Optimal Trust Design in Mass Tort Bankruptcy

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Many firms have filed for bankruptcy to manage mass tort liabilities, most notably asbestos producers. We model a bankruptcy procedure that optimally balances the liquidity needs of present claimants and an uncertain number of future claimants. We find that future claimants should receive greater awards in expectation than present claimants as compensation for bearing greater future claims risk. We also find that allocating more value to contractual creditors in bankruptcy makes an earlier filing more likely, which may increase overall welfare. Optimal risk-sharing implies that creditors should receive equity in a trust fund, with tort claimants receiving senior debtlike securities.

1. Introduction

Tort claimants differ from ordinary creditors of an insolvent firm in several respects. Since tort claimants have been damaged by the firm, they may have immediate, unanticipated liquidity needs when the injury manifests itself. Yet the total number and identity of these individuals are difficult to determine during bankruptcy proceedings because the injury to some tort claimants may arise well after the conclusion of the bankruptcy process.

The presence of these "future claimants" adds an additional layer of complexity to bankruptcies resulting from mass tort liability.[1] The problem of future claimants also vexes legislative attempts to resolve mass torts, such as the Fairness in Asbestos Injury Resolution Act of 2003 (FAIR Act).[2] Mass tort injuries, such as those caused by asbestos exposure, can entail long and variable lag times between the exposure and the resultant harm. These lag times and the associated uncertainty regarding the total extent of the harm compel judges and policy makers to make difficult decisions regarding the appropriate treatment of present claimants, future claimants, and other creditors when a limited pool of resources is available for distribution. The immediate liquidity needs of present claimants must be balanced with the requirements of an unknown number of future claimants, and these claimants in turn must be prioritized relative to creditors who own contractual claims on the firm. The resulting judgments will affect the way both value and risk will be shared by these very different groups.

A commonly cited problem with current practice is that future claimants are not adequately represented and should expect little to remain in a trust fund after present claimants and creditors are compensated. There are both conceptual and empirical justifications for this belief. Because future claimants are not identifiable before a settlement occurs, it is difficult to find an appropriate representative for them in bankruptcy proceedings (Warren and Jacoby, 1997). As a result, early claimants commonly receive a much greater share of the tort claimants' fund than warranted by their numbers (Smith, 1994). Concerned about similarly disparate treatment between present and future claimants, the Supreme Court invalidated an asbestos-related class action settlement in *Amchem Products Inc. v. Windsor* (Raskolnikov, 1998).[3]

There can be also significant financial incentive for the firm's contractual owners to delay the timing of a settlement. If the firm's assets can be easily distributed to existing creditors before these future claims materialize, a bankruptcy filing may only occur when the firm has little value left

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1. Indeed, the National Bankruptcy Review Commission conducted a conference on the issue (National Bankruptcy Review Commission, 1998).

2. Fairness in Asbestos Injury Resolution Act of 2003, S. 1125, 108th Cong. (2003).

3. See *Amchem Prods. V. Windsor*, 521 U.S. 591 (1997).

to divide. The fear of being left out of the distribution has contributed to "race to the courthouse" issues, including individuals seeking compensation and receiving large awards for injuries that have yet to materialize (Warren, 2002).

"Mass tort bankruptcies" have become increasingly prevalent. Asbestos liability alone has been implicated in the bankruptcy declarations of at least 60 corporations (Treaster, 2003). The asbestos problem is currently the subject of an ongoing congressional attempt to establish a trust fund of over $100 billion to compensate all present and future claimants of asbestos manufacturers, insurers, and related companies. In addition to asbestos, there are other potential applications in which considerations of future claimants are important. Given the tidal wave of litigation surrounding tobacco firms, for example, and the long lag time between cigarette smoking and illness, it is quite likely that future claimants will be a major issue should large tobacco firms be forced into bankruptcy or class-action settlement negotiations.

Several legal scholars have proposed innovative solutions to the problem of distributing funds to present and future claimants in the context of mass tort bankruptcies (commonly called the fair distribution problem). Roe (1984) proposes delivering damage payments as a variable annuity, adjusting payouts from a trust fund over time as new information changes expectations about the severity of future claims. Smith (1994) advocates using capital markets to formulate these expectations by giving claimants tradeable equity securities backed by a trust. At the core of these proposals is the efficient use of information about future damages to reduce the disparity in payoffs among claimants that surface at different points in time.

The explicit goal of these proposed solutions is to provide equal monetary compensation to present and future claimants. In the absence of perfect foresight about the number of future claims, however, perfect equality in compensation would be an extremely rare and fortuitous occurrence in practice. If applied correctly, the Roe and Smith schemes would provide present and future claimants with equal compensation *in expectation*.[4] Although this aim appears to be an intuitive extension of

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4. In the case of the capital markets approach, this will be true if potential tort bond buyers are risk-neutral with respect to future claimant risk and that the market is perfectly liquid.

the fairness principle under uncertainty, these solutions are not welfare-maximizing. In fact, these proposals retain some critical elements of the under/overcompensation problem that they are designed to preclude. Because future claimants' payments are subject to greater risk (namely, the uncertain number of other claimants dividing up the remaining assets), risk-averse individuals would prefer to be a current claimant than a future claimant receiving the same payout in expectation.[5] As a result, the distribution of payments between present and future claimants proposed by Roe and Smith will be neither efficient from a social welfare perspective nor completely fair.

In addition, the two solutions offer incomplete guidelines for the appropriate sharing rule between tort claimants and other creditors during bankruptcy reorganizations, and treat the timing of the bankruptcy filing as exogenous.[6] Both of these considerations are of major importance. Current bankruptcy law stipulates that tort claimants share value pro rata with other unsecured creditors. Although this will naturally affect the pool of funds available to tort claimants, it will also affect the incentive of the firm's contractual owners (its debt and equity holders) to seek a court-imposed solution.[7]

This article develops a model of optimal damage compensation to present and future claimants of a mass tort (either within bankruptcy or as part of a class action settlement) with incomplete insurance. When claimants have convex marginal utility, we find that the efficient solution requires future claimants to receive greater expected compensation than present claimants. In other words, the optimal payment policy, often weighted in favor of present claimants, should be reversed. Future

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5. This is true under reasonable specifications of the utility function that incorporate risk-aversion, including the CRRA utility function, from which some of our results are derived.

6. Both Roe and Smith correctly observe (in somewhat different contexts) that claimants are risk averse (Roe, 1984, p. 877; Smith, 1994, p. 396). Nevertheless, they fail to note that the persistence of risk implies that the current claimants' position is preferable to that of the future claimants. Although the reduction in variance of damage payments that results from their superior estimation and payment procedures is an improvement over the status quo, it does not eliminate the issue of claimant risk.

7. In this article, we do not treat the impact of bankruptcy on ex ante incentives to take precautions. For discussions, see Shavell (1986), Pitchford (1995), Roe (1984) and Kennedy (1985).

claimants should (on average) receive greater damages to avoid a scenario in which unexpectedly large numbers of future claimants lead to very low per capita awards.

This conclusion is closely related to the consumption and savings literature, where precautionary saving (driven by convex marginal utility) is shown to be the primary motivation for savings, accounting for approximately two-thirds of total savings according to a recent decomposition (Gourinchas and Parker, 2001). Moreover, this precautionary savings motive becomes increasingly important as the risks involved grow larger (Deaton, 1992). Because mass torts often involve very large risks and epidemiological estimates are subject to considerable uncertainty, we believe precautionary savings motives are particularly important in this context.

We next turn to the appropriate priority of tort claimants in relation to other contract creditors. We start by noting that the unique considerations surrounding future tort claimants (in particular, their overexposure to claimant risk and their inability to transfer this risk) justifies a reinterpretation of priority. We distinguish between "ex ante" priority, which determines how firm value is divided, and "ex post" priority, which determines how risk is shared, with regard to tort claimants and contract creditors. We demonstrate that ex post priority, the right to be paid first from the assets in the bankruptcy estate, should always be given to tort claimants over contract creditors. In other words, claimants should receive debtlike securities in the bankruptcy trust, whereas contract creditors should be the residual claimants on the trust after tort claimants are paid a prespecified amount.

The effect of this policy is to allocate as much of the claimant risk to contract creditors as possible for a given expected payment to creditors. Because a risk-averse tort claimant's payoff depends heavily on the number of future claims that arise, and contract creditors (who can hold diversified portfolios) are more plausibly risk-neutral with respect to claimant risk,[8] this arrangement reflects optimal risk-sharing. It also stands in sharp contrast to solutions imposed by previous mass tort bankruptcy

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8. We will consider claimant risk to be idiosyncratic, which would imply that the holder would not demand excess compensation for bearing such risk in a framework such as the CAPM, because it can easily be diversified away.

settlements, such as the asbestos liability related reorganization of the Johns-Manville Corporation, in which prepetition contract creditors were given claims on the reorganized firm that were implicitly senior to the claimants' trust (Delaney, 1992). As currently designed, the FAIR Act trust fund also runs the risk of running out of funds for future claimants, while limiting risk exposure for other parties (Peterson, 2003).

The optimal policy with respect to ex ante priority (the division of value between claimants and creditors) is more subtle. We show that a clear trade-off exists between higher priority for creditors, which gives the firm's owners more incentive to file early, and higher claimant priority, which allows a greater payment to claimants conditional on the timing of the filing. We find that in some circumstances, a pro rata value sharing rule can be preferable to claimant priority because the benefit of an earlier bankruptcy can outweigh a smaller expected payment to tort claimants.

The remainder of the article is organized as follows. Section 2 introduces the model of damage payments to current and future claimants. Section 3 employs the model to derive several results regarding optimal allocation of damage awards to claimants. In section 4, we use the model to study the optimal ex post priority for sharing of risk between claimants and other unsecured creditors. Section 5 discusses ex ante priority and optimal value sharing rules. Section 6 concludes.

2. Model and Assumptions

This section develops a simple framework for considering the fair distribution problem.[9] In the model, a social planner (such as a judge), who must approve all bankruptcy and class-action settlements, attempts to maximize the utility of a group of present claimants and an uncertain number of future claimants. We should note that the choice of our objective function (the maximization of total surplus) leaves aside alternative definitions of what a "fair" outcome would be.[10] Our optimal allocation

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9. Listokin and Ayotte (2004) provide a less formal analysis of some of the issues herein and include discussion on implementing optimal policy, such as incentive compensation schemes for future claimants representatives.

10. For example, one possible definition of fairness would require that present and future claimants always receive the same dollar award. This would not be welfare-maximizing, because this could only be achieved by delaying the

scheme will be fair in the sense that a potential claimant would prefer the optimal scheme to any other, before becoming aware of his or her status as either uninjured, a present claimant, or a future claimant.

Consider an economy where all individuals, including present and future claimants, have (intertemporally separable) utility in each period represented by $u(z_t)$, where z_t is total consumption in the period and the standard assumptions about utility functions $u'(\cdot) > 0$, $u''(\cdot) < 0$, apply. In addition, assume that marginal utility is convex, that is $u'''(\cdot) > 0$. This assumption is satisfied for many common utility functions, including constant relative risk aversion utility (CRRA), a standard functional form for problems of this type. It implies that although marginal utility decreases with additional income, the rate of this decrease slows as income rises. Absent any tortious harm or damage payment, individuals are assumed to have (riskless) income y in every period, a fraction of which comes from a well-diversified portfolio of securities in many publicly traded firms. Though a small fraction of these firms will cause harm that will reduce payments to their security holders, we assume that the number of firms is large enough such that no individual firm's payoff is large enough to affect y. This ensures that noninjured contract creditors will behave in a risk-neutral manner with respect to their investment in any individual firm.

The model consists of three periods. In periods 1 and 2, a small fraction of the population will become harmed by a given firm. All claimants subjected to harm by a firm are assumed to be affected for a total of two periods. We refer to individuals harmed in periods 1 and 2 as *present claimants* and those harmed in periods 2 and 3 as *future claimants*.[11] For expositional simplicity, we take the discount rate δ and interest rate r to be zero; all results here will hold for any positive $\delta = r$, and the model's results can be generalized when these assumptions are relaxed. Contract creditors will collectively hold (unsecured) claims on each firm with face value F. To focus our discussion exclusively on claimant risk, we assume that firms generate riskless cash flows worth W as of period 1. If the firm files for

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compensation to present claimants until the number of future claims is realized. Because present claimants value early payouts, this would be suboptimal.

11. We chose a structure in which harm to present and future claimants overlap by one period to compare our model more realistically to Roe's variable annuity proposal.

bankruptcy in period 1, this will be the value of the assets available for distribution from the trust fund.[12]

An important assumption underlying our analysis is that insurance markets are incomplete. This is an assumption made by both Roe (1984) and Smith (1994).[13] Although noninjured individuals are risk-neutral with respect to the risk of future claimants, several factors suggest that insurance companies will not be able to assume the entire liability for future claimants. First, damage award amounts are not exogenous. If claimants, courts, and juries know that a deep-pocketed insurance company has assumed all liability, then both the number of claims and the amount of the individual awards may rise. In addition, insurance companies may be very wary of adverse selection problems in an area where epidemiological estimates are inherently uncertain and firms often have superior private information. In practice, liability insurance almost always includes caps on coverage. For example, even the federal government, while acting as insurer of last resort for acts of terrorism, has included a limit on its liability (Terrorism Risk Protection Act §103(e)(2)). If partial insurance can be purchased at a reasonable rate, then W should be reinterpreted to include the maximum value of the insurance coverage.

In addition, we assume that present claimants cannot borrow against uncertain future payments at an attractive rate. If such borrowing were possible, then a trustee would prefer to wait until the uncertainty in the number of claimants is resolved and have early claimants borrow against future awards rather than make payments from the trust immediately. This assumption, however, is not crucial to our analysis; even if such a market were readily available, all the same issues would apply. Future claimants'

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12. This assumption can also be easily relaxed, allowing the trust fund to be composed, for example, of equity in the insolvent firm, as has often been the case in practice. This would likely result in greater precautionary saving for future claimants due to the added risk in the value of the trust as long as the value of the trust is uncorrelated with the realized number of claimants.

13. Indeed, if insurance markets were complete, the entire problem of future claimants that has plagued mass tort bankruptcies would appear to be a red herring. Rather than creating complicated trusts or invalidating class action settlements, policy makers should simply have required the purchase of insurance protecting future claimants. The fact that this simple solution has not become a prominent feature of many mass tort bankruptcies strongly suggests that insurance markets for mass tort liabilities are incomplete.

payoffs would still be subject to greater risk than that of present claimants (through the disparity would be reduced), and some optimal allocation of value and risk between creditors and claimants would still be necessary.

3. Optimal Payments with No Contract Creditors

To get a feel for the basic intuition underlying the problem and to focus on the trade-off between liquidity and risk to tort claimants, we initially assume that tort claims are the only claims on the firm and that a trust fund for these claims has been endowed with W dollars to distribute to claimants; these assumptions will be relaxed in subsequent sections. We also take by assumption (in this subsection only) that the trust fund is small enough such that it is never possible to pay all tort claimants in full.[14]

In the first period, present claimants (the number of present claimants is normalized to one) are harmed by an amount d and receive damages, denoted by C_1^p from the fund for payments (W). All as-yet unharmed future claimants and those who will never be harmed receive income y and utility $u(y) > u(y - d + C_1^p)$ in period 1; because the marginal utility of these unharmed individuals is strictly lower than harmed individuals, it is strictly suboptimal to compensate anyone in period 1 who is unharmed. Present claimants are also harmed by d in period 2 and are compensated by the amount C_2^p, which is funded from the pool of money remaining in the trust fund after period 1. In addition, there are a variable number of future claimants arising in period 2, the amount denoted by the random variable n_2, with density $f(n_2)$. These future claimants are also harmed by the amount d in periods 2 and 3. Future claimants are compensated by the amount C_2^f / n_2 per capita in period 2. C_2^f is also funded by the pool of money remaining in the trust. Finally, future claimants receive C_3^f / n_2 per capita in period 3. Applying the same logic as before, present claimants will not receive any funding in period 3 because they are no longer harmed and receive income y,[15] whereas future claimants, by assumption, are not fully compensated in period 3.

A social planner in the first period whose goal is to maximize overall social surplus (such as a judge or a trustee of the claimants' fund) should choose first period distributions when the number of future claimants is uncertain to maximize the following problem (because it is suboptimal to

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14. Formally, this is expressed by the inequality $W < 2d(1 + min\{n_2\})$.
15. The basic results will remain unchanged if this assumption is relaxed.

compensate individuals in a period in which they are unharmed, utilities of unharmed individuals are suppressed):

$$SS = \max_{C_1^p} \ u(y - d + C_1^p) + E_{n_2}[V_2(W, C_1^p, n_2)] \tag{1}$$

where $V_2(W, C_1^p, n_2)$ is the social surplus created by the optimal allocation of funds after the uncertainty in the number of future claimants is resolved. Explicitly, $V_2(W, C_1^p, n_2)$ is given by the solution to the following problem:

$$\max_{C_2^p, C_2^f} u(y - d + C_2^p)$$
$$+ n_2 \left[u \left(y - d + \frac{C_2^f}{n_2} \right) \right] + n_2 \left[u \left(y - d + \frac{W_2 - C_2^p - C_2^f}{n_2} \right) \right] \tag{2}$$

where $W_2 = W - C_1^p$.

In this setup, the motivation for damage compensation is the existence of damaged individuals with high marginal utility. Note that, by allowing C_2^p to be decided in period 2, this setup is consistent with the variable annuity solution proposed by Roe. The social planner will not want to completely withhold payment from present claimants in the first period (before the uncertainty is resolved), however, because this policy denies compensation to damaged individuals with high marginal utility. Once period 2 is reached, an opportunity to mitigate the lost utility of present claimants from damage suffered in period 1 is forever lost. Thus, the model captures the difficult trade-off between the immediate liquidity needs of present claimants and the desire to achieve a fair distribution between present and future claimants once the uncertainty is resolved.

3.1. Payments after Uncertainty Is Resolved

To determine the appropriate distribution of payments to present and future claimants, we will first solve the planner's period 2 problem (Equation 2). Solving Equation 2 for C_2^p and C_2^f yields the following first-order (Euler) conditions:

$$u'(y - d + C_2^p) - u' \left(y - d + \frac{W_2 - C_2^p - C_2^f}{n_2} \right) = 0 \tag{3}$$

and

$$u' \left(y - d + \frac{C_2^f}{n_2} \right) - u' \left(y - d + \frac{W_2 - C_2^p - C_2^f}{n_2} \right) = 0 \tag{4}$$

Combining equations, along with the assumption that $u'' < 0$, leads to lemma 1.

Lemma 1.   In an optimal trust, present claimants in period 2 and future claimants in periods 2 and 3 receive the same per capita damage award (C_2), where $C_2 = \frac{W_2}{2n_2+1}$.

Proof.   See appendix.   ■

Lemma 1 follows naturally from the compensation motive of this setup. Because present and future claimants are both damaged by the same amount d and there is no uncertainty, welfare maximization requires that all individuals receive the same damage award, a pro rata distribution of the remaining funds in the trust. This provides theoretical justification for the desire to compensate claimants equally when the number of claims is perfectly forecastable, as is the number of period 3 claimants when period 2 arrives. This reinforces the motivations behind the proposals in Smith (1994) and Roe (1984). As we will see, however, this principle of equality will only be optimal when there is no remaining uncertainty about the future.

Lemma 1 allows us to rewrite $V_2(\cdot)$ (Equation 2), by replacing C_2^p and C_2^f appropriately. In turn, this enables Equation 1 to be rewritten as

$$\max_{C_1^p} u\left(y - d + C_1^p\right) + E_{n_2}\left[(2n_2 + 1)u\left(y - d + \frac{W - C_1^p}{2n_2 + 1}\right)\right] \qquad (5)$$

Differentiating this expression with respect to C_1^p and setting equal to zero yields the Euler equation

$$u'(y - d + C_1^p) = E_{n_2}\left[u'\left(y - d + \frac{W - C_1^p}{2n_2 + 1}\right)\right] \qquad (6)$$

Intuitively, the first period payment to present claimants should be chosen to equalize the marginal utility of a present claimant with the expected marginal utility of a future claimant. With this condition in hand, we can now provide a more concrete prescription for allocating funds between present and future claimants.

3.2. Comparing Payments to Present and Future Claimants

Proposition 2.   In an optimal trust, future claimants receive greater damage awards in expectation than present claimants. That is, $E_{n_2}[\frac{W-C_1^p}{2n_2+1}] > C_1^p$.

Proof.   See appendix.   ■

Future claimants should receive greater damage payments in expectation than present claimants because the consequences of underpayment in the future (due to high n_2) are of increasingly greater significance than the consequences of overpayment.[16] A social planner desperately wants to avoid the bad eventuality of having little resources for many future claimants, who would have very high marginal utility. As a result, prudence should be the rule when awarding damages to present claimants in the first period.

The solutions to the problem of future claimants offered by Smith (1994) and Roe (1984) do not share this feature. Instead, they hope to award the same amount in expectation to the present and future claimants. The argument made here, along with the empirical evidence on precautionary savings (Gourinchas and Parker, 2001, 2002) suggests that these solutions will tend to be unfair and inefficient with respect to future claimants. Moreover, the inefficiencies associated with such proposals will tend to be large in size given the importance of the precautionary savings motive.

The recommendation of conservative awards to present claimants would have served the Manville bankruptcy's principals quite well. Instead of generously rewarding the initial claimants, only to find that there was little left for late-arriving claimants, the trust should have cautiously paid out to initial claimants to protect itself should the number of claimants prove surprisingly large (as was the case). Thus, judges (who must approve bankruptcy settlements) should insist that a greater amount of funds be set aside for future claimants than hitherto required.

It is important to recognize that the optimal allocation prescribed by Proposition 2 does not disproportionately reward future claimants. Although future claimants receive greater payments on average, they will occasionally suffer outcomes that are considerably worse than anything faced by the present claimants. Awards to future claimants must be greater on average to mitigate the harm caused by unexpectedly low damage

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16. This is the result of the convexity of marginal utility and not simply of risk aversion. It would not be true in the case of quadratic utility, for example.

payments. We should also emphasize that the intuition behind Proposition 2 applies to mass tort settlements outside of bankruptcy. Payments from a settlement fund should be awarded conservatively in the early stages, to protect against the possibility that there will be an unexpectedly large number of claimants. It is plausible that this added protection of future claimants would help assuage some of the Supreme Court's concerns regarding fairness to future claimants that were expressed in the *Amchem Prods. Inc. v. Windsor* opinion.

3.3. Comparative Statics

Having established that future claimants should receive higher damage awards on average, we now explore how the average payment differential should depend on several relevant factors. For tractability, this section further restricts the utility function to be of the CRRA type. Let $u(z_t) = \frac{z_t^{1-\gamma}}{1-\gamma}$, where γ is the coefficient of relative risk aversion. It is straightforward to verify that all the assumptions made on utility up to this point are satisfied for this class of functions, including $u'''(\cdot) > 0$.

Proposition 3.   In an optimal trust, awards to present claimants (in the first period), C_1^p, are smaller when the following conditions hold, all else equal:

(i) uncertainty in the number of future claimants $(Var(\frac{1}{2n_2+1}))$ is greater;
(ii) the income of claimants (y) is smaller;
(iii) the amount of damage per claimant (d) is larger.

Proof.   See appendix.   ■

The precautionary savings motive plays a critical role in each of the comparative statics in Proposition 3 as well. When the uncertainty in the number of future claimants rises (part 1), the chance of a very bad outcome (many future claimants) also rises. Because future claimants have high marginal utility in this eventuality, awards to present claimants in the first period should be even more conservative to ensure that some funds will be left over should there be very high numbers of future claimants. Similarly, a lower y or a higher d imply that the marginal utility of claimants is higher for a given payment from the trust. This makes the worst-case scenario (many future claimants and low trust payout per claimant) even more severe, increasing the desire of the social planner to save for insurance purposes. All of these changes imply that future

claimants should receive a higher premium with respect to present claimants (on average) from an optimally designed trust.

4. Claimants, Creditors, and Priority

We now expand the analysis to consider the appropriate treatment of tort claimants within the seniority structure of a firm's debt. At present, bankruptcy law stipulates that tort claimants occupy the same position in the priority structure as unsecured contract creditors. If the bankrupt firm's assets are not sufficient to satisfy all fixed claims, then tort claimants share value pro rata with the other unsecured creditors.[17] Though the pro rata rule is well defined for dividing up the remaining wealth in the bankruptcy estate, it does not provide any guidance with respect to the seniority of the postbankruptcy claims allocated to the two groups, which affects the sharing of risks. In the original Manville Trust settlement, a separate trust funded primarily with new Manville equity was created for tort claimants, while previous Manville unsecured creditors received a combination of cash and debt claims on the reorganized firm (Delaney, 1992). The values of these claims were set such that tort claimants and unsecured creditors received equal estimated recoveries, as required by the pro-rata rule. The effect of giving unsecured creditors more senior claims on the reorganized Manville, however, resulted in these creditors bearing none of the risk in the number of future claimants (and less of the risk in the value of Manville's assets). Even if it were possible for present claimants to sell their claims and diversify, this would not be an option for unknown future claimants. As we will see, this priority structure is exactly the opposite of one that shares risk optimally between these disparate groups.

Before we proceed, we should emphasize that the unique status of tort claimants (and in particular future claimants) justifies a more refined definition of priority that takes into account the optimal sharing of risk between claimants and creditors in addition to the optimal sharing of value. Tort claimants have been harmed, resulting in higher marginal utility, and are overexposed to firm and claimant risk. For a future claimant, even if there are no risks in the value of the firm (W is

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17. Bankruptcy Code §1129(a)(8), (b) (1).

fixed), there will still be risks from the uncertain number of future claimants that can affect wealth substantially.[18] Contract creditors, on the other hand, can optimally hold a well-diversified portfolio. Large changes in payoffs resulting from variability in the number of claimants will have a smaller effect on the overall wealth of a contract creditor, causing these claims to be priced in a risk-neutral way if claimant risk is idiosyncratic.

We define *ex ante priority* as the rule that determines the division of value between claimants and creditors based on the value of their pre-bankruptcy claims on the firm. Current law dictates that claimants and unsecured creditors have equal ex ante priority, because they share value pro rata. *Ex post priority*, on the other hand, is the rule that determines the sharing of risk in the postbankruptcy trust once the division of value is decided. A senior debt claim on the trust will carry less risk than the equity; thus, optimal trust design will dictate that ex post priority is granted to the group that is least able to bear risk.

4.1. Optimal Ex Post Priority

Suppose that an optimal bankruptcy law would dictate that for a firm worth W, unsecured contract creditors must receive a claim worth K in expectation. The value K will be determined by the appropriate ex ante priority rule, which will be analyzed formally in the next section. A higher ex ante priority for tort claimants will simply imply a lower K for a given $\{W, F\}$ pair, where F is the face value of claims held by contract creditors. We begin the formal analysis of optimal ex post priority with the period 2 problem, solving for the optimal division of the trust between tort claimants and contract creditors after the uncertainty over the number of future claimants is resolved.[19] After present claimants are paid C_1^p in period 1, $W - C_1^p$ remains to be allocated among the remaining claims. A general solution to the problem specifies a payment to contract creditors, $\pi(n_2)$, for each realization of the number of future claimants.

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18. Recall that if insurance about the number of future claimants can be purchased, W will represent the liability cap of the insurance.

19. We omit the first period problem to determine the optimal C_1^p, which is determined as before. It is straightforward to verify that future claimants will continue to receive a greater payment in expectation when contract creditors are involved.

The remainder of the trust, $W - C_1^p - \pi(n_2)$, is divided equally among tort claimants as before.

A social planner should thus solve the problem

$$\max_{\pi(n_2)} \int_0^\infty (2n_2 + 1)u\left(y - d + \frac{W - C_1^p - \pi(n_2)}{2n_2 + 1}\right)f(n_2)dn_2 \qquad (7)$$

subject to the following constraints

$$E_{n_2}[\pi(n_2)] = \int_0^\infty \pi(n_2)f(n_2)dn_2 = K \qquad (8)$$

$$\pi(n_2) \geq 0 \; \forall n_2 \qquad (9)$$

The first constraint (Equation 8) requires that the payment schedule to contract creditors should have an expected value of K, which is determined by ex ante priority. The second set of constraints (Equation 9) reflect limited liability: It assumes that contract creditors cannot be forced to provide new funds in addition to their original investment; in other words, they must receive a nonnegative payment from the trust. Given these constraints, the social planner attempts to maximize the expected utility of the tort claimants according to Equation 7.

Solving this constrained optimization problem for $\pi(n_2)$ for all n_2 (where λ is the Lagrange multiplier for Equation 8 and μ_{n_2} is the Lagrange multiplier for a given n_2 of the Equations 9) leads to the following proposition.

Proposition 4.   For any realization of n_2 such that $\pi(n_2) > 0$, $u'(y - d + \frac{W - C_1^p - \pi(n_2)}{2n_2 + 1}) = \lambda > 0$. If $u'(y - d + \frac{W - C_1^p - \pi(n_2')}{2n_2 + 1}) > \lambda$ for some n_2', then $\pi(n_2') = 0$. In an optimal trust, contract creditors receive the remainder of the trust only after remaining tort claimants receive a fixed damage award. If this fixed amount per claimant is not attainable, then tort creditors claim the entire trust.

Proof.   See appendix.   ∎

Proposition 4 implies that tort claimants should have higher ex post priority: that is, claimants should have first claim on the remainder of the trust fund $(W - C_1^p)$ set aside for the payment of contract creditors and

future tort claimants. If the number of future claimants is sufficiently high, tort claimants receive the entire trust and unsecured contract creditors receive nothing. After the per capita payment to tort claimants reaches a certain amount, however, unsecured contract creditors receive the remainder of the trust fund. The value of this fixed per capita payment is chosen to ensure that unsecured contract creditors get the appropriate amount in expected value. It is important to note that this maximum payment to tort claimants will be less than the nominal damages (d) owed to claimants and decreasing in K for a given W.

The goal of efficient ex post priority is the welfare-maximizing allocation of risk between contract creditors and tort claimants. Even assuming that pro rata sharing is desirable from an ex ante perspective, this does not imply that contract creditors and tort claimants should share equally in all scenarios. Instead, tort claimants should receive the entire trust when the value of the trust per capita is small (and the claimants thus have high marginal utility). If the value of the trust per capita is larger, then tort claimants have relatively lower marginal utility—a scenario where higher payments to contract creditors can be realized at lower cost in utility terms. This solution guarantees that contract creditors, who are risk-neutral with respect to the number of claimants, bear as much of the risk in the number of future claimants as possible. Note that this stands in direct contrast with two of the prominent mass tort bankruptcy settlements in practice. In the Manville case, as the number of claimants continued to exceed expectations, payments to tort claimants were reduced to ever smaller percentages of their liquidation values, whereas Manville's original unsecured creditors were not affected (Smith, 1994). In the bankruptcy of A.H. Robins, producer of the faulty Dalkan Shield device, by contrast, the number of future claimants fell short of expectations. As a result, the value of the trust was sufficient to compensate future claimants beyond the amounts foreseen in the bankruptcy reorganization plan. Rather than use the excess to pay creditors (as recommended here), however, an additional distribution was made to claimants.[20]

Implementation of the solution in Proposition 4 in this simple two-period problem can be achieved by awarding claimants debt contracts with a face value equal to some fraction (below one) of their actual

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20. See *In re A.H. Robins Co., Inc.*, 86 F.3d 364, 367 (3d Cir. 1996).

damages.[21] The face value will depend positively on the ex ante priority of tort claimants, because contract creditors must receive K in expectation. The face value of the debt claim will also be greater for future claimants than present claimants. Recall that Proposition 2 proves that future claimants should receive a greater payment in expectation than present claimants. As long as the future claimant risk is not borne completely by contract creditors, this will continue to hold. Under this mechanism, unsecured contract creditors will hold positions analogous to equity—they will be the residual claimants once the debt payments to claimants are satisfied.

5. Ex Ante Priority and the Timing of Bankruptcy

To this point, we have assumed the timing of the bankruptcy and the value of the firm's assets at the date of the filing are exogenous. Once in bankruptcy, it may be reasonable to assume that the bankruptcy court determines the allocation of value and risk to the relevant parties to maximize overall surplus. Before bankruptcy, however, it is more reasonable to assume that the firm's contractual owners will maximize only their own payoff when making the filing decision. Knowing this, the surplus-minded court will need to consider the optimal ex ante priority structure (the division of value between claimants and creditors) to ensure that the timing of the filing is early enough to set up an adequate trust fund for future claimants, who are excluded from the owners' objective function. If contractual owners expect an unfavorable division of firm value in bankruptcy, they may delay filing until there is little value left in the firm for claimants. Recently, some cases of fraudulent transfers have been brought against firms who have attempted to delay bankruptcy by selling assets at below-market prices, or by offering security interests on new debt to obtain new financing; both of these practices are consistent with the incentives we explore in this section.[22] The analysis that follows incorporates logic

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21. Roe (1984, pp. 876–78) briefly suggests a somewhat similar solution in a slightly different context. He does not consider the ex ante priority sharing of unsecured creditors and tort claimants described here, however. As a result, claimants in his tentative framework should receive debt contracts with a face value equal to damages, in sharp contrast to the proposal made here.

22. Owens-Corning, in bankruptcy due to asbestos liability, faces a fraudulent conveyance attack from its creditors due to a secured loan it obtained prior to filing; asbestos claimants successfully obtained a settlement from Sealed Air Corp.,

similar to Spier and Sykes (1998), who study a firm's choice of capital structure in the face of tort claims that may render a firm insolvent. Similar to Spier and Sykes (1998), we consider the role of priority between claimants and creditors and its resulting effect on the value of tort claims. Our analysis, however, focuses on the timing of bankruptcy as the firm's control variable rather than the firm's leverage, which we take as exogenous.

We will incorporate these considerations into our framework using a setup similar to White (1989). Suppose the firm's contractual owners (the combined owners of equity and debt claims), acting as a coalition, can decide to file early, in period 1, or wait until the number of future claimants is realized in period 2 and file if the firm is insolvent.[23] We assume that efficient bargaining will take place between the firm's contractual creditors and the holders of its equity; this implies that our results do not depend on whether equity or debt has ultimate control over the filing decision.

If the firm decides to wait rather than file, it must pay present claimants d, the full amount of their damages. We will assume that of the firm's assets, worth W, up to $W_1 \leq W$ will be available to pay claimants and creditors in period 1, with the rest, $W_2 = W - W_1$, becoming available only in period 2. We adopt this setup as a simple way of incorporating the ability of the court to prevent payment to creditors in the wake of bankruptcy. Voidable preference rules in bankruptcy are aimed at preventing early payment of debts that would circumvent bankruptcy priority rules; the higher is $0 < W_1/W < 1$, the less effective is the court at voiding such preferential payments to creditors.[24]

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which acquired a subsidiary from bankrupt W.R. Grace & Co. at a below-market price. See Plevin and Kalish (2002).

23. To emphasize the difference between claimants and creditors in our model, we consider the extreme case that equity and contract creditors bargain efficiently, but this coalition is not able to bargain with present claimants because they are dispersed; if present claimants could negotiate with the firm a filing would be harder to elicit because the two parties would choose the option that expropriates the most from future claimants.

24. Baird (1992) mentions that it is possible for firms to circumvent preference rules in bankruptcy by delaying a filing until 90 days after a payment to creditors is made. This can make enforcement difficult in practice.

If the firm files early, the bankruptcy court will design the trust according to the principles laid out in the above sections, with the payoff to firm owners (K) being determined by the relevant ex-ante priority rule. Given that we are explicitly incorporating contract creditors at this stage, we write our social surplus function explicitly as follows:

$$SS = u(y - d + C_1^p) \\ + E_{n_2}\left[(2n_2 + 1)u\left(y - d + \frac{W - C_1^p - \pi(n_2)}{2n_2 + 1}\right)\right] + Ku'(y) \quad (10)$$

The utility of the firm's contractual owners is given by $Ku'(y)$, reflecting our earlier assumption that claims on the firm are widely held by diversified owners who are unharmed with probability approaching one. It is straightforward to verify that it is never optimal to pay claimants more than their damages d, because funds always can be distributed to creditors at a constant marginal utility of $u'(y)$.

Because bankruptcy triggers the shift in objective functions (of the individuals controlling the firm) from owner maximization to total surplus maximization, an early filing is socially optimal in this model when future claims may render the firm insolvent.[25] A delayed filing will lead to an inefficient division of payments between present and future claimants. Present claimants will be paid in full in period 1, and future claimants will receive less than full compensation.

We now discuss three potential ex ante priority rules: creditor priority (which entails payoffs to creditors first, claimants second, and equity last), claimant priority (payment to claimants first, creditors second, and equity last), and pro rata sharing (equal priority of creditors and claimants, with equity last), and the effect each of these rules have on the probability the firm will file early for bankruptcy.

5.1. Comparing Filing Choices under Different Priority Rules

Before considering each of the ex-ante priority rules separately, we define a procedure by which a given ex ante priority rule translates into K, the dollar value of the contractual owners' claim on the trust. When the

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25. It is not clear in this environment that the cost of filing for bankruptcy will be positive; indirect costs such as debt overhang are likely to be diminished by the filing and direct costs such as legal fees have been found to be small relative to firm value (Weiss, 1990).

firm files in period 1, the court will observe F, W_1, W_2, d, and the distribution of future claims $f(n_2)$. Using these parameters, we assume the owners' claim K will be set equal to the expected payment the equity/creditor coalition would receive if all claims and payments were delayed until all future claims materialize, with the given priority rule allocating payments in states where debt exceeds assets. Although there are other possible ways to define such a procedure, we believe this one is most useful because it is easily generalizable to a more realistic multiperiod setting, thus making it implementable in practice. It also implicitly removes some (but not all) incentive to delay the filing, since the coalition's claim depends in part on equity holders' option value of continuation.[26]

To further clarify this procedure, we give a simple numerical example below that illustrates the payoff to firm owners under the various ex ante priority rules given that the firm *files early* for bankruptcy.

Example 1.   Suppose $W_1 = 21$, $W_2 = 80$, $F = 30$, $d = 20$, $n_2^h = 5$, $n_2^l = \frac{1}{2}$, $\Pr(n_2 = n_2^h) = \frac{1}{2}$.

Creditor Priority.

Payoff to owners = creditor payoff + equity payoff =

$$\sum_{n_2^j, j=h, l} \Pr(n_2^j)(\min\{W, F\} + \max\{W - F - (2n_2^j + 2)d, 0\}) =$$

$$K = \frac{1}{2}(30 + 0) + \frac{1}{2}(30 + [101 - 30 - 60]) = 35.5.$$

Claimant Priority.

Payoff to owners = creditor payoff + equity payoff =

$$\sum_{n_2^j, j=h, l} \Pr(n_2^j)(\max\ \{\min\ \{W - (2n_2^j + 2)d, F\}, 0\}$$

$$+ \max\ \{W - F - (2n_2^j + 2)d, 0\})$$

$$K = \frac{1}{2}(0 + 0) + \frac{1}{2}(30 + [101 - 30 - 60]) = 20.5$$

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26. We have experimented with other procedures, such as reducing tort claims to an expected value as of period 1. The theoretical results concerning incentives to file are qualitatively similar.

Pro Rata Sharing.

Payoff to owners = creditor payoff + equity payoff =

$$\sum_{n_2^j, j=h, l} \Pr(n_2^j) \left(\min\left\{ \frac{F}{F + (2n_2^j + 2)d} W, F \right\} \right.$$

$$\left. + \max\{W - F - (2n_2^j + 2)d, 0\} \right)$$

$$K = \frac{1}{2}\left(\frac{30}{30 + 240}[101] + 0\right) + \frac{1}{2}(30 + [101 - 30 - 60]) = 26.1$$

Two points deserve mention here. First, as we would expect, conditional on an early filing a higher priority for creditors results in a larger payoff to firm owners. This will affect the social planner's decision about the optimal ex ante priority rule. Second, given that the algorithm pays firm owners similarly to what would occur if the firm waits to file, one might expect that owners would always be indifferent between filing now and waiting, independent of the ex ante priority rule. As we will see, however, this is not the case. Firm owners have the ability to change the value of the firm's assets when it files for bankruptcy by paying out cash to satisfy claims or by borrowing and taking on new debt, and this will affect the filing decision, making ex ante priority important. Thus, the optimal rule from a social perspective will be the rule that trades off the distribution of value with the timing of the filing most effectively.

We will now compare owner payoffs, the combined value of (contractual) debt and equity, depending on the timing of the filing for each priority rule (we assume equity is junior in all cases). We will assume throughout that the firm will wait rather than file if payoffs to waiting and filing are equal (a positive bankruptcy cost, for example, would result in firms preferring to wait.)

5.1.1. Ex Ante Creditor Priority. If the firm files early under ex ante creditor priority, expected owner payoff (OP) is given by the following:

$$OP(\text{file, creditor}) = W \text{ if } W \leq F \tag{11}$$

$$= F + \int_0^{\frac{W-F}{2d} - 1} (W - F - [2n_2 + 2]d)f(n_2)dn_2 \text{ if } W > F$$

The first term is the payoff to contract creditors, which come first in the priority structure and will be fully repaid if $W > F$; if this is not possible, then creditors claim the entire firm value. The second term is the payoff to equity, which is always at the bottom of the priority structure and is only paid when all claimants and creditors are paid in full. We now compare to the payoff to waiting, which differs only slightly:

$$OP(\text{wait}, \text{creditor}) = W - d \text{ if } W \leq F + d$$

$$= F + \int_0^{\frac{W-F}{2d} - 1} (W - F - [2n_2 + 2]d) f(n_2) dn_2 \text{ if } W > F + d \tag{12}$$

Note that if the firm is solvent in states with no future claims (when $W > F + d$), the firm's owners are indifferent between filing and waiting. Waiting entails paying present claimants in full, whereas filing early may result in a reduction in their claims. The cost of this, however, is entirely born by future claimants in this scenario. If $W_1 < d$, creditors must contribute $d - W_1$ to avoid bankruptcy, with the firm taking on this amount as a debt claim payable in period 2.[27] But since $F + d - W_1 < W_2$, firm value is enough to compensate creditors in full for any additional capital they provide to keep the firm out of bankruptcy.

A difference only emerges between waiting and filing when $W < F + d$. In this scenario, the firm strictly prefers to file early because paying present claimants in full results in a lower payoff to creditors. We summarize these facts in the following proposition.

Proposition 5.   *Under creditor priority, the firm will file early if and only if it would be insolvent absent future claims ($W < F + d$).*

Proof.   Evident from inspection of Equations 11 and 12.   ■

The analysis highlights the potential problems with ex ante creditor priority: the firm owners have too much incentive to avoid bankruptcy because they expect to be repaid in full, with the cost of delay being fully borne by future claimants (who receive less compensation than present

27. We assume new debt must be fairly priced, otherwise the court can disallow it under fraudulent conveyance laws. If the face value of new debt could be set arbitrarily, future claimants could be completely expropriated by setting the face value high enough.

claimants). In addition, ex ante creditor priority results in the highest payoffs to creditors when bankruptcy occurs; this compounds the problem of undercompensation of future claimants with high marginal utility.

5.1.2. Ex Ante Claimant Priority.

Because the game between claimants and firm owners is zero-sum, we can express the owner payoff as firm value less expected claimant payoff (ECP). If the firm files early under ex ante claimant priority, expected owner payoff is the following:

$$OP(\text{file}, \text{claimant}) = W - ECP(\text{file}, \text{claimant})$$

where the expected claimant payoff under an early filing, $ECP(\text{file}, \text{claimant})$, is given by

$$\Pr([2n_2 + 2]d > W)W + $$
$$\Pr([2n_2 + 2]d \leq W)E_{n_2}[(2n_2 + 2)d | (2n_2 + 2)d \leq W] \tag{13}$$

The first term is the expected claimant payoff when the total amount of claims exceeds firm value, which results in the entire firm value being paid to claimants. The second term is the expected claimant payoff when claimants can be paid in full; the expectation is taken over n_2, which is random as of period 1.

We now compare to owner payoff when the firm waits to file:

$$OP(\text{wait}, \text{claimant}) = W - ECP(\text{wait}, \text{claimant})$$

where the expected claimant payoff when the firm waits to file, $ECP(\text{wait}, \text{claimant})$, is given by

$$d + \Pr([2n_2 + 1]d > W_2)W_2 + $$
$$\Pr([2n_2 + 1]d \leq W_2)E_{n_2}[(2n_2 + 1)d | (2n_2 + 1)d \leq W_2] \tag{14}$$

Note that if the firm does not file, present claimants will receive d.[28] It is never optimal for firm owners to leave any cash in the firm once it decides to continue, so the remainder of claims must be paid out of the remaining cash W_2. We can rewrite Equation 13 to make it comparable to Equation 14

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28. Note that OP (wait, claimant) can be negative. If contract creditors must inject funds to allow the company to continue (if $W_1 < d$), then overall payoff may be below zero as the newly added funds may also be used to pay claimants. In this scenario, however, it would be irrational for contract creditors to inject additional funds.

so we can better analyze the filing decision. *ECP*(file, claimant) can be rewritten as the following:

$$d + \Pr([2n_2 + 1]d > W - d)(W - d) + \\ \Pr([2n_2 + 1]d \leq W - d)E_{n_2}[(2n_2 + 1)d|(2n_2 + 1)d \leq W - d] \qquad (15)$$

Comparing equations (14) and (15) leads us to a very simple characterization of the filing decision under ex ante claimant priority.

Proposition 6.   *Under ex ante claimant priority, the firm waits to file if and only if it is liquid; that is, an early filing occurs if and only if $W_1 \leq d$.*

Proof.   Evident from comparing Equations 14 and 15.   ∎

The intuition is as follows. Because creditors are lower in ex ante priority than claimants, firm owners will receive a distribution only in states where firm value is enough to pay all present and future claims in full. Paying present claimants in full out of the firm's available cash W_1, then, does not cost firm owners anything if they decide to continue. Instead, firm owners will benefit from delay if $W_1 > d$, because the remaining available cash ($W_1 - d$) can be used to pay creditors in period 1. In effect, this allows creditors to "jump" future claimants in the priority structure because some debt claims come due early and future tort claims arrive late.

If $W_1 < d$, on the other hand, creditors must contribute additional funds to avoid a bankruptcy filing. The amount raised, $d - W_1$, will be paid to claimants first, with creditors receiving a junior debt claim on the firm. This results in firm owners' filing early rather than risking loss of the additional funds required to avoid bankruptcy.

Comparing the first two ex ante priority rules, it is surprising that an early filing is not necessarily more likely under claimant priority than creditor priority; cases exist in which an early filing would occur under one priority structure but not the other. It is important to recognize, however, that claimant priority does a better job of inducing an early filing except when the firm is deeply insolvent yet still liquid enough to pay present claimants (when $W < F + d$ but $W_1 > d$). In these cases, less than d would be left to be divided among all claimants under creditor priority.

5.1.3. Ex Ante Pro Rata Sharing.   Pro rata value sharing between claimants and creditors is in some ways an intermediate case between creditor

and claimant priority. For an early filing under pro rata, owner payoff is the following:

$$OP(\text{file, prorata}) = W - ECP(\text{file, prorata})$$

where the expected claimant payoff when the firm files early, $ECP(\text{file, prorata})$, is given by

$$\Pr(F + (2n_2 + 2)d > W)E_{n_2}\left[\frac{(2n_2 + 2)d}{(2n_2 + 2)d + F}W|F + (2n_2 + 2)d > W\right]$$

$$+ \Pr(F + (2n_2 + 2)d \leq W)E_{n_2}\left[(2n_2 + 2)d|F + (2n_2 + 2)d \leq W\right] \tag{16}$$

The owner payoff to waiting is similar in that insolvency occurs in the same states, but the early payment to present claimants changes both the value of the assets in the firm and the amount owed to claimants:

$$OP(\text{wait, prorata}) = W - ECP(\text{wait, prorata})$$

where the expected claimant payoff when the firm waits to file, $ECP(\text{wait, prorata})$, is given by

$$d \ + \ \Pr(F + (2n_2 + 2)d > W)E_{n_2}\left[\frac{(2n_2 + 1)d}{(2n_2 + 1)d + F - W_1}W_2|F\right.$$

$$\left. + (2n_2 + 2)d > W\right] + \Pr(F + (2n_2 + 2)d \leq W) \tag{17}$$

$$E_{n_2}\left[(2n_2 + 1)d|F + (2n_2 + 2)d \leq W\right]$$

With these expressions in hand, we can derive a clear comparison between claimant priority and pro rata sharing.

Proposition 7.   Under the ex ante pro rata priority rule, there is some $\Delta > 0$ such that the firm files early if and only if $W_1 - d < \Delta$; firm owners have a stronger incentive to file early under ex ante pro rata sharing than under ex ante claimant priority.

Proof.   See appendix.   ∎

Recall that under claimant priority, the firm owners prefer to pay present claimants in full when the firm is liquid, because the entire cost of overcompensating present claimants is borne by future claimants. With

a pro rata rule, this is not the case. Paying present claimants in full in period 1 to avoid bankruptcy implicitly moves them ahead of creditors in the priority structure, leaving creditors and future claimants to divide up a smaller firm in period 2. This provides firm owners greater incentive to file early under an ex ante pro rata rule.

The preceding discussion suggests that although ex ante creditor priority is unlikely to be optimal, there is a clear trade-off between claimant priority and pro rata sharing. Claimant priority should result in more funds available to claimants conditional on the timing of the filing. Given our assumption that claimant marginal utility is higher than creditor marginal utility when claimants are not fully compensated, this should result in a more efficient distribution of value between creditors and claimants. On the other hand, ex ante claimant priority also makes early filing less likely, which can lead to a less equitable distribution between present and future claimants.

We now return to our simple numerical example to see the costs and benefits of the various ex ante rules. In this example, we demonstrate the effect the ex ante priority rule can have on the filing decision and the way the filing decision in turn affects the distribution of payments between creditors, present claimants, and future claimants. In a previous subsection, we illustrated owner payoff when the firm files early; here we solve for owner payoffs when the firm *waits* to file and compare payoffs to find the filing decision chosen under each rule.

Example 2. Let $u(z_t) = \ln(z_t)$, $y = 20$, $W_1 = 21$, $W_2 = 80$, $F = 30$, $d = 20$, $n_2^h = 5$, $n_2^l = \frac{1}{2}$, $\Pr(n_2 = n_2^h) = \frac{1}{2}$.

Creditor Priority.

$$\text{Payoff to owners = creditor payoff + equity payoff =}$$

$$\sum_{n_2^j, j=h, l} \Pr(n_2^j)(\min\{W - d, F\} + \max\{W - F - (2n_2^j + 2)d, 0\}) =$$

$$\text{Payoff to waiting} = \frac{1}{2}(30 + 0) + \frac{1}{2}(30 + [101 - 30 - 60]) = 35.5$$

$$\text{Payoff to filing early (see Example 1)} = 35.5$$

$$\text{Owners' optimal filing decision: } \textbf{wait}$$

Overall social surplus when firm waits (see Equation 10):

$$SS(\text{creditor, wait}) = u(d) + \frac{1}{2}\left(Fu'[y] + [2n_2^h + 1]u\left(\frac{W - F - d}{2n_2^h + 1}\right)\right)$$

$$+ \frac{1}{2}\left([W - (2n_2^l + 2)d]u'[y] + [2n_2^l + 1]u[d]\right)$$

$$= \ln(20) + \frac{1}{2}\left(30 \times \frac{1}{20} + 11 \times \ln\left[\frac{51}{11}\right]\right)$$

$$+ \frac{1}{2}\left([101 - 60] \times \frac{1}{20} + 2 \times \ln[20]\right) = 16.2$$

Claimant Priority.

Payoff to owners =

$$\sum_{n_2^j, j = h, l} \Pr\left(n_2^j\right)\left(\min\left\{\max\left\{W_2 - \left(2n_2^j + 1\right)d, 0\right\} + W_1 - d, F\right\}\right.$$

$$\left. + \max\left\{W - F - \left(2n_2^j + 2\right)d, 0\right\}\right)$$

$$\text{Payoff to waiting } = \frac{1}{2}(1 + 0) + \frac{1}{2}(30 + [101 - 30 - 60]) = 21$$

$$\text{Payoff to filing early (see Example 1)} = 20.5 < 21$$

$$\text{Owners' optimal filing decision: } \textbf{wait}$$

Overall social surplus when firm waits (see Equation 10):

$$SS(\text{claimant, wait}) = u(d) + \frac{1}{2}\left(\left[2n_2^h + 1\right]u\left[\frac{W - d}{2n_2^h + 1}\right]\right)$$

$$+ \frac{1}{2}\left(\left[W - (2n_2^l + 2)d\right]u'[y] + [2n_2^l]u[d]\right)$$

$$= \ln(20) + \frac{1}{2}\left(11 \times \ln\left[\frac{80}{11}\right] + 1 \times \frac{1}{20}\right)$$

$$+ \frac{1}{2}\left(41 \times \frac{1}{20} + 2 \times \ln\left[\frac{40}{2}\right]\right) = 18.0$$

Pro Rata Sharing.

Payoff to owners under pro rata =

$$\sum_{n_2^j, j=h, l} \Pr(n_2^j)(\min\left\{\frac{F - (W_1 - d)}{F - (W_1 - d) + \left(2n_2^j + 1\right)d} W_2 + W_1 - d, F\right\}$$
$$+ \max\{W - F - (2n_2^j + 2)d, 0\})$$

Payoff to waiting:

$$\frac{1}{2}\left(\frac{29}{29 + 220}80 + 1\right) + \frac{1}{2}(30 + [101 - 30 - 60]) = 25.7$$

Payoff to filling early (see Example 1) = 26.1 > 25.7

Owners' optimal filing decision: **file early**

Total social surplus when firm files early (see Equation 10):

$$SS(\text{prorata, file}) = u(y - d + C_1^p) + \frac{1}{2}\left([2n_2^h + 1]u\left[\frac{W - C_1^p}{2n_2^h + 1}\right]\right)$$
$$+ \frac{1}{2}\left(2Ku'[y] + [2n_2^l + 1]u\left[y - d + \frac{W - C_1^p - 2K}{2n_2^l + 1}\right]\right)$$

$$\ln(11.35) + \frac{1}{2}(11 \times \ln[\frac{89.65}{11}]) + \frac{1}{2}(52.2 \times \frac{1}{20} + 2 \times \ln[\frac{37.45}{2}]) = 18.2$$

In this stylized example, total social surplus is highest under the pro rata rule and lowest under creditor priority. Comparing pro rata with claimant priority, we can see that firm owners receive a greater expected payoff under the optimal decision rule (26.1 under pro rata and 21 under claimant priority). Because claimants are not fully compensated in all states and their marginal utility is higher than that of creditors, we might expect that pro rata is necessarily worse from a social standpoint. In this case, how-ever, the value of setting up the trust at an earlier date more than com-pensates for the lower proceeds available to claimants. Contract creditors are "bribed" to file early, which creates value in two important ways. First, it redistributes value more efficiently between present and future claimants by paying present claimants a reduced damage award (11.35 versus 20). This leaves more funds available for future claimants. Second, it

redistributes value more efficiently between future claimants in different states of the world. Because money is more valuable in states with many future claimants, the trust pays creditors only when realized future claims are low. This allows more of the savings from present claimants to be passed on to future claimants when marginal utility is highest.

If we were to change the parameters slightly, for instance by holding $W = W_1 + W_2$ constant but reducing W_1 from 21 to 19, then the firm will file early under both claimant priority and pro rata. Because a greater expected payoff to claimants is socially preferred for a given filing decision, claimant priority will maximize social surplus. As we mentioned, courts have the ability to affect W_1/W by the effectiveness of voidable preference laws in bankruptcy. Thus, from a policy perspective, if an ex ante claimant priority rule is chosen, our model suggests it should be coupled with a strong rule prohibiting preferential transfers to effectively produce earlier filings. If this is not possible, an ex ante pro rata rule may be more effective.

6. Conclusion

The goal of this article is to provide a simple framework that incorporates the most important issues common to bankruptcies caused by mass tort liability. Our model demonstrates that future claimants can be undercompensated in two important respects. First, they are overexposed to the risk in the number of future claimants relative to present claimants and other creditors. As a result, we find that optimal policy requires a greater expected payment to future claimants that to present claimants as protection for bearing this additional risk. Second, the firm's contractual owners have a large incentive to delay a bankruptcy filing when future claimants are involved to pay themselves first. In an environment in which preventing such transfers is difficult, we find that higher priority for contract creditors (in particular, pro rata value sharing) can be beneficial because it encourages firm owners to file earlier for bankruptcy.

In addition, we find that tort claimants' attitudes toward risk has critical implications for the appropriate treatment of both present and future claimants in bankruptcy negotiations. Current practice (such as the Manville and A. H. Robins bankruptcies) often results in an exceedingly inefficient allocation of risk. Those least able to bear risk (tort

claimants) have been exposed to the greatest amount of uncertainty. We find, contrary to current practice, that prepetition contract creditors should be given claims on the trust, rather than be held separate from it. In particular, they should hold the equivalent of an equity position in the trust to minimize risk to future claimants. This contrast between theory and practice suggests that economic analysis of tort claimants' and other contract creditors' differential attitudes towards risk may have additional implications for related questions.

For example, the ex ante/ex post priority distinction described in the previous section may have wider applicability. This article has focused on the existence of a fixed trust fund value (W), but the trust fund will often consist of stock in the restructured company (when selling the entire company for cash may entail a great loss in value). In this scenario, judges could apply the ex ante/ex post priority process subject to some additional modifications. Because the value of the trust is no longer certain, it may be even more desirable to exercise caution with respect to future claimants, who are now subject to significant firm value risk in addition to the future claims risk we analyze here.

Finally, a full consideration of optimal ex ante priority would take into account the ex ante incentives of contract creditors to invest in the firm given the probability of a tort and the dilution of their claims that would result.[29] We expect that this would strengthen the case for ex ante claimant priority, to ensure that creditors properly internalize the damage to outside individuals before lending, and appropriately monitor the firm after lending.

7. Appendix

7.1. Proof of Lemma 1

Combining the Euler Equations 3 and 4, along with the assumption that $u'' < 0$, implies that $C_2^p = C_2^f/n_2 = C_2$. the second period, present and future claimants should receive the same compensation (C_2) because they suffer the same amounts of damage. The Euler equations also imply that with no discount rate, $C_3^f/n_2 = C_2$. In turn, this implies that

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29. Such an analysis would ideally consider the effects of joint and several liability as well. For a discussion of these issues, see Malani and Mullin (2004).

$C_3^f = n_2 C_2 = W_2 - C_2 - n_2 C_2$. Solving this equation leads to lemma 1, with $C_2 = \frac{w_2}{2n_2+1}$.

7.2. Proof of Proposition 2

Because $u'''(\cdot) > 0$, $u'(\cdot)$ is a convex function. Thus,

$$u'\left(y - d + C_1^p\right) = E_{n_2}\left[u'\left(y - d + \frac{W - C_1^p}{2n_2 + 1}\right)\right] >$$

$$u'\left(E_{n_2}\left[y - d + \frac{W - C_1^p}{2n_2 + 1}\right]\right),$$

where the inequality holds because of Jensen's inequality for convex functions (assuming that there is some variance in n_2). Because $u'' < 0$, the inequality implies that $y - d + C_1^p < E_{n_2}\left[y - d + \frac{W - C_1^p}{2n_2+1}\right]$ and the proposition follows.

7.3. Proof of Proposition 3

7.3.1. Derivation of Taylor Approximation.
Rewriting equation (6) with the CRRA utility function and rearranging yields

$$E_{n_2}\left[\left(\frac{y - d + \frac{W - C_1^p}{2n_2+1}}{y - d + C_1^p}\right)^{-\gamma}\right] = 1 \tag{18}$$

Define $g = \frac{\frac{w - c_1^p}{2n_2 + 1} - C_1^p}{y - d + C_1^p}$ (the percentage difference between the first and second period claimants' payments).

The second-order Taylor approximation of equation (18) is

$$1 \approx E_{n_2}\left[1 - \gamma g + \frac{\gamma(1+\gamma)}{2} g^2\right]$$

Rearranging, dividing by γ, and substituting in the identity $E[g^2] = var[g] + E_{n_2}[g]^2$ yields

$$E_{n_2}[g] \approx \frac{(1+\gamma)}{2}\left(var[g] + E_{n_2}[g]^2\right) \tag{19}$$

(recall that the expansion is around $g = 0$). Taking constant terms out of the expectations and recalling the definition of g leads to

$$\frac{y - d + C_1^p}{W - C_1^p} E_{n_2} \left[\frac{1}{2n_2 + 1} - \frac{C_1^p}{W - C_1^p} \right]$$

$$- \frac{1 + \gamma}{2} E_{n_2} \left[\frac{1}{2n_2 + 1} - \frac{C_1^p}{W - C_1^p} \right]^2 \approx \frac{1 + \gamma}{2} var \left[\frac{1}{2n_2 + 1} \right] \tag{20}$$

7.3.2. Part i. A slight rewriting of equation (20) yields the following:

$$\frac{y - d}{W - C_1^p} \left[E_{n_2} \left(\frac{1}{2n_2 + 1} \right) - \frac{C_1^p}{W - C_1^p} \right] + \frac{C_1^p}{W - C_1^p} \left[E_{n_2} \left(\frac{1}{2n_2 + 1} \right) \right.$$

$$\left. - \frac{C_1^p}{W - C_1^p} \right] - \frac{1 + \gamma}{2} \left[E_{n_2} \left(\frac{1}{2n_2 + 1} \right) - \frac{C_1^p}{W - C_1^p} \right]^2 \tag{21}$$

$$\approx \frac{1 + \gamma}{2} var \left(\frac{1}{2n_2 + 1} \right)$$

We seek to prove that the left-hand side of equation (21) is decreasing in C_1^p, holding $E_{n_2}(\frac{1}{2n_2+1})$ constant. First, by differentiating the first term in equation (21) it is straightforward to verify it is always decreasing in C_1^p (this will be shown in parts ii–iii). Thus it is sufficient to prove the result for $y - d = 0$. Hence, equation (21) is decreasing in C_1^p if the following expression is strictly negative:

$$\frac{\partial}{\partial C_1^p} \left(\frac{C_1^p}{W - C_1^p} \left[E_{n_2} \left(\frac{1}{2n_2 + 1} \right) - \frac{C_1^p}{W - C_1^p} \right] \right.$$

$$\left. - \frac{1 + \gamma}{2} \left[E_{n_2} \left(\frac{1}{2n_2 + 1} \right) - \frac{C_1^p}{W - C_1^p} \right]^2 \right)$$

Differentiating with respect to C_1^p and rearranging yields the following condition:

$$\frac{C_1^p}{W - C_1^p} > \frac{\gamma + 2}{\gamma + 3} E_{n_2} \left(\frac{1}{2n_2 + 1} \right)$$

But this is the exact condition required for C_1^p to be a maximum, as can be verified by differentiating the approximate first order condition

$$1 - E_{n_2} \left[1 - \gamma g + \frac{\gamma(1 + \gamma)}{2} g^2 \right] = 0$$

with respect to C_1^p and comparing to zero.

7.3.3. *Parts ii, iii.*   Again, we begin with equation (21):

$$\frac{y-d}{W-C_1^p}\left[E_{n_2}\left(\frac{1}{2n_2+1}\right)-\frac{C_1^p}{W-C_1^p}\right]+\frac{C_1^p}{W-C_1^p}\left[E_{n_2}\left(\frac{1}{2n_2+1}\right)-\frac{C_1^p}{W-C_1^p}\right]$$

$$-\frac{1+\gamma}{2}\left[E_{n_2}\left(\frac{1}{2n_2+1}\right)-\frac{C_1^p}{W-C_1^p}\right]^2\approx\frac{1+\gamma}{2}\,var\left(\frac{1}{2n_2+1}\right)$$

Part i of the proposition showed that the sum of terms two and three must decrease when C_1^p increases. We now show that the first term must also decrease (all else constant) when C_1^p increases. Differentiating the first term with respect to C_1^p and comparing to zero reveals that it is decreasing in C_1^p if and only if the following holds:

$$W > E_{n_2}\left(\frac{W-C_1^p}{2n_2+1}\right)-C_1^p$$

It is easy to verify that this condition is always true. Thus, the first term is also decreasing in C_1^p for a given $y-d$. By Proposition 2, the first term is also positive. As $y-d$ rises, then, the left-hand side of equation (21) rises, which means that C_1^p rise for equation (21) to continue to hold.

7.4. Proof of Proposition 4

Maximizing Equation 7 subject to Equation 8 and the set of Equations 9 yields the set of first-order conditions

$$u'\left(y-d+\frac{W-C_1^p-\pi(n_2)}{2n_2+1}\right)-\lambda\,f(n_2)-\mu_{n_2}=0 \tag{22}$$

for each n_2, where λ is the Lagrange multiplier for Equation 8 and μ_{n_2} is the Lagrange multiplier for a given n_2 of the Equations 9, along with a complementary slackness condition for each $\pi(n_2)$. If $\mu_{n_2}=0$, then $\pi(n_2)>0$ and Equation 22 then implies the first element of proposition 4. If $\mu_{n_2}>0$, then the complementary slackness condition implies that $\pi(n_2)=0$, which is the second element of Proposition 4.

7.5. Proof of Proposition 7

Comparing Equations 16 and 17, it is evident that an early filing will occur under pro rata if and only if the following is true:

$$E_{n_2}\left[\frac{(2n_2+2)d}{(2n_2+2)d+F}W|F+(2n_2+2)d>W\right]<d$$

$$+E_{n_2}\left[\frac{(2n_2+1)d}{(2n_2+1)d+F-W_1}W_2|F+(2n_2+2)d>W\right]$$

It is sufficient to show that an early filing will occur if this inequality holds term by term for each n_2, hence we show that

$$\frac{(2n_2+2)d}{(2n_2+2)d+F}W<d+\frac{(2n_2+1)d}{(2n_2+1)d+F-W_1}W_2$$

for all n_2 such that $F+(2n_2+2)d>W$. Relabeling $W_1=\alpha d$ and rearranging terms, we find that the above inequality holds if and only if the following holds:

$$\begin{aligned}-dF+(\alpha-1)(2n_2+2)d^2<\big(-dF\\+(\alpha-1)(2n_2+2)d^2\big)\frac{W_2}{(2n_2+2)d+F-\alpha d}\end{aligned}\tag{23}$$

Note that the fraction on the right-hand side of the inequality is always less than one because $F+(2n_2+2)d>W$. Because $-dF<0$, this expression holds strictly for $\alpha<1$, the necessary and sufficient condition for a firm to file early under claimant priority. It is also easy to show that there exist $\alpha>1$ such that $(\alpha-1)(2n_2+2)d^2<dF$, implying that the inequality will continue to hold. In these cases the firm will file early under pro rata but will not file early under claimant priority.

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