CAPITAL STRUCTURE AND TAKEOVER DEFENCES

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ABSTRACT

In this paper we show how the signalling effect of debt described by Ross (1977) does not work in an environment of hostile takeovers. This is because the effect of debt is to concentrate voting rights in the hands of the incumbent management, "jamming" the signal and preventing any value-enhancing takeover. We show that this leads to higher debt levels, underinvestment and inefficiency. We show how poison pills, by removing the threat of takeover, can restore the signalling function of debt and increase investment and efficiency. We obtain a large range of predictions about capital structure and takeovers in line with the US experience in the 1980s, and also discuss the relevance of takeover defences for the present takeover wave.

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I. INTRODUCTION

The takeover wave of the 1980s saw a vast array of different defences employed against hostile takeovers, as incumbent managers sought to protect their control rights against tender offers by hostile bidders. At the same time the capital structure of most large US corporations also changed radically, with many firms taking on considerable extra amounts of debt, or "leverage". In this paper we study the joint effect of debt and anti-takeover devices, arguing that the traditional signalling role of debt is "jammed" by the fact that debt makes a firm less likely to be taken over. We show how takeover defences can actually increase efficiency by restoring this signalling function. We obtain a large range of empirical predictions which broadly concur with the movement in capital structure and takeover patterns in the 1980s. Our results may also have relevance to the current wave of takeovers, notably in Continental Europe, where hostile takeovers, previously rare, have become more common. So far, anti-takeover devices are not used there, but we see a possible role for them in the future [1].

The 1980s takeovers were part of the 4th major merger wave to sweep the US in the 20th century. What was different to most previous mergers was the considerable number of hostile takeovers, where corporate "raiders" made tender offers to shareholders against the wishes of a firm's incumbent management. This in turn led to a variety of defensive measures used by management to resist such takeover attempts. Some of the more exotic defences included the payment of "greenmail", "Pac-man defences", and most commonly, "poison pill" provisions. All these tactics were designed to make a hostile takeover extremely difficult, and are generally conceded to have been highly effective in their deterrence function. However, many economists, such as Jensen (1983), feel such techniques actually harmed economic efficiency by

allowing potentially inefficient managers to entrench themselves and thus prevent value-enhancing takeovers. Empirical studies such as Rynagaert (1988) tend to document a slight reduction in firm value when an anti-takeover mechanism is adopted. However, there have been very few theoretical analyses of the impact of takeover defences on the wider question of their effect on economic efficiency.

We argue that a focus on takeover defences in isolation is incomplete, and that their impact should be studied in tandem with the overall capital structure of the firm. This is because capital structure itself affects the probability of successfully resisting takeovers; a higher debt level concentrates existing shares and voting rights in the hands of incumbent management and thus makes them harder to displace. This effect has been studied by Stulz (1988) and Harris and Raviv (1988) [2]. However, this effect of debt has never been studied in concert with the more standard effects of higher leverage, such as the signalling model of Ross (1977) and Myers and Majluf (1984). In these models, firms of high quality signal their type by taking on more debt and thus exposing themselves to a higher risk of bankruptcy, but also allowing them to be correctly valued by the stock market. But when debt has the simultaneous effect of preventing low quality firms being taken over, then the signal is "jammed", and the effect of debt may be indeterminate.

Using an adverse-selection based signalling model we show that when both effects of debt are considered simultaneously, then a separating equilibrium is less likely to exist, and that, if one does exist, it will imply higher debt levels than if there were no threat of takeover. We also find a large number of pooling equilibria can exist and, crucially, that the overall effect of takeovers on investment and economic efficiency can be negative. We then consider how other forms of takeover defences - for which

we use "poison pills" as a typical example - can actually improve the situation and, contrary to previous papers, potentially lead to enhanced efficiency. This is because the use of non-debt based takeover defences removes the defensive function of debt, and allows the original signalling effect of debt to be restored. This permits stock markets to correctly value firms, and also reduces the overall debt level of the economy. Some of the predictions we obtain include:

(1) High takeover probability leads to higher debt levels as long as no "poison pill" devices are allowed.

(2) Without poison pills, there will be underinvestment by existing firms.

(3) Introducing poison pills lowers debt levels and increases investment. The adoption of a poison pill may lower an individual firm's value, but this is simply because it reveals that a firm is of low quality.

(4) The effect of an increase in debt on firm value is ambiguous when there is no poison pill, but is positive when there is also a poison pill.

The original paper on the signalling effect of debt was by Ross (1977). He showed how, in a hidden type model, high quality firms took on more debt to show their type; a somewhat different version of which was developed by Myers and Majluf (1984). Both of these models predicted that a rise in debt levels would lead to a rise in firm value, a prediction which seemed in line with most empirical evidence. The possibility of pooling equilibria, where firms of different quality took on the same amount of debt, was ruled out by the use of the "intuitive criterion" of Cho and Kreps (1987), thus allowing the signalling function to work smoothly. Then, in the 1980s, when management teams were faced with the prospect of hostile takeover, economists pointed out how the debt financed stock repurchases so common at the time served to

concentrate shares and votes in the hands of the management, giving them a greater chance of fighting off a takeover. This could have a potentially negative affect on firm value, a point that seemed to have some empirical support in the mid-to-late 1980s. However, they did not analyse how this anti-takeover effect of debt modified the signalling effect.

The study of other forms of anti-takeover devices has predominantly being empirical, focusing on the impact of takeover defences on firm value. One defence frequently studied is a device known as a "poison pill", which exists in a number of forms, but basically drastically reduces the value of a firm that is taken over against the management's wishes [3]. This reduction in value is presumed to deter any potential raider from attempting to take control of the firm. The key point about a poison pill is that it is adopted purely by the management, and does *not* require shareholder approval. This is similar to debt increases; an advantage of our model is that it portrays decisions being taken by the managerial team rather than a large, diverse group of shareholders [4].

The majority of empirical studies have found that firms with poison pills are rarely successfully taken over by a hostile raider [5], but also document a statistically significant fall in firm value on the announcement of the poison pill adoption. Some economists have claimed that this is evidence of entrenching inefficient management and thus argue that poison pills should be outlawed [6]. However, what is striking is that this fall is, on average, only about 2% of firm value, considerably less than the average premium of over 20% paid when a takeover occurs. We show that this is because the adoption of a pill does not necessarily signal an inefficient manager, and may enable efficient investment to take place. So while a poison pill may protect some poor

managers, its very availability may allow good firms to signal their quality, and its availability also should lower debt levels. We suggest that the widespread adoption of poison pills towards the end of the 1980s helped stop the takeover wave, and also helped to lower debt levels in the US.

The paper is organised as follows: section 2 sets up the basic signalling model and the role for debt. Section 3 shows how the presence of takeover threats wrecks the signalling process, cuts investment and raises debt levels. Section 4 then analyses how poison pills allow debt to have its familiar signalling role back. Section 5 concludes.

II. MODEL STRUCTURE

We start by considering a version of the Ross model; there are two types of firm, high quality firms and low quality firms, respectively denoted as H and L. The firm is publicly owned, with the shares owned by: (a) a risk-neutral managerial team which controls a fraction, α, of the firm's shares, and (b) a large group of "fringe" shareholders, who between them own the remaining group of shares. These fringe shareholders can own large blocks of shares, as is the case with pension funds, but they are assumed to be uninterested in obtaining control of the corporation. Each share entitles the owner to a share of profits and a voting right. The firm's quality is known only to the managerial team; the stock market is incapable of distinguishing between the two types and assumes the ex ante probability of the firm being type H is β. Both types of firm wish to finance a new investment project which we assume that the firm cannot fund out of retained earnings, thus forcing it to go the market for new capital. We also assume that the net present value (NPV) of the project is positive for type H

firms and negative for type L firms. We assume that the expected NPV for a project financed by a firm of unknown quality is negative. In the absence of any way of knowing the type of each firm, the market will not finance the project, and we will be left with inefficient underinvestment because of the familiar adverse selection problem. We denote this cost of underinvestment as F.

Now consider extending the framework to two periods. In the first period the management of the firm has the option of issuing debt, the level of which we denote as D. Following Ross, we assume that the utility function of the management depends upon the value of the managerial holdings plus the benefits of control they enjoy. After having the option to issue debt in the first period, the firm earns profits in the second period. We assume these are continuously distributed according to some density function f(.) over the interval [0,a] for firm H and [0,b] for firm L. We assume that a is greater than b, and that the mean earnings for H are greater than for L. At the end of the second period, after earnings are realised, the firm must pay off its debt. If it does not do so then control passes to the bondholders. This loss of control is assumed to be costly to the managerial team, and we denote this loss of utility as B [7]. Given the debt level taken on by a firm, we can denote the probability of bankruptcy as $\theta(D)$. This allows us to write the managerial utility function as:

$$U_m = \alpha V - \theta B \qquad (1)$$

The key assumption we make is analogous to the well-known "single crossing" condition; that $\theta_H(D) < \theta_L(D)$ for all levels of D. This reflects the extra efficiency of type H as compared to type L. We now look for a separating equilibrium where the two types of firm take on different levels of debt. Given debt levels, we need two

conditions to hold: (A) type H will not want to imitate type L; (B) type L will not want to imitate type H. These conditions can be formalised as:

$$\alpha L - \theta_H(D_L)\, B \leq \alpha H - \theta_H(D_H)\, B \tag{2}$$

$$\alpha H - \theta_L(D_H)\, B \leq \alpha L - \theta_L(D_L)\, B \tag{3}$$

These conditions describe a continuum of debt values where firm H takes on a higher debt level than firm L, and is recognised as being of high quality. The problem of a multiplicity of equilibria is overcome by use of Cho and Kreps's (1987) "intutitive criterion" which eliminates all separating equilibria except for the most natural one, where type H takes on the minimum level of debt required to identify it, while type L takes on no debt at all. There are also pooling equilibria where both firms take on the same levels of debt, but again, the intuitive criterion can be shown to eliminate these. We summarise these results in Lemma 1:

Lemma 1: The unique equilibrium is where type L takes on no debt, while type H takes on a level defined by expression (3) holding with equality.

Proof: See appendix.

This implies that firms who finance investment with debt are of high quality, meaning that a rise in debt levels should be associated with a raise in firm value. It negates the adverse selection discussed earlier; high quality firms distinguish themselves and thus are financed, while low quality firms are prevented from engaging in negative NPV projects. Here, debt's signalling function is clear. The effect on social efficiency is not completely clear; the gain F is balanced by the possible social costs of bankruptcy, which we denote as Z. Here the expected social bankruptcy costs are

$\beta\theta_H(D_H)Z$. However, most of the literature accepts that these costs are less than the costs of mis-valuation, and we make the same assumption here.

III. SIGNALLING WITH TAKEOVERS

Now we modify the model to allow for the possibility of a hostile takeover attempt. We assume that at the end of period 1, after any debt has been taken on, but before any earnings are realised, a raider makes a takeover bid, which costs c, for the firm. If the takeover bid is successful, the manager suffers the same loss of control benefits, B, as if the firm had gone into bankruptcy. We assume that the raider is always of type H; implying that she is capable of increasing efficiency in firms of type L but not of type H. This means that only low quality firms are in danger of being taken over; this tallies with the evidence in Morck, Shleifer and Vishny (1988), who found that firms perceived by the market to be performing "poorly" were likely to be subject to a takeover attempt [8]. If an offer is made, then the result will depend upon whether sufficient shareholders tender to the raider. Debtholders have no voting rights, so as discussed by Harris and Raviv, the more debt in a company's capital structure, the greater share of votes the management has, and the more likely they are to be able to fight off a takeover. We model this by writing the probability of a successful takeover as $\lambda(c,D)$. Here λ takes on values in the interval [0,1], and is assumed to be decreasing in the cost of takeover. We assume that the majority of the fringe shareholders will tender to the raider, knowing that she is likely to raise the value of the firm. But the higher the managerial share of the voting rights, the more likely it is that management will successfully prevent control from passing to the raider. And as the debt level

increases the share of voting rights of the management also increases, and this implies a lower probability of a successful takeover attempt [9]. Thus λ is decreasing in D. Note that although the share of voting rights is greater, α, the share of the actual value of the firm is not changed - the managerial team owns a greater proportion of the equity, but the equity value has fallen as the debt value has risen, leaving the overall value unchanged.

Now consider the signalling problems faced by both types of firm. Before, debt had been unambiguously costly for both firms, but *relatively* less costly for firm H, and it was this which permitted type H to take on more debt than type L. Now, taking on debt may actually be beneficial for type L, by permitting it to avoid being taken over. Consequently, this may jam the signalling mechanism and prevent a clear signal being sent. We can rewrite equations (2) and (3) as:

$$\alpha L - \theta_H(D_L)B \leq \alpha H - \theta_H(D_H)B \tag{4}$$

$$\alpha H - \theta_L(D_H)B \leq \alpha[\lambda(D_L)H + (1 - \lambda(D_L))L] - [1 - \lambda(D_L)]\theta_L(D_L)B - \lambda(D_L)B \tag{5}$$

The decision facing type H has not changed, as it has no fear of being taken over. But equation (5), analogous to equation (3) in the case without takeovers, is very different. The left-hand side of the inequality, the payoff from imitating type H is the same, but the right-hand side adds two different effects. The first is the potential benefit from being taken over to the wealth of the managerial team. The higher λ is the more likely they are to be taken over, and the higher α is, the greater the effect on their wealth. Thus, the higher the debt level, the less likely the managers are to realise any wealth gain. The second effect is that being identified as type L means a higher probability of takeover and a consequent loss of control benefits. The manager must

trade off these effects when deciding what level of the signal (debt levels) to choose. But the single-crossing condition does not hold here; whether firm H or firm L is relatively hurt more by debt is unclear.

Looking at equation (5), we can rewrite it as the following:

$$\{\alpha H[1 - \lambda(D_L)] + \alpha L[\lambda(D_L) - 1]\}/B \leq \theta_L(D_H) - [1 - \lambda(D_L)]\theta_L(D_L) - \lambda(D_L) \qquad (6)$$

Here, we note that the left hand side is always positive. We cannot directly sign the right hand side, but we note that it will be negative if the following inequality holds:

$$\theta_L(D_H) - \theta_L(D_L) < \lambda(D_L)[1 - \theta_L(D_L)] \qquad (7)$$

The higher λ (the exogenous probability of takeover) is, the more likely inequality (7) is to hold, and the less likely a separating equilibrium will exist. This will lead to the inefficiency of the project not being financed. We can summarise our results in the following proposition:

Proposition 1: (i) For any positive value of λ, a separating equilibrium may not exist, and if it does, then the set of equilibria is smaller than there the set with no threat of takeover.

(ii) If a separating equilibrium does exist then inequalities (4) and (5) define a continuum of separating equilibria where type H takes on more debt than type L.

(iii) If λ rises, then the set of separating equilibria becomes smaller.

Proof: See appendix

It is important to emphasise that the intuitive criterion has no power here, and cannot refine away the multiplicity of equilibria. In terms of the effects of takeover on

efficiency, the overall effect is ambiguous. A separating equilibrium implies the correct level of investment, but takeovers have meant that this outcome is now less likely to occur. Against this is the possibility that type L firms are made more efficient by takeover; we note however that this is more likely when the levels of debt are low. In fact, there are a continuum of debt levels (D_L,D_H), and there is no particular reason to assume that the equilibrium played is one with a low set of debt levels. We note that there are conflicting private incentives to hold debt; the desire to avoid bankruptcy is balanced against the desire to avoid takeover. But the social incentives are for all to have low debt levels; it lowers bankruptcy costs and raises the probability of an efficient takeover. One effect we can be sure of is that, in a separating equilibrium, debt levels without takeovers will be lower than debt levels with takeovers.

Lemma 2: If a separating equilibrium exists, then the equilibrium level of debt for both types H and L will rise in λ.

Proof: See appendix.

This is in accordance with a very basic pattern observed in the 1980s - higher probabilities of takeover were linked with higher debt levels. Now, we turn to a consideration of pooling equilibria. In any such equilibrium both types of firm take on the same amount of debt, and are consequently assigned the same value by the market. To fully characterize any such equilibrium we need to specify the market's belief as to the firm's quality when they see an off-the equilibrium path level of debt. We state that if the market does not see the pooled level of debt, which we denote as D^*, then it

believes the firm is of type L. This will give us a pair of inequalities that need to be satisfied in equilibrium:

$$\alpha(\beta H + (1 - \beta)L) - \theta_H(D^*)B \geq \alpha L - \theta_H(D \neq D^*)B \tag{8}$$

$$\alpha(\beta H + (1 - \beta)L) - (1 - \lambda(D^*))\theta_L(D^*)B - \lambda(D^*)B \geq \alpha L - (1 - \lambda(D \neq D^*)\theta_L(D \neq D^*)B - \lambda(D \neq D^*)B \tag{9}$$

The first inequality refers to type H, which has no fear of takeover. The second inequality refers to type L. For type H, the best deviation from D* is clearly zero, implying that any debt level ranging from zero to some upper limit, which we call D_1 will satisfy the inequality. Because of the fear of takeover, the second inequality has to take into account potential deviations in both directions from the equilibrium, D*. We show in the appendix that, in fact, deviations to a greater level than D* are not optimal, leaving us to concentrate on deviations to a lower level of debt. We define this level of debt as D_2, and it is defined by $[\alpha\beta(H - L)]/B \geq \lambda(D^*) - \lambda(0) + (1 - \lambda(D^*)\theta_L(D^*)$. We can summarise this in the following lemma:

Lemma 3: There exists a continuum of pooling equilibria where both types of firm choose the same debt level, D. This continuum exists on the interval: $(0, \min(D_1, D_2)]$*

Proof: See appendix

An upper limit of debt exists, and this is given by either the bankruptcy probability of the type H firm, or the intensity of the takeover threat. It is important to emphasize that none of these equilibria are refined away by the intuitive criterion; again, the threat of takeover muddies the clarification of type deduced from an off-the-equilibrium path move [10]. This multiplicity of equilibria, both separating and pooling, has made an

attempt to signal one's type by debt vastly more complex. Pooling and separating equilibria co-exist and survive refinement by the intuitive criterion. When both types co-exist, the equilibrium that actually occurs will depend upon the beliefs of the market - if they are pooling beliefs, then we should see uniform debt levels across different types of firm in the same industry - a pattern that did seem to occur. We should also see a reduction of investment, as the inability of firms to signal their type prevents them from raising funds from new investment projects.

The overall effect of takeovers on efficiency in unclear, unless we make further assumptions. If no separating equilibrium exists, then there is a loss of F. There is also a bankruptcy cost of $[\beta\theta_H(D^*) + (1 - \beta)\theta_L(D^*)]Z$. This may be balanced by a gain in efficiency of $\lambda(D^*)[H - L]$. The higher D^* the greater the social loss. We would point out that this is not reflected in the private effect of debt; their F (an opportunity cost) is not taken into account If a separating equilibrium does exist, then there is no loss of F. But debt levels will be higher than before, and the social cost of the wave of bankruptcies that swept the US in the early 1990s is evidence of the potential cost of such high debt levels. One thing that is clear is that if the role of debt in protecting against takeovers could be taken away, social efficiency would improve.

IV. DEBT AND POISON PILLS

Having seen the problems a dual role for debt imply, we now consider how other forms of anti-takeover devices would function. As mentioned earlier, such devices have often being criticized by economists, arguing that they prevent value-enhancing takeovers from occurring. However, we how show how they, by making redundant the

takeover-preventing function of debt, can actually enhance efficiency. We consider the "poison-pill" provision as a typical form of an anti-takeover device, though it should be noted that almost any type of provision could be used. We focus on poison pills due to the frequency of their use during the 1980s, and the acknowledged power they have to prevent takeovers.

We now give the managers the choice, at the same time as they decide on their debt levels, of issuing a poison pill, which we denote as P. Either type of firm can issue P - the decision is in an "either-or" for both types of firm. We assume that if P is issued, then the threat of takeover is reduced to zero. This is a strong assumption, but seems to have a large degree of truth attached to it [11]. In any case, let us now analyse how this changes the type of equilibrium we are likely to observe.

First, we see that if P is adopted, there is no longer any threat of takeover. But of course there is the inference drawn by the market if they see that P was adopted. This inference is drawn from the joint signal of (a) whether P is adopted, and, (b) the debt level chosen by each type of firm. Again, we look for separating equilibrium, and prove in the appendix that the only two types of separating equilibrium are: (1) type H takes on P and a level of debt, D_H; type L takes on P and a level of debt $D_L < D_H$, (2) type H does not take on P, while type L takes on P. Both firms choose a debt level of zero. We summarise this in the following proposition.

Proposition 2: When firms choose P and their level of debt simultaneously, only two types of separating equilibrium exist: (i) Type H chooses (P, D_H) where D_H is obtained by setting $[\alpha\beta(H - L)]/B = \theta_H(D_H)$, and type L chooses (P,0); (ii) Type H chooses (NP,0) and type L chooses (P,0).

Proof: See appendix.

All other types of equilibrium are refined away by the intuitive criterion, including any pooling equilibria. The presence of a poison pill takes away the signal-jamming aspect of debt and allows the basic signal of quality to be restored. This leads to the correct level of investment, even though it does remove the possibility that a value-enhancing takeover will occur. It also leads to predictions that seem to bear a close correspondence to the events of the 1980s. Initially, as takeover intensity increased, debt levels rose in response. This led to a greater chance of actually fighting off takeovers, but had its own cost (generally a few years later) when a wave of corporate bankruptcies swept America. However, once defences such as poison pills were adopted, there was much greater protection against takeovers and we witnessed a huge decline in the number of successful takeovers. We also gradually witnessed a fall in debt levels to pre-takeover levels, as debt was restored to its original signalling role.

How does this fit in to the empirical literature on debt and takeover defences ? As mentioned in the introduction, there is evidence that the adoption of poison pills did lower firm value slightly. Looking at our equilibria, we note that while one equilibrium has only type L firms taking on P, which would imply a significant fall in value, we also see that in the other equilibrium, both types of firm take on P, which means that there would be no fall in value. We suggest that the modest fall in value is due to a cross-sectional sample which captured both types of equilibrium. We also note Datta and Datta's (1995) seemingly counter intuitive finding that firms with poison pills do not seem to take on a lower level of debt that firms without them. This pattern is preserved by both types of equilibrium; even though it might seem that poison pills render debt

unnecessary, the incentives to signal are such that taking on a poison pill does not mean one will have less debt than any other firm. In this specification of the model, an increase in debt levels should raise a firm's value; an effect which Datta and Datta also detect when a firm has a poison pill.

V. CONCLUSION

This paper has studied the impact of takeover defences and capital structure simultaneously. We found that the signalling role of debt is jammed in a takeover environment, potentially harming social efficiency. The use of takeover defences restored the signalling function and overcame the adverse selection problems associated with hidden type models. The model yielded a range of predictions in accord with the basic patterns seen in capital structure and the market for corporate control in the 1980s.

We expect that, as takeovers become more prevalent in Europe, firms will start using takeover defences such as poison pills. As such, we feel that our model may be of relevance there, particularly given the high use of debt in the "bank-based" financial systems. There is also some evidence that debt levels are rising again in the US as mergers and takeovers continue, and thus anti-takoever devices may will have a role to play in preserving the signalling function commonly associated with it.

APPENDIX

Proof of lemma 1: We first consider a separating equilibrium with $D_H > D_L$. If firm L takes on the debt level of firm H, then it signals itself as type H and its payoff is $\alpha H - \theta_L(D_H)B$. In order not to choose this, this must be less than or equal to the payoff of being seen as L, which is $\alpha L - \theta_L(D_H)B$. If firm H takes on D_L, its payoff is $\alpha L - \theta_H(D_L)B$, which must be less than or equal to the payoff from D_H, which is $\alpha H - \theta_H(D_H)B$. We note that if these two inequalities hold, type L's utility is highest when $D_L = 0$. We thus have a continuum of separating equilibria, but application of the weakly dominated strategies eliminates any level of D_H above the level where $[\alpha(H - L)]/B = \theta_L(D_H) - \theta L(0)$. This leaves us with a unique separating equilibrium

We can specify pooling equilibria with types H and L choosing a level of debt D*. Such equilibria are supported by out of equilibrium beliefs that assign a probability of 1 to the firm being of type L is any debt level other than D* is observed. Here, the best deviation is to choose D = 0, so for a pooling equilibrium we need $\alpha(\beta H + (1 - \beta)L) - \theta_L(D^*) \geq \alpha L$. This defines a continuum of pooling equilibrium. However, applying the intuitive criterion removes all these equilibria: suppose that at any equilibrium D*, the firm deviates from the equilibrium action and picks some debt level $D^* + \varepsilon$ (where $\varepsilon > 0$). This is equilibrium dominated for type L. So, after observing $D^* + \varepsilon$, the market should form the belief that the firm is of type H. And for ε small, type H should pick $D^* + \varepsilon$. Thus, this equilibrium does not satisfy the intuitive criterion. Q.E.D.

Proof of proposition 1: (i) Equation (6) defines an inequality required for a separating equilibrium to exist. We can rewrite it as:

$\{\alpha H[1 - \lambda(D_L)] + \alpha L[\lambda(D_L) - 1]\}/B \leq \theta_L(D_H) - \theta_L(D_L)[1 - \lambda(D_L)] - \lambda(D_L)$

When we compare this to equation (3), we can see that equation (3) will hold, and equation (6) will not hold when: $- \{\alpha\lambda(D_L)[L - H]\}/B - \lambda(D_L)[1 - \theta_L(D_L)] \leq 0$

For $\lambda > 0$, when we divide by $\lambda(D_L)$, this simplifies to: $\alpha(H - L)/B + \theta_L(D_L) - 1 \leq 0$.

But $\theta_L(D_L) \leq 1$, and $\alpha(H - L) > 0$, so this inequality is always satisfied. Thus, when λ is greater than zero, the set of separating equilibria is smaller than it was with no threat of takeover.

(ii) We want to rule out separating equilibria where $D_L > D_H$. We note from equation (5) that these are only possible if $\theta_L(D_L) > \theta_L(D_H) - \theta_L(D_H)\lambda(D_L) + \lambda(D_L)$. But we note that this is impossible as $\theta_L(D) < 1$. Thus any equilibrium will see type H taking on more debt that type L.

(iii) We want to see what happens when λ changes exogenously, possibly because of a fall in the cost of mounting takeover bids. Changing λ has no effect on equation (4), but does effect equation (5). We note that the derivative of the right hand side is equal to: $- \alpha(H - L)/B$, which is negative. We also note that the derivative of the left hand side is: $\theta_L(D_L) - 1$, which is also negative. However, by equation (3) we note that the absolute value $\theta_L(D_L) - 1$ is greater than $- \alpha(H - L)/B$. Thus a change in the value of λ decreases the set of parameter values that satisfy the inequality. Thus as λ rises, the set of separating equilibria becomes smaller. Q.E.D.

<u>Proof of lemma 2:</u> In the equilibrium without takeovers, D_L was equal to zero. Thus, with the possibility of takeovers, the new D_L must be at least as great as the previous D_L. When we examine equation (6), we see that the new D_H will be strictly greater than the D_H without takeovers when the following inequality holds:

$\alpha(H - L)/B + \lambda(D_L)\alpha(L - H)/B + \lambda(D_L) + \theta_L(D_L) - \lambda(D_L)\theta_L(D_L) < \theta_L(D_H)$

This is because the old D_H was given by $\alpha(H - L)/B = \theta_L(D_H)$. So we need:

$\lambda(D_L)\alpha(L - H)/B + \lambda(D_L) + \theta_L(D_L) - \lambda(D_L)\theta_L(D_L) > 0$.

We note that $\alpha(H - L)/B < 1$, by equation (2), and thus that $\lambda(D_L)[1 + \alpha(L - H)] > 0$. We also note that $\lambda \leq 1$, hence $\theta_L(D_L)[1 - \lambda(D_L)] > 0$. Therefore the whole expression is greater than zero, and debt levels in any separating equilibrium with takeovers are higher than they were without takeover threats. Q.E.D.

Proof of lemma 3: In order for a pooling equilibrium to exist where both firms choose D^*, the following inequality must hold for both types of firm:

$\alpha[\beta H + (1 - \beta)L) - (1 - \lambda(D^*))\theta(D^*)B - \lambda(D^*)B \geq \alpha L - (1 - \lambda(D{\neq}D^*))\theta(D{\neq}D^*)B - \lambda(D{\neq}D^*)B$. Let us consider possible deviations from D^*. First we consider deviations by type L. The best deviation to a level greater than D^* is to a level we call D_{max}, where λ is at a minimum. In this case, even if λ is reduced to zero, which is the best possible case, the inequality always holds as $- \lambda(D^*)\theta_L(D^*)$ will be negative . So a deviation to a debt level greater than D^* is not optimal. The best deviation to a level below D^* is to 0. Here the inequality reduces to: $\alpha\beta(H - L) \geq - \lambda(0) + \lambda(D^*) + (1 - \lambda(D^*))\theta_L(D^*)$. This defines a range of debt levels which satisfy the equilibrium condition which we denote as $(0,D_2]$, where D_2 is the highest level of D which satisfies the inequality. Now let us consider deviations by type H. Type H knows it will not be taken over, hence the inequality reduces to: $\alpha\beta(H - L) \geq \theta_H(D^*) - \theta_H(D{\neq}D^*)$. Again, the firm will not deviate to a level of $D > D^*$. If it deviates to 0, then the inequality becomes: $\alpha\beta(H - L) \geq \theta_H(D^*)$. This defines a range of debt levels which satisfy the equilibrium condition which we denote $(0,D_1]$, where D_1 satisfies the

inequality exactly. Thus, for a pooling equilibrium to exist, we see that there will be a continuum of equilibria in the range $(0, \min(D_1,D_2)]$. Q.E.D.

Proof of proposition 2: When we consider the simultaneous choice of debt levels and poison pills, we have a large number of potential separating equilibria. We denote D_H as being a higher debt level than D_L; P as having adopted a poison pill; NP as not having a poison pill. The list of potential candidates is:

#	Type H	Type L
1	(P,D_H)	(P,D_L)
2	(P,D_L)	(P,D_H)
3	(P,D_H)	(NP,D_L)
4	(P,D_L)	(NP,D_H)
5	(NP,D_H)	(P,D_L)
6	(NP,D_L)	(P,D_H)
7	(NP,D_H)	(NP,D_L)
8	(NP,D_L)	(NP,D_H)
9	(P,D_H)	(NP,D_H)
10	(P,D_L)	(NP,D_L)
11	(NP,D_H)	(P,D_H)
12	(NP,D_L)	(P,D_L)

Of these candidate equilibria, we can refine away the four where type H has a lower debt level than type L. Of the remainder, we note that in #3, type H will deviate to a lower debt level. In #5, the iteration of weakly dominated strategies would see type H

deviate to NP. In #7, neither firm has a poison pill, and although a separating equilibrium may exist, the same "signal-jamming" studied in the last section will exist. In #9, type L would deviate to a lower debt level. In #10, iteration of weakly dominated strategies would see type H deviate to NP. In #11, type L would deviate to a lower debt level. This only leaves #1 and #12. Both equilibria survive the intutive criterion, and are supported by beliefs that: for #1, assign a probability of 1 of the firm being type L if a debt level of D_H (exactly the same debt level as in section 2) and P is not observed. Under this belief structure, type L chooses a debt level of 0. For #2, the market assigns a belief of probability 1 that the firm is of type L if it observes a poison pill. Iteration of dominated strategies implies that both types of firm will choose debt levels of zero. Q.E.D.

ENDNOTES

1. The late 1990s has seen a massive revival in mergers, and a renewal of hostile takeover attempts, notably in Europe. At present, the largest hostile bid ever has been submitted by the British company Vodafone for the German company Mannesman. The latter is resisting the bid, but if their defence fails, the prospect of further hostile bids in Europe is likely.
2. A recent example was the projected takeover of the Italian firm Gucci by the French giant LVMH. On the announcement of the takeover bid, the Gucci management restricted the voting shares available by buying back shares and placing many of them in a trust. This effectively gave voting control to the current management and led to the abandonment of the bid..
3. For a description of the various types of poison pill and their specific effect, see Malatesta and Walkling (1988), and Ryngaert (1988).
4. The managerial team usually controls both capital structure and whether to adopt anti-takeover defences, and models which have the shareholders en masse choosing the debt level are correspondingly suspect.

5. Comment and Schwert (1995) discuss the effectiveness of poison pills. They do point out that the effectiveness of the poison pill may be used to extract a higher bid premium from the raider.

6. Poison pills have only being adopted in the US. In the UK, the only other country to previously experience a large wave of hostile takeovers, such devices were never used.

7. Gilson (1989) documents the costs to managers of losing control. The intensity of managerial struggles against hostile takeovers is in itself indicative of the benefits of control. Of course, changes in the US bankruptcy law in the 1980s may have affected the value of B.

8. Morck et al. in particular focused on the values of Tobin's q, finding that firms with low q values were typically takeover targets.

9. Obviously, if the management control over 50% of the shares, they will be secure against any hostile takeover. However, most economists agree that 20-25% is sufficient to win any vote over control.

10. Stein (1988) considers a model where takeover threats imply myopic behaviour. Like our model, he also finds pooling equilibria that are not refined away by the intuitive criterion.

11. The possibility that poison pills are used mainly to extract a higher bid - also referred to in Hershleifer and Titman (1990) - is not allowed in our model as we implicitly assume that the benefits of control are large enough for the managers to not want to tender even if offered an expected value of H for the company - the largest the raider would ever pay.

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