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**CROSS-COUNTRY VARIATIONS
IN CAPITAL STRUCTURES:
THE ROLE OF BANKRUPTCY CODES**

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ABSTRACT

Cross-Country Variations in Capital Structures: The Role of Bankruptcy Codes*

We conduct a theoretical and empirical investigation of the impact of bankruptcy codes on firms' capital-structure choices. In our theoretical framework, costs of financial distress are endogenously determined as a function of the bankruptcy code. Anticipated liquidation values emerge as the key variable in the capital structure-bankruptcy code link: among other things, the theory predicts that the difference in leverage between a debt-friendly bankruptcy code (such as the UK's) and a more equity-friendly code (such as the US's) should be a monotone function of liquidation values. We examine empirical support for the theory by comparing leverages in the US and the UK for the period 1990 to 2002. Our tests use two (inverse) proxies of liquidation values: asset-specificity of the firm, and the fraction of the firm's assets that are intangibles. We find the theory is strongly backed by the data. The results are robust to considerations such as employing net leverage (debt net of cash holdings) and controlling for other firm characteristics that affect leverage.

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1 Introduction

A central challenge facing financial economics today is integrating finance theory with legal frameworks so that cross-country comparisons of financial data is facilitated. This paper is concerned with one such question: the impact of bankruptcy codes on capital structures. The question has both a theoretical and an empirical basis.

Even a casual glance at bankruptcy codes across countries indicates a remarkable degree of divergence in the rights accorded to claimholders in the event of default on debt contracts. In some countries, the code overwhelmingly favors debtholders, particularly secured debtholders. To quote Davydenko and Franks (2004) on the UK code:

> In many circumstances, a secured creditor [in the UK] can liquidate the company and realize the collateral without heeding the interests of other claimants, and his actions cannot be challenged in the courts.

In other countries, equityholders are afforded substantial rights. Perhaps the most prominent example of this is Chapter 11 of the US code which allows (even a solvent) firm to suspend interest and principal payments on debt for at least 120 days during which equityholders have the exclusive right to come up with a proposal for reorganization.

Except in an idealized Coasian world, providing control rights to parties who hold non-linear claims on the firm will result in at least some inefficiencies. Debtholders with their concave claims on firm value may force "too many" liquidations, i.e., they may liquidate firms which are worth more as going concerns. Conversely, equityholders with their convex claims may induce "too few" liquidations, i.e., they may continue some firms when there is greater value from termination. In either case, deadweight losses result that represent costs of financial distress.

As a leading determinant of these deadweight costs, the bankruptcy code should have a strong and direct effect on the capital structure choices of firms. Surprisingly, while the *normative* question of designing optimal bankruptcy codes has been the subject of a number of papers, this *positive* question of how bankruptcy codes affect capital structures—in particular, how cross-country variations in capital structures are related to variations in bankruptcy codes—does not appear to have been investigated in the theoretical literature.

Nor does the available empirical evidence offer a clear pointer. A cross-country study by Rajan and Zingales (1995) finds that at an aggregate level, firms in Germany and the UK—two countries with debt-friendly codes relative to the US—are much less leveraged than US firms. However, the study finds that other G-7 countries too use more leverage than the UK and Germany, and as much or more leverage than the US, though their bankruptcy codes are not as equity-friendly as the US code. In particular, "hard" bankruptcy codes (ones that favor debtholders) do not by themselves lead to a lower use of debt.

In this paper, we make two contributions of independent interest. First, we develop a theoretical model in which the costs of financial distress are *endogenously* determined as a function of the bankruptcy code. The firm's optimal capital structure balances these costs against the benefits of debt. The model is rich but parsimonious; it identifies key determinants of capital-structure choice under either code and provides sharp empirical implications.

In the second part of the paper, we examine empirical support for the model's implications using data from the UK and the US (the canonical "debt-friendly" and "equity-friendly" regimes). We find strong backing for the model's predictions. These results clarify and extend the Rajan-Zingales findings. The material below elaborates.

1.1   The Theoretical Model

We consider a firm that raises debt and equity to fund a project with risky cash flows. If the cash flows from the project are inadequate to service the debt, the firm is in default. Control rights and continuation decisions in default are regulated by the bankruptcy code in place. We consider two polar alternatives for the code.[1] Under a debt-friendly system or DFS, control rights are transferred to debtholders. Debtholders compare their payoffs from continuing the firm to those from liquidating the firm, and choose the action that leads to higher debt values. Under an equity-friendly system (EFS), control rights remain with equityholders who similarly compare their own payoffs from continuation and termination. In all cases, the priority of the unpaid portion of the debt remains unaffected.

The non-linearity of debtholders' and equityholders' claims lead, under either code, to inefficiencies in financial distress (too many liquidations under a DFS, too many continuations under an EFS), and so to deadweight losses from being in distress.[2] Equityholders trade-off these deadweight losses against the tax benefits of debt and arrive at the optimal level of debt to raise initially. The capital structure is effectively the firm's means of "unwinding" the negative effects of the bankruptcy code. If the deadweight losses from being in financial distress are high, the firm acts to reduce these losses by carrying less debt.

Since the deadweight losses under the two codes are *endogenous* and stem from different sources (too many liquidations vs. too many continuations), the optimal capital structure chosen under the two systems will also, in general, differ. We derive and characterize the optimal level under either code with the aim, especially, of deriving empirically-verifiable implications.

We show that a key factor in the comparison is the anticipated liquidation value of the firm's assets. *Ceteris paribus*, firms with low anticipated liquidation values will use a higher degree of

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[1]As we note in the text, the model can also easily handle anything in-between these alternatives.

[2]Note that the deadweight losses represent *opportunity* costs, not direct costs of liquidation such as legal fees. Direct costs affect the codes symmetrically by lowering the firm's liquidation value.

leverage under EFS than under DFS, but the reverse is true for firms with high liquidation values. More generally, we show that for a range of parameter values, the *difference* between the optimal debt levels under EFS and DFS is a decreasing function of the anticipated liquidation value.

Figure 1 summarizes these results for a particular parametrization of our model (Section 5 provides details of the parameterization). The upper panel plots optimal debt levels under the two systems for various liquidation values, while the lower panel plots the difference in optimal debt levels. A particular implication of the figure is that "hard" (i.e., debt-friendly) codes do not, by themselves, result in lower use of debt.

What drives these results? Intuitively, a low liquidation value makes continuation more likely to be efficient. This reduces the severity of the deadweight losses from excessive continuations under an EFS but increases the deadweight losses from excessive liquidations under a DFS. As a consequence, we have a higher use of debt in the capital structure under an EFS. With high liquidation values, the argument is reversed. The severity of deadweight losses from excessive continuations under an EFS is increased, but the severity of deadweight losses from excessive liqudiations under a DFS is reduced, leading to a greater use of debt under the latter code.[3]

We also compare outcomes along one other dimension of interest: ex-ante firm values. We find that neither code dominates the other. Ex-ante firm values are higher under EFS for firms with low liquidation values, and under DFS for firms with high liquidation values. Intuitively, as we have noted, low liquidation values exacerbate the impact of deadweight losses from excessive liquidations under a DFS; and, conversely, high liquidation values magnify the impact of deadweight losses from excessive continuations under an EFS. For expositional continuity, these results are presented in Appendix A.

An important point before proceeding to the empirical results. Our model involves *endogenous* liquidation decisions. If these decisions were *exogenously* specified—always liquidate under a DFS, always continue under an EFS—then optimal debt *levels* would themselves become monotone in the liquidation values (monotone increasing under a DFS, monotone decreasing under an EFS). It is not hard to see why. Consider a DFS and suppose, as in Shleifer and Vishny (1992), that debtholders *always* liquidate a firm following default. Then, a higher liquidation value unambiguously reduces the deadweight losses from inefficient liquidations, so will lead to a higher use of debt in the capital structure. Similarly, if equityholders *always* continue the firm when it is in default, the optimal level of debt in an EFS will decrease as liquidation value increases.

With *endogenous* liquidation/continuation decisions, these implications do not hold. A change in liquidation values affects not only the *severity* of deadweight losses from inefficient liquidations/continuations but also their *likelihood*. These effects typically move in opposite directions.

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[3]This intuition is compelling, but like all intuitive arguments, it is incomplete. A change in liquidation values affects not only the severity of the deadweight losses but also their likelihood, as we discuss below. Nonetheless, it summarizes the main driving force behind our results quite well.

Figure 1: Leverage and Liquidation Values

The upper panel of this figure plots optimal debt levels under equity-friendly and debt-friendly codes (EFS and DFS, resp.) for a particular parametrization of our model. Debt levels are higher under EFS at low liquidation values and under DFS at high liquidation values. The lower panel plots the *difference* in debt levels under the two systems. This difference is monotone decreasing in the liquidation value.
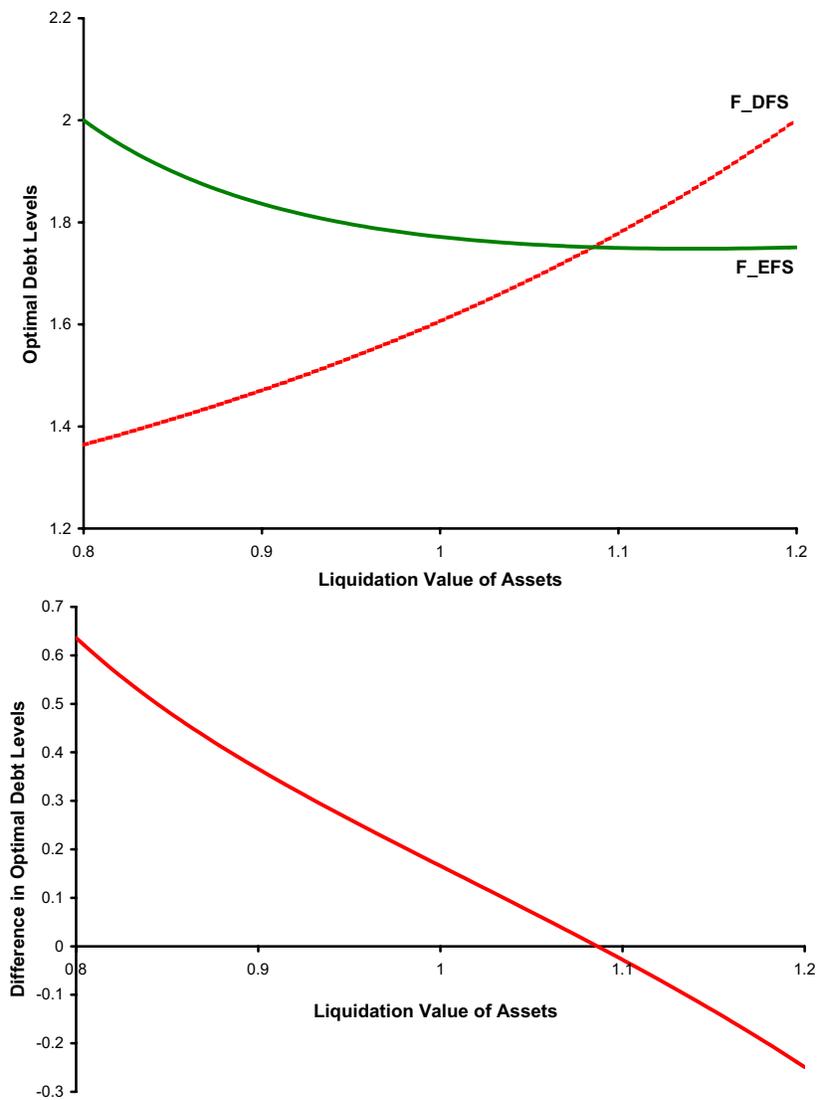
Figure 2: Difference of Differences: Time-Series Behavior

This figure plots the difference of differences between Quintiles 5 and 1 for the two proxies (asset-specificity and intangibles) after controlling for several factors using the matching procedure suggested by Heckman, Ichimura, and Todd (1997, 1998) as explained in Section 6.2. The data is from the Near Neighbor column of Table 5.
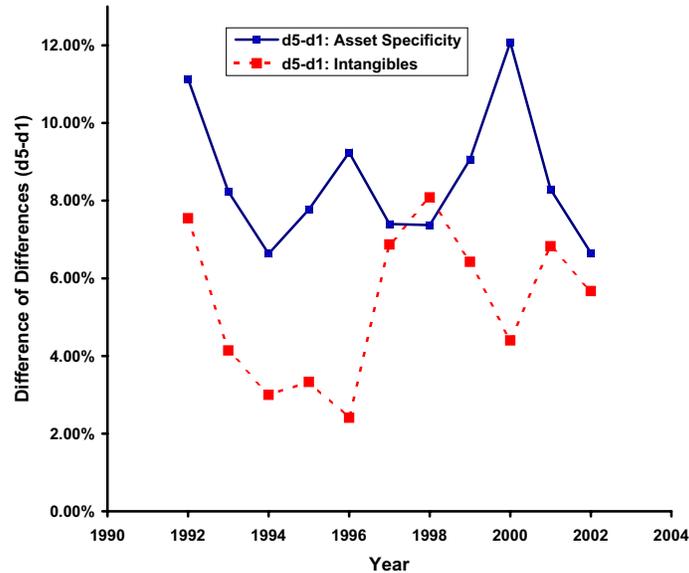
For example, if liquidation values increase, debtholders in a DFS become more likely to liquidate the firm, but the severity of the deadweight loss from a given liquidation is reduced. As a consequence, optimal debt *levels* may or may not increase, so these levels may not be monotone in liquidation values. The only empirical implication of our model is that the *difference* in leverage between the two systems is monotone decreasing in liquidation values. It is this implication that we test.

1.2 The Empirical Support

In the second part of our paper, we check for empirical backing for our model's key implication regarding the difference in leverage levels under equity-friendly and debt-friendly codes. We focus on data from the US and the UK. The difference between the US and UK bankruptcy codes is sharp and maps well onto our theoretical structure with the US code being equity-friendly and the UK one debt-friendly. Moreover, our implicit assumption that all else is equal (e.g., the level of development of equity markets) is perhaps best supported for these countries.

We examine leverage of firms in the US and the UK by looking at all firms covered by Worldscope from 1990 to 2002 except financial institutions. We examine two measures of leverage: the book value of debt divided by book value of assets, and the book value of debt divided by market value of assets. As usual, the market value of assets is defined as the book value of assets minus book value of shareholders' equity plus the market value of shareholders' equity.

We also need a proxy for anticipated liquidation values. We employ two different proxies. The first is *asset-specificity*, a notion originally proposed by Williamson (1988) and Shleifer and Vishny (1992). The idea here is that firms whose assets are *specific* (i.e., cannot readily be deployed outside the industry) are likely to experience lower liquidation values because they may suffer from "fire sale" discounts in auctions for asset sales, particularly when other firms in the industry are also in distress. Empirical studies have generally found asset-specificity (measured as the ratio of the book value of machinery and equipment to the book value of assets), to be a very good predictor of recovery rates or asset sale proceeds; see, e.g., Berger, Ofek, and Swary (1996), Pulvino (1998), Stromberg (2000), and Acharya, Bharath and Srinivasan (2003).

The alternative proxy is the fraction of the firm's assets that are *intangibles*. The motivation here is simple: *non-physical* assets (such as goodwill) of a firm are specific to the firm and cannot easily be sold to other firms. Note that both asset specificity and the proportion of intangibles are *inversely* related to liquidation values: the higher the degree of asset specificity (in the first case) or proportion of intangibles (in the second), the lower the liquidation value of the firm.

Recast in terms of these proxies, our main result says that the difference in leverage between EFS and DFS should be an increasing function of the proxy (asset-specificity/proportion of intangibles). To test this prediction, we pool all the firms in the sample in a given year, and sort the pool into five quintiles based on the proxy, with Quintile 5 representing the highest value of the proxy and Quintile 1 the lowest. Each quintile is then divided into US and UK firms. We use two measures of leverage for each quintile: the median debt to assets, and the mean debt to assets. Since assets themselves are measured both in book and market terms, this gives us four measures of leverage in all.

Each test we perform is then a "difference of differences" check. That is, for each quintile, we compute the difference between the leverages of US and UK firms in that quintile. Call these differences $d_1, \ldots, d_5$. Then, the theory predicts that we should have $d_k - d_n > 0$ whenever $k > n$.

We first check this for $d_5 - d_1$, i.e., for the firms at either end of our proxy measure. When the proxy is asset-specificity, the test is met strongly: barring a single entry, the difference of differences is positive in every single year for each of the four measures of leverage. When the proxy is intangibles, the test is again passed strongly, though not quite as uniformly as for asset specificity.

As a more continuous test, we look at inter-quintile differences, $d_n - d_{n-1}$ for $n = 5, 4, 3, 2$, and for each year. The theory suggests these inter-quintile differences should be positive. We find that this condition is met by about 80% of the entries when the proxy is asset-specificity and by around 70% when the proxy is intangibles, again providing strong support for the theory.

Robustness Checks

To complete the analysis, we perform three robustness checks. The first is to treat cash and cash equivalents as "negative debt" and subtract them from a firm's debt level to arrive at a net debt level which is then used to compute leverage. The theory's implications continue to hold comfortably, and indeed, are even more strongly supported.

Our second test is more elaborate, and perhaps the most important one. It is aimed at ensuring that characteristics other than our proxy are not driving our results. Using matching procedures suggested by Heckman, Ichimura, and Todd (1997, 1998), we match each US firm in a given year to firms in the UK in that year. The matching process utilizes several factors (such as profitability, market-to-book and size) in addition to the proxy for liquidation values. The difference in leverage is computed between the US firm and its matched UK firms. Sorting the US firms into quintiles, we perform the difference of differences tests. Once again, we find very strong support for the theory. Figure 2 presents a time-series plot of the difference of differences for this case. The data is taken from Table 5 of Section 6.2.

Finally, we check whether the results we obtain at the level of the firm also hold with aggregated industry-level data. We perform this test only for asset-specificty, since the specificity of assets is more of an industry characteristic, but the fraction of intangible assets (e.g., goodwill) is more a firm-level characteristic than an industry one. Once again, we get strong positive results in favor of the theory.

1.3   Related Work

Of the related papers in the literature, we have already mentioned Rajan and Zingales (1995). Franks, Nyborg, and Torous (1996) present a detailed comparison of US, UK, and German bankruptcy systems along several dimensions. They note that the equity-friendly nature of the US code gives managers a strong incentive to over-invest and leads to ex-post violations of the absolute priority rule. In contrast, absolute priority is generally adhered to in the debt-friendly UK code, but at the cost of premature liquidations and underinvestment.

In other empirical work, Claessens and Klapper (2002) document the usage of bankruptcy in 35 countries over the period 1990–1999, and find that stronger creditor rights are generally associated with greater use of bankruptcy. Antoniou, Guney and Paudyal (2002) investigate the

determinants of leverage for French, German and British firms using panel data with a focus on the convergence of capital structure to a target maturity structure. A historical perspective on the evolution of the US and UK codes is provided by Franks and Sussman (2000), while Franks and Davydenko (2004) analyze the effect of bankruptcy codes in France, Germany and the UK on the recovery rates and collateral requirements of bank-based contracts.

On the theoretical front, a number of papers have examined the implications of bankruptcy codes on various corporate decisions (see, e.g., White (1994), Cornelli and Felli (1997), Berkovitch and Israel (1998), Povel (1999), and Bebchuk (2002) for some interesting examples). However, we are not aware of any work that explicitly relates capital-structure decisions to control-right allocation in bankruptcy codes.

Two papers relate closely to ours. One is Dewatripont and Tirole (1994) who consider a managerial agency problem and show that the transfer of control to creditors or equityholders produces the optimal state-contingent incentives for these claimants to intervene in management or to remain passive. The other is von Thadden, Berglof and Roland (2003), who integrate the problem of designing corporate bankruptcy rules into a theory of optimal *debt* structure. Their focus is on employing multiple creditors and designing the security rights and bankruptcy rules in an optimal fashion to maximize firm-value. In contrast to these papers, we take the allocation of control rights in bankruptcy as exogenously given. The focus of our theoretical model is on obtaining sharp implications for capital structure that are readily amenable to empirical testing. We achieve this by tying capital structure decisions in our model to anticipated liquidation values.

The remainder of this paper is organized as follows. Section 2 presents our model. Sections 3 and 4 derive equilibrium outcomes under DFS and EFS, respectively. The outcomes are compared in Section 5. Section 6 presents the results of our empirical analysis. Section 7 concludes. The appendices contain proofs of several of the paper's results.

2   The Model

The centerpiece of our model is a firm operating a project with risky cash flows and financed by equity and debt. The firm's realized cash flow provides it both immediate cash (to service its debt) and information about continuation cash flows/liquidation values that may be expected from the project. If the cash flows generated by the project are insufficient to meet debt payments, the firm is in distress. Continuation decisions in distress are regulated by the bankruptcy code in place. Under a debt-friendly system (henceforth, DFS), control rights are transferred to debtholders. Under an equity-friendly system (EFS), control rights remain with equityholders. All agents are assumed risk neutral and the risk-free rate of interest in the model is normalized to zero. A detailed description of the model follows.

Our model has three dates denoted $t = 0, 1, 2$. On date 0, the firm needs to make an investment of an amount I to undertake a positive net present-value project. The firm chooses the mix of debt and equity in its capital structure to fund this investment. The debt matures on date 1. Date 2 represents a summary of the continuation possibilities for the firm after maturity of the debt. If the firm has inadequate cash flows to meet debt service requirements on date 1, the bankruptcy code comes into play. Note that we do not model the optimal maturity structure of the firm's debt; rather, our focus is on the equityholders' optimal choice of the face value F of debt.

We elaborate on the model in two steps. First, we discuss the structure of cash flows on dates 1 and 2. Then, we discuss the role of the bankruptcy code in determining how control rights beyond date 1 are allocated.

Cash Flows & Liquidation Values

The firm generates random cash flows at date 1 and—in the event it is not terminated—also at date 2. The date 1 cash flow, denoted x, is distributed uniformly on an interval $[0, H]$:

$$x \sim U[0, H]. \tag{1}$$

After observing x, the decision on liquidation/continuation is taken which determines date 2 cash flows. Both continuation and liquidation values depend on x. Before we describe these cash flows, it is useful to recount what we would like them to satisfy. For inefficiency in either direction to be possible, we must have at least two possible continuation values, one of which is superior to liquidation and one of which is inferior. Second, for the "optionality" (i.e., the non-linearity) in the debtholders' and equityholders' claims to have a non-trivial effect on their continuation/liquidation decisions, there must be uncertainty regarding continuation cash flows.

To capture these requirements in a simple but effective manner, we adopt the following structure. If the firm is continued beyond period 1, the continuation cash flow y has the distribution

$$y = \begin{cases} Lx, & \text{with prob } q \\ 0, & \text{with prob } 1 - q \end{cases} \tag{2}$$

where $L \geq 2$. The parameter q summarizes the quality of the firm's technology in the continuation. The value of q is unknown at date 0, but it is also revealed at date 1 before continuation decisions are made. The ex-ante distribution of q is given by

$$q = \begin{cases} \overline{q}, & \text{with prob } 1/2 \\ \underline{q}, & \text{with prob } 1/2 \end{cases} \tag{3}$$

Figure 3: The Timeline of Our Model

t=0	t=1	t=2
• Firm owners choose optimal level of debt F	• Debt payment F is due.	• Continuation or liquidation payoffs are realized.
• Investment is undertaken	• Cash-flow x is realized.	
	• Debt is paid off (x>F) or firm defaults (x<F).	
	• Continuation prospect q is realized: $q = \overline{q}$ or $q = \underline{q}$, each with prob 0.5.	
	• Continuation or liquidation decision is made depending on the bankruptcy code.	
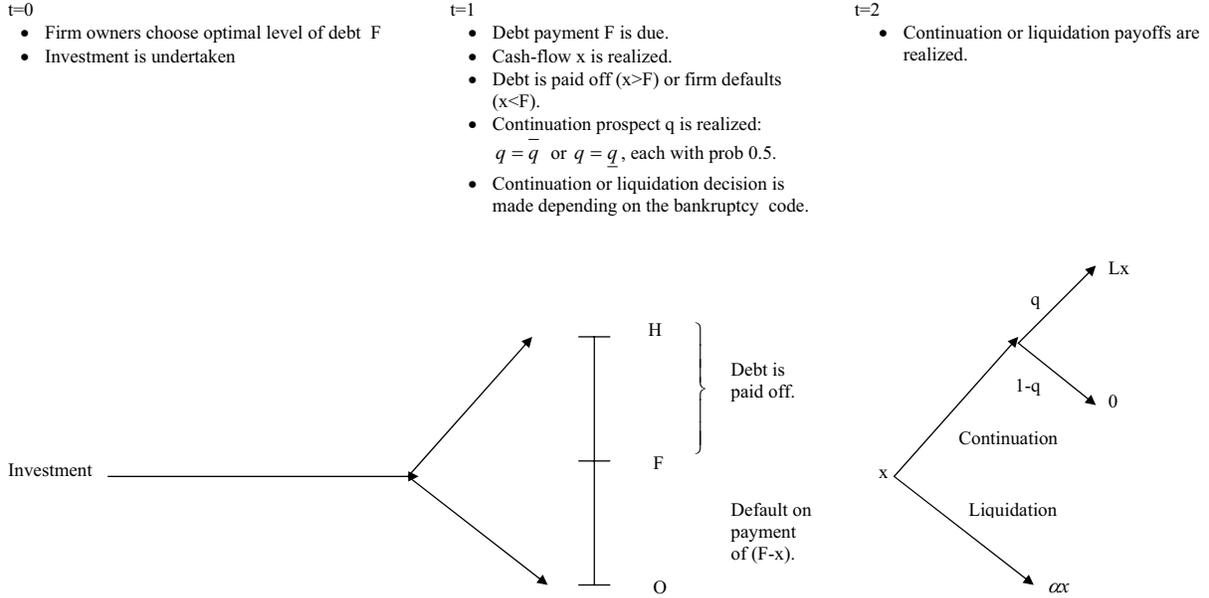
where $0 < \underline{q} < 1/2 < \overline{q} < 1$. Thus, there are two possible expected continuation values, $\overline{q}Lx$ and $\underline{q}Lx$.

If the firm is liquidated, it realizes a value αx. The parameter α governs the liquidation value of the firm's assets. We assume that

$$0 < \underline{q}L < \alpha < \overline{q}L. \tag{4}$$

Thus, given any x, it is uniquely ex-post efficient to

$$\begin{cases} \text{continue the firm if } q = \overline{q} \\ \text{liquidate the firm if } q = \underline{q} \end{cases}$$

In particular, the degree of (per unit) inefficiency from

- continuing a firm when $q = \underline{q}$ is measured by $(\alpha - \underline{q}L)$, and

- liquidating a firm when $q = \overline{q}L$ is measured by $(\overline{q}L - \alpha)$.

As we show below, the optimal debt structures and firm values under the two codes are intimately related to these measures. Expressions (11) and (12) relate firm value and capital-structure choice

11

under a DFS to the loss $(\overline{q}L - \alpha)$ from excessive liquidations, while expressions (16) and (17) relate firm value and capital-structure choice under an EFS to the loss $(\alpha - \underline{q}L)$ from excessive continuations.

Figure 3 summarizes the time line of the model.

The Bankruptcy Code and Control Rights

All payments to creditors are financed out of firm cash-flows. Recall that F denotes the face value of debt due at date 1. If $x \geq F$ on date 1, the debt is paid off and the firm becomes an all equity firm. The excess cash flow $(x - F)$, net of taxes (see below), goes to equityholders. For $x < F$, the firm cannot meet its contractual payment fully and is in financial distress or "default." It pays the available amount x to creditors and is in arrears for the remaining amount $(F - x)$; creditors get first claim on any further cash flows until they have been fully paid off.

Further cash flows depend on whether the firm is continued or liquidated at this point. The bankruptcy code in place determines who gets to make this decision. As mentioned, we consider two formulations of the bankruptcy code. In the first, the debt-friendly system (DFS), this decision is made by debtholders. In the other, the equity-friendly system (EFS), equityholders get to choose between continuation and liquidation.

Finally, we denote by τ the tax rate of the firm. Taxes are paid on gross cash flows, but debt provides a tax shield to the firm. That is, at date 1, the firm pays taxes only if $x \geq F$; in this case, its tax bill is $\tau(x - F)$. For $x < F$, there are no taxes at date 1. For simplicity, we assume that there are no taxes to be paid at date 2. This simplifies notation and makes the presentation cleaner. However, this assumption is not necessary for our results. It is not difficult to show that our results—in particular, the central result, Proposition 3—are unaffected if the firm must pay taxes at date 2 when it is not in distress.

3   Optimal Debt Levels and Firm Values Under DFS

To solve for the optimal level of debt under DFS, we fix F at an arbitrary level, identify the continuation/liquidation regions given F, and identify the resulting ex-ante firm value. Then, we maximize ex-ante firm value over F.

So fix F. We first examine the continuation/liquidation decision at date 1 given F. Suppose first that the date-1 cash flow satisfies $x \geq F$. Then, creditors receive the full amount F owed to them, while equityholders receive the net-of-taxes amount $(1 - \tau)(x - F)$. The firm now becomes an all-equity firm. After observing q, equityholders will thus decide to continue if and only if it is efficient to do so (i.e., if and only if $q = \overline{q}$), and will liquidate the firm otherwise.

Therefore, conditional on x and q, and given $x \geq F$, the expected value of the firm at date 1 (including the date 1 cash flow x) is given by

$$
\begin{aligned}
&x - \tau(x - F) + \bar{q}Lx, &&\text{if } q = \bar{q} \\
&x - \tau(x - F) + \alpha x, &&\text{if } q = \underline{q}.
\end{aligned}
\tag{5}
$$

For $x < F$, the firm is in default and the bankruptcy code comes into operation. Under DFS, the creditors take the decision whether to continue the firm or to liquidate it. If creditors decide to continue the firm, they have a senior claim of $(F - x)$ on date 2 cash flows. Given q and the distribution (2) of date 2 cash flows, the expected payoff of creditors from continuation is

$$
q \ \min(Lx, F - x).
\tag{6}
$$

If the creditors decide on liquidation, their payoff is $\min(\alpha x, F - x)$. Hence, creditors choose to continue the firm if and only if

$$
q \ \min(Lx, F - x) \ \geq \ \min(\alpha x, F - x).
\tag{7}
$$

The following lemma uses (7) to identify the continuation strategies precisely. As we note immediately following the lemma, it also captures the commonly-held belief that there are "too many" liquidations under a debt-friendly bankruptcy code. Figure 4 describes the lemma in a figure.

Lemma 1 *Under DFS, for $x < F$:*

1. *If $q = \underline{q}$, then creditors always liquidate the firm. This is ex-post efficient.*

2. *If $q = \bar{q}$, then defining $x^* = \bar{q}F/[\bar{q} + \alpha]$:*

   - *Creditors continue the firm for $x \in [0, x^*)$. This is again ex-post efficient.*
   - *Creditors liquidate the firm for $x \in [x^*, F)$. This is ex-post inefficient.*

Proof. See Appendix B. ∎

Remark Lemma 1 captures the common belief that under creditor-friendly bankruptcy codes, firms that have value as going concerns ($q = \bar{q}$ in our case) may get liquidated (here when $x \in [x^*, F)$). □

For $x < F$, if the firm is continued, then its expected value at date 1 (including the date 1 cash flow x) conditional on q and x is $x + qLx$; if it is terminated at this point, this expected value is $x + \alpha x$. Thus, from expression (5) and Lemma 1, we obtain the following expressions for the expected value of the firm on date 1 conditional on x and q:

Figure 4: The Continuation/Liquidation Decision in a DFS

This figure describes the continuation and liquidation regions under a debt-friendly system when the firm is in distress. The figure is a graphical representation of the information in Lemma 1.

Case 1: $q = \overline{q}$ **Case 2:** $q = \underline{q}$

F

$x^* \equiv \dfrac{\overline{q}F}{\overline{q} + \alpha}$ Liquidate

Continue

0

F

Liquidate

0
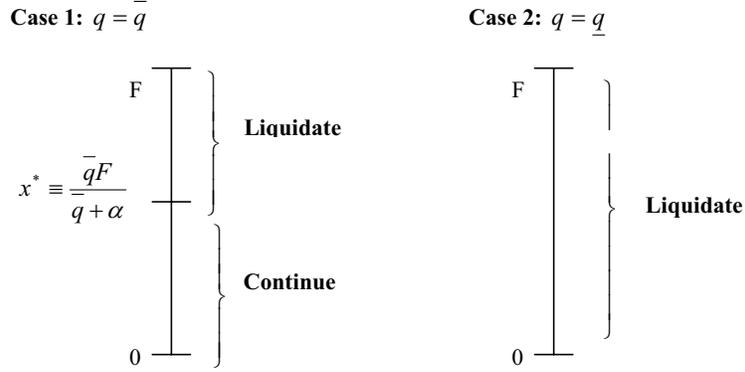
1. For $x \geq F$:

$$
\begin{aligned}
& x - \tau(x - F) + \overline{q}Lx, && \text{if } q = \overline{q} \\
& x - \tau(x - F) + \alpha x, && \text{if } q = \underline{q}.
\end{aligned}
\tag{8}
$$

2. For $x < F$ and $q = \underline{q}$: $x + \alpha x$.

3. For $x \in [0, x^*]$ and $q = \overline{q}$: $x + \overline{q}Lx$.

4. For $x \in (x^*, F)$ and $q = \overline{q}$: $x + \alpha x$.

The expected value of the firm at date 0 may now be found by integrating these firm values over the ex-ante distributions of x and q. Since $x \sim U[0, H]$ and $\overline{q}$ and $\underline{q}$ are equiprobable, the expected value of the firm at date 0 is

$$
\begin{aligned}
V(F) \;=\; \frac{1}{H} \Bigg\{ & \int_0^H x\,dx - \int_F^H \tau(x - F)\,dx + \frac{1}{2}\int_F^H \overline{q}Lx\,dx + \frac{1}{2}\int_F^H \alpha x\,dx \\
& + \frac{1}{2}\int_0^{x^*} \overline{q}Lx\,dx + \frac{1}{2}\int_{x^*}^F \alpha x\,dx + \frac{1}{2}\int_0^F \alpha x\,dx \Bigg\}
\end{aligned}
\tag{9}
$$

This expression can be simplified and put into a very intuitive form. To this end, define $\overline{V}$ to be the date-0 expected value of an all-equity firm without taxes. Such a firm necessarily involves efficient continuations (continue if $q = \overline{q}$, liquidate otherwise), so we have:

$$\overline{V} = \frac{1}{H} \left\{ \int_0^H x \, dx + \frac{1}{2} \int_0^H \overline{q} L x \, dx + \frac{1}{2} \int_0^H \alpha x \, dx \right\},$$

or what is the same thing:

$$\overline{V} = \frac{H}{2} \left[1 + \frac{1}{2} \overline{q} L + \frac{1}{2} \alpha \right]. \tag{10}$$

A little algebraic manipulation shows that the expression (9) for ex-ante firm value can be expressed in terms of $\overline{V}$ as

$$V(F) = \overline{V} - \frac{1}{H} \left\{ \int_F^H \tau(x - F) \, dx + \frac{1}{2} \int_{x^*}^F (\overline{q} L - \alpha) x \, dx \right\}. \tag{11}$$

The first term in the parenthesis represents the value loss from the taxes that a levered firm would pay at date 1. The second term corresponds to the agency costs of debt under DFS: it captures the loss in firm value from financial distress, more precisely the loss from inefficient liquidations of the firm when the going concern value exceeds the liquidation value.

Denoting the value of the debt of the firm as $D(F)$, equityholders must provide the remaining investment $[I - D(F)]$. Since debt is assumed to be priced fairly by creditors, equityholders pick F to maximize their return net of investment, that is, $[V(F) - D(F)] - [I - D(F)]$. In other words, the optimal capital structure of the firm, characterized by the level of debt F^*_{DFS}, maximizes the date–0 expected value of the firm, $V(F)$. It trades off the benefit and the cost of debt: on the one hand, increasing the level of debt enables the firm to obtain greater tax-shields at date 1; on the other, increasing the level of debt increases the region over which inefficient liquidations take place at date 1. The following result, the main result of this section, summarizes the consequence of this trade-off:

Proposition 1 *Given α, the optimal debt level of the firm under DFS is*

$$F^*_{DFS}(\alpha) = \frac{\tau H}{\tau + \frac{1}{2}(\overline{q} L - \alpha)\left[1 - \frac{\overline{q}^2}{(\overline{q} + \alpha)^2} \right]} \tag{12}$$

15

Proof. Differentiating the expression (11) for $V(F)$ with respect to F, we obtain

$$
\begin{aligned}
\frac{dV}{dF} &= \frac{\tau}{H} \int_F^H dx - \frac{1}{2} \frac{(\bar{q}L - \alpha) F}{H} + \frac{1}{2} \frac{(\bar{q}L - \alpha) x^*}{H} \frac{dx^*}{dF} \\
&= \tau - \frac{\tau F}{H} - \frac{1}{2} \frac{(\bar{q}L - \alpha) F}{H} + \frac{1}{2} \frac{(\bar{q}L - \alpha)}{H} \frac{\bar{q}F}{(\bar{q} + \alpha)} \frac{\bar{q}}{(\bar{q} + \alpha)} \\
&= \tau - \frac{\tau F}{H} - \frac{1}{2} \frac{(\bar{q}L - \alpha) F}{H} \left[1 - \frac{\bar{q}^2}{(\bar{q} + \alpha)^2} \right].
\end{aligned} \tag{13}
$$

The second-derivative of V with respect to F is

$$
\frac{d^2 V}{dF^2} = -\frac{\tau}{H} - \frac{1}{2} \frac{(\bar{q}L - \alpha)}{H} \left[1 - \frac{\bar{q}^2}{(\bar{q} + \alpha)^2} \right] < 0. \tag{14}
$$

Thus, V is a strictly concave function of F and has its unique maximum at the point where $dV/dF = 0$. From (13), the value of F at which $dV/dF = 0$ is precisely the value identified in (12). ∎

As expected, ceteris paribus, this optimal level of debt increases in tax rate τ, and decreases in the extent of agency cost $(\bar{q}L - \alpha)$ captured by the loss in firm value (per unit scale) in the region of inefficient liquidations. Note that the optimal debt level depends on both the severity of an inefficient liquidation decision (through the term $(\bar{q}L - \alpha)$) and the likelihood of such inefficiency (through the term $[1 - \{\bar{q}/(\bar{q} + \alpha)\}^2]$). However, it does not depend on $\underline{q}$, the extent of bad quality of the project at date 1.

4   Optimal Debt Levels and Firm Values Under EFS

The analysis of EFS follows similar lines to the analysis of DFS above. For $x \geq F$, creditors receive the full amount they are owed and the firm becomes an all-equity firm. Outcomes in this case are identical to those under DFS; in particular, conditional on x and q, the expected value of the firm at date 1 (including the date 1 cash flow) is given by (8).

For $x < F$, the firm is in default. Creditors receive x at date 1 and a senior claim of $F - x$ on any future cash flows. Under EFS, equityholders now take the decision on continuation or liquidation of the firm. Given $x < F$ and q, the expected payoff to equityholders from continuing the firm is evidently

$$
q \max[Lx - (F - x), 0],
$$

while their payoff in liquidation is

$$\max[\alpha x - (F - x), 0].$$

Thus, equityholders choose continuation if and only if

$$q \max\left[Lx - (F - x), 0\right] > \max\left[\alpha x - (F - x), 0\right]. \tag{15}$$

We assume that if equityholders are indifferent between the alternatives (which would happen, for example, if their claim was worth zero in both cases), then the continuation/liquidation decision is made based on which alternative creditors would prefer. The following lemma summarizes equityholders' continuation choices. Figure 5 describes the content of the lemma in a figure.

Lemma 2 *Under EFS, for $x < F$:*

1. *If $q = \bar{q}$, then equityholders continue the firm. This is ex-post efficient.*

2. *If $q = \underline{q}$, then defining x_1^* and x_2^* by*

$$x_1^* = \frac{F}{1 + L} \qquad \text{and} \qquad x_2^* = \frac{F}{1 + \left(\frac{\alpha - \underline{q}L}{1 - \underline{q}}\right)},$$

we have:

- *For $x \in [0, x_1^*]$, the firm is liquidated. This is ex-post efficient.*
- *For $x \in (x_1^*, x_2^*]$, equityholders continue the firm, This is ex-post inefficient.*
- *For $x \in (x_2^{**}, F)$, equityholders liquidate the firm. This is ex-post efficient.*

Proof. See Appendix C. ∎

Lemma 2 reflects the commonly-held belief that equity-friendly bankruptcy codes encourage "too many" continuations. In this case, it is efficient to liquidate the firm for $q = \underline{q}$ but for $x \in (x_1^*, x_2^*)$ equityholders continue the firm. Taken jointly, Lemma 1 and Lemma 2 illustrate the classic conflict between equityholders and creditors (first highlighted by Jensen and Meckling (1976) and developed in the context of bankuptcy by Dewatripont and Tirole (1994)): equityholders like risk and may prefer to continue the firm in order to keep their "option" alive, whereas the creditors dislike risk and may prefer to liquidate the firm.

To identify the date 0 expected value of the firm under EFS, note that the only differences between a firm under EFS and an all-equity firm without taxes are (a) the tax-payments/tax-shields at date 1, and (b) the loss in firm-value from inefficient continuations. Under EFS, the

Figure 5: The Continuation/Liquidation Decision in an EFS

This figure describes the continuation and liquidation regions under an equity-friendly system when the firm is in distress. The figure is a graphical representation of the information in Lemma 2.
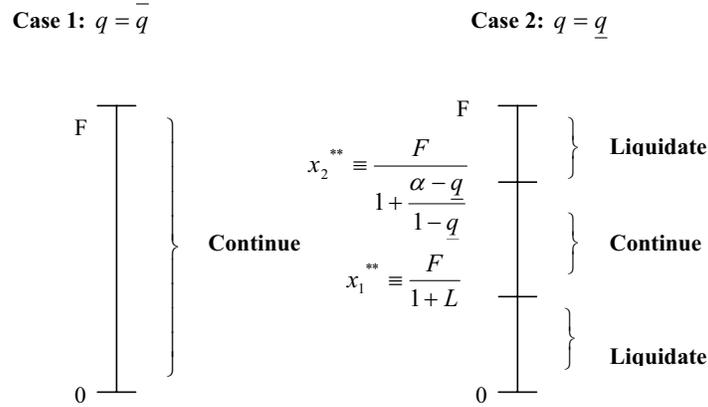
latter arises only for $q = \underline{q}$ and x in the region (x_1^*, x_2^*). Hence, the expected firm value at date 0 is given by

$$
V(F) \;=\; \overline{V} - \frac{1}{H} \left\{ \int_F^H \tau(x - F)\, dx + \frac{1}{2} \int_{x_1^*}^{x_2^*} (\alpha - \underline{q}L)x\, dx \right\}. \tag{16}
$$

This expression is the analog of the DFS expression (11). The first term in the parenthesis on the right-hand side arises from the taxes that a levered firm would pay at date 1. The second term captures the loss in value that arises from ex-post inefficient continuation of the firm when the ongoing concern value of the firm is lower than its liquidation value. The optimal capital structure of the firm, level of debt F_{EFS}^*, is the value of F that maximizes (16). The following result gives an analytical expression for F_{EFS}^*:

Proposition 2 *Under EFS, the optimal level of debt for the firm is*

$$
F_{EFS}^*(\alpha) \;=\; \frac{\tau H}{\tau + \frac{1}{2}\left(\alpha - \underline{q}L\right) z(\alpha)} \tag{17}
$$

where

$$
z(\alpha) \;=\; \left[\frac{1}{\left(1 + \left[\frac{\alpha - \underline{q}L}{1 - \underline{q}}\right]\right)^2} - \frac{1}{(1 + L)^2} \right] \tag{18}
$$

18

Proof. Differentiating (16) with respect to F, we obtain

$$
\begin{aligned}
\frac{dV}{dF} &= \frac{\tau}{H} \int_F^H dx - \frac{1}{2}\left[\frac{(\alpha - \underline{q}L)}{H} x_2^*\right]\frac{dx_2^*}{dF} + \frac{1}{2}\left[\frac{(\alpha - \underline{q}L)}{H} x_1^*\right]\frac{dx_1^*}{dF} \\
&= \tau - \frac{\tau F}{H} - \frac{1}{2}\frac{(\alpha - \underline{q}L)F}{H}\left\{\frac{1}{\left[1 + \left(\frac{\alpha - \underline{q}L}{1 - \underline{q}}\right)\right]^2} - \frac{1}{[1 + L]^2}\right\} \\
&= \tau - \frac{\tau F}{H} - \frac{1}{2}\frac{(\alpha - \underline{q}L)F}{H} z(\alpha).
\end{aligned}
\tag{19}
$$

Taking the second derivative with respect to F,

$$
\frac{d^2V}{dF^2} = -\frac{\tau}{H} - \frac{1}{2}\frac{(\alpha - \underline{q}L)}{H}z(\alpha) < 0.
\tag{20}
$$

The last inequality follows since $L > (\alpha - \underline{q}L)/(1 - \underline{q})$, as pointed out earlier, which implies in turn that $z(\alpha) > 0$.

Thus, $V(F)$ is strictly concave in F, so the firm-value maximizing level of debt is that at which the first derivative is zero. This is precisely the point F_{EFS}^* identified in expression (17). ∎

Ceteris paribus, this optimal level of debt increases in the tax rate τ and decreases in the degree of agency cost $(\alpha - \underline{q}L)$ captured by the loss in firm value (per unit scale) in the region of inefficient continuations. Once again, the optimal debt level depends on both the severity of inefficient liquidations (through the term $(\alpha - \underline{q}L)$) and its likelihood (through the term $z(\alpha)$), but it does not depend on $\overline{q}$, the extent of good quality of the project at date 1.

5   Comparison of Outcomes under DFS and EFS

Having derived the optimal capital structures under the two bankruptcy codes, we turn now to a comparison of equilibrium outcomes under these codes. There are two questions of interest in this context:

1. How does the level of leverage compare across the codes? In particular, when does EFS lead to a higher use of debt than DFS (and vice versa)?

2. How do welfare levels compare across the codes? That is, when does EFS lead to higher ex-ante expected firm values than DFS (and vice versa)?

The first of these questions is a main motivation for the paper, and is the focus of the empirical work that follows in the rest of the paper. We examine this question in the rest of this section. The second question is examined in Appendix A.

Our main findings concerning the capital structures are summarized in Proposition 3 below. A critical role here is played by the parameter α. The result shows (a) that optimal capital structures involve more debt under EFS for low α and under DFS for high α, and (b) the difference in optimal debt levels is itself monotone in α for suitably high α. Recall that the range of permissible values for α is the interval $(\underline{q}L, \overline{q}L)$.

Proposition 3 *There are α^* and α^{**} in $(\underline{q}L, \overline{q}L)$ such that $\alpha^* < \alpha^{**}$ and*

1. $F^*_{EFS}(\alpha) > F^*_{DFS}(\alpha)$ *if $\alpha < \alpha^*$.*

2. $F^*_{EFS}(\alpha) < F^*_{DFS}(\alpha)$ *if $\alpha > \alpha^{**}$.*

Further, $[F^*_{EFS}(\alpha) - F^*_{DFS}(\alpha)]$ is strictly decreasing in α for $\alpha \in (\max\{\underline{q}L, \widehat{\alpha}\}, \overline{q}L)$, where $\widehat{\alpha} \approx 0.36\,\overline{q}L$.

Remark 1 The second part part of the proposition implies that under the mild condition $0.36\,\overline{q} \leq \underline{q}$ (roughly, the high state is not more than three times better than the low state), we have $\alpha^* = \alpha^{**}$, so (a) there is a unique crossover point for the optimal debt levels, and (b) the difference in optimal debt levels is monotone over the entire range of admissible values of α. □

Remark 2 Figure 1 in the Introduction illustrates Propositions 1–3. It plots outcomes under the two codes for the parametrization $H = 2$, $L = 2$, $\tau = 0.35$, $q_h = 0.60$, and $q_l = 0.40$.   □

Remark 3 Our results are readily generalized to codes which lie between the extremes we consider. Suppose that when the firm is financial distress, continuation decisions are made by equityholders with probability π and by debtholders with probability $1 - \pi$. (This captures in a simple way the possibility that neither party has complete say over outcomes.) The EFS and DFS cases correspond, respectively, to $\pi = 1$ and $\pi = 0$. It is not hard to show that the optimal debt structure under this code, denoted $F^*_\pi(\alpha)$ say, is just the common numerator of (12) and (17) divided by the π-weighted convex combination of the denominators of (17) and (12). Then, extending the arguments used in the proof of Proposition 3, it can be shown that $F^*_{\pi_1}(\alpha) - F^*_{\pi_2}(\alpha)$ is decreasing in α whenever $\pi_1 > \pi_2$.   □

Proof. A comparison of the expressions (12) and (17) for the optimal debt levels under DFS and EFS, respectively, shows that whether $F^*_{EFS}(\alpha)$ is greater than, equal to, or less than $F^*_{DFS}(\alpha)$ is determined by whether $f(\alpha)$ is greater than, equal to, or less than zero, where

$$f(\alpha) \; = \; (\overline{q}L - \alpha)\left[1 - \frac{\overline{q}^2}{(\overline{q} + \alpha)^2}\right] - (\alpha - \underline{q}L)z(\alpha). \tag{21}$$

A simple check shows that $f(\alpha) > 0$ as $\alpha \to \underline{q}L$ and $f(\alpha) < 0$ as $\alpha \to \overline{q}L$. The existence of the the desired α^* and α^{**} follow easily now from the continuity of $f(\cdot)$ in α.

The second part of the result requires considerably greater work. In the interests of expositional continuity, we present the arguments in Appendix D. ∎

6 Empirical Evidence

We take to data the main empirical prediction of our analysis that the difference between the debt levels under EFS and DFS should be a decreasing function of the anticipated liquidation values. We focus on two countries in our empirical analysis: the US and the UK. The difference between the bankruptcy codes in these two countries is sharp and maps well onto our theoretical assumptions with the US and UK being equity- and debt-friendly, respectively. Moreover, our implicit assumption that all else is equal is perhaps best supported for these countries: the level of development of equity markets is comparable for both the countries, and banks are either barred (in the US) or typically do not (in the UK) take equity stakes in firms to whom they lend.

We examine leverage of firms in the US and the UK by looking at all firms covered by Worldscope from 1990 to 2002 except financial institutions (SIC code 6, that is, firms engaging in finance, real estate, or insurance). We focus on two measures of leverage: the book value of all debt (short-term and long-term) divided by book value of assets, and the book value of all debt divided by market value of assets. As usual, market value of assets = book value of assets − book value of shareholders' equity + market value of shareholders' equity.

Our data is similar to that of Rajan and Zingales (1995) in terms of overall summary characteristics. For 1991, the year for which Rajan and Zingales report their results, the mean (median) Debt to Book Assets is greater for the US than for the UK by about 6% (7%). The aggregate Debt to Book Assets, which is the assets-weighted average of the ratio, is greater for the US by about 9%. These numbers are quite comparable to those in Rajan and Zingales. Moreover, these differences in leverage between the US and the UK are quite stable in the time-series during the period 1990 to 2002, with the sample mean (median) Debt to Book Assets being 25% (31%) for the US and 19% (24%) for the UK.

We proxy for expected liquidation values in two ways, each of which is inversely related to liquidation values. The first is through a firm's *asset-specificity*, the second is through the fraction of the firm's assets that are *intangibles*. We discuss these proxies first.

The notion of asset-specificity of firms was proposed by Williamson (1988) and Shleifer and Vishny (1992). In summary, this literature suggests that firms whose assets tend to be *specific*, that is, whose assets cannot be readily redeployed by firms outside of the industry, are likely to experience lower liquidation values because they may suffer from "fire-sale" discounts in cash auctions for asset sales, especially when firms within an industry get simultaneously into financial or economic distress. Since industry cycles are often key drivers of firm-level default, asset-specificity suggests itself as a(n inverse) proxy for expected liquidation values.

There is strong empirical support for this idea, as shown, for example, by Pulvino (1998) for the airline industry, and especially, Acharya, Bharath, and Srinivasan (2003) for the entire universe of defaulted firms in the US over the period 1981 to 1999 (see also Berger, Ofek, and Swary (1996) and Stromberg (2000)). We adopt the definition of asset specificity that has been employed in the latter three papers: asset specificity is the Book Value of Machinery and Equipment divided by the Book Value of Assets. Under this definition, Land and Property, are not considered as specific assets but are viewed as being fungible across industries.

Our second proxy, the fraction of total assets comprising of Intangibles,[4] has a simple motivation. It is based on the thesis that liquidation proceeds are lower for firms with a large proportion of non-physical assets since these assets, for example goodwill, are not easily sold or transferable to other firms.

Since these proxies are each inversely related to firm value, the hypothesis we are testing is that the difference in debt levels between EFS and DFS is an *increasing* function of the proxies.

6.1   Testing the Theory

If α_l and α_h represent low and high liquidation values, respectively, then our theory predicts that

$$[F_{US}(\alpha_h) - F_{UK}(\alpha_h)] \ < \ [F_{US}(\alpha_l) - F_{UK}(\alpha_l)],$$

or, equivalently, that

$$[F_{US}(\alpha_l) - F_{UK}(\alpha_l)] - [F_{US}(\alpha_h) - F_{UK}(\alpha_h)] \ > \ 0.$$

---

[4]Intangibles are assets not having any physical existence, and are defined as Goodwill (cost in excess of net assets purchased), Patents, Copyrights, Trademarks, Formulae, Franchises of no specific duration, Capitalized software developments and Computer programs, Organizational costs, Customer lists, Capitalized advertising cost, Licences of no specific duration, Mastheads (newspapers), Capitalized servicing rights, and Purchased servicing rights.

The first term on the left-hand side is the difference in leverage between US firms and UK firms with high values for the proxy (recall that our proxies are inversely related to liquidation values α) while the second term is the difference in leverage between US firms and UK firms with low values for the proxy. Our theoretical prediction is that this **"difference of differences"** is positive.[5] We first apply this difference of differences test when asset specificity is the proxy for liquidation values, and then repeat the procedure using intangibles as the proxy.

To classify firms according to asset-specificity, we pool all firms in the sample in a given year and divide the pool into five quintiles based on asset-specificity. Quintile 5 represents the highest degree of asset-specificity and Quintile 1 the lowest. Each quintile is then broken up into US firms and UK firms. Firms are re-grouped into quintiles at the beginning of each year. We refer to Quintile 1 as the Low Asset-Specificity firms and to Quintile 5 as the High Asset-Specificity firms.

Table 1 presents the leverage ratios for the High and Low Asset-Specificity Firms in the US and UK, and the difference of differences computed from these numbers, from 1992 to 2002.[6] The table considers four measures of leverage: Median Debt to Book Assets, Median Debt to Market Assets, the Mean Debt to Book Assets, and the Median Debt to Book Assets. The first two measures are in the upper panel, and the latter two in the lower panel. Employing medians has the advantage that outliers are less likely to drive the results, whereas employing means has the advantage that more cross-sectional information is utilized.

Table 1 shows that the time-series average of difference of differences is 9.54% (7.12%) when Median Debt to Book (Market) Assets is employed as the measure of leverage. Moreover, the difference of differences is positive and of roughly similar magnitude in every single year from 1992 to 2002. Its lowest value is 2.22% (0.35%) and its highest value is 14.41% (18.94%).[7]

The results are similar but of somewhat smaller magnitude when the mean is used as the measure of leverage. The lower panel of Table 1 shows that the time-series average of difference of differences is 5.13% (4.77%) when Mean Debt to Book (Market) Assets measures leverage. With a single exception, the difference of differences is again positive in every single year, with a minimum value of 0.28% (-0.66%) for Mean Debt to Book (Market) Assets and a maximum

---

[5]Besides being naturally implied by our theory as a test variable, looking at the difference of differences potentially helps us reduce the impact of heterogeneity (other than the applicable bankruptcy codes) between the firms and their environment in the US and the UK.

[6]The data on Machinery and Equipment becomes available for most US and UK firms in the Worldscope only starting 1992.

[7]A number of papers have argued about the "stickiness" of capital structure decisions from a theoretical as well as an empirical standpoint (Fisher, Heinkel, and Zechner, 1989; Strebulaev, 2003, Hennessy and Whited, 2004, Leary and Roberts, 2004). Hence, we present our difference of differences results in every single year of the sample for both measures of debt. Furthermore, the year-wise difference of differences is likely to be serially correlated, so we do not compute the statistical significance of the time-series average.

Table 1: Difference of Differences Test: Asset-Specificity

At the beginning of each year, all firms in US and UK are pooled and placed in quintiles based on their ratio of book value of Machinery and Equipment to book value of Assets. The leverage difference for a country is the difference between book Debt to Total Assets of high asset-specificity firms (Quintile 5) and that of low asset-specificity firms (Quintile 1) in the country. The difference of differences is calculated by subtracting the leverage difference of the UK from the leverage difference of the US. We use both mean and median leverages using both Debt to Total Book Assets and Debt to Total Market Assets. Total Market Assets are computed by subtracting the book value of common equity from book assets and adding back the market value of common equity.

	Median Debt to Total Asset (Book)				Difference of Differences Debt to Total Asset	Median Debt to Total Asset (Market)				Difference of Differences Debt to Total Asset
	US		UK			US		UK		
	Q5	Q1	Q5	Q1		Q5	Q1	Q5	Q1	
Observations	205	206	81	81		205	206	81	81	
1992	26.09%	9.65%	20.84%	18.81%	14.41%	20.04%	3.50%	16.73%	19.13%	18.94%
	379	379	177	175		379	379	177	175	
1993	24.67%	9.57%	17.56%	13.68%	11.23%	16.88%	4.06%	12.02%	10.87%	11.67%
	628	625	188	186		628	625	188	186	
1994	22.66%	9.76%	16.09%	11.38%	8.19%	16.68%	5.89%	10.75%	7.67%	7.70%
	715	711	187	185		715	711	187	185	
1995	23.25%	7.93%	16.98%	14.41%	12.74%	15.62%	3.71%	11.72%	9.88%	10.07%
	829	824	188	188		829	824	188	188	
1996	22.81%	4.51%	18.12%	13.26%	13.43%	16.67%	1.98%	12.24%	8.21%	10.66%
	918	920	179	179		918	920	179	179	
1997	24.71%	7.49%	18.66%	8.43%	6.99%	16.02%	4.25%	13.25%	5.23%	3.76%
	1108	1115	166	167		1108	1115	166	167	
1998	26.79%	8.09%	21.22%	11.91%	9.39%	19.67%	8.81%	15.38%	8.24%	3.73%
	1102	1100	153	154		1102	1100	153	154	
1999	26.39%	3.46%	21.58%	10.33%	11.68%	17.44%	3.16%	16.53%	7.72%	5.48%
	1012	1009	177	175		1012	1009	177	175	
2000	26.99%	3.13%	23.64%	5.84%	6.05%	20.79%	1.86%	19.07%	2.97%	2.84%
	879	879	186	183		879	879	186	183	
2001	26.00%	4.95%	24.78%	5.96%	2.22%	19.25%	3.25%	21.34%	5.69%	0.35%
	784	778	163	160		784	778	163	160	
2002	25.03%	6.10%	20.92%	10.56%	8.57%	20.64%	4.51%	20.17%	7.16%	3.12%
				Mean	9.54%				Mean	7.12%

	Mean Debt to Total Asset (Book)				Difference of Differences Debt to Total Asset	Mean Debt to Total Asset (Market)				Difference of Differences Debt to Total Asset
	US		UK			US		UK		
	Q5	Q1	Q5	Q1		Q5	Q1	Q5	Q1	
Observations	205	206	81	81		205	206	81	81	
1992	26.91%	16.37%	20.90%	21.59%	11.24%	21.61%	11.91%	18.42%	21.56%	12.84%
	379	379	177	175		379	379	177	175	
1993	24.70%	16.45%	18.09%	17.46%	7.61%	18.98%	12.17%	14.57%	14.58%	6.81%
	628	625	188	186		628	625	188	186	
1994	23.25%	16.98%	16.68%	15.38%	4.97%	20.98%	14.37%	12.00%	12.69%	7.29%
	715	711	187	185		715	711	187	185	
1995	23.96%	17.19%	17.70%	16.99%	6.06%	20.04%	13.02%	13.55%	14.24%	7.71%
	829	824	188	188		829	824	188	188	
1996	24.59%	15.43%	18.91%	16.51%	6.76%	20.47%	11.83%	13.73%	13.00%	7.90%
	918	920	179	179		918	920	179	179	
1997	25.97%	17.92%	19.16%	14.56%	3.45%	20.11%	14.06%	14.75%	11.59%	2.89%
	1108	1115	166	167		1108	1115	166	167	
1998	27.68%	17.91%	21.37%	16.57%	4.96%	23.82%	18.11%	16.55%	13.82%	2.98%
	1102	1100	153	154		1102	1100	153	154	
1999	27.28%	14.29%	21.98%	16.43%	7.44%	22.52%	15.07%	17.70%	14.02%	3.78%
	1012	1009	177	175		1012	1009	177	175	
2000	27.47%	14.21%	22.58%	11.19%	1.87%	24.31%	13.65%	20.04%	9.41%	0.04%
	879	879	186	183		879	879	186	183	
2001	27.09%	15.79%	22.90%	11.87%	0.28%	23.85%	13.66%	21.42%	10.57%	-0.66%
	784	778	163	160		784	778	163	160	
2002	26.45%	16.61%	22.17%	14.11%	1.78%	24.84%	15.24%	21.45%	12.75%	0.91%
				Mean	5.13%				Mean	4.77%

Table 2: Difference of Differences Test: Intangibles

At the beginning of each year, all firms in US and UK are pooled and placed in quintiles based on their ratio of book value of Intangibles to book value of Assets. The leverage difference for a country is the difference between book Debt to Total Assets of high asset-specificity firms (Quintile 5) and that of low asset-specificity firms (Quintile 1) in the country. The difference of differences is calculated by subtracting the leverage difference of the UK from the leverage difference of the US. We use both mean and median leverages using both Debt to Total Book Assets and Debt to Total Market Assets.

	Median Debt to Total Asset (Book)				Difference of Differences Debt to Total Asset	Median Debt to Total Asset (Market)				Difference of Differences Debt to Total Asset
	US		UK			US		UK		
	Q5	Q1	Q5	Q1		Q5	Q1	Q5	Q1	
Observations	134	135	37	38		134	135	37	38	
1990	29.06%	22.52%	25.91%	17.48%	-1.88%	23.00%	19.73%	19.16%	16.20%	0.31%
	187	187	34	35		187	187	34	35	
1991	32.20%	19.56%	26.86%	17.92%	3.71%	20.15%	13.89%	20.34%	13.26%	-0.82%
	240	239	34	34		240	239	34	34	
1992	29.50%	19.29%	26.16%	16.23%	0.28%	17.65%	13.36%	20.36%	13.28%	-2.79%
	277	276	32	33		277	276	32	33	
1993	28.84%	17.80%	21.04%	15.55%	5.55%	16.78%	11.89%	13.91%	14.66%	5.64%
	426	426	32	33		426	426	32	33	
1994	24.80%	20.03%	22.75%	13.95%	-4.03%	15.21%	15.30%	14.11%	10.86%	-3.34%
	486	491	33	34		486	491	33	34	
1995	26.93%	18.54%	26.93%	16.21%	-2.34%	15.65%	13.36%	15.02%	9.83%	-2.90%
	570	568	47	47		570	568	47	47	
1996	26.66%	19.44%	22.63%	17.52%	2.11%	16.29%	13.70%	14.87%	9.73%	-2.55%
	653	656	54	54		653	656	54	54	
1997	29.53%	17.15%	15.20%	17.35%	14.54%	18.36%	12.26%	7.70%	8.61%	7.01%
	812	806	97	97		812	806	97	97	
1998	31.14%	16.24%	18.54%	19.20%	15.56%	21.30%	11.46%	12.14%	13.14%	10.83%
	819	820	145	148		819	820	145	148	
1999	27.75%	17.77%	17.28%	23.31%	16.01%	18.27%	10.24%	8.55%	17.24%	16.72%
	800	803	173	177		800	803	173	177	
2000	22.74%	14.12%	12.20%	16.65%	13.08%	18.42%	10.61%	4.70%	12.87%	15.98%
	736	734	184	187		736	734	184	187	
2001	24.84%	15.86%	11.49%	17.60%	15.09%	16.26%	10.27%	7.61%	14.79%	13.16%
	659	658	167	171		659	658	167	171	
2002	23.77%	15.85%	12.22%	18.24%	13.94%	16.63%	12.72%	10.33%	15.69%	9.27%
				Mean	7.05%				Mean	5.12%

	Median Debt to Total Asset (Book)				Difference of Differences Debt to Total Asset	Median Debt to Total Asset (Market)				Difference of Differences Debt to Total Asset
	US		UK			US		UK		
	Q5	Q1	Q5	Q1		Q5	Q1	Q5	Q1	
Observations	134	135	37	38		134	135	37	38	
1990	32.56%	24.03%	24.80%	17.33%	1.06%	27.58%	21.57%	22.12%	17.11%	0.99%
	187	187	34	35		187	187	34	35	
1991	33.01%	20.95%	22.59%	18.41%	7.88%	25.59%	17.79%	20.90%	17.00%	3.89%
	240	239	34	34		240	239	34	34	
1992	29.91%	21.60%	24.48%	15.47%	-0.70%	20.85%	17.26%	23.30%	14.69%	-5.02%
	277	276	32	33		277	276	32	33	
1993	29.10%	20.64%	21.99%	17.41%	3.88%	19.12%	16.78%	17.91%	15.55%	-0.02%
	426	426	32	33		426	426	32	33	
1994	26.52%	20.87%	19.82%	14.46%	0.29%	19.01%	19.66%	15.23%	10.93%	-4.95%
	486	491	33	34		486	491	33	34	
1995	28.38%	20.71%	22.14%	15.96%	1.48%	19.21%	18.41%	16.90%	12.17%	-3.93%
	570	568	47	47		570	568	47	47	
1996	28.04%	21.29%	21.92%	17.99%	2.82%	20.51%	18.48%	17.84%	13.84%	-1.97%
	653	656	54	54		653	656	54	54	
1997	30.73%	21.16%	19.19%	16.48%	6.87%	23.38%	18.13%	13.39%	12.15%	3.99%
	812	806	97	97		812	806	97	97	
1998	31.63%	21.08%	20.96%	20.42%	10.00%	25.19%	18.84%	15.38%	16.16%	7.13%
	819	820	145	148		819	820	145	148	
1999	28.80%	21.35%	20.62%	22.88%	9.71%	23.41%	18.68%	12.56%	18.96%	11.12%
	800	803	173	177		800	803	173	177	
2000	25.74%	20.55%	16.56%	19.36%	8.00%	23.89%	18.33%	10.68%	16.65%	11.53%
	736	734	184	187		736	734	184	187	
2001	26.70%	20.73%	16.11%	20.21%	10.06%	22.28%	18.23%	12.41%	17.62%	9.27%
	659	658	167	171		659	658	167	171	
2002	25.72%	20.23%	17.06%	20.96%	9.39%	20.91%	19.77%	15.10%	19.90%	5.94%
				Mean	5.44%				Mean	2.92%

value of 11.24% (12.84%).

Table 2 is constructed in an identical manner to Table 1 except that the quintiles are formed on the basis of Intangibles rather than on the basis of asset-specificity. The results are provided for the entire period 1990 to 2002 since Intangibles data is available from 1990 onwards for most firms in our sample. The time-series average of difference of differences is 7.05% (5.12%) when Median Debt to Book (Market) Assets is employed as the measure of leverage, and it is 5.44% (2.92%) when Mean Debt to Book (Market) Assets is employed as the measure of leverage. However, the difference of differences is not as uniformly positive over years as when asset-specificity is employed as a proxy for liquidation values.

To exploit more of the cross-sectional information, we perform a more "continuous" test: rather than use only quintiles 1 and 5, we examine the difference of differences computed using successive quintiles. That is, for $n = 5, 4, 3, 2$, we compute the difference in leverage between Quintiles n and $n-1$ in the US and the UK, and then compute the difference of these differences. These differences should all be positive under our theory.

Table 3 presents these inter-quintile difference of differences. The upper panel of the table is computed using asset-specificity as the proxy, and the lower panel using intangibles. For brevity, we only present the results for two measures of leverage Median Debt to Book Assets and Mean Debt to Book Assets.

Regardless of the measure of leverage (median or mean), the upper panel of Table 3 shows that the average over the sample period of the inter-quintile difference of differences is positive. Indeed, 34 out of 44 inter-quintile differences have the right sign, the exceptions arising mainly in the difference between quintile 2 and quintile 1. The results are similar, but slightly weaker, for intangibles. Again, the average of the inter-quintile differences over the sample period is positive except for the difference between quintile 2 and quintile 1. The fraction of inter-quintile differences with the correct sign (35 out of 52 differences) is smaller than in the case of asset-specificity.

These results lend empirical support to our theory that the effect of bankruptcy codes on capital structures should interact with the anticipated liquidation values of firms. It should also be noted that the magnitude of difference of differences in Tables 1–4 between the extreme quintiles, quintile 5 and quintile 1, is substantial and economically important. It is comparable to the overall difference of 7.00% (4.00%) in median Debt to Book (Market) Assets between the US and the UK (Table III, Panel A).[8] This demonstrates that the implications of our theory for cross-country capital-structure patterns are economically important.

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[8]One potential concern is that the variation in capital structures in the US is larger than that in the UK, and that therefore, the difference of differences we compute is positive due to a purely mechanical reason. To verify that this is not driving our results, we have also computed the difference of differences as $[F_{US}(\alpha_l)/F_{US}(\alpha_h)] - [F_{UK}(\alpha_l)/F_{UK}(\alpha_h)]$. This measure of difference of differences (between the extreme quintiles) is also generally positive over the sample period.

Table 3: Inter-Quintile Difference of Differences Tests

At the beginning of each year, all firms in US and UK are pooled and placed in quintiles based on their specificity (ratio of book value of Machinery and Equipment to book value of Assets) or intangibility (ratio of book value of Intangibles to book value of Assets. The inter-quintile leverage difference for a country is the difference between Book Debt to Total Assets of high asset-specificity or high intangibles firms (Quintile n) and that of low asset-specificity or low intangibles firms (Quintile $n-1$) in that country. The difference of differences is calculated by subtracting the inter-quintile leverage difference of the UK from the leverage difference of the US. Leverage is computed using both mean and median Debt to Total Book Assets.

Panel A: Inter-quintile difference of differences based on Asset Specificity

	Median Debt to Total Assets (Book)					Mean Debt to Total Assets (Book)				
	Q5 - Q1	Q5 - Q4	Q4 - Q3	Q3 - Q2	Q2 - Q1	Q5 - Q1	Q5 - Q4	Q4 - Q3	Q3 - Q2	Q2 - Q1
1992	14.41%	-1.77%	8.12%	3.01%	5.06%	11.24%	-0.97%	4.12%	2.34%	5.75%
1993	11.23%	2.39%	2.54%	6.38%	-0.09%	7.61%	1.18%	2.06%	2.62%	1.75%
1994	8.19%	1.33%	1.53%	6.68%	-1.35%	4.97%	-0.14%	3.41%	2.00%	-0.30%
1995	12.74%	2.33%	-1.08%	6.53%	4.96%	6.06%	0.16%	1.37%	2.46%	2.07%
1996	13.43%	1.01%	3.58%	3.69%	5.16%	6.76%	-0.43%	3.53%	0.45%	3.21%
1997	6.99%	2.82%	6.69%	1.82%	-4.34%	3.45%	1.05%	3.97%	0.60%	-2.18%
1998	9.39%	3.22%	3.20%	0.07%	2.90%	4.96%	1.91%	1.68%	-0.52%	1.90%
1999	11.68%	2.29%	2.17%	6.90%	0.31%	7.44%	1.60%	1.28%	2.81%	1.75%
2000	6.05%	0.12%	3.30%	3.87%	-1.24%	1.87%	1.73%	1.03%	0.99%	-1.89%
2001	2.22%	-1.00%	-0.22%	6.56%	-3.12%	0.28%	1.93%	-0.13%	3.27%	-4.79%
2002	8.57%	0.48%	5.35%	-1.88%	4.62%	1.78%	1.18%	2.65%	-0.30%	-1.75%
Mean	**9.54%**	**1.20%**	**3.20%**	**3.97%**	**1.17%**	**5.13%**	**0.84%**	**2.27%**	**1.52%**	**0.50%**

Panel B: Inter-quintile difference of differences based on Intangibles

	Median Debt to Total Assets (Book)					Mean Debt to Total Assets (Book)				
	Q5 - Q1	Q5 - Q4	Q4 - Q3	Q3 - Q2	Q2 - Q1	Q5 - Q1	Q5 - Q4	Q4 - Q3	Q3 - Q2	Q2 - Q1
1990	-1.88%	-1.45%	0.83%	6.86%	-8.13%	1.06%	2.45%	2.47%	4.73%	-8.59%
1991	3.71%	3.21%	1.42%	-4.68%	3.76%	7.88%	9.73%	-1.47%	-1.33%	0.95%
1992	0.28%	7.19%	-2.56%	2.91%	-7.26%	-0.70%	7.78%	-2.21%	0.29%	-6.56%
1993	5.55%	10.52%	-1.89%	-2.29%	-0.78%	3.88%	7.44%	-2.18%	-0.42%	-0.95%
1994	-4.03%	-3.15%	5.72%	1.79%	-8.39%	0.29%	2.29%	3.14%	-0.22%	-4.91%
1995	-2.34%	-5.95%	0.08%	6.53%	-3.00%	1.48%	0.31%	-0.48%	2.75%	-1.10%
1996	2.11%	-1.59%	6.26%	-3.04%	0.48%	2.82%	0.32%	1.42%	0.72%	0.35%
1997	14.54%	6.60%	4.30%	7.49%	-3.84%	6.87%	2.94%	5.96%	1.36%	-3.40%
1998	15.56%	8.13%	2.41%	1.81%	3.22%	10.00%	5.30%	1.06%	3.47%	0.18%
1999	16.01%	3.76%	3.34%	5.49%	3.42%	9.71%	1.78%	2.31%	3.84%	1.79%
2000	13.08%	4.21%	8.80%	-0.34%	0.41%	8.00%	3.50%	5.23%	-1.32%	0.60%
2001	15.09%	8.17%	6.88%	1.72%	-1.68%	10.06%	5.78%	4.73%	0.51%	-0.96%
2002	13.94%	7.98%	1.70%	3.68%	0.57%	9.39%	5.32%	2.22%	0.97%	0.87%
Mean	**7.05%**	**3.66%**	**2.87%**	**2.15%**	**-1.63%**	**5.44%**	**4.23%**	**1.71%**	**1.18%**	**-1.67%**

27

6.2   Robustness Checks

We perform three checks concerning the robustness of these conclusions.

As a first check, we subtract Cash and Cash Equivalents from a firm's leverage in order to compute Net Debt to Book Assets and Net Debt to Market Assets. This correction may be important if firms "undo" the bankruptcy codes by managing cash reserves rather than by (or in addition to) altering the choice of direct leverage. For instance, a firm with high asset-specificity in the UK can reduce expected costs of bankruptcy by keeping high cash reserves.

Table 4 illustrates that the results are in fact stronger with leverage net of cash, consistent with the idea that firms can retain cash reserves (as a substitute for lowering debt) in order to avoid costly bankruptcy. Using Net Debt to Book Assets as the measure of leverage, the time-series average of the difference of differences using quintile 5 and quintile 1 on the basis of asset-specificity is 23.21% (21.02%) for median (mean) leverage. The corresponding numbers for the classification based on Intangibles are 15.30% (18.09%).

Importantly, the difference of differences is now almost uniformly positive over the sample period for *both* proxies. This suggests that violations of the theory observed to some extent for results with Intangibles (Table 2) may be due to the omission of cash in measuring the true leverage of the firm. Examining the data closely revealed that the reason for this is that firms in the UK with high Intangibles carry cash levels that are high enough to in fact leave them with negative levels of net debt. When we truncate negative values of Net Debt to zero, the difference of differences is somewhat smaller but remains almost uniformly positive for both classifications.

Our second robustness check is perhaps our most important. It consists of ensuring that characteristics other than our proxy for liquidation values are not driving our results. A large body of empirical literature has identified a set of cross-sectional determinants that affect corporate capital structures. While some of these effects have been recently attributed to mechanical relationships arising from stickiness in capital-structure changes (Strebulaev, 2003, Hennessy and Whited, 2004), we take these determinants on face value and check if our results are affected when we control for their effect. In particular, we use the four determinants also employed by Rajan and Zingales (1995): (a) Tangibility defined as the book value of Property, Plant and Equipments (PPE) or fixed assets divided by the book value of total assets, (b) Market-to-book defined as the ratio of the book value of assets less the book value of equity plus the market value of equity all divided by the book value of assets, (c) Logsale defined as the logarithm of net sales, and (d) Profitability defined as EBITDA divided by book value of assets.

We control for these capital-structure determinants through a matching procedure. We employ the procedures in Heckman, Ichimura and Todd (1997, 1998) in order to match each firm in the US (treatment sample) in a given year to firms in UK (control sample) for that year, where the matching is based on the four determinants described above plus the proxy for liquidation

Table 4: Robustness Check 1: Difference of Differences Using Net Debt

As in previous tables, all firms in US and UK are pooled and placed in quintiles based on their asset-specificity or intangibles. We use both mean and median leverages using both Debt to Total Book Assets and Debt to Total Market Assets, but subtract Cash and Cash equivalents in order to obtain a measure of net leverage. We also report results where the negative values of net leverage are truncated to zero. The net-leverage difference for a country is the difference between book Debt to Total Assets of high asset-specificity or high intangibles firms (Quintile 5) and that of low asset-specificity or low intangibles firms (Quintile 1) in the country. The difference of differences is calculated by subtracting the net-leverage difference of the UK from the net-leverage difference of the US.

	Liquidation costs proxied by Asset Specificity				Liquidation costs proxied by Intangibles			
	Median leverage		Mean leverage		Median leverage		Mean leverage	
	Cash as negative debt	Net debt truncated at zero	Cash as negative debt	Net debt truncated at zero	Cash as negative debt	Net debt truncated at zero	Cash as negative debt	Net debt truncated at zero
1990					23.50%	23.50%	20.93%	15.90%
1991	31.73%	-2.20%	26.22%	-0.36%	19.36%	19.36%	22.36%	12.40%
1992	31.14%	13.02%	33.80%	11.63%	6.00%	6.00%	12.20%	5.60%
1993	22.23%	12.18%	22.17%	7.81%	4.54%	4.54%	13.06%	3.57%
1994	11.64%	5.36%	15.64%	5.52%	2.06%	2.06%	12.53%	4.39%
1995	21.11%	13.06%	21.22%	7.70%	-0.15%	-0.15%	8.52%	1.59%
1996	29.23%	9.76%	26.82%	7.56%	2.34%	2.34%	9.68%	1.26%
1997	22.00%	8.89%	19.90%	5.11%	17.80%	17.80%	21.18%	10.68%
1998	21.97%	12.73%	22.60%	6.44%	22.72%	22.72%	25.18%	10.92%
1999	36.27%	8.07%	32.59%	8.75%	24.44%	24.44%	26.77%	10.12%
2000	19.78%	2.29%	11.05%	3.01%	29.37%	29.33%	21.83%	9.89%
2001	13.16%	-0.60%	6.11%	-0.25%	24.47%	24.47%	19.77%	11.55%
2002	18.26%	1.54%	14.16%	0.64%	22.45%	22.45%	21.23%	11.18%
Mean	**23.21%**	**7.01%**	**21.02%**	**5.30%**	**15.30%**	**15.30%**	**18.09%**	**8.39%**

values (either asset-specificity or intangibles). We employ two algorithms suggested by Heckman et al. for determining the weights on the matched sample of UK firms: the Near Neighbour technique where we employ ten nearest neighbouring firms in the UK to form the control sample for each treated firm in the US, and the Local Linear technique where a "composite" UK firm is created from the neighbouring firms for each treated firm in the US. The difference in leverage is then computed between a US firm and its matched sample of UK firms. The US firms are then sorted into quintiles on the basis of their asset-specificity or Intangibles. Finally, inter-quintile difference of differences is computed for each pair of successive quintiles and also between quintile 5 and quintile 1.

The results from this matching exercise are presented in Table 5. We only report results that employ Debt to Book Assets as the measure of leverage. The comparison of these numbers to earlier ones shows that controlling for the other determinants of capital structure *strengthens* support for our theory. The difference of differences between quintile 5 and quintile 1 has an average value over the sample period of 8.53% (8.27%) for the Near Neighbour (Local Linear) matching when asset-specificity is used to form quintiles. The corresponding values are 5.34% (4.46%) when Intangibles are used to form quintiles. These values are similar to the values obtained in Tables 1 and 2 where we did not control for other determinants of leverage.

Importantly, the inter-quintile differences continue to have the right sign as well (except the quintile 2 to quintile 1 difference for Intangibles). The magnitudes of these inter-quintile differences are similar to those in Tables 3 and 4, but there are fewer violations of the theory in that negative entries occur in only 4 to 5 out of 44 observations for the asset-specificity results,

Table 5: Robustness Check 2: Controlling for Other Factors

At the beginning of each year, each firm in the US is matched to firms in the UK based on the Near-neighbour and Local-linear matching techniques of Heckman, Ichimura and Todd (1997, 1998). The matching is based on Tangibility, Profitability, Log Sales, and Market-to-Book (see Rajan and Zingales, 1995), and either Asset-Specificity or Intangibility. Next, firms in the US are placed in quintiles based on their asset-specificity or intangibles. The inter-quintile leverage difference for the US is the difference between book Debt to Total Assets of high asset-specificity or high intangibles firms (Quintile n) and that of low asset-specificity or low intangibles firms (Quintile $n-1$) in the country. For UK, the leverage difference is computed using the matched firms for the US firms in Quintile n and Quintile $n-1$. The difference of differences is calculated by subtracting the inter-quintile leverage difference of the UK from the leverage difference of the US. We use mean and median leverages using Debt to Total Book Assets.

Liquidation costs proxied by Asset Specificity

Near Neighbour (10 Nearest) matching / **Local Linear matching**

	Q5-Q1	Q5-Q4	Q4-Q3	Q3-Q2	Q2-Q1		Q5-Q1	Q5-Q4	Q4-Q3	Q3-Q2	Q2-Q1
	Difference of difference						Difference of difference				
1992	11.13%	0.70%	4.16%	2.40%	3.87%	1992					
1993	8.24%	1.33%	3.55%	-0.06%	3.41%	1993	6.81%	-0.07%	3.84%	-0.70%	3.73%
1994	6.63%	0.89%	2.74%	2.20%	0.81%	1994	6.62%	0.90%	2.72%	2.03%	0.97%
1995	7.77%	2.05%	2.22%	2.34%	1.16%	1995	7.54%	1.82%	2.41%	2.04%	1.27%
1996	9.24%	1.91%	3.21%	2.99%	1.13%	1996	9.34%	1.79%	3.57%	2.93%	1.05%
1997	7.40%	3.31%	4.05%	2.30%	-2.26%	1997	7.64%	3.41%	4.13%	2.29%	-2.19%
1998	7.37%	4.01%	2.35%	1.47%	-0.45%	1998	7.70%	4.25%	2.40%	1.64%	-0.58%
1999	9.06%	2.74%	1.76%	2.99%	1.57%	1999	9.30%	2.59%	2.04%	2.78%	1.89%
2000	12.08%	3.01%	4.51%	3.17%	1.40%	2000	12.30%	3.10%	4.68%	3.00%	1.51%
2001	8.29%	3.43%	2.34%	3.67%	-1.16%	2001	8.44%	3.49%	2.65%	3.55%	-1.24%
2002	6.65%	3.21%	2.65%	3.46%	-2.67%	2002	7.00%	3.60%	2.65%	3.27%	-2.52%
Mean	**8.53%**	**2.42%**	**3.05%**	**2.45%**	**0.62%**	**Mean**	**8.27%**	**2.49%**	**3.11%**	**2.28%**	**0.39%**

Liquidation costs proxied by Intangibles

Near Neighbour (10 Nearest) matching / **Local Linear matching**

	Q5-Q1	Q5-Q4	Q4-Q3	Q3-Q2	Q2-Q1		Q5-Q1	Q5-Q4	Q4-Q3	Q3-Q2	Q2-Q1
	Difference of difference						Difference of difference				
1992	7.55%	5.99%	1.32%	0.17%	0.07%	1992					
1993	4.14%	5.27%	-1.27%	0.02%	0.12%	1993	1.50%	4.25%	-2.06%	-0.76%	0.08%
1994	3.00%	4.56%	-0.63%	0.01%	-0.93%	1994	2.33%	3.87%	-0.61%	-0.38%	-0.55%
1995	3.33%	2.10%	1.06%	-0.72%	0.90%	1995	2.81%	2.22%	0.51%	-0.78%	0.86%
1996	2.41%	0.59%	1.51%	0.71%	-0.41%	1996	0.93%	0.63%	0.66%	0.62%	-0.98%
1997	6.87%	3.83%	3.20%	1.33%	-1.49%	1997	5.39%	3.14%	2.59%	1.01%	-1.35%
1998	8.08%	3.00%	3.58%	1.41%	0.10%	1998	7.43%	2.41%	3.74%	1.51%	-0.22%
1999	6.42%	1.28%	2.49%	4.87%	-2.22%	1999	7.18%	1.73%	2.31%	4.95%	-1.81%
2000	4.40%	1.14%	3.32%	0.78%	-0.84%	2000	4.30%	1.24%	3.14%	0.52%	-0.60%
2001	6.83%	3.77%	2.73%	0.45%	-0.13%	2001	7.06%	3.72%	2.79%	0.58%	-0.03%
2002	5.67%	3.07%	2.07%	0.94%	-0.41%	2002	5.69%	2.62%	2.56%	1.03%	-0.53%
Mean	**5.34%**	**3.15%**	**1.76%**	**0.91%**	**-0.48%**	**Mean**	**4.46%**	**2.58%**	**1.56%**	**0.83%**	**-0.51%**

and only 10 out of 44 observations for the results with Intangibles.

This suggests that controlling for determinants of capital structure other than our two proxies for liquidation values produces results that are more in line with our theoretical predictions. Figures 2 and 6 graph these numbers. In Figure 2, we plot the time-series difference of differences between quintiles 5 and 1. The two differences are significantly positive, particularly for asset-specificity. In Figure 6, we plot directly the result for the main test of the theory that the difference in leverage between the US and the UK should decrease with liquidation values, that is, increase in our proxies. In particular, we plot the difference in leverage between the US and the UK for quintiles 1 through 5, and illustrate that the plot is increasing for both proxies of liquidation values.

Figure 6: Difference in Leverage between the US and the UK: Cross-sectional Behavior

This figure plots the average difference in leverage between the US and the UK for quintiles 1 through 5 for the two proxies (asset-specificity and intangibles). The data corresponds to the differences in leverage between the US and the UK used to compute the difference of differences reported in Table 5.
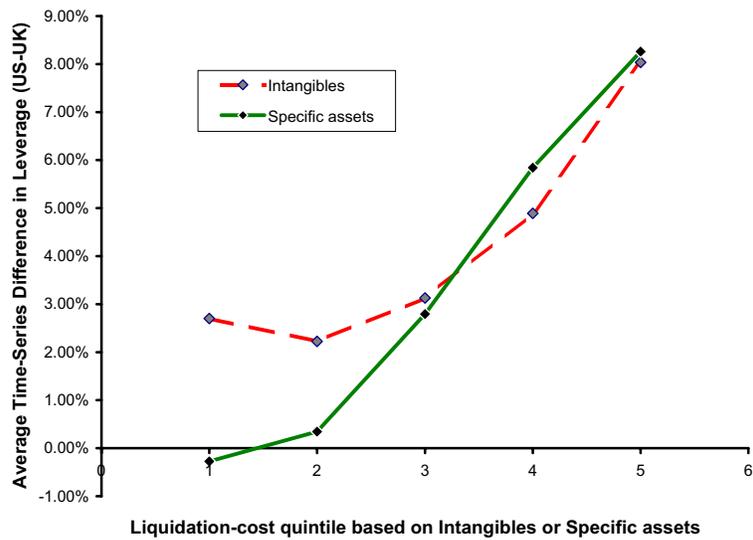
Finally, we provide evidence that the results we obtained for asset-specificity generalize also at the level of industries. We do not conduct this exercise for Intangibles since fraction of assets that are intangible, e.g., goodwill, is more of a firm-specific characteristic, whereas the specificity of assets is more of an industry characteristic. An advantage of the industry-level aggregation in results is that it reduces to an extent any bias in our tests introduced by managerial influence on capital structures (for reasons such as market-timing, as in Baker and Wurgler, 2002).

We classify firms into eight industries based on the SIC codes as in Dyck and Zingales (2001). The eight industries are (i) Agriculture, Forestry, and Fishing (SIC codes 01–09), (ii) Mining (10–14), (iii) Construction (15–17), (iv) Manufacturing (20–39), (v) Transportation and Public Utilities (40–49), (vi) Wholesale Trade (50–51), (vii) Retail Trade (52–59), and (viii) Services (70–89). As before, we compute the median asset-specificity for each of the eight industries using the book value of machinery and equipment divided by book value of total assets. In addition, we also compute the median ratio of specific assets to non-specific assets (at the industry level as well as at firm level), where non-specific assets are defined as the ratio of cash and equivalents plus land divided by book value of total assets (as in Stromberg, 2000). We sort industries on the basis of median asset-specificity and also on the basis of median ratio of specific to non-specific assets.[9]

The sorting reveals that Mining, Transportation and Public Utilities, and Manufacturing have the highest specific assets: 60%, 38%, and 26%, respectively, for the US, and 17%, 24%, and 36%, respectively, for the UK. Wholesale has the lowest Specific Assets in the US (12%) and Construction has the lowest Specific Assets in the UK (9%). When sorted by the ratio of specific assets to non-specific Assets, we find that Mining, Transportation and Public Utilities, and Manufacturing are always in the top four ranks for both the US and the UK, whereas Wholesale, Construction, and Services are in the bottom four ranks for all the sorts within US and in the bottom four or five for all the sorts in the UK.

Based on these results, we identify two categories of industries. Industries with high asset-specificity are Mining, Transportation, and Manufacturing, and industries with low asset-specificity are Wholesale, Construction, and Services. The other two groups, Agriculture, Forestry, and Fishing, and Retail generally have low asset-specificity. However, we do not include them since Agriculture, Forestry, and Fishing has very few observations throughout the sample period and the rank of Retail into high or low asset-specificity is the least stable amongst all industries (details not reported but available upon request).

In Table 6, we report the difference of differences between the US and the UK, and between the high-specificity and the low-specificity industries. We find the time-series average of difference

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[9]Our classification of the data does not appear to hinge on these particular definitions. For example, if we include intangibles as part of the specific assets, and if we include receivables in the non-specific assets, our results are little affected.

Table 6: Robustness Check 3: Difference of Differences at Industry Level

High asset-specificity industries include Mining, Transportation and public utilities, and Manufacturing. Low asset-specificity industries include Wholesale, Construction, and Services. Industry classification is based on the two-digit SIC code as adopted by Dyck and Zingales (2001). The leverage difference for a country is the difference of book debt to total assets of high asset-specificity industries and that of low asset-specificity industries in the country. The difference of differences is calculated by subtracting the leverage difference of the UK from the leverage difference of the US. We use both mean and median leverages using both Debt to Total Book Assets and Debt to Total market Assets.

	Median Debt to Total Asset (Book)				US-UK, High-Low Diff of Diff Debt to Total Asset	Median Debt to Total Asset (Market)				US-UK, High-Low Diff of Diff Debt to Total Asset
	US		UK			US		UK		
	High	Low	High	Low		High	Low	High	Low	
Observations	1447	467	659	383		1448	468	660	383	
1990	26.46%	23.28%	18.38%	17.64%	2.43%	22.15%	19.37%	15.36%	14.67%	2.09%
	1595	551	664	379		1596	552	665	379	
1991	25.42%	20.02%	18.77%	17.88%	4.50%	18.69%	14.54%	15.19%	13.84%	2.80%
	1662	594	642	370		1663	595	642	370	
1992	23.92%	16.76%	19.11%	17.91%	5.96%	16.53%	10.30%	15.02%	13.24%	4.45%
	1772	656	650	366		1773	658	650	366	
1993	22.35%	15.71%	17.81%	14.54%	3.37%	14.54%	8.79%	11.92%	10.56%	4.39%
	2717	1074	659	387		2719	1074	659	387	
1994	21.32%	13.90%	16.40%	13.36%	4.38%	15.47%	9.10%	10.68%	8.66%	4.35%
	2993	1273	654	373		2996	1275	654	373	
1995	21.59%	13.62%	17.13%	14.11%	4.94%	14.21%	6.86%	11.55%	9.15%	4.95%
	3332	1604	731	531		3334	1610	731	531	
1996	20.90%	10.77%	16.76%	14.31%	7.68%	13.16%	5.42%	10.39%	9.24%	6.59%
	3575	1939	751	571		3578	1943	751	571	
1997	21.07%	10.79%	16.91%	11.64%	5.02%	12.95%	6.12%	10.75%	7.06%	3.14%
	4117	2452	685	548		4118	2460	685	548	
1998	22.18%	10.64%	18.15%	13.36%	6.74%	15.86%	6.95%	12.40%	7.77%	4.28%
	3891	2439	629	552		3896	2443	629	552	
1999	22.39%	7.79%	18.53%	11.80%	7.87%	15.23%	3.95%	12.53%	7.08%	5.83%
	3539	2189	581	616		3545	2195	581	616	
2000	21.19%	8.00%	17.31%	8.19%	4.07%	14.87%	5.13%	11.21%	4.46%	2.98%
	3174	1844	583	630		3184	1855	583	630	
2001	21.79%	8.02%	16.72%	10.49%	7.55%	14.85%	4.54%	12.87%	6.53%	3.96%
	2853	1590	524	550		2859	1606	524	550	
2002	21.61%	9.06%	15.67%	9.55%	6.43%	16.41%	6.38%	13.43%	6.79%	3.39%
				Mean	5.46%					4.09%

	Mean Debt to Total Asset (Book)				US-UK, High-Low Diff of Diff Debt to Total Asset	Mean Debt to Total Asset (Market)				US-UK, High-Low Diff of Diff Debt to Total Asset
	US		UK			US		UK		
	High	Low	High	Low		High	Low	High	Low	
Observations	1447	467	659	383		1448	468	660	383	
1990	26.48%	25.18%	19.27%	19.70%	1.74%	24.07%	23.60%	17.18%	17.51%	0.80%
	1595	551	664	379		1596	552	665	379	
1991	25.47%	23.31%	19.86%	20.14%	2.43%	21.32%	19.81%	17.47%	18.19%	2.23%
	1662	594	642	370		1663	595	642	370	
1992	24.28%	21.20%	19.92%	19.60%	2.75%	19.39%	17.46%	17.60%	18.22%	2.54%
	1772	656	650	366		1773	658	650	366	
1993	22.98%	20.38%	18.83%	17.69%	1.46%	17.54%	15.91%	14.99%	14.34%	0.99%
	2717	1074	659	387		2719	1074	659	387	
1994	22.15%	18.81%	17.55%	15.54%	1.33%	19.41%	15.74%	12.99%	11.74%	2.41%
	2993	1273	654	373		2996	1275	654	373	
1995	22.58%	19.22%	18.09%	15.71%	0.99%	18.10%	14.97%	13.77%	12.21%	1.57%
	3332	1604	731	531		3334	1610	731	531	
1996	22.41%	17.97%	17.80%	16.41%	3.05%	17.66%	14.69%	13.22%	13.46%	3.21%
	3575	1939	751	571		3578	1943	751	571	
1997	22.90%	18.65%	17.65%	15.78%	2.39%	17.86%	15.03%	13.23%	11.91%	1.52%
	4117	2452	685	548		4118	2460	685	548	
1998	24.05%	18.62%	18.76%	16.68%	3.35%	20.56%	16.85%	14.67%	12.44%	1.49%
	3891	2439	629	552		3896	2443	629	552	
1999	24.10%	17.62%	19.81%	16.23%	2.89%	20.32%	15.17%	15.44%	12.80%	2.52%
	3539	2189	581	616		3545	2195	581	616	
2000	23.20%	17.27%	18.93%	14.02%	1.02%	20.24%	15.76%	14.97%	10.89%	0.39%
	3174	1844	583	630		3184	1855	583	630	
2001	23.48%	16.77%	19.22%	14.75%	2.24%	19.78%	14.05%	16.65%	12.07%	1.15%
	2853	1590	524	550		2859	1606	524	550	
2002	23.04%	16.78%	18.82%	15.27%	2.72%	20.77%	13.54%	16.93%	13.55%	3.86%
				Mean	2.18%					1.90%

of differences is 5.46% (4.09%) when median Debt to Book (Market) Assets is employed as the measure of leverage for each group of industries. The time-series average of difference of differences based on mean leverage is 2.18% (1.90%) for Debt to Book (Market) Assets. Both the difference of differences are uniformly positive throughout the sample period. These results lend further support to the important role played by bankruptcy codes in explaining the pattern of leverage between the US and the UK when firms are examined cross-sectionally on the basis of anticipated liquidation values.

7   Conclusion

This paper has made two contributions. The first is a theoretical model relating a firm's capital structure choice to the bankruptcy code under which a firm operates. To our knowledge, this is the first such model in the literature. The theory indicates that a key factor influencing capital structure choice is a firm's anticipated liquidation value. More precisely, it predicts that firms with low liquidation values will employ greater leverage under a bankruptcy code that favors equity-holders (an "equity-friendly system" or EFS) than under one that favors debt holders (a "debt-friendly system" or DFS); and that the difference in optimal debt levels under EFS and DFS should itself be a decreasing function of the degree of liquidation values.

The paper's second contribution lies in testing the theoretical prediction using data from the US (a country with an equity-friendly bankruptcy code) and the UK (which has a debt-friendly code). We find the data backs the theory strongly. In particular, the difference between leverage ratios in the two countries depends on anticipated liquidation values in the manner predicted by the theory.

Several future directions of investigation are indicated by these results. Some of the issues that need further study are asymmetric information between equity- and debt-holders, the role of managers, and the possibility of renegotiation in bankruptcy. On the empirical front, a theoretical model encompassing some of these issues would enable extending the analysis to data from other countries whose codes cannot easily be classified currently.

A Agency Costs and Equilibrium Firm Values

In this section, we compare ex-ante firm values resulting from the optimal capital structures choices in the two codes (DFS and EFS). From equation (11), the firm value under DFS at the optimal capital structure $F^*_{DFS}(\alpha)$ is

$$V^*_{DFS}(\alpha) = \overline{V} - \frac{1}{H} \left\{ \int_F^H \tau(x - F)\, dx + \frac{1}{2} \int_{x^*}^F (\overline{q}L - \alpha)\, x\, dx \right\}, \tag{22}$$

with $\overline{V}$ as in equation (10), x^* defined as in Lemma 1, and F, of course, being set equal to $F^*_{DFS}(\alpha)$. Evaluating this expression yields

$$V^*_{DFS}(\alpha) = \overline{V} - \frac{\tau}{2H}\left[H - F^*_{DFS}(\alpha)\right]^2 - \frac{(\overline{q}L - \alpha)}{4H}\left[(F^*_{DFS}(\alpha))^2 - (x^*)^2\right]. \tag{23}$$

The middle term on the right-hand side measures the impact of taxes (including the anticipated tax savings from debt), while the last term captures the agency cost from inefficient liquidations under DFS.

The equilibrium firm value in the EFS case has a similar representation. From equation (16), we obtain the firm value under EFS at the optimal capital structure $F^*_{EFS}(\alpha)$ as

$$V^*_{EFS}(\alpha) = \overline{V} - \frac{1}{H} \left\{ \int_F^H \tau(x - F)\, dx + \frac{1}{2} \int_{x_1^*}^{x_2^*} (\alpha - \underline{q}L)\, x\, dx \right\}, \tag{24}$$

where x_1^* and x_2^* are defined in Lemma 2, and F is set to $F^*_{EFS}(\alpha)$. Evaluating this expression yields

$$V^*_{EFS}(\alpha) = \overline{V} - \frac{\tau}{2H}\left[H - F^*_{EFS}(\alpha)\right]^2 - \frac{(\alpha - \underline{q}L)}{4H}\left[(x_2^*)^2 - (x_1^*)^2\right]. \tag{25}$$

Once again, the middle term captures the anticipated tax savings from debt while the last term represents the agency cost from inefficient continuations under EFS.

Figure 7: Ex-Ante Firm Value Comparison

This figure plots the ex-ante firm values under the two bankruptcy codes for the same parameter values as used in Figure 1. The ex-ante firm values are V_{DFS} and V_{EFS}, respectively. The firm values under the codes after removing agency costs (i.e., after removing the impact of deadweightlosses from inefficient continuation/liquidation decisions) are also reported.
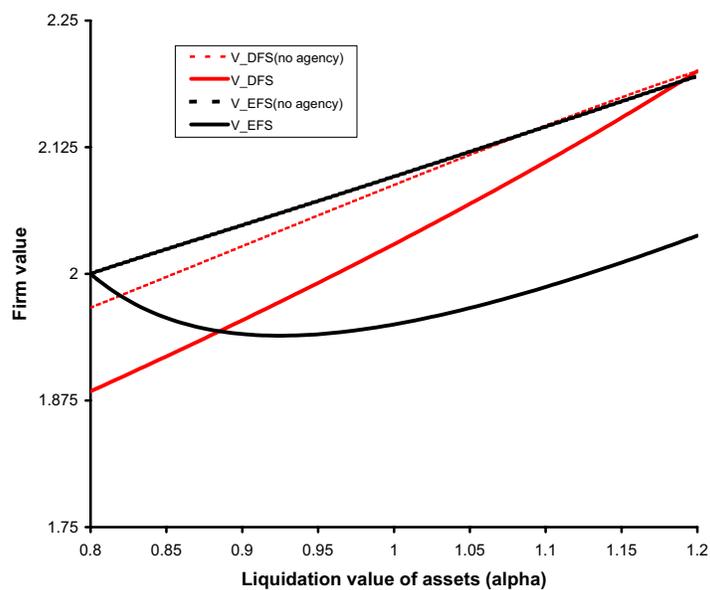
Comparing the last terms of (23) and (25), the agency costs of inefficient continuation are lower under DFS than under EFS if and only if

$$(\bar{q}L - \alpha) \left[(F_{DFS}^*(\alpha))^2 - (x^*)^2 \right] \; < \; (\alpha - \underline{q}L) \left[(x_2^*)^2 - (x_1^*)^2 \right]. \tag{26}$$

Of course, a higher level of agency costs does not automatically translate to a lower firm value since there are also the tax savings from debt; this is the middle term in (23) and (25). Equilibrium firm values under DFS are higher than those under EFS if and only if

$$
\begin{aligned}
2\tau \left[H - F_{DFS}^*(\alpha) \right]^2 \; &+ \; (\bar{q}L - \alpha) \left[(F_{DFS}^*(\alpha))^2 - (x^*)^2 \right] \\
&< \; 2\tau \left[H - F_{EFS}^*(\alpha) \right]^2 + (\alpha - \underline{q}L) \left[(x_2^*)^2 - (x_1^*)^2 \right].
\end{aligned}
\tag{27}
$$

These expressions are too complex to analyze analytically, so we investigate them numerically (see Figure 7. The figure shows exactly what one would expect intuitively: that at low liquidation values firm value is higher under an EFS, but at high liquidation values it is higher under a DFS.

B Proof of Lemma 1

Expression (7) in the text provides the inequality that determines if creditors continue or liquidate the firm under a DFS when the firm is in distress $(x < F)$. The lemma is established by examining (7) for a series of cases.

Case 1 $(F - x) \leq \alpha x < Lx$, i.e., $x \geq F/[1 + \alpha]$.

In this case, creditors receive $F - x$ in the state Lx under continuation and nothing in the other state for an expected value of $q(F - x)$. They also receive $F - x$ for certain under liquidation. Thus, creditors choose to liquidate in this case for both $q = \bar{q}$ and $q = \underline{q}$.

Case 2 $\alpha x < (F - x) \leq Lx$, i.e., $F/[1 + L] \leq x < F/[1 + \alpha]$.

In this case, creditors receive αx under liquidation, while under continuation, they receive $F - x$ in the state Lx and nothing otherwise. Thus, creditors choose to continue if and only if $q(F - x) > \alpha x$, i.e., if and only if

$$x \; < \; \frac{qF}{q + \alpha}. \tag{28}$$

If $q = \underline{q}$, we have

$$\frac{qF}{q+\alpha} < \frac{F}{1+L}. \tag{29}$$

Since the right-hand side of (29) is the lowest admissible value of x in this case, this means there is no value of x here that satisfies (28). This means creditors always liquidate the firm for $q = \underline{q}$.

When $q = \overline{q}$, we have

$$\frac{qF}{q+\alpha} > \frac{F}{1+L} \tag{30}$$

from our assumption that $\overline{q}L > \alpha$. This means there are values of x that satisfy (28). In particular, creditors choose to continue the firm for

$$x \in \left[\frac{F}{1+L}, \frac{\overline{q}F}{\overline{q}+\alpha}\right),$$

and they choose to liquidate the firm for

$$x \in \left[\frac{\overline{q}F}{\overline{q}+\alpha}, \frac{F}{1+\alpha}\right).$$

Case 3 $\alpha x < Lx < (F - x)$, i.e., $x < F/[1+L]$.

In this case, creditors receive αx under liquidation, while under continuation, they receive Lx in the state x and nothing otherwise. Then, creditors continue the firm if and only if $qLx > \alpha x$ or, what is the same thing, if and only if $q = \overline{q}$. Thus, for $q = \overline{q}$, there is continuation for $x \in [0, F/[1+L])$ and for $q = \underline{q}$ there is liquidation over this region.

C Proof of Lemma 2

Once again, we consider three regions of x.

Case 1 $(F - x) \leq \alpha x < Lx$, i.e., $x \geq F/[1+\alpha]$

In this case, equityholders receive positive payoffs under both liquidation and under continuation. They choose to continue iff

$$q\left[Lx - (F - x)\right] > \left[\alpha x - (F - x)\right],$$

that is, if and only if

$$x < x_2^*, \tag{31}$$

where, as in the statement of Lemma 2, we define

$$x_2^* = \frac{F}{1 + \left(\frac{\alpha - qL}{1 - q}\right)}.$$

When $q = \bar{q}$, we have $qL > \alpha$. In this case, $x < F$ implies (31) necessarily holds, so equityholders always choose to continue.

When $q = \underline{q}$, we have $qL < \alpha$. Moreover, $\alpha < L$, so $\left[(\alpha - qL)/(1 - q)\right] < \alpha$. This implies

$$\frac{F}{1 + \alpha} < x_2^*.$$

Thus, equityholders liquidate the firm for

$$x > x_2^*$$

and continue the firm for

$$x \in \left[\frac{F}{1 + \alpha}, x_2^*\right].$$

Case 2 $\alpha x < (F - x) \le Lx$, i.e., $\frac{F}{1+L} \le x < \frac{F}{1+\alpha}$

In this case, equityholders receive positive payoffs in the state Lx at date 2, but receive nothing under liquidation. Thus, equityholders always decide to continue.

Case 3 $\alpha x < Lx < (F - x)$ i.e., $x < \frac{F}{1+L}$.

In this case, equity has zero value under both continuation and liquidation. The choice is made in creditors' interest. This means for there is continuation for $q = \bar{q}$ and liquidation for $q = \underline{q}$.

Summarizing, for $q = \bar{q}$, equityholders decide to continue in all three cases. For $q = \underline{q}$, they continue in Case 1 only if $x \le x_2^*$, always continue in Case 2, and always liquidate in Case 3. This is exactly the statement of Lemma 2.

D Proof of Proposition 3

Define $f(\alpha)$ as in (21). To complete the proof of the Proposition, we show that $f(\alpha)$ is monotonically decreasing for $\alpha \in (0.36\overline{q}L, \overline{q}L)$. Using the definition of $f(\alpha)$, we obtain that

$$f'(\alpha) = -1 + \frac{\overline{q}^2}{(\overline{q}+\alpha)^2} + \frac{2\overline{q}^2(\overline{q}L-\alpha)}{(\overline{q}+\alpha)^3} - \frac{1}{\left(1+\frac{(\alpha-\underline{q}L)}{(1-\underline{q})}\right)^2} + \frac{1}{(1+L)^2}$$

$$+ \frac{2(\alpha-\underline{q}L)}{(1-\underline{q})\left(1+\frac{(\alpha-\underline{q}L)}{(1-\underline{q})}\right)^3},$$

which can be expressed as

$$f'(\alpha) = -1 + \frac{1}{(1+L)^2} + g(\alpha) + h(\alpha), \text{ where} \tag{32}$$

$$g(\alpha) \equiv \frac{\overline{q}^2}{(\overline{q}+\alpha)^2} + \frac{2\overline{q}^2(\overline{q}L-\alpha)}{(\overline{q}+\alpha)^3}, \text{ and} \tag{33}$$

$$h(\alpha) \equiv \frac{2(\alpha-\underline{q}L)}{(1-\underline{q})\left(1+\frac{(\alpha-\underline{q}L)}{(1-\underline{q})}\right)^3} - \frac{1}{\left(1+\frac{(\alpha-\underline{q}L)}{(1-\underline{q})}\right)^2}. \tag{34}$$

Consider $h(\alpha)$ first:

$$h(\alpha) = \frac{2(\alpha-\underline{q}L)(1-\underline{q})^2}{[(1-\underline{q})+(\alpha-\underline{q}L)]^3} - \frac{(1-\underline{q})^2}{[(1-\underline{q})+(\alpha-\underline{q}L)]^2}$$

$$= \frac{[2(\alpha-\underline{q}L)-(1-\underline{q})-(\alpha-\underline{q}L)]}{[(1-\underline{q})+(\alpha-\underline{q}L)]^3}(1-\underline{q})^2$$

$$= \frac{[\alpha-\underline{q}L-(1-\underline{q})]}{[(1-\underline{q})+(\alpha-\underline{q}L)]^3}(1-\underline{q})^2. \tag{35}$$

Thus, we obtain that

$$h'(\alpha) = \frac{(1-\underline{q})^2}{\left[(1-\underline{q})+(\alpha-\underline{q}L)\right]^4}\left[4\left(1-\underline{q}\right)-2\left(\alpha-\underline{q}L\right)\right]. \tag{36}$$

Hence, $h'(\alpha)=0$ at $\alpha=2(1-\underline{q})+\underline{q}L$. Furthermore,

$$h''(\alpha) = \frac{6\left(1-\underline{q}\right)^2}{\left[(1-\underline{q})+(\alpha-\underline{q}L)\right]^5}\left[\left(\alpha-\underline{q}L\right)-3\left(1-\underline{q}\right)\right] \tag{37}$$
$$< 0 \text{ at } \alpha=2\left(1-\underline{q}\right)+\underline{q}L.$$

Thus, $h(\alpha)\le h\left(2\left(1-\underline{q}\right)+\underline{q}L\right)=\frac{\left(1-\underline{q}\right)^3}{27\left(1-\underline{q}\right)^3}=\frac{1}{27}$. In turn,

$$f'\left(\alpha\right)\le-1+\frac{1}{\left(1+L\right)^2}+g(\alpha)+\frac{1}{27}\ . \tag{38}$$

Consider $g(\alpha)$ next. Note that $g(\alpha)$ can be simplified to yield

$$g(\alpha)=\frac{\overline{q}^3+2\overline{q}^3L-\overline{q}^2\alpha}{\left(\overline{q}+\alpha\right)^3}\ , \tag{39}$$

which is decreasing in α. Let $\hat{\alpha}(\theta)=\theta\overline{q}L$, $\theta\in(\underline{q}/\overline{q},1)$. Then, $\forall\ \alpha\in(\hat{\alpha}(\theta),\overline{q}L)$, we obtain that

$$g(\alpha)\ \le\ g\left(\hat{\alpha}(\theta)\right)\ =\ \frac{1+(2-\theta)L}{\left(1+\theta L\right)^3}\ . \tag{40}$$

This, in turn, implies that $\forall\ \alpha\in(\hat{\alpha}(\theta),\overline{q}L)$,

$$f'\left(\alpha\right)\le-1+\frac{1}{\left(1+L\right)^2}+\frac{1+(2-\theta)L}{\left(1+\theta L\right)^3}+\frac{1}{27}\ . \tag{41}$$

It can be shown (for example, using Mathematica) that as long as $L \geq 2$ (our maintained assumption),

$$-1 + \frac{1}{(1+L)^2} + \frac{1+(2-\theta)L}{(1+\theta L)^3} + \frac{1}{27} < 0, \ \forall \, \theta \geq 0.36 \ . \tag{42}$$

Thus, $f'(\alpha) < 0$, $\forall \, \alpha \in (0.36\bar{q}L, \ \bar{q}L)$.

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