a framework that combines moral hazard and rent extraction *can* explain LBO-style leverage, in our view, better than the precedent literature.

G.2 Replicating our results in Müller and Panunzi (2003)'s extension

To be precise about our relative contribution, the second part of this appendix considers the key results of our paper within the framework of Section 6 in Müller and Panunzi (2003). Before doing so, it is worth drawing attention to two peculiarities of the binary outcome structure. First, $\alpha^* = 1$ regardless of the effort cost function C.[50] This is because, without the free-rider problem, debt and equity are equivalent under binary v-or-0 outcomes in terms of effort incentives (cf. Remark 1). This is not the case in alternative models, where the optimal α is not always the upper bound and C is not irrelevant. Second, $D^* = \frac{v}{2}$ regardless of C. This, too, is specific to binary v-or-0 outcomes (see Remark 2 below). More generally, optimal debt levels vary with C, which affects the degree of moral hazard and hence the severity of the incentive constraints on financing. That is, $D^* = \frac{v}{2}$ and $\alpha^* = 1$ (being independent of C) are "special cases," and not general predictions.

Remark 2. *To explain why $D^* = v/2$ regardless of C in this model, it helps to spell*

[50] This means that post-takeover "inside" owners, such as (new) management and private equity firms, own 100 percent of the equity. This prediction is arguably counterfactual, considering the role of limited partners (passive equity investors) in LBO financing. In other words, in Müller and Panunzi (2003)'s extension, no *outside* equity financing obtains.

out how the free-rider problem affects the moral hazard problem. Taking $\alpha = 1$ *to simplify matters, compare the objective in the bidder's ex post effort choice*

$$e(v - D) - C(e)$$

to that in her ex ante financing choice, which due to the free-rider condition is

$$eD - C(e)$$

(see (M)). For $D < v - D$*, the bidder will exert more effort ex post than is optimal for her ex ante.*[51] *Indeed, note that she maximizes the value of debt ex ante but the value of equity ex post. Increasing* D *reduces the discrepancy which, in this specific setting, is minimized (even eliminated) at* $D = v - D$*. So,* $D^* = \frac{v}{2}$ *regardless of* C*.*[52]

To see that this is a knife-edge result, recall that, in this binary v*-or-*0 *outcome model, debt and equity are equivalent as what matters is only how* v *is split (Remark 1). Further, effort only affects the probability that the* v*-state is realized, and so the marginal effect of effort on debt and on equity depends only on the division of* v *in that singular state. Hence any difference in the marginal effect of effort across debt and equity—and thus between the ex ante optimal and the ex post optimal effort—is eliminated by splitting* v *equally between debt and equity in that singular state. So,* $D^* = \frac{v}{2}$ *for any and all* C*.*

In a model in which firm value can assume more than one strictly positive value, the equivalence of debt and equity breaks down and this knife-edge logic does not hold. In such a model, C *affects which set of (states with differing) firm values is likely to be realized and so, more importantly, how effort affects debt and equity at the margin.*

[51] Burkart and Lee (2022) refer to this discrepancy as the "unrecompensed effort problem." The discrepancy obtains also when the effort is chosen before the takeover, but is unobservable.

[52] $D > \frac{v}{2}$ is suboptimal here for the standard reason that the negative incentive effect of further outside financing (more debt in this case) reduces the expected debt value, i.e., the bidder's ex ante debt capacity.

Depending on C, the logic of reducing the discrepancy between the ex ante and ex post optimal effort levels plays out in different ranges of the firm value or states of nature, thus translating into different optimal debt levels.[53]

We will now consider the four main results of our paper within the binary v-or-0 setting.

Result 1: Social efficiency As Müller and Panunzi (2003) point out, leverage has both a direct, negative and an indirect, positive effect on the bidder's effort. On one hand, holding the bidder's equity constant, leverage creates a debt overhang problem. On the other hand, an increase in leverage increases the bidder's equity, and thus the raider's incentives.

Their analysis emphasizes how the negative incentive effect reduces the use of debt: "To counteract the adverse incentive effects of high leverage ... the [bidder] reduces his debt to $D^* = \frac{v}{2}$" (p.25), relative to a benchmark debt level of $D = v$ in the model without moral hazard.

A striking fact they do not discuss is that the positive effect *dominates* for $D < \frac{v}{2}$. This is not obvious as it could in principle be optimal for the bidder to substitute debt for equity in such a way that bidder profit increases while incentives remain the same (i.e., negative and positive effects cancel out), or even when incentives are on balance compromised (i.e., the negative effect slightly dominates). To fill this gap, let us consider the effect of an exogenous limit $\bar{D}$ on takeover debt, i.e., bootstrapping.

Proposition G.2. *Any limit $\bar{D} < \frac{v}{2}$ reduces expected post-takeover firm value.*

Proof. As show in the proof of Proposition G.1, the bidder's optimal strategy is to maximize D and set $\alpha = \frac{D}{D-v}$. Absent an exogenous debt limit, the optimum is hence given by the upper bound on α, i.e., $\alpha = 1$ and the associated debt level $D = \frac{v}{2}$. With

[53] To give a simple example, imagine a model with two possible firm values v_l and $v_h > v_l$, with the higher one requiring (or being more likely for) higher effort. If effort is very costly (cheap), the split of v_l (v_h) is likely more relevant to the marginal return of effort across debt and equity. Depending on how costly effort is, splitting v_l or v_h will thus be more relevant for the optimal debt level.

the exogenous debt limit $\bar{D} < \frac{v}{2}$, the optimum is instead given by the upper bound on D, i.e., $D = \bar{D}$ and the associated equity share $\bar{\alpha} \equiv \frac{\bar{D}}{\bar{D}-v}$. The decreases in D and α have opposite effects on the bidder's incentives. To see the net effect, insert $\bar{D}$ and $\bar{\alpha}$ into the first-order condition for the optimal effort (G.1). This yields

$$C'(e) = \bar{\alpha}[\bar{D} - v] = \bar{D}, \tag{G.5}$$

and so $e(\bar{D}) = f(\bar{D})$ where f is increasing in $\bar{D}$. □

Because the bidder profits through debt, her objective is to maximize eD ex ante, but once in control of the target, she maximizes $e\alpha(v-D)$ ex post. This discrepancy results from the interaction of the free-rider problem with the moral hazard problem (cf. Remark 2). When her choice of D is constrained to $\bar{D}$, her ex ante incentives fall. Her optimal response is to adjust α downwards to $\bar{\alpha}$ such that her ex post marginal return to effort reduces to her lower ex ante marginal return to effort, namely $\Pi'(e) = \bar{D}$ (cf. first-order condition (G.5) in the proof). Hence, her effort falls as $\bar{D}$ decreases.

Intuitively, the bidder's ex ante willingness to provide herself with value creation incentives stems solely from the value she extracts through debt financing available under those incentives. As she is only willing to commit via higher α to creating more value ex post to the extent that she gets more debt financing ex ante, imposing limits on debt effectively reduces her willingness (to adopt incentives) to improve value.

Proposition G.2 is material because it stands in stark contrast to the takeaway in Müller and Panunzi (2004) that a "minimal amount of debt" is socially optimal. In the presence of moral hazard, any binding debt limit is inefficient; *all* of the debt raised by the bidder in equilibrium is socially desirable. In this specific model, this debt amount is substantial at a debt-to-equity ratio of 100 percent, or $\frac{eD*}{e[v-D*]} = 1$.[54]

Comparing Proposition G.2 and Proposition G.1 highlights the difference in focus between the analysis in Section 6 of Müller and Panunzi (2003) and that in our paper.

[54]The examples in Appendix D of our paper feature even higher socially efficient leverage ratios.

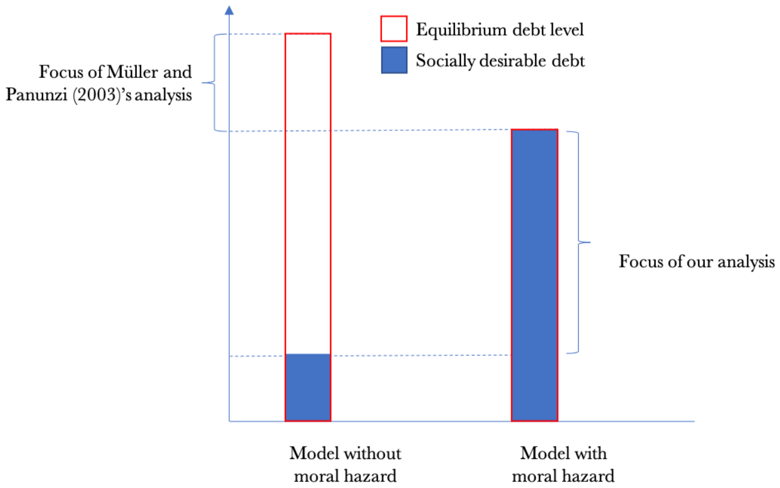

Figure 2: Müller and Panunzi (2003) show that the equilibrium debt level is lower in the setting with moral hazard. We emphasize that the *socially desirable* debt level is *higher* in that setting: In the absence of moral hazard, part (likely, most) of the equilibrium debt reflects pure rent seeking. In the presence of moral hazard, *all* of the equilibrium debt is socially efficient because it increases total value creation.

One emphasizes how moral hazard affects the bidder's privately optimal level of debt, while the other focuses on how moral hazard affects the social optimality of debt (see Figure 2).

Proposition G.2 also hints at another potential qualification of the main takeaway in Müller and Panunzi (2004): If the use of debt to extract rents generates an increase in total surplus rather than being purely a redistribution, it is possible that the target shareholders are *not* harmed by it.

Result 2: Sharing rule As for target shareholders, Müller and Panunzi (2003) focus again on the comparison to the model without moral hazard, and concretely, to the fact that the drop in debt relative to the model without moral hazard translates into an increase in the takeover premium to $p^* > 0$ (from $p = 0$ in the model without moral hazard).

That comparison *across* the different settings—with and without moral hazard—reinforces the impression from Müller and Panunzi (2004) that bootstrapping harms target shareholders conditional on the buyout being realized.

But this comparison is misleading in that it obscures the practically more relevant question whether bootstrapping harms the target shareholders *within* a given setting, conditional on the buyout. In the setting without moral hazard, the answer is "yes." With moral hazard, the opposite can be true. In fact, with a quadratic cost function as in Müller and Panunzi (2003), the following result obtains.

Proposition G.3. *For $C(e) = \frac{c}{2}e^2$ and $c > v$, any limit $\bar{D} < \frac{v}{2}$ reduces the takeover premium and hence target shareholder wealth.*

Proof. For any given $\bar{D} \in (0, \frac{v}{2})$, the equilibrium outcome is derived as in (the proofs of) Propositions G.1 and G.2. It is pinned down by conditions (G.1)-(G.3) and the corner value $D = \bar{D}$. Retracing steps from the proof of Proposition G.1, we then have $p = f(\bar{D})[v-\bar{D}]$ in equilibrium. For the present proof, we must determine the sign of

$$\frac{dp}{d\bar{D}} = f'(\bar{D})(v - \bar{D}) - f(\bar{D}).$$

Now assume $C(e) = \frac{ce^2}{2}$. Moreover, let $c > v$ to focus on (ensure) an interior solution to the effort problem. Then $C'(e) = ce$. The inverse f of C' is $f(x) = \frac{x}{c}$. With this,

$$\frac{dp}{d\bar{D}} = f'(\bar{D})(v - \bar{D}) - f(\bar{D}) = \frac{1}{c}(v - \bar{D}) - \frac{1}{c}\bar{D}.$$

Hence $\frac{dp}{d\bar{D}} \geqslant 0$ if and only if $v - \bar{D} \geqslant \bar{D}$, which holds if and only if $\bar{D} \leqslant \frac{v}{2}$. Recall that the optimal debt level in the absence of a limit is $D^* = \frac{v}{2}$. It follows from $D^* = \frac{v}{2}$ and $\frac{dp}{d\bar{D}} > 0$ for all $\bar{D} \leqslant \frac{v}{2}$ that any debt limit $\bar{D} < \frac{v}{2}$ (i.e., any limit that would be binding) reduces target shareholder wealth. □

What creates the possibility that target shareholders benefit too is that leverage increases not only bidder profits but also total surplus. But why would the bidder not extract more of the (added) surplus? The key is that the negative impact of debt on her incentives (i.e., debt overhang) constrains how much debt she can raise and hence

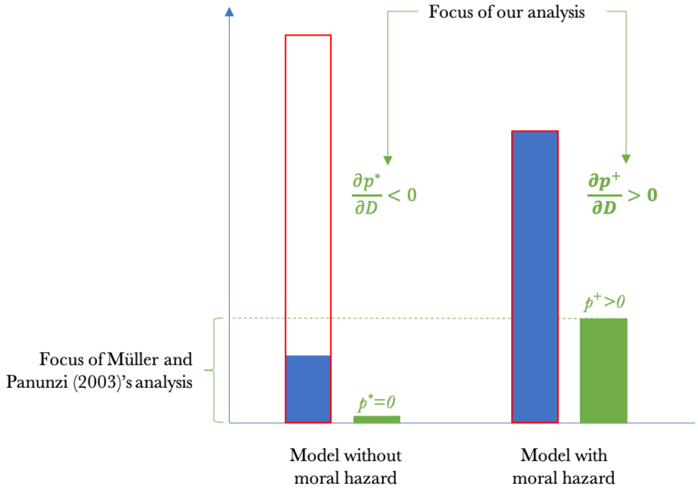

Figure 3: Müller and Panunzi (2003) show that the takeover premium is higher in the setting with moral hazard, where the equilibrium debt level is lower. This comparison suggests that debt reduces the takeover premium. We consider comparative statics of the takeover premium with respect to debt *within* each of the two models: Debt *increases* the premium in the presence of moral hazard, while decreasing it in the absence of moral hazard.

how much she can extract. The financing constraint de facto acts as a *sharing rule* for how (any increase in) total surplus is split between bidder and target shareholders.

Müller and Panunzi (2003)'s analysis misses the point that in their own model extension with moral hazard target shareholders *gain* on the (intensive) margin as the bidder raises more debt to extract more for herself. This matters because it reconciles the rent-extraction theory of buyout debt with the empirical finding that—"despite" high leverage—takeover premiums are large and appear to allocate a substantial part of the takeover gains to target shareholders. Furthermore, the fact that leverage can benefit target shareholders raises the possibility that bidding competition does *not* decrease leverage. We turn to this point further below.

Condition $c > v$ in Proposition G.3 rules out that optimal effort hits the upper bound $e = 1$. This is not merely a technical matter. At $e = 1$, effort and so total surplus become *inelastic* to further debt increases, which thus revert to a pure rent extraction mechanism. This suggests that whether or to what extent buyout leverage benefits or harms target shareholders depends on the elasticity of bidder effort to the firm's post-buyout ownership and capital structure (α and D), or put more plainly, on how much the buyout would improve incentives. The results in our paper confirm this intuition (as e.g., reflected by the log-concavity condition in Proposition 2).

Result 3: Bidding competition The result that increases in buyout leverage on the intensive margin can benefit rather than harm target shareholders suggests that bidding competition may not induce bidders to reduce bootstrapping. Proposition 5 of our paper indeed reveals the opposite: In a framework with moral hazard, bidding competition generally induces bidders to use *more* debt. This contradicts a key point in Müller and Panunzi (2004)'s reasoning for why a theoretical framework based on the free-rider problem cannot explain LBO-style leverage (p.1220).

That said, Section 6 of Müller and Panunzi (2003) does not explore competition, nor can Proposition 5 of our paper be replicated within their specific model variant. The reason is that the binary v-or-0 structure causes post-buyout ownership to hit the boundary value $\alpha^* = 1$ regardless of any other model element (Remark 1 and the discussion above Remark 2). That is, "insiders" *always* end up owning 100 percent of the post-buyout equity. Not only is this empirically debatable (considering, e.g., the limited partners in buyout funds) but it also rules out that more intense bidding competition pushes bidders to raise α (along with D) as part of making more attractive bids, which is key to our Proposition 5.

In the framework of our paper, the optimal ownership structure is not invariably the upper bound ($\alpha^* = 1$) and it depends on other model elements and parameters. We conjecture that, generally in models where $\alpha^* < 1$ in the absence of competition, the prediction is that bidding competition leads to more buyout leverage: If a bidder can design a more attractive bid by either "creating less value but also extracting less" or by "creating more value but also extracting more," she prefers the latter. In other words, given some intended target shareholder payoff, bidders fare better competing with offers that generate a higher total surplus (which are offers with higher α's and higher D's).

Result 4: Upfront payout Müller and Panunzi (2004) show that, in their model without moral hazard, upfront payouts to the bidder can occur. Though suggestive, it is not obvious that the result is robust to the inclusion of moral hazard; in financing models with moral hazard, *ex ante* cash-outs by agents who subsequently manage the firm are suboptimal from an incentive perspective.

Müller and Panunzi (2003) do not analyze the ex ante financing contributions or payouts in their model extension with moral hazard. If they had, the following result would have been obtained:

Proposition G.4. *The bidder's upfront payout equals 0.*

Thus, in Müller and Panunzi (2003)'s model extension, bidders do not receive upfront cash payouts. However, this result is not due to a negative incentive effect of cash-outs but rather an artifact of the binary v-or-0 outcome structure.

Recall from Remark 2 that, under the binary outcome v-or-0 structure, the optimal debt level equals exactly *half* the firm value in the success state, $D^* = \frac{v}{2}$, regardless of other model parameters. With $D^* = \frac{v}{2}$, the (expected) equity value is $q(e^*)\frac{v}{2}$ where $q(e^*)$ is the rationally expected probability of the outcome v. Due to the free-rider condition, this equals the bid price. With the bidder buying all shares ($\alpha^* = 1$), the cash payment to target shareholders is hence $p = q(e^*)\frac{v}{2}$. On the financing side, the (expected) debt value is equally $q(e^*)\frac{v}{2}$, which in turn is the funding the bidder receives from creditors to fund the takeover. Thus, the debt financing exactly equals the cash transfer to target shareholders, with no ex ante payout to the bidder.

The model setting in our paper does not reproduce the knife-edge solution of the

v-or-0 structure. Rather we find that, in the presence of moral hazard, upfront payouts are positive for reasons that (a) highlight the interplay of moral hazard with the free-rider problem, (b) resonate with free cash flow theory, and (c) make LBO financing isomorphic to a managerial incentive compensation contract (see Section 4.3 and Proposition 3 in our paper).

Overall, our analysis shows that, in a buyout model with moral hazard *and* free-riding, upfront payouts to bidders play a *positive* incentive role; restricting them undermines bidders' willingness to adopt more incentive-efficient financing structures, which harms (not only bidders but also) target shareholders.[55] Showing that ex ante payouts are generally positive in a framework with moral hazard and play a positive incentive role are novel insights of our analysis.

G.3 Summary of comparison

Müller and Panunzi (2004) conclude that they cannot explain LBO-style debt levels based on a chain of three arguments: (1) The socially optimal level of takeover debt is small, (2) takeover debt harms target shareholders, and (3) bidding competition thus pushes the debt level down to the social optimum (minimum needed to not frustrate the buyout). Results (1)-(3) are derived in a model with free-riding but absent moral hazard.

We show that these conclusions are not valid in a setting with moral hazard and free-riding. There, another chain of arguments applies: (a) The socially optimal level of takeover debt is *high*, (b) takeover debt *benefits* target shareholders when incentive effects are important in the buyout, and so (c) bidding competition pushes debt levels *up*. Crucially, results (a)-(c) are not derived in Müller and Panunzi (2003), and being the opposite of (1)-(3), *do* explain LBO-style debt levels as well as the importance of (d) bootstrapping and upfront fees for the incentive efficiency of LBOs.

[55] By contrast, in Müller and Panunzi (2004), limiting upfront payouts to the bidder would merely reduce rent seeking, that is, lower bidder profits and benefit target shareholders.

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