Recovery of Face Value at Default: Theory and Empirical Evidence

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Abstract

We examine defaulted bonds of predominantly US-based issuers who at the time of the initial default event had several publicly traded bonds outstanding. We find that in the vast majority of cases bonds of the same issuer and seniority are valued equally or within one dollar by the market, irrespective of their time to maturity. This strongly suggests that the amount recovered in default is best modelled as a fraction of face value at the time of default (RFV) as other assumptions, in general, cannot generate such a payoff pattern in bonds. We argue that this assumption is generated by the institutional framework which affects corporate bond pricing and thus is the only assumption with an underpinning theory. This may have important implications for empirical studies of credit risk which use models that do not incorporate RFV. While it has been remarked in the literature that RFV is often used in practice, up to now there has been little detailed discussion on why this should be the case nor any empirical support for such a hypothesis. In fact, some recent papers show support for alternative recovery assumptions. The results within strengthen the argument that the market may incorporate RFV when valuing corporate debt securities.

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1 Introduction

In this paper we examine, at the time of the initial default event, the value of bonds for a sample of defaulted issuers having multiple publicly traded bonds outstanding. Considering the prices at the default date as a proxy for the recovery value of a given bond, we find that the data supports the *Recovery of Face Value at Default* (RFV) assumption as described in Duffie (1998)[1] and Lando (1998). This recovery assumption states that bondholders receive a fractional recovery of par *at* the default date. A primary implication of such an assumption is that bonds of the same issuer and seniority will converge to the same value regardless of the remaining maturity. Our focus on the *relative* recovery rates for bonds of the same issuer and seniority allows us to determine whether such an assumption better describes the data compared with alternative recovery forms. We find that in 83% of the cases in our sample the difference between the maximum and minimum bond price for a given issuer is less than \$1, a result which is hard to generate under typical implementations of other recovery forms. To the best of our knowledge this is the first study which shows empirical evidence regarding relative recovery values for bonds with the same issuer and seniority.

There are a number of recovery value assumptions seen in the literature for defaultable debt modelling. While each embeds different empirical implications, it unusual to see a theory associated with the recovery form assumed. We argue that a close study of the institutional framework affecting the corporate bond should generate this theory. Specifically, the bond indenture and relevant bankruptcy code should be the critical determinants of the relationship between recovery values across bonds of the same issuer and seniority. The debt acceleration clause found in the typical bond indenture generates the hypothesis that an RFV assumption should hold. Our examination of the US bankruptcy code does not lead us to generate an additional or a modified hypothesis on what the relative recovery values should be. Specifically, we can interpret from the code that recovery values could easily deviate from RFV as a result of a specific bankruptcy plan, but not in

[1] This reference cites Brennan and Schwartz (1980) as an early example that used such a recovery assumption in a (convertible) debt pricing model. Further references are listed below.

a systematic or predetermined way. Our empirical results lend support to this assertion.

1.1 Related Literature

A major factor affecting the valuation of defaultable debt is the amount recovered by the debtholder when default occurs. Estimating this recovery value is a difficult task for a variety of reasons. First, the absolute priority rule is often violated in practice – due in part to the complex nature of the bargaining game that takes place between the corporate claimants at default. This feature seems to be especially important in the US bankruptcy code (see Franks and Torous (1989)). Second, empirical evidence suggest that recovery values vary across both firms and time. Characteristics of the company's assets affect the firm's liquidation value at default[2], while macroeconomic conditions defined by the current state of the economy also seem to play a major role.[3] In addition, the recoveries can depend on whether default is triggered by financial rather than economic difficulties. These combined facts have led researchers to model recovery as an exogenous variable within pricing models which one can then estimate by using historical information.

In models with exogenous recovery a number of different assumptions have been made regarding its form. In structural defaultable debt models, such as Longstaff and Schwartz (1995) and Saa-Requejo and Santa-Clara (1999), it is usually assumed that the recovery amount is a fixed fraction of an equivalent coupon and maturity risk-free bond. Alternatively in this class of model, it could be easily assumed that the recovery amount of default is non-zero only for the principal. In this case, the recovery amount would be a fixed fraction of a zero-coupon risk-free bond with the same maturity as the defaultable bond (Collin-Dufresne and Goldstein (2001)). In intensity-based defaultable bond models the recovery assumption is the main feature that distinguishes one model from another. In Jarrow and Turnbull (1995) and Jarrow, Lando, and Turnbull (1997) debtholders, as mentioned above, receive a fixed fraction of the face amount at the maturity of the defaultable

[2]Altman and Kishore (1996) find that certain industries consistently have higher recovery rates. One explanation for this is the nature of the assets.

[3]**?** documents that the yearly average lows of recovery rates correspond to recession periods as well as times where corporate default rates have peaked. Franks and Torous (1994) show that recovery is significantly and related to the past performance of the aggregate stock market.

bond. In Duffie and Singleton (1999) debtholders receive a fraction of the market value of the defaultable bond just prior to default. This assumption is made mainly for technical reasons as it leads to much simplified expressions for the price of risky debt. Following the terminology used in Duffie and Singleton (1999) and Bakshi, Madan, and Zhang (2002), we label the first two recovery assumptions described the *Recovery of Treasury* (RT and RT-F)[4] models; and the last assumption as the *Recovery of Market Value* (RMV) model.

Despite the large and expanding literature on defaultable bonds, the RFV assumption has not always been addressed, especially in the empirical literature. Duffie (1998) discusses this recovery form in the context of intensity-based models. He provides a few tractable cases where prices of defaultable debt can be computed. This is important for practical applications as such models are used to extract implied risk-neutral default probabilities from traded credit instruments which can be used for valuation and risk management of credit derivative products. Finkelstein (1999 and 2000) carries this point forward and gives an example how this change in recovery assumption can substantially affect the relative valuation of bonds of the same issuer and seniority as well as implied risk-neutral default probabilities from market credit spreads. He also asserts that, in addition to recovery of par at default, the investor is owed the accrued interest on the last coupon and incorporates this feature into the model.[5] A similar point is made in Jarrow and Turnbull (2000) when discussing which types of recovery assumptions can be used within intensity-based models. They label the assumption the "legal claim approach", acknowledging that this form of recovery is often used by practitioners. However, in neither of these papers is strong evidence given that RFV is a more correct assumption. This paper attempts to provide this reasoning as well as empirical support. Hull and White (2000) compare the RFV assumption with the RT assumption for pricing credit default swaps.

Other papers have done more extensive work comparing the different recovery assump-

[4]To distinguish between the case where coupons have non-zero recovery in addition to the face amount and that where only the face value has non-zero recovery, respectively.

[5]As we will notice later, this is a slight overspecification of the general point that the language in bond indentures has a direct effect on the recovery value of bonds at default.

tions. While the intensity-based model presented in Duffie and Singleton (1999) assumes a RMV, the authors also recognize the fact that for the case of corporate bonds RFV may be more realistic assuming either liquidation at default or that absolute priority holds. The main arguments used to support their RMV model in such cases are: 1) computational advantages versus the RFV model; and 2) absolute priority is not always maintained in bankruptcy courts and liquidation at default is often avoided. Nevertheless, they investigate the pricing implications of models under both recovery assumptions and show under chosen parameters that the implied credit spreads under the two assumptions are similar. However, they also remark that it is possible under certain scenarios (e.g. bonds with significant premium or discount, steeply upward or downward sloping yield curve) that the RMV and RFV assumptions can have markedly differing spread implications for a given exogenous recovery rate. Delianedis and Lagnado (2002) similar to Finkelstein (2000) compare three recovery assumptions, RT-F[6], RMV, and RFV, for the pricing of credit default swaps and for inferring risk-neutral default probabilities from hypothetical zero-coupon risk-free and risky term structures. They demonstrate the sensitivity of implied conditional default probabilities to the recovery assumption and conclude that the choice of recovery model is an important consideration for credit risk pricing. They find that for most cases the RMV and RT-F models generate similar term structures of risk-neutral default probabilities assuming some initial credit risky term structure while the RFV assumption results in distinctly different probabilities. Interestingly, they argue that the RFV model fails to generate admissible long-dated risk-neutral default probabilities. The RFV assumption also leads to significantly higher default swap spreads than the other two assumptions.

Bakshi, Madan, and Zhang (2002) analyze the effect of recovery on the price of defaultable debt in the context of intensity-based defaultable debt models using individual corporate bond data. It is the first paper to provide an empirical test that compares different recovery concepts within such models. They compare three recovery assumptions: RT-F, RMV, and RFV in a robust setting where recovery rates of each firm are stochastic and a function of the underlying hazard rate which is in itself related to the stochastic

[6]No coupon-paying bonds were considered in their comparative analysis.

riskfree rate process, all consistent with empirical data. The two main empirical findings are: 1) the bond data better supports the notion of the RT-F assumption in that pricing errors are significantly smaller; and 2) the RFV model provides the more stable implied recovery rates.[7] The authors explain their first finding by the fact that the RT-F model recognizes time-value of money considerations and claim that such an assumption may be more closer to truth in market valuation, compared to either RFV or RMV. We do not address here the ex-ante effect of *actual* recovery form on bond prices as their paper. However, our findings suggest that typical implementations of RT-F, which hold the expected recovery rate constant, may lead to a significant mispricing of bonds of the same issuer and seniority as the assumed cashflow patterns of the bonds would be far different than from reality.

The paper is organized as follows. Section 2 shows an example of RFV for the publicized cases of Enron Corporation and Worldcom Incorporated. In Section 3 we discuss the institutional factors that provide the framework which underlies this assumption. Section 4 discusses the data sources and selection procedure used. The core of the paper is found in Section 5 where we describe the recovery values in the selected sample and compare our data to hypothetical values generated by different recovery models. We offer some concluding remarks in Section 6.

2 Recovery Convergence: Enron Corp. and Worldcom Inc.

We discuss in detail two "case-study" examples of RFV for corporate bonds. Specifically, we examine prices of bonds issued by Enron Corporation and Worldcom Incorporated over the period leading up to their initial default events. These companies are of particular interest as they represent the two largest Chapter 11 bankruptcy filings in U.S. history. While just examples, the two cases produce strong evidence of the phenomenon we wish to document and show later is a pervasive feature of corporate debt.

Table I shows the prices and contractual details of nine bonds of the same seniority (senior unsecured) within Enron's capital structure. The shortest bond, #1, matures on

[7] Compared to the RT-F model. In the RMV model, the recovery rate is unidentified.

3 April 2001; while the longest maturity bond, #9, matures on 15 July 2028. The coupon rate varies across bonds, ranging from 6.40% to 9.125%. Table II shows the dealer bid prices and respective yields to maturity for the bonds in the months and days leading up to the official initial default event, a Chapter 11 bankruptcy filing on Sunday, 2 December 2001. On the following day the bonds that have a face value of par are quoted at the same price of $21. However, the table shows that the bonds converged to within one dollar of the same price a few days before, on 28 November 2001. On this date a previously announced merger bid by a rival company, Dynergy Inc., was called off.

Figures 1 and 2 show the dramatic effect that convergence in recovery values has on the corporate yield curve. The most striking feature of RFV is that yields on short maturity bonds increase dramatically compared to long-maturity bonds. In price terms short bonds suffer more on a relative basis compared to long-maturity bonds. Bond 1 declines 64% in one day when the failed merger is announced while Bond 9 decreases 54%. At this same date compared with 28 September 2001, when the bonds were trading at pre-distress level, Bond 1 declines 80% versus 76% for Bond 9.

Table III and Figures 3 and 4 show a similar patter for the case of Worldcom Inc. We observe the prices of 13 senior unsecured bonds as seen in Table I[8]. Bond #1, the shortest dated bond, matures on 15 May 2003. The longest dated bond, #13, matures on 15 May 2031. The official initial default event occurs on 15 July 2002 when the company misses interest payments on some of their outstanding bonds. At this stage bonds 1-5 are quoted at just a little over $14, the quoted price for bonds 6-13. When Worldcom eventually files for Chapter 11 on 21 July, all 13 bonds are quoted at $13.25. Though these cited dates may be the official dates of record for default and bankruptcy the bond start trading near this level on 26 June 2002; when Worldcom announced that it had hidden $3.8 billion in losses for over a year. Immediately, the bonds were quoted at close to $11.50, apart from bond 1 which was quoted at $14. As in the Enron case the short maturity bonds suffer comparatively more than the longer maturity bonds. On the day of

[8]For purposes of saving space in the tables we only show a table of the prices and yields for a subset of the 13 bonds. The 4 bonds omitted, however, show the same pattern as those bonds described in the table.

the news announcement the bond 1 declines by 80% while bond 13 decreases in value by 70%. These two examples display at least some evidence of RFV, a recovery assumption generally not considered in most empirical studies of credit risk pricing.

3 Institutional Factors and Relative Recovery Values

In this section we discuss the effect institutional features may have on the relative recovery value of bonds in the same seniority class. We restrict our discussion to the US market. Understanding which institutional factors may affect defaulted bond prices and to what extent is an important point. Any particular pattern that we may see in relative recovery values should have an underpinning theory. We believe the foundation of this theory can be found in the particular institutional details. We focus on: 1) the *bond indenture*, the legal instrument that describes a borrower's responsibilities and constrains their actions; and 2) the *bankruptcy code*, which will affect the value of debt claims if the company files for bankruptcy, and thus any ex-ante valuation of such claims.

3.1 Bond Indentures

The bond indenture sets out in detail the legally binding agreement between an issuer of a bond and the bondholder. They cover considerations such as, but not limited to: 1) contractual form of the bond; 2) amount of the issue; 3) collateral pledged (if a secured issue); 4) protective covenants; 5) credit enhancements; 6) redemption rights and call privileges; and 7) defaults and remedies. The indenture also provides for the appointment of a trustee to act on behalf of the bondholders, in accordance with the Trust Indenture Act of 1939 (TIA), to which, in general, all publicly sold corporate bonds must conform.

Indentures are necessarily bond specific documents and thus to some extent idiosyncratic. However, most indentures are based on a *model indenture form* produced by organizations such as the American Bar Association[9] and these model forms provide a useful

[9]The most cited documents are the *American Bar Foundation Commentaries on the Model Debenture Indenture Provisions* (1971), the *American Bar Foundation Mortgage Bond Indenture Form* (1981), and the *Model Simplified Indenture of the Section of Business Law* (1983). Recent attempts to modernize these model indentures to recent changes in the capital markets include the

guide to the contents of a typical-asked about indenture. The critical part of the indenture that influences recovery value is found in the article concerning "Events of Default and Remedies"; this is also outlined in the bond prospectus. In this article the term "Event of Default" is defined in detail and may include the following: 1) failure to make an interest or principal payment on a due date; 2) failure to perform any other covenants over a specified time period; 3) any event of bankruptcy or receivership; and 4) trigger of cross-default provisions. Next, the remedies available to the bondholder after default has occurred are listed. The key point here is that a *debt acceleration* clause is usually specified. That is, the trustee or the holders of a large percentage (usually at least 25%) of the aggregate principal amount of the bonds outstanding can declare the principal amount immediately payable. In many cases the accrued interest, if any, and the redemption premium, if any, is also declared immediately payable. Furthermore, the indenture usually gives the trustee, upon the event of default, the power to exercise a broad range of additional remedies on behalf of the bondholders, including the right to sue for past due principal and interest. The trustee or the majority of bondholders can also rescind any declared acceleration and restore the status quo if the events which led to default are cured or waived, although such an action is usually rare. As an example of the type of language that is commonly used for this acceleration of debt payments, we reproduce below a paragraph from the prospectus supplement of the 6.875% Enron Corp bond, maturing on 15 October 2007. Notice that in this particular case neither a cross-default clause nor an acceleration of any accrued interest/premium is specified:

"If an Event of Default described in clause (a) or (b) in the foregoing paragraph has occurred and is continuing with respect to Indenture Securities of any series, the Indenture provides that the Trustee or the holders of not less than 25% in principal amount of the outstanding Indenture Securities of that series may declare the principal amount of all of the Indenture Securities of that series to be due and payable

Form Indenture and Commentary (2000), produced by the National Association of Bond Lawyers (NABL); and the Revised Model Simplified Indenture (1999), prepared by the American Bar Association. (ABA). We primarily refer to these latter two documents, both which can be downloaded from the internet (http://www.nabl.org/library/topicalmats/modelindent/2000/indenture2000.PDF and http://www.abanet.org/buslaw/trust/rmsi0500.html), in our paper.

immediately, and upon any such declaration such principal amount shall become immediately due and payable. If an Event of Default described in clause (c) or (d) of the foregoing paragraph occurs and is continuing, the Trustee or the holders of not less than 25% in principal amount of all of the Indenture Securities then outstanding may declare the principal amount of all of the Indenture Securities to be due and payable immediately, and upon any such declaration such principal amount shall become immediately due and payable. (Section 502.)

A default under other indebtedness of Enron is not an Event of Default under the Indenture, and an Event of Default under one series of Indenture Securities will not necessarily be an Event of Default under another series."

While additional information detailing the rights and remedies available to bondholders is typically included in this section of the indenture, the main conclusions to be drawn from bond indentures for our purposes are that: 1) the bondholders have an absolute and unconditional right to receive payment of principal and accrued interest (if any and specified) on the bonds and can institute suit for the enforcement of such payment; and 2) the debt becomes due immediately. Thus, the terms of the indenture mean that the stated maturity of the bonds should have no impact on the price of the *principal* portion of bonds within the same seniority class at default. This conclusion is independent of the specific bankruptcy code that is applicable if the company makes such a filing and provides the initial description of the recovery claim for defaulted issues within the same seniority class.

3.2 Bankruptcy Code

The consequences of the indenture may put pressure on the obligor to cure the defaults if they are able to do so and thus rescind the debt acceleration. Alternatively, the acceleration may force the debtor to seek the protection of the bankruptcy courts, if such a filing were not the initial default event. The Bankruptcy Act of 1978 is the main bankruptcy code law of the United States. It defines the procedures for a liquidation, through Chapter 7 of its code, and for a reorganization through Chapter 11. While the debtor may attempt to workout a reorganization outside Chapter 11, for most large companies with multiple bonds outstanding (the typical firm in our sample) Chapter 11 is the usual first option.

Chapter 11 protects the debtor company from its creditors while it attempts to work through its financial difficulties. The objective of Chapter 11 is to preserve the company while a plan for reorganization is worked out among creditors. The immediate effect following a filing is that the bankruptcy court automatically suspends all default notices from lenders. The next step is that the debtor company proposes a plan of reorganization (which can be presented at the time of filing i.e. a prepackaged bankruptcy) describing how creditors and shareholders are to be treated under the new plan. The claimants in each class of creditors are entitled to vote on the plan. If the plan is approved, within each class, by a majority of creditors by number and two-thirds by value, then the debtor can seek confirmation of the plan from the bankruptcy court. If the court approves the plan, a newly reorganized company emerges from bankruptcy.

The stage of the Chapter 11 process that most directly affects the relative recovery values of bonds within the same class is the classification of claims as proposed in the reorganization plan. The rules for allocation are based on Section 1122 of the 1978 Act. We reproduce this section below:

"*Section 1122. Classification of claims or interests*

a) Except as provided in subsection (b) of this section, a plan may place a claim or an interest in a particular class only if such claim or interest is substantially similar to the other claims or interests of such class.

b) A plan may designate a separate class of claims consisting only of every unsecured claim that is less than or reduced to an amount that the court approves as reasonable and necessary for administrative convenience."

The main point is that only substantially similar claims can be put into the same class. However, because the guidance provided by the code is relatively broad, it may be easier to determine what is *not* "substantially similar" than to say what is. Of course, we would not expect secured and unsecured debt to be grouped in the same class. Yet within the same seniority class no specific provisions are made for dealing with the bond-specific contractual details such as the maturity or coupon. As long as the court views a group of securities as reasonably similar, the claims can be placed in the same class. Once the allocation has been made, Section 1123 of the code, which describes the contents of the plan, states that a plan:

> "(a)(4)provide the same treatment for each claim or interest of a particular class, unless the holder of a particular claim or interest agrees to a less favorable treatment of such particular claim or interest"

This allows for a wide range of allocations within each class as a result of bargaining. For example, the relative recovery values might be strongly affected by the concentration of claim ownership. One single creditor can block a plan if it holds one-third of the value of any class of claimants. However, creditors are typically dispersed and it is difficult to assess how the negotiating game may play out. Bondholder committees are usually formed with the help of the trustee to speak on behalf of each class of creditors, but their role for determining *intra*-class allocation is less clear. In general, it may be the case that to appease certain bondholders versus others within the same class concessions could be made in a proposed plan, leading to a recovery form inconsistent with RFV.

The role of the bankruptcy code on the ex-ante relative valuation of same seniority defaulted debt is complex. While the bond indenture provides strict language on the nature of the claim at default, the bankruptcy code only outlines a few general principles regarding the allocation of the new claims. Therefore, the US bankruptcy code neither implies that a RFV will hold, nor precludes it.

4 Data Description

4.1 Data Sources

This study uses data on issuers who have defaulted on their debt and on the details of individual corporate bonds once the issuers have been chosen. We identify defaulted issuers using the Moody's corporate bond default database and we thus restrict the universe of debt issuers to those having outstanding debt rated by Moody's. In addition, we employ Moody's particular definition of a default event. The main features of the definition of a Moody's default event is the occurrence of one of three events: 1) a missed or delayed interest and/or principal payment, 2) a bankruptcy filing or legal receivership occurs, or 3) a distressed exchange where either the exchange had the purpose of avoiding default or the new securities offered to the bondholders amount to a diminished financial obligation. A full description of Moody's definition can be found in Hamilton, Cantor, and Ou (2002). Moody's default research is also used for identifying the date and type of the initial default event. For cases where this information is not available in the Moody's reports we use Bloomberg. Bankruptcy filing dates, if such an event occurred and was not the initial default event, are also retrieved from Bloomberg.

We obtain individual corporate bond price data both before and after the default event from the Dow Jones Interactive website (http://djinteractive.com) owned by the Dow Jones Company, hereafter referred to as the "bond data source". According to the website the historical prices come from Tradeline, a product of SunGard Market Data Services (http://www.tradeline.com). The underlying source of data is specified by either the exchange where the bond is traded (e.g. NYSE) or labelled "Dealer-priced", which are dealer bid prices. We use only dealer bid prices due to the well known problems inherent with exchange-traded corporate bond prices (Warga (1991)). Apart from the coupon rate and final maturity date of each bond, very little static information for the bonds is available on this website. We use Bloomberg, Moody's Industrial Manuals, and prospectuses for each individual bond to obtain more detailed static information.

4.2 Data Selection

The full sample of defaulted issuers used for this study is determined as follows. First, with the help of an investment bank, we perform a search of the Moody's default database to find all bond issuers which defaulted from January 1997 to May 2002 in the US and Europe and filter those that had at least 5 (non-convertible) bonds outstanding at the time of the initial default event. This generates a list of 32 issuers. Since the information on the number of bonds outstanding for this search is taken from a different data source from the one used to obtain prices, we further filter this list by checking, for each issuer, whether price data are available for more than one bond. This step reduces the list to

30 issuers. We then check whether we have data for more than one bond of the same seniority type at the initial default event date. This further reduces the list to 26 issuers. We augment this sample by searching through all the defaulted bond issuers as listed in the Moody's default reports for 2000, 2001, and the first quarter of 2002 and which are not in the previous sample. This secondary search adds a further 16 issuers, a total of 42 issuers that are analyzed below.

We select bonds for each issuer as follows. For 33 of the 42 issuers all the bonds available on the bond data source are considered, while for the remaining nine issuers a subsample of the available bonds are used[10]. We then select bonds if a traded price exists at the initial default date. We are interested only in bonds from the same issuer and with the same seniority. Most of the bonds in our sample were senior unsecured debt. For five of the issuers, they were subordinated unsecured debt. Table IV shows the selected sample of issuers along with the number of bonds selected for each issuer.

4.3 Data Summary

We see in table IV that 38 of the 42 selected issuers are domiciled in either the US (34) or Canada (4). Thus, for the most part, focusing on just one type of bankruptcy regime (US) should be sufficient. Table V summarizes the issuer data by the year of default and by the initial default event type. 37 of the 42 issuers (88%) were defaults since the beginning of 2000. The table also shows the mean and median default volume of the selected sample of firms over time. Although the sample period is relatively short we find that the size of the mean and median defaulted issuer, if proxied by default volume, has increased. This is the case even though the largest default in history, Worldcom, is not included in the sample.

The vast majority of initial default events were either a Chapter 11 bankruptcy filing (48% of sample) or a missed interest or principal payment (38% of sample). However, even if the initial event is not a bankruptcy filing, bankruptcy may still be imminent. Table VI shows that in total 36 of the 42 issuers (86%) eventually file for Chapter 11 protection.

[10] In these case the number of available bonds were numerous enough that we saw it sufficient to download a subset of bonds which covered as wide a range of maturities as possible.

Twenty-three cases were conventional filings while the balance were prepackaged. The majority (21 of 36) of the bankruptcies filed in the sample are still pending at the time of maturity while in 15 of the cases the company has either emerged from bankruptcy or completed through a different manner (i.e. sale of assets, merger). The table also describes the length of time between the initial default event and the bankruptcy filing. The mean and median times to file are 141 and 76 days respectively. The maximum number of days between the two events is 409 days, while the minimum time is 7 days.

Table VII gives the distribution of the number of bonds in the sample issued by a given company and the distribution of the range of maturities of bonds, issued by a given company. The maturity range refers, for each issuer, to the difference between the final maturity dates of the longest and shortest dated bonds. The table also shows that we are able to examine only a small number of bonds for each issuer. For 26 of the firms we have data for only 2 or 3 bonds while we have data for at least 6 outstanding bonds from six issuers. For 25 of the issuers the maturity range is 5 years or less. The mean and median maturity ranges are 7.34 years and 3.78 years respectively with a standard deviation of 8.49 years. The maximum range is 27.85 years and the minimum range is zero.

5 Relative Analysis of Recovery Values

This section summarizes the relative recovery values at default in our sample. An important issue is the metric used for determining how close the recovery values are. We look at simple measures of dispersion in the data and these suggest that the RFV pattern in recovery is pervasive. We then compare our data to hypothetical values generated by alternative recovery assumptions.

5.1 Simple Dispersion Measures

The simplest measure of dispersion is the range, defined here as RV_{Range}, i.e. the difference between the maximum and minimum values in the data. Under strict RFV where no accrued interest is included as part of the claim at default RV_{Range} would be equal to zero. When accrued interest is part of the claim, as specified in some indentures, we would expect the measure to be within the difference between accrued interest due on respective bonds. Panel A of table VIII shows a distribution of this measure at two dates: 1) the initial default date and 2) the bankruptcy filing date. In 17 of the 42 cases (40%) RV_{Range} is zero, i.e. the recovery value is identical across issues. Furthermore, 29 of the 42 issuers (69%) have a RV_{Range} less than or equal to \$2. On the other hand, 6 of the issuers show a RV_{Range} greater than \$5, the largest being \$52.16 for Owens Corning. The mean and median of the RV_{Range} at the initial default date are 3.30 and 0.88 respectively. The RV_{Range} at the Chapter 11 filing date display a broadly similar pattern with a slightly higher percentage (77%) of issuers having a value less than or equal to \$2. In 15 of 36 issuers (42%) the RV_{Range} is equal to zero while 3 of the issuers have a RV_{Range} greater than \$5.

Panel B of table VIII shows the average deviation, RV_{AD}, of each issuer's bonds at the initial default and bankruptcy filing dates. This measures the average absolute deviation from the mean of an issuer's bond prices at the specified date. This metric may be more reliable as it averages across all bonds of a particular issuer, thus measurement errors due to stale data from one particular bond are less problematic. We see that at the initial default date 34 of the 42 issuers (81%) RV_{AD} is at or below \$2 and only two cases have an RV_{AD} greater than \$5. Results at the bankruptcy filing date are similar where 31 of the 36 issuers (86%) have a RV_{AD} less than or equal to \$2. The mean and median of the average deviation of recovery values in sample are 1.20 and 0.31 respectively.

We also determine if for each issuer whether a mode in the set of bond prices exists. A mode exists if the same price is quoted for more than one bond at a particular date. Although the information is binary it may lend more support to RFV compared to other recovery assumptions. For example, in the case of an RT or RT-F assumption we would not expect, in general, to see any mode for bonds of differing maturities due to the discounting effect. For the RMV assumption we would only expect to see a mode if the pre-default prices of the different bonds were trading at the same level. Panel C of table VIII shows that a mode exists for 27 of the 42 (64%) firms at the initial default date and 26 of the 36 firms at the bankruptcy filing date (72%).

5.2 Examination of Outliers

The results of the previous section suggest that for a great majority of the default events in our sample RFV is a good approximation to relative default values. Nevertheless, there are cases where the pattern of default values is different and where such differences cannot be accounted for by accrued interest. A closer look at these cases may help determine if there are systematic reasons why RFV does not hold in all cases. We focus on the 4 cases with the highest RV_{Range} at the initial default date. These cases also had the 4 highest RV_{AD} at the initial default date and in two of these cases no mode in the recovery value of defaulted bonds existed. These 4 selected issuers are: 1) Owens Corning; 2) Fruit of the Loom, Inc.; 3) Southern California Edison Company; and 4) Polaroid Corporation. We summarize these cases below. More detailed accounts can be found in Appendix A.

For the case of Owens Corning we find that 4 of the 6 bonds we obtain data for do in fact display RFV at the initial default date. On further examination of the two remaining bonds we find that the majority of amount outstanding for these bonds were tendered by the company nearly two years before the default date. We believe these bonds suffered from thin trading problem, and therefore the prices in our database did not reflect the true economic value of the bonds. This conclusion is supported by the fact that eventually the prices do trade at the same prices as the other bonds.

We analyze 3 bonds issued by Fruit of the Loom, Inc. At the initial default date (a bankruptcy filing) two of the bonds, with a maturity differential of 20 years, show a RFV pattern. However, the third bond of the same seniority, trades at a much lower price at the default date and continues to do so throughout the sample. It is difficult to say precisely why this bond is an outlier. It was issued in 1981, a little over a decade before the other two bonds. Perhaps related to this, is the fact that this bond is managed by a different trustee from that of the other bonds. We believe the best explanation for this departure from RFV for this bond is that it is being considered to be in a different class than the other bonds.

Southern California Edison Company is a unique case in our sample, since, although it does experience a default event, no bankruptcy if filed and eventually the company is able to pay back the defaulted interest payments within the time period considered. Perhaps, this resolution of the company's difficulties was expected by the market and therefore their issued bonds did not experience RFV at the time of default.

For the case of Polaroid Corporation, we find that only one day after the initial default date the RV_{Range} is equal to \$2 as opposed to the \$9 seen at the initial default date. By the time Chapter 11 is filed, the three bonds we analyze display an RFV pattern. We can conclude for this case that at the initial date there was some measurement error in the data and that the prices use to measure the dispersion were not an accurate reflection of their true value.

From these outlying cases we find no systematic large deviation away from the RFV assumption that would either cause us to believe RFV is an inferior description for the general case of defaulted debt or lead us to favor an alternative recovery assumption. In only one case (FTL) does there exist data that we believe that we cannot fully explain if RFV did indeed always hold.

5.3 Comparison of Recovery Assumptions

The basic dispersion measures seem to provide empirical support for RFV. Nevertheless, it is useful to compare our results to what the data would look like if alternative recovery forms were to hold. Specifically, we consider typical implementations of such recovery forms where the expected recovery rate is assumed constant. We introduce some notation to describe the assumptions we will compare[11].

The recovery value at default date u for a bond maturing at time T and paying semi-annual coupons at an annual rate c, $RV_c^T(u)$,can be written as the product between the *expected* recovery rate, $\omega, 0 \leq \omega \leq 1$ and the expected claim amount. This latter term defines the particular recovery assumption we wish to consider.

Recovery of Face Value at Default (RFV):

[11] This classification closely follows that described in Bakshi, Madan, and Zhang (2002) and Delianedis and Lagnado (2002).

$$RV_c^T(u) = \omega F \tag{1}$$

This assumption takes the claim amount to be the promised face value of the bond F. We ignore here for simplicity the accrued interest component that may be due to the bond investor as a result of the language in the bond indenture.

Recovery of Treasury - Face Value (RT-F):

$$RV_c^T(u) = \omega D(u,T)F \tag{2}$$

where $D(u,T) = E_u^Q\left[\exp\left(-\int_u^T r(s)ds\right)\right]$, the value of the default-free zero-coupon bond at time u maturing at time T. This assumption takes the claim amount to be the promised face value F discounted at the default-free interest rate r.

Recovery of Treasury (RT):

$$RV_c^T(u) = \omega\left[D(u,T)F + \sum_{i=1}^{2T} D(u,T_{i/2})\frac{c}{2}\right] \tag{3}$$

RT is similar to RT-F but also discounts any promised coupon payments at the default-free interest rate and assumes those to be part of the claim amount.

Recovery of Market Value (RMV):

$$RV_c^T(u) = \omega P_c^T(u_-) \tag{4}$$

where $P_c^T(u_-)$ is the price of the risky coupon bond with coupon rate c and maturity T just before the default event.

We construct the hypothetical recovery values as follows. First we impute the expected recovery rate ω from the data by assuming that RFV holds exactly at the initial default date. For 27 of the 42 cases this means we use the mode of the issuer's defaulted bond values even if the bonds have not converged to a unique value. This requires us to assume that measurement error exists for those bonds observed not converging to the mode. In the remaining 15 cases we assume the mean of the bond values to be the expected recovery rate. We discount future promised coupon and principal payments at the default date using zero-coupon bonds estimated from the US dollar interest rate swap curve downloaded from Datastream.

This procedure is sufficient for computing recovery value for the RFV, RT-F, and RT cases. Constructing recovery values for the RMV requires some judgement. The straightforward approach would be to assume the claim amount to be the bond price a day before the Moody's initial default date. However, there are cases where the default event is perhaps not a surprise and bond prices have declined to close to their recovery value leading up to their default date. In such cases, using the imputed recovery rate ω would lead to markedly lower recovery values in default. Another possible interpretation is that there is a lag between the Moody's default date and the actual default event[12]. In an attempt to correct for this we consider traded prices 30 days before the initial default date to be the claim amount for the RMV assumption. Unfortunately, this proxy for pre-default market prices does not succeed too well. Figure 5 shows that there is a close correspondence between these values and the defaulted bond values. This shows the need for further research on the actual timing of default events compared to those events which may designate the official occurrence of default. In addition, it may also call to question what value of the expected recovery rate, δ, should be inputted in models where an RMV assumption holds.

Table IX shows the comparative dispersion statistics for the different recovery assumptions along with the empirical distribution. The RFV assumption, assuming no accrued interest is due to bond investors, predicts that the RV_{Range} and RV_{AD} be equal to zero in all cases. However, in a version where accrued interest is due we would expect that many of the cases would fall between 0 and 1. As mentioned above this matches the empirical data rather well. The RT-F assumption results in a range and average deviation of recovery values noticeably exceeding those found in the empirical distribution. There are 13 cases where RV_{Range} is greater than 10. The mean of RV_{Range} and RV_{AD} for the

[12] The 19-day lag seen for the Worldcom Bonds in section 2 is a typical example of this.

RT-F assumption is 9.34 and 3.36 respectively, versus 3.30 and 1.20 found in the empirical distribution. This results from the cases where there exists a large maturity differential between the shortest and longest dated bonds. Such an assumption could better fit the data if the recovery rate, ω, were assumed to be time-dependent. The RT assumption seems to fit the data better than RT-F with means for RV_{Range} and RV_{AD} of 3.75 and 1.45 respectively. The medians of RV_{Range} and RV_{AD} for the RT assumption are noticeably higher than those found in the actual data (1.98 and 0.92 versus 0.88 and 0.31). This shift in the distribution is due to the fact that under the RT assumption bonds can never converge to exactly the same recovery value unless they have the same coupon and maturity. The RMV assumption, as mentioned, produces recovery values that are much lower than those found in the data due to the pre-default prices being close to the defaulted bond prices. Thus, we view any results regarding this assumption with caution. However, to be complete we show that this same feature results in dispersion statistics for the RMV assumption which are broadly similar to those found in the data. For example, in 8 of the 42 cases the bonds had converged to the same level, $RV_{Range} = 0$, and a further 16 cases show an RV_{Range} less than one.

To summarize this section, the RFV assumption seems better at matching the empirical data than typical implementations of the RT-F and RT assumptions. These two recovery forms could be adjusted to generate RFV-type payoffs at default by making the expected recovery rate parameter a time-dependent function. However, it seems difficult to know how to ex-ante specify these functions in an economically sensible way. This argues in favor for use of the RFV assumption in applications of defaultable debt models. The RT recovery form seems to result in a close approximation to RFV, especially versus RT-F, when holding constant the expected recovery rate. We conclude that if one were to use a Recovery of Treasury model in pricing defaultable debt, it would be better to include any promised coupon payments as part of the claim in recovery. It is hard for us to judge for or against the RMV assumption given our data. More work is needed to understand the timing of default events and to discover accurately what represents a pre-default price.

6 Concluding Remarks

Corporate debt securities typically embed a long list of complicated institutional features that lead to difficulty in applying standard asset pricing techniques. The importance of bond indentures and bankruptcy code in affecting corporate bond pricing and related economic issues has long been recognized and studied in the seminal works of Black and Cox (1976), Smith and Warner (1979), and Franks and Torous (1989). We continued this literature stream by highlighting that these important institutional features directly affect how one should consider modelling the recovery form within defaultable bond pricing models. Next, we examined a unique dataset of defaulted bond prices of predominantly US-based issuers who at the time of the initial default event had several publicly traded bonds outstanding. We found that in the vast majority of cases bonds of the same issuer and seniority are valued equally or within one dollar by the market, irrespective of their time to maturity. This result naturally suggests that the amount recovered in default follows an RFV recovery form. While there are a few cases where significant departures from RFV are seen, after further investigation we find no evidence of a systematic deviation from RFV. While this initial evidence is supportive of RFV, as a final and important step we examined our data considering typical implementations of alternative recovery forms seen in the literature. We found that such forms can be inaccurate as a proper description of the data.

Our results on post-default recovery form may be particularly interesting given that some recent research in this area has found that RFV can be a suboptimal recovery form under certain empirical measures . A joint understanding of the results presented here and those found in these other papers still remains to be done. On the current research agenda is first trying to quantify the valuation and hedging effects of the RFV recovery form for modelling defaultable debt within a structural credit risk model. While our results do not necessarily imply that the market presumes RFV when valuing bonds, it would be useful to see the implications that the RFV form would have for theoretical prices and sensitivities compared to alternative recovery forms. Performing this within a structural model framework would allow us to examine the effect of recovery form on *fundamental* corporate bond valuation. Future work could examine the empirical implications of any potential findings. At this stage we can only conjecture that incorporating RFV in corporate bond models is necessary to properly model such debt and to accurately assess credit risk in empirical studies.

One obvious source of concern here is the quality of the data for these distressed bonds. It is well known that liquidity in such markets can often be scarce and that the pricing of individual bonds can be greatly affected by the dispersion in ownership of the particular bonds. These are all legitimate concerns that may affect some of the points we have made. However, given that we witness a certain empirical regularity across a sizeable number of issuers, along with conversations we have had with various market participants we feel confident in our main arguments. However, it still may be useful to study more in depth the microstructure of the distressed debt market. Another area of further research within this topic is the effect that the credit derivatives market may have on recovery values. The most widely traded credit derivative is the plain vanilla credit default swap[13]. In a typical credit swap the counterparty who has bought protection against a default event for a particular issuer must physically deliver a bond to the protection seller in exchange for par if the issuer has indeed defaulted. In general, the protection buyer can also choose among a range of *pari passu* bonds of a particular issuer in deciding which one to deliver. It seems possible that this recent development in the credit markets will have an effect on both the absolute and relative levels of defaulted bond values. Determining exactly how may be useful for corporate bond valuation.

[13]See Duffie(1999) for a description.

Table I: Contractual Details of Selected Bonds Issued by Enron and Worldcom

Enron Corporation			Worldcom Incorporated		
ID	**Coupon**	**Maturity**	**ID**	**Coupon**	**Maturity**
1	9.125%	01-Apr-03	1	7.875%	15-May-03
2	7.875%	15-Jun-03	2	6.250%	15-Aug-03
3	6.625%	15-Nov-05	3	7.550%	01-Apr-04
4	6.400%	15-Jul-06	4	6.500%	15-May-04
5	7.125%	15-May-07	5	6.400%	15-Aug-05
6	6.875%	15-Oct-07	6	7.375%	15-Jan-06
7	6.750%	01-Aug-09	7	8.000%	15-May-06
8	7.375%	15-May-19	8	7.750%	01-Apr-07
9	6.950%	15-Jul-28	9	8.250%	15-May-10
			10	7.500%	15-May-11
			11	7.750%	01-Apr-27
			12	6.950%	15-Aug-28
			13	8.250%	15-May-31

Table II: Enron Bonds: Prices and Yields Leading up to Bankruptcy

Shown below are the dealer-bid prices and yields of 9 selected Enron bonds whose contractual details are found in Table I. All bonds are senior unsecured debt. The initial default event date defined by when Enron files for Chapter 11 bankruptcy is 2 December, 2001. On 28 November, 2001 it became apparent that a potential merger bid by a rival company would not take place.

Panel A: Prices

ID	31-Jul-01	31-Aug-01	28-Sep-01	31-Oct-01	21-Nov-01	23-Nov-01
1	106.23	106.28	106.89	87.09	69.89	64.95
2	104.87	104.91	105.47	82.19	62.88	63.92
3	102.61	102.74	103.75	78.19	57.76	61.84
4	101.13	101.78	103.13	77.7	57.74	60.82
5	104.3	104.59	105.74	77.9	56.72	59.82
6	102.53	103.25	104.33	76.89	65.4	59.81
7	100.49	100.81	100.68	77.73	61.66	58.76
8	101.04	101.93	97.69	74.66	56.63	57.81
9	94.5	96.15	91.37	73.93	54.86	56.81
ID	26-Nov-01	27-Nov-01	28-Nov-01	29-Nov-01	30-Nov-01	03-Dec-01
1	50.01	58.07	21	22.03	19	21
2	49.99	57.07	21	22.03	19	21
3	47.95	56.12	21	22.1	19.01	21
4	46.97	55.14	21	22.12	19.01	21
5	44.99	54.15	21	22.12	19.01	21
6	44.99	53.16	20.99	22.13	19.01	21
7	44.98	53.19	21.01	22.13	19	21
8	41.97	49.2	22	22.12	19	21
9	40.99	47.99	21.99	22.08	18.98	21

Panel B: Yields

ID	31-Jul-01	31-Aug-01	28-Sep-01	31-Oct-01	21-Nov-01	23-Nov-01
1	5.17%	4.95%	4.36%	20.01%	39.78%	46.76%
2	5.11%	4.97%	4.52%	21.41%	42.69%	41.48%
3	5.92%	5.88%	5.59%	13.85%	23.53%	21.33%
4	6.13%	5.97%	5.64%	12.86%	21.09%	19.63%
5	6.23%	6.16%	5.91%	12.82%	20.68%	19.34%
6	6.37%	6.23%	6.01%	12.49%	16.19%	18.29%
7	6.67%	6.62%	6.64%	11.11%	15.42%	16.36%
8	7.27%	7.18%	7.61%	10.58%	14.12%	13.83%
9	7.42%	7.28%	7.72%	9.69%	13.05%	12.61%
ID	26-Nov-01	27-Nov-01	28-Nov-01	29-Nov-01	30-Nov-01	03-Dec-01
1	73.38%	58.05%	185.17%	178.31%	201.70%	187.26%
2	62.71%	51.22%	155.33%	149.69%	168.90%	157.04%
3	29.86%	24.55%	62.34%	60.08%	66.98%	62.48%
4	27.18%	22.46%	54.76%	52.76%	58.82%	54.89%
5	26.88%	21.92%	51.24%	49.32%	55.10%	51.30%
6	25.34%	21.15%	48.15%	46.33%	51.76%	48.20%
7	21.82%	18.34%	41.23%	39.65%	44.47%	41.28%
8	18.75%	16.17%	34.00%	33.82%	39.09%	35.52%
9	17.25%	14.84%	31.58%	31.45%	36.53%	33.06%

Table III: Worldcom Bonds: Prices and Yields Leading up to Bankruptcy

Shown below are the prices and yields of 9 selected Worldcom bonds whose contractual details are found in Table I. All bonds are senior unsecured debt. The official initial default event date defined by when Worldcom misses an interest payment is 15 July, 2002. The Chapter 11 bankruptcy filing occurs on 21 July, 2002. On 26 June, 2002 it became public information that the firm had concealed $3.9 billion of losses for more than a year.

Panel A: Prices

ID	31-Jan-02	28-Feb-02	28-Mar-02	30-Apr-02	31-May-02	18-Jun-02
1	103.27	99.69	95.62	75	84.5	81
3	103.06	98.50	91.47	60	73.5	70
5	99.22	96.45	86.51	50	57	54.5
6	100.00	97.66	87.40	49	56	53
8	101.96	97.80	86.65	45.5	54	49.5
9	103.09	101.06	88.83	48	50	47.5
10	97.68	96.35	83.88	47	49	46.5
12	85.28	82.31	69.66	42	38.5	39
13	99.05	96.12	80.66	44	43	42
ID	21-Jun-02	25-Jun-02	26-Jun-02	27-Jun-02	15-Jul-02	22-Jul-02
1	75	68.5	14	17	14.25	13.25
3	61.5	57.5	11.5	13.75	14.25	13.25
5	49	46.5	11.5	13.75	14.25	13.25
6	48.5	45	11.5	13	14	13.25
8	45.5	42	11.5	13	14	13.25
9	44	42	11.25	14	14	13.25
10	43.5	41	11.5	13.5	14	13.25
12	37.5	36.5	11	14	14	13.25
13	40	38	11.25	13	14	13.25

Panel B: Yields

ID	31-Jan-02	28-Feb-02	28-Mar-02	30-Apr-02	31-May-02	18-Jun-02
1	5.21%	8.13%	12.11%	39.36%	27.36%	33.82%
3	6.02%	8.34%	12.48%	39.01%	26.72%	30.51%
5	6.65%	7.58%	11.31%	32.04%	27.37%	29.49%
6	7.37%	8.09%	11.56%	31.68%	27.20%	29.51%
8	7.28%	8.29%	11.31%	29.35%	24.48%	27.22%
9	7.73%	8.07%	10.31%	22.52%	21.72%	22.90%
10	7.85%	8.07%	10.26%	20.68%	19.93%	21.02%
12	8.34%	8.66%	10.31%	16.87%	18.33%	18.11%
13	8.34%	8.61%	10.36%	18.87%	19.30%	19.75%
ID	21-Jun-02	25-Jun-02	26-Jun-02	27-Jun-02	15-Jul-02	22-Jul-02
1	44.43%	57.89%	438.35%	373.50%	471.50%	518.88%
3	39.67%	44.76%	203.29%	181.19%	182.57%	194.27%
5	33.97%	36.29%	111.19%	99.51%	98.80%	104.19%
6	32.95%	35.97%	105.48%	97.54%	94.26%	98.05%
8	29.84%	32.42%	87.78%	80.80%	77.34%	80.51%
9	24.67%	25.78%	76.27%	63.57%	63.59%	66.53%
10	22.40%	23.67%	67.62%	59.04%	57.30%	59.98%
12	18.80%	19.30%	62.64%	49.38%	49.45%	52.27%
13	20.71%	21.78%	72.63%	62.98%	58.45%	61.67%

Table IV: Sample of Defaulted Issuers

Listed are the defaulted issuers whose outstanding bonds at the time of default are examined in this paper. The source of the data is Moody's corporate bond default database. The filtering procedure which we used to arrive at this sample is described in Section 2.4. Panel A shows the issuers that were selected with help of an Investment Bank's database. Panel B shows those issuers selected in our second pass search of Moody's data. The far right column shows the number of bonds for each company available for the study.

	Name of Company	**Default Year**	**Issuer Domicile**	**Selected Bonds**
Panel A: Issuers from Bank Database				
1	Armstrong World Industries, Inc.	2000	US	4
2	Call-Net Enterprises Inc.	2001	Canada	2
3	Chiquita Brands International, Inc.	2001	US	4
4	Comdisco, Inc.	2001	US	6
5	Enron Corp.	2001	US	9
6	Exodus Communications, Inc.	2001	US	3
7	Federal-Mogul Corporation	2001	US	3
8	FINOVA Capital Corporation	2001	US	6
9	Frontier Corporation	2002	US	2
10	Fruit of the Loom, Inc.	1999	US	3
11	Gaylord Container Corporation	2002	US	2
12	Integrated Health Services, Inc.	1999	US	3
13	Kmart Corporation	2002	US	11
14	Laidlaw Inc.	2000	Canada	6
15	Loewen Group International, Inc.	1999	Canada	4
16	Lomas Financial Corporation	1995	US	2
17	LTV Corporation (The)	2000	US	2
18	McLeodUSA Incorporated	2002	US	4
19	NTL Communications Corp.	2002	US	2
20	Owens Corning	2000	US	6
21	Pacific Gas and Electric Company	2001	US	5
22	Penn Traffic Company	1998	US	4
23	Southern California Edison Company	2001	US	5
24	USG Corporation	2001	US	2
25	Viatel, Inc.	2001	US	2
26	XO Communications, Inc.	2001	US	5
Panel B: Issuers Collected from Moody's Reports				
1	Amresco, Inc.	2001	US	2
2	Bethlehem Steel Corporation	2001	US	2
3	Burlington Industries Inc	2001	US	2
4	ContiFinancial Corporation	2000	US	3
5	Doman Industries Limited	2002	Canada	2
6	Global Crossing Holdings Limited	2002	Bermuda	4
7	Globalstar, L.P.	2001	US	3
8	Metromedia Fiber Network	2002	US	2
9	Netia Holdings II B.V.	2001	Poland	2
10	Paging Network, Inc.	2000	US	3
11	Polaroid Corporation	2001	US	3
12	PSINet Inc.	2001	US	4
13	Regal Cinemas, Inc.	2000	US	2
14	RSL Communications PLC	2001	Bermuda	3
15	Teligent Inc	2001	US	2
16	United Pan-Europe Communications N.V.	2002	Netherlands	3
Total:42				

Table V: Time-series Distribution of Initial Default Events

Initial default events by year and type of selected sample of issuers as listed in table IV. The data selection procedure is described in section 2.4. The "Other" column aggregates 3 types of default events (distressed exchange, payment moratorium, rating withdrawn) that occurred in the time sample. Mean and median (by issuer) default volumes are also shown on the right 2 columns.

Year	Chapter 11	Missed Payment	Suspension of Payments	Other	Total	Mean Volume(MM)	Median Volume(MM)
1995	1	0	0	0	1	$480	$480
1998	0	1	0	0	1	$1,025	$1,025
1999	2	1	0	0	3	$976	$910
2000	4	2	1	0	7	$1,034	$800
2001	10	7	2	2	21	$2,556	$1,950
1Q2002	3	5	0	1	9	$3,042	$2,596
Total	20	16	3	3	42	$2208	$1397

Table VI: Type and Timing of Chapter 11 Bankruptcy

The number of firms in the sample which eventually filed for Chapter 11 and if it was done on a prepackaged basis versus a traditional filing. A description of the timing between the initial default event and the Chapter 11 filing is shown as is the bankruptcy status as of 15 August 2002.

Type of Bankruptcy Filing	
Prepack	13
Normal	23
	Total: 36

Bankruptcy Status	
Emerged	9
Completed	6
Pending	21

Days between Default and Filing	
0	20
0-30	5
30-100	5
over 100	6

Table VII: Distribution of Issuers in Terms of Bond Data

The firms are sample are distributed with respect to the number of bonds selected for each firm and the maturity range in years of the selected bonds. The maturity range is defined as the difference between final redemption maturities of the longest dated bond and the shortest dated bond for each firm. The right column shows the number of firms for each designated bin shown in the left column.

Number of Selected Bonds for Each Company	
2	17
3	9
4	7
5	3
6	4
>6	2
	42

Bond Maturity Range in Years	
0-2	13
2-5	12
5-10	8
15-25	5
>25	4
	42

Table VIII: Dispersion Statistics of Relative Recovery Values at Initial Default and Bankruptcy Filing Dates

Reports the distribution of three dispersion measures: the Range (Panel A), the Average Deviation (Panel B), and the Existence of a Mode (Panel C) of the relative recovery values in the sample. Two dates are examine: 1) the initial default date and 2)the bankruptcy filing date. The range, denoted by RV_{Range} is the difference between the maximum and minimum prices of an issuer's bonds at the specified date. The average deviation, RV_{AD}, is the average of absolute deviation from the mean of an issuer's bond prices at the specified date. Sample mean and median values are also shown. A mode exists for a particular issuer if the same price is quoted for more than one bond.

Panel A: Range of Recovery Values		
	Default Date	*Filing Date*
$RV_{Range} = 0$	17	15
$0 < RV_{Range} \leq 1$	8	7
$1 < RV_{Range} \leq 2$	4	6
$2 < RV_{Range} \leq 5$	7	5
$5 < RV_{Range} \leq 10$	4	1
$RV_{Range} > 10$	2	2
Total	42	36
Mean	3.30	2.97
Median	0.88	1.00

Panel B: Average Deviation of Recovery Values		
	Default Date	*Filing Date*
$RV_{AD} = 0$	17	15
$0 < RV_{AD} \leq 1$	13	15
$1 < RV_{AD} \leq 2$	4	1
$2 < RV_{AD} \leq 5$	6	3
$5 < RV_{AD} \leq 10$	1	1
$RV_{AD} > 10$	1	1
Total	42	36
Mean	1.20	1.08
Median	0.31	0.35

Panel C: Existence of Mode in Recovery Values		
	Default Date	*Filing Date*
Mode Exists	27	26
No Mode	15	10
Total	42	36

Table IX: Comparative Dispersion Statistics of Theoretical Relative Recovery Values at the Initial Default Date

Reports the distribution of two dispersion measures: the Range (Panel A) and the Average Deviation (Panel B) for the 4 different recovery assumptions described in Section 5.3. The assumptions are: 1) *RFV* (Recovery of Face Value), 2)*RT-F* (Recovery of Treasury - Face Value), 3) *RT* (Recovery of Treasury), and 4) *RMV* (Recovery of Market Value). The assumptions were used to create *hypothetical* recovery values at the initial default date for comparison with the empirical distribution from table VIII which is reproduced in the last column. Accrued interest which may be due to the bond investor under some interpretations of *RFV* is ignored. Sample mean and median values are also shown.

Panel A: Range of Recovery Values

	RFV	*RT-F*	*RT*	*RMV*	*Empirical*
$RV_{Range} = 0$	42	1	0	8	17
$0 < RV_{Range} \leq 1$	0	10	15	16	8
$1 < RV_{Range} \leq 2$	0	7	6	7	4
$2 < RV_{Range} \leq 5$	0	7	8	5	7
$5 < RV_{Range} \leq 10$	0	4	10	2	4
$RV_{Range} > 10$	0	13	3	4	2
Total	42	42	42	42	42
Mean	0.00	9.34	3.75	2.08	3.30
Median	0.00	3.40	1.98	0.31	0.88

Panel B: Average Deviation of Recovery Values

	RFV	*RT-F*	*RT*	*RMV*	*Empirical*
$RV_{AD} = 0$	42	1	0	8	17
$0 < RV_{AD} \leq 1$	0	18	21	25	13
$1 < RV_{AD} \leq 2$	0	6	11	3	4
$2 < RV_{AD} \leq 5$	0	8	8	5	6
$5 < RV_{AD} \leq 10$	0	7	2	1	1
$RV_{AD} > 10$	0	2	0	0	1
Total	42	42	42	42	42
Mean	0.00	3.36	1.45	0.75	1.20
Median	0.00	1.59	0.92	0.14	0.31

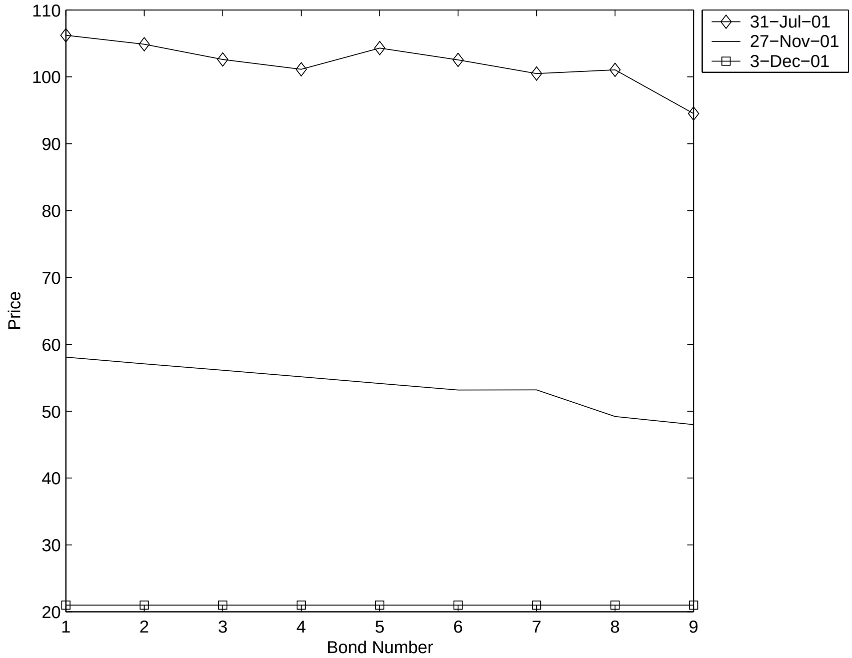

Figure 1: Enron Corporation Bond Prices

The plot shows prices for nine bonds issued by Enron Corporation at three different dates leading up to their official default date on 3 December 2001. The bonds are sorted by maturity, their contractual details are found in Table I.

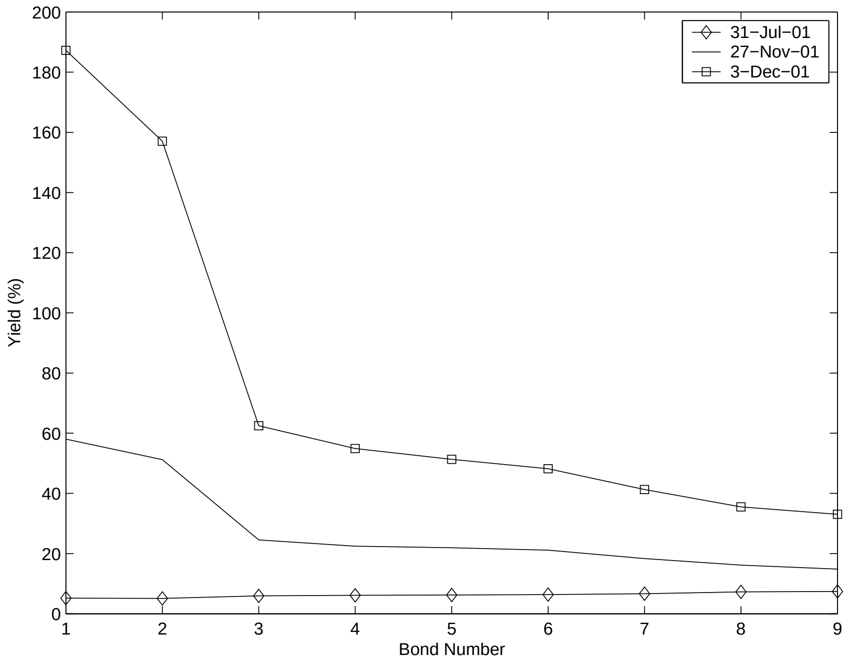

Figure 2: Enron Corporation Bond Yields

The plot shows redemption yields for nine bonds issued by Enron Corporation at three different dates leading up to their official default date on 3 December 2001. The bonds are sorted by maturity, their contractual details are found in Table I.

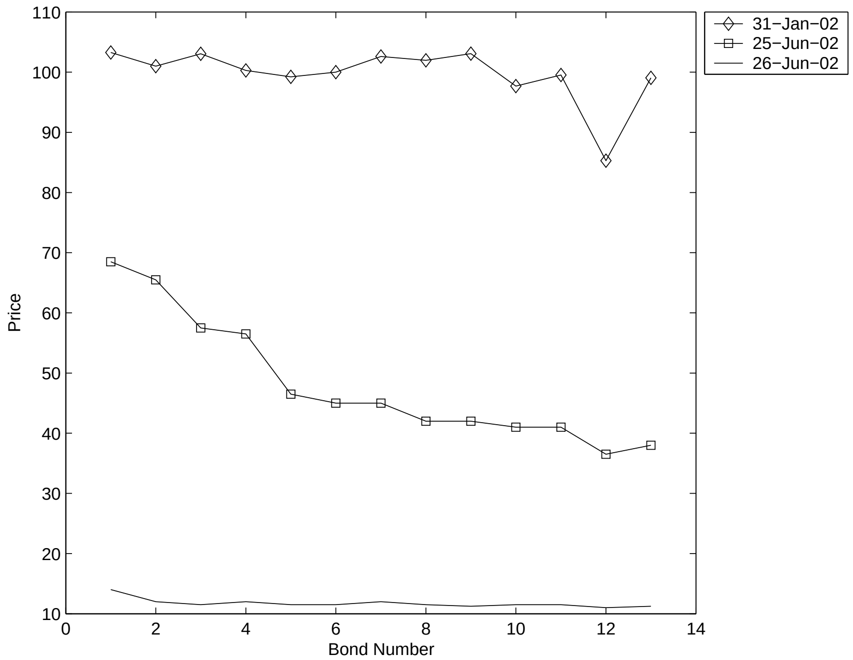

Figure 3: Worldcom Inc. Bond Prices

The plot shows prices for thirteen bonds issued by Worldcom Incorporated at three different dates leading up to their official default date on 15 July 2002. The bonds are sorted by maturity, their contractual details are found in Table I.

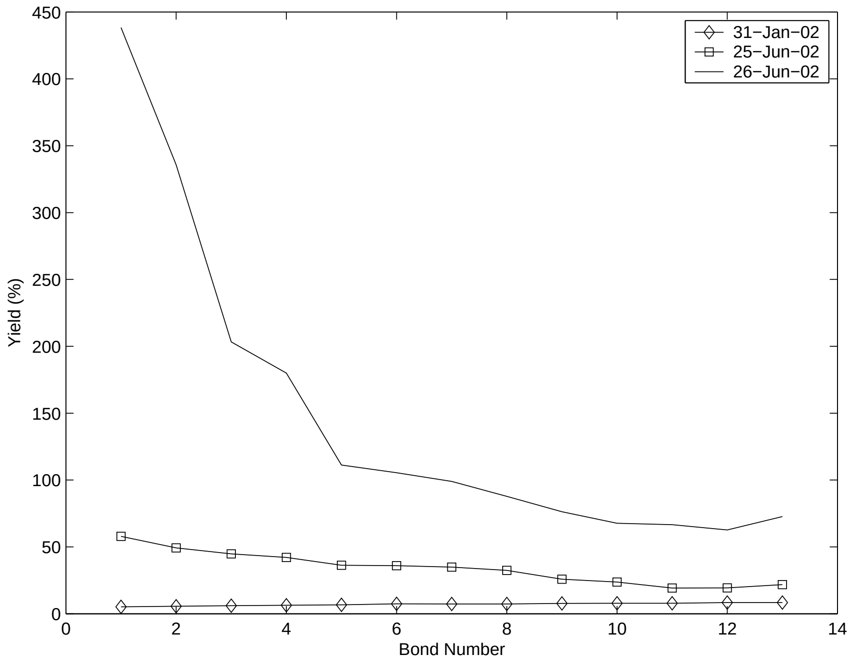

Figure 4: Worldcom Inc. Bond Yields

The plot shows redemption yields for thirteen bonds issued by Worldcom Incorporated at three different dates leading up to their official default date on 15 July 2002. The bonds are sorted by maturity, their contractual details are found in Table I.

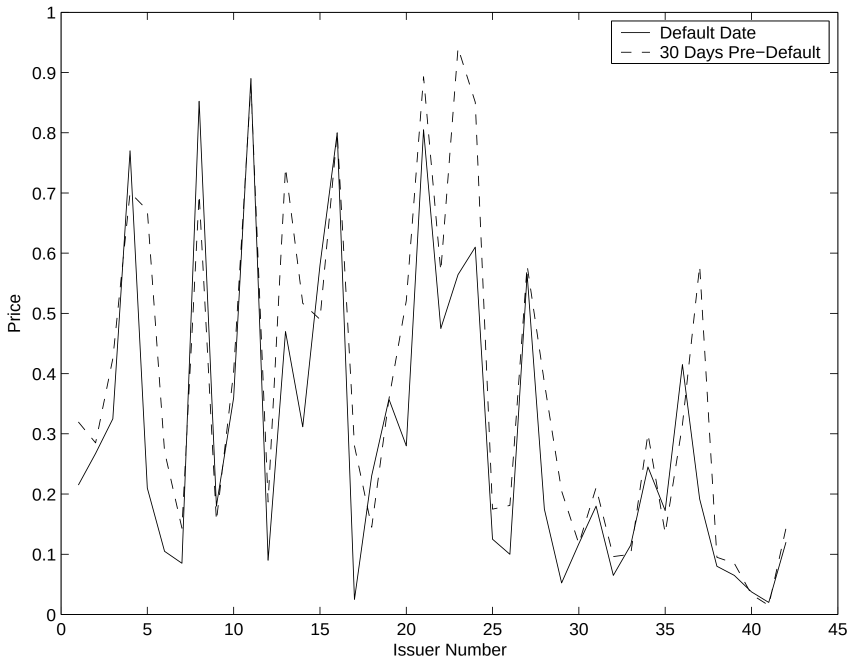

Figure 5: Average Bond Prices at Default Date and 30 Days Prior

The plot shows the average bond price as a percentage of par across all issuers both at the official Moody's default date and 30 days prior to this date.

APPENDIX

A Description of Outlier Cases

In this appendix we give a more detailed description of the four cases outlined in Section 5.2. The four selected cases are: 1) Owens Corning; 2) Fruit of the Loom, Inc.; 3) Southern California Edison Company; and 4) Polaroid Corporation.

Owens Corning

On 5 October 2000, Owens Corning filed for Chapter 11 protection, this was also the initial default event. We obtained data for 6 of their bonds with the same seniority (senior unsecured), with maturity dates ranging from 1 June 2002 to 1 August 2018 and coupon rates ranging from 7% to 8.875%. On this announced date 4 of the 6 bonds converge to the same price of \$28[14]. However, the 8.875% bond due 1 June 2002 has a quoted price of 80.16, while the 9.375% bond due 1 June 2012 is quoted with a price of \$53.23. Examination of the prospectuses show no covenants or other features of their indentures that should cause these two bonds to diverge from the other bonds. We study the news reports related to these two bonds and find that on 20 July 1998 Owens Corning announced a debt tender offer for this pair of bonds. Of the original \$150 million of the 2002 bonds, \$110 million was purchased by the company leaving \$40 million outstanding. Of the original \$150 million of the 2012 bonds, \$143 million was purchased leaving \$7 million outstanding. This is in contrast to the other 4 bonds which had an amount outstanding equal to the debt amount originally issued, ranging from \$250 million to \$400 million. One reasonable conclusion to make is that these two bonds suffered, relatively speaking, from thin trading problems which affected their price quotes. Such a conclusion seems especially plausible for the 2012 bond as in just a few weeks time (15 November 2000) it is trading at the same level (28) as the 4 bonds which had converged at the default date. The 2002 bond, although it decreases in price substantially during these weeks after default, stays at a quote on average 30 dollars higher than the other 5 bonds until the last week of July 2001 when it too also converges to the same price of 28 on 30 July 2001. We believe that this anomaly is due to the relative lack of marketability of the two bond which deviate from RFV. This is a result of: 1) the small amount outstanding; and 2) the relative short remaining maturity left on the bond. If this interpretation is correct then we can regard Owens Corning, the most deviating case under the simple dispersion measures in our sample ($RV_{Range} = 52.16$ and $RV_{AD} = 17.20$), as another example of a company which experiences RFV.

Fruit of the Loom, Inc.

Fruit of the Loom, Inc. filed for Chapter 11 protection, its initial default event, on 29 December 1999. The company was eventually bought by Berkshire Hathaway, Inc., a deal announced in November 2001 and approved by the court in April 2002. We obtained data for 3 senior unsecured bonds: 1) 6.500% Note due 15 November 2003; 2) 7.000% Debenture due 15 March 2011; and 3) 7.375% Debenture due 15 November 2023. At the default date bonds 1 and 3 converge to a price of 36 and stay converged throughout the bankruptcy period. However, bond 2 at the default date is quoted at 23 and throughout the bankruptcy period is quoted at, on average, two-thirds of the price of the other two bonds. From examining the details of the bond we find that bond 2 is callable unlike the other bonds, which are all straight. Yet this feature is unlikely to cause such a price discrepancy, given the unlikelihood of the company calling the debt back. We look at the amount of the issue outstanding to see if marketability may be the cause of the discrepancy. While only \$75 million of the original \$125 million issued is outstanding for bond 2, we believe that this size is adequate for the bond to be traded as frequently as the other bonds. Bond 2 was issued in 1981 as opposed to 1992 and 1993 for bonds 1 and 3. In fact, it was an original Northwest Industries (which included Fruit of the Loom) bond before Fruit of the Loom emerged as its own entity. However, we cannot find any information on why this would affect the relative valuation of the bonds. Bond 2 is managed by a different trustee than bonds 1 and 3, which are managed by the same trustee. Thus, one conclusion could be that the \$300 million of debt overlooked by the trustee for bonds 1 and 3 has a better recovery due to these two bonds being put into a different class than bond 2, although all 3 bonds are senior unsecured debt. With the information[15] available this seems to be the most plausible conclusion. Not considering

[14] All bond prices are quoted as dollar amounts per \$100 face value.

[15] We are unable to find the bond indenture for bond 2.

bond 2 and its various idiosyncrasies, the behavior of bonds 1 and 3 does support the RFV hypothesis, and is particularly significant given the maturity differential of 20 years.

Southern California Edison Company

On 15 January 2001 Southern California Edison defaulted on interest payments on $200 million of notes. We collected data on 6 bonds, with maturity dates ranging from 1 June 2001 to 1 April 2029. Immediately following the default event the RV_{Range} decreased from 22.58 to 9.26. However, in only a few weeks time this metric had drifted back up to 15 and we see little evidence going forward of the bonds converging. This case is unique in our sample in the sense that, although the firm defaults, no bankruptcy is filed and eventually the company is able to pay back the defaulted interest payments within the time period we consider. The default occurred due to the power crisis California was experiencing at that time. Over the following months it defaulted on due interest and principal payments while struggling to convince state lawmakers to approve a rescue plan to avoid bankruptcy. In October 2001 the company reached an agreement with the California Public Utilities Commission to use a portion of customer bills to pay its debt, and in March 2002 it was able to pay its creditors defaulted payments. We can conclude that in this case the bond prices did not represent true defaulted prices in the sense that the market had incorporated a strong probability of a rescue in its valuation. If the company would have had to file for Chapter 11 protection, a RFV could have been a definite possibility

Polaroid Corporation

On 11 July 2001 Polaroid Corporation announced it would not be making its scheduled bond interest payment due later that month, signifying its initial default event. A few months later on 12 October 2001 the company filed for Chapter 11. We have data for 3 unsecured bonds: 1) 6.75% Note due 15 January 2002; 2) 11.50% Note due 15 February 2006; and 3) 7.25% Note due 15 January 2007. Prior to the default announcement the quoted prices for the 3 bonds in the above order are: 44.5, 28.5, and 24.5. After the default event the prices are 24.5, 17.5, and 15.5, an asymmetric decrease of value percentage-wise, but still not exemplary of RFV ($RV_{Range} = 9.00$). However, the following day the prices are 27.5, 26.5, and 25.5. Indeed, the RV_{Range} does not go above 4 over the following weeks and usually is within the $3 range. As the filing date approaches the bonds converge and at filing date all bonds are quoted at price of 7. We can conclude for this case that at the initial date there was some measurement error in the data and that the prices used to measure the dispersion were not an accurate reflection of their true value.

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