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CROSS–OWNERSHIP AND TAKEOVER DETERRENCE

by

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ABSTRACT

Firms having significant shareholdings in one another is not an unusual phenomenon in countries where the law admits such ownership arrangements, like Sweden and Japan. In this paper the role of cross–ownership as means for deterring takeovers is examined in the framework of a simple two–firm, two–period model with raiders, differing with respect to their valuation of a potential target, turning up randomly.

The paper argues the following points: If cross–ownership increases managerial influence — the consequences for the shareholders depend on the probability that the firm would have received a tender offer in absence of cross–ownership and managers benefit from it up to a point but their gains are negatively related to the their ability to resist takeover attempts.

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1 Introduction

There has been an ongoing debate about ownership issues in Sweden in recent years, spurred, perhaps, by some conspicuous "affairs" that have shaken the stock exchange. In particular, it appears that cross–ownership has caught the eye of many critics. According to the folklore, intertwined ownership structures increase managerial power to the detriment of shareholders.

Recognizing that managers may not always merely be benevolent servants to shareholders but rather can be expected to act in their own self–interest, separation of ownership and control can present a problem from the shareholders' point of view whenever managerial incentives do not coincide with owner interests. This issue was first raised by Berle and Means (1932).

Several authors, notably Jensen, e.g. Jensen (1986), emphasize the significance of agency problems in large corporations. In this context, dispersed ownership structures have been pointed out as being especially prone to suffer from problems of this type. The existence of a market for corporate control has been argued to be one of the most important safeguards against managerial malpractice and conspicuous executive perquisites. The fear of a hostile takeover is thought to to have a considerable disciplining effect on managers. Therefore, it seem as if shareholders to a larger extent are at the mercy of corporate managers, if the market for corporate control is impaired.

However, cross–ownership also has its proponents, some of whom do not seem to dispute the folklore logic but rather view a strengthened defense against takeovers, in particular foreign, as a goal in itself. Some industrialists and officials have expressed concern over the increased exposure to the European market for corporate control, that may follow an accommodation to European legislation concerning foreign ownership.

In the "formal", in Williamson's (1989) terminology, principal agent literature the focus is on the risk sharing problem. In that context, takeovers

can enhance efficiency to the extent that raiders contribute information that can be used to more accurately evaluate risk averse managers' performance and thus reduce their risk exposure. Hence, it is conceivable that takeovers can economize on resources spent on monitoring, provided that information is more cheaply available to raiders than to owners. Scharfstein (1988) examines the "disciplining" effect of takeovers where raiders contribute information within a principal agent framework.

This paper is not concerned with the risk sharing problem. It studies under what circumstances a deterring effect of cross–stockholdings may be beneficial to shareholders despite increased managerial influence. In section 2.1 I present a simple two–period model where managerial compensation contracts are negotiated in the first period after which production takes place and the proceeds are divided among the shareholders in the crosswise ownership structure. In section 2.2 a stylized market for corporate control is introduced so that in the second period the firm is either taken over by a corporate raider or conducting business as usual. Finally, the assumption that managerial influence increases with cross–stockholdings is added in section 2.3.

2 The Model

2.1 Cross–Ownership

The ownership concept refers to a set of claims that either an individual or an institution has on some asset. In the principal agent literature ownership is often analytically dichotomized into claims on returns from an asset and the right to control its use. Such rights are frequently bundled together in a one to one relation in shares, although there are also shares with differential voting power.

In most large corporations managers have full discretion in controlling the day to day operation of the firm, even though formally superior control rests with the board of directors as the representatives of the shareholders. One of the duties of the board is to design managerial incentive contracts. The contracts are chosen to optimize the board's objectives. Disregarding the intricate issue of how to most appropriately model the relative influence of different shareholders on the board of directors it is here simply assumed that the objective function of the board is a weighted average of the owners' preferences, the weights being the fraction of the shares held by the different shareholders.

A firm may hold equity positions in other companies which in turn, have minority shareholdings in the first company. This type of intertwined ownership relation is henceforth referred to as "cross–ownership".

Consider two identical firms, firm A and firm B, with incumbent management and a body of atomistic shareholders, where A holds a fraction β of B's shares and B owns α in A. The pair (α,β) can be said to define an ownership structure. The return on the firm's production in the second period is r_a, which after deduction of supernormal executive remuneration, I_a, i.e. compensation above the reservation level, yields the profit

(1) $\pi_a = r_a - I_a$

Managers are assumed to have utility functions that are linear in income. Furthermore, in order to attract anybody to a managerial position in the firm the offered contracts must keep the agents on or above their reservation utility, which is normalized to 0. The expected utility of an agent accepting the contract is given by

(2) $U_a = I_a$

The proceeds are distributed to shareholders in the form of dividends. Cross–ownership complicates matters slightly in the sense that a share in A not simply represents a claim on the returns generated by facilities originally associated with firm A but rather a claim on a mixture of the proceeds of the A and B facilities. However, these payoff claims can be sorted out, with not too arduous calculations (Wärneryd 1988), and profit streams assigned to final owners. In the two firm case the payoff accruing to the individual shareholders of A is

(3) $\Pi_a = \frac{1-\alpha}{1-\alpha\beta}(\pi_a+\beta\pi_b)$

2.2 Introducing a market for corporate control

In this section a simple representation of a market for corporate control is introduced. In the second period either production takes place as before or the firm is presented with a tender offer. The latter event occurs with some probability that may depend on the business opportunities that happen to prevail at the time, the number of skilled entrepreneurs that might come up with ideas about how to restructure the firm to enhance its profitability.

If the view that takeovers are motivated by real synergies, as opposed to e.g. merely being a reflection of hubris on the part of management in the raiding firm, is adopted, then these transactions creates a surplus that is to be shared between the target and the raider. The outcome of the division depends on the bargaining power of the parties. According to the Grossman and Hart (1980) argument shareholders would have incentives to free ride on each other

and not tender their shares in order to get the capital gains following a takeover. In absence of "dilution", i.e. activities by which a raider after a takeover can obtain benefits or transfers from the firm not available to other shareholders, these must exceed the value of the offer if it to profitable for the raider to launch a tender offer in the first place. Hence, tender offers would never succeed. However, takeovers do occur, whether it is due to dilution or some other reason.

If raiders totally lack bargaining power the discussion about potential benefits generated by managerial resistance, white knights lose much of its interest. The approach followed here, is to assume that there is plenty of room for improving the bargaining power of the shareholders and seek to determine if and when cross–ownership may be of any significance in this respect. Arguments can be made for shareholders having relatively weak bargaining power.[2]

Given that shareholders have weak bargaining power and are able to secure only a small part of the gap between the raiders reservation price and the "market valuation" of the firm, then encouraging managerial entrenchment may constitute a means for improving shareholder bargaining position and the expected return on their assets. Assuming that a succesful takeover involves the immediate replacement of top management, generously paid managers would be more reluctant to accept a tender offer uncontested than executives that receive ther reservation wage. Managers would be prepared to spend an amount equal to the difference in monetary terms between remaining in charge and being fired on fending off the offer. Raiders are assumed to be restricted to offering a uniform price for the shares. Whereas raiders have to earn a positive rent on every share they acquire, and therefore would prefer to buy all the shares in the target company, managers only have

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[2]This rests on the assumption that the shareholders are willing to sell to any price above the present one. This could be motivated by arguing that all shareholders can be made pivotal in a cleverly constructed tender offer and therefore do not have any opportunity to free ride. See Bagnoli and Lippman (1987) for a formal development of this argument. For the argument to go through it seems that we have to assume away the possibility of side payments by managers to shareholder, to persuade at least one not to accept the offer.

to convince fifty percent of the shareholders to turn down the bid. Hence the money spent on resistance is highly levered, i.e. with factor two. Managerial resistance may thus bring some benefits to the shareholders, provided that the value of the improved bargaining position outweighs the cost of managerial compensation and the reduced frequency of takeovers.

This would be true for any ownership structure. A crucial assumption in this model is that cross–stockholdings magnifies the deterring effect of managerial resistance. In particular, cross–ownership is assumed to increase managers ability to contest tender offers by giving them an edge compared to managers in firms without cross–ownership in that it suffices for them to convince an even smaller fraction, $0.5-\alpha$, of the shareholders not to accept the offer to be able to continue business as usual. This is the same as assuming that the shares held by the other firm will not be tendered unless a takeover is unavoidable. The resources available for resistance are most efficiently spent as premiums, bribes or some other financial settlement that is infinitesimally better than the raider's offer directed at the smallest proportion of shareholders necessary to fend off the offer. The more vigorous the resistance the higher the threshold price that must be exceeded to overcome it and the lower the probability of a successful takeover occurring.

Abstracting from the determinants of how likely a firm is to be targeted the probability of the firm remaining independent can be described by a distribution function G(k) where the variable k is the lowest tender offer that would be accepted by the shareholders.[3] Corresponding to G(k) there is a density function g(k) that is assumed to be twice continuously differentiable.

A potential raider will choose to make a tender offer if a takeover appears to be an attractive venture at the price k. Hence, 1–G(k) can be interpreted as the probability that a sufficiently talented raider stumbles over the firm or that a potential raider happens to make a very fortunate draw from an urn containing restructuring ideas of varying quality or that the state of nature

[3]No notational distinction is made between the particular value of the argument in the distribution function that represent the lowest acceptable offer and the argument itself since the meaning should be obvious from the context.

changes and creates potential synergies that can be realized through a merger.[4]

However, if the raider has some initial holdings in the firm, the proceeds from a takeover would include capital gains in addition to any gain on the purchased shares. Due to the increase in share value following a successful tender offer it is clearly advantageous to acquire as large holdings as possible before making the offer.[5] This complication will be disregarded in the model as the intuitive effect of initial holdings is straightforward.

Four events are conceivable in the second period two of which are symmetric. First, there might not be any successful tender offers in the period, second, a single offer directed at one of the two firms may materialize and finally, both firms can receive simultaneous offers. The distributions describing the probability of each of the firms to be taken over are assumed to be independent.

The ex ante value of managing firm A is denoted H_a, and is a probability weighted sum of the payoffs associated with the four possible events. The utility from conducting business as usual is U_a. If the other firm is raided the crosswise ownership pattern is dissolved, but managers remain in their positions and receive their contractual compensation never–the–less. In case of a successful takeover managers lose their positions and end up with a lower utility, which is normalized to zero. The magnitude of the utility gap can be influenced by factors such as the importance of undesirable reputation effects following removal from top management and the size of potential golden parachutes. The expected managerial payoff is

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[4]To some extent G(k) gives an indication of the competence of the incumbent management relative to other potential management teams. It is not a clear cut relationship since k is determined by both the value of holding a share in the firm, taking into account the probability of the firm being taken over, and the magnitude of the premium above this value in case of a tender offer being launched. The size of the premium is assumed to depend on the degree of managerial resistance. Thus, a high G(k) might reflect managerial entrenchment as well as managerial competence.

[5]There is usually a limit to how much stock a raider can purchase before having to disclose the purchases. In the U.S. the limit is set to 5% by the Williams act of 1967 as compared to 10% for Sweden.

(4) $H_a = G_aG_bU_a + G_a(1-G_b)U_a = G_aU_a$

which must be greater than or equal to zero to satisfy the individual rationality constraint.

In order to determine the equilibrium cost of taking over a firm the payoffs of the owners must be examined first. The payoff accruing to the shareholders of A in each of the four different events can be summarized in an expression very resemblant of (3)

(5) $\Pi_{aij} = \frac{1-\alpha}{1-\alpha\beta}(x_i + x_j)$

where $x_i \in \{\pi_a, k_a\}$, $x_j \in \{\pi_b, k_b\}$ and $i,j \in \{1,2\}$, which denotes the first and the second element in the sets, depending on if takeovers occurred or not. Now, an expression for k_a can be calculated. A tender offer presents A's stockholders with the choice between entering π_a or k_a in place of x_a in their payoff and thus their reservation price is π_a. To this amount should be added the resources spent on fending of the offer. That is, to make an offer successful the raider has to offer the value of the asset in productive use to current shareholders plus a premium on all shares at least as high as the maximum bribe when divided on the fraction $0.5-\alpha$ of the shares.

$$\frac{1-\alpha}{1-\alpha\beta}k_a = \frac{1-\alpha}{1-\alpha\beta}\pi_a + \frac{1-\alpha}{0.5-\alpha}U_a$$

thus,

(6) $k_a = \pi_a + \frac{1-\alpha\beta}{0.5-\alpha}U_a$

The expected value of aggregate individual stockholdings in firm A, V_a, is a probability weighted average of the payoffs in the different states given by (5). Using (6) and a corresponding expression for k_b yields

(7) $V_a = \Pi_a + \frac{1-\alpha}{0.5-\alpha}(1-G_a)U_a + \frac{1-\alpha}{0.5-\beta}(1-G_b)U_b$

Shareholders in firm A wish to choose a compensation level for managers such

that the value of their shares is maximized. The maximand for this problem is thus

(8) $L_a = V_a + \lambda_a H_a$

Differentiating expression (8) with respect to I_a yields the following first order condition.

(9) $\frac{dL_a}{dI_a} = [-\frac{1-\alpha}{1-\alpha\beta} - g_a U_a \frac{1-\alpha}{0.5-\alpha}\frac{dk_a}{dI_a} + (1-G_a)\frac{1-\alpha}{0.5-\alpha}] + \lambda_a[g_a U_a \frac{dk_a}{dI_a} + G_a] = 0$

An examination of the Lagrange multiplier, λ_a, shows if and when the constraint may be relaxed.

(10) $\lambda_a = \frac{\frac{1-\alpha}{0.5-\alpha}[g_a U_a \frac{dk_a}{dI_a} + G_a - \frac{0.5+\alpha-\alpha\beta}{1-\alpha\beta}]}{g_a U_a \frac{dk_a}{dI_a} + G_a}$

Since, the denominator is strictly positive, the sign of (10) is determined by the numerator. If $\lambda_a > 0$, then U_a is equal to zero, and the numerator simply states that the marginal cost of increasing remuneration is not outweighed by the marginal benefits that may be obtained in terms of an increased k.

It should be noted that it is not obvious that points which satisfy the first order condition, when the constraint is relaxed, are maximum points. The optimality of the solution depends critically on the properties of the probability distribution, G. However, it is sufficient that the distribution is such that the maximand is concave. The requirement is essentially that g' must not be too negative. This does not mean that it has to be positive, for instance, any exponential distribution will guarantee a maximum.[6] In proceeding the analysis it is assumed that the probability distribution posesses the desired properties.

In this section, where managers are assumed to have no influence over contract design, cross–ownership cannot be harmful to shareholders by

[6]This is discussed more thoroughly in appendix A.

definition. In this context cross–stockholdings simply provide shareholders with the option to take advantage of a relatively more efficient mechanism, compared to a situation without cross–ownership, to improve their bargaining power in case of takeover attempt. Hitherto, the ownership structure has been regarded as exogenous. Suppose that this restriction was to be relaxed. Then it would obviously be the case that in the region where the first–order condition yields solutions that gives managers their reservation utility, shareholders would wish to increase the degree of cross–stockholdings.[7]

When it comes to managers, at first is may seem plausible that they would always benefit from inereases in cross–stockholdings, however, this need not be the case. The reason why increases in α may yield a reduction of managerial compensation is that owners face a trade off between bargaining power and probability of receiving a tender offer. An increased α means a better leverage in managerial resistance but can reduce the probability of receiving an offer too much which must be compensated by lowering executive remuneration. Thus, managers would be better off if they were somewhat less able to contest takeover attempts.

Concerning the deterring effect of cross–ownership it can be said that as long as the effect on compensation is positive so is the deterring effect, and in a symmetric specification, where $\alpha=\beta$, it can be shown that for $\alpha\leq 0.234$ the effect on k_a is positive regardless of the level of compensation to managers.

2.3 Managerial influence

Assuming that cross–stockholdings really gives rise to increased managerial influence, in what way would this change the analysis? First, a mechanism that relates executive influence to the degree of cross–stockholdings is introduced. Second, a few results corresponding to the ones in the previous section are derived and compared with those.

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[7]For a more thorough discussion see section B of appendix.

Managerial influence is assumed to work through the board of directors. More specifically, when a firm holds stock in other companies the top management is assumed to be entrusted the responsibility to represent the firms' interests on the boards of those companies.

Recognizing that managers in one firm may exert some influence over the employment contract of managers in other firms suggests that executives in companies with intertwined ownership at least have incentives to collude. Managers are assumed to take full advantage of the opportunity to improve their lot by agreeing to represent one another rather than pursuing the interests of the shareholders in the board of the other firm. In this way managers are able to obtain some indirect owner–control over their own firm and thus have some say in the design of their own contracts. It should be kept in mind that in this model control only refers to influence over the design of the contract.

Given the assumptions made about the boards of directors, it is the case that whereas payoffs are entirely divided among shareholders this is not the case when it comes to control. Thus, as cross–wise relations become more pronounced owner–control, i.e. voting rights, is gradually transferred from shareholders to managers even though all residual claims still rest with the shareholders. The objective function of the board is now composed of both owner and manager preferences

$$(11)\quad \max L_a = (1-\alpha)\Pi_a + \alpha U_b + \lambda_a U_a$$

which, taking into account that managers are assumed to collude, is equivalent to

$$(11')\qquad (1-\alpha)\Pi_a + \alpha U_a + \lambda_a U_a$$

Differentiating (11') with respect to I_a yields

$$(12)\quad \frac{dL_a}{dI_a} = \frac{(1-\alpha)^2}{0.5-\alpha}\left[\frac{0.5+\alpha-\alpha\beta}{1-\alpha\beta} - g_a U_a \frac{dk_a}{dI_a} - G_a\right] + (\alpha+\lambda_a)\left[g_a U_a \frac{dk_a}{dI_a} + G_a\right] = 0$$

from which λ_a is derived

$$(13)\quad \lambda_a = \frac{\frac{1}{0.5-\alpha}\left[(1-2.5\alpha+2\alpha^2)g_a U_a \frac{dk_a}{dI_a} + G_a - (1-\alpha)^2\frac{0.5+\alpha-\alpha\beta}{1-\alpha\beta}\right]}{g_a U_a \frac{dk_a}{dI_a} + G_a}$$

In the slightly modified problem in this section the requirement on the probability distribution, in order for the first order conditon to yield a unique maximum, is essentially the same as in the last section save for a factor without significance.

In the precence of managerial influence it seems plausible that cross–ownership structure could be detrimental to shareholder wealth. If this is the case it would be of interest to characterize under what circumstances can improvements in bargaining power be expected to outweigh the disadvantage of increased managerial influence.

A brief examination of the symmetric case with identical firms, equal crosswise shareholdings and equal probabilities of receiving tender offers yields that both outcomes ar possible. In absence of cross–ownership the shareholders' bargaining power vis–á–vis a raider is null and shareholder wealth is $V^0=\pi^0$, whereas when cross–ownership is present shareholder wealth is given by V. Hence, the potential benefits of cross–ownership can be expressed as

$$(14)\quad V-V^0 = \pi - \pi^0 + 2\,\frac{1-\alpha}{0.5-\alpha}(1-G)U$$

where $\pi-\pi^0$ equals minus U. Setting (14) equal to zero and plotting the shareholders' points of indifference with respect to ownership structre, i.e. the alphas and Gs that satisfy this condition, yields a graph "starting" in (0.75,0) above which shareholders benefit from cross–ownership and below which they would do equally well or better without it. Doing likewise with equation (13) a graph, depicting the border between the reservation level region and the positive compensation region, is obtained.

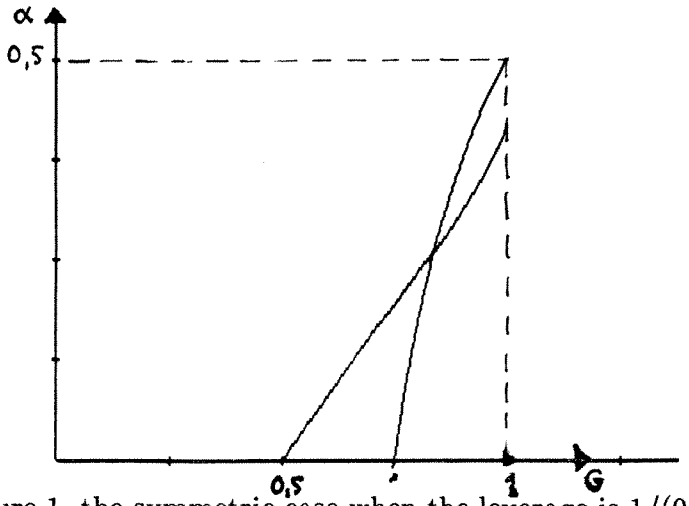

Figure 1, the symmetric case when the leverage is $1/(0.5-\alpha)$.

Below the graph beginning in (0.5,0) managerial compensation is held at reservation level and shareholder wealth is not affected. Above this region but below the other graph cross–ownership reduce shareholder wealth.

How would the analysis be affected if managerial bargaining power was weaker than what has been assumed? Maintaining the assumption that the ability to contest tender offers increase with the degree of cross–ownership the leverage factor, $1/(0.5-\alpha)$ is changed to $1/(1-\alpha)$. This amounts to assuming that managers are alomost in the same position as raiders and have to spend their resources on all shareholders, except for the fraction α held by the other firm. Deriving the equivalents of equations (13) and (14) allows us to draw the counterpart of Figure 1.

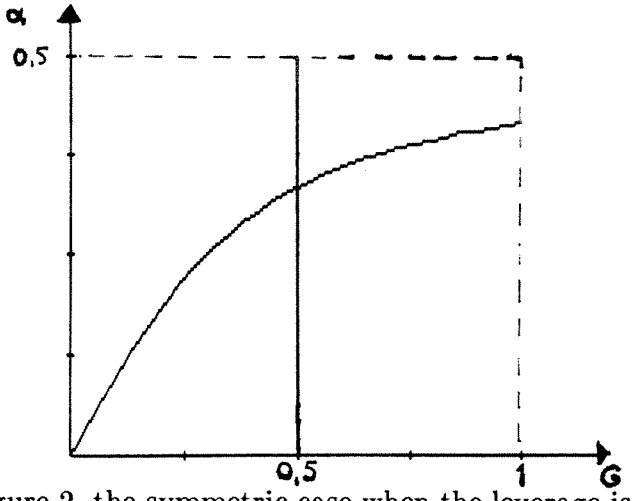

Figure 2, the symmetric case when the leverage is $1/(1-\alpha)$.

As in fiure 1 the board would find it optimal to keep the remuneration level as low as possible below the curve whereas it is profitable to offer more generous contracts to the left, or above, the curve. On the G=0.5 line shareholders are indifferent with respect to changes in managerial compensation. That is, whenever G is greater than 0.5 and the individual rationality constraint is slack (If $\lambda \geq 0$ then $V-V^0$ is of course zero.) cross–ownership the is a burden to the shareholders. In the symmetric case discussed here this would require that $\alpha \geq 1/3$. In the region to the right of this line and above the curve cross–ownership is harmful to shareholders.

3 Conclusions

The environment of the firm in terms of the probability of the firm being taken over and the shape of the probability distribution of tender offers as a function of the equilibrium price, k, determines the effects of an intertwined ownership structure on the company.

Concerning the effect of cross–ownership on shareholder wealth the intuition is quite straightforward, if a company is likely to be taken over improvements in bargaining power are valuable and owners may find it worthwhile to improve executive compensation, provided that there is no superior way of improving their bargaining position in case of a tender offer.

Conversely a low probability of a tender offer will tend to keep agents on their reservation utility. If that is not the case due to a high degree of cross–ownership, i.e. assuming that managers excert some influence over contract design, chances are that the managerial benefits are obtained at the expense of shareholders

An increasing degree of cross–ownership is not unambiguosly favourable from an executive perspective. If the lever for fending off tender offers is too powerful further increases in cross–stockholdings will result in a lower compensation to managers.

Appendix A

The second derivative of the maximand is given by

$$(A1)\quad \frac{1-\alpha}{0.5-\alpha}\left[-g'U_a\left(\frac{dk_a}{dI_a}\right)^2 - 2g\frac{dk_a}{dI_a}\right]$$

and the second derivative of the constraint is

$$(A2)\quad g'U_a\left(\frac{dk_a}{dI_a}\right)^2 + 2g\frac{dk_a}{dI_a}$$

and will thus have the opposite sign. Should the maximand be concave this is enough to ensure a unique maximum in this model despite the fact that this yields a convex constraint. This follows from that the constraint "starts" from zero and then is strictly increasing in compensation and thus the objective function is maximized over a convex set. Since the maximand is assumed to be greater or equal to zero when paying the reservation wage to managers there exists an equilibrium and it is unique.

It can easily be verified that an exponential distribution will yield a maximum. Suppressing the firm index, let

$$(A3)\quad g = \frac{1}{m}e^{-k/m}$$

then,

$$(A4)\quad g' = -\frac{1}{m^2}e^{-k/m}$$

where m is a parameter determining the width of the distribution. First, not that as long as λ_a is strictly positive (A1) is negative. Thus, it suffices to show that (A1) greater than or equal to zero implies a strictly positive λ_a. Second, inserting (A3) and (A4) into (A1) yields

$$(A1')\quad \frac{e^{-k/m}}{m}\left[\frac{U_a}{m}\frac{dk_a}{dI_a} - 2\right]\frac{dk_a}{dI_a}$$

where the first term within the brackets must be greater than two to disrupt concavity. Third, analogous insertion into the first–order condition gives us

$$(A6) \quad \frac{e^{-k/m}\left[\frac{U}{m}\frac{dk_a}{dI_a} - 1\right] + \frac{0.5-\alpha}{1-\alpha\beta}}{e^{-k/m}\left[\frac{U_a dk_a}{m\, dI_a} - 1\right] + 1}$$

Recalling that $\frac{U_a dk_a}{m\, dI_a}$ was required to exceed two it is obvious that λ_a is greater than zero, which concludes the verification.

Appendix B (Preliminary and incomplete)

Does increased cross–ownership monotonically increase deterrence? Up to a certain point the deterrence effect can be expected to increase with cross–ownership but as the leverage of managerial resistance becomes stonger a good bargaining position can be bought with less executive compensation which in turn improves the return of the firm and to determine the effect of α on k definition ( ) is differentiated

$$(\ ) \quad k_a = \pi_a - \frac{1-\alpha\beta}{0.5-\alpha} U_a = 0$$

$$(\ ) \quad \frac{dk_a}{d\alpha} = \frac{0.5+\alpha(1-\beta)}{0.5-\alpha}\frac{dI_a}{d\alpha} + \frac{1-0.5\beta}{(0.5-\alpha)^2}U_a$$

$$(\ ) \quad \frac{dk_a}{d\beta} = \frac{0.5+\alpha(1-\beta)}{0.5-\alpha}\frac{dI_a}{d\beta} + \frac{\alpha}{(0.5-\alpha)^2}U_a$$

where $\frac{dI_a}{d\alpha}$ can be obtained by taking the total differential of the first order condition and using the implicit function theorem.

$$(\ ) \quad \frac{dI_a}{d\alpha} = -\frac{\frac{\partial L_i}{\partial \alpha}}{\frac{\partial L_i}{\partial I_a}} = \frac{\frac{1-0.5\beta}{(1-\alpha\beta)^2} - \frac{1-0.5\beta}{(0.5-\alpha)^2}U_a(g'U_a\frac{dk_a}{dI_a} + 2g)}{g'U_a\frac{dk_a}{dI_a} + 2g}$$

which can be either positive or negative depending on the level of supernormal compensation to managers, U_a. At the border, $\lambda_a=0$, it is trivially positive, unless α equals 0.5.

$$(\ )\ \frac{dI_a}{d\beta} = -\frac{\frac{\partial L_i}{\partial \beta}}{\frac{\partial L_i}{\partial I_a}} = -\frac{\frac{\alpha(0.5-\alpha)}{(1-\alpha\beta)^2} - \frac{\alpha}{(0.5-\alpha)^2}U_a\left(g'U_a\frac{dk_a}{dI_a} + 2g\right)}{g'U_a\frac{dk_a}{dI_a} + 2g}$$

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