TRIGGERS AND PRIORITY: AN INTEGRATED MODEL OF THE EFFECTS OF BANKRUPTCY LAW ON OVERINVESTMENT AND UNDERINVESTMENT

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I. INTRODUCTION

A. *Limited Liability and Bankruptcy*

Limited liability is a cornerstone of corporate law. Given limited liability, bankruptcy rules are bound to be of some importance. Almost by definition—since equity owners cannot be held accountable for damages or other liabilities that exceed the value of the firm—limited liability implies some firms will be bankrupt with positive probability. This result will occur whether or not the firm explicitly contracts for debt, and is independent of any agency problems that may shape the relationships between firm managers and owners.

Bankruptcy law needs to address at least two issues: (1) distribution and (2) continuation. The distribution question arises because a typical insolvent firm has liabilities that exceed its (immediately liquid) assets. Thus, bankruptcy procedures must divide an insufficient pie among many competing claims. The continuation issue exists because a firm that is currently insolvent will not necessarily be unprofitable in the future. In other words, bankruptcy procedures need to sort among insolvent firms and hopefully promote the survival of efficient firms and the death of inefficient firms.

Many of the costs of bankruptcy result directly from the resolution of the distribution and continuation issues. As such, many reform proposals (e.g., the papers by Professor Adler[1] and Professors Aghion, Hart, and Moore[2] in this Symposium) seek to reduce these costs. The desirability of any

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1. Barry E. Adler, *A World Without Debt*, 72 WASH. U. L.Q. 811 (1994).
2. Philippe Aghion et al., *Improving Bankruptcy Procedure*, 72 WASH. U. L.Q. 849 (1994).

reform, however, is a function of how well current procedures function in fulfilling these goals. The paper by Professor White[3] in this Symposium directly addresses the ability of the two-track U.S. procedure (Chapter 11 for reorganization and Chapter 7 for liquidation) to solve the continuation question.

One historical motivation for limited liability, however, may have been to encourage entrepreneurs to take risks that they would not otherwise accept. In this sense limited liability itself is neither efficient nor inefficient; its relative efficiency depends on the kinds of investments that would be made under, for example, unlimited liability. Limited liability might be economically beneficial if it serves to overcome risk aversion, for example, and improves investment. But limited liability might also be harmful, for example, under the standard economic notion that markets enforce risk neutrality. In that case, unlimited liability would provide efficient incentives, and limited liability—since it leads to the externalization of some consequences of firm decisions—would provide inefficient incentives.

B. Limited Liability, Bankruptcy, and Investment: This Paper

While bankruptcy law serves two immediate purposes (resolving the distribution and continuation issues), the law also has larger implications for investment decisions, and thus the ultimate performance of the economy. This paper develops a simple model relating bankruptcy rules to firm investment choices in a limited liability regime. In particular, the distribution issue is ignored, and the continuation issue handled simply. This model focuses the analysis on one underlying question: Can bankruptcy law ameliorate the inefficient investment incentives possible under limited liability?

In particular, limited liability can induce "overinvestment"—firms choosing investments or projects that entail inefficiently excessive risk—as well as "underinvestment"—firms choosing not to undertake investments that promise net positive expected (social) returns. One goal of this paper is to generate a more integrated understanding of the causal relationship between underinvestment and overinvestment than is currently available in the literature. To achieve this goal, the paper develops a formal model of firm investment choice in which "underinvestment" and "overinvestment" are both endogenous possibilities, depending on the bankruptcy rules in place. The analysis facilitates a second goal, namely to evaluate currently

3. Michelle J. White, *Does Chapter 11 Save Inefficient Firms?*, 72 WASH. U. L.Q. 1319 (1994).

proposed reforms of bankruptcy law, and to provide a vehicle for commenting on several of the papers presented at this Conference.

In some respects the motivation of this analysis is similar to that of Professor Rasmussen's in this Symposium,[4] but the analysis here is significantly more general, and consequently less rich in detail. Specifically, in this paper two dimensions of investment are considered: (1) the firm's choice of capitalization or its capital-intensity of production (including the amount of capital invested in the firm, and the debt/equity mix); and (2) given the firm's choice of capitalization, its choice among alternative investment opportunities. Dimension (1) covers what is usually referred to as the "underinvestment" problem by characterizing the firm's endogenous choices of debt and equity capital. Dimension (2) covers what is usually referred to as the "overinvestment" problem by characterizing the use to which the firm applies any amount of capital.

Previous formal modeling of these issues has focused exclusively on dimension (2), with little or no formal analysis of firms' choices on dimension (1).[5] The connection between capitalization and investment choice is highlighted by the simple story in the model. Given any bankruptcy rule (which specifies the level of returns that trigger bankruptcy, the payoff to equity, and the priority of claims, including whether secured credit is allowed), imagine that the firm—i.e., the equityholders, since this analysis does not permit the managers' incentives to deviate from those of the owners'—makes two investment decisions. First, the firm chooses the amount of equity and debt capital that will be placed into the firm. This decision is the firm's choice on dimension (1). Then, given the initial capital investment, the firm chooses among a set of investment opportunities, each of which is described by a distribution over returns. This decision is the firm's choice on dimension (2).

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4. Robert K. Rasmussen, *The Ex Ante Effects of Bankruptcy Reform on Investment Incentives*, 72 WASH. U. L.Q. 1159 (1994). Many of the issues in this paper have also been discussed elsewhere; Professor Rasmussen, *supra*, provides a comprehensive review of the literature pertaining to the effects of bankruptcy law on investment decisions. *See also* Barry E. Adler, *Bankruptcy and Risk Allocation*, 77 CORNELL L. REV. 439 (1992); Robert Gertner & David Scharfstein, *A Theory of Workouts and the Effects of Reorganization Law*, 46 J. FIN. ECON. 1189 (1991); Thomas H. Jackson & Robert E. Scott, *On the Nature of Bankruptcy: An Essay on Bankruptcy Sharing and the Creditors' Bargain*, 75 VA. L. REV. 155 (1989); George G. Triantis, *A Theory of the Regulation of Debtor-in-Possession Financing*, 46 VAND. L. REV. 901 (1993).

5. In addition to the paper by Rasmussen in this Symposium, *supra* note 4, see Susan Rose-Ackerman, *Risk-Taking and Ruin: Bankruptcy and Investment Choice*, 20 J. LEGAL STUD. 277 (1991). *See also* Michelle J. White, *The Corporate Bankruptcy Decision*, J. ECON. PERSP., Spring 1989, at 129, 134. These papers, however, only consider the possibility of overinvestment (given an initial choice of capitalization), and, in contrast to this paper, do not allow capitalization to be endogenous.

C. *Overview of the Results*

Overinvestment occurs when the firm's initial choice of equity capital value allows it to externalize the risk implied by its investments. This result is purely an implication of limited liability, and, since managers have the same incentives as owners in this model, does not rely on agency problems. In particular, whenever the firm chooses an equity capital value that is, in aggregate, larger than the largest possible liability it may face, the firm is *undercapitalized* (dimension (1)). Under limited liability, undercapitalized firms externalize risk through overinvestment (dimension (2)).

A central conclusion of this paper is that this overinvestment problem is unlikely to be remedied by a simple, single-track bankruptcy law. Propositions 1 to 3 show that *no* bankruptcy rule that determines firm treatments only on the basis of a firm's current capital value and cash flow can reliably improve (or solve) the overinvestment problem, given that firms initially choose to be undercapitalized. Indeed, the relative efficiencies of such bankruptcy rules are shown to depend crucially on the assumed probabilistic nature of investment opportunities. A given rule might improve some firms' incentives while simultaneously diluting the incentives of other firms. In particular, this conclusion is true for rules incorporating "loss sharing" as discussed by Rasmussen, as well as rules reflecting elements of current reform proposals. Accordingly, one should treat with suspicion any "general" conclusions about the relative efficiency of properties of bankruptcy law such as "loss sharing."

Proposition 4 shows, however, that "two-track" procedures such as Chapter 11 and Chapter 7 can improve matters. By conditioning the bankruptcy rule on the actual investment decisions of the firm—for example, treating "inefficient" firms differently than "efficient" firms—incentives are created that encourage, but do not guarantee, first-best investment decisions. Beyond providing motivation and context for the paper in this Symposium by Professor White,[6] this result reinforces the bottom line: given that firms choose to be undercapitalized, no single bankruptcy rule is likely to overcome the overinvestment problem for all firms (and all distributions over investment returns). Here, the externalized risk can take the form of tort claims, environmental or other obligations to governments, or shortfalls in payments to creditors or workers.

The point here is not the particular incidence of the overinvestment

6. White, *supra* note 3.

problem, but its ubiquity: undercapitalized firms overinvest in risk of all kinds, no matter which bankruptcy rule is in place. The question to be answered, then, is *when* the firm chooses to be undercapitalized. Two possibilities are considered: (1) absolute priority for secured credit, and (2) absolute priority for torts (with no secured credit allowed). When there is no secured credit, absent tax advantages to debt, the firm is financed purely through equity. In that situation, Propositions 5 and 6 show that if the first-best capital choice—the capital value that maximizes productive efficiency—would leave the firm undercapitalized, then in equilibrium the firm underinvests: it invests strictly less than the first-best capital choice, and thus passes up capital investment opportunities that have positive expected net return. The tradeoff for the firm is that greater equity value implies more productive efficiency, but also greater liability for the downside of investments whenever the firm is undercapitalized. Hence, at least when the first-best capital choice would leave the firm undercapitalized, limited liability leads the firm to underinvest: the firm chooses strictly less than the first-best amount of legally recoverable, but physically productive, equity capital.

Otherwise, if the first-best capital choice would leave the firm fully capitalized, then the efficient capital level becomes one (but not the only) solution of the firm's capital choice problem. Proposition 7 shows that the first-best capital investment can be assured for all firms by awarding absolute priority to secured credit. Intuitively, this result follows because secured credit breaks the link between underinvestment in capital and overinvestment in risk. Once secured capital is awarded priority over all other risks, it drives out equity capital. The firm completely substitutes secured debt for equity. This remedies the underinvestment problem—since secured debt is not encumbered by liabilities that may result from investment downsides, the firm chooses the level of secured capital that maximizes productive efficiency—but exacerbates the overinvestment in risk. Because the firm substitutes secured debt for equity, it can fully externalize the downside risk of its investments. This process leads to maximal overinvestment in risk.

II. LIMITED LIABILITY, OVERINVESTMENT, AND BANKRUPTCY

This Part develops a mostly graphical approach to understanding the incentives introduced by limited liability, and the ability of bankruptcy law to ameliorate the resulting inefficiencies. As highlighted by the papers in this Symposium, however, bankruptcy procedures introduce potentially perverse incentives, which lead to another set of inefficiencies that may in

fact exacerbate the problems of limited liability. The graphical approach developed in this section provides a simple way to integrate these possible inefficiencies.

The analysis will distinguish between two distinct firm decisions. We will assume that these decisions are made sequentially. Specifically, assume the firm first determines its *capitalization.* Capitalization is simply the amount of legally recoverable (equity) capital the owners sink into the firm. Second, the firm determines its *investment.* Investment describes how the firm uses its capital. That is, once any initial capital value is chosen, the firm must then choose which investment opportunity and implied distribution over returns it will select. Thus, the paper overall will investigate how the firm's capitalization choices (with the possibility of "underinvestment" in capital) and investment choices (and possible "overinvestment" in risk) depend on the properties of bankruptcy law applied ex post.

This Part, however, focuses only on the second issue, that of investment, and treats the capitalization decision as predetermined. Specifically, this Part investigates the conditions under which overinvestment (i.e., when the firm makes inefficiently risky investments) occurs. Part IV explicitly develops the firm's endogenous capital choice as a function of the bankruptcy rules, and the relative priority of debt.

A. Firm Wealth, Returns, and Insolvency

We begin with a simple possible model of firm investments. Suppose (for now) that the firm is financed only through equity, and there are no transactions costs that inhibit contracting between shareholders and managers. Therefore, we will assume that the managers and owners of the firm have the same incentives. Since there is no debt at this point in the story, we can identify all creditors as having priority over shareholders, and we will not differentiate between types of creditors or claimants.

The story begins with the owners of the firm investing some initial capital. Given this initial capital choice, the firm can then choose among a set of investment opportunities. Each investment opportunity generates a probabilistic stream of returns. There is a rule of limited liability, and thus the firm can be held accountable for damages or other costs only up to the value of the firm's wealth. Absent any return, and any preemptive sale of assets, the legally recoverable wealth or *salvage value* of the firm equals v.[7]

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7. Even in a world of symmetric expectations, in some cases it is appropriate to assume that the firm (i.e., owners and managers) would value retaining ownership in the event of insolvency by more

The firm's investment is risky: sometimes returns are high, sometimes low, and possibly negative. The firm's total return from a given investment is r, a random variable that can take on either positive or negative values. Each investment opportunity is described by a probability distribution defined over values of r. Think of a realization of r as the sum of both direct returns—e.g., revenues net of production expenses—and indirect returns—e.g., tort claims or environmental liabilities.

1. Bankruptcy Triggers: Questions of Level and Hardness

Bankruptcy law and the proposed reforms address, at minimum, the following two questions. First, at which realizations of r is a firm considered bankrupt? Second, what happens in the case of bankruptcy? We address these questions with the notion of bankruptcy *triggers*. A trigger is described by (1) its *level* or value of r that brings the firm into bankruptcy, and (2) by its degree of *hardness*. Hardness describes what happens when the firm goes into bankruptcy. A soft trigger may let the firm operate, conditioned on an audit of the future returns of its investments. A hard trigger, by contrast, results in the immediate liquidation of the firm, once r falls below the trigger level.

For simplicity, we will abstract from the continuous set of possible bankruptcy triggers, and focus on polar examples of each trigger type. Thus, until noted otherwise, we will assume:

(1) A *hard trigger* results in reassignment of the value of the firm from its owners to its creditors, whenever

$$r \leq 0. \tag{1}$$

That is, whenever the current cash flow of the firm becomes negative, under the hard trigger the firm is bankrupt—and the owners of bankrupt firms lose everything.

(2) A *soft trigger* results in the closing of the firm whenever

$$r \leq -v. \tag{2}$$

Thus, one could think of a soft trigger as effectively having any level between zero and v, with bankruptcy involving a costless adjudication of both firm wealth and the transfer appropriate to creditors. Once the firm's net wealth becomes negative, the bankruptcy procedure serves only to

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than v. For example, managers may have made firm-specific human capital investments that would not be valuable elsewhere. Thus, one can imagine that v is the total cost of losing the firm to the owners and managers, while legally recoverable capital is actually less than v. This assumption does not affect the analysis, except in the case of secured debt. In that case, since v exceeds the security value of the firm, the equity value will always be strictly positive. See *infra* Part IV for further discussion.

allocate v among all creditors.

The analysis is simplified with little loss of generality by initially restricting attention to the bankruptcy rules that do not subsidize firms. In other words, equityholders receive nothing when the firm is bankrupt under either the hard or the soft triggers. Part II.A.3 relaxes this assumption by considering "loss sharing," in which the owners of insolvent firms retain some equity, even when some creditors' claims are not completely satisfied.

2. Bankruptcy Triggers and Firm Investment Returns

Two other assumptions will simplify the exposition, without affecting the qualitative properties of the conclusions. First, assume all investment opportunities require the same initial investment and imply the same salvage value v (that is, conditional on a realization of r, the gross value of any firm is $v + r$). Second, for now we will ignore dynamics, and therefore abstract from the possibility of legally recoverable firm value that exceeds the value of the firm's capital stock (e.g., the value of the firm's reputation that might be capitalized into the firm's stock value).

Given that we are currently ignoring dynamic issues, imagine that the firm makes an initial investment which permits it to choose among a set of probability distributions over realizations of returns. Given a realization r that lies above the bankruptcy trigger, the firm obtains *net returns*

$$v + r \tag{3}$$

when it is not bankrupt, and, when bankrupt, a net return determined by the bankruptcy law (the properties of the trigger) that is in place.

The following figure compares the firm's net returns (under hard and soft triggers) with the returns to society and the firm's incentives under unlimited liability. One's initial conclusion from this figure is correct: limited liability truncates the firm's incentive to internalize the "downside" of its decisions, since all realizations r that result in insolvency are equally costly to the firm. Unlimited liability, by contrast, implies firm incentives that coincide with society's incentives.[8] As will be shown below, however, there are additional conclusions that can be drawn from this simple framework that may not coincide with one's initial intuition.

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8. A natural question arises: Why not simply have unlimited liability? A considerable amount of literature addresses this complicated question, which cannot be done justice in this Article. In the context of the current analysis, unlimited liability is used as an abstract welfare benchmark, but it is assumed not to be a feasible solution to the inefficiencies introduced by limited liability.

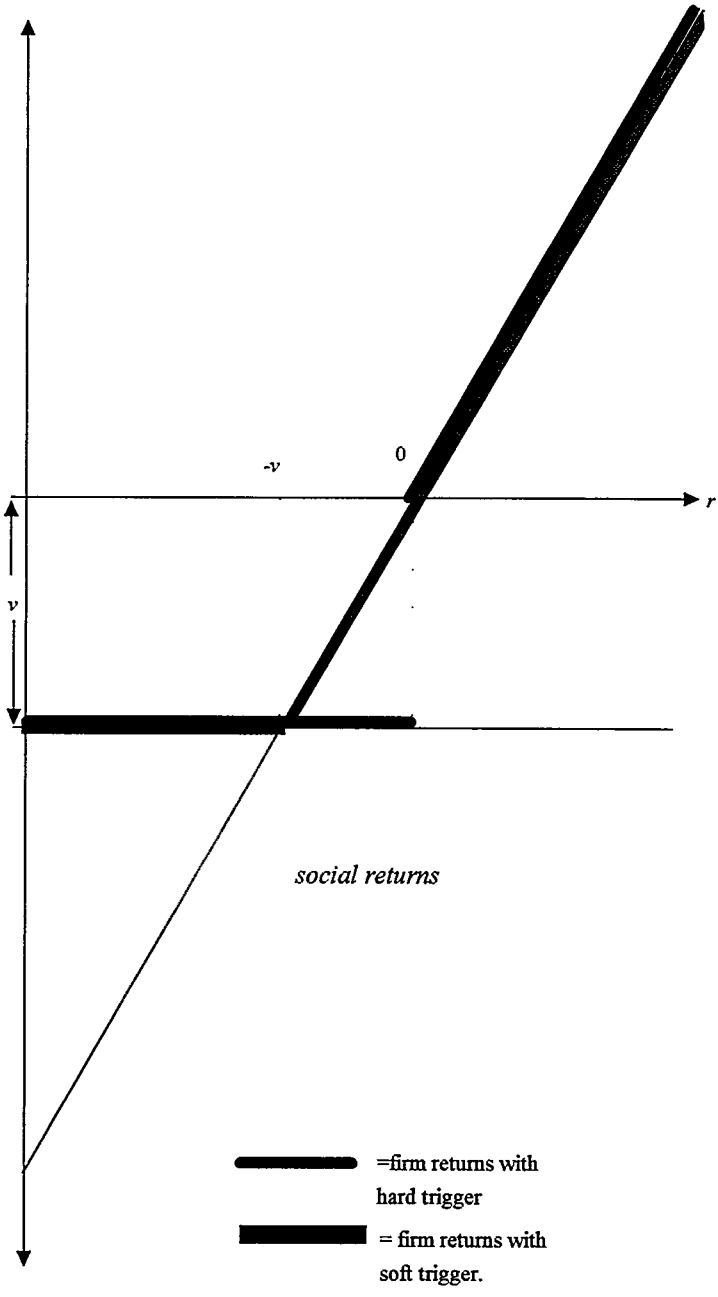
-v
0
r
v
social returns
=firm returns with hard trigger
= firm returns with soft trigger.

Figure 1

This figure obviously relies on the notion that the firm cannot fully "contract out" of a hard trigger to produce what is effectively a soft trigger. This assumption appears to be reasonable.[9]

3. "Two-Point" Firm Investment Opportunities

One of the central insights of this subpart is that the choice between hard and soft bankruptcy triggers depends crucially on the distribution over returns r that characterize alternative investment opportunities open to the firm. We initially focus on the special case in which each investment opportunity i generates only two possible realizations of r,

$$r_H^i > r_L^i. \tag{4}$$

For any investment opportunity i, we define p_L^i as the probability that the "downside" realization r_L^i occurs, and $(1 - p_L^i)$ as the probability that the "upside" return r_H^i obtains.

(a) Social Welfare Versus Firm Choices

Given the assumed "two-point" distribution over returns summarized in equation (4), we have the following definition. If at least some investment would increase social welfare, then the *efficient investment* is the opportunity which maximizes gross social returns:[10]

$$p_L^i (r_L^i) + (1-p_L^i) (r_H^i). \tag{5}$$

Subpart II.A.3(b) shows how the firm's choice among investment opportunities depends on the type of bankruptcy law that is in place.

(b) Hard Versus Soft Trigger with Two-Point Investments

We begin with a basic result.

PROPOSITION 1: When the firm is limited to only two-point investments, the soft trigger bankruptcy law is always at least as efficient as the hard trigger. Further, there exist values of v and firm investment opportunity sets such that soft trigger is strictly more efficient than hard trigger.

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9. For example, consider those realizations of r that would imply bankruptcy under a hard trigger but not a soft (namely, when r is in the interval $(-v,0)$). Under a hard trigger, the firm might want to enter into loan agreements with third parties in order to avoid triggering bankruptcy proceedings. By ruling out such agreements, we are implicitly assuming that due to a combination of collective action problems, nonpecuniary firm value (*see supra* note 2), management synergies, or other reasons, such contracts are infeasible.

10. Throughout this paper, the terms "efficiency," "welfare," and "gross social returns" will be used interchangeably.

The proof of Proposition 1 is not difficult.[11] First, observe that under either type of bankruptcy rule, realizations of r that are less than the value of the firm ($r < -v$) leave the firm bankrupt. So consider the set of investment opportunities that have "downsides," r_L, that lie strictly below $-v$. Out of this set of opportunities, the firm prefers the opportunity that has the highest *expected upside*:

$$(1-p_L^i)\ (r_H^i).$$

That is, because all downside realizations leave the firm bankrupt, the firm is indifferent over the particular values of r_L^i implied by alternative investments. In other words, all downside realizations that leave the firm insolvent imply the same private cost to the firm—bankruptcy—even though the social cost of alternative realizations differs.

This indifference over downsides is the source of the inefficiency of investment under limited liability. The investment i with the highest expected upside could have an expected social downside $p_L^i r_L^i$ sufficiently bad so that, from the welfare theoretic perspective, the firm's incentives lead it to the least—rather than the most—efficient investment choice. Intuitively, therefore, the more a bankruptcy rule leads a firm to internalize the expected social costs of downside realizations, the more likely it is that the firm will be led to more efficient investment choices. Given the assumed two-point distribution over returns, the incentives created by the soft trigger more closely parallel social returns than those created by the hard trigger, and therefore lead to investment incentives that are at least as efficient as the incentives implied by the hard trigger.

To illustrate, there exists a set of investment opportunities for which

$$-v \le r_L \le 0. \tag{6}$$

For each investment opportunity in this set, the firm is insolvent when r_L occurs under the hard trigger, but not the soft. Hence, under hard trigger, the firm is indifferent over the expected downsides for each member of this set of investments. But under soft trigger, the firm's (marginal) incentives over alternative investments in this set mirror society's. Therefore, if limited to investments in this set, the firm would make efficient choices under soft trigger, but (unless the efficient choice also has the highest expected upside) will not make efficient choices under hard trigger. The proof of Proposition 1 is complete by noting that for all opportunities for

11. More formal proofs of all results in this article are available from the author upon request.

which it is not the case that $-v \leq r_L \leq 0$, hard and soft triggers give the same returns to the firm, and therefore imply equivalent investment choices.

In summary up to this point: conditional on making an investment, the firm's choice is perverted by limited liability—the firm overinvests in risk. Despite the propensity to undertake inefficiently excessive risk, however, with the soft trigger and the two-point distribution over returns this inefficiency is lower than with the hard trigger. As v grows, with the soft trigger the firm internalizes an increasing range of possible downsides; indeed, within the limit the firm has a capital value sufficient to offset any negative return, and limited liability effectively becomes unlimited liability.[12]

B. Do Soft Triggers Solve the "Overinvestment" Problem?

Proposition 1 shows that soft triggers are better than hard triggers when investment opportunities can be described by two-point distributions over returns. Since the firm internalizes the social benefits and costs of realized returns above the trigger, lowering the trigger makes the firm's incentives more closely resemble society's. This intuition is similar to the familiar notion in torts that compensatory damages are efficient when enforcement is perfect. [13] Just as in the tort application, however, this intuition does not carry over to more general situations.[14] The following simple example demonstrates this point.

1. Three-Point Investment Opportunities

Suppose that there are three possible realizations of returns, not two. For any investment opportunity j, denote these three realizations as L, M, and H, i.e., assume returns are ordered by

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12. Hard trigger displays another property that is not needed to prove the proposition, but nevertheless important. Realizations in the interval specified by equation (6) cost the firm more under hard trigger than under soft; they can also cost the firm more under hard trigger than their social cost. So while the firm's indifference among insolvent realizations can lead it to overinvest in risk if it invests, under hard trigger the firm also has a reduced incentive to invest at all. Since some realizations cost the firm more than they do society under hard trigger, there are investment opportunity sets for which the firm would not make an otherwise efficiency-enhancing investment under hard trigger, but would make the investment under soft trigger.

13. *See, e.g.*, Gary S. Becker, *Crime and Punishment: An Economic Approach*, 76 J. POL. ECON. 169 (1968); A. Mitchell Polinsky & Steven Shavell, *Enforcement Costs and the Optimal Magnitude and Probability of Fines*, 35 J.L. & ECON 133 (1992).

14. *See* James Boyd & Daniel E. Ingberman, *Noncompensatory Damages and Potential Insolvency*, 23 J. LEGAL STUD. 895 (1994) (showing that noncompensatory damages are typically efficient in torts when enforcement is perfect).

$$r_L^j < r_M^j < r_H^j. \tag{7}$$

In order to highlight the implications of the example in a simple way, postulate the following probabilistic relationship among the returns. Assume that the high realization H occurs with probability (1-p), and, with probability p, returns are not high, i.e., one of the two lower realizations (L or M) occurs. Specifically, conditional on returns not being high (probability p), assume that the low realization L occurs with probability q and the medium realization M occurs with probability (1 - q).

2. Welfare With Three-Point Opportunities

Suppressing the j superscripts for clarity, the efficient investment is the opportunity which maximizes

$$p \cdot (q \cdot r_L + (1 - q) \cdot r_M) + (1 - p) \cdot r_H \tag{8}$$

over the set of possible investment opportunities. The firm's choice of investment opportunity, however, depends on its incentives. Given the three-point distribution, the firm's incentives depend only on the type of bankruptcy rule in place.

3. Efficiency of Hard Triggers with Three-Point Investment Opportunities

Unlike the two-point distribution case, in this example the hard trigger can be more efficient than the soft. That is, investment choices can be made to more fully reflect social welfare (equation (8)) under the hard trigger. To see this concept, suppose the firm chooses between two investments, the efficient investment E and the inefficient investment N. For simplicity, assume that p and q do not vary across the opportunities, and let the returns for each be as follows:

Realization	Value in Opportunity E	Value in Opportunity N
r_H^j	$K_E v$	$K_N v$
r_M^j	ε	$-\varepsilon$
r_L^j	$-v$	$-Cv$, $C > 1$

Here K_N exceeds K_E, so the expected upside of the N investment dominates the E investment. Also, the number ε is assumed to be arbitrarily close to zero, so that while opportunity E is better in realization M than is opportunity N, the difference between the gross returns of the two investments in realization M is trivial. Further, for any values of $K_N > K_E$, appropriate choice of the parameter C implies that investment E is efficient

(i.e., the additional upside of the N investment does not—from the social welfare perspective—justify its much worse downside in comparison to investment E).[15]

Now consider the firm's investment choice. The payoffs to the firm for each realization and bankruptcy rule are as follows:

Investment Realization	Hard trigger firm payoff		Soft trigger firm payoff	
	E	N	E	N
r_H^j	$K_E v$	$K_N v$	$K_E v$	$K_N v$
r_M^j	ε	$-v$	ε	$-\varepsilon$
r_L^j	$-v$	$-v$	$-v$	$-v$

Since ε was chosen to be close to zero, under the soft trigger the two investments have essentially equivalent downsides (the M and L realizations) to the firm. Therefore, under the soft trigger the firm prefers the less efficient investment opportunity, N.

By contrast, under the hard trigger, there is always a set of values of the parameters $K_N > K_E$ such that the firm finds N to be worse than E. Because the M and L realizations are assumed to be correlated, the hard trigger provides better investment incentives. Limited liability leads the firm to discount the full social costs of the L realization, so given the correlation between the M and L realizations, the firm's investment choices can be improved by increasing the costs it bears in the M realization. For example, even when K_N slightly exceeds K_E, N is chosen under the soft trigger. But under the hard trigger, the M realization induces bankruptcy and a loss of value. For any positive value of v, slight improvement offered by N on the upside (the H realization) does not compensate the firm for the higher costs of the M realization. Obviously, this reasoning extends over a range of parameter values and probabilities of each realization. Just as obviously, though, there are other distributions over three possible returns for which the soft trigger induces more efficient choices than the hard.

This insight, together with Proposition 1, yields a fundamental result.

PROPOSITION 2: Given fixed firm value v, the relative efficiency of investment choices induced by hard and soft trigger bankruptcy rules is

15. The formulaic assumption is that $K_E < K_N < K_E + (C\text{-}1)(pq/(1\text{-}p))$.

> determined entirely by the distribution over returns associated with alternative investment opportunities. That is, although investment opportunity sets exist for which soft trigger bankruptcy induces more efficient choices than hard trigger, other investment opportunity sets exist over which hard trigger induces more efficient choices than soft.

Proposition 2 says that neither a hard trigger nor a soft trigger bankruptcy rule can solve the "overinvestment" problem (except in degenerate cases). As such, at this level of analysis a preference for a hard or soft bankruptcy rule—on the basis of its effect on investment alone—is implicitly a statement concerning one's belief about an empirical question (properties of the distributions of returns available to firms in the real world). No matter how plausible we find the kind of correlation posited in the above example, there are other potentially plausible distributions over three possible returns for which a hard trigger would be *less* efficient than a soft.

C. Loss Sharing and Professor Rasmussen's Paper

Up to this point, we have assumed that insolvent firms are never subsidized, so that equityholders never receive any value until all creditors' claims are fully satisfied. It is well known, however, that many features of bankruptcy law serve to subsidize firms in Chapter 11.[16] It is also empirically established that owners of insolvent firms do retain equity after reorganization when creditor claims are incompletely satisfied.[17]

Professor Rasmussen, in his paper in this Symposium,[18] argues that loss sharing can improve both the overinvestment (in his model, "asset substitution") and the underinvestment problems. Underinvestment, and its connection to overinvestment and rules of priority, is discussed in Part IV below. However, the possibility that loss sharing might ameliorate overinvestment incentives can be addressed with a simple extension of the arguments made so far.

The following figure contrasts the soft trigger rule examined above with a particular loss sharing rule. This loss sharing rule has the property that the firm's net payoffs always fall as realization of (social) returns r falls. The question is: Does loss sharing unambiguously dominate either the hard or soft trigger?

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16. *See* Rasmussen, *supra* note 4, at 1167-73 (discussing the features of Chapter 11 from which these subsidies emanate); White, *supra* note 5, at 144 (same).

17. *See, e.g.*, Lynn M. LoPucki & William C. Whitford, *Bargaining Over Equity's Share in the Bankruptcy Reorganization of Large, Publicly Held Companies*, 139 U. PA. L. REV. 125, 165 (1990).

18. *See* Rasmussen, *supra* note 4.

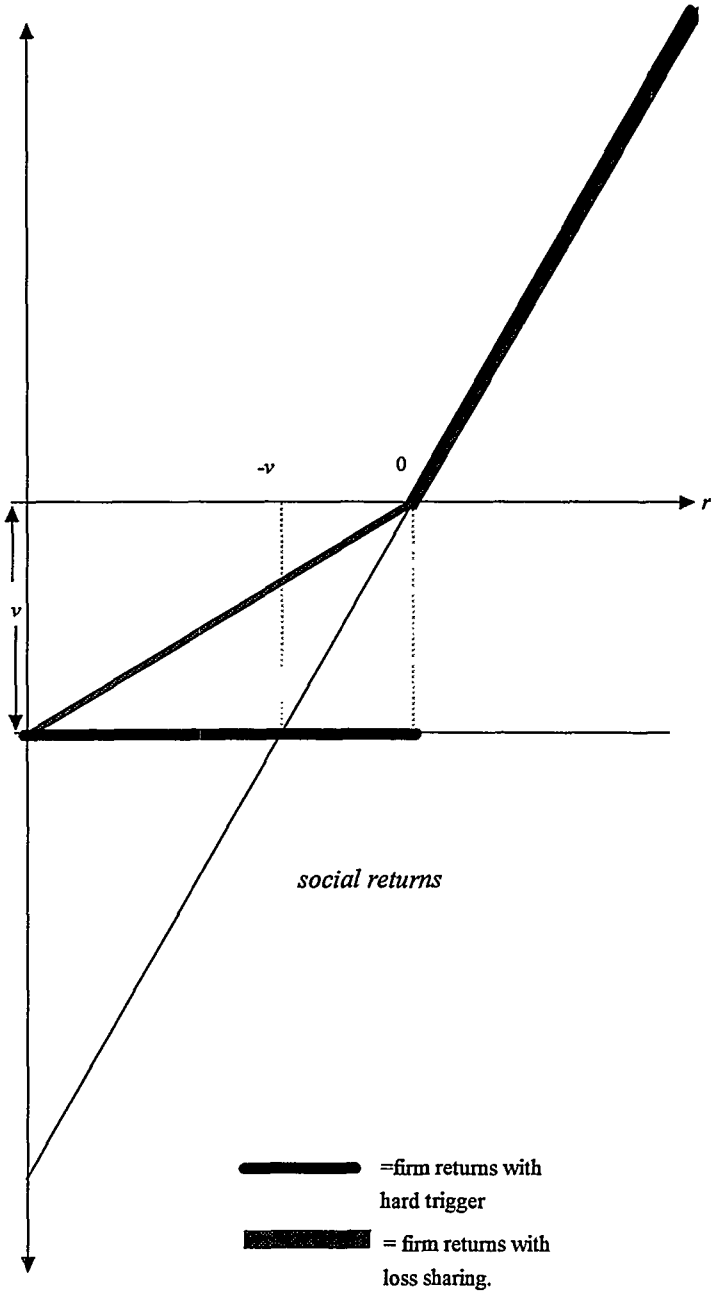
-v
0
r
v
social returns
=firm returns with hard trigger
= firm returns with loss sharing.

Figure 2

The answer is "no." The intuition is similar to the earlier comparison between soft and hard trigger. Specifically, whether loss sharing induces more efficient investment choices than either soft or hard trigger depends entirely on the distribution over investment returns.

PROPOSITION 3: Loss sharing induces investment choices that are at least as efficient as those induced by either hard or soft trigger for some investment opportunity sets, but other investment opportunity sets exist over which loss sharing yields less efficient choices than either soft or hard trigger.

To prove Proposition 3, first recall the "three-point" example used to prove Proposition 2. In that example, the hard trigger rule induces the efficient investment E, while the soft trigger leads the firm to the inefficient investment N. As shown by the figure, however, in this example the only significant difference between loss sharing and the soft trigger occurs in realization L, which is relatively less costly under loss sharing. So in this example, loss sharing induces the firm to choose the inefficient investment N, and therefore, the hard trigger yields less "overinvestment" than loss sharing.

Now consider two-point distributions over returns. Recall that Proposition 1 showed that the hard trigger is dominated by the soft in this case. Thus, we can restrict attention to the comparison between loss sharing and soft trigger. Here, the relative effects of loss sharing on investment decisions depend entirely on the locations of the low realizations of investments. If all investment opportunities have low realizations L that would leave the firm insolvent under a soft trigger ($r_L < -v$), then loss sharing is unambiguously more efficient than soft trigger. The reason is that all low realizations leave the firm insolvent under soft trigger, and so the firm will choose the investment opportunity with the highest expected upside. Under loss sharing, the firm is only insolvent under the worst possible realization, so the firm will internalize at least a fraction of the social costs of investment downsides that are entirely discounted under soft trigger. Therefore, relative to soft trigger, in this case loss sharing never reduces, and sometimes improves, the efficiency of the firm's investment choices.

This case, however, is special. When low realizations of two-point distributions can lie such that the firm is not insolvent under the soft trigger (i.e., $-v < r_L$), this preference for loss sharing can be reversed. To see this possibility, suppose that $-v < r_L$ for all low realizations in every possible investment opportunity. In this case, soft trigger implies firm incentives that mirror society's, and yields the first-best investment choices. This result can lead to inefficient choices by reducing the costs of investment

downsides, but not changing the values of upside realizations. Consequently, even when only some investment opportunities have low realizations in this region ($-v < r_L$), loss sharing could reduce efficiency.

This last case is similar to Professor Rasmussen's discussion of the incentives of a "solvent firm."[19] Specifically, Professor Rasmussen concludes that loss sharing will promote inefficient asset substitution and thereby reduce the efficiency of a "solvent firm's" investment choices. The discussion above, however, shows that unless the "solvent firm" is solvent for *every* possible realization of returns (e.g., $-v < r_L$), the effect of loss sharing on overinvestment depends entirely on the distributions over returns that characterize alternative investment opportunities. The difficulty with Rasmussen's argument is his implicit assumption that absent loss sharing, the "solvent firm" would make first-best investment choices.[20] In this case he means that (1) the firm would not overinvest in risk, *and* (2) the firm would not underinvest, i.e., pass up investment opportunities that have positive (social) net expected returns. But the first assertion is true only when the firm is solvent for every realization of returns. And, as will be shown below in Part IV's analysis of underinvestment, even if bankruptcy law can induce the firm to avoid the overinvestment problem (the first assertion), there is no reason to believe that the firm will be solvent for every possible realization of returns.

III. CAN BANKRUPTCY REFORM REMEDY THE OVERINVESTMENT PROBLEM?

All of the bankruptcy rules considered above share the property that the treatment of the firm—namely, when the firm goes into bankruptcy, and the residual value it retains, if any—is conditioned solely on realized investment returns r. One might infer from Proposition 2 that no rule conditioned solely on r can unambiguously lead to more efficient investment choices than any other rule. Among the points in favor of this conjecture are the fairly general properties of hard and soft triggers, and the linear formulation of the loss sharing case.[21] The counterargument is that

19. *See* Rasmussen, *supra* note 4, at 1182-83.

20. However, Professor Rasmussen is correct in the following sense: holding the distribution of investment returns fixed, as v grows, loss sharing is less likely to induce inefficient overinvestment in risk.

21. For example, one might look at a whole family of hard trigger rules that differ in the level of r that triggers bankruptcy and the amount of value that the firm can retain. It is easy to see that the analog of Proposition 2 will apply to the soft trigger in addition to this family of hard triggers. Indeed, one might argue that the *effective* bankruptcy rule (the practical effects of the statutory rule, taking into account the potential incentives and abilities of parties to contract out of the bankruptcy rule) must be

there is a spectrum of possible bankruptcy rules (of which only three have been explicitly considered). Nevertheless, I conjecture that the results of Propositions 2 and 3 generalize. That is, I believe there is no bankruptcy rule conditioned solely on r that provides unambiguously better investment incentives than any other bankruptcy rule. Overinvestment is always a problem, whatever rule we adopt.

A. Efficient Bankruptcy Procedures Conditioned on Firm Types

Optimal bankruptcy rules, therefore, are likely to be conditioned on more than simply r and v. Empirically, it is difficult to evaluate whether current bankruptcy rules and procedures do more than simply assess r and v, and then allocate the shortfall among competing claimants. However, at least in a "two-tier" system, such as the systems used in Chapter 7 and Chapter 11 in the United States, it seems plausible to imagine that bankruptcy rules as a whole are motivated in part to differentiate firms according to their "types." For example, some insolvent firms have expected future returns that are large enough to justify rescheduling liabilities and possibly reorganizing the firm. In Professor White's formulation, these are the "efficient firms" that should be preserved.[22] Other insolvent firms, by contrast, promise sufficiently small future returns so that any possible reorganization and rescheduling cannot yield positive surplus. These are the "inefficient firms" that should be liquidated.[23]

This story is clearly consistent with the focus of Professor White's paper as well as the other papers in this Symposium, and may be a good summary of the intent of current rules, if not their practical effects. To see how a two-track bankruptcy procedure can affect investment incentives, consider a modified version of the example developed for the three-point investments. The only difference between this example and the last is that the M realization gives identical returns in both opportunities E and N:

Realization	Value in Opportunity E	Value in Opportunity N
r_H^j	$K_E v$	$K_N v$
r_M^j	0	0
r_L^j	$-v$	$-Cv$, $C > 1$

As before, though, investment E is the efficient choice.

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some form of hard or soft trigger, or some form of loss sharing.

22. White, *supra* note 3, at 1319.

23. *Id.*

The following table summarizes the firm's incentives under hard and soft triggers. Observe that unlike the previous example, here the M and L realizations impose equal costs on the firm, independent of whether a hard or soft trigger is in place. Therefore, under either bankruptcy rule, if the firm makes any investment, it makes the less efficient investment N:

Investment Realization	Hard trigger firm payoff		Soft trigger firm payoff	
	E	N	E	N
r_H^I	$K_E v$	$K_N v$	$K_E v$	$K_N v$
r_M^I	$-v$	$-v$	0	0
r_L^I	$-v$	$-v$	$-v$	$-v$

Suppose, however, that the firm's net returns in bankruptcy are conditioned on the efficiency of its choice of investment, rather than just r and v. In particular, suppose that if realization M or L occurs, firms that choose inefficient investments N will face hard triggers, while firms that choose efficient investments E face soft triggers.[24] For example, once the firm has a realization $r \leq 0$, the court could determine r, v, and the type of the firm's investment, N or E, and impose net payoffs accordingly.

When the firm's net payoffs in bankruptcy are conditioned on the type of its investment in this way, the firm faces the following net returns:

Realization	Value in Opportunity E	Value in Opportunity N
r_H^I	$K_E v$	$K_N v$
r_M^I	0	$-v$
r_L^I	$-v$	$-v$

Reasoning analogous to Proposition 2 implies that for a range of $K_N > K_E$, this bankruptcy rule induces strictly more efficient choices than either a hard or soft trigger that is conditioned only on the realization of returns. That is, even though opportunity N has the better expected upside, investment opportunity N implies that the firm faces a hard trigger bankruptcy rule, which increases the costs of the downside enough to induce the firm to make an efficient investment choice.

Again making the analogy to tort liabilities, this bankruptcy law is like a negligence rule that imposes punitive damages on negligent firms (which

24. More generally, the court could evaluate the expected future returns from the firm's investments, not conditional on the current adverse outcome. Those firms whose future returns will increase social surplus could face a soft trigger, while those firms whose future returns will decrease social surplus could face a hard trigger.

make inefficient choices), and compensatory damages up to firm value for non-negligent firms (which make efficient choices). As such, we can generalize the above example to obtain the following result.

> PROPOSITION 4: Consider any bankruptcy law that is conditioned only on firm wealth and the current realization of returns (v and r). There then exists another bankruptcy law that is also conditioned on the type or efficiency of the firm's investment choices, and that generates investments which are at least as efficient as the rule conditioned on r and v only. However, for small enough v, even a rule conditioned on the efficiency of the firm's investment choices will not deter the firm from overinvestment.

The proof of Proposition 4 is a straightforward application of the logic of the above example. Conditioning the firm's net returns in bankruptcy on the efficiency of its investment choices increases the cost of inefficient investments without reducing the benefits of efficient investments. Therefore, when v is substantial, more efficient firm investments are induced by conditioning on the firm's investment choice than by conditioning only on r and v. Holding all else fixed, however, there always exists a range of firm values of v such that the firm still prefers the inefficient investment N. For example, consider the limit as v approaches zero. The downsides of the investments N and E are equivalent, and the firm prefers investment N.

B. A Context for Professor White's Paper

The key implications of the analysis so far are:

- No bankruptcy law that is conditioned only on r and v will induce efficient firm investments for all distributions over returns; and
- Any law that is conditioned only on r and v is dominated by—i.e., it produces less efficient investment incentives than—a bankruptcy law that also conditions the treatment of the firm on the overall efficiency of its investment choices.

Thus, the argument so far provides a possible rationale for having two separate bankruptcy procedures.

The argument, however, assumes that bankruptcy courts are capable of evaluating the efficiency of a bankrupt firm's investment choices. In her paper in this Symposium, Professor White begins with the assumption that courts, in fact, find it difficult to evaluate the efficiency of a firm's investment choices.[25] Instead, the failing firm itself makes the choice

25. White, *supra* note 3, at 1319.

between filing for bankruptcy under Chapter 7 (liquidation) or under Chapter 11 (reorganization).

The central concern in Professor White's study is the possibility that type 1 error—reorganizing otherwise inefficient firms that should be liquidated—might be an equilibrium result of the current bankruptcy scheme. In other words, bankruptcy law might result in a "filtering failure" in which inefficient firms are saved. Specifically, Professor White suggests that filtering failure can occur for two reasons.[26] First, only the firm knows whether it is efficient or not. Second, all managers prefer to misrepresent the true state of the firm's health. Managers of inefficient firms prefer to appear more efficient, since they prefer reorganization to liquidation. Managers of efficient firms want to appear less efficient than they really are, since they can pay creditors less in the final reorganization.

Professor White concludes that the possibility of filtering failure is inefficient, and hence the "two-track" bankruptcy procedure may be improved by recent reform proposals.[27] However, even under Professor White's hypothesis that courts cannot effectively discriminate among firms according to the efficiency of investments, filtering failure does not always occur. Therefore, to the extent that actual bankruptcy procedures can be conditioned in any objective way on the efficiency of firm investments, Propositions 2 to 4 imply that none of the various reform proposals will necessarily improve the efficiency of investment.[28] For example, reforms that promptly subject insolvent firms to auction might be thought of as imposing a hard trigger. But Propositions 2 and 3 imply that a softer trigger sometimes produces better investment incentives. Further, Proposition 4 implies that regardless of the properties of the trigger, a two-track procedure, to the extent that it can effectively filter firms, will dominate any simple, single-track procedure.

IV. OVERINVESTMENT, UNDERINVESTMENT, AND PRIORITY

The analysis in Part II assumed that the firm's capital value was fixed, and examined the firm's incentive to overinvest as a function of its capital

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26. *Id.* at 1320-21.

27. *Id.* at 1339-40.

28. In Professor White's other recent work, she characterizes a set of inefficiencies that transcend the "overinvestment" problem highlighted so far in this paper. Although her analysis differs from mine, she also concludes that none of the various reform proposals are likely to be unambiguously more efficient than any other. *See, e.g.*, Michelle J. White, *The Costs of Corporate Bankruptcy: A U.S.-European Comparison, in* BANKRUPTCY: ECONOMIC AND LEGAL PERSPECTIVES (Jagdeep S. Bhandari ed., forthcoming 1995).

value, the distributions of returns available in alternative investments (applications of its capital value), and the bankruptcy rule in place. This Part steps back to permit the firm's capital value to be endogenously determined. This addition to the model opens up another dimension to bankruptcy law, namely the treatment of debt versus equity and other obligations.

As shown in Part II, given limited liability, underinvestment in (equity) capital subsequently causes overinvestment in risk, but this result depends on the set of investment opportunities available to the firm. As a result, we permit a generalized distribution over returns. However, to place overinvestment in an appropriate concrete context, assume that the "risky" element of returns reflects potential tort liabilities—specifically, possible damages assigned according to strict products liability. This assumption permits a simple measure of overinvestment in risk (the comparison between the firm's expenditures on product safety and the social optimum) that does not depend on the existence of credit. However, the results extend immediately to any probabilistic environment in which: (1) the firm first chooses a level of equity and debt capital; (2) the firm next chooses an "investment" (e.g., an expenditure on safety) that implies a distribution over social returns, and given the bankruptcy rule in place, firm returns; and (3) the firm realizes returns and settles all accounts according to limited liability.

To simplify matters, subparts IV.A. and IV.B. abstract from debt financing. The key result is that the firm's incentive to invest in equity is mitigated by limited liability: the "underinvestment" problem. Since the shortfall in the firm's capitalization reflects a loss in productive efficiency, the firm is effectively passing up capital investments that promise positive expected (social) returns. Underinvestment in capital implies over-investment in risk (i.e., the firm's equilibrium safety investment is strictly less than the social optimum).

Subpart IV.C. explores the effects of priority in bankruptcy. Two possible priority schemes are considered: (1) priority of torts over all credit, and (2) priority of secured credit over all other claims. A central conclusion is that the efficiency of capital investment is improved by awarding secured credit priority over tort claims. The tradeoff, however, is that when secured credit has priority, the firm has an incentive to substitute debt for equity, which in turn increases the firm's incentive to overinvest and externalize risk.

A. *Endogenous Equity Capital Investment and Avoidance of Tortious Losses*

1. The Market: Technology, Information, and Timing

The analysis below examines the implications of the limited liability rule for capital investments (capitalization) and the use to which that capital is applied (investment).[29] These concepts are reflected in the analysis below by the firm's choice of capitalization k, safety s, and output q. Capitalization represents how much the firm can possibly lose; safety is the firm's investment in risk-reduction; output measures the size of the aggregate risk imposed by the firm's activities. Assume for now that the firm is financed entirely through equity, and as before, there are no explicit dynamics or discounting.[30] All production, realizations of product failures and resulting tort damages, and investor returns occur within a single period. However, a firm makes its decisions at four discrete dates during the single period. The timing is as follows:

DATE 1. Each firm commits to a technology. Each technology is characterized by its capital intensity, k, which measures the amount of (legally recoverable) capital needed to produce a unit of output. Capital is financed through equity investments, and with the firm's choice of k observable to all market participants. Firm capital investments are immobile or irretrievable until all tort claims against the firm are satisfied at Date 4.

DATE 2. Given the fixed technology, the firm plans its output q and safety s, obtains the needed capital through the sale of equity, and produces its product. Output and safety decisions are observable only to the firm. Firms are risk neutral.

DATE 3. Firms sell output in a perfectly competitive market (i.e., entry is costless, given the information structure and liability rule). The firm's direct cost is

$$C(k,q) = c(k,q) + qwk,$$

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29. The analysis in Part IV.A. is a direct application of work done by James Boyd and myself regarding joint and several liability. *See* James Boyd & Daniel E. Ingberman, Extending Liability: Should the Sins of the Producer Be Visited Upon Others? (John M. Olin Center in Business, Law, and Economics Working Paper, 1994).

30. In particular, this assumption means that the only legally recoverable value of the firm is the value of its capital. Since this model is static, the firm has no nonpecuniary or "soft" assets, such as reputation, that would be capitalized in the price of its stock, and hence, potentially legally recoverable to pay for product liabilities.

where w is the opportunity cost of capital (the market risk-free net rate of return to capital[31]). All else being equal, higher capital intensities k reduce production costs (i.e., $c(k,q)$ decreases with k). Total costs are the sum of safety expenditures, s, direct production costs, $C(k,q)$, and expected liability claims. For tractability, assume that expected average costs are U-shaped in q.

All markets allow free entry and exit. Therefore, equilibrium transaction prices equal the minimum of (expected) average costs. As such, prices include a payment above direct production and safety costs that reflects expected liability claims (i.e., capital investments at Date 1 earn an expected net rate of return equal to w, the market rate of return). Liability claims are adjudicated at Date 4 (see below). In particular, as a byproduct of the firm's actions, a maximum social loss of $\$qL$ can occur. Compensatory damages are in place, so the maximum liability of the firm is $\$qL$. For any $b \in [0,1]$, $r(b,s)$ measures the probability that a social loss $\$bqL$ results from the firm's actions, as a function of the firm's safety expenditure, s.[32] Although the capital initially invested in the firm is immobile, the difference between market price and direct production costs is distributed to investors upon receipt by the firm.

DATE 4. Realizations of product failure occur, and are costlessly and perfectly adjudicated by the court under a *strict liability* rule with compensatory damages. Liability is limited (legally recoverable damages are bounded by the firm's capital value kq), and bankruptcy law displays a soft trigger. Following payment of damages by the firm, investors retrieve their proportionate share of the firm's capital value, if any remains.

2. *Limited Liability Versus the First-Best Capital and Safety Choices*

This section characterizes the firm's choice of capital and the implied choice of safety. Although limited liability can result in the first-best capital and safety choices, it need not. In particular, let:

k^* = the first-best or welfare-maximizing capital intensity, i.e., the per unit capital value of the firm which equates marginal productive benefits

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31. Consider an equity investor's decision to place one unit of capital in the firm. In its best alternative risk-free use, that unit of capital earns a gross return of $w + 1$. So if the firm were to suffer zero tort costs, a unit of capital invested at Date 1 would be retrieved at Date 4. Therefore, absent any liability costs, the cost of capital invested in the firm would simply be w.

32. One interpretation is that for each unit of output that fails, a social cost of L occurs. Thus, b can be interpreted as the fraction of output that fails. In this sense, think of $r(b,s)$ as the probability that the average failure rate will be b, given s. That is, output is large enough so that the central limit theorem applies: increased investments in safety yield a better technology, with a lower failure rate.

of capital to w, the opportunity cost of capital; and

s^* = the first-best or welfare-maximizing safety choice, i.e., the investment in safety that equates the social marginal benefits and costs of safety.

The key feature of the assumed timing of decisions is that capitalization k is chosen before safety s and output q. Once capitalization is set, the firm's incentive is to pick the safety and output that maximize its profits, given the predetermined value of k. Thus, given an initial choice of k, let $\hat{s}(k)$ and $\hat{q}(k)$ represent the choices of safety and output that maximize the firm's (expected) profits at Date 2.

Now consider the choice of k at Date 1. Clearly, the firm knows that its subsequent safety and output decisions depend on its choice of k. Taking this dependence into account, let $\hat{k}$ denote the firm's profit-maximizing choice of k at Date 1.

To understand the intuition, suppose the firm's technology is such that $k^* > L$. Note that since L does not enter into the specification of the marginal *productive* benefits of capital, nor in the definition of the opportunity cost of capital, k^* and L are independent. Thus, we should expect to observe technologies for which $k^* > L$. Now, given such a technology, also suppose that the firm in fact chooses $\hat{k} = k^*$. This choice means that the firm is *fully capitalized*: it possesses at least as much (here more) legally recoverable capital as the largest amount of tort damages that it could possibly be assessed (L is the maximum damage per unit of output, which is by assumption strictly less than the firm's choice of k, which is the per unit capital value of the firm). As a result, in this special example, the firm fully internalizes all possible tort liabilities and makes the first-best choice of safety.

The following explanation shows that when $k^* > L$, the firm will choose the first-best capital intensity, and by implication, make the first-best choice of safety. However, whenever $k^* < L$, the firm will choose to be *undercapitalized*. It will choose a capital intensity that is strictly less than the first-best—so there are some possible realizations of social loss whose resulting tort liabilities will leave the firm insolvent—and consequently will also make an inefficiently small investment in safety. This is the "underinvestment" problem: not only does the firm choose a production process with an inefficiently low capital intensity, but these unduly shallow pockets cause the firm to externalize some of its expected tort liabilities.

PROPOSITION 5: In market equilibrium, firm-only liability yields weakly less than the first-best capital investment ($\hat{k} \leq k^*$), but also implies a strictly positive safety investment, $\hat{s}(k)$, that is weakly less than the first-best safety investment, s^*.

The proof strategy is to set up and solve the welfare problem, and then contrast that solution to the representative firm's decisions in market equilibrium. For the sake of brevity, only the firm's choice will be highlighted. First, recall that $\hat{s}(k)$ denotes the firm's profit-maximizing Date 2 safety expenditure, as a function of its Date 1 choice of k. Standard comparative static techniques show that, for $k < L$, $\hat{s}(k)$ increases with k. For $k \geq L$, $\hat{s}(k) = s^*$, the first-best capital investment that equates the social marginal benefits and costs of safety.

Similarly, $\hat{q}(k)$ increases with k, meaning that firms that choose relatively higher capital intensities k will also produce relatively more output, and have "deeper pockets" (more legally recoverable capital in the aggregate) than firms that choose relatively lower capital intensities. Thus, relative to low k firms, firms choosing higher k's—more capital-intensive productive processes—will, in equilibrium, have deeper pockets overall, and will elect to spend more on safety.

Now consider the firm's choice of k at Date 1. Under the assumptions made, the firm invests in the $\hat{k}$ which solves

$$\min_{k} AC(\hat{s}(k),k) = AC(k) =$$

$$\min_{k} \frac{C(k,q)+\hat{s}(k)}{q} + \left(L \cdot \left[\int_{0}^{\min\{k/L,1\}} b\,\tau(b,\hat{s}(k))\,db \right] + k \cdot \left[\int_{\min\{k/L,1\}}^{1} \tau(b,\hat{s}(k))\,db \right] \right). \quad (9)$$

The benefit of choosing a technology with a higher capital intensity k is lower direct production costs; the tradeoff is that higher k's imply a larger set of realizations of social loss in which damages are fully borne by the firm. Under the assumptions made, the benefits of investing in capital k (i.e., the reduction in average costs) are concave in k. However, capital costs per unit of output are also concave in k. In particular, the marginal cost of investing in capital is

$$w + \int_{k/L}^{1} \tau(b,\hat{s}(k))\,db. \quad (10)$$

That is, the marginal cost of capital is simply the sum of the opportunity cost of capital w plus the probability of bankruptcy (the probability that the fraction of the firm's output that fails is at least k/L), given the equilibrium

safety and output choices induced by the given value of k.[33] Note that as k increases, the probability of bankruptcy from damages falls, since the firm spends more on safety, and a given level of damages is more likely to fall below the firm's capital value. Indeed, as k approaches L, the marginal cost of k approaches the opportunity cost w, since the probability of bankruptcy goes to zero.

Figure 3 graphs the marginal benefits and costs of capital intensity k.[34] Whenever the firm is undercapitalized, the marginal cost of capital lies above w. Therefore, as shown in the figure, if the firm would be undercapitalized at the first-best capital intensity ($k^* < L$), then the firm will underinvest in both capital and safety ($k^* < L$ implies $\hat{k} < k^*$ and $\hat{s}(\hat{k}) < s^*$)). Thus, because a rule of limited liability need not result in the first-best capital and safety investments, limited liability need not be more efficient than a rule of no liability. This observation is true, even though a rule of no liability would result in zero expenditures on safety, and complete externalization of all tort damages. However, a rule of no liability would result in the firm choosing the first-best capital intensity k^*.

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33. This is an "envelope" result: an incremental increase in the capital invested in the firm costs the risk-free rate of return (w) plus the probability that the additional capital is not paid back at the end of the period. Note, however, that the average cost of capital per unit of output strictly exceeds the marginal cost for all k.

34. Given the fact that marginal costs are downward sloping, it is possible that a firm could maximize profits with a corner solution (either the minimum possible capital, or a capital choice that exceeds L). Or, there may be a multiplicity of technologies k that yield the same expected average costs to the firm, so that firms with a variety of k's could coexist in the same market. Or, it may be that no competitive equilibrium exists. For the remainder of the paper, assume that $\hat{k}$ is, in fact, well-defined, and solves first order conditions. For example, one can assume that the marginal benefit of capital at $k = 0$ is $+\infty$, and that marginal benefits always cut marginal costs from above. Then firm choices and market equilibria must solve the first order conditions of their associated maximization problems. More generally, although the usual curvature properties used to demonstrate existence of equilibrium need not hold under every liability rule considered, market participants' objective functions are continuous in all actions. As such, a (mixed-strategy) Nash equilibrium always exists.

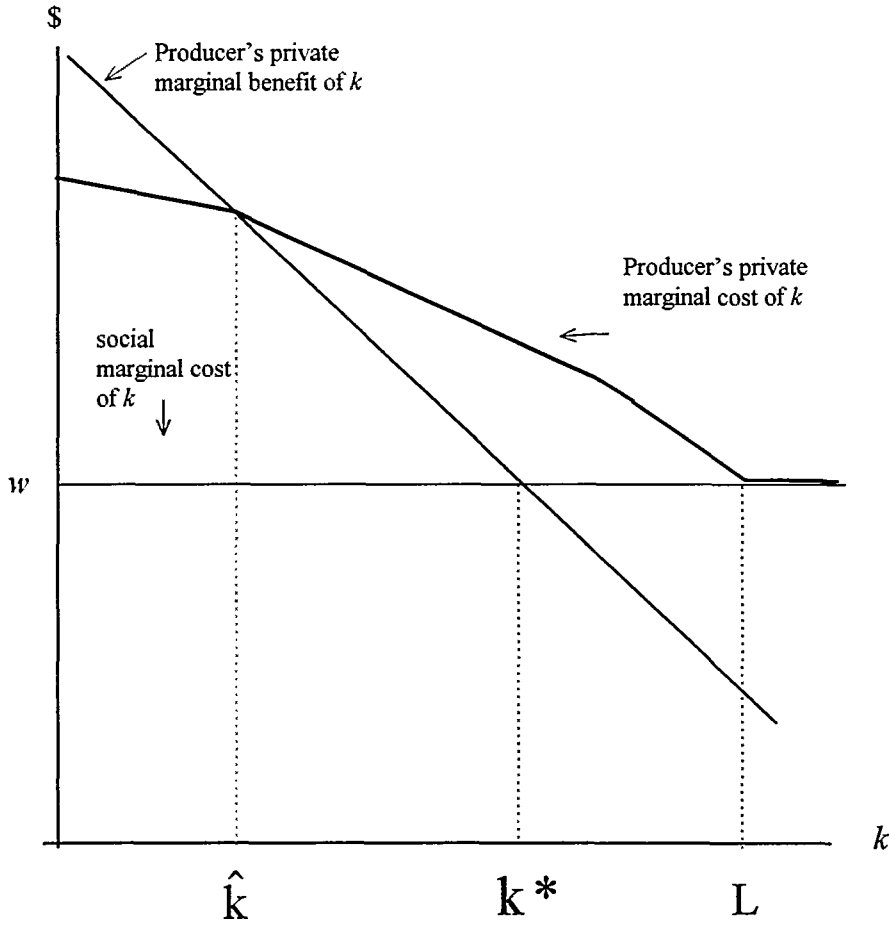
$
Producer's private marginal benefit of k
Producer's private marginal cost of k
social marginal cost of k
w
k
k̂
k*
L

Figure 3

When the firm chooses $k > L$, however, firm-only liability yields the first best. Thus, when $k^* \geq L$, the firm chooses to be fully capitalized. In that case, the firm has sufficient capital to pay all possible damages, and thus has a marginal cost of capital exactly equal to the opportunity cost w.[35]

B. Underinvestment and Overinvestment

Part II, and subpart II.C. in particular, focused on the issue of overinvestment: for any given capital value of the firm, limited liability creates an incentive to make inefficient investment choices, since the firm does not bear the full social costs of downside realizations. Overinvestment thus summarizes the firm's incentive—created by limited liability—to discount downside risk, since those costs are externalized.

So far, the discussion in Part IV has focused on the underinvestment problem—how limited liability can lead to firms choosing inefficiently low capital intensities—and has drawn the connection between the underinvestment problem and the firm's incentive to invest in "safety," e.g., in a tort context. Part IV has also shown that underinvestment leads to inefficiently low investments in safety.

To connect these pieces of the analysis, imagine that once the firm chooses its capital intensity, it then makes investment choices with that given capital intensity. These investment choices were parameterized above with the notion of safety expenditures. It is important to note that while the words differ, what was called overinvestment in Part II is logically identical to the suboptimal safety investment that results when firms are undercapitalized. That is, underinvestment in capital ($\hat{k} < k^*$) leads to suboptimal safety ($\hat{s}(\hat{k}) < s^*$), and in that sense, overinvestment in risk. To see this, observe that in the context of Part II, if v is large enough, then the firm will internalize all social costs and benefits and make efficient investment choices. This situation corresponds to one in which the firm chooses to be fully capitalized ($\hat{k} = k^* > L$). Otherwise, when the firm is undercapitalized ($\hat{k} < L$), it does not bear all the downside risk of its actions. Thus, interpret the firm's expenditure on safety as the amount of "expected upside" it gives up in order to obtain better expected downside. When the firm is fully capitalized, it makes the efficient expenditure on

35. This result implies that any rule that has a capital investment of k^* and a safety investment of s^* also yields the first-best capital intensity. Therefore, unlimited liability—i.e., routine "piercing of the corporate veil" to collect from the personal wealth of stockholders the damages that exceed the capital value of the firm—can yield the first-best capital intensity, if additional sources of capital obtained by veil-piercing are adequate to internalize all possible liabilities.

safety, i.e., given its initial choice of k, the firm's investment choice trades off optimally between expected upsides and downsides. When the firm is undercapitalized, however, it will not be willing to make the efficient safety choice, i.e., in some cases the firm will prefer investment opportunities that yield higher, but inefficiently bad, upsides.

Therefore, limited liability leads the firm to overinvest in risk only when the firm is also led to underinvest, i.e., when the firm chooses an initial capital intensity that leaves it undercapitalized ($\hat{k} < L$). It follows that limited liability causes underinvestment in capital, which in turn causes overinvestment in risk.

C. *Priority and the Secured Credit Dilemma*

There is another dimension of bankruptcy law that affects our conclusions about the relationship between limited liability, underinvestment, and overinvestment—the issue of priority. Typically, a firm faces different types of claimants—e.g., secured and unsecured creditors, tort victims, government agencies—who need not be, and usually are not, treated equivalently when the firm is bankrupt. The claims of particular claimants may be assigned priority over other claims, so that in the event of insolvency, these creditors are paid first, and other claimants divide any firm value that remains.

The question addressed in this section is: How do alternative priority arrangements affect incentives introduced by limited liability, and in particular, are there rules of priority that ameliorate the underinvestment and overinvestment problems? For simplicity, consider first two polar cases: (1) absolute priority of secured credit, and (2) absolute priority of torts. Absolute priority of secured credit means that secured creditors are paid first, and after the full amount of the secured claims are satisfied, all other claims are settled. Absolute priority of torts is similar, except the tort creditors are paid first. In either case, assume that all claimants have priority over equity, so that equity claims in bankruptcy proceedings can be ignored (with the soft trigger the firm never enters bankruptcy unless its equity capital value is less than the value of its obligations). Also assume in each case that all claimants—except equityholders—who do not enjoy absolute priority have equal priority. That is, after priority claims (secured credit or tort) are settled, all other claims are settled on a pro rata basis at the same ratio (settlement/claim).

The economic motivation for each of these absolute priority regimes is clear, but contradictory. Underinvestment in capital is the only economic rationale for absolute priority of secured credit. Since secured credit has

priority over other obligations, and does not suffer from the "marginal liability cost" of equity capital (recall Figure 3), it permits the firm to make more efficient capital investments. However, while absolute priority for secured credit can solve the underinvestment problem—by leading to a more efficient choice of capital intensity—it exacerbates the problem of overinvestment in risk. Absolute priority of secured credit leads to an overall increase in capital intensity, but also implies a substitution of debt for equity, which mitigates the firm's incentives to invest in safety.

By contrast, absolute priority of torts may improve safety incentives. Unlike most creditors, tort claimants are unable to contract ex ante with the firm, and undercapitalized firms have incentives to discount their tort liabilities. Conversely, creditors who can contract ex ante with the firm are able to lead the firm to internalize (more of) the effects of its decisions, since those effects can be captured in transaction prices. In particular, if creditors can condition transaction prices on credible predictors of the firm's safety incentives (e.g., the fraction of the firm's capital intensity k that represents equity), this analysis understates the benefit of according torts absolute priority.

1. Absolute Priority of Torts

Now permit the firm to finance its capital intensity k through either debt or equity. That is, let

$$k = k_d + k_e \tag{11}$$

where k_d and k_e represent the debt and equity components of k. Absolute priority of torts means in particular that first tort claimants are paid, then debtholders, and then equityholders. For any given value of k, this ordering means, as before, that when $b \geq k/L$, debt and equity receive zero return.

Since underinvestment causes overinvestment, we first focus on the effects of priority on the firm's choice of its mix of debt and equity. The central result of this subpart can be made clear via the following simple example. Suppose the firm wants to produce with a given capital intensity k; which is cheaper, debt, equity or neither (cost of debt=cost of equity)? The key is that when creditors cannot condition transactions on the firm's choice of s, the firm's incentive to invest in safety depends on k_e, not k_d. For example, suppose all debt and equity investments must be in place before safety can be chosen, and creditors cannot observe s. Once all capital is in place, the owners of the firm only have k_e at stake, and therefore spend $\hat{s}(k_e)$ on safety, not $\hat{s}(k_e+k_d)$. That is, when s is

unobservable, there are contractual devices that can credibly commit the firm to spend more than $\hat{s}(k_e)$ on safety.

The same kind of analysis used to derive equation (10) implies that for any given value of $k = k_d + k_e$, the price of capital—whether in the form of debt or equity—is the sum of w and the probability that the firm will be bankrupt. However, holding k constant, as we increase k_d and reduce k_e, the probability of bankruptcy increases, since the firm's expenditure on safety falls with k_e. Therefore, it is cheaper to finance any k through equity rather than debt. And this conclusion holds even when creditors can monitor the firm's safety, as long as such monitoring is not free. Therefore:

> PROPOSITION 6: When tort liabilities have absolute priority, and there are no taxes or agency problems between managers and owners, the firm is financed entirely through equity. Therefore, firm capital and investment decisions are as described in Proposition 5.

Thus, the assumption made in subpart IV.A.2. that the firm is financed entirely through equity is not binding when secured credit does not have absolute priority. Therefore, the analysis of Part IV.A.2.—in particular, the relationship between undercapitalization, underinvestment, and overinvestment—applies immediately to the case where torts have absolute priority.

The caveats of Proposition 6, however, may be important in actual application of this result. First, as is well known, dividends in the United States are subject to double taxation, which yields a tax advantage for debt even when all the other assumptions made continue to hold. Thus, we abstract from taxes. Second, equity financing has been shown to lead to a greater incentive to invest in safety, and therefore to a lower probability of bankruptcy and cheaper capital costs. Clearly, however, the conclusion that the firm will be financed entirely through equity relies on the assumption that the incentives of the owners of the firm and its managers are identical. When managerial incentives diverge from owners' incentives, an agency problem exists. Since unsecured creditors may have an incentive to attempt to monitor debtor firms' safety or other managerial activities, agency problems can create an incentive for debt financing when monitoring costs are not prohibitive.

Now suppose that torts have priority over all debt—secured or not—but for some reason the firm chooses to finance through debt (e.g., due to tax advantages or agency problems). Since torts have priority, debt capital as well as equity capital is at risk. Recall, however, that we have assumed

that k is observable to credit markets, but s is not. If creditors can infer $\hat{s}(k)$, then they will price the debt with a correct understanding of the probability of bankruptcy. Because $\hat{s}(k)$ depends on the equity value of the firm, and the price of (unsecured) debt falls as the firm's equity value increases, when the advantages of debt are large enough, the firm can have an incentive to *increase* its equity value in order to reduce the price it must pay for debt.[36]

2. Absolute Priority of Secured Credit

Now suppose that secured credit has absolute priority. For concreteness, imagine that each possible value of k maps into a particular set of physical capital, including plant, machinery and so on. If the firm is financed through equity, then the situation is as before: in the event of insolvency, the equityholders receive nothing, and the capital assets are distributed among other claimants according to equal priority. If the firm is financed through secured credit, however, then the secured creditors own the capital in the firm. Assume that, in the event of insolvency, secured creditors can retrieve the full value of the firm's capital stock before any other claims are addressed. Thus, unlike equity capital, in this subpart (secured) debt capital is immune to tort liabilities.

Thus, secured credit investment of k at Date 1 returns k with probability one at Date 4, assuming that bankruptcy does not diminish the value of secured claims. Therefore, the marginal (and average) cost of debt capital k_d equals w, the risk-free opportunity cost of capital. By contrast, the marginal cost of equity capital k_e equals w plus the probability of bankruptcy, which strictly exceeds the marginal cost of debt capital whenever $k_e < L$. Even in that case, however, the average cost of equity capital strictly exceeds debt, since equity capital is subject to tort liabilities while debt capital is not.

As a result, the firm will be financed entirely through secured credit. Since the incentive to invest in safety is determined by the amount of equity capital at stake—in this case, zero—the firm spends nothing on safety. Therefore:

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36. Beyond taxes, this model ignores many possible advantages of debt. First, collective action problems can cause equityholders to be less effective than debtholders in disciplining management. *See* Adler, *supra* note 1; Barry E. Adler, *An Equity-Agency Solution to the Bankruptcy-Priority Puzzle*, 22 J. LEGAL STUD. 73, 76 (1993). Second, in a model that does not enforce perfect competition, the ability to add debt cheaply can provide a strategic advantage to a firm vis-á-vis its competitors.

PROPOSITION 7: When secured credit has absolute priority, bankruptcy does not diminish the value of secured capital, and there are no tax advantages to equity, then the firm is financed entirely through debt ($k_e = 0$). As a result, the firm uses the first best capital intensity ($k_d = k^*$), but invests nothing in safety ($\hat{s} = 0$).

Thus, secured credit produces the first-best capital intensity, and achieves optimum productive efficiency in the market. Firms will increase capital intensity as long as the decrease in the marginal cost of production offsets the risk-free cost of capital. In this sense, absolute priority for secured credit solves the underinvestment problem. But since this priority scheme cuts the connection between capital investment and the firm's incentive to invest in safety, the firm spends nothing on safety.

Thus, the tradeoff or dilemma of secured credit is that it solves the underinvestment problem, but exacerbates the overinvestment problem. That is, the firm will spend nothing on safety, since the secured capital is not at risk. While the effect of secured credit on the overinvestment problem has been argued elsewhere,[37] the positive effect—solving the underinvestment problem and yielding first-best productive efficiency—has not received significant prior attention.[38]

Some caveats exist with respect to this result. First, since the liability advantages of secured credit imply the firm finances entirely through debt when there are no taxes, as long as the tax system does not introduce a bias towards equity, Proposition 7 will continue to hold. For example, as noted above, double taxation of corporate income in the United States is likely to provide an incentive for debt financing, all else equal. The second caveat may be less obvious. Since this is a single period model, nonpecuniary firm assets such as reputation cannot represent legally recoverable capital. In a truly dynamic model, however, nonpecuniary firm assets will be capitalized into the stock value of the firm. In some cases, then, such nonpecuniary values will be legally recoverable by reassigning ownership of the residual value of the firm to tort claimants. Even in that case, however, the qualitative conclusion of Proposition 7 will continue to hold. The firm will consist of the minimum possible equity capital and the maximum possible secured debt; while the firm's safety expenditure ($\hat{s}(k_e)$)

37. *See, e.g.*, Lynn M. LoPucki, *The Unsecured Creditor's Bargain*, 80 VA. L. REV. (forthcoming 1994); David W. Leebron, *Limited Liability, Tort Victims, and Creditors*, 91 COLUM. L. REV. 1565, 1646 (1991).

38. *But see* Robert K. Rasmussen, *Debtor's Choice: A Menu Approach to Corporate Bankruptcy*, 71 TEX. L. REV. 51, 63 (1992) (discussing related intuition).

is not zero in this case, the firm spends strictly less on safety than if secured debt is not afforded absolute priority.

V. IMPLICATIONS FOR REFORM

There are two distinct motivations for reform of bankruptcy law: (1) reducing the transactions costs associated with resolving competing claims for the assets of an insolvent firm, and (2) ameliorating the inefficient investment incentives introduced by limited liability. This paper addresses the second issue.

On the basis of the efficiency of investment, the discussion has focused on two dimensions of inefficiency, overinvestment (in risk) and underinvestment (in capital). The primary conclusions are summarized below.

First, overinvestment in risk is caused by underinvestment in capital. Priority in bankruptcy determines the relationship between overinvestment and underinvestment, and the magnitude of these effects. When capital investment and legally recoverable firm value are endogenous, and torts have priority over all debt (including secured credit), overinvestment is caused by underinvestment. Limited liability creates an incentive for underinvestment, which can be offset in some cases by the productive benefits of capital.

If secured capital has absolute priority against all other claims, then the underinvestment problem is solved. Since secured capital is immune from liability claims, the firm chooses the amount of (secured credit) capital that maximizes productive efficiency. When there are no taxes, agency problems, or firm value beyond securable assets, priority implies full substitution of secured credit for equity. The tradeoff of secured credit, therefore, is that by leading the firm to use the first-best productive method, it promotes minimal equity value, and therefore, maximal overinvestment (e.g., in product risk). Thus, secured credit solves the underinvestment problem by exacerbating the overinvestment problem.

Second, "single-track" bankruptcy rules that treat all similar firms similarly—i.e., only on the basis of r (current cash flow) and v (equity value)—are unlikely to solve (in all situations) the tendency toward overinvestment in risk that is generated by limited liability. This limitation remains true even when the firm is unable to substitute debt for equity. The result follows because, for any particular bankruptcy rule, the efficiency of investment choices (encompassing issues like asset substitution) depends entirely on the probability distributions over returns available

in alternate investment opportunities. Thus, at least out of the classes of single-track rules considered (hard trigger, soft trigger, and loss sharing), arguments that a particular rule can generally improve incentives of (any subset of) firms are inherently suspect.

Many bankruptcy reforms seek to impose simple procedures that reduce discretion and treat insolvent firms relatively harshly (e.g., by imposing liquidation or ownership transfers on all insolvent firms). In the language of this paper, such reforms substitute a single-track hard trigger applied to all firms for (what currently appears to be) a system of loss sharing intended for "efficient" firms (reorganization through Chapter 11) combined with a hard trigger intended for "inefficient" firms (liquidation through Chapter 7).

Propositions 2 to 4, however, imply that a preference in such reforms for the hard trigger on the basis of its effect on investment is simply an implicit statement about two features of the legal-economic environment. If single-track hard trigger really does imply better investment incentives than a two-track system (as described in Proposition 4), then (1) the distributions of returns that characterize firms' investment opportunities must not be two-point, and must favor the hard trigger over either the soft trigger or loss sharing; and (2) using Professor White's terms, filtering failure (inefficient firms reorganizing through Chapter 11) must be likely.