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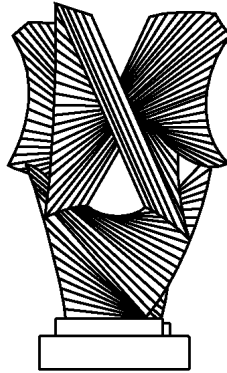
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THE LAW SCHOOL
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OPTIMAL TIMING AND LEGAL DECISIONMAKING:
THE CASE OF THE LIQUIDATION DECISION
IN BANKRUPTCY

Douglas G. Baird and Edward R. Morrison†*

I. INTRODUCTION

Patience is, perhaps, the first virtue of the decisionmaker. Before we make a decision, we have to know when to make it. Too soon, and we may not have enough information. Too late, and opportunities may be lost forever. We must have information before we can make a sound decision, but gathering information takes time. As George Stigler pointed out many years ago, every decisionmaker must be able to recognize the point at which information-gathering should stop and a course be chosen.¹ In few places is the problem more acute than in law. The challenge of knowing when to make a decision permeates our legal system. The judge must decide when in the course of litigation to entertain summary judgment motions; the administrator must decide when to issue regulations; the lawyer must decide when to settle; the plaintiff must decide when to bring suit.

Legal institutions should be designed to ensure that those who make such decisions make them at the right time. This paper explores how we can usefully study the legal system from this vantage point. A few scholars have shown how the timing of decisions af-

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¹ George J. Stigler, *The Economics of Information*, 69 J. Pol. Econ. 213 (1961). One can understand this paper as an effort to apply Stigler's idea of search to the task of judging. Instead of the consumer engaged in search for information before deciding what to buy, it is the judge who must search before deciding the matter before her.

fects such things as incentives to bring suit and the structure of civil procedure,² incentives to breach under different contract damages regimes,³ and the timing of environmental regulation.⁴ The importance of the timing of decisions is, however, largely unappreciated in law, particularly in bankruptcy, where timing issues so often are front stage and center. By way of illustration, we focus on one of the central questions in bankruptcy cases—the question of when to shut a firm down. We waste resources if we are merely postponing the inevitable, but when we liquidate a firm, firm-specific assets, including human capital, are lost forever.

² Bradford Cornell, *The Incentive to Sue: An Option-Pricing Approach*, 19 J. Leg. Stud. 173 (1990). See also Peter H. Huang, *A New Options Theory for Risk Multipliers of Attorney's Fees in Federal Civil Rights Litigation*, 73 N.Y.U.L. Rev. 1943 (1998) (using a real options approach to assess the effect of damage multipliers on the incentive of parties to settle).

³ Alexander J. Triantis & George G. Triantis, *Timing Problems in Contract Breach Decisions*, 41 J.L. & Econ. 163 (1998) (showing that that an expectations damages regime creates a real option to breach that the parties will tend to exercise earlier than is socially optimal).

⁴ AVINASH DIXIT & ROBERT PINDYCK, *INVESTMENT UNDER UNCERTAINTY* 405-18 (Princeton 1994) (using real options theory to explore the optimal timing of environmental regulations to control pollutants and the incentives of firms to comply with the Clean Air Act Amendments of 1990).

In a related literature, a number of legal scholars have used the theory of financial options (which are similar to, but quite different from, real options) to explain features of the legal system or to propose reforms. For a taste of this literature, see Lucian Bebchuk, *A New Approach to Corporate Reorganizations*, 101 Harv. L. Rev. 775 (1988) (using options theory to propose a new method for sorting out the rights of creditors in corporate reorganizations), and Paul G. Mahoney, *Contract Remedies and Options Pricing*, 24 J. Legal Stud. 139 (1995) (using options theory to explain why courts rationally favor money damages over specific performance). This literature, however, does not focus squarely on the optimal time to exercise options. It is this timing issue that is central to the emerging literature using real options theory.

The timing of a decision is, of course, driven by the difficulty of gathering information, and problems associated with information are nothing new to legal analysis generally nor to bankruptcy scholarship more specifically. Indeed, much of bankruptcy scholarship in recent years has focused on private information—information available to one or more of the parties, but not to the court.⁵ But the timing question is a distinct one. Indeed, in this paper, we ensure our focus remains squarely on the timing question by making many simplifying assumptions. First, we assume there is no private information. Information takes time to gather, but it is equally available to everyone. Second, we assume that the decisionmaker is an unbiased and complete master of all available information. In short, we focus only on the *timing* of the decision.

We find there is much to say about the structure of bankruptcy law after posing the liquidation question in the simplest possible terms. For this reason, we are confident that this way of looking at legal decisionmaking can be profitably and broadly applied across many frontiers.

II. THE RECAPITALIZATION PROBLEM

A firm is in financial distress when its future earnings are insufficient to pay its creditors what it owes. The law of corporate reorganizations exists to allow firms in financial distress to create a new capital structure in which fixed obligations are more aligned with the firm's future income.

Some firms that file for Chapter 11 suffer only from financial distress (what practitioners call a “balance sheet problem”), not from economic distress. For example, a firm goes through a leveraged buyout that leaves it too thinly capitalized to withstand a downturn in the economy. There may be nothing wrong with the way the

⁵ See Michelle J. White, *Does Chapter 11 Save Economically Inefficient Firms?*, 72 Wash. U. L.Q. 1319 (1994).

firm's assets are deployed. It simply has a capital structure that is inconsistent with the firm's present and future cash flows.

Other firms (indeed perhaps the majority of those that file for Chapter 11) suffer economic distress and have no prospects as going concerns. The firm might be an unsuccessful retailer whose supplier as already repossessed its entire inventory. Chapter 11 may be an effective vehicle for sorting out the rights to what few assets the firm has.⁶

The remaining firms in Chapter 11 are those of interest to us. These firms are in financial distress, but we cannot yet tell whether or perhaps the extent to which they are in economic distress as well. The firm was successful in the past, but then encountered hard times. Perhaps the firm can no longer compete effectively and should be shut down. But it is also possible that it made a misstep that is not likely to be repeated. In highly competitive markets, the occasional bad year is inevitable. Shutting down the firm destroys both a brand name and firm-specific capital, including marketing infrastructure and the job-specific human capital of employees.

The law of corporate reorganizations can create a new capital structure in two different ways. First, it can provide a mechanism by which the firm is sold to a third party. As in the case of firms that has never been in financial distress, the new owner is free to create whatever capital structure she pleases. There is no reason to believe a regulator would do better than a sole owner in making capital structure decisions. Meanwhile, the proceeds of the sale are divided

⁶ See Samuel L. Bufford, *What is Right About Bankruptcy Law and Wrong About its Critics*, 72 Wash. U. L.Q. 829 (1994). Shortly after the 1978 Bankruptcy Act was put into effect, there were many firms that had few prospects of surviving as a going concern, but that turned to Chapter 11 for one last chance. Rarely could one justify these cases in economic terms. There are fewer of these cases now, however. Moreover, bankruptcy judges, particularly after *United Savings Association v. Timbers*, 484 U.S. 365 (1988), are likely to dismiss such firms from bankruptcy at the start of the case.

among the investors according to the priorities they enjoy either by contract or by statute.

Instead of an actual sale to a third party, the law of corporate reorganizations can provide a process by which there is a hypothetical sale. A new corporate entity with a new capital structure is created and, instead of receiving proceeds from an actual sale, old investors receive interests in the new firm that respect their priority rights. Chapter 11 as it is now practiced is a hybrid of the two systems. The bankruptcy judge oversees the deliberative hypothetical sale process, but may, on the proper occasion, order a sale to a third party.

Comparisons between Chapter 11 and other reorganization regimes suggest that hypothetical sales are likely to take longer than sales to a third party.⁷ Even the process of selling a firm to a third party, however, takes time—several months on average and perhaps as much as a year. Hence, a study of the liquidation decision is important for any bankruptcy regime, not just those like Chapter 11 where the idea of a hypothetical (as opposed to actual) sale of assets

⁷ There are very few empirical studies that compare bankruptcy auctions to Chapter 11 proceedings. An exception is Karin S. Thorburn, *Bankruptcy Auctions: Costs, debt recovery, and firm survival* (Aug. 1999) (unpublished manuscript, Amos Tuck School of Business, Dartmouth College). Thorburn focuses on bankruptcy filings in Sweden, where the bankruptcy law provides that all bankrupt firms are immediately sold through public auctions. Using a sample of bankruptcy filings during the period 1988-1991, Thorburn finds that the average time from filing to the date firm assets are sold is about 2.4 months. However, the large standard deviation – 3.4 months – suggests that auctions of some firms take significantly longer. In contrast, Thorburn cites an unpublished study finding that Chapter 11 reorganizations can take over two years. See E. Flynn, *Statistical analysis of Chapter 11* (1989) (unpublished manuscript, Admin. Office of U.S. Courts) (cited in Thorburn, *supra*) (using a sample of small firm cases and finding that average time in bankruptcy is about 25 months).

ensures that making liquidation decisions well is of central importance.⁸

Ensuring that liquidation decisions are well-made in this environment is hard. The players in the bankruptcy practice all seem to have bias, lack expertise, or both. Assume that the firm can be shut down and its assets sold for \$100, including \$50 in cash. The firm can stay in business, but it will have to spend the \$50 to buy new inventory. If the business turns around, it will be worth more than \$150. If it fails, it will be worth \$50 in a year's time. The creditors are owed \$100.

Liquidating the firm would be a bad idea if the firm had an 80% chance of success; it would be a good idea if it had only a 20% chance of success.⁹ The creditors as a group, however, will prefer

⁸ Defenders of the current regime sometimes are simply hostile to the idea that markets can work effectively when firms are in distress, but some scholars who ordinarily embraces market mechanisms defend Chapter 11 as well, see Frank H. Easterbrook, *Is Corporate Bankruptcy Efficient?* 27 J. Fin. Econ. 411 (1990). Recent evidence suggests that the costs of Chapter 11 may not be large, publicly traded firms. See Gregor Andrade & Steven N. Kaplan, *How Costly Is Financial (Not Economic) Distress? Evidence from Highly Leveraged Transactions That Became Distressed*, 53 J. Fin. 1443 (1998); Vojislav Maksimovic & Gordon Phillips, *Asset Efficiency and Reallocation Decisions of Bankrupt Firms*, 53 J. Fin. 1495 (1998). It should be noted, however, that these firms are the ones least likely to liquidate. See Kai Li, *An Empirical Examination of U.S. Firms in Chapter 11 Bankruptcy* (UBC Working Paper 1998; available at <http://finance.commerce.ubc.ca/re-search/abstracts/>).

⁹ We are following the convention in the law and economics literature and assuming that the goal of bankruptcy is to maximize the value of the firm's assets. Some bankruptcy scholars take a different view. See Karen Gross, *FAILURE AND FORGIVENESS: REBALANCING THE BANKRUPTCY SYSTEM* (Yale 1997). The basic points we make about the liquidation decision, however, do not turn on this assumption. Virtually everyone understands that, at some point, the prospects of surviving as a going concern do not justify continuing. We show that understanding whether that point has

liquidation, regardless of the firm's chances. They will be paid in full if the firm liquidates. They can do no better if the firm succeeds as a going concern and they can do worse. (They never receive more than \$100 even if the firm flourishes and, if things go badly, they receive only \$50.)

By contrast, the shareholders receive nothing if the firm is liquidated today, but they receive \$50 if the firm stays in business and things turn out well. Hence, they will favor reorganization, even if the firm had only a 20% chance of success. The managers of the debtor may also be shareholders. Even if they are not, they may favor reorganization because the reorganization always them to keep their jobs, at least for a while longer.

The problem is far from trivial, even if one had in place an unbiased party who was adept at making such decisions. In this paper, we model rigorously the decisionmaking process that such a person must go through. The model helps us in at least two ways. First, it gives us additional insight into the costs we face by having a longer reorganization and hence the benefits of a regime, such as the actual sale, that cut it short. Second, it allows us to understand the way in which we can shape our legal rules to minimize the costs that arise from entrusting the liquidation decision to someone other than a sole owner.

The model we use assumes that no private information exists, that whoever is entrusted with the liquidation decision is as well informed as anyone. Because this assumption is contrary to most other models of corporate reorganizations, we set out in the next part of the paper why this assumption is justified, at least in the context of an initial effort to understand the liquidation decision.

been crossed, regardless of where it is set, turns crucially on the information one has and the additional information one expects to acquire.

III. THE LIMITED ROLE OF PRIVATE INFORMATION IN BANKRUPTCY

To make sensible decisions about whether to keep a firm intact, the decisionmaker must know both about its financial condition and the underlying business. It is not enough to know what revenues the firm produces, one also wants to know whether the firm is profitable. Similarly, it is not enough to know what products the firm is producing today, one also wants to know about its future products and whether they can be built on schedule. It is, of course, costly for the decisionmaker to gather this information. The largest cost may simply be time, but we also have to ask whether those who possess the relevant information have the power to keep it from the decisionmaker.

One might think that the owner-managers have much better insight into the prospects of the business but be unable to convey this information credibly. Information about profits and new product development and the firm's ability to meet changes in the industry seem hard to convey. The owner-managers will present any information they have in a way that reflects their own biases and there may be no easy way to correct for them. If there is no way to check whether their claim that the firm's prospects are bright, the court will have no way of knowing whether the firm will in fact do well or whether the owner-managers are merely playing for time.¹⁰

There are reasons to believe, however, that such problems do not loom large in reorganizations. If we believed that private information were an important determinant of the costs of decisionmaking by firms, investors should favor organizational forms that reduce these costs. Yet, if one looks broadly at different ownership structures, one sees little evidence that private information drives organizational form.¹¹ Managerial opportunism is not a large problem,

¹⁰ See, e.g., White, *supra* note 5.

¹¹ The most comprehensive account is Henry Hansmann, *THE OWNERSHIP OF ENTERPRISE* (Harvard 1996). Hansmann shows that, in industry after

given our existing legal regime.¹² In monitoring the managers, the greatest dangers seem to be excessive slack and retention of earnings. But these dangers are small when a firm experiences financial distress.

Firms in Chapter 11 are those whose managers have every incentive to work as hard as they can. A healthy firm might be hard to value because there may be earning potential that is untapped and profits that are squirreled away, but the onset of financial distress itself disciplines the managers. Indeed, the justifications for leveraged buyouts often center around the discipline that they bring to managers.¹³

The dangers of private information are most important in firms in which a single owner-manager controls the operation, such as high technology start-up firms. These firms, however, rarely enter bankruptcy. Financed with venture capital, they typically have a financial structure with little debt. The investors have made equity investments and the only creditors are unpaid wages and accounts payable. These debts are small relative to the value of the firm's assets. Hence, these firms can be doing extremely poorly and still no bank-

industry, private information seems to have only a small role in determining the capital structure of firms.

¹² The problems can be considerable, however, in other legal regimes, such as those in Russia. See Andre Shleifer & Robert Vishny, *A Survey of Corporate Governance*, 52 J. Fin. 773 (1997).

¹³ See Douglas G. Baird, *Leveraged Buyouts*, 2 NEW PALGRAVE DICTIONARY OF LAW AND ECONOMICS 192 (1998).

ruptcy petition will be in the offing.¹⁴ The decision to liquidate such ventures therefore is controlled by contract, not by bankruptcy law.¹⁵

These contracts themselves suggest that private information may not loom large when a firm is in financial distress. They suggest that venture capitalists believe they can enforce contracts that are contingent on many different subsequent measures of financial and nonfinancial performance and output. We commonly see clauses that turn on financial measures often thought hard to observe (such as the firm's net worth and profitability), as well as nonfinancial characteristics of a firm's operations (such as whether there are material deviations from the business plan or product improvements that incorporate new functionality).¹⁶

In short, there is enough reason to doubt the importance of private information in bankruptcy decisionmaking to begin the task of modeling the timing of decisions using a simple model in which information takes time to gather, but is equally available to everyone.¹⁷ It is such a model to which we turn in the next Part.

¹⁴ Bankruptcy law is primarily concerned with sorting out the rights of multiple creditors. While there is no requirement of insolvency (of liabilities in excess of assets) for voluntary bankruptcy petitions, a court will likely dismiss a filing unless there is "a financially beleaguered debtor with real debt and real creditors." See *In re Johns-Manville Corp.*, 36 Bankr. 727 (Bankr. S.D.N.Y. 1984).

¹⁵ They provide that in bad states of the world the venture capitalist acquires control of the corporation and the power to shut the firm down. Steven N. Kaplan & Per Stromberg, *Financial Contracting Theory Meets the Real World: An Empirical Analysis of Venture Capital Contracts* (April 1999) (unpublished manuscript, The University of Chicago).

¹⁶ See Kaplan & Stromberg, *supra* note 15.

¹⁷ We do not claim that bankruptcy judges stand in the same position as venture capitalists. We argue to the contrary in Section VII. In that section, however, we show that judges may possess sufficiently powerful information gathering tools that they can gain access to much of the information available to venture capitalists.

IV. THE LIQUIDATION DECISION AS
THE EXERCISE OF A REAL OPTION

In a coherent reorganization regime, there must be a mechanism that tries to ensure that the firm will be liquidated at the time when it is in everyone's interest. To keep things simple, we start by assuming that the mechanism is one that entrusts this task with a single unbiased individual for whom relevant information is as accessible as it is to anyone else.

The decisionmaker must, at every moment in time, ask whether it is in everyone's interest to liquidate the firm. The challenge she faces is known in the finance literature as an optimal stopping problem, and economists have, in recent years, developed a powerful set of tools to analyze such problems.¹⁸

We begin with a stylized model (Appendix 1 contains a general model).¹⁹ At $t = 1$, the firm receives earnings of π_1 .²⁰ At the same time, the firm starts the process of forming a new capital structure. (For our purposes, it does not matter whether the process involves an actual or hypothetical sale, only that whatever process is chosen takes at least until $t = 3$.) The liquidation value of the firm's assets at $t = 1$ is L . If we wait until $t = 2$ to liquidate the firm, we shall still receive L in nominal dollars,²¹ but time is money. We are always better off receiving a certain sum today rather than at some time in

¹⁸ See DIXIT & PINDYCK, *supra* note 4.

¹⁹ This model draws on the framework in DIXIT & PINDYCK, *supra* note 4, at 26-46.

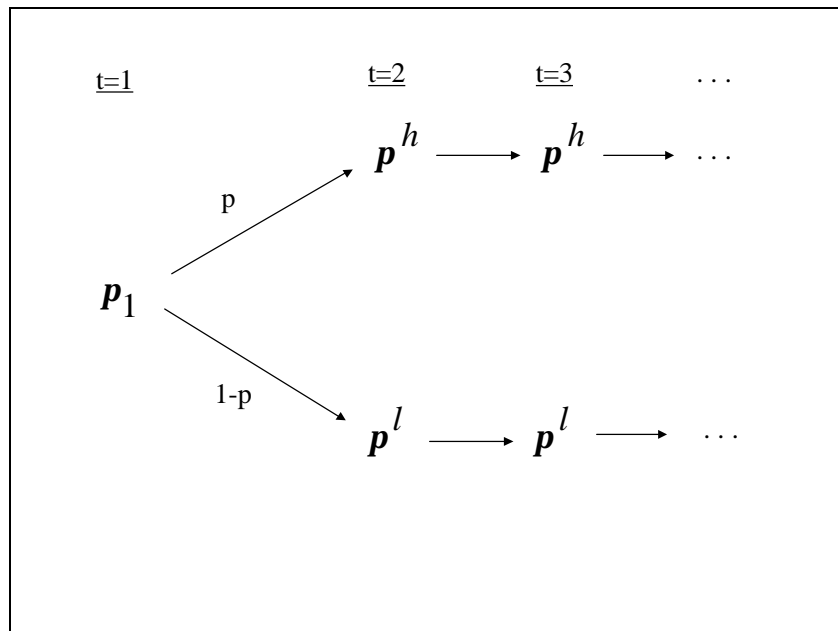
²⁰ These earnings are net of any expenses incurred during the period and exclude any payments to creditors.

²¹ We are assuming that when the firm liquidates and its assets are sold off, all firm-specific value is lost. The assets are fungible goods sold for the competitive price. Hence, there is no real option connected with the timing of their sale. In our model, we assume that the nominal amount that can be realized from the sale remains constant over time. Creditors lose only from the time value of money associated with the delay.

the future. We shall assume a discount rate of 10% for each period.²² If the decisionmaker decides not to liquidate the firm and it remains as a going concern, the firm receives earnings at $t = 2$ that are either high (π^h) with probability p or low (π^l) with probability $1-p$.

At $t = 2$, the decisionmaker can again decide to liquidate the firm for L . If she does not liquidate the firm at that time, it remains as a going concern forever. After $t = 2$, the earnings of the firm are constant. If firm earnings are high (π^h) at $t = 2$, they will be high (π^h) in all later periods; if earnings are low (π^l), they will be low in all future periods. Thus, when the firm first files for Chapter 11 protection, the decisionmaker faces the distribution of firm earnings depicted in Figure 1.

Figure 1



²² In other words, we are indifferent between receiving \$100 at $t = 1$ and \$110 at $t = 2$: the present value of \$110 at $t = 2$ is \$100 at $t = 1$.

We shall assume that the liquidation value of firm assets (L) is \$100, firm earnings are $\pi^h = 1.5\pi_1$ and $\pi^l = .5\pi_1$, and that the probability of π^h at $t = 2$ is $p = .5$. At $t = 2$, all uncertainty disappears. If the firm receives high earnings at $t = 2$, it will receive high earnings at $t = 3$ and at all subsequent times. If we discount this income stream, its present value at $t = 2$ is (not including the earnings received at $t = 2$) $10\pi^h = 10 \times 1.5\pi_1 = 15\pi_1$. By contrast, if the firm generates low earnings at $t = 2$, the discounted value of its earnings for the rest of its life, measured at $t = 2$ (and again not including earnings received at $t = 2$), is $10\pi^l = 10 \times 0.5\pi_1 = 5\pi_1$.

First, let us examine the decisionmaking process at $t = 2$. Assuming the firm was not liquidated at $t = 1$, the decisionmaker can either liquidate at $t = 2$ and realize \$100 or it can keep the firm intact as a going concern forever. If the decisionmaker takes the latter course when earnings are low (π^l), the firm will generate a stream of earnings starting at $t = 3$ and continuing forever. We know this stream is worth $5\pi_1$. If this sum is less than \$100 (that is, if $\pi_1 < 20$), the decisionmaker will always liquidate at $t = 2$ when earnings are low. If the firm's earnings turn out to be high (π^h) at $t = 2$, we can do a similar calculation and discover that the decisionmaker will liquidate if $\pi_1 < 6.67$, but not otherwise.

The problem the decisionmaker faces at $t = 1$ is harder. Let us assume that $\pi_1 = 8$ and we want to calculate the expected value of the firm if it remains a going concern indefinitely. The firm will receive earnings of $\pi^h = \$12$ or $\pi^l = \$4$ at $t = 2$ with equal probability. Hence, from the vantage point of the judge at $t = 1$, the firm has an expected return at $t = 2$ of \$8. We similarly have an expected return of \$8 at $t = 3$ and each subsequent period. (Since earnings at $t = 1$ are the best forecast of earnings at $t = 2$, $t = 3$, and all future periods, we are implicitly assuming that the growth rate of earnings is zero.) This expected earnings stream discounted to its present value at $t = 1$

is \$80.²³ This amount is less than what the firm is worth if liquidated at $t = 1$ (\$100). Thus, it might seem that the decisionmaker should liquidate the firm. But this would be the wrong conclusion. We must also take into account the value of waiting for a period to find out whether the firm's future earnings in all future periods will be high or low.

Let us assume that the decisionmaker does not liquidate the firm at $t = 1$. What is the expected value of the firm to the creditors, bearing in mind that the decisionmaker has the power to liquidate at $t = 2$? It is possible that earnings will be high and the firm will receive \$12 at $t = 2$ and in all subsequent periods. As we showed above, this income stream has a present value of \$120 at $t = 2$ and a decisionmaker will liquidate only if $\pi_1 < 6.67$. Since $\pi_1 = 8$ here, we know that a decisionmaker will not liquidate if earnings are high at $t = 2$. Hence, in the good state, \$132 will be available to the creditors at $t = 2$. (The creditors enjoy the \$12 the firm receives at $t = 2$ and the income stream worth \$120 it will start to receive at $t = 3$.)

However, it is equally likely that the firm's earnings at $t = 2$ will be low. The decisionmaker then must decide whether to liquidate the firm. In the bad state, this decision is easy. We know a decisionmaker will liquidate if $\pi_1 < 20$, which is clearly the case here. Since $\pi_1 = 8$, the firm would only produce an earnings stream of only \$40 if kept intact, much less than \$100, the amount that can be realized by liquidation at $t = 2$. Hence, in the bad state of the world,

²³ We know that the value of the income stream at $t = 2$ (including the earnings received at $t = 2$) is $0.5(11\pi^h + 11\pi^l)$. We also know that $11\pi^h = 16.5\pi_1$ and that $11\pi^l = 5.5\pi_1$. Hence, the expected value of the firm at $t = 2$ is $11\pi_1$. Because we are looking at this income stream at $t = 1$, however, we must discount it. (The firm receives π_1 at $t = 1$ even if it liquidates at $t = 1$. Therefore, we have to compare the amount we realize on liquidation (\$100) with an income stream that starts only at $t = 2$.) At $t = 1$, the value of an income stream of $11\pi_1$ starting at $t = 2$ is worth $10\pi_1$ when the discount rate is 10%.

\$104 is available at $t = 2$ (\$4 in earnings received at $t = 2$ and \$100 received from selling the assets).

Thus, assuming the decisionmaker does not liquidate the firm at $t = 1$, the expected value of the firm at this date must reflect the equal possibilities of the good state (worth \$132) or the bad state (worth \$104) in the next period. The expected value of the firm at $t = 2$ is \$118. Using a 10% discount rate, this amount is worth \$107 at $t = 1$.

We want to compare the amount we can realize at $t = 1$ by liquidating (or \$100) with the expected present value of the firm if we delay liquidation decision until after we learn whether its earnings will be high or low (or \$107). When $\pi_1 = 8$, the decisionmaker should wait until $t = 2$ and should not liquidate at $t = 1$. Even though at $t = 1$ the liquidation value of the firm is \$100 and its expected value as a going concern is only \$80, it should still be kept intact. If we focus only on the value of the firm if it remains as a going concern, we fail to take into account the benefits of waiting until we gather more information. In this case, the benefits of waiting are large enough to justify continuing the firm, even though its expected value as a going concern alone is not.

Of particular interest to us are those cases in which the present value of the firm as a going concern is less than its liquidation value. In these cases, the value of the ability to postpone the liquidation decision until $t = 2$ instead of having to make a once-and-for-all decision at $t = 1$ is given by

$$.5\left(\frac{1}{1.1}\right)[(1.5p_1 + 15p_1) + (.5p_1 + 100)] - 100 \quad (1)$$

which is the difference between the expected value of the firm (discounted) if the liquidation decision is made at $t = 2$ and the liquidation value of the firm at $t = 1$. Simplifying, the value of this *liquidation option* becomes:

$$7.73\pi_1 - 54.5 \quad (2)$$

This example illustrates a more general point. In deciding whether to liquidate a firm, the decisionmaker must take into account the costs and benefits of waiting until more is known about the value of the firm. Even when the expected earnings of the firm when discounted to present value is less than the liquidation value (as was the case when π_1 was \$8), the decisionmaker may still want to keep the firm intact, at least for a short period. In other words, we can think of the ability to postpone the liquidation decision as an *option*. To assess the merits of liquidating a firm today or keeping it intact as a going concern, the decisionmaker must estimate not only the expected value of the earnings of the firm if it remains intact, but also the value of the liquidation option.²⁴

²⁴ Many scholars have noted that traditional net present value (NPV) analysis (or “discounted cash flow” analysis) is an inappropriate measure of projects where the decisionmaker possesses real options. See, e.g., DIXIT & PINDYCK, *supra* note 4, ch. 1. Traditional NPV analysis evaluates a project (e.g., whether to liquidate a firm, whether to build a factory) by comparing the discounted value of the project’s expected future payoffs to the costs necessary to implement the project. If payoffs exceed costs (NPV is positive), the project is worthwhile.

NPV analysis, as traditionally applied, is an appropriate valuation technique under conditions where the decisionmaker must make a now or never investment decision (i.e., there is no ability to *delay* the decision) and cannot do anything to affect the value of the project in subsequent periods, or where the investment decision can be delayed but the decisionmaker can undo any decision and recoup any expenditures. These conditions may characterize some investments, such as bonds and stocks, but they do not hold true in many projects, such as the decision to build a factory or to shut down a firm. In these projects, real options exist. Most obviously, the decisionmaker can delay the decision whether to invest in a project. During the delay, the decisionmaker may receive new information that affects the value of the firm. Thus, the ability to delay is valuable. It represents a real option because the decisionmaker possesses the equivalent of a call option: the decisionmaker has the right, but not the obligation, to invest in a project now or in the future. If new information reveals that

The information the decisionmaker needs to value the liquidation option is different from the information she needs to value the expected earnings of the firm as a going concern (i.e., the “net present value” of the firm). We can show this by considering a variation on our model. To estimate the value of a firm as a going concern, the decisionmaker need know only the value of π_1 , not the value of either π^h or π^l . In expectation, the firm will earn π_1 in every period. Indeed, we can increase the spread between π^h and π^l without affecting the value of the firm as a going concern. Such a change, however, has an effect on the value of the option.

Previously we let $\pi^h = 1.5\pi_1$ and $\pi^l = .5\pi_1$. Suppose now that $\pi^h = 1.75\pi_1$ and $\pi^l = .25\pi_1$. As before, we shall assume that the decisionmaker will always liquidate the firm at $t = 2$ if earnings are π^l . Modifying equation (1), we see that the value of the liquidation option here is:

$$.5\left(\frac{1}{1.1}\right)\left((1.75p_1 + 17.5p_1) + (.25p_1 + 100)\right) - 100 \quad (3)$$

Simplifying, this becomes:

the project is more valuable than previously expected, the decisionmaker will exercise this option and invest. If the new information shows that the project is actually a dud, the option will go unexercised.

Investment projects may feature other types of real options. For example, a project with negative NPV may be worthwhile because it creates the opportunity to make “follow-on” investments in the future. The ability to make follow-on investments is a valuable real option. After the initial project is completed, the decisionmaker will have additional information about these investments. Only if the information reveals that these investments are worthwhile will the option be exercised. See Richard A. Brealey and Stewart C. Myers, *PRINCIPLES OF CORPORATE FINANCE* ch. 21 (1991), for a simple numerical example of this type of real option.

$$8.86\pi_1 - 54.5 \quad (4)$$

Comparing (2) and (4), we see that the value of the option changes in the face of uncertainty about future earnings of the firm, even though in expectation the present value of the earnings of the firm, if it remains as a going concern, does not. The value of the liquidation option *rises* as the uncertainty about future earnings increases, implying that the decisionmaker should be more patient—more willing to defer the liquidation option to the next period—when there is large uncertainty over firm earnings than when future earnings are more predictable.

To make the liquidation decision, therefore, the decisionmaker must estimate both the firm's earnings in every period in the future and the uncertainty associated with these earnings. She first establishes the value of π_1 and builds her estimate on that. She uses the information given her to estimate the way this value is likely to change and the degree of uncertainty associated with her estimate. This method of valuing a firm is well understood in the finance literature. We can capture how the earnings change at any moment in time in the following way:

$$dp_t = \mathbf{m}p_t dt + \mathbf{s}p_t dW_t \quad (5)$$

Equation (5) models the process by which the earnings of the firm change (dp_t) at each moment in time.²⁵ We can then use this process

²⁵ This representation of the process is known as geometric Brownian motion with drift, where changes in the level of earnings are lognormally distributed. We can understand this process and the way it tracks the value of a troubled firm's earnings by imagining a random walk with drift. Consider the following story. We are on a large open field and we are standing on a long straight line. We blindfold a person and ask that person to walk along that line. We want to predict how much that person changes the distance between her and the straight line at each moment in time.

to determine the value of the liquidation option. The process has two components. The first tells us how we expect earnings to change over time. In our model, we assumed that earnings remained constant after $t = 2$. If the firm is recovering from economic distress, however, we would expect the earnings to improve over time. The predicted rate of growth of earnings is μ . The higher μ , the more valuable the firm as a going concern and the more valuable the liquidation option.

Also crucial is the second component, σ , which measures the volatility (or variance) of future earnings. During any period, the condition of the firm may turn out to be better or worse than we expect. Not only does the condition of the firm affect earnings for that period, but for future periods as well. Just as we based our predictions of earnings at $t = 2$ on earnings at $t = 1$, we also based our predictions of earnings at $t = 3$ on earnings at $t = 2$. If earnings were

The answer depends upon two things. First, we need to know how much the person is likely to deviate from a straight line unconsciously. (People do this because they favor one leg over another.) This effect is analogous to the first term, the rate of *drift* μ . It tells us the path we expect this person to follow. Second, we need to know how likely each step is to depart from this predicted path. A clumsy person paying less attention might make bigger departures from this path at every step than someone who was careful and whose steps were more measured. We can have two people with the same predicted path, but one may be more likely to stray from it in one direction or another. This effect is captured in the second term: the amount of variance, the random error the person makes with each footstep, is given by σ .

To return to bankruptcy decisionmaking, the straight line is our benchmark π_1 , the earnings that the firm now enjoys. Our prediction that earnings will increase over time at a given rate is μ . It is analogous to predicting how much our person will tend to drift to the right. (In the simple model here we have assumed that $\mu = 0$.) The amount that earnings will depart from our expectations is σ and it is analogous to the amount the person is likely to stray from our predicted path at each point.

high at $t = 2$, we expect them to be high at $t = 3$; if earnings were low at $t = 2$, we expect the same at $t = 3$. Thus, to estimate future earnings, we need to know how much better or worse earnings might depart from what we predict. In our example, it is knowing whether future earnings are likely to be $1.5\pi_1$ or $.5\pi_1$, rather than $1.75\pi_1$ or $.25\pi_1$.

We can measure the variance in earnings over time using the term σ . Although σ has no *independent* effect on the expected value of the future stream of earnings of the firm as a going concern, it does affect the value of being able to postpone the liquidation decision. As the volatility of firm earnings increases, the potential gain from waiting increases.

The volatility of future earnings does not affect the liquidation value. We can still liquidate the firm for the same amount L at any point in time. The increase in downside exposure from higher volatility is merely the lower earnings we receive before we liquidate, not the amount realized in the event of liquidation. These low earnings in bad states do indeed become even lower as the variance increases. But the possibility of very low earnings for one period (immediately after which the decisionmaker will then liquidate the firm for L) is more than offset by the possibility of high earnings in *all* future periods when things turn out better than we expected.

In our example, the increased downside was the risk of receiving a return of $.25\pi_1$ rather than $.5\pi_1$ for a single period, but the upside gain was the possibility of receiving $1.75\pi_1$ rather than $1.5\pi_1$ in each period indefinitely. As we can see from comparing (2) and (4), the possible gain over all future periods when variance increases is greater than the loss in a single period. This result holds in the general case as well.²⁶

V. EXERCISING THE LIQUIDATION OPTION

The decisionmaker needs to know how much can be realized by selling the assets; she also needs to know the current income the firm

²⁶ See Appendix 1.

is generating. But option pricing forces us to focus on two additional elements: (1) the average growth (μ) of this earnings stream over time; and (2) the variance of earnings (σ) within any period of time. These characteristics of firm earnings pin down the value of the decisionmaker's option to liquidate.

Both characteristics of the firm— μ and σ —will depend on industry- and firm-specific factors. In some industries, firms are likely to generate a more or less constant and predictable flow of revenue over time. We open a pizza parlor. Income during the first few months may be somewhat variable as we iron out the kinks in management and customers learn about our service. But after those first few “start up” months, our firm will generate a steady stream of income over time. It will rise more or less in sync with inflation and there will be relatively little variance, and much of that will be connected with overall conditions of the economy. Thus the expected growth rate of firm earnings μ is low and the variance of earnings each period σ is close to zero.

Armed with this information alone, a decisionmaker might well be able to make the liquidation decision once she had only modest and readily accessible knowledge about the firm. The pizza parlor occupies a highly desirable storefront. It has been in business for several years, it is not meeting its ongoing operating expenses, and nothing in the environment is about to change. Because it is unlikely that firm revenues (and profit) will increase in the future, we are may be better off if the decisionmaker liquidates firm assets sooner rather than later.

In other words, when profitability of firms in a particular industry grows slowly and is fairly predictable (μ and σ are relatively low), the value of the liquidation option is small. The decisionmaker does not raise the value of the firm by deferring the liquidation decision to a future date. The relevant information is at hand and the possibility that earnings will unexpectedly rise in the future is low. Hence, we are better off if the decisionmaker exercises the liquidation option sooner rather than later.

The hard cases arise when the volatility of firm profit (σ) is high. Volatility may exist at the outset because of conditions that are firm specific. The firm needs to make significant changes in its operations, perhaps because of mismanagement in the past. Similarly, mismanagement may make it hard for anyone to have a grasp on the firm's prospects. During the first few months of the postpetition period, earnings will be highly uncertain, but the volatility may decline over time. Long-term volatility, the climate in which the liquidation decision matters the most, can arise when there is wide-variation among similar firms in the same industry. From the perspective of the decisionmaker, the variance of earnings σ is quite high in these firms, even though the expected growth rate μ may be high or low.

When the variance of firm profit (σ) is high, the decisionmaker is most likely to increase the welfare of all parties by deferring the liquidation decision to some future date and waiting for more information about firm profitability in the interim. Greater uncertainty (σ) increases the value of the liquidation option. The potential upside increases (the possibility that firm profit will increase in the future) while the potential downside is limited by the liquidation value of firm assets. If the firm is at least generating a positive cash flow and the liquidation value of the assets is stable, delaying the liquidation decision merely postpones the time at which we realize L , the liquidation value of the firm. This cost is worth bearing when there is a possibility that the future income in every period may turn out to be large.²⁷

²⁷ Although we characterize σ as a measure of the volatility, uncertainty, or "riskiness" of firm profits, we use these terms informally. Technically, σ is only a measure of the standard deviation of profits, i.e., the spread of outcomes around the expected (average) profit level. Thus, σ should not be confused with the standard measure of "riskiness", *beta* (β), which measures the sensitivity of an asset to market movements. If an investor holds the market portfolio (e.g., the Standard and Poor's Composite Index) and is considering purchasing a share of firm profits, beta would measure the contribution of that share to the riskiness of the investor's portfolio, i.e.,

When a firm first enters the recapitalization process—the process of the actual or hypothetical sale that leads to a better capital structure—the decisionmaker has very little information about the firm and its prospects. The decisionmaker will not know the extent of the firm's assets. Also unclear may be the ability of the firm to generate earnings in the future. There may be uncertainty about the demand for the firm's products. Costs may be uncertain as well. The firm may need to restructure its management or operations in order to reduce costs. Only time will tell whether these efforts are successful. Finally, uncertainty may arise from the state of the industry. Troubled firms are often in a troubled industry, and the future prospects of the firm may depend heavily on the prospects of the industry as a whole.

These forms of uncertainty will affect the expected earnings π_t . Notice that each form of uncertainty will also affect the variance of future profitability σ . As the court receives more information about firm assets or the ability of the firm to cut costs, it will gain a clearer picture of the firm's future prospects. Thus, we expect this component of variance to decline over time. However, we do not expect total variance σ to fall so far that the variance of profits becomes trivial. Uncertainty about the industry and about demand for firm product—as well as uncertainty arising from factors not considered here—will remain relatively constant over time. Thus we expect σ to fall, but at a decreasing rate. In other words, there are diminishing returns to gathering information over time.

the extent to which that share of firm profits increases the variance of the investor's portfolio. In contrast, σ merely measures the extent to which firm profits will deviate from the expected (average) level of profits. While an increase in σ will increase the variance of profits, it may reduce the variance of the investor's portfolio (if firm profits are negatively correlated with the market rate of return). For more discussion of the relationship between σ and beta, see Brealey and Myers, *supra* note 24, ch. 7 (1991).

Thus, the value of the liquidation option will decrease with time. Recall that the value of the liquidation option increases with the variance of profit: the higher the variance, the higher the probability that profits will increase tomorrow. The variance of profit is decreasing; hence the value of the liquidation option is decreasing. This implies that the earnings p^* one needs to justify delaying the liquidation decision *increases* over time. In other words, a decisionmaker should be less patient, more willing to make a once-and-for-all liquidation decision, as she learns more about the prospects of the firm (and therefore the variance of future earnings σ declines).

These features of our model have testable implications. The probability that a decisionmaker will liquidate firm assets should be low when the firm enters the recapitalization process and then rise dramatically as more information becomes available and the variance of earnings σ falls. However, the probability of liquidation should eventually decline. If the decisionmaker chooses not to liquidate a firm's assets within the first few months of the recapitalization process, she is unlikely to do so ever. Since the firm has survived the decisionmaker's scrutiny during the early months when she is gathering information, it must be a firm with strong prospects.

This is a form of "selection" effect: only the firms with strong prospects will survive the early period of judicial scrutiny. These are the firms that should remain as going concerns, so the probability of liquidation will be quite low. In short, the probability of liquidation during the postpetition period should be "hump" shaped. It should be low initially when little information is available, then rise substantially as the decisionmaker identifies the firms with no future, and then fall since the only remaining firms have strong prospects.²⁸

²⁸ These implications of our model are identical to those arising from models of job search, where a real options model is frequently used to study the decisions of workers to enter and exit firms. A seminal paper in this area is Boyan Jovanovic, *Job Matching and the Theory of Turnover*, 87 J. Pol. Econ. 972 (1979). Scholars have confirmed the empirical predictions of these job search models and found that the probability (or "hazard rate")

IV. THE LIQUIDATION DECISION AND FIRM-SPECIFIC INVESTMENT

Thus far we have made several simplifying assumptions that permit us to focus squarely on the liquidation option in bankruptcy decision making. We have assumed, for example, that the bankruptcy judge has only two choices in each period: either liquidate the firm or allow it to continue operating. In reality, the judge will face a more complex set of choices: if she does not liquidate the firm today, she can still choose among several alternative reorganization plans that offer different combinations of expected earnings growth μ and volatility σ . A richer set of choices, however, would not change our analysis in the previous section. In each period, the judge would rank the various reorganization plans using a somewhat complex algorithm that depends critically on the plan's combination of μ and σ .²⁹ Once the best plan is identified, that plan becomes the alternative to liquidation and the judge applies the same decisionmaking process that we identified in Section IV.

Perhaps more controversially, we have assumed that the liquidation value of the assets L remains constant.³⁰ There are many good reasons why the liquidation value L may rise or fall if the bankruptcy judge permits a troubled firm to continue operating. Frequently some of the existing assets will be used as the firm operates. If the firm

that workers will exit a firm is “hump shaped” with respect to worker tenure. See, e.g., Julia Lane & Michael Parkin, *Turnover in an Accounting Firm*, 16 *J. Labor Econ.* 702 (1998).

²⁹ This algorithm is known as a dynamic allocation index (DAI) and is central to the “multi-armed-bandit” literature. For a discussion of this literature and the assumptions underlying a DAI, see Robert A. Miller, *Job Matching and Occupational Choice*, 92 *J. Pol. Econ.* 1086 (1984). A seminal paper in this literature is Martin L. Weitzman, *Optimal Search for the Best Alternative*, 47 *Econometrica* 641 (1979).

³⁰ There is no inflation in our model, so L measures the value of firm assets in real terms.

performs poorly, these assets will be lost and L will fall; if the firm performs well, however, these assets may be recouped and L will be unchanged (or may even rise). For example, hard assets like money can be spent on research and development. If the firm subsequently fails, the dollars spent on R&D are lost and the value realized in nominal dollars from the asset sale is lower than if liquidation had take place earlier. But if the firm is successful in subsequent periods, the R&D expenses may enhance the value of firm assets: product innovation not only attracts new customers but also increases the value of the firm's brand name, its good will, and other assets. Again, however, the qualitative results of our simple model in Section IV do not change when we allow L to rise or fall over time.

There are many ways to explain why we might see variation in the liquidation value L . We might assume, for example, that the liquidation value in any period is correlated with earnings in that period. If earnings fall, L also falls. We believe, however, that the most natural way to think about changes in the liquidation value of firm assets is to assume that L varies as a result of *investment decisions*. When a firm needs a new capital structure, it may need new capital investments as well. Some of these may be investments in human capital. (For example, we must pay a bonus to bring on a new chief executive officer.) We may also need to replace some of the key equipment. Or we need to acquire new inventory. We incorporate this possibility into the model in this part. The most important cases are those where the expected earnings of the firm as a going concern (discounted to present value) are less than the liquidation value when the bankruptcy starts at $t = 1$. Hence, we focus on these.

We can return to our model and assume that, if the firm is not liquidated for $L = \$100$ at $t = 1$, we shall need to spend \$20—half on new equipment and half on new inventory. If the firm liquidates at $t = 2$ or in any later period, L in nominal dollars will only be \$90 because only half of what we spend on pump-priming can be recovered in a liquidation. We can recapture a large part of the value of the new equipment, but only a small part of the value of the new inventory. To highlight the effect of reductions in L on the liquidation option, we will assume first that the \$20 expenditure has no effect on

the growth (μ) or volatility (σ) of earnings. Therefore, the decision-maker should wait before liquidating the firm only if

$$.5\left(\frac{1}{1.1}\right)\left[(1.5p_1 + 15p_1) + (.5p_1 + 90)\right] - 100 > 0 \quad (6)$$

Simplifying, this becomes:

$$7.73p_1 - 59.09 > 0 \quad (7)$$

The left-hand side of (7) is simply the value of the liquidation option, so waiting makes sense only when this option has positive value. Comparing (7) with the value of the liquidation option in our original model (2), we see that when money must be spent at the start of the case in order to keep the firm intact, the value of this option goes down. If the earnings received at $t = 1$ are still \$8, the decisionmaker should still keep the firm intact. The liquidation option has positive value so long as $\pi_1 > 7.64$. But the decisionmaker can reach this conclusion only if she understands how money spent at the start of the case affects both the liquidation value and the liquidation option.

A closer look at our model helps illuminate the question of pump priming. We can separate the money being spent each period by the firm and separate it into two categories. First are the expenses of the ongoing operation of the firm; second are those that can be considered investments on which there will be returns in the future. Money spent on new equipment or on research and development all fall in the second category.

Firm-specific capital investments (broadly defined, including human capital) increase the value of the firm if it remains as a going concern. In terms of our model, it increases μ , the rate at which the earnings will grow. But such investments, at least over the short term, reduce L —the value of the assets if liquidated. A firm-specific investment, by its nature, has value only if the firm continues as a

going concern. These investments also affect the value of σ . The effect on σ , however, is ambiguous. Some investments may, for example, improve the reliability of the firm's equipment and ensure that the firm can maintain a high level of output. Other investments, however, may have a high component of risk associated with them. These are perhaps the most interesting ones.

A firm must retool its factory to remain competitive. The choice might be between something conventional and something that uses new technology. The safer alternative preserves the value of L . The new technology requires custom machines that are harder to liquidate than more generic ones. While there are greater returns to the firm that uses the new technology, there is also greater uncertainty about these returns. In other words, new technology increases both μ and σ .

The more L decreases, other things equal, the earlier one should exercise the liquidation option. But the same riskiness that leads to a lower liquidation value also should lead to greater benefits from keeping the firm intact as a going concern. Much turns on the relationship between the time at which firm-specific investments need to be made and the speed that we learn whether they will pay off. The liquidation option is most likely to be valuable where the initial firm-specific investments are small and where σ declines quickly. Waiting is least attractive when the investments come early and information about their efficacy comes later.

VII. THE LIQUIDATION DECISION IN CHAPTER 11

In this part, we draw on our model to assess how well Chapter 11 makes the liquidation decision. There is no specific provision of the Bankruptcy Code that deals with liquidation as we are using the term. Rather, there are a number of processes that, in the context of the case, are tantamount to asking the judge to shut the firm down. For example, granting a motion to convert a Chapter 11 case to Chapter 7 case typically has the effect of shutting the firm down.³¹

³¹ See 11 U.S.C. §1112.

Similarly, a judge that grants a secured creditor's motion to seize its collateral knows that her decision will close the door of the firm forever.³² Denying the debtor the ability to use cash collateral or to obtain debtor-in-possession financing may have the same effect.³³

We can assess how much sense it makes to entrust the bankruptcy judge with the liquidation decision by comparing her position with that of the decisionmaker we see emerge when the matter is left to private contracting. In high technology industries, the venture capitalist controls the liquidation decision when the firm is in economic distress. The Chapter 11 mechanism is similar in that it too puts the liquidation decision the hands of a single individual. We need to ask, however, whether the substantial differences between venture capitalists and bankruptcy judges are ones that matter for purposes of making the liquidation decision.

Bankruptcy judges are not subject to market discipline. Venture capitalists have their own money on the line.³⁴ Not only does their own financial stake make them intensely interested in making good decisions, but there is a natural sorting mechanism as well. The venture capitalists who make good liquidation decisions succeed. Those who cannot run out of money and cease to be venture capitalists. There is no similar competitive process or sorting mechanism for bankruptcy judges who make these decisions badly. They are subject to reappointment every 14 years, but making the liquidation decision is a small part of their docket and the people who make the reappointment decision (other federal judges) are not themselves well-positioned to assess the bankruptcy judge's performance.

³² See 11 U.S.C. §362(d)

³³ See 11 U.S.C. §364.

³⁴ Those who contribute to venture capital funds usually insist that the person actually making the decisions have her own capital invested in the fund as well. This investment ordinarily represents 10% of the entire fund and a much larger percentage of the venture capitalists net worth.

Another force at work may magnify this effect. The debtor's lawyers have flexibility to shop for different venues.³⁵ Their natural bias may be towards jurisdictions in which the judge is most likely to award them generous fees. Fees are higher the longer the bankruptcy runs. Hence, the liquidation decision may be entrusted to those bankruptcy judges who are most reluctant to make it.³⁶

Venture capitalists tend to specialize in particular industries and spend much of their time picking and choosing among different investment opportunities. The venture capitalist then closely monitors the firm during the entire period of its investment. By contrast, the bankruptcy judge is a generalist. The overwhelming majority of her cases (and much of her time) is spent with consumer debtors. Of the few Chapter 11 cases on her docket, only a handful will involve ongoing businesses in which a nontrivial liquidation decision must be made. The lack of experience may magnify the cognitive bias one often sees in decisionmaking of this kind, the familiar problem of escalating commitment.³⁷ This cognitive bias may lead bankruptcy judges to make liquidation decisions too late.

Successful venture capitalists are sophisticated investors. Bankruptcy judges are lawyers by training. Most will have never run a business or made payroll or brought a new product to market. They typically have no training even in the fundamentals of corporate fi-

³⁵ Eisenberg and LoPucki find that "forum shopping" takes place in half of the large Chapter 11 cases. See Theodore Eisenberg & Lynn M. LoPucki, *Shopping for Judges: An Empirical Analysis of Venue Choice in Large Chapter 11 Reorganizations*, 84 Cornell L. Rev. 895 (1999). This study is incomplete, however, because it is unable to show whether the observed "forum shopping" reflects rent-seeking by lawyers or instead reflects the debtor's search for judges with greatest expertise.

³⁶ See Robert Rasmussen & Randal S. Thomas, *Timing Matters: An Economic Explanation of Forum Shopping by Insolvent Corporations* (manuscript, Vanderbilt University May 1999).

³⁷ See, e.g., Barry M. Staw, *Knee-Deep in Big Muddy: A Study of Escalating Commitment to a Chosen Course of Action*, 16 Org. Behav. & Hum. Perf. 22-44 (1976).

nance. One can become a bankruptcy judge without knowing the first thing about discounting to present value, marginal and average costs, and sunk costs.

In addition, the venture capitalist will have detailed expertise about the firm long before it encounters financial distress. At the start of the case, the bankruptcy judge will know nothing about the firm itself. In the rare case in which the bankruptcy judge is familiar with a firm or the people who run it, she might be forced to recuse herself because of the appearance of a conflict of interest.

Finally, once the Chapter 11 case starts, the judge must stand at a distance. Section 341 of the Bankruptcy Code forbids the bankruptcy judge from attending the meetings at which the managers of the firm must turn over information to the creditors. Rules of judicial conduct limit the ability of the bankruptcy judge to gather information informally. She probably cannot even talk with any of the players outside the presence of the others.

For all these reasons, one might well conclude that the bankruptcy judge is ill-equipped to make the liquidation decision and that therefore one should focus upon recapitalization processes, such as expeditious sales of the entire firm to third parties, that take as little time as possible.

We need to be careful here, however. The trajectory of bankruptcy reform over the last 15 years has been emphatically in the direction of a shorter process and the use of market mechanisms. But shortening the process is itself costly. One does not, for example, want to incur the costs of orchestrating a going-concern sale if the firm will be liquidated before the sale can be consummated. More to the point, reorganization regimes will always take some amount of time. It is hard in such an environment to create a mechanism in which the person who makes the liquidation decision has a financial stake in making the decision well. One might require the bankruptcy judge to accept bids from investment bankers and others to oversee the sale and make the liquidation decision if necessary. This process itself, however, will take time. More to the point, it may be no easier

for the bankruptcy judge to make this decision well than to make the liquidation decision.

Many of the other benefits that the venture capitalist enjoys relative to the bankruptcy judge may exist with respect to other possible decisionmakers as well. The judge does not have the venture capitalist's experience with the firm, but anyone else brought on to the scene would not have it either. Unlike ordinary judges, the bankruptcy judge can bring in experts to evaluate the firm.³⁸ In this respect, she is no worse off than an investment banker. Moreover, she can compel those who work for the firm to turn over information and testify under oath. Moreover, the natural bias of the equityholders in favor of reorganization and that of the creditors in favor of liquidation induces each to turn over information to the bankruptcy judge. As we have already noted, the contracts that venture capitalists write assume that judges can acquire firm-specific information.

The liquidation decision may be the one where the differences between the venture capitalist and the judge matter relatively little. Venture capitalists play many roles in addition to that of the person who makes the liquidation decision. Most important perhaps, she must decide whether to inject new capital into the firm. The liquidation decision itself requires only an up-or-down decision. The decisionmaker needs to be able to answer three questions:

1. What are the prospects of this firm relative to others in the industry?
2. How unpredictable are the prospects of firms in this industry?
3. How much will we receive if we shut the firm down and how will this change?

The questions here are simply another way of asking about the values of μ , σ , and L respectively. The bankruptcy judge may be well equipped to answer these questions even if she would not be

³⁸ She can do this by having an examiner appointed.

adept at making operating decisions. Indeed, it may be much more important to have an intelligent person who is able to be decisive than it be to have someone who poses particular expertise. The common virtue for any judge lies in being able to make decisions and live with them. It may be far better to have a judge make the liquidation decision than an economist, a law professor, or a mid-level corporate executive. For the liquidation decision, what matters most is that someone has the power to gather information and is surrounded by people who have every incentive to convey it in an accessible way. After this point is reached, the challenge may not lie in the flow of information or the ability to process it, but rather in having a decisionmaker who possesses the confidence, the willingness, and the ability to act decisively.

There is another way of putting the point. If asked to evaluate trial judges, lawyers most often distinguish among them by their ability to listen and make decisions when the time comes. Bad judges don't listen to the evidence, they cannot bring things to closure, and, when they do, they act indecisively and inconsistently. Bankruptcy judges who are otherwise good judges have the virtues needed to make the liquidation decision well. The ability of Chapter 11 to make the liquidation decision well may turn on how able the bankruptcy judges are as a general matter. If judges are well chosen for other purposes, they will be adept at making the liquidation decision, at least if they know what questions to ask.

Let us assume that we have created a reorganization process that lasts the optimum amount of time and we want to know how to improve the way in which liquidation decisions are made. Given the nature of the liquidation decision, asking this question is likely to be little different from asking how to make bankruptcy judges better. To be sure, the inquiry here is one in which intuitions about finance may matter more than for a judge whose docket consisted of criminal law cases, but such intuitions are important for bankruptcy judges as a general matter. One might prefer a legal system like those in civil law countries in which judging is a discrete career path and promotion turns on performance. Such a system may place a

higher premium on an ability to take action when the time comes. But the arguments here may track those that already exist in the larger debates on this point.

There is, however, an important caveat to this claim that a reorganization regime with well-chosen judges is likely to be one that makes liquidation decisions well. The bankruptcy judge's role in a reorganization is passive. The bankruptcy judge's window on the case is now largely limited to the discrete issues parties bring to her in open court. By contrast, the venture capitalist decides when to gather additional information and when to take the measure of the firm. The venture capitalist can take the pulse of the firm as often as she wants. The bankruptcy judge can do it only after a party requests a decision and after other interested parties are notified and brought into open court.

In a typical tort case, such procedures are unproblematic. Common law actions revolve around money damages. Tort law works because it aligns incentives before the fact. By contrast, the liquidation decision is a decision about how resources are used. Being able to control the timing of the decision matters as much as being able to make the correct decision when asked to do so. To make the liquidation decision effectively, the bankruptcy judge must be able to decide when the question comes before her. We return to the model in the next part and show that this deficit matters the most in the cases that we care the most about.

VIII. THE COSTS OF PASSIVE JUDICIAL DECISIONMAKING

When a firm must make firm-specific investments, what is clear is the need for the decisionmaker to have a constant flow of information. At every point in time, the decisionmaker must assess the cost and benefits of exercising the liquidation option. This can happen only if the decisionmaker is well-informed. Judges frequently make their liquidation decisions turn on the existence of a business plan from the debtor. Similarly, proposed legislation provides that the bankruptcy judge must dismiss the Chapter 11 case or convert it

to Chapter 7 if the debtor fails to attend meetings or fails to provide information.³⁹ This practice and these rules can be seen as devices to ensure that the judge possesses the information needed to make the liquidation decision. The information matters not simply because it tells the judge whether the debtor can implement a plan. It also tells the judge whether it is worth waiting any longer to find out.

Under current law, however, the judge has the power to liquidate only when a discrete issue comes before her. A venture capitalist can decide when to make a further inquiry and ensure she is prepared to make the liquidation decision whenever it makes sense. The bankruptcy judge must wait for others to come to her. Their incentives may lead them to miss the optimal moments. Even if someone has the incentive to come at the optimal time, others can take actions that have the effect of speeding up the process or slowing it down. To return to our stylized example, current law puts the judge in the situation we would be in if the firm continued to receive earnings in each period, but the judge could make the liquidation decision only in every other period. This part explores the effects of this constraint on the liquidation option.

When a venture capitalist has a controlling interest in a firm, she has the power to liquidate it at any time. By contrast, the bankruptcy judge can decide to liquidate a firm only when there is a hearing. Even if interested parties did not behave strategically in bringing the question to the court, the bankruptcy judge stands in a position different from and inherently inferior to that of the venture capitalist. The bankruptcy judge's greatest handicap may not lie in how much expertise she possesses or how much knowledge she possesses relative to the venture capitalist, but in her inability to assess the value of the firm continuously.

Over the years, bankruptcy judges have mitigated this deficit by calling status hearings on their own motion. Congress added explicit statutory authority for this practice in 1994 when it added §105(d) to

³⁹ S. 625.

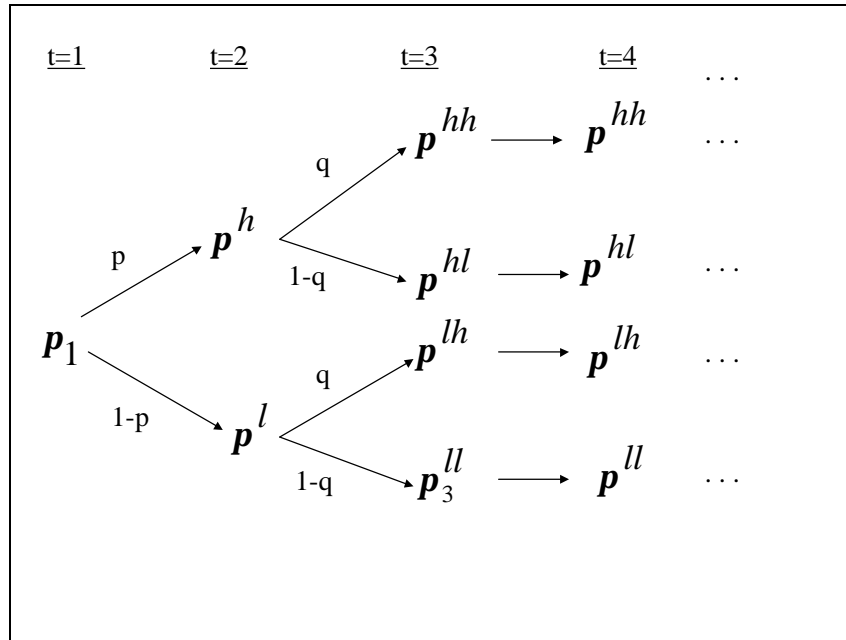
the Bankruptcy Code. It also gives the bankruptcy judge the power to set a date for the filing of a plan of reorganization. These provisions, however, fall short of giving the bankruptcy judge the ability to monitor the case as closely as the venture capitalist. Our model of the liquidation decision suggests that this inability is costly. Indeed, it is the most costly in those cases where it matters the most, those where the variance in future earnings is the highest and therefore the liquidation option is worth the most.

It is a commonplace that many of the costs of bankruptcy arise because of the dramatic change in the debtor's condition between one decision point and another. Intuition tells us that the potential cost of waiting rises as we move from a setting where the decisionmaker controls the timing of the decisions to one in which the decisionmaker can make the decision only when others present it to her. Our model provides a rigorous way to unpack this intuition.

A. A Model of Passive Judicial Decisionmaking

The simple two-period model of the previous section was a model in which the decisionmaker could make a decision at every relevant date (although we only allowed for two decision dates). To explore the consequences of decisionmaking in which the decisionmaker lacks such control, we extend this model to three periods (Appendix 2 contains a general model). Thus, consider the distribution of firm earnings in Figure 2.

Figure 2

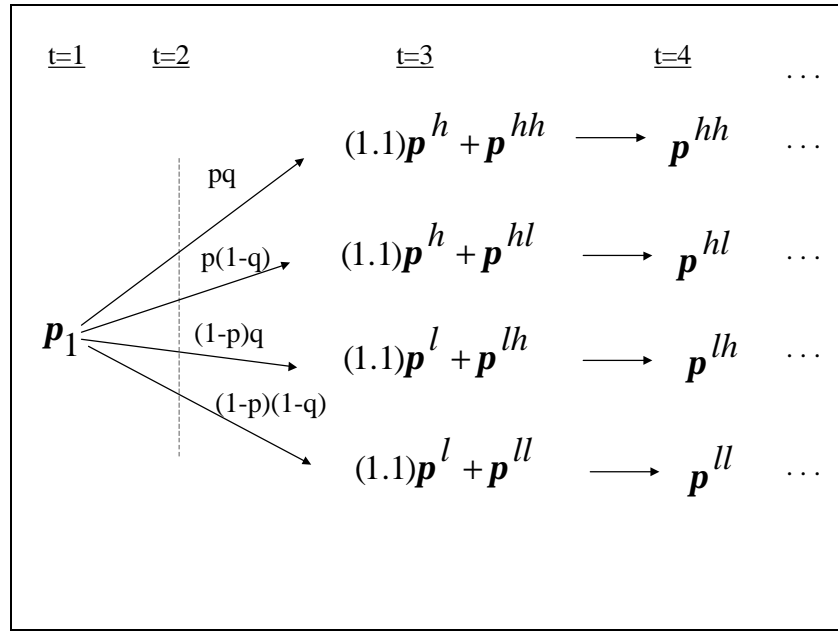


As before we are assuming that a firm files for Chapter 11 protection at $t = 1$, the liquidation value of the firm is constant L at every date, and the discount rate is 10%. Now, however, there are *potentially* three opportunities to make the liquidation decision—in periods $t = 1$, $t = 2$, and $t = 3$. If the firm is not liquidated at $t = 3$, it will continue as a going concern indefinitely.

Additionally, there is uncertainty over future earnings at both dates $t = 2$ and $t = 3$. At $t = 2$, earnings will be high π^h with probability p and low π^l with probability $1-p$. At $t = 3$, the distribution of earnings depends on the price in previous period. If earnings are high at $t = 2$, earnings at $t = 3$ will be high π^{hh} with probability q and low π^{hl} with probability $1-q$. Similarly, if earnings are low at $t = 2$, we expect earnings to rise to π^{lh} with probability q and fall to π^{ll} with probability $1-q$.

If the judge could make decisions continuously, she would face the distribution of earnings in Figure 2. We want to explore what happens when the judge can make decisions not at every possible time, but only at a scheduled hearing.⁴⁰ We can incorporate this idea into the model here by assuming that the judge can only make decisions at dates $t = 1$ and $t = 3$. Unlike a venture capitalist, she cannot make a decision at $t = 2$. A judge in this setting faces the distribution of firm earnings in Figure 3.

Figure 3



⁴⁰ Under § 1109, every party in interest may raise and appear and be heard on any issue in the case. Hence, we are assuming that the handicap that bankruptcy judges suffer is not that one party can manipulate the time at which a meeting is held, but rather that meetings must be scheduled before a decision can be made and this in turn takes time.

In this setting,⁴¹ the judge faces a “lock-in” effect. If she chooses not to liquidate the firm at $t = 1$, she has *locked* herself and all other parties into this decision for a discrete interval (i.e., until $t = 3$). We are capturing the idea that she cannot make a liquidation decision again until the parties are gathered in court before her on another issue. During this interval, events may occur—earnings may fall and liquidation may be optimal—but the judge will be unable to react.⁴²

This lock-in effect reduces, but does not destroy, the value of the liquidation option. Indeed, even in a setting of discrete decision-making the judge must balance the value of waiting two periods (from $t = 1$ to $t = 3$) for more information before liquidating the firm against the immediate payoff from liquidation. The lock-in effect, however, implies that a judge will be less patient—and more willing to exercise the liquidation option at $t = 1$ —than the venture capitalist. Moreover, even if the judge does wait until $t = 3$ to liquidate the firm, liquidation may take place later than was socially optimal.

The lock-in effect implies that the longer the period between decisions, the greater the social costs due to poorly timed (i.e., premature or delayed) liquidation of troubled firms. The value of the liquidation option will be lower when the judge faces Figure 3 than when she faces Figure 2. Most significantly, the greater the uncertainty about the future profitability of the firm, the more dramatic this effect. Discrete judicial decisionmaking is most costly (due to

⁴¹ We inflate earnings received at $t = 2$ (π^h or π^l) at the rate 10% to reflect accurately their expected value at $t = 3$.

⁴² Parties, of course, have the ability to make emergency motions and obtain expedited review. Some forms of relief, such as a temporary restraining order, do not even require the presence of other parties. One might obtain such relief if, for example, those running the company were about to abscond with its assets. But ordinarily a sudden change in condition (such as the debtor’s failure to renew its insurance policy) is needed to obtain review outside the ordinary course. Our concern, however, is primarily with which information accretes gradually over time.

poorly timed liquidation decisions) for firms with high variance σ in earnings. The liquidation decision matters the most for firms whose earnings are the most uncertain. Yet it is precisely these firms that are hurt the most by delay in judicial decisionmaking. And the longer the delay between judicial decisions, the higher the cost of premature or delayed liquidation.

As in our previous model, we make a number of simplifying assumptions. The liquidation value of firm assets L is \$100. Initial earnings π_1 are \$10. Firm earnings at $t = 2$ are either \$15 or \$5 with equal probability.⁴³ If earnings were high at $t = 2$, earnings will be \$17.50 or \$12.50 with equal probability at $t = 3$.⁴⁴ And if earnings were low at $t = 2$, we expect earnings of \$7.50 or \$2.50 at $t = 3$ with equal probability.⁴⁵

Consider first the value of the liquidation option when the decisionmaker controls the timing of decisions, that is, when she is *not* a passive decisionmaker. The value of the liquidation option at $t = 1$ will depend on the decisionmaking process in all future periods. Hence, it is easiest to start by looking at the decisionmaking process at $t = 3$ and then reason backwards. If current earnings are $\pi^{hh} = \$17.50$, the discounted value of the future stream of earnings at $t = 3$ is \$175. If earnings are $\pi^{hl} = \$12.50$, the present value of future earnings falls to \$125. In both cases, the decisionmaker will keep the firm intact as a going concern, as both amounts exceed the liquidation value of \$100.

If earnings fall at $t = 2$, but then rise at $t = 3$, the present value of future earnings (in this case, earnings of $\pi^{lh} = \$7.50$) is \$75. Finally, if earnings are $\pi^{ll} = \$2.50$ at $t = 3$ (that is, if earnings are low at both times), future earnings are worth only \$25. In either case, the decisionmaker will liquidate the firm at $t = 3$, as both earning streams are less than \$100.

⁴³ We are assuming that $\pi^h = 1.5\pi_1 = 15$ and $\pi^l = .5\pi_1 = 5$.

⁴⁴ We are assuming that $\pi^{hh} = 1.75\pi_1 = 17.5$ and $\pi^{hl} = 1.25\pi_1 = 12.5$.

⁴⁵ We are assuming that $\pi^{lh} = .75\pi_1 = 7.5$ and $\pi^{ll} = .25\pi_1 = 2.5$.

Now turn to the decisionmaking process at $t = 2$. Assume first that earnings are high at $t = 2$. If the firm is allowed to continue operating, the worst that could happen would be for the earnings to drop to \$12.50 each period and remain there forever. The discounted value of such an earnings stream is \$125, while if the decisionmaker liquidates, the payoff to creditors is only \$100. Hence, if the earnings are high at $t = 2$, we are better off keeping the firm intact, even if we encounter the worst possible outcome at $t = 3$. Keeping the firm intact is a strictly dominant strategy.

The opposite is the case when earnings are low at $t = 2$. The best the firm can do is earn \$7.50 at $t = 3$ and then \$7.50 each period afterwards. Discounted to its value at $t = 2$, this income stream is worth only \$75. Even in the best case, we are always better off liquidating the firm and receiving \$100 if we have low earnings at $t = 2$. Liquidation is a strictly dominant strategy.

With this characterization of the decisionmaking process at $t = 2$, we can consider the value of the liquidation option at $t = 1$. As before, we need to compare the liquidation value of \$100 to the value of waiting to make the liquidation decision next period. If earnings are high at $t = 2$, we shall keep the firm intact. Hence, the expected income stream from the firm if earnings prove high at $t = 2$, discounted to its value at $t = 1$, is \$150.⁴⁶

If earnings turn out to be low at $t = 2$, we know we shall liquidate the firm. We shall receive low earnings of \$5 at $t = 2$ and we shall also receive the liquidation value of \$100 at $t = 2$ as well. We discount this total of \$105 to its value of a little more than \$95.45 at $t = 1$. Our expected return from waiting until $t = 2$ before deciding whether to liquidate the firm is therefore \$122.73, the average between these equally likely outcomes (\$150 and \$95.45 respectively).

⁴⁶ We know that we shall never liquidate if earnings are high at $t = 2$. Hence, we take the income stream of \$15 a period (the average of receiving with equal likelihood either \$17.50 or \$12.50 at $t = 3$) in every period thereafter and we discount it to present value. This equals \$150 at $t = 1$.

The value of the liquidation option is the difference between this amount and \$100, or \$22.73.

We now consider the case of *passive* decisionmaking – the decisionmaker can decide to liquidate the firm at $t = 1$ or $t = 3$, but not at $t = 2$. The decision process at $t = 3$ is the same as before. The decisionmaker must make a once-and-for-all decision whether to liquidate the firm. We know that the decisionmaker, if given the chance, will keep the firm intact if earnings are either \$17.50 or \$12.50. Similarly, we know she will liquidate if earnings are \$2.50 or \$7.50.

As in the two-period model, we value the liquidation option at $t = 1$ in this setting by comparing the immediate \$100 payoff from liquidation to the present value of the earnings of the firm if we wait until $t = 3$ to make the liquidation decision. If earnings are high at $t = 2$, we know we shall keep the firm intact no matter what happens between $t = 2$ and $t = 3$. We already know that this earnings stream is worth \$150.⁴⁷ Because it is likely to happen half the time, we discount it to \$75. If instead earnings are low at $t = 2$, we need to take into account the effect of liquidating at $t = 3$, which is optimal whether earnings rise or fall between $t = 2$ and $t = 3$. If earnings are high (\$7.50), the payoff to creditors is: (a) \$5.50, earnings at $t = 2$ adjusted to reflect their value at $t = 3$;⁴⁸ (b) current period earnings received at $t = 3$ (or \$7.50); plus (c) the liquidation value (or \$100). When we discount this amount to its value at $t = 1$, and adjust to reflect the probability that it will happen only one time in four, we have \$23.35. Similarly, if earnings fall to \$2.50, the discounted expected payoff is \$22.40.

Summing these discounted payoffs, we obtain the value of waiting to liquidate firm assets and find that it is \$120.75. Subtracting the liquidation value of \$100, we discover the option value is \$20.75. Thus, there is a difference between the value of the liquida-

⁴⁷ Once again, we are simply taking a stream of payments starting at $t = 2$ with an expected value of \$15 and continuing forever. Measuring at $t = 1$ and discounting by 10%, such a stream is worth \$150.

⁴⁸ This figure comes from $1.1 \times 1.5\pi_1 = 1.65\pi_1 = \16.50 , where π_1 is 10.

tion option if the decisionmaker is always able to liquidate (\$22.73) and its value if she cannot (\$20.75). The \$2 difference reflects the cost of liquidating the firm at the wrong time (in our case, the cost of liquidating too late). The parties are clearly better off with an active decisionmaker who has the ability to liquidate at $t = 2$ as well as at $t = 3$. When the decisionmaker is passive, however, the parties suffer. Half the time, creditors receive the \$100 liquidation value a period later than they would otherwise.

B. The Effect of Increasing Variance in Earnings

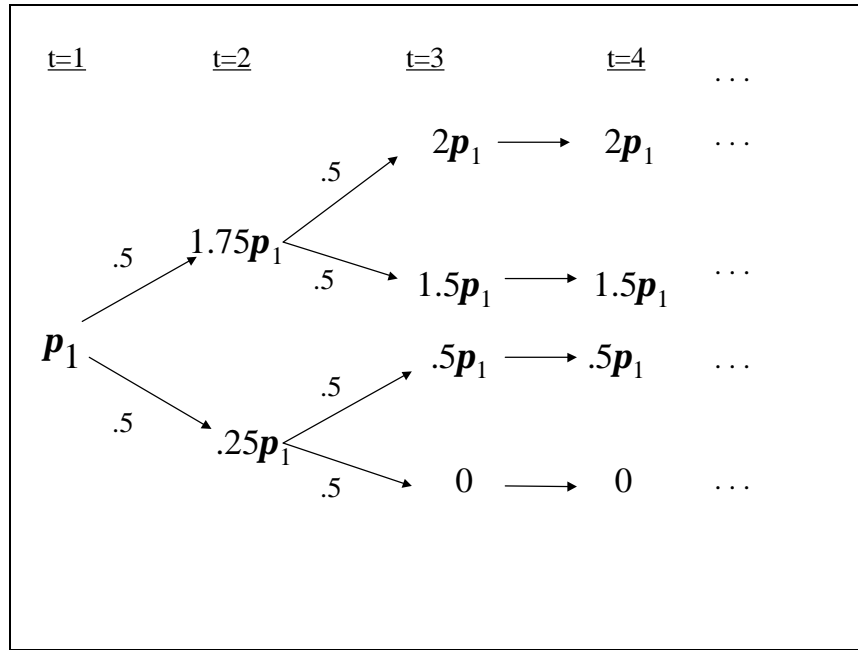
We have already shown that the value of the liquidation option increases as uncertainty over future earnings (i.e., the variance of earnings) increases. When the decisionmaker can decide at every relevant time, she possesses a liquidation option that allows her to wait for more information about firm profitability without exposing the firm to significant loss. But there is a new lesson here as well. If a judge is unable to make the liquidation decision at the optimal time, she is less able to take advantage of new information about firm earnings. Hence, the inability to control when decisions are made matters the most where the variance in earnings and the value of the liquidation option are highest.

We have already explored the effect of uncertainty on the liquidation option by increasing the “spread” of future earnings (i.e., the range of possible values) while holding constant the expected (mean) level of future earnings. We now do the same when the bankruptcy judge cannot control when decisions are made as well as the venture capitalist. Thus, assume now that distribution of firm earnings is given by Figure 4.

While the spread in future earnings is greater, the expected value of earnings at $t = 1$ if the firm remains intact as a going concern is unchanged. Thus, while we have increased the variance (σ) of earnings, we have held constant the expected growth rate (μ). Here we expect nominal earnings of \$10 in each period where $\pi_1 = 10$, but greater variance.

Our goal here is to examine the effect of uncertainty on the value of the liquidation option when the decisionmaker has the ability to liquidate at $t = 2$ and when she does not. We compute the option value in this setting of high uncertainty in precisely the same way we computed it in the setting of low uncertainty. We first identify the decisionmaker's optimal decision at $t = 3$ and then work our way back to $t = 2$. Finally, we can turn to the decision at $t = 1$ and compute the value of the liquidation option.

Figure 4



Because of the higher variance, the worst outcome if earnings at $t = 2$ are high is now \$15, instead of \$12.50. Similarly, the best outcome if earnings at $t = 2$ are low is \$5 instead of \$7.50. In the first example, the bankruptcy judge always kept the firm intact at $t = 3$ if earnings were high at $t = 2$ and always liquidated if earnings were low at $t = 2$. The same applies here even more strongly.

We can now turn to the liquidation decision at $t = 2$. If earnings are low in this period, the decisionmaker will liquidate the firm because again nothing is to be gained by waiting. The best outcome is a stream of earnings of \$5 in every period. The present value of such a stream discounted at 10% is \$50. We are better off if the firm is liquidated immediately for \$100. By contrast, if earnings are high at $t = 2$, the decisionmaker will continue the firm because she knows that liquidation will never be optimal at $t = 3$, where the worst outcome is a stream of \$15 each period, which has a present value of \$150.

Now we may turn to the decisionmaker's problem at $t = 1$ and compute the value of the liquidation option at that date. The decisionmaker must choose either to liquidate at $t = 1$ or preserve the firm until the next decisionmaking date. As always, liquidation yields \$100. If the firm is preserved, there are two outcomes next period. Earnings may rise and the payoff is a stream of payments of \$20 or \$15 with equal probability (or \$17.50 per period in expected value). Discounting to its value at $t = 1$, this stream is worth \$175. However, it is equally likely earnings will be low at $t = 2$ and we shall liquidate the firm. In that event, we shall receive earnings of \$2.50 and \$100 from liquidating the assets at $t = 2$. The expected value of these payments at $t = 1$ is \$93.18.

Given these outcomes are equally likely, the expected value of the firm if we wait until $t = 2$ is the average of \$175 and \$93.10 or \$134.09. As before, the value of the liquidation option is this amount less \$100 or about \$34. As in our two-period model, increasing the variance increases the value of the liquidation option, in this case from almost \$23 to a little more than \$34.

Consider now the value of the liquidation option when the decisionmaker can make decisions only at $t = 1$ and $t = 3$. We already know that if earnings at $t = 2$ are high, we shall keep the firm intact at $t = 3$ and that the expected value of the income stream, measured at $t = 1$, is worth \$175. We also know that the decisionmaker will liquidate at $t = 3$ if earnings were low at $t = 2$. The process for valuing the firm in this event is familiar. We confront two possibilities. The firm's fortunes might improve between $t = 2$ and $t = 3$. In this

event, the payoff to creditors at $t = 3$ is: (a) \$2.75, earnings at $t = 2$ (\$2.50) adjusted to reflect their value at $t = 3$;⁴⁹ (b) current period earnings (\$5); and (c) the liquidation value \$100. When we discount this amount to its value at $t = 1$, we have \$89.05. Similarly, if earnings fall between $t = 2$ and $t = 3$, we have the same type of calculation, except that there are no earnings at $t = 3$. When we discount this amount to its value at $t = 1$, we have \$84.92.

To measure the value of waiting until $t = 3$ to make a decision, we sum an even chance of receiving an income stream worth \$175, a 25% chance of receiving an income stream of \$89, and a 25% chance of receiving one worth \$84. This expected income stream is worth a little less than \$131. The value of the liquidation option is therefore about \$31.

As before, the greater uncertainty improves the value of the liquidation option. Even when the judge can decide only at $t = 3$, the higher uncertainty increases the value of the option from little less than \$21 to a little less than \$31. More interesting for us, however, is the importance of controlling the timing of the decision when the variance of the earnings increases. As we have seen, these are the cases where the liquidation option is worth the most.

When variance was low, the liquidation option was worth about \$23 when decisions could be made continuously and about \$21 when they could not be. The cost of discrete decisionmaking was \$2. As variance increased, the loss from discrete decisionmaking increased as well. The liquidation option was worth only \$31 instead of \$34. The difference of \$3 is greater than when the variance was lower. The \$1 difference, of course, is an artifact of our model, but the result itself is a general one. The more uncertainty in the earnings, the more harm done when the ability to liquidate the firm comes and goes.

We are worse off in a world in which the bankruptcy judge cannot control the timing the liquidation decision as well as the venture capitalist. Moreover, the ability to make decisions continuously

⁴⁹ This figure comes from $1.1 \times .25\pi_1 = .275\pi_1 = \2.75 , where π_1 is 10.

matters the most in the cases in which σ is highest. The greater the variance, the more important the liquidation option. But the greater the variance, the more important the ability to exercise the option at the optimum time. Separating the judge from active involvement in the case compromises the judge's ability to do this.

There is another effect worth noting. We have assumed that the decisionmaker is equally well-informed when she can make decisions only at given intervals. In terms of our model, we have assumed that the variance in earnings, σ , remains the same when the decisionmaker can make decisions at $t = 1$, $t = 2$ and $t = 3$ and when she can make decisions only at $t = 1$ and $t = 3$. Recall, however, that one of the components of σ was the decisionmaker's lack of information about the firm and its assets. If the decisionmaker has the ability to monitor as she chooses, the information flowing to her may be more steady and more reliable. If she returns to the case only when there is a new hearing and a new issue to be resolved, she may not know as much. This implies that σ will tend to decline more slowly over time when the judge lacks the ability to control the process actively. The less the judge can control the process, the more slowly will σ decline over time. Relative to the alternative world, we have to wait longer before we know enough to liquidate.

Under current law, judges cannot actively monitor the firm. Such a regime has two bad effects. First, the judge is less well-informed. Second, she is less able to take advantage of what she does know. Both these costs reinforce each other and both these costs matter the most in the cases in which making the optimal liquidation decision is most important.

Thus, we should reevaluate the paradigm that has insulated the bankruptcy judge from active case management and rules that tend to separate the bankruptcy process into a series of discrete decisions. Reducing the number of chances to make a decision unambiguously makes the costs of liquidating at something other than the optimal

time. Exercising the liquidation option at the optimal time ensures that resources are put to their highest valued use.⁵⁰

IX. CONCLUSION AND EXTENSIONS

Formal models of bankruptcy have relied on two ideas for many years. First, they begin with the observation that no one in the process is likely to make decisions well. All the players either have built-in biases or lack the information needed to make necessary decisions. What we know about venture capitalists and about ownership structures elsewhere, however, suggests that nonverifiable information may be a much smaller problem than these models assume. Second, these models rest on the belief that market mechanisms can replace much of the bankruptcy decisionmaking about the optimal use of assets. This belief, however, needs to be reexamined. Preparing assets for sale takes time and during the interim someone has to decide how these assets are to be deployed. Market mechanisms cannot eliminate the need to make decisions about how the assets are to be deployed.

In bankruptcy, as elsewhere, we need to spend resources gathering information, and we need to know when we have reached the point where we should stop. In bankruptcy, the most important question revolves around the question of whether we keep the firm intact as a going concern and answering this question depends crucially on gathering the right amount of information of the right kind.

Every legal system depends upon judges and others to make good decisions at the right time. This aspect of the legal system is largely unexplored. Similarly, every legal system affects both how and when people make decisions. We now possess the tools to ex-

⁵⁰ Our model reinforces Triantis's observations about the way in which Canadian bankruptcy law empowers bankruptcy judges to "screen" firms while they are being reorganized. See George G. Triantis, *The Interplay Between Liquidation and Reorganization in Bankruptcy: The Role of Screens, Gatekeepers, and Guillotines*, 16 Internat'l Rev. L. & Econ. 101 (1996).

plore these problems rigorously. The analysis we provide in this paper can be naturally extended. For example, a judge's ability to grant a motion for summary judgment at any point during a trial represents another form of real option. Particularly in cases where the dispute involves the allocation of a property right (which may be more valuable in one party's hands than another), the judge can either grant the motion or wait for additional argument that her decide how to allocate the property right. Indeed, by viewing the evidence in a light most favorable to the non-moving party, she effectively biases the information before her and adds greater variance to the possible outcomes from trial. This increase in variance, as we have seen, raises the value of the option to wait for more information.

Real options are also implicit in the judge's decision whether to grant a prisoner's request for parole or a request for relief contained in a habeas corpus petition. In both cases the judge can either grant the request or wait for additional information about the prisoner's readiness to leave prison or about the conditions within the prison. Similarly, a judge exercises a real option when she chooses to certify a class action lawsuit. Although her choices are constrained by statute in many cases, the judge frequently has some freedom to deny certification until additional information (about the harm suffered by class members) becomes available.

Some of the most striking examples of real options come from the regulatory state. As Dixit and Pindyck suggest in their analysis of the Clean Air Act Amendments,⁵¹ regulatory agencies must always balance the social payoff from regulating today against the value of deferring regulation until the agencies have more information about potential harm. This calculus involves the valuation of a real option. Similarly, the SEC exercises a real option whenever it issues a No-Action letter stating that the Commission will not take action against a particular individual or firm engaging in particular

⁵¹ See DIXIT & PINDYCK, *supra* note 4, at 405-18.

conduct. Instead of waiting for additional information about the nature of the conduct, the Commission commits itself not to regulate.

APPENDIX 1

A Simple Model of Judicial Decisionmaking

Consider a firm that has filed for Chapter 11. Under the reorganization plan, the firm is expected to generate profit p_t each period; however, this profit is uncertain and may vary considerably. The real options literature offers a convenient and intuitive way to model the flow of profits each period:

$$dp_t = \mu p_t dt + \sigma p_t dW_t \quad (\text{A1})$$

This equation⁵² implies that the change in profit at any instant in time ($d\pi_t$) will depend on the growth rate of firm profits (μ) and the variance in possible outcomes each period (σdW_t). Here W_t is a Wiener process with mean $E[dW_t] = 0$ and variance $E[dW_t^2] = dt$, which merely implies that the variance of firm profits is a form of random walk.⁵³ Notice that the level of profits at time t (π_t) will magnify the effect of μ and σ on the growth rate of profit.

At any date, the firm's assets can be liquidated for a price L .⁵⁴ Thus, at decisionmaking date t , the court must decide whether to allow the firm to continue operating or to order liquidation of the assets. Due to bankruptcy procedure and time scarcity, the court can only render a decision every k periods. Thus, if it orders liquidation, the one-time payoff to creditors is L . However, if the court allows the firm continue operations, the creditors will receive a certain pay-

⁵² This representation is known as geometric Brownian motion with drift, where the changes in the level of profits are lognormally distributed.

⁵³ DIXIT & PINDYCK, *supra* note 4, at 59-132, discuss the properties of Brownian motion.

⁵⁴ To be more precise, if the firm's assets are liquidated, creditors will receive an asset (a perpetuity) that pays l every period indefinitely. Given the creditors' discount rate r , the present value of this asset is $L = \frac{l}{r}$.

off $\mathbf{p}_t dt$ today⁵⁵ and uncertain payoffs $\mathbf{p}_{t+i} dt$ each period until the next decisionmaking date k periods later. This is a recursive problem that can be modeled using dynamic programming tools.⁵⁶ Assuming that creditors discount future cash flows at rate r , the court must solve the following problem (a Bellman equation⁵⁷) at each decisionmaking date:

$$V(\mathbf{p}_t) = \max \left\{ L, \mathbf{p}(t, t+k) + e^{-rk} E_t [V(\mathbf{p}_{t+k})] \right\} \quad (\text{A2})$$

where π_t is governed by the definition in equation (1). Here $V(\mathbf{p}_t)$ represents the value of the court's decision at time t , $\mathbf{p}(t, t+k)$ measures the expected present value of the uncertain stream of (net) profits between the current decisionmaking date t and the next date $t+k$, and E_t is the expectation operator, which conditions only on information at time t . For simplicity, we will first consider a setting where the court can make liquidation/continuation decisions continuously, i.e., $k = dt$. Problem (1) then becomes

$$V(\mathbf{p}_t) = \max \left\{ L, \mathbf{p}_t dt + e^{-rdt} E_t [V(\mathbf{p}_{t+dt})] \right\} \quad (\text{A3})$$

subject to equation (1).

Intuitively, we expect the solution to the court's problem (3) to be a critical level of profit π^* at which the optimal court decision is

⁵⁵ We multiply the *rate* of profit π_t by the length of the period dt to obtain the *level* of profits that the firm generates during the period.

⁵⁶ This problem is also known as an "optimal stopping" problem. A good general framework for analyzing these types problems appears in DIMITRI P. BERTSEKAS, *DYNAMIC PROGRAMMING AND STOCHASTIC CONTROL* 95-12 (Academic 1976). See also DIXIT & PINDYCK, *supra* note 4, chapters 4 and 5.

⁵⁷ A good discussion of the properties of Bellman equations appears in, DIXIT & PINDYCK, *supra* note 4, at 59-132.

to liquidate the firm assets.⁵⁸ When expected profit π_t dips below this threshold value, it is best to liquidate the firm and divide the payoff L among the creditors according to their relative priorities. As long as profit exceeds π^* , however, the court should allow the firm to continue operations until the next decisionmaking event, k periods later.⁵⁹ This suggests that we can characterize the payoff to creditors $V(\mathbf{p}_t)$ as two regions: a “stopping region” and a “continuation region.” In the stopping region, profits are below the critical level, $\pi_t < \pi^*$, it is optimal to liquidate the firm, and the payoff to creditors is L . In the continuation region, on the other hand, profits exceed the critical level, $\pi_t > \pi^*$, the court should permit the firm to continue as a going concern, and the payoff is stochastic $\mathbf{p}_t dt + e^{-rdt} E_t[V(\mathbf{p}_{t+dt})]$. At the threshold value π^* , creditors should be indifferent between liquidating the firm and allowing it to continue (at least for short while). At this point, therefore, the payoffs from stopping and continuing should be the same: $L = \mathbf{p}_t dt + e^{-rdt} E_t[V(\mathbf{p}_{t+dt})]$. If we can characterize the value function $V(\mathbf{p}_t)$, we can use this indifference condition to solve for the threshold profit level π^* .

Before we can characterize $V(\mathbf{p}_t)$, we need to know the information available to the court in making its decision. Although these profits are uncertain, information in the reorganization plan should give the court a good sense of the probable growth rate of firm profit (μ) and the variance in possible outcomes each period (σ). Thus, the court will know the *process* determining firm profits, as defined in

⁵⁸ We are assuming that the creditors’ discount rate r exceeds the growth rate of profit μ because the solution would be trivial otherwise: the court would never liquidate the firm since the growth rate of firm profits exceeds the growth rate on any other investment available to the creditors.

⁵⁹ We need to impose more structure on the profit process (1) and the value function $V(\mathbf{p}_t)$ to ensure that the critical level π^* exists and is unique. The necessary assumptions are standard in the economics literature and are described in DIXIT & PINDYCK, *supra* note 4, at 128-30.

equation (1). Thus, we can characterize $V(\mathbf{p}_t)$ by substituting the process (1) into the court's problem (3). Substituting (1) into (3)⁶⁰ and applying Ito's Lemma,⁶¹ we obtain a differential equation describing the profit process:

$$\mathbf{p}_t + \mathbf{m}\mathbf{p}_t V'(\mathbf{p}_t) + \frac{1}{2} \mathbf{s}^2 \mathbf{p}_t^2 V''(\mathbf{p}_t) - rV(\mathbf{p}_t) = 0 \quad (\text{A4})$$

If we assume that equation (A4) describes all profits $\pi_t > \pi^*$ and that $V(\pi_t)$ is a continuous function when profit is positive, we can solve this equation using the standard tools for second-order, non-homogeneous differential equations.⁶² We obtain the following solution:⁶³

$$V(\mathbf{p}_t) = A\mathbf{p}_t^b + \frac{\mathbf{P}_t}{r - \mathbf{m}}$$

⁶⁰ Substitution yields $(1 - e^{-rdt})V(\mathbf{p}_t) = \mathbf{p}_t dt + e^{-rdt} E_t[dV(\mathbf{p}_t)]$, where $dV(\mathbf{p}_t) = V(\mathbf{p}_{t+dt}) - V(\mathbf{p}_t)$. Note that if r is small (which we will assume is the case), we can use the approximation $e^{-rdt} = 1 - rdt$.

⁶¹ Ito's Lemma states that

$$dV(\mathbf{p}_t) = V'(\mathbf{p}_t)\mathbf{m}\mathbf{p}_t dt + \frac{1}{2}V''(\mathbf{p}_t)(\mathbf{s}\mathbf{p}_t)^2 dt + V'(\mathbf{p}_t)\mathbf{s}\mathbf{p}_t dW_t.$$

Substituting this into the equation in the previous footnote, omitting terms that converge to zero faster than the increment dt as $dt \rightarrow 0$, and simplifying, we obtain equation (4) in the text.

⁶² See ALPHA CHIANG, FUNDAMENTAL METHODS IN MATHEMATICAL ECONOMICS 502-11, 541-43 (McGraw-Hill 1984) for details.

⁶³ We are using the property $\lim_{p \rightarrow \infty} \left(\frac{V(\mathbf{p})}{\mathbf{p}} \right) < \infty$.

where A is a constant (which we will determine below) and \mathbf{b} is a function of μ and σ and is always less than zero.⁶⁴ We need to add more structure to this problem to solve for A . The standard assumption is “smooth pasting.” First, the payoff from liquidation must equal the payoff from continuation at the threshold level of profits: $L = \mathbf{p}^* dt + e^{-rdt} E_t[V(\mathbf{p}_{t+dt})]$. Second, at the threshold profit level, the derivative of the payoff from liquidation (L) with respect to profit must be equal to the derivative of the payoff from continuation with respect to profit. That is, $V'(\mathbf{p}_t) = 0$ when this derivative is evaluated at π^* . Imposing the second smooth pasting condition, we can show that $A = \frac{-(\mathbf{p}_c^*)^{1-b}}{\mathbf{b}(r-\mathbf{m})}$ and $V(\mathbf{p}_t) = \left(\frac{1}{r-\mathbf{m}} \right) \left[\mathbf{p}_t - \frac{\mathbf{p}_t^b}{\mathbf{b}} (\mathbf{p}_c^*)^{1-b} \right]$. Imposing the second condition, we finally obtain the threshold level of profit:

$$\mathbf{p}_c^* = L(r-\mathbf{m}) \left(\frac{\mathbf{b}}{\mathbf{b}-1} \right) \quad (\text{A5})$$

where the subscript c indicates that this is a solution for the continuous decisionmaking setting.

There are several important features of the optimal liquidation point (A5). First, a judge should not liquidate the firm even if expected value of future earnings (discounted to present value) is less than the liquidation value of firm assets. In other words, even if the “net present value” of the firm is negative, a judge should still wait to liquidate at a future date. As traditionally defined, the net present value (NPV) of an investment is the difference between the present

⁶⁴ Since β must satisfy the quadratic expression $Q(\mathbf{b}) = \frac{1}{2} \mathbf{s}^2 \mathbf{b}(\mathbf{b}-1) + \mathbf{m}\mathbf{b} - r = 0$, the negative root of the expression is

$$\mathbf{b} = \frac{1}{2} - \frac{\mathbf{m}}{\mathbf{s}^2} - \sqrt{\left[\frac{\mathbf{m}}{\mathbf{s}^2} - \frac{1}{2} \right]^2 + \frac{2r}{\mathbf{s}^2}}.$$

value of the (expected) return on an investment and the cost of that investment. In the context of bankruptcy decisionmaking, NPV is the difference between the present value of (expected) firm profits and the liquidation value of firm assets:

$$NPV_t = E_t \left[\int_0^{\infty} e^{-r(t+s)} \mathbf{p}_{t+s} ds \right] - L$$

A traditional NPV approach would lead the court to liquidate whenever $NPV < 0$. This approach, however, would be erroneous. To see this, consider the NPV of the firm at the optimal liquidation point: when π_t is equal to π^* . Using equation (A5),⁶⁵ the NPV equation becomes:

⁶⁵ Notice that $E_t[\mathbf{p}_{t+z}] = e^{mz} \mathbf{p}_t$. This follows from the following proof. Given the law of motion $d\mathbf{p}_t = m\mathbf{p}_t dt + \mathbf{s}\mathbf{p}_t dW_t$, we can create the transformation $y_t = \ln \mathbf{p}_t$. Using Ito's Lemma $\left(df(x) = f'(x)dx + \frac{1}{2}(\mathbf{s}x)^2 f''(x) \right)$, we have

$$dy_t = \frac{1}{\mathbf{p}_t} (m\mathbf{p}_t dt + \mathbf{s}\mathbf{p}_t dW_t) - \frac{1}{2} (\mathbf{s}\mathbf{p}_t)^2 \left(\frac{1}{\mathbf{p}_t} \right)^2 dt = \left(m - \frac{\mathbf{s}^2}{2} \right) dt + \mathbf{s} dW_t.$$

Notice that this is a very simple expression independent of π_t . We are ultimately interested in $E_t[\mathbf{p}_{t+z}]$. Since we now have an expression for the change in $y_t = \ln \mathbf{p}_t$ over time, we can determine the total change in $\ln \mathbf{p}_t$ between dates t and $t+z$:

$$y_{t+z} - y_t = \ln \mathbf{p}_{t+z} - \ln \mathbf{p}_t = \ln \left(\frac{\mathbf{p}_{t+z}}{\mathbf{p}_t} \right) = \int_t^{t+z} dy_s$$

or

$$\ln \left(\frac{\mathbf{p}_{t+z}}{\mathbf{p}_t} \right) = \int_t^{t+z} \left(m - \frac{\mathbf{s}^2}{2} \right) dt + \mathbf{s} dW_t = \left(m - \frac{\mathbf{s}^2}{2} \right) z + \mathbf{s} (W_{t+z} - W_t)$$

Applying the exponential function to both sides, we have

$$NPV_t = \mathbf{p}^* \int_0^{\infty} e^{-(r-m)s} ds - L = L \left(\frac{1}{\mathbf{b} - 1} \right) \quad (\text{A6})$$

Since $\beta < 0$, we know $\frac{1}{\mathbf{b} - 1} < 0$. Therefore, $NPV_t < 0$ at the threshold

level of profits. That is, at the optimal liquidation point the NPV is negative: the court should not liquidate until the net present value of the firm has fallen sufficiently below the liquidation value of the firm assets. At the optimal liquidation point, the wedge between the (negatively valued) NPV and zero reflects the *option value* of being able to defer liquidation until the court gathers additional information. Until the NPV dips sufficiently below zero, the court may wait to liquidate because there is a positive probability that firm profit will rise in the future. Liquidation is optimal only when the opportunity cost of allowing the firm to continue operation (measured by the negative value of the NPV) offsets the value of being able to wait.

$$\mathbf{p}_{t+z} = \mathbf{p}_t e^{\left(\frac{m - \mathbf{s}^2}{2} \right) z + \mathbf{s}(W_{t+z} - W_t)} \quad (\text{F1})$$

Finally, when we compute the expectation of π_{t+z} , conditioning on information available at t , we obtain the desired result:

$$E_t[\mathbf{p}_{t+z}] = E_t \left[\mathbf{p}_t e^{\left(\frac{m - \mathbf{s}^2}{2} \right) z + \mathbf{s}(W_{t+z} - W_t)} \right] = \mathbf{p}_t e^{mz}$$

This follows from the fact that $(W_{t+z} - W_t)$ is a normally distributed random variable with mean zero and variance z . The expected value of the exponential of such a random variable is $E_t \left[e^{\mathbf{s}(W_{t+z} - W_t)} \right] = e^{\mathbf{s}^2 z / 2}$. Thus

$$E_t \left[e^{\mathbf{s}(W_{t+z} - W_t)} \right] = e^{\frac{\mathbf{s}^2 z}{2}}.$$

A second important feature of (A5) is the effect of changes in the growth rate (μ) or variance (σ) of earnings on the optimal time to liquidate firm assets. We can show that π^* decreases as either μ or σ increases.⁶⁶ Intuitively, this is sensible: the higher the growth rate μ , the higher the likelihood that profits will rise in the future. If the NPV of the firm becomes negative due to a sudden shock, the higher the growth rate the higher the probability that the firm will recover in the future and the NPV will rise above zero. Thus, we expect courts to be more patient, to be less willing to exercise the liquidation option, the higher the expected growth rate of profits. Similarly, the higher the variance in profit σ , the higher the likelihood that profit will unexpectedly increase significantly in the future. Hence, there is greater value in waiting as σ increases.

The discussion in the main text suggests that we may write the variance of profit as a function of time: $\mathbf{s} = \mathbf{s}(t)$. One natural assumption is that $\frac{d\mathbf{s}(t)}{dt} < 0$, i.e., variance will fall over time as more information is gathered. Incorporating these modifications into our

⁶⁶ Consider first the effect of changes in μ on π^* . From (5), we know $\frac{\partial p^*}{\partial m} = \frac{L}{b-1} \left((r-m) \frac{1}{b-1} \frac{\partial b}{\partial m} - b \right)$. Since $b < 0$, the sign of this derivative will be negative if $\frac{\partial b}{\partial m} < 0$. To show that this is the case, recall that β

must satisfy the quadratic equation $Q(b) = \frac{1}{2} s^2 b(b-1) + mb - r = 0$.

Totally differentiating this equation with respect to μ , we have

$$\frac{\partial Q}{\partial b} \frac{\partial b}{\partial m} + \frac{\partial Q}{\partial m} = 0. \quad (\text{F2})$$

Since $\frac{\partial Q}{\partial b} < 0$ and $\frac{\partial Q}{\partial m} < 0$, (F2) requires that $\frac{\partial b}{\partial m} < 0$. Therefore,

$\frac{\partial p^*}{\partial m} < 0$. Similar analysis shows that $\frac{\partial p^*}{\partial s} < 0$.

earlier model, we can model the judicial decisionmaking process as the solution to the following problem:

$$V_t = \max \left\{ L, \mathbf{p}_t dt + e^{-rdt} E_t [V_{t+dt}] \right\}$$

subject to the law of motion for profits $d\mathbf{p}_t = \mathbf{m}\mathbf{p}_t dt + \mathbf{s}(t)\mathbf{p}_t dW_t$. The solution method for this problem is somewhat complex (requiring numerical computation) and will not be pursued here. However, it should be intuitively clear that the value of the liquidation option will decrease with time. Recall that the value of the liquidation option increases with the variance of profit: the higher the variance, the higher the probability that profits will increase tomorrow. Under the assumption that $\frac{d\mathbf{s}(t)}{dt} < 0$, the variance of profit is decreasing; hence the value of the liquidation option is decreasing. This implies that the threshold profit rate \mathbf{p}^* should *increase* over time: $\frac{d\mathbf{p}^*(t)}{dt} > 0$.

APPENDIX 2

A Simple Model of Passive Judicial Decisionmaking

Here we reconsider the formal model of Appendix 1 in a setting where the bankruptcy judge can make liquidation decisions only when she is asked to do so (i.e., on the motion of a creditor). In other words, the judge is a passive decisionmaker, reaching the liquidation decision at discrete points.

Recall the general problem (A3) facing the judge:

$$V(\mathbf{p}_t) = \max\{L, \mathbf{p}(t, t+k) + e^{-rk} E_t[V(\mathbf{p}_{t+k})]\}$$

where k measures the interval between decisions. In Section I we considered a setting where the court could make decisions continuously, so we let $k = dt$. Suppose now that the judge no longer possesses the *option* to make decisions continuously. Instead, she must wait $k = n$ periods between each decision. Thus, if the judge chooses to liquidate the firm at date t , the payoff is L . But if she chooses to keep the firm intact at t , she will be unable to reconsider this decision until date $t+n$. During the intervening n periods, the firm will accumulate an uncertain amount of profit $\mathbf{p}(t, t+n)$. From the vantage point of the judge at date t , the expected value of this uncertain

stream of net profit is $\mathbf{p}(t, t+n) = E_t \int_0^n e^{-rz} \mathbf{p}_{t+z} dz$, where π_t follows

the usual law of motion, $d\mathbf{p}_t = \mathbf{m}\mathbf{p}_t dt + \mathbf{s}\mathbf{p}_t dW_t$. When the next decisionmaking date arrives, at $t+n$, the value of the firm will depend on the level of profits at that date, π_{t+n} . Since these profits are uncertain when the judge makes a decision at date t , the expected value of the firm at the next decisionmaking date will be $e^{-rn} E_t[V(\mathbf{p}_{t+n})]$. Hence, the payoff in the continuation region will be the sum of the expected profit stream until the next decisionmaking date plus the expected value of the firm at that date:

$E_t \int_0^n e^{-rz} \mathbf{p}_{t+z} dz + e^{-rn} E_t[V(\mathbf{p}_{t+n})]$. We can simplify this by noting that,

from the vantage point of the bankruptcy judge at date t ,

$\mathbf{p}_{t+z} = \mathbf{p}_t e^{\left(\frac{m-s^2}{2}\right)z + s(W_{t+z} - W_t)}$. That is, π_{t+z} is a lognormal random variable with mean $\mathbf{p}_t e^{mz}$ and variance $\mathbf{p}_t e^{2mz} (e^{s^2 z} - 1)$. Hence, the payoff from permitting the firm to continue as a going concern is $\frac{\mathbf{p}_t}{r-m} (1 - e^{-(r-m)n}) + e^{-rn} E_t[V(\mathbf{p}_{t+n})]$.

Thus, the problem facing the bankruptcy judge in a setting of passive decisionmaking is

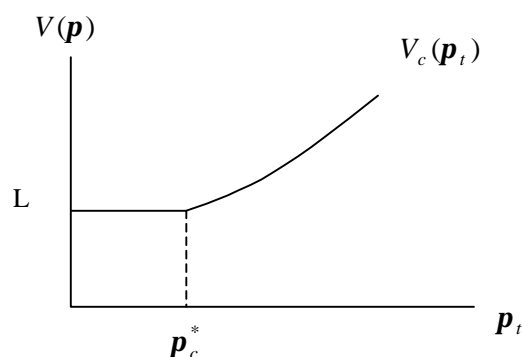
$$V(\mathbf{p}_t) = \max \left\{ L, \frac{\mathbf{p}_t}{r-m} (1 - e^{-(r-m)n}) + e^{-rn} E_t[V(\mathbf{p}_{t+n})] \right\} \quad (\text{A7})$$

The solution to this problem is quite difficult and we do not attempt it here.⁶⁷ Instead, we will only characterize the solution graphically. Our goal here is to illustrate informally the effect of n (the length of time between judicial decisions) on the value of the firm $V(\mathbf{p}_t)$ and the optimal time to exercise the liquidation option \mathbf{p}_d^* .

Consider first two limiting cases: (1) $n = 0$ and (2) $n = \infty$. We considered the first case in the continuous time model of Appendix 1, where we found $V(\mathbf{p}_t) = \left(\frac{1}{r-m} \left[\mathbf{p}_t - \frac{\mathbf{p}_t^b}{\mathbf{b}} (\mathbf{p}_c^*)^{1-b} \right] \right)$ in the continuation region, $V(\mathbf{p}_t) = L$ when the court liquidates firm assets, and $\mathbf{p}_c^* = L(r-m) \left(\frac{\mathbf{b}}{\mathbf{b}-1} \right)$ is the threshold profit rate at which liquidation is optimal. We depict this characterization of judicial decisionmaking in Figure A1.

⁶⁷ Bertsekas offers a general framework for solving this problem. See BERTSEKAS, *supra* note 56, 95-102.

Figure A1

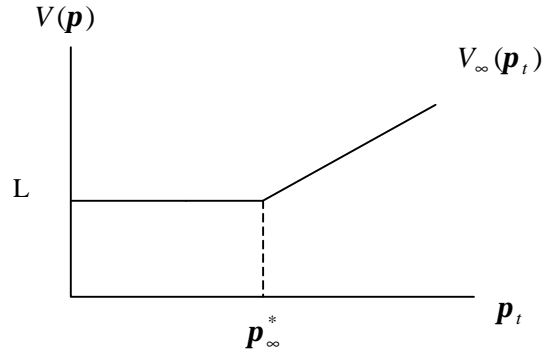


Now consider the other limiting case, $n = \infty$. Here the court is effectively making a one-time liquidation decision; there is no liquidation option. The court's problem boils down to the standard NPV calculation: liquidate the firm so long as the expected present value of future profits is less than or equal to the liquidation value of the assets. More formally, this problem is

$$V_{\infty}(\mathbf{p}_t) = \max \left\{ L, E_t \left[\int_0^{\infty} e^{-rz} \mathbf{p}_{t+z} dz \right] \right\}$$

subject to the usual characterization of $d\mathbf{p}_t$ in equation (A1). The solution to this problem is $V_{\infty}(\mathbf{p}) = L$ for $\mathbf{p}_t \leq \mathbf{p}_{\infty}^*$ and $V_{\infty}(\mathbf{p}) = \mathbf{p}_t \left(\frac{1}{r - \mathbf{m}} \right)$ for $\mathbf{p}_t \geq \mathbf{p}_{\infty}^*$, where \mathbf{p}_{∞}^* is the threshold rate of profit at which liquidation is optimal. This threshold satisfies the condition $\mathbf{p}_{\infty}^* = L(r - \mathbf{m})$, at which the NPV of the firm is zero. That is, there is no liquidation option. Figure A2 depicts the value of the firm under this legal regime.

Figure A2



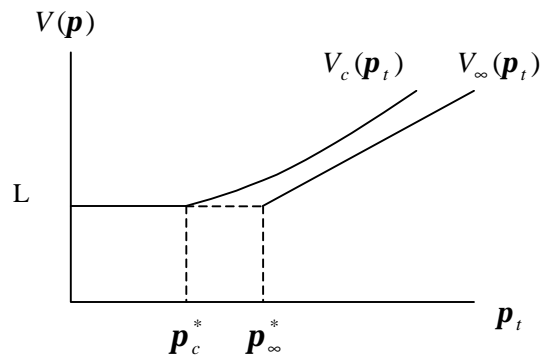
Two important features of these two limiting cases deserve attention. First, the threshold (or liquidation) rate of profit is higher in the case where $n = \infty$ than where $n = 0$: $\mathbf{p}_\infty^* \geq \mathbf{p}_c^*$. As stated, NPV of the firm is zero at the threshold \mathbf{p}_∞^* ; there is no liquidation option when the court must wait an infinite number of periods to reconsider the liquidation question. In (A6) of Appendix 1, we showed that the NPV of the firm will be negative at the optimal time to liquidate the firm when there is a positive liquidation option. Indeed, the greater the option value of waiting, the lower the threshold \mathbf{p}_c^* and the more negative the NPV of the firm at the threshold level of profits. The difference between \mathbf{p}_c^* and \mathbf{p}_∞^* reflects the value of the liquidation option.

Second, the going concern value of the firm – the value when profit exceeds the threshold rate (\mathbf{p}_c^* or \mathbf{p}_∞^*) – is lower when $n = \infty$ than when $n = 0$. Formally, $V_c(\mathbf{p}) \geq V_\infty(\mathbf{p})$ for all $\mathbf{p} \geq \mathbf{p}_c^*$. Intuitively, the value of the firm is higher when the court can make better liquidation decisions. When $n = 0$ and the court can continuously monitor the firm, the court can choose the optimal time to liquidate. But when it must wait $n > 0$ periods between each decision date, the court may make the liquidation decision late. During the waiting time

between decisions, the value of the firm may fall below the critical threshold but the court will be unable to act.

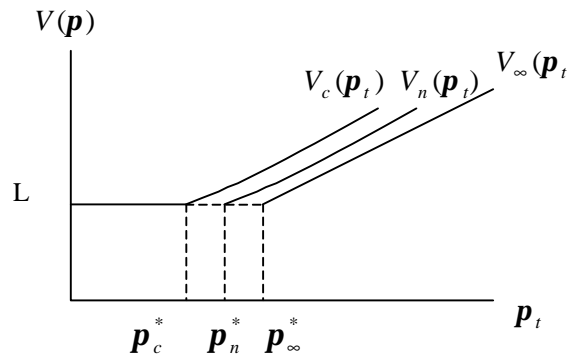
Figure A3 illustrates both of these features.

Figure A3



This figure makes clear that the going concern value of the firm will always suboptimal when $n > 0$. Consider, for example, some finite waiting time $n > 0$. Figure A4 illustrates the value of the firm under this legal regime.

Figure A4



The going concern value of the firm $V_n(\mathbf{p})$ will be lower than the value in a world of continuous decisionmaking $V_c(\mathbf{p})$ (but higher than the value in a world with no options $V_\infty(\mathbf{p})$): since the court has potentially lost the option to make liquidation decisions at the optimal time, the value of the firm is lower. Additionally, the threshold rate of profit (when liquidation is optimal) will be higher than \mathbf{p}_c^* (but less than \mathbf{p}_∞^*).

Thus, the value of the firm is highest $V_c(\mathbf{p})$ when the bankruptcy judge is free to exercise the liquidation option at the optimal moment. The value of the firm is lowest $V_\infty(\mathbf{p})$ when the judge can never exercise this option. And the value is somewhere in between these two extremes when the judge is a passive decisionmaker who does possess a liquidation option, but may be unable to exercise it at the optimal moment. During the n periods between decisionmaking dates, the earnings of the firm may fall dramatically and liquidation may be optimal, but the judge will be unable to act. As n increases, it becomes more likely that the judge will be unable to exercise the liquidation option at the right time.

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