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I. Introduction.

How can the rules and regulations under which competition for corporate control occurs be designed so that control gets allocated by the market to that firm which can manage the assets most profitably? If all relevant information were common knowledge, the problem is simple—current shareholders in a corporation would immediately sell control to whomever can manage the corporation's assets most profitably.[1] Even when shareholders are not fully informed, however, there is still a presumption in the literature that, at least as long as all bidders face the same rules, competition for control of a corporation should still lead to control by that firm under which the assets are most valuable. For example, Bradley and Rosenzweig [1986a, p. 328] state directly that "A fair competition between the managers of targets and bidders for the right to control the target's resources will lead to the optimal allocation of those resources." Their intuition is that the manager who can use the assets most profitably will be able to bid the most for these assets, and the shareholders will sell to the highest bidder.[2]

The objective of this paper is to define a simple form of "fair" competition between the manager and the raider for corporate control, and then explore the characteristics of the resulting allocation process. In particular, we let the raider make one any–or–all bid for shares in the firm,[3] and allow the manager to respond by declaring support or opposition, and if opposition by making a bid to repurchase a fixed number of the outstanding shares.[4] In doing so, we rule out a variety of defensive tactics, such as greenmail, poison pills, or simply imposing endless delays on the process, since these tactics are available only to the manager and so are "unfair."[5] Use of a repurchase bid as a defensive tactic has become more common recently, and we provide a formal analysis of when and why it can be used successfully.

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[1] Even this conclusion is debated. See Grossman–Hart [1980] or Bradley [1980]. As Bagnoli and Lipman [1987] show, this conclusion does follow with a finite number of stockholders.

[2] They also argue that a variety of forms of "unfair" competition between bidder and manager, such as allowing the manager but not the raider to buy shares on the open market, will lead to an inefficient outcome.

[3] We do not allow a bid for only some fraction of the firm's shares to avoid the complications arising from a possible threat of dilution, but also assume, unlike Grossman–Hart, that bids are made costlessly.

[4] Such a bid is often referred to as a defensive self–tender offer. One important restriction is that the shares must be acquired in a non–discriminatory manner.

[5] See, for example, Shleifer and Vishny [1986b], Berkovitch and Khanna [1987] or Hirshleifer and Titman[1987] for an analysis of a takeover attempt when such tactics are used.

Even this bidding process leaves some asymmetry between raider and bidder, however. No matter how many shares the manager has the firm repurchase, the takeover can still succeed if the raider buys a high enough fraction of the remaining shares. A more symmetric alternative would be for the manager to bid personally for the shares. However, if the manager is also restricted to an any–or–all bid, to avoid the threat of dilution, then this process leads to a firm being taken private when the manager is successful. We hope to find a mechanism for corporate allocation which does not lead to a possible sacrifice of the risk–sharing benefits of diversified ownership of the firm.

There are many aspects of the allocation process of corporate control which can lead to inefficiencies when the stockholders are not perfectly informed. To begin with, some raiders who might be able to operate the firm more efficiently than the current manager may not even make a bid, perhaps because the current shareholders overestimate the value of the firm under the manager's control. In addition, if a bid is made, the manager may have the incentive and the ability to block even beneficial takeovers. Finally, the shareholders, in making a decision whether or not to approve the takeover, may not have enough information about the true value of the firm under either the manager or the raider to induce an efficient outcome. In fact, as we argue later, the equilibrium behavior of the shareholders may not even be in their group self interest. An efficient set of rules and regulations for the takeover process must try to circumvent all these possible problems.

To show how easily these problems can arise, suppose there is only a single bidder, that the manager cannot respond to a takeover bid, and that the manager has better information about his ability to run the firm than the stockholders or the bidder have. While it is true that the bidder's actions could reveal some of his private information, without the revelation of the manager's private information the stockholders cannot learn whether or not the bidder is more efficient than the manager. Hence there is no reason to expect that the outcome will generally be efficient. It is quite possible that the firm can be run more efficiently by the raider even though he finds it unprofitable to make a bid. It is also possible that the raider successfully acquires a firm that he cannot run as efficiently as the current management.

When the manager can respond with a repurchase bid, the repurchase cannot directly block the takeover, since the takeover succeeds as long as shareholders sell enough of the remaining shares to the raider. Instead, the repurchase serves as a signal that the manager believes the firm is in fact worth more than the shareholders had thought. We will find that determining the outcome of such a bidding process is much more complicated than it might at first appear, since bids are made strategically, taking into account the information they convey to the other parties.

The organization of the paper is as follows. In section II, we develop more formally the equilibrium in which the manager cannot respond at all, in order to develop some of the properties of the model in a simpler setting.[6] In section III, we analyze the "fair" allocation process described above in which the manager can respond to the raider's bid by making a counter bid to repurchase some of the firm's stock.

Section IV examines the types of potential inefficiencies in the resulting allocation of control. As the above discussion suggests, the key problem is how well shareholders have been able to infer from the two bids whether the raider or the manager can operate the firm more profitably. We discuss briefly what shareholders might do to redesign the incentives of managers so as to lessen the possible misallocations. One obvious remedy for these inefficiencies is to encourage insider trading by the firm in its own stock. This induces the manager to reveal information and allows the stockholders to learn the true value of the firm. Then, in the event of a takeover, the true value of the firm is common knowledge and all successful takeovers are efficient. Alternatively, we describe some compensation schemes for the manager which induce efficient takeovers. However, the stockholders' objective is not efficiency since they are concerned solely about their own wealth and not social wealth. Actions which force the raider to bid more for the firm therefore may be attractive, even though they lead to some inefficient outcomes.[7]

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[6] Other attempts to incorporate information transmission aspects of this problem have been made by Shleifer and Vishny [1986a] and Hirshleifer and Titman both of which study the information that is revealed by a larger shareholder's takeover attempt.

[7] A similar point was made by Grossman–Hart.

II. No Defensive Tactics.

Consider a firm whose N shares are owned by I stockholders. The holdings of the i'th stockholder are h_i where, of course, $\sum_i h_i = N$. We let $K \geq N/2$ denote the number of shares that must be acquired to effectively control the firm. All of these variables are integers. For simplicity, we assume that no shareholder owns enough shares to unilaterally block the takeover or unilaterally cause the takeover to succeed. When the firm's assets are controlled by the current manager, their "true value" per share is x, a value known only to the current manager.[8] There is a single potential acquirer, the raider. Under the raider's management, the firm would be worth y per share, where y is known only to the raider.[9]

The shareholders have more limited information about the values of x and y. They realize, however, that the true values of x and y are positively correlated since the same assets are used to produce the income under the control of either manager.[10] Learning that y is high is therefore "good news" about x, though we also assume that the news is not "too good."[11] In particular, we assume that $\mathrm{E}[x \mid y \geq y^*]$ is continuously differentiable in y^* and that $0 < \partial \mathrm{E}(x \mid y \geq y^*)/\partial y^* < 1$. Finally, we assume that x and y have the same support.

We assume that the stockholders are risk neutral and so act to maximize the expected value of their holdings. That is, if the raider offers b per share and stockholder i sells $\sigma_i \leq h_i$ shares, his expected payoff is $\sigma_i b + (h_i - \sigma_i)\mathrm{E}(y \mid b)$ if the bid is successful and is $\sigma_i b + (h_i - \sigma_i)\mathrm{E}(x \mid b)$ otherwise. The raider maximizes his expected profit from the takeover ignoring any costs associated with making a bid. That is, if he acquires $k \geq K$ shares at b per share, his expected profits are $k(y - b)$, while they are $k(\mathrm{E}(x \mid y) - b)$ if he acquires fewer than K shares. For simplicity, we suppose that if his expected profits are

[8] For concreteness, one may think of the firm as simply holding a pot of money to be divided among the stockholders on some "last day." At the outset, the pot contains Nx dollars, where only the manager knows x.

[9] The raider's and the manager's information concerning x and y, respectively, can be derived from the stockholders' information by conditioning their beliefs on the private information of the respective player.

[10] An alternative way to think of this is that the shareholders believe that there is some chance that the raider seeks undervalued assets and some chance that there are true synergy gains.

[11] If y is known to be larger, this could be due either to a more capable raider or to more valuable assets. The expectation of x should rise since the assets may be more valuable, but not by the full increase in y since the higher y might also be due to a more capable raider.

zero, he strictly prefers making no bid.

The timing is very simple. First, the raider has the option of bidding or not. If he bids, he makes an any-or-all bid at a price of his choosing.[12] Then the stockholders simultaneously choose how many shares, if any, to tender.

We analyze the pure strategy, sequential equilibria of this game where we focus on those equilibria satisfying a requirement analogous to Grossman and Perry's [1986] consistency condition. Equilibrium is defined more precisely in Appendix A where we indicate how the consistency condition is used. Intuitively, equilibrium requires that each agent chooses an optimal strategy given his beliefs and the strategies of the other players and that beliefs are consistent with Bayes' Rule wherever applicable. The additional consistency condition restricts beliefs when a zero-probability event is observed.

It is easy to show that the raider's bid is successful if and only if the bid is at least $E(x \mid b)$.[13] To see this, note that a bid certainly tells stockholders that $y > b$. Since y and x are correlated, this information about y gives them information about x. If this information makes their expectation of x larger than b, $E(x \mid b) > b$, then in equilibrium no one would sell shares to the raider. Given that no other stockholder is selling, stockholder i cannot cause the takeover to succeed unilaterally and hence selling causes him to earn b per share sold when he could earn $E(x \mid b) > b$ otherwise.[14]

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12 That is, he offers to purchase any and all shares tendered at the stated price.

13 Such behavior of shareholders, derived by Bagnoli-Lipman in a model in which every shareholder recognizes he is decisive in determining the outcome of the takeover, differs from that described in Grossman-Hart, where shareholders are "atomistic" and believe that their behavior never influences the outcome. Our model can be modified in a straight-forward way to incorporate instead the Grossman-Hart story of shareholder behavior. In particular, we would need to assume that the raider makes a conditional rather than an any-or-all bid, so that an equilibrium exists when $E(x \mid b^0) < b^0 < E(y \mid b^0)$, we would need some amount of dilution to give raiders an incentive to bid, and we would need to follow Grossman and Hart's assumptions in resolving remaining multiple equilibrium problems. The conclusions from the model would remain almost entirely unchanged using this alternative story of shareholder behavior—all raiders with a y above a critical value will successfully take over the firm with a common bid equal to the expectation of y conditional on this bid. See Shleifer-Vishny[1986a] for a formal development of such a model. (The changes in the conclusions of the model in section III, under this alternative story of shareholder behavior, will be noted below.)

14 In this equilibrium, the raider cannot succeed in acquiring the firm with a bid below the current market value of a share, even though if the takeover succeeds shareholders may well expect the value of untendered shares to be high since the expected value of y may be high. While other sequential equilibria may exist, we solve the multiple equilibrium problem by focusing on this one response by stockholders because it seems unreasonable to expect that a takeover bid below the current stock price would be successful. However, this implies that shareholders reject such takeover bids even when $(N-K)y^e + Kb^0 > x^e$, and so do not always act in their group self-interest. If we had focused

On the other hand, if $\mathrm{E}(x \mid b) \leq b$, we are in a position exactly identical to that considered by Bagnoli and Lipman. As they show, there are many pure strategy equilibria but all of them have $\sum_i \sigma_i = K$. The reasoning behind this result is quite simple. Consider any strategies for the stockholders such that the takeover fails. Since the bid will fail, any stockholder who is tendering fewer than all his shares must be made better off by tendering another. This is true because the shares he was tendering still earn b, the additional tendered share was earning $\mathrm{E}(x \mid b)$ but now earns the larger amount b, and any untendered shares either do not change value (because the bid still fails) or else go from earning $\mathrm{E}(x \mid b)$ to earning the larger amount $\mathrm{E}(y \mid b)$.[15] Hence at least K shares must be tendered. So suppose this inequality is strict and consider any tendering stockholder. He could tender one fewer share and the bid would still succeed. Thus the value of the untendered shares is unaffected, the value of the tendered shares is obviously b either way, but the additional share that he holds goes from earning b to earning $\mathrm{E}(y \mid b)$. Hence there is no pure strategy equilibrium which does not have K shares tendered in this situation.

Finally, any strategies for the stockholders such that K shares are tendered is an equilibrium. To see this, note that deviating to tendering fewer shares causes the bid to fail. Hence these shares go from earning b to $\mathrm{E}(x \mid b)$ and cause all untendered shares to fall in value as well, making such a deviation unprofitable. Deviating to tendering more shares causes the additional tendered shares to go from earning $\mathrm{E}(y \mid b)$ to earning b while it does not affect the value of the other shares. Thus a deviation must be unprofitable. Hence, if $b \geq \mathrm{E}(x \mid b)$, the raider acquires exactly K shares.

Turning to the raider's problem, since he succeeds and acquires K shares if $b \geq \mathrm{E}(x \mid b)$, it is clear that the cheapest way to take over is to choose the smallest b such that $b \geq \mathrm{E}(x \mid b)$. If this smallest b is bigger than y, then the raider cannot profitably take over the firm. If it is smaller than y, he will choose to make this bid. Hence the observation of this bid signals only that y is larger than the bid. Therefore, $\mathrm{E}(y \mid b) = \mathrm{E}(y \mid y > b)$ and similarly for $\mathrm{E}(x \mid b)$. Hence if the raider bids, the bid he makes is defined by $b = \mathrm{E}(x \mid y > b)$.[16]

Our assumptions on the conditional expectation guarantee that there is exactly one

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instead on the equilibrium in which the takeover succeeds, the rest of our analysis would be essentially unaffected.

[15] The bid at least signals that $y > b$. Therefore, $\mathrm{E}(y \mid b) > b \geq \mathrm{E}(x \mid b)$.

[16] The multiple equilibrium problem that arises here is eliminated by our consistency conditions on off-the-equilibrium path beliefs in a manner analogous to those used by Grossman-Perry.

solution to this equation. Let this bid be b^*. This equilibrium is portrayed in Figure 1 where the vertical axis describes the shareholder's expectation for x, with an origin at its value before any bidding, while the horizontal axis is the bid b, with an origin at the same dollar value. Since any bid provides some good news about x, the curve $E(x \mid y > b)$ lies everywhere above the horizontal axis, and has a slope less than one. The other curve is simply a 45^o line. The bid is accepted if $E(x \mid b) \leq b$, which occurs only if the bid b is greater than or equal to b^*.

Therefore in equilibrium, control is transferred to the bidder if and only if y is greater than or equal to b^*. This is a very different outcome than the efficient one, which has control pass to the bidder if and only if $y > x$.[17] The bidding process reveals only whether $y > b^*$, and not whether $y > x$. This difference is portrayed graphically in Figure 2, where the origin for x is the shareholders' initial expectation for x, while the origin for y is this same dollar value. The efficient outcome would involve transferring the assets to the bidding firm if and only if the pair of values of y and x known by the bidder are above the 45^o line. In equilibrium, however, control passes to the bidder for those pairs of y and x above the horizontal line at $y = b^*$. If y and x were in the area A marked on the graph, control is transferred when it should not have been, and conversely for points in the area B.

[17] Here, and throughout the paper, we make the simplifying assumption that the social gain to control by one group or the other equals the private gain. See, for example, Shleifer–Summers [1987] for a discussion of possible differences between social and private gains.

III. Defensive Stock Repurchases.

In this section, the manager can respond to the raider's takeover bid by announcing verbal support or opposition and, if opposed, by offering to repurchase a fraction of the outstanding shares at some price b^1. Since a repurchase, if successful, changes the number of shares of voting stock and hence the number of shares required to gain control, it is useful to define $K(n)$ as the number required to control the firm when there are n shares outstanding. We assume that $K(n)$ is integer–valued, nondecreasing, and is between 1 and n for all n. We let $K = K(N)$.

We make assumptions about the joint distributions of x and y similar to those in the previous model. In particular, we assume that $\mathrm{E}(x \mid x \geq x^*, y = y^*)$ is continuously differentiable in x^* and y^*, that

$$\frac{\partial \mathrm{E}(x \mid x \geq x^*, y = y^*)}{\partial x^*} < 1, \tag{1}$$

for all x^* and y^* and that x and y have the same support. The intuition for the condition in equation (1) is that raising the lower bound of the support of the distribution should not increase the expectation of x too much.[18]

Also, we make two stronger assumptions about the relationship of x and y. First, we assume that they are related by Milgrom's [1981] MLRP condition, implying that each is "good news" about the other. Under this assumption, when one value is known to be higher, the shareholders' revised probability distribution for the other value stochastically dominates their prior distribution. Second, we assume that $\mathrm{E}[x \mid y = \mathrm{E}(x)] = \mathrm{E}(x)$. Intuitively, we wish to assume that the raider and manager are as symmetrically positioned as possible.

The game proceeds as follows. First, the raider can make an any–and–all bid, b^0, or choose not to bid at all. If he does not bid, the game ends. If a bid is made, the manager can then urge the shareholders to either accept or reject it. If he urges acceptance, we assume that this commits the manager to leave the firm. We will show that in equilibrium, the shareholders transfer controlling interest to the raider. This choice corresponds to a

[18] Any distribution with a nondecreasing hazard rate will satisfy this assumption. A simple counter example would be a distribution which has most of its density concentrated around 5 and around 20. Then if the lower bound on the support is raised past 5, the expectation will increase dramatically.

friendly takeover. If he rejects the bid, then he can choose whether or not to repurchase shares. A repurchase is an offer to buy up to κ shares at some price b^1 of his choosing. If more than κ shares are tendered to him, he purchases the same fraction from each tendering stockholder and returns the unpurchased shares.[19] We take $\kappa < N$ to be fixed, primarily to simplify the analysis.[20] Since the shares so acquired are no longer part of the voting stock in the firm, if k shares are repurchased the number of shares the raider has to acquire to control the firm falls to $K(N-k)$.

If the manager rejects the bid but does not attempt a stock repurchase, the stockholders, knowing this, choose how many shares, if any, to tender to the raider. If the manager does attempt a repurchase, the stockholders first choose how many shares, if any, to tender to the manager, and then after observing this outcome choose how many shares, if any, to tender to the raider.[21]

As in the previous section, the stockholders are assumed to be risk neutral and to maximize the expected value of their holdings. If they sell k shares to the manager at price b^1, and if the manager succeeds in blocking the takeover through this repurchase, then the true value per share in the firm will be

$$x_k(x, b^1) = \frac{Nx - kb^1}{N-k}.$$

Here, we assume that the true cost of the funds used in the repurchase is just their cash value.[22] If, in spite of the repurchase of k shares, the raider acquires controlling interest,

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[19] The exact way the manager chooses which κ shares to purchase does not affect the equilibrium so long as the method is not discriminatory. This particular assumption is used because it is consistent with the requirements of the Williams Act.

[20] In addition, we assume that $\max_i h_i < N - K(N-\kappa)$, so that no individual has enough shares to unilaterally block the takeover even if the manager acquires κ shares from all but the largest stockholder.

[21] The timing of moves is specified in this fashion so that a defensive stock repurchase may prevent the takeover from being successful but cannot simply delay it. One can imagine many reasons why delay might induce the raider to drop his bid. However, it is difficult to see how this could lead to efficient outcomes.

[22] It would be easy to incorporate a liquidity cost of payouts without changing the results in any fundamental way.

then the value per share in the newly acquired firm will be[23]

$$y_k(y, b^1) = \frac{Ny - kb^1}{N - k}.$$

Also, as in the last section, we assume that the raider maximizes his expected profit ignoring any costs associated with making a bid. Again, we assume that he strictly prefers not bidding to making a bid earning zero expected profits.

We assume that the manager's incentives can be summarized as follows. The present value of his compensation while he works for the firm is a monotonically increasing function of x, denoted by $V_0(x)$. If he leaves the firm as a result of a successful takeover, he receives the income from some alternative employment plus he sells all his shares in the firm to the raider for b^0, yielding him a utility which we can denote by $V_1(b^0)$. Note that V_1 includes any golden parachute received by the manager. Since the manager's risk preferences do not affect the equilibrium, we can take the monotonic transformation V_0^{-1} of all of his payoffs. Thus we will take his payoff if he stays with the firm to be x and his payoff if he leaves the firm to be $h(b^0) \equiv V_0^{-1}(V_1(b^0))$. For simplicity, we will assume that $h(b^0) < b^0$ for all b^0. It certainly seems reasonable that the manager will be worse off in the event of a takeover than he would have been managing the existing firm with a value of x equal to b^0. We also assume that there is a small cost to the manager in making a repurchase bid.[24] Finally, we assume that the manager strictly prefers leaving the firm as a result of a friendly takeover to leaving as a result of a takeover he opposed.[25]

These incentives for the manager may be plausible but obviously are not derived as

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23 We assume that the payout of kb^1 to repurchase shares also costs the raider only the cash amount used in the repurchase. Having a repurchase involve the same extra liquidity costs for the raider as for the manager would not be a problem. In general, the repurchase could involve a sale of assets which are valued more highly by the raider, making the repurchase more effective in blocking a takeover. In this paper, we ignore any restructuring of the firm's assets as a device to prevent takeovers, and focus solely on the signaling effects of a repurchase.

24 Our intent here is to avoid a type of poison pill, in which the manager upon seeing that a raid will succeed can offer to repurchase shares at some outrageously high price. Without this additional assumption, this action costs him nothing, since he receives $h(b^0)$ anyway, and serves the purpose of discouraging raids. We assume, however, that this action leaves the manager with slightly less than $h(b^0)$, so that at the time of the decision the manager would not choose to make a repurchase if the raid would succeed anyway. The costs to the manager of "gutting" the firm in this way, in addition to the effort involved and loyalty to former colleagues, could include loss of pension or other contractual benefits promised by the firm, lawsuits from remaining shareholders, and a reputation for seemingly vindictive and irrational actions.

25 Presumably, the manager's termination benefits in the former case would be more attractive. We did not incorporate such differences in compensation into the model to avoid the extra notation. Doing so has no effects on the results.

the optimal solution to any principal–agent problem. In the next section, we will discuss how the shareholders might wish to structure his incentives to maximize their wealth.

As in the last section, we focus on pure strategy sequential equilibria satisfying certain consistency conditions. The details are provided in Appendix A. A strategy for the raider, which we denote $b^0(y)$, may depend on y. Similarly, a strategy by the manager depends on his information, in this case the raider's bid b^0 and x. The manager must first decide whether to accept the raider's bid, denoted a, and, if not, denoted r, whether or not to make a bid, $b^1(b^0, x)$, to repurchase shares. If he chooses not to make a repurchase bid, we let $b^1 = -\infty$.

To analyze what must happen in equilibrium, consider first the stockholders' responses to any bid by the raider given their response to any bid b^1 by the manager. Suppose that the raider bid b^0, the manager opposes the raid and chooses b^1 (where this includes the possibility of $b^1 = -\infty$), and $k \leq \kappa$ shares were repurchased by the manager. Let the stockholders' expectations of x and y given these observations be x^e and y^e and define

$$x^e_k = \frac{Nx^e - kb^1}{N - k}$$

and

$$y^e_k = \frac{Ny^e - kb^1}{N - k}.$$

It is easy to show that similar arguments to those made in the previous section apply here as well. If $x^e_k > b^0$, then shareholders choose not to sell any shares to the raider, and the raid fails. If instead $x^e_k \leq b^0$, then shareholders will prefer to sell out to the raider.[26]

Now let's back up a step to analyze what happens in response to the manager's actions. We begin by considering the stockholders' response when the manager chooses not to make a repurchase bid. Next we show that if he bids "too little," no shares are tendered to him. Finally, we consider the more complicated case in which shares may be tendered to him.

If the manager urges rejection but does not make a repurchase bid, then, as the analysis above indicates, the takeover fails iff $b^0 \leq \mathrm{E}[x \mid b^0, r, b^1 = -\infty]$, the stockholders' revised expectation of the value of a share if the manager continues to control the firm.

[26] Notice that if $y^e_k < b^0$ the raider will end up acquiring *all* the remaining shares, whereas if $y^e_k \geq b^0$ the raider will still take over but acquire only $K(N - k)$ shares.

Next, suppose the manager attempts a repurchase at a bid of b^1. If b^1 is smaller than the shareholders revised expectation of x, given the raider's bid and the observed repurchase bid, then the shareholders will not sell shares to the manager. If they sell an additional share when k are currently being sold to the manager, they give up $x^e_k - b^1$. While they also gain $x^e_{k+1} - x^e_k$ per share they continue to own, this gain is necessarily smaller since the expected gain to the firm, $x^e_k - b^1$, is spread among all outstanding shares. In this situation, the raider acquires control iff $b^0 > x^e(b^0, r, b^1)$.

If instead $b^1 \geq x^e(b^0, r, b^1)$, then whenever the manager acquires any shares, the expected value of a share must fall since the firm is paying more for these shares than the stockholders think they are worth. Therefore, if $b^0 > x^e(b^0, r, b^1)$ then $b^0 > x^e_k$ and the takeover will succeed in spite of the repurchase bid, regardless of the number of shares sold to the manager. If, on the other hand, $b^0 \leq x^e(b^0, r, b^1)$, then the outcome depends on the relative sizes of b^0 and $x^e_\kappa(b^0, r, b^1)$. If $b^0 \leq x^e_\kappa$, then the stockholders will tender κ shares to the manager and none to the raider. If a stockholder were to tender shares to the raider, he would lose $x^e_\kappa(b^0, r, b^1) - b^0$ on shares that would otherwise have been held and would lose $b^1 - b^0$ on shares that would otherwise have been tendered to the manager. Having stockholders tender fewer than κ shares to the manager is also not an equilibrium. If an individual stockholder were to tender fewer shares to the manager, he would lose. Since $b^1 \geq x^e(b^0, r, b^1)$, we know that $x^e(b^0, r, b^1) \geq x^e_k(b^0, r, b^1)$ for all $k \leq \kappa$. Selling one share less to the manager therefore results in a loss of $b^1 - x^e_k(b^0, r, b^1)$ on that share but a gain on the shares still held (at least if $b^1 > x^e$). However, the gain must be less than the loss because the gain in the value of the firm $(b^1 - x^e_\kappa)$ is shared with the other stockholders.

In contrast, when $b^0 > x^e_\kappa$, and, as before, $b^1 \geq x^e(b^0, r, b^1)$, the takeover must succeed. To see this, suppose that only k shares are tendered, where $b^0 < x^e_k$. If any stockholder sells more shares to the manager, he will increase his payoff, by the same argument used in the previous case. The fact that he may sell additional shares to the raider, and get b^0 rather than x^e_{k+1}, or get y^e rather than x^e_{k+1} on any unsold shares, simply increases the payoff to this deviation. Hence the takeover must succeed in this case.

To summarize,

Proposition 1. *In equilibrium, the manager can block the takeover simply by rejecting the bid iff* $\mathrm{E}[x \mid b^0, r, b^1 = -\infty] \geq b^0$. *The manager can block the takeover with a stock repurchase iff* $b^1 \geq x^e(b^0, r, b^1) \geq x^e_\kappa(b^0, r, b^1) \geq b^0$.

Consider next the manager's problem. If he accepts the bid or if he cannot block the takeover, he receives $h(b^0)$. If he rejects the bid and does not attempt a repurchase, his payoff is x if the takeover fails. Finally, if he attempts a repurchase at a price of b^1 and succeeds in blocking the takeover, his payoff is x_κ.

Suppose first that $E[x \mid b^0, r, x \geq h(b^0)] \geq b^0$ and suppose that the manager chooses to simply reject the bid if $x \geq h(b^0)$ and, by Proposition 1, blocks the takeover. In this situation, the manager would gain by making a repurchase bid only if by doing so the raider's bid continues to fail and the true value of a share rises.[27] But this can occur only if the manager can induce some shareholders to sell shares to the firm at a price below the true x. Since shareholders understand the manager's incentives they would never sell shares to the manager in this situation. Under our assumptions, therefore, no repurchase would be attempted. Hence, if he can block by urging rejection, he cannot block with a repurchase. Therefore, the manager simply announces opposition to the takeover if $x \geq h(b^0)$, and supports it otherwise.

If, in contrast, $E[x \mid b^0, r, x \geq h(b^0)] < b^0$, then the takeover will succeed if the manager simply rejects the bid. The manager would be willing to repurchase shares even at a price above x if by doing so he can convince shareholders that x is large enough so that they should oppose the takeover. In particular, the manager would be willing to bid some price b^1 for κ shares and thereby block the takeover if and only if

$$h(b^0) \leq x_\kappa = \frac{Nx - \kappa b^1}{N - \kappa}$$

or equivalently,

$$x \geq \gamma b^1 + (1-\gamma)h(b^0), \tag{2}$$

where $\gamma = \kappa/N$. Denote the value of the right-hand side of equation (2) by $x^*(b^0, b^1)$.

This signal that $x \geq x^*(b^0, b^1)$ is credible only if the manager does in fact end up repurchasing these shares and the takeover is blocked. By Proposition 1, this occurs iff

$$b^1 \geq x^e(b^0, r, b^1) \geq x^e_\kappa(b^0, r, b^1) \geq b^0. \tag{3}$$

Among those bids, if any, which satisfy equation (3), the manager would choose the smallest bid since the true value per share in the surviving firm, x_κ, is strictly decreasing in the

[27] If the manager makes a repurchase bid at a price too low to acquire any shares, he is worse off due to the cost of making the bid.

manager's bid. Let the smallest such bid, assuming there is at least one, be b^*. (Notice that this will be a function of b^0 in general.)

To characterize this bid, b^*, notice that there is a unique bid that satisfies $\hat{b} = x^e(b^0, r, \hat{b})$ by equation (1). At this bid, $x^e = x^e_\kappa$. It follows easily that if this bid exceeds b^0, then it equals b^*, and otherwise no bid satisfying equation (3) exists. To see this, note that x^e_κ is a declining function of b^1.[28] Therefore, the condition $x^e_\kappa \geq b^0$ places an upper bound on a successful blocking bid b^1—if the manager's bid is too high, the resulting firm will be reduced in value so much by the repurchase that the raiders' bid will be accepted. Since $\hat{b}$ is a lower bound on any bid satisfying equation (3), if any bids exist which satisfies equation (3) the minimum such bid, b^*, equals $\hat{b}$.

Therefore, if $\hat{b} \geq b^0$ and if $x \geq \gamma\hat{b} + (1-\gamma)h(b^0)$, the manager will make a repurchase bid $\hat{b} = b^*$, acquire κ shares, and thereby block the raid. If either condition is not satisfied, then the manager has no option but to allow the raid to succeed, and under our assumptions urges the shareholders to accept the raider's bid.[29] Hence, if the stockholders infer that $x \geq x^*(b^0, b^1)$ upon observing a repurchase bid b^*, then the manager makes a repurchase bid of b^* if $x \geq x^*(b^0, b^1)$. Conversely, if no repurchase bid is made, they infer that $x < x^*(b^0, b^1)$ if a successful bid b^* exists, and infer nothing about x if no such bid exists.

So far, we have ignored what happens when the manager urges the shareholders to accept a takeover bid. Under our assumptions, the shareholders will in fact agree to tender their shares to the raider. To see this, consider first bids b^0 where $\mathrm{E}[x \mid b^0, r, x \geq h(b^0)] \geq b^0$. If the manager urges shareholders to accept such a bid, they infer that $x < h(b^0)$ since all other managers can successfully block the takeover. But, by assumption, $h(b^0) < b^0$, so shareholders know that $x < b^0$ and choose to tender their shares. Second, if $\mathrm{E}[x \mid b^0, r, x \geq h(b^0)] < b^0$ and a successful bid b^* exists, then when the manager urges acceptance the shareholders learn that $x < x^*(b^0, b^*)$. But the expectation of x, given this information, is less than the expectation of x given only that $x < h(b^0)$ which itself is less than b^0, so shareholders will tender their shares in this situation. Finally, if there is no successful repurchase bid regardless of the value of x, this implies that there is no way a manager can raise the expectation of x above b^0, so shareholders will always tender to the

[28] The derivative of x^e_κ with respect to b^1 is $(N/(N-\kappa))\partial x^e/\partial b^1 - \kappa/(N-\kappa)$. But, using equation (1), $\partial x^e/\partial b^1 = (\partial x^e(b^0, r, x \geq x^*)/\partial x^*)(\partial x^*/\partial b^1) < (\partial x^*/\partial b^1) = \kappa/N$. Together, these imply that $\partial x^e_\kappa/\partial b^1 < 0$.

[29] The manager could still bid enough to succeed in repurchasing shares, but doing so would not block the takeover and would impose the cost of making such a bid on the manager. The manager would therefore prefer to accept the raid.

raider.

Proposition 2, whose proof is available from the authors upon request, formally describes the manager's unique equilibrium strategy.[30]

Proposition 2. *For any b^0 satisfying $\mathrm{E}[x \mid b^0, r, x \geq h(b^0)] \geq b^0$, the manager's equilibrium strategy is to accept the bid if $x < h(b^0)$ and to reject it and make no repurchase otherwise. For any b^0 not satisfying this equation, if there exists a b^* satisfying equation (3), and if $x \geq \gamma b^*(b^0) + (1-\gamma)h(b^0)$, then his equilibrium strategy is to urge rejection and bid $b^*(b^0)$. He accepts the takeover bid otherwise.*

Figure 3 illustrates the situation. In the figure, the shareholders' expectation of x is on the vertical axis, with the origin being their expectation given b^0. The horizontal axis is the repurchase bid, b^1, with the origin being the same dollar value. The expectation of x, given by $\mathrm{E}[x \mid b^0, r, x \geq x^*(b^0, b^1)]$, lies everywhere above the horizontal axis, and has a slope less than γ. This curve intersects the 45° line where $b^1 = b^*$. Notice also that $x^e_\kappa = x^e$ when $b^1 = b^*$, and x^e_κ is a declining function of b^1. In the figure, we assume that $b^0 < b^*$. Any bid, b^1, which is between b^* and b^{**} will succeed in blocking the takeover. The manager will choose the lowest bid that blocks the merger, which is b^*. If, in contrast, b^0 were above b^*, then any bid which is high enough to induce shareholders to sell to the manager will result in a value of x^e_κ below b^0, and the takeover will succeed. Such a bid by the raider cannot be blocked.

We will not provide a detailed examination of the raider's equilibrium strategy. Instead, we will derive a few general properties of his strategy. First,

Proposition 3. *A sufficient condition for the raider to bid is that $h(y) > \underline{x}$, where $\underline{x} = \inf\{x : x \in X\}$. If $h(y) \leq \underline{x}$, and $y < \mathrm{E}(x)$, then the raider does not bid.*

Proof: If $h(y) > \underline{x}$, then there will be an interval of possible bids below y with a nonzero probability of success because the manager will certainly urge acceptance if $x < h(b^0)$.[31]

[30] If we had used the Grossman–Hart story about shareholder behavior in this section, the only change is that the manager can also block a takeover if his actions signal that y is sufficiently large. Hence the manager's equilibrium strategy is to bid $\hat{b}$ when $\hat{b} \geq b^0$ or when $E[y \mid b^0, r, \hat{b}] > b^0$, provided that doing so is preferable to leaving the firm.

[31] If $\mathrm{E}[x \mid x \geq h(b^0)] < b^0$ and a bid b^* exists, then the manager urges acceptance iff $x < x^*(b^0, b^1)$. But x^* satisfies $x^*(b^0, b^1) = \gamma\mathrm{E}[x \mid b^0, r, x \geq x^*(b^0, b^1)] + (1-\gamma)h(b^0)$, implying that $x^* > h(b^0)$, so if $x < h(b^0)$ then the manager certainly accepts. If $\mathrm{E}[x \mid b^0, r, x \geq h(b^0)] < b^0$ and no bid b^* exists, then a manager urges acceptance for all x.

Therefore, raiders with these values of y will certainly bid.

If $y < \mathrm{E}(x)$, and therefore $b^0 < \mathrm{E}(x)$, then the raid will fail unless the manager provides unfavorable enough news about x. Since $h(y)$ is less than the minimum possible value of x, then all managers will reject the bid and the raid will fail. Therefore, under these conditions, the raid will surely fail and the raider will not choose to bid. ∎

Since takeover bids do not seem to occur in practice at prices below the initial market price, we conclude that potential raiders view lower bids as having no chance of success. This would certainly be true in our model if $h(\mathrm{E}(x))$ is less than the minimum possible value of x under existing management compensation schemes. In other words, if $\underline{x} \geq h(\mathrm{E}(x))$, then $y \geq \mathrm{E}(x)$ is necessary for a bid.

The second general property is.[32]

Proposition 4. *In any equilibrium, $b^0(y)$ is weakly increasing in y.*

The intuition of this result is simple. The higher is the raider's bid b^0, the higher is the probability the bid will be successful. Since raiders with a larger y gain more when a raid is successful, they would be willing to bid at least as much as raiders with a lower y.

In fact, the probability of a successful raid jumps discontinuously at two different values of b^0. First, for the value of b^0 where $\mathrm{E}[x \mid b^0, r, b^1 = -\infty] = b^0$, the probability of the raid failing is the probability that $x \geq h(b^0)$, while for a slightly higher value of b^0 the probability of failure is the probability that $x \geq x^* > b^0 > h(b^0)$. In the other case, at the value of b^0 where $\mathrm{E}[x \mid b^0, r, b^*(b^0)] = b^0$, the probability of failure is the probability that $x > x^*$, while for a slightly higher value of b^0 the raid succeeds for sure. In equilibrium, there must therefore be two discontinuous jumps in the bidding function $b^0(y)$ at these two values of b^0. Below the first jump point, the raid fails if the manager simply says no—these raids may well appear in the data as friendly mergers rather than as hostile takeovers. Above the second jump point, the raid succeeds for sure. Since there is no gain to a higher bid if the raid succeeds for sure anyway, the maximum observed bid will be "slightly above" that b^0 satisfying $b^0 = \mathrm{E}[x \mid b^0, r, b^*(b^0)]$.

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32 The proof of this result is available from the authors upon request.

IV. Characteristics of the Equilibria.

For the takeover process to be efficient, takeovers should occur if and only if $y > x$. The actual equilibrium described in the previous section is far more complicated however.

In describing this equilibrium, we begin by graphing the outcome as a function of y and x in Figure 4. (This graph is meant to be illustrative of the complications that can arise, but does not describe the only possible pattern of outcomes.) In this graph, the origin for x is the shareholders' initial expectation for x. The origin for y is the same dollar value. The bid, as a function of y, is represented by some curve marked b.[33] This bid function must necessarily lie below the 45° line. We have assumed in drawing it that no bids occur below the initial value of $\mathrm{E}(x)$, consistent with our reading of the empirical evidence. Any bid which does occur must therefore raise the expectation of x, implying that the $\mathrm{E}(x \mid b^0)$ is greater than $\mathrm{E}(x)$ and increasing in b^0 which itself is weakly increasing in y.

From Proposition 2, we know that if $\mathrm{E}[x \mid b^0, r, x \geq h(b^0)] > b^0$, the manager will reject the bid if $x \geq h(b^0)$ and accept otherwise. In the figure, this conditional expectation of x is denoted x^e,[34] and so the condition is satisfied for all $y < y'$. The manager will approve the takeover if $x < h(b^0)$ when y is in this range. In the graph, this means that for any points under the curve marked $h(b^0)$, where $x = h(b^0(y))$, and to the left of y', there will be a "friendly" takeover.

For $y \geq y'$, $\mathrm{E}[x \mid b^0, r, x \geq h(b^0)] \leq b^0$. From Proposition 2, we know that the manager attempts a repurchase at $b^*(b^0)$, if such a b^* exists, as long as $x \geq x^*(b^0, b^*)$. In the graph, the curve $\hat{b}$ denotes the values of $\hat{b}$, where $\hat{b} = x^e(b^0, r, \hat{b})$, and the curve x^* denotes the minimum value of x above which the manager will choose to make a counter bid $\hat{b}$.[35] Given the shape of the curve $\hat{b}$ as drawn, a successful repurchase bid, b^* exists for values of y between y' and y''. Therefore, for all values of x above the curve x^*, and for values of y between y' and y'', the manager bids $b^*(b^0(y))$, acquires κ shares, and blocks the takeover. For values of x below x^*, the manager accepts the raider's bid and the raid succeeds.

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[33] We showed above that this curve is weakly increasing in y and must have two discontinuities.

[34] This curve must lie above the horizontal axis and be upward sloping. Our results say little, however, about the relative positions of curves x^e and b.

[35] Note that $x^*(y) = \gamma b^*(y) + (1 - \gamma)h(b^0(y))$, so that the curve x^* is located a fixed fraction of the way between the curves $h(b^0)$ and $\hat{b}$.

Finally, if y is above y'', the manager cannot block the takeover, regardless of the value of x. Therefore, the takeover will succeed for all the areas below and to the right of the heavily shaded line. As seen in the graph, there certainly will be cases when takeovers do not occur even though $y > x$. The simplest example is when y is small enough that the raider does not bid, but $x < y$. Depending on the location of the various curves, there may also be cases when takeovers occur which should not. In Figure 4, this situation arises for any value of y above y'', and for any x greater than that value of y. Comparing figure 4 with figure 2, we find that allowing managers to make a repurchase bid dramatically changes the set of outcomes, in part because the bid function of the raider changes in response. Unfortunately, misallocations of control can still occur.

The efficiency of the allocation of corporate control would be maximized if the manager's compensation scheme were designed to maximize

$$\int [xq(x,y) + (1 - q(x,y))y] f(x,y) \mathrm{d}x\mathrm{d}y,$$

where $f(x,y)$ is the shareholder's density function for x and y, and where $q(x,y)$ is a dummy variable equaling 1 if a takeover will fail for that set of points and zero otherwise. There are several approaches available to insure that takeovers occur if and only if $y > x$.

One possible approach is to create incentives under which the true value of x is always revealed to the market. If this occurs, then under our assumptions a raid would succeed if and only if $y > x$. An obvious way to reveal information about the true x is to allow the firm to buy and sell its own shares freely. The difficulty is that shareholders would not trade shares with the firm knowingly, since if the firm wants to trade, the shareholders do not. But, under existing institutions, at least small amounts of trading by the firm need not be revealed publicly beforehand, so shareholders will not be aware of the firm's trading position. However, the firm's trading, by putting pressure on the market price, should cause shareholders to revise their expectations of the value of the firm. This learning process could be hastened by forcing the nature of the firm's trades to be revealed quickly after the fact. This is just the effect of insider trading regulations, but these regulations currently reveal insider trading after at least a month's delay.[36]

If shareholders do not learn the true x prior to a takeover attempt, another approach to designing efficient incentives would be to make it in the manager's interest to reveal

[36] Under these regulations, insider trading must be reported at the end of the month following the month in which the trading occurred, and there is then a delay in publishing this information.

whether a takeover would be efficient or not. This can easily be done as long as the equilibrium for the raider's bid is separating so that the manager can infer from the bid, b^0, what the true value of y is.[37] In fact, there are at least two possible approaches.

First, the compensation function $h(b^0)$ can be designed so that the manager will urge shareholders to support a takeover bid if and only if $y > x$. As we showed in the previous section, a manager will support a bid when $h(b^0) > x$ if $\mathrm{E}[x \mid b^0, r, x \geq h(b^0)] > b^0$. Therefore, given the raider's bidding function, $b^0(y)$, if the compensation function is chosen such that $h(b^0(y)) = y$ for all y, then $\mathrm{E}[x \mid b^0, r, x > y] > y > b^0$ so that the manager will support efficient and only efficient takeovers . Since $b^0 < y$, this requires that $h(b^0) > b^0$, contrary to the assumptions made in the previous section. One problem this creates is that $h(x) > x$, implying that the manager has the incentive to engineer a takeover by insiders who will then leave the operations of the firm unchanged. This anomaly would be eliminated if $h(b^0) \leq b^0$ but at the cost of some inefficiency in the allocation of control.

Alternatively, the compensation function can be designed such that the manager will make a successful repurchase bid if and only if $x > y$. For such a repurchase bid to be successful, the bid price, b^1, must be at least equal to $\mathrm{E}(x \mid x > y)$, and the manager would therefore choose a strict equality.[38] We showed earlier that the manager will choose to make a repurchase bid, b^1, if and only if $x \geq \gamma b^1 + (1-\gamma)h(b^0(y))$. For these incentives to lead to efficient and only efficient takeovers, the compensation function must be designed such that $\gamma \mathrm{E}(x \mid x > y) + (1-\gamma)h(b^0(y)) = y$ for all y. Since we know that $\mathrm{E}(x \mid x > y)$ must be strictly greater than y, it follows that $h(b^0(y))$ must be strictly less than y. It will not necessarily be the case, however, that $h(b^0) < b^0$ implying that the above anomalies are still possible.

These three approaches to achieving efficient allocation of control all impose risk on the manager before the raider's bid, if any, is known. However, this risk can be made arbitrarily small, since the manager's decision depends only on the sign and not the quantitative importance of the difference in his compensation under different outcomes.[39]

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[37] If the design of the manager's incentives affects the amount of information revealed by the raider's bidding function, then the optimization problem becomes much more complicated.

[38] Note that if managers can infer y from the bid b^0, so can shareholders.

[39] A fourth possible approach, also leading to an efficient allocation of control, would be to have the manager receive all the marginal fluctuations in the value of the firm. This approach, however, results in no risk-sharing whatsoever.

It is not in the shareholder's interests to design efficient incentives, however. The shareholders' objective in designing the manager's compensation scheme is to maximize their own expected utility, which in our model equals[40]

$$\int [xq(x,y) + (1 - q(x,y))((K/N)b^0 + ((N-K)/N)y)]f(x,y)\mathrm{dxdy}.$$

A major complication is that they need to take into account how their choice of a compensation scheme for the manager affects the bidding function, $b^0(y)$, of the raiders. Unless b^0 always equals y, this objective function differs from the previous objective function. Since some of the gains of a takeover go to the raider, shareholders face inadequate incentives to encourage managers to allow a takeover to go through. In addition, shareholders should want to credibly commit themselves to reject at least some efficient takeovers in order to induce raiders to increase their bids.[41] They can do so through the design of the manager's compensation scheme.

These problems suggest the possibility that tax distortions affecting the attractiveness of takeovers or affecting the composition of managerial compensation schemes might, at least within some range, create an efficiency gain. Certainly many types of tax distortions affecting these decisions exist.[42] Given the complicated nature of the equilibrium in this setting, however, it is premature to conclude anything concrete about which of these policies might be defended as providing efficiency gains.

One other interesting property of our equilibrium is the forecasted pattern of share prices in the event of a takeover bid. When a raider bids, under the plausible assumption that no bids below $\mathrm{E}(x)$ will occur,[43] shareholders learn at least that $y > \mathrm{E}(x)$, raising the expected value of x. If the manager announces opposition to the bid or makes a repurchase bid, the model forecasts that $\mathrm{E}(x)$ rises further, since either action signals that x is not "too" low.[44] The resulting price rise should remain if the takeover bid lapses.

[40] We ignore here any conflicts among shareholders arising because they may sell different fractions of their shares to the raider in the equilibrium.

[41] This claim is no different than the claim than union and management representatives will choose bargaining strategies which lead to a positive probability of a strike.

[42] See, for example, Butters et al [1951], Feld [1982], and Miller-Scholes [1982].

[43] In the previous section, we showed that this is guaranteed if $h(\mathrm{E}(x)) \leq \underline{x}$. Grossman-Hart impose this assumption directly.

[44] One interpretation of this favorable news is that the manager informs shareholders that their assets had been undervalued, and that the raider may simply have been trying to profit from this undervaluation.

This result is consistent with the empirical work of Bradley, Desai, and Kim [1983]. They showed that the effect of an unsuccessful takeover bid dissipates over a two year period if no subsequent bid is made. Our model, of course, does not consider what happens in this period. However, notice that in our model, if no subsequent bid is made, this fact must be bad news as it must signal that the y of later potential raiders is too low. This suggests that in a dynamic model based on this one, the fact that no bid is observed for some length of time would be associated with a declining stock price and thus would be consistent with this data.

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Appendix A: Definition of Equilibrium.

In order to clearly define our equilibrium concept, some additional notation is needed. To avoid having to define the concept for each of the two models studied, the definition will be described for the model with defensive tactics. The appropriate modifications for the model without defensive tactics will be apparent.

Recall that we have assumed that the random variables x and y have the same support. Let X be that common support and let F be their joint distribution function. Also, $z_{\sim i}$ stands for the vector z with the i^{th} component deleted.

Next, we need to define the strategy spaces for each of the players. Since we have a multistage game where players observe other players' actions, each player is able to condition his action on those observations. Since the raider moves first, he has only observed y when he is required to make an any–and–all bid. Thus a strategy[1] for the raider is a function $b^0(y)$. That is, it is a function from the support of the random variable that he observes, y, to a bid, say b^0. We let the bid $-\infty$ represent the situation when the raider chooses not to bid. The manager observes x and the raider's bid and is then permitted to urge acceptance or rejection and, in the event of rejection, is permitted to choose a price at which he is willing to repurchase shares. As a result, a strategy for the manager is a pair $\sigma_m(b^0, x), b^1(b^0, x)$. One interprets the former as saying, for each observed bid by the raider (b^0) and for any possible true value of a share (x), whether the manager urges acceptance (a) or rejection (r). The latter, b^1, is a function that says for any b^0, x, and given that the manager has urged rejection, what price the manager bids for the shares, b^1. Recall that we have restricted the manager's strategy space so that if $\sigma_m(b^0, x) = a$ then $b^1 = -\infty$.[2] That is, if the manager urges acceptance, he cannot make a repurchase attempt. A strategy for the i^{th} stockholder is a pair $\sigma_i^1(b^0, d, b^1), \sigma_i^0(b^0, d, b^1, \sigma^1)$, for $d \in \{a, r\}$, where the former specifies for each choice that may have been made by the raider and the manager (that the stockholder can observe) how many shares to tender to the manager. The latter specifies how many shares to tender to the raider after having observed not only the choices of the raider and the manager but the number of shares tendered to the manager by each of the stockholders (the vector σ^1). With a slight abuse of notation, when it will not cause confusion, σ_i^1 and σ_i^0 will also represent the number of shares tendered to the manager and the raider respectively and σ^j will represent the vector $(\sigma_1^j, \sigma_2^j, \ldots, \sigma_I^j)$ for $j = 0, 1$.

An equilibrium in this game will be a sequential equilibrium that satisfies an additional condi-

[1] The strategy space for a player is simply the set of functions of the type described.

[2] We also allow $b^1 = -\infty$ when the manager has urged rejection but chooses not to make a repurchase bid.

tion on beliefs.[3] Consequently, we must first define a pure strategy sequential equilibrium (henceforth SE) for this game. Basically, this means that we must specify a strategy and belief function for each of the $I+2$ players in the game which are optimal for each player given that player's beliefs and the strategies of the other players. In addition, the beliefs must be consistent with the strategies of the other players and Bayes' rule wherever possible. More precisely, an SE specifies a vector

$$< b^0(y), (\sigma_m(b^0, x), b^1(b^0, x), \mu_m(y \mid x, b^0)), (\mu(x, y \mid b^0, d, b^1), \sigma_i^1(b^0, d, b^1), \sigma_i^0(b^0, d, b^1, \sigma^1))_{i=1}^I >$$

which must satisfy certain properties. [The strategies have been described above, and the μ functions are the belief functions. The stockholders are assumed to form the same belief which is represented by μ and depends on what they have observed, b^0, d, b^1 while μ_m is the belief of the manager who knows x and observes the raider's bid b^0.]

The properties that the vector must satisfy include the obvious restrictions on the strategies described in the text (*e.g.* the stockholders must tender an integer numbers of shares which is not more than the number that they own) as well as the following restrictions:

(1a) For each b^0, d, b^1, and σ^1 and for each i, $\sigma_i^0(b^0, d, b^1, \sigma^1)$ is a best response[4] to $\sigma_{\sim i}^0(b^0, d, b^1, \sigma^1)$ where expectations are taken with respect to the distribution $\mu(x, y \mid b^0, d, b^1)$.

(1b) For each b^0, d and b^1 and for each i, $\sigma_i^1(b^0, d, b^1)$ is a best response[5] to $\sigma_{\sim i}^1(b^0, d, b^1)$ given $\sigma^0(b^0, d, b^1, \sigma^1)$ where expectations are taken with respect to the distribution $\mu(x, y \mid b^0, d, b^1)$.

(1c) For each b^0, each $x \in X$, and each d, $b^1(b^0, x)$ maximizes the manager's expected utility[6] given $(\sigma_i^1(b^0, d, b^1), \sigma_i^0(b^0, d, b^1, \sigma^1))$ for $i = 1, 2, \ldots, I$, where expectations are taken with respect to the distribution $\mu_m(y \mid x, b^0)$.

(1d) For each b^0 and each $x \in X$, $\sigma_m(b^0, x)$ maximizes the manager's expected utility given $b^1(b^0, x)$ and $(\sigma_i^1(b^0, d, b^1), \sigma_i^0(b^0, d, b^1, \sigma^1))$ for $i = 1, 2, \ldots, I$, where expectations are taken with respect to μ_m.

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[3] To be precise, we do not consider what Kreps and Wilson [1982] define as a sequential equilibrium. Their definition is restricted to games with a finite strategy set for each player, while our game allows both the raider and the manager infinite strategy sets. Also, they require a particular consistency condition that we will not verify. Intuitively, it is easy to see how to construct the relevant limiting argument for our model to justify our use of the term sequential equilibria.

[4] We require that whenever b^0 is less than the stockholder's expectation of x, the raider acquires no shares.

[5] We require that, if indifferent, stockholders tender to the manager.

[6] We require that, for all x, the manager does not bid if b^0 is less than the expected value of x given b^0. This expectation is calculated using the marginal distribution for x derived from μ.

(1e) For each $y \in X$, $b^0(y)$ maximizes the raider's expected profits given $\sigma_m(b^0, x)$, $b^1(b^0, x), (\sigma^1, \sigma^0)$ where expectations are taken with respect to the conditional distribution $F(x \mid y)$.

(2a) For each b^0_* such that $\mathcal{Y}(b^0_*) = \{Y \mid b^0(y) = b^0_*\}$ is nonempty,

$$\mu_m(y \mid x, b^0_*) = \begin{cases} 0, & \text{if } y \notin \mathcal{Y}(b^0_*); \\ \frac{f(y|x)}{\int_{\mathcal{Y}(b^0_*)} f(y|x)}, & \text{otherwise.} \end{cases}$$

(2b) For each b^0_*, d_* and b^1_* such that $\mathcal{Y}(b^0_*)$ is nonempty and such that $\mathcal{X}(b^0_*, d_*, b^1_*) = \{x \in X \mid b^1(b^0_*, x) = b^1_*\}$ is nonempty,

$$\mu(x, y \mid b^0_*, d_*, b^1_*) = \begin{cases} 0, & \text{if } x \notin \mathcal{X}(b^0_*, d_*, b^1_*) \text{ or } y \notin \mathcal{Y}(b^0_*); \\ \frac{f(x,y)}{\int_{\mathcal{X}(b^0_*, d_*, b^1_*)} \int_{\mathcal{Y}(b^0_*)} f(x,y)\, dx}, & \text{otherwise.} \end{cases}$$

(Recall that $F(x, y)$ is the joint distribution function of x and y. We use $f(x, y)$ to denote the joint generalized probability density function. See DeGroot [1970].)

(2c) For each b^0_* and d_*, such that $\mathcal{Y}(b^0_*)$ is nonempty and such that $\mathcal{X}(b^0_*, d_*) = \{x \in X \mid \sigma_m(b^0_*, x) = d_*\}$ is nonempty,

$$\mu(x, y \mid b^0_*, d_*) = \begin{cases} 0, & \text{if } x \notin \mathcal{X}(b^0_*, d_*) \text{ or } y \notin \mathcal{Y}(b^0_*); \\ \frac{f(x,y)}{\int_{\mathcal{X}(b^0_*, d_*)} \int_{\mathcal{Y}(b^0_*)} f(x,y)\, dx}, & \text{otherwise.} \end{cases}$$

Before describing the additional condition on beliefs, a few points about the above conditions must be made. First, the items (1) require that all strategies are sequentially rational. That is. for any player, given the strategies of the other players and given this player's beliefs, this player chooses a strategy that maximizes his expected payoff. Second, we have added three restrictions that are not present in the standard definition of sequentially rational. The first restriction is our assumption that if the raider's bid is below the conditional expectation of x, then no shares are tendered to the raider. It is easy to see that this is an equilibrium. If any stockholder deviated, his deviation could not cause the takeover to succeed because $h_i < N - K(N - \kappa)$. Hence he merely tenders shares which are worth the expectation of x for less than this. What is less obvious is that this assumption is not irrelevant. One can construct examples of equilibria where the takeover succeeds if the expectation of y is larger than the expectation of x. We solve this multiple equilibrium problem by opting for what seems to us the more intuitively plausible equilibrium. The second restriction is that if the stockholders are indifferent, we assume that they sell to the manager. The third restriction is that the stockholders' beliefs are unaffected when they observe the number of shares tendered to the manager. This is not unreasonable because we have assumed that the stockholders are symmetrically informed so that there actions ought not to change their beliefs about x or y.

The items (2) are the requirements that the players beliefs satisfy Bayes' rule given the strategy choices of the other players whenever Bayes' rule is applicable. Notice that the requirements for an SE say nothing about the beliefs off the equilibrium path. That is, if the manager chooses a bid which has probability zero given his strategy function, then the beliefs of the stockholders about x and y given this bid are entirely unspecified. This specification, however, is often crucial in verifying that a particular strategy is, in fact, optimal. Thus the fact that SE requires nothing about such beliefs typically leads to a vast multiplicity of SE's. This has motivated much research on refinements of sequential equilibria. These refinements typically focus on finding "reasonable" or "plausible" restrictions on off the equilibrium path beliefs.

Most of the restrictions are motivated by the following consideration. Suppose that a bid is observed that had probability zero in the (sequential) equilibrium. What should the stockholders infer? Suppose that there is some belief for which the manager would in fact deviate to this bid if x is in some set, say, A. Suppose further that he would not deviate to this bid if $x \notin A$. Finally, suppose that this belief is consistent with learning from this bid that $x \in A$. Then this seems like a sensible belief to hold after observing this deviation. Of course, if this belief is in fact held, the original strategy function was not optimal for the manager. Hence this SE exists only if some other, possibly not consistent, belief is held when this bid is observed. Concepts like perfect sequential equilibrium would then rule out this SE.

Our restriction is motivated by these same considerations. For simplicity, we add condition (3c) as well, because we find it intuitively appealing. We will define an equilibrium to be an SE according to the definition above which also satisfies:

(3a) Consider any b_*^0 such that $\mathcal{Y}(b_*^0)$ is empty and any $Y' \subseteq Y$. Let

$$\tilde{\mu}_m(y \mid x, b_*^0) = \begin{cases} 0, & \text{if } y \notin Y'; \\ \frac{f(y|x)}{\int_{Y'} f(y|x)}, & \text{otherwise.} \end{cases}$$

Let $\tilde{\sigma}_m(b_*^0, x), \tilde{b}^1(b_*^0, x, d)$ be a strategy for the manager given b_*^0 and let $\tilde{\mathcal{X}}(b_*^0, d_*, b_*^1) = \{x \mid \tilde{\sigma}_m(b_*^0, x) = d_*, \tilde{b}^1(b_*^0, x, d_*) = b_*^1\}$. For each d_*, b_*^1 such that $\tilde{\mathcal{X}}(b_*^0, d_*, b_*^1)$ is nonempty, let

$$\tilde{\mu}(x, y \mid b_*^0, d_*, b_*^1) = \begin{cases} 0, & \text{if } x \notin \tilde{\mathcal{X}}(b_*^0, d_*, b_*^1) \text{ or } y \notin Y'; \\ \frac{f(x,y)}{\int_{\tilde{\mathcal{X}}(b_*^0, d_*, b_*^1)} \int_{Y'} f(x,y) dx}, & \text{otherwise.} \end{cases}$$

Suppose $\tilde{\sigma}_m(b_*^0, x), \tilde{b}^1(b_*^0, x, d_*), \tilde{\sigma}^1(b_*^0, d_*, b_*^1), \tilde{\sigma}^0(b_*^0, d_*, b_*^1, \tilde{\sigma}^1)$ are sequentially rational strategies for the manager and the stockholders respectively when $\tilde{\mu}_m$ and $\tilde{\mu}$ are their beliefs given b_*^0. Let $\tilde{Y}$ be the set of y such that the expected profits of the raider given the bid b_*^0 and the strategies $\tilde{\sigma}(b_*^0, x), \tilde{b}^1(b_*^0, x, d_*)$ and $\tilde{\sigma}^1(b_*^0, d_*, b_*^1), \tilde{\sigma}^0(b_*^0, d_*, b_*^1, \tilde{\sigma}^1)$ are strictly larger than the expected profits of the raider in the equilibrium. Then we must have $\tilde{Y} \neq Y'$.

(3b) Consider any b_*^0, d_* and b_*^1 such that $\mathcal{Y}(b_*^0)$ is not empty but $\mathcal{X}(b_*^0, d_*, b_*^1)$ is empty. Consider any $X' \subseteq X$. Let

$$\tilde{\mu}(x, y \mid b_*^0, d_*, b_*^1) = \begin{cases} 0, & \text{if } x \notin X' \text{ or } y \notin \mathcal{Y}(b_*^0); \\ \frac{f(x,y)}{\int_{X'} \int_{\mathcal{Y}(b_*^0)} f(x,y)\, dx}, & \text{otherwise.} \end{cases}$$

Let $\tilde{\sigma}^1(b_*^0, d_*, b_*^1), \tilde{\sigma}^0(b_*^0, d_*, b_*^1, \tilde{\sigma}^1)$ be sequentially rational strategies for the stockholders when $\tilde{\mu}$ are their beliefs given b_*^0, d_* and b_*^1. Let $\tilde{X}$ be the set of x such that the expected utility of the manager given b_*^0, d_* and b_*^1 and the strategies $\tilde{\sigma}^1(b_*^0, d_*, b_*^1)$, $\tilde{\sigma}^0(b_*^0, d_*, b_*^1, \tilde{\sigma}^1)$ is strictly larger than the expected utility of the manager in equilibrium given the bid b_*^0. Then we must have $\tilde{X} \neq X'$.

(3c) Whenever possible, μ_m and μ put zero probability on y or x for which the observed bid is a strictly dominated strategy.

These conditions are simpler than they might appear. The first says the following. Take an SE and calculate the raider's expected profits in equilibrium as a function of y. Call this function $\pi(y)$. For each bid that the raider makes with zero probability in equilibrium, calculate the sequentially rational strategies for the manager and stockholders given this bid when the bid leads them to infer that $y \in Y'$ for some $Y' \subseteq Y$.[7] Calculate the expected profits of the raider given this response to the off the equilibrium path belief. If it turns out that the set of y for which these profits are strictly larger than $\pi(y)$ is exactly Y', then this particular inference "should" be made by the manager and stockholders when this bid is observed. But if so, the strategy of the raider is not optimal and so this should not be considered an equilibrium. The interpretation of the second condition is analogous. The third condition simply says that, if another explanation exists, one should not infer that a player chose a strictly dominated strategy.

[7] Of course, there may be many sets of sequentially rational strategies for these players. We only require that $\tilde{\sigma}^0, \tilde{\sigma}^1$ and $\tilde{\sigma}_m, \tilde{b}^1$ be one of these.

Proof of Proposition 2

Case I: b^0 does satisfy $\mathrm{E}[x \mid b^0, n, x \geq h(b^0)] \geq b^0$. If the manager urges acceptance when $x < h(b^0)$ and urges rejection without a repurchase attempt otherwise, the manager's payoff is $h(b^0)$ in the first case and is x in the second case because the raider's attempted takeover fails. This latter fact follows from Proposition 1.

To see that no manager type prefers to imitate another manager type, simply notice that a manager of type $x < h(b^0)$ who imitates a type $x \geq h(b^0)$ is worse off as his payoff to blocking the takeover is lower than his payoff to urging acceptance. Similarly, for a manager of type $x \geq h(b^0)$, urging acceptance yields a lower payoff.

To complete this portion of the proof, we must show that no manager type prefers to deviate to an off–the–equilibrium path action—urge rejection and make a repurchase bid. To do so, we must complete the description of the equilibrium by adding the stockholders beliefs. Along the equilibrium path, they must satisfy Bayes' rule and so are simply the conditional distributions given the manager's strategy and the raider's bid. We assign the following off–the–equilibrium path beliefs: if a repurchase bid is made, the stockholders infer that the set of manager types is the set $\tilde{X} = \{x : x_\kappa \geq h(b^0) \text{ and } x < h(b^0), \text{ or } x_\kappa > x \text{ and } x \geq h(b^0)\}$, and compute the conditional distribution based on this assumption. Notice that membership to this set requires that $x_\kappa > x$ which requires that $x > b^1$. The stockholders' sequentially rational response to this belief is to tender no shares to the manager because they believe that the manager is trying to purchase shares for less than they are worth. If the takeover succeeds, then no manager type $x < h(b^0)$ prefers this deviation because there is a small cost associated with making a repurchase bid. No manager type $x \geq h(b^0)$ prefers this deviation because their payoff falls from x to $h(b^0)$. If the takeover fails, then no manager of type $x < h(b^0)$ prefers this deviation because they receive x rather than $h(b^0)$ and no manager type $x \geq h(b^0)$ prefers this deviation because he receives x in either case. Hence, we have a sequential equilibrium.

To show that this satisfies our definition of equilibrium, we must also show that the beliefs satisfy conditions (3b) and (3c). To see this, note that for each $X' \subseteq X$, either the stockholders respond in such a way that they tender shares to the manager or they don't and the takeover succeeds or it fails. If they respond by tendering shares and the takeover succeeds, as shown in the previous paragraph, no manager is better off so that X' cannot equal this set. If they respond by not tendering and the takeover succeeds it is again the case that no manager is better off. If they respond by not tendering and the takeover fails, no manager type $x < h(b^0)$ is better off because he receives x rather than $h(b^0)$ and no manager type $x \geq h(b^0)$ is better off because there is a small cost to making the repurchase bid. Finally, if they respond by tendering and the takeover fails, the set of manager types who are better off depends on the repurchase bid b^1. If

x_κ exceeds the manager type's equilibrium payoff, then this manager type is better off. Therefore, the set that would prefer to deviate is exactly $\tilde{X}$ but as explained above, the stockholders' optimal response is to not tender to the manager. Hence, in this case, we again satisfy conditions (3b). Finally, we must have the stockholders' beliefs place zero probability on those types for which the observed action is strictly dominated by another action. Just above, it was shown that $\tilde{X}$ is the set of manager types that prefers to deviate and repurchase shares if the stockholders tender those shares and the raid fails. Hence, the proposed deviation cannot be a dominated strategy for these manager types. Thus, we have shown that if b^0 satisfies $\mathrm{E}[x \mid b^0, n, x \geq h(b^0)] \geq b^0$, then the manager's equilibrium strategy is to urge acceptance if $x < h(b^0)$ and to urge rejection without a repurchase attempt otherwise.

Case II: b^0 does not satisfy $\mathrm{E}[x \mid b^0, n, x \geq h(b^0)] \geq b^0$. The manager's strategy requires that if $x \geq \gamma b^*(b^0) + (1-\gamma)h(b^0)$ and if there is a b^* which satisfies

$$b^* \geq x^e(b^0, n, b^*) \geq x^e_\kappa(b^0, n, b^*) \geq b^0, \tag{3}$$

then the manager urges rejection and makes a repurchase bid of b^*. By Proposition 1, his payoff is x_κ because he succeeds in blocking the takeover. If either condition fails, the manager urges acceptance and his equilibrium payoff is $h(b^0)$.

Case IIa. Suppose that there is no bid that satisfies equation (3). In this case all managers must prefer to urge acceptance and so every deviation is to an off–the equilibrium path action. If the stockholders observe the manager simply urging rejection, we assign them the belief that $x \geq h(b^0)$. With this belief, Proposition 1 implies that observing n without a repurchase attempt leads to a successful takeover since b^0 does not satisfy $\mathrm{E}[x \mid b^0, n, x \geq h(b^0)] \geq b^0$. Hence no manager type prefer this deviation because the manager prefers to leave the firm after urging acceptance rather than leaving the firm after urging rejection. If the stockholders observe a deviation to urging rejection with a repurchase bid, we assign the beliefs that $x \in \tilde{X}$ and the arguments above show that there are no manager types that prefer to deviate in this way.

Again, we must show that the beliefs satisfy conditions (3b) and (3c). That (3c) is satisfied is clear from the fact that the stockholders could choose to tender shares to the manager or choose to not tender enough shares to the raider depending on which action would increase the payoff to the relevant set of manager types that the stockholders' off–the–equilibrium path beliefs are concentrated on. That the latter beliefs, $x \in \tilde{X}$ if n and a repurchase bid is made, satisfy (3b) follows from the argument made above. That the belief that $x \geq h(b^0)$ when n and no repurchase attempt is made also satisfies (3b) can be seen as follows. If the takeover succeeds, no manager type is better off so that the set that prefer to deviate cannot be the set beliefs are concentrated on. If the takeover fails, the types that prefer to deviate are exactly $x \geq h(b^0)$. However, if this is the set of types the stockholders concentrate their beliefs on, Proposition 1 implies that the stockholders' optimal actions result in a successful takeover because we are in the case where b^0 does not satisfy $\mathrm{E}[x \mid b^0, n, x \geq h(b^0)] \geq b^0$.

Case IIb. Suppose that equation (3) is satisfied. In this case, the manager's equilibrium strategy is to urge acceptance if $x < \gamma b^*(b^0) + (1-\gamma)h(b^0)$ and to urge rejection and make a repurchase bid of b^* otherwise. We must show that no manager type wishes to deviate to an alternative strategy. As explained in the text, it is immediate by the construction of the strategies that no manager type prefers to deviate to an on–the–equilibrium path action. It is left to show that none prefer to deviate to an off–the–equilibrium path action. The relevant actions are to urge rejection without a repurchase attempt or to attempt the repurchase at a different price.

Suppose that the stockholders observe that the manager has urged rejection without a repurchase attempt. Assume that their beliefs in this event are that $x \geq h(b^0)$. Proposition 1 implies that since b^0 does not satisfy $\mathrm{E}[x \mid b^0, n, x \geq h(b^0)] \geq b^0$, the stockholders' optimal actions result in a successful takeover. Thus, no manager type $x < \gamma b^*(b^0) + (1-\gamma)h(b^0)$ prefers this deviation since he leaves the firm either way. The definition of b^* ensures that $x \geq \gamma b^*(b^0) + (1-\gamma)h(b^0)$ which implies $x \geq h(b^0)$ so that no manager that is attempting a repurchase in equilibrium prefers to deviate either.

Now, suppose that the stockholders have observed that the manager has urged rejection and made a repurchase attempt at some bid $b' \neq b^*$. In this event, assume that the stockholders beliefs are concentrated on the set $X'(b') = \{x : x \geq \gamma b' + (1-\gamma)h(b^0)\}$. The definition of b^* ensures that when $b' < b^*$, the necessary condition in Proposition 1 to have the stockholders defeat the takeover attempt is violated. Hence, no manager type prefers this deviation because he either continues to leave the firm but now after urging rejection and incurring the cost of a repurchase attempt or leaves the firm when he would not have and receives $h(b^0)$ rather than the larger value $x \geq \gamma b^*(b^0) + (1-\gamma)h(b^0) > h(b^0)$. If $b' > b^*$, equation (1) guarantees that the takeover attempt fails. This means that no manager prefers this deviation either because they $h(b^0) > x_\kappa(b')$ or because they continue to defeat the takeover but at a higher cost.

Again, we must show that conditions (3b) and (3c) are satisfied. With arguments similar to those used above, (3c) is straightforward. To show that (3b) is satisfied, first consider the deviation to n without a repurchase attempt. Either the takeover succeeds or it does not. In the former case, the argument in the previous paragraph showed that no set of manager types preferred this deviation. In the latter case, the manager types $x \geq h(b^0)$ prefer the deviation.[8] If the stockholders were to concentrate their beliefs on this set, the fact that Proposition 1 and the assumption that b^0 does not satisfy $\mathrm{E}[x \mid b^0, n, x \geq h(b^0)] \geq b^0$, ensure that the stockholders' optimal response results in a successful takeover. Hence (3b) is satisfied for this deviation.

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[8] Note that if the equilibrium strategy for the manager is to repurchase shares, $x = x_\kappa$.

If the deviation is to n and a repurchase bid $b' \neq b^*$, We must deal with four possibilities—either shares are tendered to the manager or they are not and either the takeover succeeds or it fails. The first possibility is that the manager does not acquire shares and the takeover succeeds. The argument in the previous paragraph shows that there is no set the stockholders can concentrate their beliefs on so that when they choose optimally given this belief, the set of manager types that prefer the deviation is the original set the stockholders' beliefs were concentrated on. The second possibility is that no shares are tendered to the manager and the takeover fails. In this case, manager types $x \geq h(b^0)$ prefer to deviate. Again, the argument in the previous paragraph suffices. The third possibility is that shares are tendered to the manager and the takeover succeeds. Since the takeover succeeds, the set that prefer this deviation is the same as the set that preferred it when no shares were tendered and the takeover succeeded. The final possibility is that shares are tendered to the manager and the takeover fails. In this case, the set of manager types that prefer to deviate is $\tilde{X}(b') = \{x : x_\kappa(b') \geq h(b^0)$ and $x < \gamma b^* + (1-\gamma)h(b^0)$, or $x_\kappa(b') > x = x_\kappa(b^*)$ and $x \geq \gamma b^* + (1-\gamma)h(b^0)\}$. By the construction of b^* and Proposition 1, any $b' < b^*$ results in a successful takeover which means that the outcome—shares tendered to the manager and a defeated takeover must be supported by beliefs concentrated on some set other than $\tilde{X}(b')$. If $b' > b^*$, the set that prefer to deviate is the set for whom the bid price is less than x and $x_\kappa(b')$ exceeds their equilibrium payoff. The former condition immediately implies that the stockholders' optimal response when beliefs are concentrated on this set is to not tender shares to the manager. Again, this means that the outcome, shares tendered to the manager and a defeated takeover require that beliefs be concentrated on some other set. Consequently, we have shown that the beliefs satisfy condition (3b).

Uniqueness. The discussion in the text has shown that the manager either blocks the takeover through a repurchase or by simply urging rejection but not both. This fact, together with the requirement that Bayes' rule be satisfied on the equilibrium path means that we must only show that there is no other repurchase bid that can be made as part of an equilibrium. To see that no lower bid can be made follows from the discussion in the text which showed that $b^*(b^0)$ was the smallest repurchase bid that could block the takeover.

To show this, we will rely on our consistency conditions. Suppose that a repurchase bid $b' > b^*(b^0)$ is an equilibrium. We know that the set of manager types making such a bid is $x \geq \gamma b' + (1-\gamma)h(b^0)$ while the others choose to urge acceptance. To show that such an situation cannot be an equilibrium, consider a deviation to $b^*(b^0)$. If the stockholders respond in such a way that the takeover is still defeated, then the following manager types would wish to make this deviation. The managers for whom $x \geq \gamma b' + (1-\gamma)h(b^0)$ because either they repurchase shares for even less than they are worth ($x \geq b'$) or pay a smaller premium for the shares ($b' > x \geq \gamma b' + (1-\gamma)h(b^0)$). Further, any manager type $\gamma b' + (1-\gamma)h(b^0) > x \geq \gamma b^*(b^0) + (1-\gamma)h(b^0)$ switches from urging acceptance to urging rejection and making a repurchase at $b^*(b^0)$ and is better off due to the last inequality. No other manager type deviates to this bid. Notice that the set that prefer this bid is the set $x \geq \gamma b^*(b^0) + (1-\gamma)h(b^0)$ so that if the stockholders concentrate their beliefs on this set, they respond by not tendering to the raider. Hence, the conjectured equilibrium does not satisfy our consistency conditions. ▌

Proof of Proposition 4

Suppose not, then $y' > y$ but $b' \equiv b^0(y') < b^0(y) \equiv b$. Let $Y = b^{0^{-1}}(b^0(y))$ and $Y' = b^{0^{-1}}(b^0(y'))$ represent the sets of raider types that bid b and b' respectively, and let the conditional probability of a successful takeover at the bid made by the set of raider types Z, for a raider of type z (not necessarily in Z) be $P(Z \mid z)$. In equilibrium, no member of one set must prefer the bid made by a member of the other or,

(B1) $$P(Y \mid y)(y-b) \geq P(Y' \mid y)(y-b')$$

and

(B2). $$P(Y' \mid y')(y'-b') \geq P(Y \mid y')(y'-b)$$

These can be rewritten as

(B3) $$(1-\lambda)y + \lambda b' \geq b \geq (1-\lambda')y' + \lambda' b',$$

where $\lambda \equiv \frac{P(Y'|y)}{P(Y|y)}$ and $\lambda' \equiv \frac{P(Y'|y')}{P(Y|y')}$. Since $b' < b$, equation (B1) implies that

(B4). $$P(Y \mid y) > P(Y' \mid y)$$

First, consider the case where $\lambda' \leq \lambda$. Since a raider type's equilibrium bid must be smaller than his type, $\lambda' \leq \lambda$ implies that

$$(1-\lambda)y' + \lambda b' < (1-\lambda')y' + \lambda' b',$$

while $y < y'$ implies that

$$(1-\lambda)y + \lambda b' < (1-\lambda)y' + \lambda b'.$$

Together, these imply

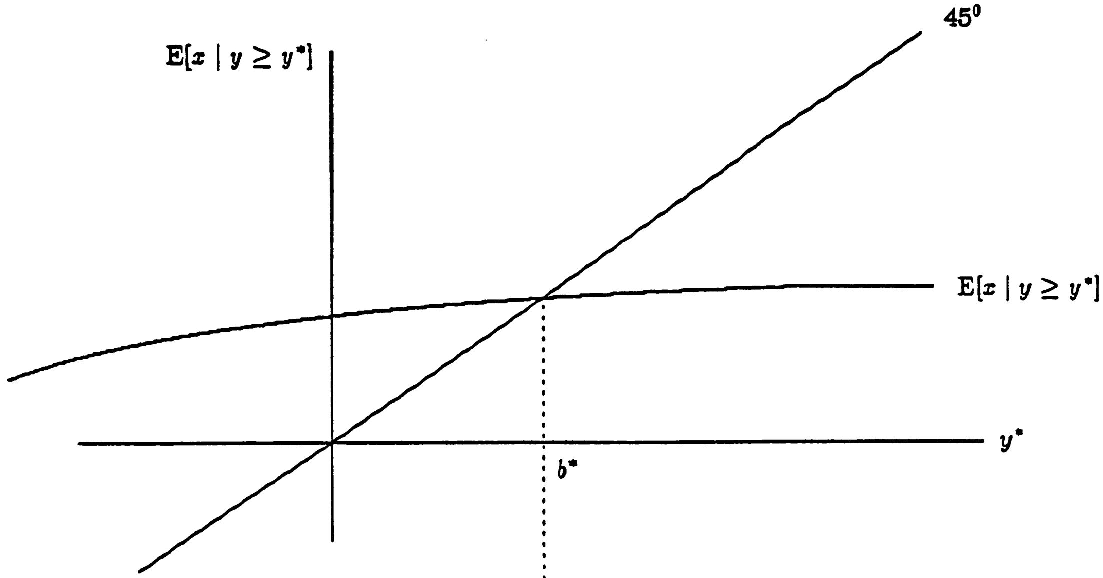
$$(1-\lambda)y + \lambda b' < (1-\lambda')y' + \lambda' b',$$

which contradicts equation (B3). As a result, $\lambda' > \lambda$.

So, suppose that $\lambda' > \lambda$ and recall that the conditional probability of success, $P(Z \mid z) = \text{Prob}[x \leq x^*(Z) \mid y = z]$, where $x^*(Z)$ is the critical value of x such that a manager of type $x \leq x^*(Z)$ urges acceptance of the raider's bid. Milgrom has shown that the MLRP condition implies that $P(Z \mid y') > P(Z \mid y)$ for any $x^*(Z) \in X$. This fact and $\lambda' > \lambda$ require that $x^*(Y') > x^*(Y)$.[9] This last fact implies that $P(Y' \mid y) > P(Y \mid y)$ which contradicts equation B4. Hence, we have shown that the equilibrium bid function b^0 is weakly monotonically increasing. ▌

[9] This is readily verified by contradiction.

FIGURE 1



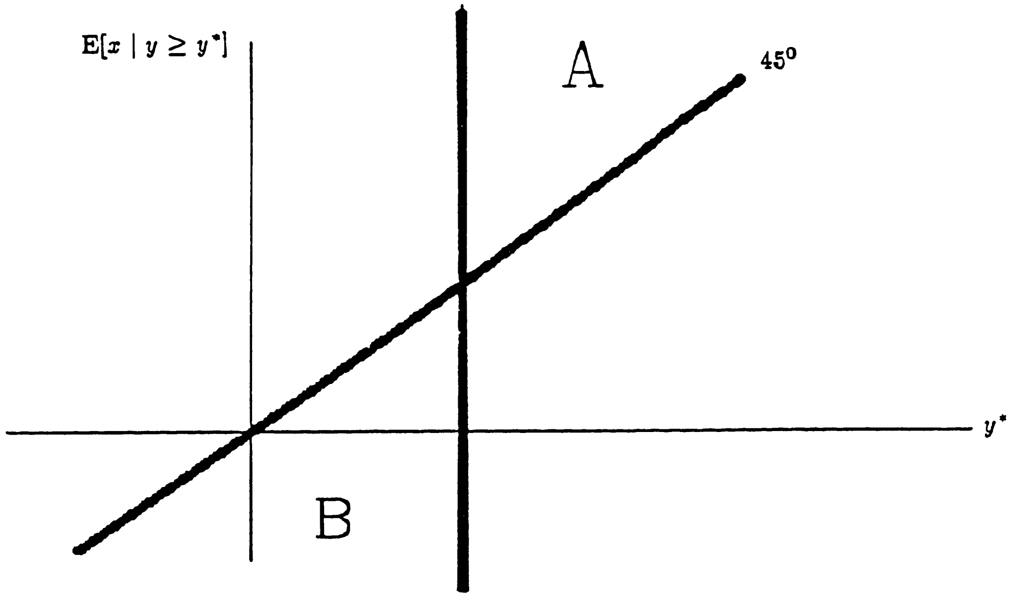
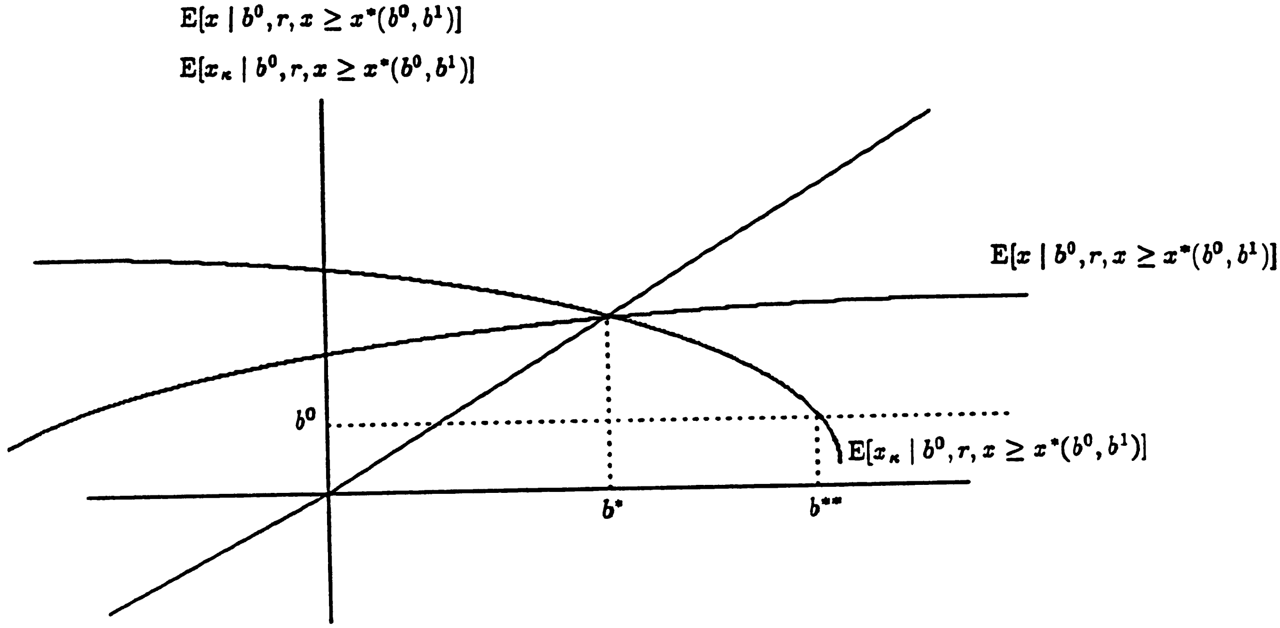


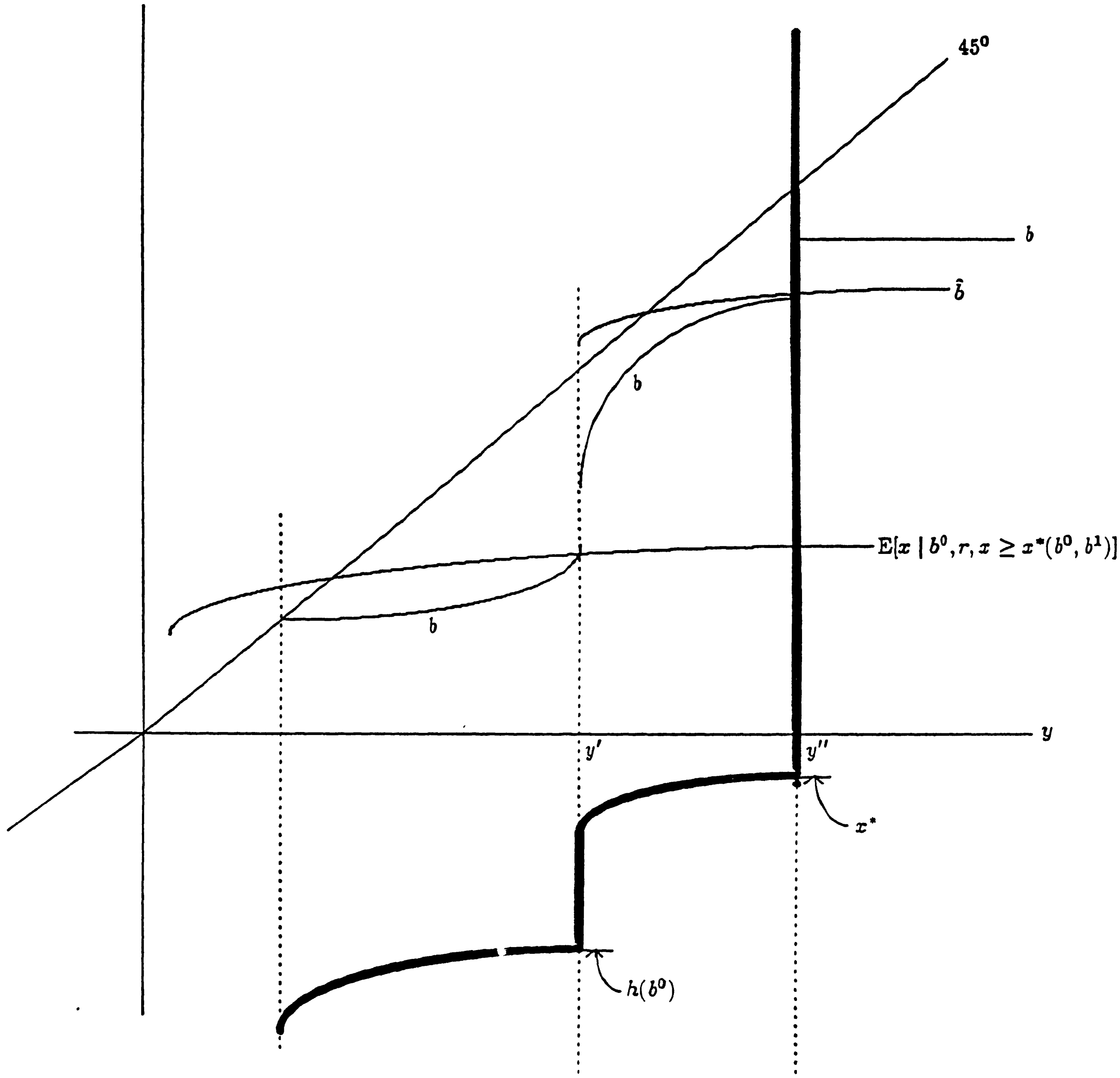
FIGURE 2



$E[x \mid b^0, r, x \geq x^*(b^0, b^1)]$
$E[x_\kappa \mid b^0, r, x \geq x^*(b^0, b^1)]$
$E[x \mid b^0, r, x \geq x^*(b^0, b^1)]$
b^0
$E[x_\kappa \mid b^0, r, x \geq x^*(b^0, b^1)]$
b^*
b^{**}

FIGURE 3

FIGURE 4



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