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Auctions in bankruptcy

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Abstract

This paper examines whether mandatory auctions promote the efficient restructuring of distressed firms relative to a reorganization-based bankruptcy system such as Chapter 11. Under a mandatory auction system, aggressive bidding by a coalition of incumbent management and pre-bankruptcy creditors may deter outside bidders, may result in the coalition paying more than its valuation to acquire the firm, and may result in assets remaining in a lower value use. In a reorganization-based bankruptcy system, management's voluntary choice to seek an auction conveys information about the coalition's valuation, which facilitates competition. Our model shows that a reorganization-based bankruptcy system that encourages, but does not mandate auctions, can actually increase the likelihood that an outside bidder enters and the assets of the bankrupt firm are redeployed.

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The design of an efficient bankruptcy system generally involves weighing the advantages and disadvantages of a reorganization-based system such as Chapter 11 versus a system which mandates an auction of the bankrupt firm. Critics of the Chapter 11 process argue that the bargaining process in Chapter 11 is too costly, too protective of incumbent management, and leads to excessive continuation of economically inefficient firms.[1]

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[1] See for example Bradley and Rosenzweig (1992) and Jensen (1991).

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They suggest that a mandatory auction may (1) remove biases toward reorganization, and (2) be more likely to ensure that assets are redeployed to higher value uses. A further commonly suggested benefit of auctions relative to a Chapter 11 type system is that the decision with respect to the best use of the firm's assets can be separated from the decision as to how value is allocated among pre-bankruptcy claimants.

A bankruptcy system requiring an auction, however, may introduce a different set of problems. Aghion et al. (1992) and LoPucki and Whitford (1993) argue that auctions will not result in an efficient transfer of assets; few bidders will enter because the costs of acquiring information needed to evaluate insolvent companies will be high. As a result, firms will be sold off "at a substantial discount in a piecemeal liquidation."[2] Further, a mandatory auction may cause incumbent management to delay filing for bankruptcy, leading to a greater loss in firm value.

The discussion of these extremes in the design of a bankruptcy system generally does not recognize that voluntary auctions of the firm often occur in a reorganization-based system such as Chapter 11. Hotchkiss and Mooradian (1998) describe the provisions for this type of sale in Chapter 11, and show that these sales frequently lead to successful reorganizations with significant gains in the operating performance of the combined post-bankruptcy firm. Sales of companies in bankruptcy also appear to occur with increasing frequency in recent years.[3]

In this paper, we model both a mandatory cash auction bankruptcy system and a reorganization-based system (Chapter 11) which provides for a voluntary auction of the firm, and contrast the outcomes under each system. The paper contributes to the debate over the design of bankruptcy systems by incorporating two important features. First, in modeling the mandatory auction process, we recognize that the incentives and therefore bidding behavior of management and pre-bankruptcy claimants are dependent on the structure of their existing claims. Specifically, they may bid higher than their true valuation, and the bidder with the highest value may not win the auction. Overbidding behavior may deter outside bidders from entering the auction. Second, in modeling a reorganization-based system, we recognize that management may choose to voluntarily put the firm up for sale. Management voluntarily seeks an auction when it can gain more from a sale than from a reorganization, which is likely to occur when its own valuation is relatively low. Management's choice to seek a buyer conveys information about its own valuation to potential bidders; we show that this can increase the likelihood of a competitive auction relative to a mandatory auction regime.

We first model a cash auction bankruptcy where there are two potential bidders, a coalition of management and creditors and an outside bidder with no initial stake in the bankrupt firm. When a bankrupt firm is auctioned, existing creditors and management

[2] Aghion et al. (1992).

[3] See for example "The Return of the Wall Street Vulture", Business Week, 9/1/2001.

form a coalition to make a bid for the firm.[4] This coalition, acting as both a seller of existing claims and a potential buyer, has an incentive to overbid (bid above his own valuation) in order to get a higher counteroffer to sell his existing stake at a higher price. The inefficiency arises if the coalition overbids and wins the contest.

Our analysis of a mandatory auction initially follows from Burkart (1995) who demonstrates that an inefficient allocation can result from an auction in which one bidder has an initial stake.[5] Our first extension of Burkart (1995) is to show that the coalition's overbidding is positively related to the size of its initial stake, but is negatively related to the priority of the initial stake. Further extending this model, we do not assume that there are always at least two bidders competing in the auction, and explicitly model the second bidder's decision to enter the auction.

Overbidding raises the price a second outside bidder pays for the firm if he wins the contest and reduces the second bidder's expected profits. The coalition's potential overbidding deters a second bidder's entry into the contest; without a second bidder, the auction is not competitive and assets are not redeployed. The potential for overbidding, leading to inefficient investment outcomes, is likely to be particularly important for sales of bankrupt firms because initial stakes can be quite large.[6] Our analysis shows that the overbidding problem, and therefore the second bidder's decision to enter and the outcome of the auction, depend on the structure of the firm's claims.

Having established these results for a mandatory auction regime, we then introduce a reorganization-based bankruptcy system that presumes the bankrupt firm may have greater value as an ongoing firm than liquidated, and promotes bargaining between management and creditors over a plan to reallocate claims on the bankrupt firm. Chapter 11 grants management considerable bargaining power in the form of the exclusive right to propose the plan of reorganization. Brown (1989) models the bargaining between management and creditors and demonstrates that management is able to capture some portion of value in excess of the bankrupt firm's liquidation value. The ability to extract this surplus is not

[4] The management/creditor coalition presented in this paper is consistent with those presented in Bulow and Shoven (1978), Gertner and Scharfstein (1991), and Brown et al. (1993). Moreover, following Gertner and Scharfstein (1991), management has strong incentive to seek financing for a bid from existing creditors. An existing creditor is more willing to provide financing at potentially better terms than a new lender because an existing impaired lender also benefits from any increase in the value of her existing claim as a result of the bid. Recent empirical evidence is also consistent with this view. Stromberg (2000) and Stromberg and Thorburn (1996) find for a sample of Swedish firms auctioned in bankruptcy that 74% of the firms are preserved as a going concern; in 54% of these cases, the assets are sold back to the pre-bankruptcy owner, and most often financed by an existing creditor. In US Chapter 11 cases, Gilson et al. (2000) also find that management often acts strategically with either senior or junior creditors.

[5] Cramton et al. (1987), Singh (1998), Engelbrecht-Wiggans (1994), and Burkart (1995) demonstrate that an inefficient allocation can result from an auction in which one bidder has an initial stake.

[6] Stromberg (2000) reports for Swedish firms that when senior creditors purchase the firm in coalition with management, on average they hold 10.3% of the firm's pre-bankruptcy debt. Hotchkiss and Mooradian (1997) report that active investors in bankrupt firms' debt frequently purchase 1/3 of a class of debt in order to influence the negotiations. In contrast, while toeholds are recognized to impact bidding behavior in corporate takeovers, these initial stakes are generally smaller; Jennings and Mazzeo (1993) report mean toeholds of 3% for a sample of 647 takeovers.

present in the event of an auction since auctions proceeds are distributed following strict absolute priority.

Empirically, we observe the outcome of this bargaining in Chapter 11 in the form of deviations from the absolute priority rule which benefit claims held by a management-led coalition. Regardless of the distributions on its claims, management also may derive benefits by remaining in control in Chapter 11. Although we do not explicitly model this aspect of the bargaining associated with reorganization, we do consider that the structure of Chapter 11 provides management opportunity to extract a portion of the surplus associated with a reorganization.[7] If the expected gains to management are sufficient to outweigh the rents they would otherwise extract in a reorganization, management chooses a voluntary auction.

In our model of a reorganization-based bankruptcy system, the management/creditor coalition can seek a buyer or it can attempt a reorganization. If the coalition voluntarily chooses to sell the firm, then the reorganization-based system requires that the firm be auctioned.[8] In such an auction, if the coalition's valuation is relatively low, the coalition potentially can gain more as a seller of its initial stake than as a buyer of the firm. Therefore, if management seeks a buyer, i.e., a second bidder, the coalition conveys the information that it has a low valuation and will bid relatively low. This results in higher expected profits for a second bidder and a higher probability that a second bidder enters the contest. With a reorganization-based system that permits auctions, unlike a mandatory auction based system, management's choice to seek a buyer provides information to potential bidders, which increases the likelihood of a competitive auction.

The model shows the conditions under which voluntary sales in a reorganization system are more efficient than when sales are mandatory, and has implications for the design of bankruptcy law. Which system is most likely to ensure the efficient transfer of assets depends on the typical structure of claims. When firms are primarily financed by senior bank lenders, a bankruptcy law which mandates auctions is more favorable because coalitions involving senior creditors have no incentive to overbid and no interest in seeking a second bidder. For more complex capital structures, or when management is more likely to be aligned with junior creditors, a bankruptcy system that allows but does not mandate an auction is more likely to result in the transfer of assets to the higher value user; a coalition involving junior creditors has a strong incentive to seek a second bidder with a higher valuation. The likelihood of an efficient transfer of assets in a reorganization-based system also depends on the magnitude of the surplus management may otherwise extract in a reorganization.

The paper is organized as follows. Section 1 outlines the model where the bankruptcy law requires an auction of all firms following a bankruptcy filing. Section 2 extends the model to an environment similar to the US bankruptcy law where bankrupt firms may voluntarily seek an auction. Section 3 provides a discussion of the theory's implications for the design of bankruptcy law and concludes.

[7] In addition, since the value of the reorganized firm on which the plan distributions are based is unobservable, management may strategically use projected valuations to promote a plan which increases the relative distributions to their claims (Gilson et al., 2000).

[8] Hotchkiss and Mooradian (1998) describe outcomes of voluntary auctions in Chapter 11 cases.

1. The model

We first model a mandatory cash auction bankruptcy system. Section 1.1 describes the setup of our model. Section 1.2 demonstrates the overbidding problem as well as the impact of potential overbidding on bidder 2's decision to enter. Section 1.3 extends the model to show more generally how the outcome of the auction depends on the structure of the firm's claims.

1.1. Mandatory cash auction

If at least one agent is willing to make a bid for the bankrupt firm, the court conducts an auction of the firm where the winner of the auction acquires the firm's assets but does not assume the firm's liabilities. As soon as it is acquired, the firm exits bankruptcy proceedings. If the firm is not acquired in bankruptcy, the firm is liquidated. In either a liquidation or sale, proceeds are distributed to creditors strictly based on absolute priority. The value of the firm in liquidation is normalized to zero and is assumed to be common knowledge.

Bidders 1 and 2 are potential acquirers of the target firm. Bidder 1 is a coalition of a creditor(s) and management. Consistent with prior theoretical research (see footnote 4), we assume that management's incentives are aligned with the interests of the creditors which management represents. Creditors have incentive to align themselves with management, given management's knowledge of its own valuation of the firm under its control. Management also has incentive to align itself with an existing creditor(s), rather than seeking financing for the bid from a new lender.[9]

Let s be the sum of the face value of the coalition creditors' initial stake and the face value of all claims senior to and pari passu with those of the coalition creditors. For now, we assume that $s \geq 1$, where 1 is the largest potential bid. This means that the claims held by the coalition are impaired, i.e., coalition creditors hold the residual claim on the firm. As the residual claimholder, the value of the creditors' initial stake is strictly increasing in the price paid for the firm.[10] We also assume the sum of the face value of all claims senior to those of the coalition is less than the liquidation value of the firm, i.e., more senior claims are not impaired.

The initial stake held by creditors in the coalition is potentially large. Define α as the proportion of the residual claim held by creditors in the creditor/management coalition, where $0<\alpha<1$. The proportion of the residual claim held by the creditors in the coalition (bidder 1) is assumed to be common knowledge.

[9] It is also possible that management is aligned with shareholders; in our model, this is equivalent to a management coalition with junior creditors, and a large amount of debt senior to these claims. While deviations from absolute priority have sometimes been viewed as management acting on behalf of shareholders, empirical evidence for the US shows that small deviations from absolute priority occur even when management acts strategically with more senior claimants (Hotchkiss and Mooradian, 1997).

[10] In Section 1.3, we relax this assumption to consider cases where potential purchase prices can leave the coalition creditors' claims unimpaired. In such cases, the value of the creditors' initial stake is nondecreasing but not strictly increasing in the price paid for the firm, which can impact the coalition's bidding.

Let v_1 be the increase in firm value if bidder 1 acquires the target. The valuation v_1 is uniformly distributed on the interval [0,1], where the distribution function is common knowledge.[11] Since management is likely to possess superior information with respect to the value of the firm under its control, we assume that bidder 1 (the coalition) knows, without incurring any costs, its private valuation v_1. Moreover, because bidder 1 does not incur any costs to learn its valuation and because its valuation is always nonnegative, bidder 1 will always make a bid for the bankrupt firm.

Prior to the bidding, bidder 2 has no stake in the firm. Bidder 2 may be either type L, with probability $(1-\theta)$, or H, with probability θ and bidder 2's distribution function is common knowledge. The conditional valuation $v_2|\mathrm{H}$, the conditional valuation for bidder 2 given type H, is uniformly distributed on the interval [0,1], where v_1 and $v_2|\mathrm{H}$ are independent.[12] However, if bidder 2 learns he is type L, his valuation is negative and he will not bid. If a type L bidder 2 operates the firm, the value of the firm is less than its liquidation value, which is normalized to 0. Furthermore, the unconditional expected valuation for bidder 2 is negative; bidder 2 will not bid without first learning his type.[13] Because bidder 2 is an outsider to the firm, we assume that in order to learn his type and private valuation, he must first perform an evaluation of the firm with cost, C, prior to the auction. Moreover, because bidder 2 must incur a cost to learn his type, bidder 2's expected profits from the auction can be negative depending on the expected bidding behavior of bidder 1. If bidder 2's expected profits from the auction are negative, then bidder 2 will not incur the costs to learn his type and will not enter the auction.

Competition between the two bidders for the target company is modeled as a second-price sealed-bid auction.[14] Assume that bidders do not incur bidding costs if they participate in the auction. Bids must be nonnegative, i.e., $b_i \geq 0$ where $i=1,2$. Cash proceeds from the auction are used to repay creditors following absolute priority. Bidders may not acquire the firm through negotiation with incumbent management, creditors, or the court. Collusion and/or communication among bidders and retrading following an auction are not allowed. The court accepts the highest offer if the offered price is nonnegative (i.e., any bid greater than the liquidation value).

[11] The assumption of a uniform distribution is made to obtain a closed form solution for the expected profits for bidder 2.

[12] Since empirical evidence of Stromberg and Thorburn (1996) and Hotchkiss and Mooradian (1998) shows that bidders for distressed firms are typically strategic rather than financial buyers, we model the sale as a private value auction. This approach is also used in models of overbidding in takeover contests (Burkart, 1995; Singh, 1998) and bankruptcy auction design (Bhattacharyya and Singh, 1999). In addition, the result of overbidding by a bidder with an initial stake is robust to the assumption of auction type; Bulow et al. (1999) show that overbidding is potentially more severe in a common value auction.

[13] Suppose bidder 2 bids without learning his type and wins the auction. Independent of his type, he must decide whether to operate or liquidate the firm. If he liquidates the firm, the firm's value is 0. If he operates the firm, the firm's expected value is negative. Therefore, bidder 2 will not bid without first learning his type.

[14] English auctions can be modeled as second-price sealed-bid auctions, i.e., auctions where the highest bidder wins the auction but pays the amount of the second highest bid, proposed by Vickrey (1961). Engelbrecht-Wiggans (1994) and Burkart (1995) demonstrate that in cases where 2 or fewer bidders have initial stakes, the English and the second-price sealed-bid auctions are strategically equivalent.

1.2. Overbidding

This section analyzes the equilibrium bidding strategies.

Lemma 1. *It is a dominated strategy for any bidder to bid below his own valuation.*

Lemma 2. *It is a dominated strategy for a bidder with no initial stake to bid above his own valuation.*

The lemmas above restate the commonly known result that for a bidder without an initial stake, bidding his valuation dominates all other strategies.

The bidder with an initial stake (bidder 1) has a strong incentive to overbid. If bidder 1 loses the auction, his bid determines the price paid for his initial stake. Bidder 1's overbidding results in an inefficient allocation with positive probability.[15] If bidder 1 wins the auction but bidder 2 has bid more than bidder 1's valuation, the bidder with the higher valuation does not win the auction.[16] Bidder 1 pays more than his valuation to acquire the remaining residual claims on the firm.

In determining his bid, bidder 1 considers both the expected gains from selling his initial stake at a higher price if he loses the auction and the expected losses from buying the remaining residual claims at a price higher than his valuation if he wins the auction. Bidder 1's equilibrium bid is shown in the proposition below.

Proposition 1. *Bidder 1's equilibrium bid is*

$$b_1^*(v_1) = \frac{\alpha + v_1}{1 + \alpha}, \tag{1}$$

and bidder 2's equilibrium bid is $b_2^* = v_2$.

Proof: see Appendix A.

Since bidder 1 has an initial stake, bidder 1 can profit both as a buyer and a seller. As a potential seller, he overbids. Moreover, his overbidding is a function of the size of his initial stake. The larger is bidder 1's initial stake, the higher is his bid.

$$\frac{\partial b_1^*}{\partial \alpha} = \frac{1 - v_1}{(1 + \alpha)^2} > 0. \tag{2}$$

A larger initial stake increases the gains and reduces the potential losses associated with submitting a higher bid, encouraging bidder 1 to bid more aggressively. Bidder 1 has a larger stake, α, to sell if he loses the auction and has a smaller amount of claims to buy, $(1-\alpha)$, if he overbids and wins the auction.

[15] Our analysis of the behavior of bidder 1 (Proposition 1) follows from Burkart (1995). Cramton et al. (1987) and Singh (1998) also demonstrate the same overbidding result. Bhattacharyya and Singh (1999) and Berkovitch et al. (1998) model auctions in bankruptcy but exclude claimants as potential bidders. Bhattacharyya and Singh (1999) show that senior and junior claimants have conflicting incentives concerning the specific selling mechanism.

[16] Rhodes-Kropf and Viswanathan (2000) demonstrate that non-cash auctions can also lead to inefficient investment outcomes because of asymmetric information with respect to the value of non-cash bids.

Because bidder 1 profits as a buyer if he pays less than his valuation, he bids more given a higher valuation.

$$\frac{\partial b_1^*}{\partial v_1} = \frac{1}{1+\alpha} > 0. \tag{3}$$

However, the extent to which bidder 1 overbids is decreasing in his valuation.

$$\frac{\partial (b_1^* - v_1)}{\partial v_1} = \frac{-\alpha}{1+\alpha} < 0. \tag{4}$$

The higher is bidder 1's valuation, the lower is the probability that bidder 2 has a higher valuation than bidder 1. It is less likely that bidder 1 can profit from overbidding. Therefore, the extent to which he overbids is less.

1.2.1. The effect of bidder 1's overbidding on bidder 2

Bidder 1's overbidding reduces expected profits for bidder 2. Overbidding reduces the likelihood that bidder 2 wins the contest and increases the price bidder 2 pays, if bidder 2 wins the contest. Because overbidding reduces bidder 2's expected profits from the contest, bidder 2 is less likely to enter the contest, given costs to learn his type. Overbidding reduces the probability that the auction is competitive.[17]

Bidder 2's expected profits, without competition from bidder 1, are $(\theta/2)-C$, where θ is the probability that bidder 2 is of type H. Bidder 2 incurs costs of C to learn his type. Bidder 2 will not bid unless he learns he is type H. Moreover, if bidder 2 is type H, his expected valuation is 1/2 and without competition, he bids 0 to acquire the bankrupt firm. Bidder 2's profit (if he bids) is the difference between his valuation and the price paid to acquire the firm less the cost to learn his type.

Given competition from bidder 1, bidder 2 will incur the costs, C, but will not win the contest unless his valuation is higher than bidder 1's bid. The higher that bidder 1 overbids, the less likely is it that bidder 2 wins the auction. Moreover, if bidder 2 does win the auction, he pays bidder 1's bid which is higher because of the overbidding. Expected profits for bidder 2 are reduced because of bidder 1's overbidding.

Proposition 2. *Bidder 2's expected profits from the contest are*

$$\Pi_2(\alpha, \theta) = \frac{\theta}{6(1+\alpha)^2} - C, \tag{5}$$

which equals $(\theta/6)-C$ for $\alpha=0$, and $(\theta/24)-C$ for $\alpha=1$. If $C=0$, the second bidder's expected profits are always positive. Conditional on bidder 2's entry into the contest, overbidding can still lead to an inefficient outcome where the bidder with the lower valuation wins the auction.

[17] Other authors present models, which demonstrate that auctions can result in an inefficient allocation. In our model with simultaneous bids, the incentive for bidder 1 to overbid deters bidding by a second bidder. In contrast, Fishman (1988) and Hirshleifer and Png (1989) present auction models with sequential bidding where an initial bidder has an incentive to deter bidding by a second bidder. The first bidder may choose to make a preemptive bid where the response from the second bidder is to not participate in the auction.

Proof: see Appendix A.

Competition from bidder 1 reduces the probability that bidder 2 will acquire the firm and increases the expected price paid by bidder 2. Since bidder 1's bid is increasing in his initial stake, the larger is bidder 1's initial stake, the less likely it is that bidder 2 wins the contest. Moreover, conditional on bidder 2 winning the contest, on average he pays a higher price. Both effects reduce bidder 2's expected profits. Differentiating bidder 2's expected profits, $\Pi_2(\alpha,\theta)$, with respect to α yields

$$\frac{\partial \Pi_2(\alpha,\theta)}{\partial \alpha} = -\frac{\theta}{3(1+\alpha)^3} < 0 \qquad \text{for } 0 \leq \alpha \leq 1. \tag{6}$$

The second derivative is

$$\frac{\partial^2 \Pi_2(\alpha,\theta)}{\partial \alpha^2} = \frac{\theta}{(1+\alpha)^4} \geq 0 \qquad \text{for } 0 \leq \alpha \leq 1. \tag{7}$$

Bidder 2's expected profits are decreasing in α, and the rate of decrease is the lowest (most negative) for values of α close to 0. Given a small initial stake for bidder 1, i.e., a small α, a small increase in α results in a large reduction in bidder 2's expected profits. Bidder 1's initial stake does not have to be very large to have a large adverse effect on bidder 2's expected profits from the auction.

If bidder 1 has an initial stake, even one that is not very large, the expected gains to bidder 2 from the contest are small. The costs to bidder 2 of learning his type and valuation need not be very large for bidder 2 to have negative expected profits from the contest. In this case, bidder 2 will not enter the contest and the auction is not competitive. Bidder 1 is the only bidder and pays a price equal to the firm's liquidation value (normalized to 0) to acquire the firm.

1.3. Seniority of claims held by coalition

To examine the relation between the bidding behavior of bidder 1 (the coalition) and the priority of the coalition's claims, we now relax the assumption that the value of the coalition creditors' initial stake is strictly increasing in the price paid for the firm. The previous sections assume the coalition's claims are always impaired; the sum of these and all claims of equal and higher priority are greater than the maximum bid ($s \geq 1$). We now examine the bidding behavior of a coalition for which the priority of the coalition creditor's claims is more senior. We now assume that the sum of all claims of equal or higher priority, s, are greater than zero but less than one, so that bids greater than s leave the coalition unimpaired. The value of the coalition creditors' claims is only strictly increasing in the price paid for the firm if the price paid is less than or equal to s.[18] If the

[18] For tractability, we continue to assume that the face amount of claims senior to the coalition is less than the liquidation value, such that these claims are always unimpaired. Relaxing this assumption, for very low valuations (and correspondingly very low bids) the value of the coalition's claims is not increasing in the price bid and the coalition will not overbid.

price paid is greater than s, at the margin, the coalition creditors' initial stake is unimpaired and its value is invariant to the price paid. The coalition does not gain from bidding more than its valuation (overbidding) if the price paid is above s.

Proposition 3. *For $0<s<1$, bidder 1's equilibrium bid is*

$$b_1^*(v_1) = \frac{\alpha + v_1}{1+\alpha} \qquad \text{for } s > \frac{\alpha + v_1}{1+\alpha} \tag{8i}$$

$$b_1^*(v_1) = s \qquad \text{for } v_1 < s \leq \frac{\alpha + v_1}{1+\alpha} \tag{8ii}$$

$$b_1^*(v_1) = v_1 \qquad \text{for } s \leq v_1. \tag{8iii}$$

Proof: see Appendix A.

Eq. (8i) refers to valuations and corresponding bids where bidder 1 is impaired and will overbid as before (Proposition 1). The extent of overbidding is limited, however, to no more than $(s-v_1)$. Given $v_1<s$, bidder 1's gains as a seller are only increasing in the price paid up to a price paid of s. A price paid greater than s leaves bidder 1 unimpaired. Bidder 1 has no incentive to bid more than s because any amount paid above s would go to pay off more junior claimants (Eq. (8ii)). Finally, for higher valuations, the coalition is not impaired and will not overbid. In this case, bidder 1 bids its valuation v_1 (Eq. (8iii)).

Bidder 1's overbidding impacts bidder 2's expected profits from the contest. However, the negative impact is now smaller because overbidding does not occur when bids are sufficiently high that the coalition is no longer impaired.

Proposition 4. *Bidder 2's expected profits from the contest are*

$$\Pi_2(\alpha, s, \theta) = \frac{\theta}{6}\left[1 - 3s^2 + 2s^3\right] - C, \qquad \text{for } 0 \leq s \leq \frac{\alpha}{1+\alpha}, \tag{9i}$$

and

$$\Pi_2(\alpha, s, \theta) = \frac{\theta}{6}\left[\left(1 - 2\alpha s\{3 - 3s + s^2\}\right) + \frac{\alpha^2}{(1+\alpha)^2}(3 + 2\alpha)\right] - C,$$
$$\text{for } \frac{\alpha}{1+\alpha} < s \leq 1. \tag{9ii}$$

Proof: see Appendix A.

Corollary 1. *Bidder 2's expected profits, if the coalition is not impaired for any bids, are the same as his expected profits if the coalition does not have an initial stake.*

$$\Pi_2(\alpha, 0, \theta) = \Pi_2(0, s, \theta) = \frac{\theta}{6} - C. \tag{10}$$

If the coalition is impaired for all bids, bidder 2's expected profits are

$$\Pi_2(\alpha, 1, \theta) = \frac{\theta}{6(1+\alpha)^2} - C, \tag{11}$$

which is identical to Eq. (5).

Proof: see Appendix A.

Competition from bidder 1 reduces the probability that bidder 2 will acquire the firm and increases the expected price paid by bidder 2. Since bidder 1's bid is increasing in s (see Eqs. (8i)–(8iii)), the larger is s, the less likely it is that bidder 2 wins the contest. Moreover, conditional on bidder 2 winning the contest, on average, he pays a higher price. Both effects reduce bidder 2's expected profits.

Corollary 2. *Bidder 2's expected profits are decreasing in s, but the rate of decrease in bidder 2's expected profits approaches 0 for values of s close to 0 and for values of s close to 1.*

Proof: see Appendix A.

Given a small s or s=0, a small increase in s results in little difference in bidder 2's expected profits. Bidder 1 may overbid by $s-v_1$; however, since s is small, bidder 1 overbids only for v_1 small. Now suppose that $s<1$ but approaches 1, the maximum possible valuation and bid. Bidder 1 is already overbidding for a wide range of valuations, v_1. A change in s only impacts the bidding of a bidder 1 with a high valuation. Moreover, from Eq. (4), the extent to which bidder 1 overbids is lowest for high values of v_1. Therefore, given s close to 1, a change in s has a very small impact on bidder 1's bidding and thus a very small impact on bidder 2's expected profits. Whether $s<1$ but close to 1 or $s\geq 1$, there is little difference in bidder 2's expected profits.

The model demonstrates that the outcome of the auction depends on the structure of the firm's claims. The outcome depends on s, the extent to which the coalition creditors' claims are impaired, because s impacts bidder 1's bidding behavior and thus bidder 2's expected profits. For s close to 1 or $s\geq 1$, bidder 1 overbidding is large and the impact of overbidding on bidder 2's expected profits is large.

While the parameter s represents the structure of the firm's claims, s can also be viewed as a proxy for the seniority of the coalition creditors' claims. A small s corresponds to a coalition of management and senior creditors. Bidder 1 overbidding is small and the impact of overbidding on bidder 2's expected profits is small. In general, a coalition involving senior creditors can be approximated by a coalition with no initial stake. In contrast, an s close to 1 corresponds to a coalition of management and junior creditors. In general, a coalition involving junior creditors can be approximated by a coalition with an initial stake and $s\geq 1$.

2. The model with a reorganization-based bankruptcy system

Bargaining rules in Chapter 11 afford the management-led coalition an opportunity to extract some portion of the value of the reorganized firm in excess of the liquidation value.

In contrast, under any auction, proceeds are transparent and are distributed based on absolute priority. Management must weigh the benefits of a reorganization against its share of a potentially higher value received in an auction.

Our model focuses on the manager's choice to auction the firm in bankruptcy. When management chooses to sell the company, Chapter 11 requires that any sale be conducted by way of an auction. If management chooses an auction, then the coalition benefits from any sale at a higher price. The coalition holds a proportion α of the residual claim on the firm and benefits as a seller. Therefore, we would expect the likelihood that management pursues an auction to be increasing in the coalition's share of any gains from a sale and the potential for a higher price.

We first consider the necessary conditions for the management/creditor coalition to seek an acquisition. The coalition seeks an acquisition, i.e., an auction, if the potential gains for the coalition as a seller exceed the potential gains as an acquirer. A coalition with an initial stake and sufficiently low valuation will seek a buyer with a potentially higher valuation.

Proposition 5. *Bidder 1 seeks an auction if his valuation is sufficiently small, i.e.,*

$$v_1 \leq \bar{v}_1 = 1 - \sqrt{(1-\alpha^2)}, \tag{12}$$

where $\bar{v}_1$ is the valuation where bidder 1 is indifferent to seeking a second bidder.[19]

Proof: see Appendix A.

For low private valuations, the coalition prefers to have a second bidder. If the coalition's valuation is low, the gains as a buyer are small. However, the coalition can gain from selling at a higher price. The valuation for which the coalition (bidder 1) is just indifferent to seeking a second bidder is an increasing function of α,

$$\frac{\partial \bar{v}_1}{\partial \alpha} = \frac{\alpha}{\sqrt{(1-\alpha)^2}} \geq 0. \tag{13}$$

Bidder 1's valuation, for which he is just indifferent to seeking a second bidder, is also increasing at an increasing rate in α.

$$\frac{\partial^2 \bar{v}_1}{\partial \alpha^2} = \frac{1 + \frac{\alpha^2}{(1-\alpha^2)}}{\sqrt{(1-\alpha^2)}} > 0. \tag{14}$$

Recall that $v_1 \in [0,1]$ and $\alpha \in [0,1]$. Since the valuation for which the coalition is just indifferent to seeking a second bidder is a convex increasing function of α, unless α is large, the coalition seeks a second bidder only if the coalition's valuation is small. For example, if $\alpha = 0.31225$, the coalition (bidder 1) seeks a second bidder if its valuation, $v_1 \leq 0.05$.

[19] This assumes in reorganization the coalition receives v_1, i.e., the difference between the reorganization value and the liquidation value (normalized to zero). If we instead assume this surplus was shared between the coalition and other creditors, then the payoff to the coalition in a reorganization would be lower and it would be less likely to choose reorganization. Our assumption that the coalition receives the entire surplus biases our results toward the coalition seeking a reorganization rather than an alternative such as an acquisition. Even with this bias, however, we demonstrate conditions under which the coalition seeks an acquisition.

If bidder 1 seeks a second bidder, bidder 2 infers that bidder 1 has a low valuation. Bidder 2 knows α, can infer that bidder 1's valuation $v_1 \leq \bar{v}_1 = 1 - \sqrt{(1-\alpha^2)}$ and knows that bidder 1 overbids with a bid of $b_1^*(v_1) = (\alpha+v_i)/(1+\alpha)$.

Proposition 6. *If bidder 1 seeks a second bidder, the second bidder's expected profits are*

$$\begin{aligned}\Pi_2(\alpha,\theta) =& \theta\left[\int_{\frac{\alpha}{1+\alpha}}^{\frac{\alpha+\bar{v}_1}{1+\alpha}}\left\{[\hat{G}(v_2)]v_2 - \int_{\frac{\alpha}{1+\alpha}}^{v_2} b_1\hat{g}(b_1)db_1\right\}dv_2\right.\\ &\left.+\int_{\frac{\alpha+\bar{v}_1}{1+\alpha}}^{1}\left\{v_2 - \int_{\frac{\alpha}{1+\alpha}}^{\frac{\alpha+\bar{v}_1}{1+\alpha}} b_1\hat{g}(b_1)db_1\right\}dv_2\right]\\ &-C = \frac{\theta}{6}\left[\frac{\sqrt{1-\alpha^2}+2-\alpha^2}{(1+\alpha)^2}\right]-C, \end{aligned} \tag{15}$$

where $\hat{G}$ and $\hat{g}$ are the c.d.f. and corresponding density function for bidder 1's bid, given $v_1 \leq \bar{v}_1$.

Proof: see Appendix A.

Corollary 1. *Bidder 2's expected profits are greater in a reorganization-based system if a bidder seeks a second bidder than bidder 2's expected profits under a mandatory cash auction system.*

Proof: see Appendix A.

For example, given α=0.31225, if bidder 1 seeks a second bidder, it follows from Eq. (15) that bidder 2's expected profits are $(0.2761)\theta - C$. In contrast, in a cash auction without the information about bidder 1's valuation, bidder 2's expected profits are only $(0.0968)\theta - C$ (from Proposition 2).

In a reorganization-based bankruptcy system, the sale of the firm in bankruptcy is not mandatory; however, management may still seek a buyer. If the management/creditor coalition (bidder 1) seeks a second bidder, bidder 2 can infer that bidder 1's valuation is low (from Proposition 5). This implies that bidder 2 is more likely to win the auction, and if he does win the auction, he on average will pay a lower price. It follows from Corollary 1 that expected profits for a second bidder are higher. Given costs to determine his private valuation, a second bidder is more likely to enter a contest.

In a reorganization-based bankruptcy system, if bidder 1 does not seek a buyer, bidder 2 infers that bidder 1's valuation is high (from Proposition 5). Since bidder 1's valuation is high, the expected economic gains from an auction are low, i.e., an outside bidder is less likely to have a higher valuation. This implies that bidder 2 does not incur the costs, C, to learn his type and valuation, when the expected economic gains from a change in control are low.

The model suggests the following for a reorganization-based bankruptcy system such as Chapter 11 relative to a mandatory auction system. Given a coalition of management and junior creditors with an initial stake, a second bidder with a higher valuation is more likely to enter and win a contest if the coalition has a low valuation. When the expected economic gains from a change in control are greatest, i.e., when the coalition has a low

valuation, the likelihood that a second bidder enters and wins the contest is greater under a reorganization-based system.

3. Empirical implications and conclusions

In this paper, we contrast the outcomes of a mandatory auction bankruptcy system versus a reorganization-based system (Chapter 11) which provides for a voluntary auction of the firm. We demonstrate that it is not straightforward that the outcomes of mandatory auctions dominate outcomes of a reorganization-based bankruptcy system. Mandating a cash auction does not ensure ex-post efficiency, in that there may not be competitive bidding and the bidder with the highest value may not win. Furthermore, similar to the outcome of a Chapter 11 reorganization, the outcome of a mandatory auction is still dependent on the structure of the firm's claims.

The paper's major contribution is to show that a reorganization-based bankruptcy system such as Chapter 11 that encourages but does not mandate auctions can actually increase the likelihood that an outside bidder enters and the assets of the bankrupt firm are redeployed. Despite the fact that Chapter 11 allows managers to extract rents with a reorganization that they cannot capture with an auction, we demonstrate that Chapter 11 is still more likely to result in a change in control when the economic gains from a change in control are greatest. This is consistent with evidence by Hotchkiss and Mooradian (1998), who observe large subsequent operating gains when firms are auctioned in Chapter 11.

Our paper provides a number of testable implications about bidding for bankrupt firms. In a cash auction setting, outsiders are less likely to bid given:

- management bids in coalition with lower priority creditors;
- a larger initial stake held by the coalition;
- higher costs for the outsider to determine his valuation.

When these deterrents are significant, we expect to observe cases where the management/creditor coalition is the only bidder. These results are generally consistent with the description of the bidding process in cash auctions provided by Stromberg and Thorburn (1996). A coalition of management and creditors purchases the firm in 54% of the cases where the firm is kept as a going concern, and is the only bidder in 76% of these cases. They also find that bidding is more competitive (multiple bidders enter) when the firm is not sold to the pre-bankruptcy owners.

In our model, the costs to an outsider of determining the value of the bankrupt firm are an important deterrent to competitive bidding. This is consistent with Stromberg's (2000) findings that the probability of a sale to a management/creditor coalition increases with industry indebtedness and with asset uniqueness. In Chapter 11, Hotchkiss and Mooradian (1998) find that bidders often have some prior relationship with the target, reducing the costs to these outside bidders.

Overall, our model points out several sources of potential inefficiencies in mandatory auctions versus a reorganization-based bankruptcy system such as Chapter 11. While further empirical evidence is needed to resolve this debate, our model contributes

toward defining the issues to be considered in designing an efficient bankruptcy mechanism.

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Appendix A

Proof of Proposition 1: Lemmas 1 and 2 imply that $b_2=v_2$. Since v_2 is uniformly distributed on the interval [0,1], the cumulative distribution function of bidder 2's bid is $F_2(b_2)=b_2$ and the corresponding density function is $f_2(b_2)=1$.

Bidder 1's maximization problem is

$$\max_{b_1} \alpha b_1(1-F_2[b_1]) + v_1 F_2[b_1] - (1-\alpha)\int_0^{b_1} b_2 \mathrm{d}F_2[b_2]. \tag{16}$$

From the first order condition

$$\alpha(1-2b_1) + v_1 - (1-\alpha)b_1 = 0, \tag{17}$$

it follows that

$$b_1 = \frac{\alpha + v_1}{1+\alpha}. \tag{18}$$

□

Proof of Proposition 2: Since v_1 is uniformly distributed on the interval [0,1], the cumulative distribution function of bidder 1's valuation is $F_1(v_1)=v_1$ and the corresponding density function is $f_1(v_1)=1$. The c.d.f. of bidder 1's bid is

$$\begin{aligned} G(b_1) &= P\left(\frac{\alpha+v_1}{1+\alpha} \le b_1\right) = P(v_1 \le (1+\alpha)b_1 - \alpha) = \int_0^{(1+\alpha)b_1-\alpha} f_1(v_1)\mathrm{d}v_1 \\ &= (1+\alpha)b_1 - \alpha. \end{aligned} \tag{19}$$

Differentiating with respect to b_1, the corresponding density function is

$$g(b_1) = (1+\alpha). \tag{20}$$

Given Eq. (18), bidder 1's bid,

$$b_1 \in \left[\frac{\alpha}{1+\alpha}, 1\right]. \tag{21}$$

If bidder 2 incurs costs C and learns he is type H with valuation v_2, his expected profits (not including C) are

$$[G(v_2)]v_2 - \int_{\frac{\alpha}{1+\alpha}}^{v_2} b_1 g(b_1)\mathrm{d}b_1 = \frac{1+\alpha}{2}v_2^2 - \alpha v_2 + \frac{\alpha^2}{2(1+\alpha)}. \tag{22}$$

Before bidder 2 incurs the cost C and learns his type and valuation, his expected profits are

$$\theta \int_{\frac{\alpha}{1+\alpha}}^{1} \left[\frac{1+\alpha}{2}v_2^2 - \alpha v_2 + \frac{\alpha^2}{2(1+\alpha)}\right] f(v_2)\mathrm{d}v_2 - C = \frac{\theta}{6(1+\alpha)^2} - C. \tag{23}$$

It follows from Eqs. (5) and (6) that second bidder expected profits are nonnegative if C=0.

Bidder 1 bids more than his valuation. An inefficient outcome occurs when bidder 2's bid (which is equal to his valuation) is greater than bidder 1's valuation, but less than bidder 1's bid. □

Proof of Proposition 3: It follows from Proposition 1 that $b_1^*=(\alpha+v_1)/(1+\alpha)$ for $s>(\alpha+v_1)/(1+\alpha)$. Now suppose that $v_1<s\leq(\alpha+v_1)/(1+\alpha)$. From the proof of Proposition 1, Eqs. (16), and (17), it follows that bidder 1's expected profits are increasing in his bid for $b_1<(\alpha+v_1)/(1+\alpha)$ and $b_1<s$. It follows that $b_1^*=s$. Lemmas 1 and 2 imply that $b_1^*=v_1$ for $s\leq v_1$. □

Proof of Proposition 4: Since v_1 is uniformly distributed on the interval [0,1], the cumulative distribution function of bidder 1's valuation is $F_1(v_1)=v_1$ and the corresponding density function is $f_1(v_1)=1$. The c.d.f. of bidder 1's bid is

$$G(b_1) = P\left(\frac{\alpha+v_1}{1+\alpha}\leq b_1\right) = \int_0^{(1+\alpha)b_1-\alpha} f_1(v_1)\mathrm{d}v_1 = (1+\alpha)b_1 - \alpha, \tag{24}$$

for $s>(\alpha+v_1)/(1+\alpha)$, i.e., $\alpha/(1+\alpha)\leq b_1<s$. However, $G(b_1)=P(v_1\leq b_1)=b_1$ for $s\leq(\alpha+v_1)/(1+\alpha)$, i.e., $b_1\geq s$. Differentiating $G(b_1)$ with respect to b_1, the corresponding density function is

$$g(b_1) = (1+\alpha) \text{ if } \frac{\alpha}{1+\alpha} \leq b_1 < s, \text{ and } g(b_1) = 1 \text{ if } b_1 \geq s. \tag{25}$$

If bidder 2 incurs costs C and learns he is type H with valuation v_2, his expected profits (not including C) are:

$$[G(v_2)]v_2 - \int_{\frac{\alpha}{1+\alpha}}^{v_2} b_1 g(b_1)\mathrm{d}b_1 = \frac{1+\alpha}{2}v_2^2 - \alpha v_2 + \frac{\alpha^2}{2(1+\alpha)},$$
$$\text{for } s > v_2 \text{ and } s > \frac{\alpha}{1+\alpha}; \tag{26}$$

$$[G(v_2)]v_2 - \int_{\frac{\alpha}{1+\alpha}}^{s}(1+\alpha)b_1 \mathrm{d}b_1 - \int_{(1+\alpha)s-\alpha}^{s} s\mathrm{d}b_1 - \int_{s}^{v_2} b_1 \mathrm{d}b_1$$

$$= \frac{v_2^2}{2} + \frac{\alpha s^2}{2} - \alpha s + \frac{\alpha^2}{2(1+\alpha)}, \qquad \text{for } s < v_2 \text{ and } s > \frac{\alpha}{1+\alpha}; \tag{27}$$

and

$$[G(v_2)]v_2 - \int_{s}^{v_2} b_1 \mathrm{d}b_1 - \int_{0}^{s} s\mathrm{d}b_1 = \frac{(v_2^2 - s^2)}{2}, \qquad \text{for } s \leq \frac{\alpha}{1+\alpha}. \tag{28}$$

Before bidder 2 incurs the cost C and learns his type and valuation, his expected profits are

$$\Pi_2(\alpha, s, \theta) = \frac{\theta}{6}[1 - 3s^2 + 2s^3] - C, \text{ for } 0 \leq s \leq \frac{\alpha}{1+\alpha}, \text{ and}$$

$$= \frac{\theta}{6}\left[(1 - 2\alpha s\{3 - 3s + s^2\}) + \frac{\alpha^2}{(1+\alpha)^2}(3 + 2\alpha)\right] - C,$$

$$\text{for } \frac{\alpha}{1+\alpha} < s \leq 1. \tag{29}$$

□

Proof of Corollary 1: Eq. (10) follows from substituting $s = 0$ into Eq. (9i) and from substituting $\alpha = 0$ into Eq. (5). Eq. (11) follows from substituting $s = 1$ into Eq. (9ii). □

Proof of Corollary 2: Differentiating bidder 2's expected profits with respect to s yields,

$$\frac{\partial \Pi_2(\alpha, s, \theta)}{\partial s} = \theta[-s + s^2] < 0 \text{ for } 0 \leq s \leq \frac{\alpha}{1+\alpha}, \text{ and}$$

$$= -\alpha\theta[s^2 - 2s + 1] < 0 \text{ for } \frac{\alpha}{1+\alpha} < s \leq 1. \tag{30}$$

The second derivative is

$$\frac{\partial^2 \Pi_2(\alpha, s, \theta)}{\partial s^2} = \theta[-s + s^2] < 0 \text{ for } 0 \leq s \leq \frac{\alpha}{1+\alpha}, \text{ and}$$

$$= 2\alpha\theta[1 - s] > 0 \text{ for } \frac{\alpha}{1+\alpha} < s \leq 1. \tag{31}$$

Bidder 2's expected profits are decreasing in s, and given $0 \leq s \leq \alpha/(1+\alpha)$, the rate of decrease is the highest (least negative) for values of s close to 0. Bidder 2's expected profits are decreasing in s, and given $\alpha/(1+\alpha) < s \leq 1$ the rate of decrease is the highest (least negative) for values of s close to 1. □

Proof of Proposition 5: From Eq. (16) it follows that bidder 1's expected profits in a competitive auction are

$$\alpha b_1(1-b_1)+v_1b_1-(1-\alpha)\int_0^{b_1} b_2 \mathrm{d}b_2, \tag{32}$$

where

$$b_1^*(v_1)=\frac{\alpha+v_1}{1+\alpha}. \tag{33}$$

Since we assume that bidder 1 extracts all of the surplus from a reorganization, bidder 1 earns an expected profit of v_1 if he gains control of the firm by way of a bankruptcy reorganization in place of an auction.

It follows from the above equations that bidder 1 seeks an auction if

$$v_1 \leq \alpha b_1(1-b_1)+v_1b_1-(1-\alpha)\int_0^{b_1} b_2 \mathrm{d}b_2, \tag{34}$$

where

$$b_1^*(v_1)=\frac{\alpha+v_1}{1+\alpha}. \tag{35}$$

Substituting for b_1^* and solving for v_1, it follows that bidder 1 seeks an auction if

$$v_1 \leq 1-\sqrt{(1-\alpha^2)}. \tag{36}$$

□

Proof of Proposition 6: Suppose that bidder 1 seeks a second bidder. Bidder 2 knows α and can infer that bidder 1's valuation is less than or equal to $\bar{v}_1$, where

$$\bar{v}_1=1-\sqrt{(1-\alpha^2)}. \tag{37}$$

The second bidder's expected profits depend on θ, the probability that bidder 2 is of type H, C, the cost to bidder 2 of learning his type and valuation, and his expected profit if he learns he is type H. If bidder 2 learns that he is type H, then expected profits are bidder 2's probability of winning the auction multiplied by bidder 2's valuation less the expected price paid for the firm, i.e.,

$$\int_{\frac{\alpha}{1+\alpha}}^{\frac{\alpha+\bar{v}_1}{1+\alpha}} \left\{ [\hat{G}(v_2)]v_2 - \int_{\frac{\alpha}{1+\alpha}}^{v_2} b_1\hat{g}(b_1)\mathrm{d}b_1 \right\} \mathrm{d}v_2, \qquad \textit{if } v_2 \leq \bar{v}_1, \tag{38}$$

where $\hat{G}$ and $\hat{g}$ are the c.d.f. and corresponding density functions for bidder 1's bid.

If bidder 2 learns that he is type H, then expected profits are

$$\int_{\frac{\alpha+\bar{v}_1}{1+\alpha}}^{1} \left\{ v_2 - \int_{\frac{\alpha}{1+\alpha}}^{\frac{\alpha+\bar{v}_1}{1+\alpha}} b_1\hat{g}(b_1)\mathrm{d}b_1 \right\} \mathrm{d}v_2, \qquad \text{if } v_2 \geq \bar{v}_1. \tag{39}$$

In this case, bidder 2 always wins the auction and expected profits are the difference between bidder 2's valuation and the expected price paid for the firm. Combining the above equations, if bidder 1 seeks a second bidder then bidder 2's expected profits prior to learning his type are

$$\Pi_2(\alpha,\theta)=\theta\left[\int_{\frac{\alpha}{1+\alpha}}^{\frac{\alpha+\bar{v}_1}{1+\alpha}}\left\{[\hat{G}(v_2)]v_2-\int_{\frac{\alpha}{1+\alpha}}^{v_2}b_1\hat{g}(b_1)\mathrm{d}b_1\right\}\mathrm{d}v_2+\int_{\frac{\alpha+\bar{v}_1}{1+\alpha}}^{1}\left\{v_2-\int_{\frac{\alpha}{1+\alpha}}^{\frac{\alpha+\bar{v}_1}{1+\alpha}}b_1\hat{g}(b_1)\mathrm{d}b_1\right\}\mathrm{d}v_2\right]-C. \tag{40}$$

Eqs. (19) and (20) provide the c.d.f. and the corresponding density function of bidder 1's bid, where $0\le v_1\le 1$. It follows that the c.d.f. and the corresponding density function are

$$\hat{G}(b_1)=\frac{1}{\bar{v}_1}[(1+\alpha)b_1-\alpha], \tag{41}$$

and

$$\hat{g}(b_1)=\frac{1}{\bar{v}_1}(1+\alpha), \tag{42}$$

where $0\le v_1\le\bar{v}_1$ and $\alpha/(1+\alpha)\le b_1\le(\alpha+\bar{v}_1)/(1+\alpha)$.

It follows from Eqs. (37), (40), (41), and (42) that

$$\Pi_2(\alpha,\theta)=\frac{\theta}{6}\left[\frac{\sqrt{(1-\alpha^2)}+2-\alpha^2}{(1+\alpha)^2}\right]-C. \tag{43}$$

□

Proof of Corollary 1: From Eqs. (5) and (15), it follows that the difference between bidder 2's expected profits in a reorganization-based system if bidder 1 seeks a second bidder and bidder 2's expected profits in a mandatory cash auction based system is

$$\frac{\theta}{6(1+\alpha^2)}[\sqrt{1-\alpha^2}+1-\alpha^2], \tag{44}$$

which is strictly greater than zero for all $0\le\alpha<1$. □

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