Job Market Paper

Do Tests of Capital Structure Theory Mean What They Say? *

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Abstract

In the presence of frictions firms will make changes to their capital structure only infrequently. As a consequence, in a dynamic economy, the leverage of most firms, most of the time is likely to differ from the "optimum" leverage at the time of readjustment. This paper replicates well-established cross-sectional tests of capital structure theory on data simulated using a dynamic trade-off model with adjustment costs. I show that these tests produce results that are qualitatively - and, in some cases, even quantitatively - consistent with those reported in the empirical literature. In particular, I find that: (a) leverage is inversely related to profitability; (b) leverage can be largely explained by stock returns; (c) leverage mean reverts. The tests highlight the fact that commonly used empirical methodology produces results on the relation between leverage and firm-level variables that are profoundly different from predictions based on model comparative statics at refinancing points. Indeed, some tests lead to the rejection of precisely the model that generates the simulated data. The framework is also able to provide explanations for a number of observed puzzles and, taken together, the results suggest a rethinking of the way tests of capital structure are conducted.

Keywords: Capital structure, asset liquidity, simulations, refinancing point, dynamic economy, profitability, credit spreads

JEL Classification Numbers: G12, G32

I Introduction

Recent empirical research in capital structure has focused on regularities in the cross section of leverage to distinguish between various theories of financing policy. Both book and market leverage are related to profitability, book-to-market, and firm size. Changes in market leverage are largely explained by changes in equity value. Past book-to-market ratios have been shown to predict current capital structure. Firms appear to use external debt financing too conservatively, with the leverage of stable, profitable firms being particularly low. Even if firms have a target level of leverage, they move towards it slowly, at a "snail's pace" (Fama and French (2002)). Firms with low and high leverage react differently to external economic shocks.[1] Existing explanations for these findings are related to various versions of the pecking order, trade-off or market timing theories. Each of these theories is supported by some evidence and challenged by other evidence. This paper attempts to reconcile these apparently conflicting results by providing a quantitative, as well as qualitative, connection between empirical cross-sectional studies of capital structure and dynamic models of optimal financing behavior.

The starting point is a simple but, I believe, powerful observation: in a dynamic economy with frictions the leverage of most firms, most of the time, is likely to deviate from "optimal leverage" prescribed by a model of optimal financial policy. With transaction costs optimizing shareholders will prefer to adjust leverage by issuing or retiring securities infrequently, at "refinancing points". One simple consequence of this observation is that, even if firms follow a certain model of financing behavior, a static model may nonetheless fail to explain differences between firms in a cross-section since, between refinancing points, the actual and "optimal" leverage differ. It has been long recognized that deviations from optimal leverage may create problems for interpreting the results of empirical research. For example, Myers (1984, p. 578) emphasizes that "any cross-sectional test of financing behavior should specify whether firms' debt ratios differ because they have different optimal ratios or because their actual ratios diverge from optimal ones".

In this paper I reverse the standard approach. Instead on fixing on a methodology to distinguish between alternative theories, I fix the theory and ask how the results of existing empirical tests should be interpreted. Specifically, I construct a model of optimal dynamic corporate financing behavior in the presence of frictions and then ask whether, using data generated by this model, tests similar to those used in empirical studies replicate the empirical properties of firms' financing policies that are found empirically. In a nutshell, my results can be summarized methodologically as follows: (i) cross-sectional tests performed on data generated by dynamic models can produce results that are profoundly different from their predictions for corporate financing behavior at refinancing points; moreover, some results would lead to the rejection of precisely the model on which these tests are based; and (ii) results of even a stylized trade-off

[1] See Graham (2000) on conservatism in financing decisions; Titman and Wessels (1988), Rajan an Zingales (1995), Fama and French (2002), among others, on cross-sectional determinants; Fama and French (2002), Hovakimian, Opler and Titman (2001) and Graham and Harvey (2001) on slow mean reversion of debt ratios; Baker and Wurgler (2002) on the influence of past book-to-market ratios; Welch (2004) on the influence of changes in equity market value on debt ratios; and Opler and Titman (1994) on reaction of high-leveraged companies to industry shocks and Korajczyk and Levy (2003) on their reaction to macro shocks.

model of dynamic capital structure with adjustment costs are consistent with those observed empirically, and some are able to replicate empirical results quantitatively. These results suggest that there is need both to rethink current empirical methodology and to develop dynamic models of financing capable of delivering quantitative predictions.

A prerequisite for my analysis is a model that captures the dynamics of firms' financing behavior. Among many existing interesting explanations of capital structure only the trade-off argument has a fully-worked out dynamic theory that leads to quantitative predictions of leverage ratios in dynamics. In the trade-off theory firms arrive at their optimal capital structure by balancing the corporate tax advantage to debt with the bankruptcy and agency costs. The choice of the trade-off model might seem regrettable because there exist at best mixed empirical support for this model. However, as I show in the paper, empirical data seems to be more consistent with the trade-off theory than has been found to date, and so ex-post the choice might seem less regrettable. To this end, therefore, I take a standard state-contingent model of dynamic capital structure rooted in a trade-off argument. While several features differentiate the model from others in the field, the basic setup is widely used in the literature. In the model, firms are always on their optimal capital structure path even though, because of the presence of adjustment costs, they choose to refinance only occasionally. Apparently small adjustment costs can lead to large waiting times and large changes in leverage, a result consistent with findings of Fischer, Heinkel, and Zechner (1989). Firms that perform consistently well re-leverage to exploit the tax related benefits of debt. Firms that perform badly face a liquidity crisis and may sell their assets to pay down debt. If their financial condition deteriorates still further, they resort to costly equity issuance to finance their debt payments and, once all other possibilities are exhausted, they default and equity ownership is transferred to debtholders.

I use the model in two ways. First, I derive the conditions that determine the path of firm's optimal financing decisions. This enables me to study the cross-section of optimal leverage at times when firms change their leverage: I call these "refinancing points". Naturally, when firms are at their refinancing points, all the comparative statics predictions of the model are in line with the predictions of the trade-off theory.

In the second stage of the analysis, I perform a number of cross-sectional tests on simulated dynamic data generated by the model. Several results stand out. Firstly, the analysis highlights difficulties in interpreting the leverage-profitability relationship, a relationship that has been central to many empirical attempts to disentangle competing theories. In the pecking order theory, more profitable firms decrease their borrowing to reduce costs of external financing. Under the trade-off theory, higher profitability decreases expected costs of distress and allows firms to increase their tax benefits by increasing leverage. Thus, an inverse relationship between leverage and profitability, frequently found in the data and that Myers (1993) calls as perhaps the most pervasive empirical capital structure regularity, represents a substantial failure of the trade-off model and is considered by some writers to be decisive in its rejection. The leverage-profitability relation is critical since it is one of only a small number of predictions that distinguish unambiguously between the trade-off and pecking order frameworks. In the model expected profitability is indeed positively related to leverage at the refinancing points, as one would expect since the model is based on a trade-off argument. In contrast, I show that in a dynamic economy cross-sectional tests produce a negative relationship. The basic intuition is simple: in a world of infrequent adjustment, an increase in profitability lowers leverage by increasing future profitability and thus the value of the firm. For one subset of firms an increase in firm value does not lead to refinancing, and so, leverage decreases, while other firms refinance and their leverage increases. In the cross-section, it is the first subset that dominates. My results allow this effect to be quantified. In the simulation under all considered scenarios the model gives rise to a negative coefficient and in many cases the magnitude seems consistent with that observed empirically.

Secondly, again using simulated data on dynamics generated by the model, the approach allows me to replicate almost exactly the test recently conducted by Welch (2004). His major finding is that debt ratios can be largely explained by past stock returns, implying that corporations do not readjust their debt levels to counteract the mechanistic effect of stock returns on leverage. This observation is important, not least because other proxies used in the literature (including profitability) are found to effect leverage largely through stock returns. Results of the same regression tests conducted on the data simulated using the model are numerically very similar to Welch's results, suggesting that a stylized dynamic model with small adjustment costs can explain these findings. Over a one year horizon, there is almost a one-to-one relation between leverage and the implied debt ratio, a variable whose change is entirely determined by one-year stock returns. This result seems surprising in an empirical context since it implies that corporations are largely passive as regards their issuance policy and yet we know from empirical studies that firms typically are quite active in issuing debt and equity. This apparent paradox is also present in the model: in the benchmark case more than 8% of corporations refinance their debt every year and this seems inconsistent with evidence that firms do not adjust leverage to counteract changes in equity value. An explanation for this seemingly conflicting result is straightforward in my model: for both results to hold it is enough for changes in outstanding debt to be contemporaneously independent of the changes in market value of equity. This is what happens in the model since debt changes reflect the cumulative outcome of the firm value changes over a long period and thus equity changes over a short period do not, on average, induce debt issuance or retirement. Restructuring, however, occurs only when equity returns in the last period are positive and this explains the finding that the correlation between debt changes and equity returns are weakly positive. Empirically, we also observe a very low positive correlation and thus this may provide one explanation for why it has proved difficult to identify the determinants of corporate debt issuance. As such, it provides support for Welch's (2004) findings on the relation between profitability and leverage and a rationalization of firms' seemingly inert behavior.

Thirdly, since the behavior of the cross-section in dynamics is radically different from the comparative statics properties at the refinancing points, comparing empirical findings with the theoretical properties of leverage at refinancing points can be misleading. To give an example, recent research has concentrated on possible explanations for the so-called "low leverage puzzle". This refers to the simple observation that, according to estimates based on COMPUSTAT data on the book value of debt and market value of equity, the median corporate debt to capital ratio in the U.S. averaged 31.4% between 1965 and 2000 and, in addition, two out of five firms had an average debt to capital ratio of less than 20%.[2] Traditional trade-off models of optimal capital structure produce substantially higher numbers. For example, Leland (1994) obtains an optimal leverage ratio in the range of 75-95% and this value is relatively insensitive to variation in the parameters within a reasonable range. That trade-off models imply substantially higher optimal leverage ratios that the low levels observed in practice is not surprising in the light of the famous remark by Merton Miller (1977) about "horse and rabbit stew": bankruptcy costs are simply negligible compared to the tax benefits of debt. Recent estimates show that, by increasing its leverage, an average firm can increase its value by as much as 5% taking into consideration both personal and corporate taxes on debt and by 9% excluding personal tax considerations (Graham (2000)). To explain the observed low level of leverage we need to understand better what factors might counteract the tax benefits. Studies by Graham (2000) and Minton and Wruck (2000) are unable to identify any cost that is large enough in a trade-off sense to justify the apparently conservative debt policy of most firms. One proposed solution is to consider a dynamic trade-off framework. Firms that can increase debt in the future if they are successful, will choose lower leverage initially. Studies by Goldstein, Ju, and Leland (2001) and Ju, Parrino, Poteshman, and Weisbach (2003) show that in a dynamic framework firms will choose to have substantially lower leverage than in a static framework. My results generally support this conclusion but at the same time suggest that average leverage over time, i.e. in "true dynamics", is substantially larger than leverage measured simply at refinancing points.[3] Therefore, one needs to compare empirical estimates with model estimates in dynamics.

One possible criticism of my approach is that the findings are specific to a number of firm-specific parameters and on the initial conditions of the economy. I therefore perform extensive robustness tests and conclude that, while changing the specification and the cross-sectional structure of the parameter set, as well as changing empirical procedures, can add some new nuances, they are largely of second-order importance and overall the main thrust of the results survives.

My paper relies upon several streams of previous research. First, it shares with a number of recent papers, including Leland (1998) Goldstein, Ju, and Leland (2001), Ju, Parrino, Poteshman, and Weisbach (2003), Christensen, Flor, Lando, and Miltersen (2002), a theoretical framework in which the standard structural models of risky debt pricing are enriched to incorporate dynamic financing behavior. These models follow, on the one hand, earlier static capital structure models

[2]Debt to capital ratio is defined as: COMPUSTAT data items d9+d34 divided by d9+d34+d25xd199. These are unadjusted figures. Adjusted (see Rajan and Zingales (1995)) figures would be lower.

[3]For example, a benchmark case of Goldstein, Ju, and Leland (2001) has the leverage ratio of 37%. In dynamics, however, it is about 45%. Ju et al. (2003) develop a model with finite maturity debt where at fixed refinancing points shareholders take optimal decisions. The three main reasons why their dynamic trade-off model produces low leverage at refinancing points are: (a) the level of asset volatility they use is chosen to match recovery rates and corporate bond spreads; (b) new debt is issued only after existing debt matures; this creates a "real option" to increase leverage in the future and reduces current leverage; (c) the default boundary is specified exogenously and leads to higher default frequency than in a model with an endogenous boundary. They also show that if a risk-averse manager maximizes his utility rather than the firm value, leverage is lowered further. In a static model Morellec (2003) also shows that low leverage ratios can arise in the presence of stockholder/manager conflicts.

developed, among others, by Leland (1994) and, on the other hand, dynamic capital structure models developed by Fischer, Heinkel, and Zechner (1989) whose research was, in turn, based on insights by Kane, Marcus, and McDonald (1984; 1985). Fischer, Heinkel, and Zechner (1989) were also the first to suggest that the leverage ratio is inadequate for cross-sectional studies, proposing instead using the range of leverage between refinancing points. Their empirical tests demonstrated that the properties of this variable satisfied their hypothesis. The paper studies the further implications of their observation.

The basic setup of my model most closely resembles that of Goldstein, Ju, and Leland (2001). Christensen et. al. extend this framework to incorporate strategic behavior of the kind first described by Anderson and Sundaresan (1996) and Mella-Barral and Perraudin (1997). A distinct feature of the model is that firms whose value falls substantially face a prolonged period of turbulence instead of simply running up a large debt burden and then defaulting. The model thus reflects the empirical findings of Asquith, Gertner, and Scharfstein (1994) according to which firms unable to service their debt obligations sell a fraction of their assets in order to pay down their debt. In the sample of financially distressed firms in Asquith et. al. more than 80% of firms sold assets. For the sake of realism, I model asset sales as discrete. While asset sales may ease a firm's financial position by lowering its leverage and staving off the immediate threat of default, they also reduce the level of future payouts from the project. This, combined with the financial costs that firms bear in selling assets, affects future financial flexibility and leads to a more conservative debt policy.[4] A decrease in debt usage can be thought of, roughly, as a simple hedging tool.[5] Firms whose condition continues to deteriorate have to resort to issuing equity to finance their debt payments. Consistent with empirical research (e.g. Altinkilic and Hansen (2000; 2003)), equity issuance is costly in the model. These costs lead shareholders to default sooner and thus decrease the level of leverage at which the firm's equityholders will find it in their interest to default and transfer their ownership rights to debtholders. Morellec (2001) considers asset liquidity issues in a model of static optimal capital structure and provides an interesting analysis of a firm's adjustment of its assets in response to the output price changes when the value of assets in second-best usage is fixed. Asset sales in the model differ from his case since they are conducted exclusively in financial distress at prices that reflect a discount proportional to the firm's value at the time of sale and are conducted in discrete amounts. Acharya et al (2002) introduce costly equity issuance in a structural model of credit spreads; however, they do not consider optimal leverage decisions.

The approach applied in the paper closely resembles Berk, Green, and Naik (1999) who, in a deep analysis, focus on the cross-sectional relationship between a firm's investment policy, systematic risk and expected returns. They build a highly non-linear dynamic model in which firms, though identical at the inception of the economy, become heterogenous as a result of the endogenous evolution of the value of their assets. To investigate cross-sectional patterns and

[4] Graham and Harvey (2001) find that firms consider financial flexibility as the most important determinant of their debt policy.

[5] More complex hedging policies (see e.g. Froot, Scharfstein, and Stein (1994)) are not considered here. See also Graham and Smith (1999).

regularities in their economy they perform simulations, an approach I endeavor to replicate since my model has discontinuity points and is also very non-linear. Firms' technology parameters are calibrated to resemble, in a sense discussed later, the properties of samples of firms typically used in empirical studies. Then, I simulate data on firm values, leverage, etc. for dynamic economies and perform a number of cross-sectional tests similar to those performed in the empirical literature. While the model treats every firm independently, in other words, each firm arrives at its optimal policy independently of other firms, the evolution of firms' asset values is cross-sectionally dependent due to the presence of systematic shocks. The modelling approach of firm behavior in Berk, Green, and Naik (1999) is both richer than mine in some areas and less rich in others: they are able to analyze a wider spectrum of questions by considering separately existing assets in place and future growth opportunities. However, their firms are in fact myopic optimizers since the fact that investment projects are assumed independent combined with a complete lack of any financial policy means that a firm does not have to take into account the evolution of its assets over time in taking current investment decisions.

A stream of recent, influential empirical studies has motivated my interest in this topic. Bradley, Jarrell, and Kim (1984), Titman and Wessels (1988), Rajan and Zingales (1995), Baker and Wurgler (2002), and Fama and French (2002) study, among others, the cross-sectional determinants of leverage. Shyam-Sunder and Myers (2001), Hovakimian, Opler, and Titman (2001) and Fama and French (2002) study mean-reversion in leverage ratios. Opler and Titman (1994) and Korajczyk and Levy (2003) investigate the reaction of high/low leveraged firms to external shocks, and Pulvino (1998) investigates the relation between asset liquidity costs and leverage. The paper is also closely related in spirit to a recent empirical paper by Welch (2004) who investigates empirically whether existing empirical tests are robust to the inclusion of stock returns in empirical regressions.

The rest of the paper is organized as follows. The next Section considers the model of dynamic capital structure, providing the valuation framework. Section III is the main section of the paper: it presents the simulation procedure and the predictions of the model for a number of cross-sectional properties of leverage. Section IV describes the robustness tests. The paper concludes with Section V. Appendix contains details of the simulation method.

II The model

II.1 General assumptions

My model is based on a standard contingent claims framework analyzing an individual firm in a version proposed by Goldstein, Ju, and Leland (2001). I consider an economy populated by firms each of which is endowed with monopoly access to some infinitely lived project operated in continuous time. The value of each firm stems from a perpetual entitlement to the current and future income from the project ("EBIT-generating machine"). The income is divided between the net payout to claimholders and retained earnings. In common with many other models of capital structure, the Modigliani and Miller assumption that the project's cash flows are invariant to financial policy is retained.[6] Investment is financed by retained earnings which contribute to an increase in book assets that grow at a rate g, which incorporates the rate of depreciation. The state variable in the model is the total net payout to claimholders, δ_t, in period t, where claimholders can be both insiders (equity and debt) and outsiders (government and various costs). The reason δ_t plays this role is similar to that outlined by Goldstein, Ju, and Leland (2001).[7] The evolution of δ_t is ruled by the following process under pricing measure $\mathbb{Q}$[8]

$$\frac{d\delta_t}{\delta_t} = \mu dt + \sigma dZ_t \qquad \forall t \geq 0, \delta_0 > 0, \tag{1}$$

where μ and σ are constant parameters and Z_t is a Brownian motion defined on a filtered probability space $(\Omega, \mathcal{F}, \mathbb{Q}, (\mathcal{F}_t)_{t\geq 0})$. Here, μ is the risk-neutral drift and σ is instantaneous volatility of project's net cash flow.

I assume that management acts in the best interest of shareholders and, throughout the paper, I use managers and equityholders interchangeably. To avoid further complications, the default-free term structure is assumed flat with an instantaneous after-tax riskless rate r at which investors may lend and borrow freely. The marginal corporate tax rate is τ_c. The marginal personal tax rates on dividends is τ_d and on income is τ_i, and they are assumed to be identical for all investors. Finally, all parameters in the model are assumed to be common knowledge.

II.2 Debt contract assumptions

All corporate debt is in the form of a perpetuity entitling debtholders to a stream of continuous coupon payments c per annum and allowing equityholders to call the debt at any time at the face value. The main features of the debt contract are standard in the literature. First, the perpetuity feature is shared with numerous other papers such as models of Leland (1994), Morellec (2001) as well as with the dynamic capital structure models of Fischer, Heinkel, and Zechner (1989), Goldstein, Ju, and Leland (2001), and Christensen et. al. (2002). The virtue of perpetual debt is that it makes the problem more tractable by guaranteeing time-homogeneity of claims.[9] Second, the debt contract is callable. As demonstrated by Goldstein, Ju, and Leland (2001), in a model with

[6]Several papers have analyzed interactions between financing and investment policy, including joint decisions on production and capital structure (Brennan and Schwartz (1984, 1985), Mello and Parsons (1992), Mauer and Triantis (1994)) and effects of asset substitution (Leland (1998), Decamps and Faure-Grimaud (2002)).

[7]Another approach is to consider the dynamics of unlevered equity value, where claims of outsiders are added to the value of the firm. The "δ-approach" has a number of methodological advantages, e.g., by eliminating the need to consider levered and unlevered assets as separately traded assets. The results of applying both approaches are, however, roughly similar. Early usage of δ-approach is by Mello and Parsons (1992).

[8]Since I consider an infinite time horizon, some additional technical conditions on Girsanov measure transformation (e.g., uniform integrability) are assumed here. In addition, the existence of traded securities that span the existing set of claims is assumed. Thus, a pricing measure is unique.

[9]An alternative time-independent scenario is when the debt is continuously rolled over at a fixed interest rate. See Leland (1994) and Leland and Toft (1996) for further discussion. Introduction of finite maturity debt in the dynamic case would introduce flexibility on the part of equityholders who may be able to achieve lower adjustment costs by waiting until a bond matures rather than restructuring earlier. Ju, Parrino, Poteshman, and Weisbach (2002) consider the case of fixed maturity, but in their model the firm must wait until debt maturity to issue a new one. Thus, their framework does not allow equityholders to follow a dynamic debt policy by choosing the time of refinancing which is a pivotal essence of dynamic choice in my model.

inherent scaling feature callability does not really matter in good times as long as it is assumed that both old and new debt have equal seniority: newly issued debt dilutes the old debt claim and in equilibrium the market price of old debt is identical to its original face value.[10] Finally, the coupon rate is assumed fixed. Floating rate debt is formally excluded since interest rates are constant.Also excluded are "exotic" contracts in which promised debt payments are contingent on the state-of-the-world (see, e.g., Hart and Moore (1994)). In particular, debt contracts promising state-contingent cash flows are likely to fall under scrutiny of the tax authorities.

If the firm fails to honor a coupon payment in full, it enters restructuring. Restructuring, either a work-out or formal bankruptcy, is modelled in a reduced form. The absolute priority rule is enforced and all residual rights on the project are transferred to debtholders.[11] However, such restructuring is costly. In the model restructuring costs are assumed to be a fraction α of the value of assets on entering restructuring. Restructuring occurs instantaneously; thus, the costs that result from the time spent in default are modelled implicitly as restructuring costs.

Debt contracts are assumed to be non-renegotiable, so that equity cannot default strategically, a feature modelled in several recent debt pricing models (Anderson and Sundaresan (1996) and Mella-Barral and Perraudin (1997)). Additionally, debt contracts may restrict the rights of equityholders to sell the firm's assets (Smith and Warner (1979)). This standard assumption prevents equityholders from attempting to appropriate the firm value. Essentially, all proceedings from asset sales accrue to residual claimants only after other claims have been satisfied.

II.3 Financial flexibility

Figure 1 shows a number of possible paths for firm's net payout. It can be seen that the firm's financing policy is asymmetric in the state of nature. Path 1 is for a successful firm that raises more debt to take advantage of tax deductability of interest. Paths 2 and 3 are for firms whose condition deteriorates and whose managers must take some corrective action. Empirical research has shown that firms often become insolvent on a flow basis but not on a stock basis. For such firms the present value of future income exceeds their debt obligations but they experience a temporary liquidity crisis since fixed assets are a poor substitute for cash. In the model this occurs when the firm hits a "liquidity" boundary for the first time. The liquidity boundary that I model closely resembles a definition of a financially distressed firm by Asquith, Gertner, and Scharfstein (1994). They classify a firm as financially distressed if either, in any two consecutive years, the firm's earnings before interest, taxes, depreciation, and amortization (EBITDA) is less than its reported interest expense; or, in any one year, EBITDA is less than 80% of its interest expense. In the model, the boundary reflects an intermediate case: the firm becomes financially distressed whenever its cash flow is insufficient to cover its interest expense, and thus

[10] It is assumed that debtholders are dispersed and perfectly competitive and therefore situation of "squeezes" where price of a bond speculatively rises in anticipation of a recall or purchase like the one described in Dunn and Spatt (1984) in the case of sinking fund provisions is ruled out. Also, constant interest rates are essential since otherwise decision to call will be governed by a factor not directly related to the state of the firm.

[11] The model can be easily extended to take account of absolute priority violations found in empirical studies (see e.g. Franks and Torous (1989)). This is likely to lead to a lower leverage. Leland (1994) demonstrates that the impact of introducing APR violations on optimal leverage is minor at the time of readjustment.

Figure 1: **Possible paths of firm value.**

the liquidity boundary is triggered for the first time at T_L whenever $\delta_{T_L} < c$ and $\delta_t \geq c$ for all $t < T_L$.[12] In most structural models of debt pricing and capital structure the mechanism that allows equityholders to avoid default is to subscribe to new equity in anticipation of better times. In practice, however, firms choose from a richer set of options. In the sample studied by Asquith, Gertner, and Scharfstein (1994) distressed firms restructure both bank and public debt liabilities, cut investment expenditure, and restructure assets by selling assets.[13]

I investigate the last of these alternatives. My motivation is driven by the observed frequency and size of the phenomenon: in the Asquith, Gertner, and Scharfstein (1994) sample, the majority of firms did sell assets, with 18 out of 102 companies selling over 20% of their assets. Returning to Figure 1, both firms 2 and 3 encounter financial distress at $\delta = \delta_L$ and sell a fraction of assets to decrease their debt burden. The model captures several critical features of asset sales that are observed in practice. First, asset sales occur in discrete amounts: when the firm spin-offs part of the enterprize, it is usually a one-off event of disposition of considerable fraction of assets.[14] Second, asset sales are costly to firms. Firms in financial distress tend to realize less by selling assets than the present value of the cash flows these assets would deliver in a frictionless world for all sorts of reasons: potential buyers are likely to be financially constrained, less well informed, lack necessary expertise; sellers are time constrained and detach their human capital from the project. In other words, an asset sale can be viewed as a forced abandonment of assets in light

[12] Similar boundary is considered in Kim, Ramaswamy, and Sundaresan (1993).

[13] The sample was restricted to firms which issued junk debt. The motivation was to locate firms in financial, not economic, distress. In another stream of research, Gilson (1990) and Gilson, John, and Lang (1990) study companies with the worst performance on NYSE and AMEX. Half of their sample that restructured debt, restructured through private workouts, and another half filed for Ch. 11.

[14] Models of debt pricing also use "asset sales" or "asset liquidation" terminology, but it refers to the case of proportional asset liquidation that is equivalent in fact to the net payout ratio being positive since in these models cash flows originate exclusively via asset liquidation.

of the traditional measure of liquidity (Shleifer and Vishny (1992)).

The firm sells a fraction $1 - k$ of its assets immediately upon entering financial distress. In essence. The following equation captures the way asset sales are modelled:

$$(1 - q_A)(1 - k)V_L(1 - \tau) = \frac{(1 - w)D_0}{1 - q_{RC}}, \tag{2}$$

In (2) D_0 is the par value of debt at the time of issuance and V_L is the present value of project's future cash flows at time T_L. The parameter q_A represents the proportional costs incurred in selling assets, and τ is the effective corporate tax rate on the asset sale.[15] Thus, the left-hand side is the after-tax income received by the firm as a result of the asset sale. Equality in (2) implies that all proceeds are used to pay the debt down with a fraction w of par value of debt purchased. The proportional adjustment costs q_{RC} of issuing/retiring debt are incurred (in other words, for each \$1 of cash \$(1-q_{RC}) of debt can be purchased).[16]

An asset sale reduces operating net payout to a fraction k of its previous value. This is shown in Figure 1 where paths 2 and 3 have downward jumps at the time of liquidity crisis. Firm 2's fortunes improve substantially after a liquidity crisis so that later it refinances. Financing decisions in the model depend on the past financial history and so refinancing boundaries for firms 1 and 2 are different. However, as path 3 demonstrates, an asset sale may provide a firm only with temporary breathing space: if its asset value continues to decline, equityholders resort, as in earlier models, to equity issuance. A number of empirical studies have shown that issuing equity is costly (Altinkilic and Hansen (2000; 2003), Hansen (2001), Corwin (2003)). In the model the direct costs of external equity financing are proportional to the amount issued. Finally, as path 3 shows, a firm will default if conditions continue to worsen.

II.4 Valuation

In this section I derive the value of the firm and the conditions that determine equityholders' decisions. The fundamental driving force of the model is the inherent conflict of interest between the different claimholders since ex-ante (prior to the issuance of debt) and ex-post (after debt has been issued) incentives of equityholders are not aligned. Debtholders foresee future actions by equityholders and value debt accordingly.

At every date t equityholders decide on their actions. As in Fischer, Heinkel, and Zechner (1989), Leland (1998), and Goldstein, Ju, and Leland (2001), firms whose net payout reaches an upper threshold will choose to retire their outstanding debt at par and sell a new, larger issue to take advantage of the tax benefits to debt. Refinancing thus takes the form of a debt-for-equity swap. I call these thresholds "refinancing points". In my framework the financial history of the

[15] $(1 - k)V_L(1 - \tau)$ is the maximum price any buyer is willing to pay for these assets in the absence of frictions. I assume for simplicity that the buyer is unlevered. Note that since all firms face the same marginal tax rate, τ is also the effective tax rate of an unlevered carbon copy of the firm.

[16] Another variation that I have considered is where debt can be purchased at market prices (assuming that no-squeeze conditions are satisfied, see footnote 10). No results have been significantly changed. This is partly due to the fact that while debtholders are worse off at the moment of repurchase, the remaining debt is safer.

firm matters: the threshold value depends on whether the firm has experienced financial distress and sold assets in the past. Since future profit capacity and the amount of debt are changed in distress, it is natural to expect that refinancing barriers' values will be different.

The tractability of this and other models stems from a scaling feature or, in other words, a first order homogeneity property. A scaling feature means that values of all thresholds and par value of debt are scaled up by the same proportion at the first and each subsequent refinancing point. This feature is inherent in the log-normal nature of the state variable process and also restricts costs to be proportional to value of firm or claims. In other words, at each refinancing point the firm is just a scale of itself and thus does not depend on accumulated financial history. Therefore, I start by considering the values of equity and debt over one refinancing cycle (i.e. before any of the upper barriers is hit). These values, once debt is issued and before the liquidity barrier is hit, can be written as the sum of the present values of cash flows accruing to claimholders in four regimes: (i) while the firm is financially healthy, (ii) at the time the liquidity barrier is hit for the first time, (iii) on continuation after the barrier is hit, and (iv) in default. At time $t = 0$

$$\begin{aligned} E^R(\delta_0) = &\mathbb{E}_{\delta_0}\left[\int_0^{T'} e^{-rs}(1-\tau)(\delta_s - c)ds\right] + \mathbb{E}_{\delta_0}\left[\int_{T_L}^{T''} e^{-rs} q\left((1-\tau)(k\delta_s - wc) - \tau_l wc\mathbf{1}_{[\delta_s<\delta_\tau]}\right) ds\right] \\ &+\mathbb{E}_{\delta_0}\left[e^{-rT_B}\max\left[(1-\alpha)\int_{T_B}^{+\infty} e^{-rs}k(1-\tau)\delta_s ds - wD_0, 0\right]\Big|\phi_{LU}^B = 0\right], \end{aligned} \quad (3)$$

and

$$\begin{aligned} D^R(\delta_0) = &\mathbb{E}_{\delta_0}\left[\int_0^{T'} e^{-rs}(1-\tau_i)cds\right] + \mathbb{E}_{\delta_0}\left[e^{-rT_L}|\phi_U^L = 0\right](1-w)D_0 + \mathbb{E}_{\delta_0}\left[\int_{T_L}^{T''} e^{-rs}(1-\tau_i)wcds\right] \\ &+\mathbb{E}_{\delta_0}\left[e^{-rT_B}\min\left[(1-\alpha)\int_{T_B}^{+\infty} e^{-rs}k(1-\tau)\delta_s ds, wD_0\right]\Big|\phi_{LU}^B = 0\right], \end{aligned} \quad (4)$$

where expectations, here and throughout the paper, are taken under the pricing measure $\mathbb{Q}$, R stands for one refinancing cycle, $T' = \min(T_L, T_U)$ and $T'' = \min(T_B, T_{LU})$. The functions ϕ_i^j take the value 0 if event j occurs before event i, and 1 otherwise.

The first term in expression (3) is the present value of cash flows to equityholders when neither the liquidity barrier, δ_L, nor the first refinancing barrier, δ_U, have been reached. As residual income claimants, equityholders retain whatever is left of net income after coupons and taxes are paid. The tax rate τ takes into account both corporate and personal taxes: $\tau = 1-(1-\tau_c)(1-\tau_d)$. The second term is the present value of cash flows on continuation after the liquidity barrier has been hit and until either default occurs at time T_B or the second refinancing barrier, δ_{LU}, is reached. The function $q(x)$ accounts for costly equity issuance and can be written as

$$q(x) = \begin{cases} 1, & \text{if } k\delta_s > wc \\ q_E x, & \text{otherwise} \end{cases} \quad (5)$$

In addition, if corporate income, δ_t, is sufficiently small, the firm loses part of its tax shelter and this results in a lower effective tax benefit $\tau - \tau_l$.[17] The first and the third terms in expression

[17] Goldstein, Ju, and Leland (2001) model partial loss offset to tax in a similar manner.

(4) are the net present values of payouts to debtholders before and after a liquidity crisis, respectively. The second term reflects the amount of debt purchased when assets are sold. In default proportional costs α are incurred and, since absolute priority is enforced, equityholders receive either nothing or the residual after the remaining debt is repaid at its face value (the third term in (3) and the fourth in (4)).

The total value of a debt claim issued at date 0 is thus

$$D(\delta_0) = D^R(\delta_0) + \mathbb{E}_{\delta_0}\left[e^{-rT_U} D_0 | \phi_L^U = 0\right] + \mathbb{E}_{\delta_0}\left[e^{-rT_{LU}} w D_0 | \phi_B^{LU} = 0\right] \tag{6}$$

Equityholders make decisions taking into consideration what happens after refinancing occurs. The total value of all payouts to equity (except at refinancing points) is given by

$$E^D(\delta_0) = E^R(\delta_0) + \mathbb{E}_{\delta_0}\left[e^{-rT_U} \gamma_U E^D(\delta_0) | \phi_L^U = 0\right] + \mathbb{E}_{\delta_0}\left[e^{-rT_{LU}} \gamma_{LU} k E^D(\delta_0) | \phi_B^{LU} = 0\right] \tag{7}$$

and the value of all debt issues is

$$D^D(\delta_0) = D(\delta_0) + \mathbb{E}_{\delta_0}\left[e^{-rT_U} \gamma_U D^D(\delta_0) | \phi_L^U = 0\right] + \mathbb{E}_{\delta_0}\left[e^{-rT_{LU}} \gamma_{LU} k D^D(\delta_0) | \phi_B^{LU} = 0\right] \tag{8}$$

where γ_U and γ_{LU} are proportions by which the net payout increases between two refinancing points if the liquidity barrier has, or has not been hit, respectively.

Combining these values yields the total value of the firm that equityholders maximize at time $t = 0$ (and by the scaling feature at each subsequent refinancing point):

$$F(\delta_0) = \frac{E^R(\delta_0) + (1 - q_{RC}) D(\delta_0)}{1 - \gamma_U \mathbb{E}_{\delta_0}\left[e^{-rT_U} | \phi_L(U) = 0\right] - k \gamma_{LU} \mathbb{E}_{\delta_0}\left[e^{-rT_{LU}} | \phi_B(LU) = 0\right]} \tag{9}$$

Thus, (9) states that managers maximize the sum of (i) the present value of the after-tax cash flows accruing to equity and (ii) the present value of after-tax income payments to all debt claims to be yet issued. Note that the total equity value takes into account the present value of future adjustment costs that will be incurred at all future refinancing points.

Equityholders choose the coupon and refinancing barriers to maximize the value of their ex-ante claim:

$$\mathbf{c}^* = \arg \max_{\{c, \gamma_U, \gamma_{LU}\} \in \mathbb{R}_+^3} \left[F(\delta_0)\right] \tag{10}$$

An additional feature of realism in which I follow Goldstein, Ju, and Leland (2001) is that firm's financial decisions affect the firm's net payout ratio. In particular, higher reliance on debt leads empirically to a larger net payout. It is assumed, for simplicity, that net payout ratio depends on the coupon rate and taxes linearly:

$$\frac{\delta}{V} = a + (1 - \tau_c) \frac{c}{V_0}, \tag{11}$$

where V is the present value of all future net payouts.

To characterize the default threshold, note that equityholders will balance the present value of future equity cash flows if they remain in control with the cost of equity issuance they have to subscribe now. The value of equity they care about is $E(\delta_t) = F(\delta_t) - wD(\delta_t)$, where the fact that the liquidity barrier has been hit is taken into account in calculating the value of claims. It is well known that this threshold satisfies the smooth-pasting condition:

$$\frac{\partial E(\delta_t)}{\partial \delta_t}\Big|_{\delta_t=\delta_B} = 0. \tag{12}$$

The full problem facing equityholders thus consists of solving (10) subject to (11) and (12). Closed-form solution to the stated problem does not exist, so the numerical procedure was used.

II.5 Comparative statics

The purpose of this subsection is to compare the properties of firms' financial decisions at refinancing points in my model to the earlier literature. Table I summarizes the comparative statics of the main financial variables: the leverage ratio, ML, bankruptcy value, δ_B, restructuring boundaries, δ_U and δ_{UL}, the liquidity barrier, δ_L, and credit spread, CS. The market leverage ratio, ML, is defined as the ratio of market debt value ($D(\delta_0)$) to total capital ($F(\delta_0)$),

$$ML_0 = \frac{D(\delta_0)}{F(\delta_0)}. \tag{13}$$

Not surprisingly, many results are similar to the comparative statics results obtained by Leland (1994) for the static case (his Table II for unprotected debt) and by Goldstein, Ju, and Leland (2001) for the dynamic case (their Table 2). In particular, as expected, higher business risk, bankruptcy costs and a lower tax advantage to debt all reduce optimal leverage. A higher risk-free interest rate, contrary to the result given in Leland (1994), unambiguously reduces the leverage ratio since the higher costs of borrowing more than offset the larger tax advantage to debt. Also, as we might expect, an increase in asset sale and equity issuance costs lower borrowing.

The relation between the leverage ratio and the restructuring costs exhibits a reverse U-pattern. Firms with either high or low cost access to external markets optimally prefer lower leverage than those with intermediate costs. This is because firms face a trade-off between the frequency of restructuring and the amount of borrowing. Firms with low costs prefer to rebalance frequently; as costs increase, the level of the restructuring boundaries rises (note that δ_U and δ_{UL} are increasing functions of q_{RC}) and firms therefore borrow more initially. As costs rise further, however, debt becomes less and less advantageous and is replaced by equity.

Rows 2 and 3 of Table I illustrate the behavior of default and upper restructuring boundaries. The behavior of the default boundary is very similar to that of the leverage ratio, including its response to changes in risk-free interest rate. Higher costs of bankruptcy lead to a reduction in the level of refinancing boundaries to offset the lower amount of borrowing. Also, higher volatility might be expected to lower the level of refinancing boundaries providing the same offset but it does not: unlike bankruptcy costs higher business risk increases both the expected costs of bankruptcy and expected gain from refinancing in the future. The latter effect works as an offsetting mechanism to lower amount of borrowing.

The value of equity that managers maximize is negatively related to the tax rates on both corporate income and interest. This intuitive result is different from e.g. Fischer, Heinkel, and Zechner (1989) and Leland (1994) since the state variable in that framework is the value of an unlevered firm and therefore tax benefits are accounted for as inflows of funds. The coupon level (and thus, the liquidity boundary) is negatively related to firm volatility; the difference between investment-grade and junk firms observed by Leland (1994) disappears in a dynamic model. In a Leland's world firms with very large business risk will optimally commit to pay sizable coupons since they expect a dramatic improvement in their fortune with non-negligible probabilities. In a dynamic world they will instead commit to refinancing when their fortune improves.

To complete the comparison with earlier results on comparative statics, the last row in Table I also shows the behavior of the credit spread, CS, that is defined as $\frac{c}{D(\delta_0)} - \frac{r}{1-\tau_i}$. A few results here merit comment. Interestingly, credit spreads are negatively related to the costs of restructuring, asset sales, equity issuance, and bankruptcy. The latter relation is also noted by Leland (1994). While larger costs make debt less attractive to creditors, they also reduce the optimal amount of borrowing and, typically, the default boundary as well. Both actions make debt less risky. Finally, credit spreads decrease as risk-free interest rate rises. In addition to the effect described by Longstaff and Schwartz (1995), according to which debt becomes less risky due to an increase in the risk-neutral drift of the net payout, an increase in the interest rate in this framework also lowers the riskiness of debt by reducing the optimal level of borrowing.

III Capital Structure in a Dynamic Economy

The objective of this section is to investigate the cross-sectional and time-series properties of leverage ratios in a dynamic economy. Ultimately I am interested in building a bridge between empirical research and the empirical hypotheses that the model can deliver. The first step would be to relate leverage ratios and other variables of interest used in empirical studies to the ones I am using here. When adjustment costs are present, we have seen that firms will optimally commit not to refinance too often. In fact, in the model, *most firms most of the time will be optimally off their optimal leverage at refinancing point.* Quite clearly, if an empiricist studies an economy generated by the model, his data set typically would not contain many refinancing point optimal leverage ratios. To relate the model to empirical studies, it is necessary to *produce within the model a cross-section of leverage ratios qualitatively similar to those which would have been studied by an empiricist.*

A natural question to ponder is to what extent studying cross-section in dynamics over studying comparative statics at refinancing point matters. That using static implications can cloud inference has been recognized in studies of leverage mean-reversion and debt issuance (see e.g. Hovakimian, Opler, and Titman (2001), Fama and French (2002)). If leverage deviates from its target substantially, an assertion supported by a stream of research, then firms will not respond properly to changes in their economic attributes as predicted by the theory. Indeed, already

Myers (1984, p.578) points out that "any cross-sectional test of financing behavior should specify whether firms' debt ratios differ because they have different optimal ratios or because their actual ratios diverge from optimal ones". This paper addresses the problem of what exactly empirical evidence produces in detail. First, I study whether the cross-sectional relations in a dynamic economy different from cross-sectional relations at refinancing point. Then I turn to replicating several cross-sectional studies of capital structure both on level of leverage and changes in leverage. Two questions I am especially interested in are whether my model can produce qualitatively the effects shown by empirical research, and, if so, whether the empirical estimates could have been generated by the model with reasonable probability under feasible set of parameters.

As in Berk, Green, and Naik (1999), my model is highly nonlinear in a number of important parameters and, as a result, individual dynamic leverage ratios, the main variable of interest, are difficult to obtain analytically. The complexity of dynamic effects in cross-sectional patterns of leverage means that it is impossible to ascertain dynamic interaction between leverage and its determinants by performing a simple comparative statics exercise. For example, a positive shock of the same magnitude can have different effects on firms in the same leverage group, leading to a complex interaction in the cross-section since some firms will refinance while others will not. Similarly, high leverage can be the result of optimally low borrowing due to high costs or a distressed outcome of an unsuccessful firm with any cross-section of firms is likely to include both firms who have performed well with leverage lower than their target and firms that have done badly and are in or near financial distress.

Therefore, as in Berk, Green, and Naik (1999), I use simulation to generate artificial data from the model. Since individual leverage ratios and some commonly used regressors are observable in the simulation, I am able to replicate a number of empirical research methods. In particular, I compare the cross-sectional properties of leverage in the simulated economy with those predicted from the comparative statics of leverage at refinancing points, the focus of most current theory, and then investigate empirical hypotheses on the issues that have been the focus of many empirical studies. These issues include the average level of leverage in the economy and its distribution, the cross-sectional relationship between profitability and leverage, mean reversion of leverage ratios, and impact on previous stock returns on capital structure.

III.1 Running simulations

This section describes the simulation procedure. Technical details are given in Appendix A.

To start with, observe that while only the total risk of the firm matters for pricing and capital structure decisions (since each firm decides on its debt levels independently of others), the evolution of the firm assets is interrelated. In particular, I can rewrite equation (1) as

$$\frac{d\delta_t}{\delta_t} = \mu dt + \sigma_I dZ^I + \beta \sigma_S Z^S \qquad \forall t \geq 0, \delta_0 > 0. \tag{14}$$

Here, σ_I and σ_S are constant parameters and Z_t^I and Z_t^S are Brownian motions defined on a filtered probability space $(\Omega, \mathcal{F}, \mathbb{Q}, (\mathcal{F}_t)_{t\geq 0})$. This formulation implies that the shock to each project's cash flow is decomposed into two components: an idiosyncratic shock that is independent from other projects ($\sigma_I dZ^I$) and a systematic (market-wide) shock that affects all firms in the economy ($\sigma_S dZ^S$). The parameter β is the systematic risk of the firm's assets, which I will refer to as the firm's "beta", and systematic shocks are assumed independent from idiosyncratic shocks. Brownian motion dZ from equation (1) is then represented as an affine function of two independent Brownian motions, $dZ = dZ^I + \beta dZ^S$, and

$$\sigma \equiv (\sigma_0^2 + \beta^2 \sigma_S^2)^{\frac{1}{2}}. \tag{15}$$

At date zero all firms in the economy are "born" and choose their optimal capital structure. The comparative statics of the system at date zero (where all firms are at their refinancing points) is thus analogous to that described in Section II.5. For the benchmark estimation I simulate 300 quarters of data for 3000 firms. To minimize the impact of the initial conditions, I drop the first 152 observations leaving a sample period of 148 quarters (38 years). The resulting data set is called a "simulated economy". On this resulting panel data set I perform cross-sectional tests similar to those in the literature. The presence of the systematic shock makes cross-sectional relations dependent on the particular realization of the market-wide systematic component.[18] Therefore I follow the methodology applied in Berk, Green, and Naik (1999) and repeat simulation and all accompanying analysis 320 times. This allows me to study sampling distributions for statistics of interest produced by the model in dynamics.

At any period each firm observes its asset value dynamics over the last quarter. If the value does not cross any boundary, the firm does not take any action. It is critical to stress that *it is optimal for the firm to remain passive.* If its value crosses an upper restructuring boundary, it conducts a debt-for-equity swap reversing the leverage ratio to the optimal level at refinancing point, starting a new refinancing cycle. If the liquidity boundary is hit for the first time in the current refinancing cycle, asset sales are conducted in the same period. If the firm ever defaults, bondholders take over the firm and it emerges in the same period as a new firm with a new optimal leverage ratio. Thus, firms emerge from the reorganization process very quickly (albeit with a loss of α of existing assets).[19] Observe that my procedure implies a constant population of firms in the economy: in particular, births of new firms are not allowed. This is not an important restriction since new firms parameters would have been drawn from the same sampling distribution as existing firms.

III.2 Choice of Parameters

This section describes how firms' technology parameters and economy-wide variables are calibrated to meet certain criteria and match a number of sample characteristics with those of the

[18] In the absence of the systematic shock (i.e. when the total risk consists exclusively of the firm's idiosyncratic risk), cross-sectional relations will be nearly identical in all simulations once economies reach their steady state.

[19] It is easy to change the dynamics of the model, requiring firms to spend a randomly specified time in bankruptcy (using distributions established by empirical researchers, e.g. Franks and Torous (1989)) This modification is likely to have a negligible impact on cross-sectional dynamics (the only change is a temporary reduction in the number of firms in the cross-section).

COMPUSTAT and CRSP data. Firms are different in a number of important dimensions. But shocks to firms' earnings are drawn from a distribution having a common systematic component. Thus, cross-sectional characteristics of financial variables such as leverage are attributable both to exogenous properties of individual firms and to dependencies in the evolution of their assets.[20]

An important caveat is that for most of these parameters there is not much evidence that would allow one to estimate their sampling distribution or range precisely. Even more difficult is to estimate the cross-sectional relationship between various firms' parameters, since empirical evidence is either non-existent or mixed. In addition, all parameters are estimated as time-invariant. Therefore, it has to be the case that any attempt to construct these parameters will be at present ad hoc. There are two ways I deal with this inherent problem. First, I try to follow well-known established empirical results for the parameters that have been estimated (such as tax rates). Second, and more importantly, I perform numerous robustness checks (see Section IV) and show that my results are not qualitatively affected by changing parameters in feasible range. Introducing cross-sectional dependencies between parameters can introduce some interesting additional effects but they are of second-order importance. Table II summarizes the descriptive information for parameters described below.

III.2.1 Firm technology parameters

The present value of the net payout and value of book assets at date zero are identical for each firm and scaled to be equal to 100. In the model with fixed investment and persistent earnings firm value returns are perfectly correlated with changes in earnings. In calibrating the standard deviation of net payout I therefore use data on securities returns. To start with, firms differ in their systematic risk represented by β. A distribution of firms' systematic risk is obtained by running a simple one-factor market model regression for monthly equity returns of all firms in the CRSP data having at least three years of monthly return data between 1965 and 2000 with the value-weighted CRSP index as the proxy for the market portfolio. All obtained betas, β^0, are adjusted towards the mean using a simple so-called "Bloomberg" adjustment (Grinblatt and Titman (2002, p.157)): $\beta = 0.66\beta^0 + 0.34$.[21] The resulting β is used as estimation of asset beta. Systematic debt risk is assumed to have a small impact compared to systematic risk of equity.

The distribution of firms' volatility is taken to match parameters of the distribution of the standard deviation of rates of return on firm assets reported by Schaefer and Strebulaev (2003).[22] The mean and standard deviation of that distribution are 0.255 and 0.10, respectively. The

[20] I repeat the whole exercise specifying that all firms are identical ex ante (using several benchmark scenarios). The main thrust of cross-sectional effects due to asset dynamics stays in place.

[21] Beta shrinkage reflects the estimation error where larger betas are likely to be overestimated and smaller betas are likely to be underestimated.

[22] Note that the Schaefer and Strebulaev's (2003) sample is confined to firms that issue public debt. As such, we might expect volatility distribution be biased (smaller firms can have higher mean volatility that is more dispersed). In robustness checks I show that changing assumptions on volatility distribution has an economically significant quantitative impact on average leverage ratios without affecting, though, any of qualitative cross-sectional results.

standard deviation of the common movements across firms' values, σ_S, is estimated as

$$\sigma_S = \sqrt{(1 - L_{av})^2 \sigma_E^2 + L_{av}^2 \sigma_D^2 + 2L_{av}(1 - L_{av})\sigma_{ED}}. \tag{16}$$

Here, σ_E is the volatility of monthly returns on the CRSP value-weighted equity return index, σ_D is the volatility of monthly returns on the 10-year T-note index over period 1965–2000 provided by CRSP, and σ_{ED} is the covariance between equity and debt returns. Estimates of these volatilities, 0.155, 0.081 and 0.023, respectively, are close to those reported by Campbell and Ammer (1993). Leverage, L_{av}, is computed from annual estimation of leverage for 1965–2000, averaged first for each year over firms and then averaged over time. Leverage is defined as the ratio of book debt to the sum of book debt and market equity. The volatility of idiosyncratic shocks, σ_I, must be chosen to match criteria for other parameters. After considering a number of ways of characterizing individual shocks, they are assumed to have a distribution with the probability density function $f(\sigma_I) \sim a_0 + a_1\chi^2(n)$. This distribution implies that projects with both low risk and very high risk projects are relatively common. A positive value of a_0 also ensures that there will be no cash flows with negligible total risk.[23]

Since proportional costs of restructuring in default, adjusting leverage, selling assets and issuing equity are all likely to be related to either liquidity of firm assets and/or easiness of access to external markets, all these costs are postulated to have a common covariance matrix. It is assumed that 20% of each costs' value is due to the common component. In particular, each cost, q_x, is drawn from the following distribution: $q_x \sim \mathcal{U}[a_x, a_x + \frac{2}{3}(b_x - a_x)] + \frac{1}{3}(b_x - a_x)s$, where a_x and b_x are bounds for the value of costs and $s \sim \mathcal{U}[0, 1]$. This formulation insures that the correlation between the values of different costs is 0.2. This distribution is symmetric and its trapezoid probability density function implies that the values closer to the boundaries are less likely to occur and the values in the range around the mean are equally likely to occur.

Values for the proportional cost of restructuring in default, α, are assumed to lie between 0.03 and 0.10. Empirical values reported in Weiss (1977; 1990), Altman (1984), Cutlers and Summers (1988), Alderson and Betker (1995) belong to this range. Some of the above papers report lower estimates, partially because the costs are evaluated using market value of equity one year prior to default. Recent evidence by Andrade and Kaplan (1998) suggests somewhat higher values. In any event, these bankruptcy costs are relatively small to explain any of the observed leverage ratios. Leland (1994) uses similarly defined costs of 0.5, Leland (1998) of 0.25, and Goldstein, Ju, and Leland (2001) of 0.05.

Fischer, Heinkel, and Zechner (1989) and Goldstein, Ju, and Leland (2001) use similarly defined restructuring costs, q_{RC}, of 1%. Datta, Iskandar-Datta, and Patel (1997) report total expenses of new debt issuance over 1976–1992 of 2.96% and Mikkelson and Partch (1986) find underwriter costs of 1.3% for seasoned offers. This author's unreported calculation using Fixed Income Securities Database (see Davydenko and Strebulaev (2003) for a detailed description) over the period 1980–2000 suggests that the average underwriters and management spread is between

[23]The "safest" companies in the Schaefer and Strebulaev (2003) sample have volatility value of about 0.06.

5 and 6 basis points. For a risk-free perpetuity a proportional cost of 1% implies a cost of about 5 basis points in annual yield when the risk-free rate is 5%. Note, however, that costs in this framework are proportional to the total amount of debt issued to avoid infinitesimal adjustments. Therefore, I choose substantially smaller adjustment costs in the range between 0.05% and 0.35% that is consistent in the benchmark scenario with costs *per new debt issued* be of the order of 1%.

Proportional equity issuance costs are assumed to be distributed with support [0.02, 0.08]. Recent empirical research emphasized that in most cases of initial public offerings a simple 7% solution was used to settle underwriter costs (Hansen (2001)). Seasoned equity offerings costs are likely to be smaller, however. Corwin (2003) reports gross spread of 5.4% and direct expenses of 1.5%. In addition, there is evidence (Altinkilic and Hansen (2000; 2003)) that equity costs come mostly from the variable component.

The costs of asset sales in a liquidity crisis are assumed to be distributed with support [0.05, 0.25]. Such costs are admittedly enormously difficult to estimate. In one of the most elaborate empirical attempts to date, Pulvino (1998) estimates that these costs are on average around 14% for companies with an above median debt ratio. Whether the companies with substantially higher debt ratios than the median (e.g. those facing a liquidity crisis) will face even higher costs as one may believe since they have less time to search for a better buyer has not been empirically established. Also, it is not entirely clear to what extent the airline industry example (as analyzed by Pulvino) can be extended to other industries. Anecdotal evidence from the financial press reports suggests that these costs can be even higher.[24]

The fraction of assets that remains after an asset sale, k, is assumed to have a uniform distribution with support [0.6,1]. Asquith, Gertner, and Scharfstein (1994) report that on average companies sell 12% of their assets.[25] Twenty one out of seventy six companies in their sample that took visible steps to restructure their firms sell more than 20%, and, most interestingly, the median level of asset sales among these twenty one firms is 48%.

The rate of net investment growth, g, is assumed equal to the expected growth rate of firm's net cash flows. It is consistent with firms having expected finite non-zero market-to-book ratio in an infinite horizon. It is also consistent with the fact that investment equal in magnitude in depreciation is needed to keep the firm as a going concern. Net payout ratio increases with interest payments according to (11). Parameter a depends ultimately on price-earnings ratios and dividend policy of firms. The range of its value is between 0.03 and 0.04; the value of 0.035 is also used in Goldstein, Ju, and Leland (2001).

When the net payout flow is substantially small, the firm starts losing part of its tax shelter. Since remaining tax shelter depends on carry-forwards and carry-backs benefit provisions it is likely that firms lose substantial part of offset when current income is not sufficient to cover interest payments. I model the partial loss offset boundary as $\delta_\kappa = \kappa\delta_L + (1-\kappa)\delta_B$, where κ is uniformly distributed on [0.7,0.9]. Therefore, it is assumed that when the net payout is below δ_κ, τ_κ is lost per each dollar of full offset, where τ_κ is set to be equal to 0.5. Note that this

[24]I have had a look on all cases on asset sales in Financial Times between January and September 2003: unreported results demonstrate that according to these reports, discount can be up to 40-50%.

[25]Based on book value. For distressed companies market value estimates can be larger.

formulation assumes that full tax benefits are resumed when the firm comes out of distress.

III.2.2 Economy-wide parameters

Corporate tax is assumed to be equal the highest existing marginal tax rate, $\tau_c = 0.35$. To decide on marginal personal taxes on interest income and dividend payments I follow Graham (1999; 2000). In particular, Graham (1999) estimates τ_i as 0.351 and τ_d as 0.122 over the period of 1980-1994. I ignore state taxes. While Graham (1999; 2000) estimates that state taxes may have the possible impact of about 0.025 to the total tax rate, he does not use state tax information in most of the analysis to minimize the effect of state tax rate measurement error. Thus, the maximum tax benefit to debt, net of personal taxes, is $(1 - \tau_i) - (1 - \tau_c)(1 - \tau_d) = 0.078$ per one dollar of debt. In estimating taxes I commit to at least two important simplifications: taxes are varying both across firms and across time. Introducing time-varying taxes would explicitly violate the scaling feature in the model. An estimate of the cross-section of marginal tax rates across firms can be obtained from the distribution described in Graham (1996; 1999; 2000). Difficulty arises in defining what marginal investor's personal tax rates are (Mayer (1990), Rajan and Zingales (1995)). Since we do not know whether these marginal firm-specific tax rates are correlated with firm characteristics, I choose to deal with firm-invariant tax rates. In addition, Gordon and Lee (1999) showed that marginal corporate tax rates seem to differ significantly between large and small firms. As such, the chosen marginal tax rate is more related to taxes faced by large firms.

After-tax risk-free interest-rate is 0.05. It is calibrated as a mean of three-month Treasury bill rate over the period 1965–2000 multiplied by $(1 - \tau_i)$. Ibbotson Associates (1995) report an average annual equity risk premium of about 0.08 and expected default premium of about 0.01 for the postwar period. Using L_{av} (see above), asset risk premium of the net payout ratio is estimated in the region of 0.065.

III.3 Preliminary empirical analysis

I now confront the calibrated model with the results of comparative statics at the refinancing point and some of the empirical results. I use two definitions of leverage, both based on the market value of equity. The first, the market leverage ratio, has already been defined for date zero in (13). For any other period it is defined analogously. Typically, however, market values of debt are not available and book values are used. I therefore introduce a second definition, the quasi-market leverage ratio, defined as the ratio of the par value of outstanding debt to the sum of this par value and market value of equity:

$$QML_t = \frac{D_0(\delta_t)}{D_0(\delta_t) + F(\delta_t) - D(\delta_t)}. \tag{17}$$

We expect difference between ML and QML be very small on average. For financially distressed firms, however, it can be more substantial. Intuitively, these ratios relate to how the firm has been financed in the past since the par value or market values of debt reflect decisions taken early in a refinancing cycle. Some researchers have suggested that these measures were accounting better for past financing decisions than alternatives such as the ratio of total debt to net assets, or total liabilities to total assets (Rajan and Zingales (1995)). To ascertain how close the firm is to financial distress a flow measure that show whether the firm can meet its debt payments is more relevant since firms enter financial distress at different levels of leverage. Therefore, I also consider the interest coverage ratio which is defined as the ratio of net payout to the coupon.

Table III summarizes the cross-sectional distribution of these various measures as well as credit spreads, giving values for the full sample, the median, and for a number of percentiles of the distribution. For credit spreads and market leverage I also give values that relate to leverage at the refinancing point. The average leverage ratio at the refinancing point is 0.27, compared to 0.37 in a similar model by Goldstein, Ju, and Leland (2001). The two main reasons for the difference are (i) the presence of additional financial constraints such as liquidity crisis costs and (ii) a lower tax advantage to debt since the tax rate on dividend income that I use is smaller.

Of more importance, however, is the descriptive statistics for dynamics. Means for dynamic statistics are estimated in a two-step procedure. First, for each simulated economy statistics are calculated for each year in the last 35 years of data. Second, statistics are averaged across years for each simulated economy and then over economies. To get a flavor of the impact of systematic shocks on the economy, for market leverage and credit spreads I also present minimum and maximum estimates over all economies. I begin the examination by comparing the leverage statistics in the dynamic economy to the valuation that ignores the dynamic evolution of the firm's assets. What Table III shows is that leverage ratios in the dynamic cross-section are larger than at refinancing points. Leverage ratios of firms that are in distress or close to a bankruptcy typically exceed 70%. Predictably, their impact on average statistics disproportionate. Thus, it shows that it is somewhat prematurely to claim a success in explaining low leverage ratios and one should be careful by using leverage at refinancing points to make any empirical claims.[26] Also, as one would expect, the distribution of dynamic leverage ratios is more disperse than the distribution of leverage in the cross-section at the refinancing point since in dynamics firms are more heterogenous. But this effect is weakened by the presence of the systematic shock.

For now, I have established that the cross-section of firms in dynamics differs from refinancing points in several important aspects. This happens because in the cross-section firms are at different stages in their refinancing cycle and firms' leverage reacts differently to economic shocks of the same magnitude. Next I turn to comparison with empirical data on leverage. Bernanke, Campbell, and Whited (1990) show a distribution of similar statistics for the three years 1986–88. Since they impute the market value of debt, I use my market leverage ratio for comparison. Overall, the magnitude looks quite similar with their mean of 0.33 is similar to mine. More interesting, however, is that the right tail of my distribution mirrors theirs closely suggesting that while different set of parameters will lead to different expected average values, *a cross-section of leverage ratios in a dynamic economy can replicate an empirically observed distribution, while the cross-section at a refinancing point can not.* Unfortunately, they do not report the left-tail

[26] I repeated the whole exercise using the model by Goldstein, Ju, and Leland (2001). It produces a dynamic average leverage ratio of 0.45 (all firms start at their benchmark case).

of their distribution: if the distributions are different, it is most likely to show up in the left tail, since many COMPUSTAT firms have very low leverage and this contributes to a bimodal distribution of leverage that the model cannot produce. Rajan and Zingales (1995) report, among other statistics, unadjusted quasi-market leverage ratios. For 1991 the U.S. mean and median are, respectively, 0.32 and 0.28, as opposed to 0.33 and 0.30 in my model.[27]

Rajan and Zingales report a median interest coverage ratio of 2.41 (4.05) when deducting (not deducting) depreciation. Bernanke, Campbell, and Whited report a mean value slightly above 5 before depreciation is deducted. Both results are similar in magnitude to mine of between 3 and 4. The tax advantage to debt is calculated as the ratio of the difference between the current value of the firm and the after-tax value of unlevered assets to the after-tax value of unlevered assets. This ratio ranges between 0 and 10% with a mean of 5%. This gain in moving from no-leverage to the optimal dynamic leverage, accounting for personal taxation, is comparable to the results on the net tax advantage of debt estimated by Graham (2000).

A brief look at credit spreads reveals an interesting pattern: while credit spreads at the refinancing point are quite low, with a mean (median) of 81bp (72bp), in dynamics they are larger at 121bp (80bp). Average credit spreads for investment-grade rated bonds over 1987-1996 are 60-118bp (Elton et al (2001)) and are 109bp with median 85bp over 1996-2000 (Davydenko and Strebulaev (2003)). In dynamics credit spreads also can become very substantial (99% value is more than 800 bp). Since credit spreads are highly convex in the value of the firm, in dynamics higher levered and particularly distressed firms start dominating the sample. This explains a substantial increase in the mean credit spread in dynamics. However note that in the model bondholders take over the firm in the case of default, albeit at a cost, and therefore extreme credit spreads that are sometimes observed in the market do not occur here.

Table IV shows that the annual default frequency is around 43 basis points; around 8% of firms restructure every year; 1.15% conduct asset sales (i.e. reach the liquidity barrier for the first time) and about 6% are in financial distress and have to resort to costly equity issuance.

To this point, I have simply compared some average statistics in dynamics, at the refinancing point and obtained in existing empirical work. But what can be said about the behavior of firms in the cross-section? In particular, why some firms are low-leveraged and some firms are near or in distress? Firms can have low leverage for two reasons. First, some firms are optimally conservative in their debt usage. Such firms can be characterized as high risk (large volatility of cash flows); on average they face large ex ante distress and bankruptcy costs, have illiquid assets (i.e., with higher asset liquidation costs) and expect to be less profitable. Comparative statics results in Table I and regression analysis in Table VI support this conjecture. Second, firms may also have low leverage if they have been successful for considerable time in the past but have nonetheless refrained from restructuring. Thus, firms that are profitable and successful may also use debt conservatively. These firms can probably be thought of those that Graham (2000, p. 1902) describes as "large, profitable, liquid, in stable industries, and face low ex ante costs of

[27]To complement the comparison, I constructed an empirical distribution of quasi-market debt to capital ratio on COMPUSTAT data each year between 1965 and 2000. 90% and 95% percentiles of distribution are between 57 and 89%, and 62 and 92%, respectively. See footnote 2 for definition of debt to capital ratio.

distress".[28] Stable firms (those with lower business risk) are more prone to a decrease in leverage since they are more sensitive to changes in the value of assets. It also takes longer for them to reach refinancing points. Also, some firms of the first type are likely to have higher leverage since they have experienced a stream of low earnings. Conversely, the lower value of second-type firms' restructuring boundaries results in a decrease of their influence in the cross-section.

Unlike low-leveraged firms, firms with leverage significantly above average can only be distressed firms who have experienced bad times. Leverage at refinancing point rarely exceeds 0.55 as Table III demonstrates while average leverage of firms with EBIT lower than 1.1 is about 0.80.

As a preface to the next section, I investigate whether the cross-sectional relations between leverage and its determinants differ between comparative statics results at refinancing point and in dynamics using a simple correlation analysis. Table V reports correlations between the market leverage and its determinants. Panel A reports correlations at refinancing point, while Panel B for dynamics. Three results stand out. First, while market leverage and credit spreads are negatively correlated at refinancing point, in dynamics the opposite result is observed. To see why leverage and credit spreads are negatively associated at refinancing point, observe that large leverage is associated with low volatility and low costs of distress and bankruptcy. But the lower are volatility and these costs the lower are credit spreads. This intuition, however, is in dissonance with market observations. A positive association between leverage and credit spreads is widely reported (see e.g. Davydenko and Strebulaev (2003), Schaefer and Strebulaev (2003)), and this is clearly consistent with what we observe in the model dynamics. Relation between leverage and credit spreads changes profoundly in the dynamic context since firms with worst performance observe an increase in both their leverage (equity value falls by more than debt value as distress approaches) and credit spreads (outstanding debt becomes riskier) while firms with best performance observe a decrease in their leverage (until refinancing) with their credit spreads not increasing above the initial level.

Second, the relation between volatility and leverage becomes weaker in dynamics. Third is the change in the sign of the relation between leverage and profitability, the result to which the next section is largely devoted.

III.4 Cross-sectional regression analysis

III.4.1 Leverage-profitability relationship

I have established that both the distribution of leverage and the cross-sectional relation between leverage and other variables of interest may differ substantially between refinancing points and dynamics. Table V shows that, in particular, the relationship between leverage and profitability appears puzzling. Profitability is defined as the ratio of earnings before taxes and interest (in the model the sum of net payout and retained earnings) to the book value of assets in place, A_{t-1},

[28] Graham (2000) introduces a concept of a "kink", the point where marginal tax benefit curve becomes downward sloping. As the model does not have any explicit carry-forward, carry-back provisions, and non-debt tax shields, kink here is simply δ_t.

which grows at a rate of g per annum:

$$\pi_t = \frac{\delta_t + \Delta A_t}{A_{t-1}}. \tag{18}$$

The trade-off theory predicts that a persistent increase in earnings pushes firms towards higher usage of debt financing by increasing the tax advantage to debt and reducing expected costs of distress and bankruptcy. This is reflected in a positive correlation between leverage and profitability at the refinancing point reported in Panel A.[29] The negative sign in Panel B shows that in dynamics this relationship becomes negative *even for* a trade-off model. This section investigates the nature and the magnitude of this effect for the main empirical tests reported in the literature and use simulated data generated by the model to gauge whether this is important for understanding the results of empirical tests. Section IV then assesses the extent to which this result, from both qualitative and quantitative perspectives, is dataset- and model-dependent.

Why is the leverage-profitability relation singled out? Firstly, as Myers (1993) has pointed out, perhaps the most pervasive empirical capital structure regularity is the inverse relation between debt usage and profitability. Indeed, the relationship is one of several widely established results in the empirical capital structure literature that does not depend on the specifics of the cross-sectional regression methodology.[30] More importantly, it is also one of a few (if not the only cross-sectional relation) that helps to discriminate between the trade-off model and various theories associated with the pecking order idea, according to which, if profitability is persistent then, holding investment fixed, higher profitability enables firms to use less leverage. This holds for both static and dynamic pecking order intuition. In a static pecking order world, when investment outlays are less than earnings, retained earnings grow and leverage falls. In a dynamic environment, firms face an intertemporal trade-off between current and future investments and the costs of external financing. As earnings grow, expected future earnings also increase and firms can maintain a lower debt ratio. In cases of other factors, either the predictions of both pecking order and the trade-off theory are the same or the predictions of various versions of the pecking order theory differ. For example, both the pecking order and trade-off models predict that higher volatility of the firm's cash flow is likely to lower the optimal amount of borrowing. For another important determinant of leverage, investment outlays, the static pecking order suggests that higher investment leads to higher borrowing when retained earnings are fixed, while the dynamic version predicts higher expected investment to decrease current debt so as the debt capacity is preserved for the future. It follows, therefore, that a consistently negative relation between leverage and expected profitability is interpreted as a major failure of the trade-off model.

I turn now to whether the cross-sectional leverage-profitability and other relationships that my

[29] Note that all changes in earnings in the model are persistent and thus firms with higher profitability at date zero expect to be more profitable in the future and opt optimally for higher borrowing. Extraordinary cash flows resulting from asset sales are not counted.

[30] An incomplete list of papers that have established this result include Titman and Wessels (1988), Fama and French (2002), Baker and Wurgler (2002). Rajan and Zingales (1995) establish that the inverse relationship holds for 6 out of 7 developed countries apart from Germany and Booth, Aivazian, Demirguc-Kunt, and Maksimovic (2001) report that it holds for most of developing countries.

framework delivers, are consistent with those reported in the empirical capital structure research. I perform a number of cross-sectional regression tests using simulated data from the model on the level of leverage and its changes. Recall that each simulated data set ("economy") consists of 3000 firms for 300 quarters and that economies differ because of a systematic shock. As before, I drop the first half of the observations leaving a sample period in each simulation of 38 years. For each economy I then conduct the regression tests outlined below. I report means of coefficients and t-statistics obtained over all simulated economies for each set of regressions, and also the distribution of coefficients for several of them.

Table VI reports the results of the first set of experiments. Column 1 reports the regression for market leverage at the refinancing point and Columns 2–4 – on simulated economies. Early empirical tests of capital structure (e.g. Bradley, Jarrell, and Kim (1984), Long and Malitz (1985)) conducted simple cross-section ordinary least squares regressions of quasi-market leverage ratio on several determinants, including profitability. Column 2 in Table VI attempts to replicate their method by performing OLS regression of quasi-market leverage, QML, against profitability and the constant "firm technology" parameters on the last year of each simulated economy. Thus, the regressand and regressors are measured contemporaneously. Some deficiencies of these tests have been recognized by Rajan and Zingales (1995) and, in an attempt to replicate their procedure, Column 3 reports OLS regression of market leverage taken in year t against four year averages of the regressors over years $(t-4)-(t-1)$, where year t is the last year in each data set. Thus, independent variables are lagged one year and then averaged over four years. Rajan and Zingales lag regressors to reduce the problem of endogeneity. Since profitability is persistent and other regressors are time-invariant, it does not have any impact on my results. Rajan and Zingales average the explanatory variables to reduce the noise and to account for slow adjustment.[31]

Fama and French (2002) estimate "target leverage" using a two-step procedure. They first estimate year-by-year cross-sectional regressions and then use the Fama-MacBeth methodology to estimate time-series standard errors that are not clouded by the problems encountered in both single cross-section and panel studies. The main problem with these methods stems from correlation in the regression residuals across firms and the presence of autocorrelation in the average regressions coefficients. In the simulated economy, correlation in the regression residuals exist because firm values are correlated via the systematic shock and the average slopes are also autocorrelated because leverage is a cumulative outcome of past idiosyncratic shocks. I follow a simple and conservative rule used by Fama and French and assume that the standard errors of the average slopes should be multiplied by a certain factor to account for autocorrelation before judging the significance of a variable. Unreported results demonstrate that average coefficient on profitability is autocorrelated and behaves like an AR(1) process with observed maximum of about 0.75 and thus (see Fama and French (2002, p. 12)) a multiplication factor is 2.5. In other words, t-statistics are required to be around 5.0, rather 2.0, to reject the null hypothesis. The autocorrelation of the other coefficients is of the same order. Column (4) of Table VI shows the

[31] Rajan and Zingales also employ a censored Tobit model since in some cases they face negative values of leverage which they truncate. They also report (their footnote 28) that OLS results are very similar.

results of running a Fama-MacBeth regression on the last 35 years of each simulated economy and then averaging the result across economies.

To summarize, each of the regressions above can be written as:

$$QML^P = d_0 + d_1\pi^P + d_2\sigma + d_3\alpha + d_4 q_{RC} + d_5 q_A + \epsilon^P, \tag{19}$$

where P, $P \in$\{BJK,RZ,FF\}, refers to the method. For example, $QML^{RZ} = QML_t$; $\pi^{RZ} = \frac{1}{4}\sum_{m=t-1}^{t-4}\pi_m$, and so forth.

I begin by describing briefly the first regression reported in Column 1, Table VI. It demonstrates the quantitative importance of different factors on optimal leverage at refinancing points. A 1% increase in expected profitability increases target leverage by 2.3% and a 1% increase in the firm's business risk produces an offsetting effect on leverage of the same magnitude. The effect of bankruptcy and distress costs is smaller in absolute magnitude demonstrating again that by themselves these costs are not sufficient to act as a main offsetting factor in the trade-off to the tax advantage to debt. Perhaps surprising is insignificance of restructuring costs. Recall, however, that leverage is a non monotonic function of them.

The results of Columns 2–4 are roughly similar and this similarity is in line with the Fama-French observation that their results are mainly supportive of previous findings. In particular, the negative leverage-profitability relation survives the regression analysis. The Fama-MacBeth estimates produce negative average slopes that are more than 10 standard errors below zero.

Note the particular importance of this result: *an empiricist would be likely to interpret such a finding as evidence in favor of the pecking order theory and contrary to the predictions of the trade-off model.* However, we know, that firms in the simulated economies do indeed choose their leverage on the basis of the trade-off between tax benefits to debt and costs of financial distress. But why, in this case, is the profitability coefficient significantly negative in dynamics? An increase in profitability effects future profitability and thus the value of the firm. But while an increase in the value of the firm lowers leverage, it does not necessarily lead to refinancing in a world with transaction costs. Note that in the framework target leverage is constant, and the observed positive relation between leverage and profitability at the refinancing point is purely a cross-sectional effect. The negative relation is firm-specific since it lowers the current leverage of individual firm. There exist, however, another effect. At any point in time some successful firms choose to releverage and this weakens the negative relationship. The results in Table VI imply that the first effect dominates in the simulated data. To my knowledge, this is the first attempt to identify this effect explicitly in a dynamic trade-off model.

That the presence of frictions may cloud inference has been recognized in a number of previous studies. For example, Fama and French (2002) note that their result may overstate the long-term relation between leverage and profitability by picking up transitory variation in leverage rather than variation in target leverage making it difficult to disentangle the trade-off and pecking order models since a negative coefficient may be the result of the transitory component, pecking order behavior or both. It is instructive, therefore, to look at the size of the coefficient in simulated data to judge whether a trade-off model can give rise to a value similar to that found empirically.

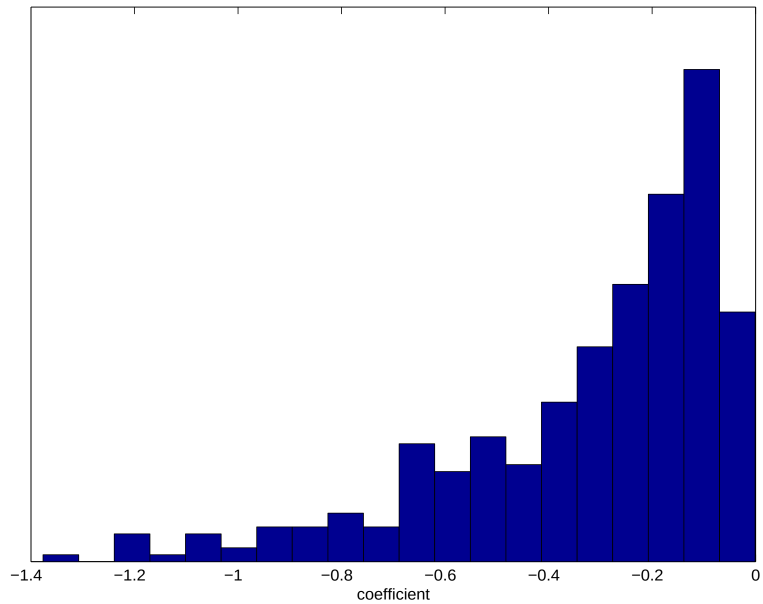

Figure 2: **Profitability coefficient. Fama-French (2002) regression.**

The population value of the profitability regression coefficient is above those found by previous researchers. Profitability coefficients reported by previous studies include −0.90 (Fama and French (2002)), −0.6 (Rajan and Zingales(1995)), and −0.61 (Baker and Wurgler (2002)).[32] However, my estimate of −0.32 for the Fama and French-type regressions is simply the population mean across all economies. It is, therefore, useful to examine the empirical distribution of coefficients across simulated economies to gauge whether estimate in the range −0.6 to −0.9 are likely to occur with high likelihood in the model. Figure 2 shows this distribution for 300 such economies. Several observations stand out. Firstly, nearly all the coefficients are negative, though some are insignificant (taking into account the five standard error rejection threshold). Columns 6 and 7 of Table VI report 10% and 90% percentiles of this distribution. Under the assumptions of the model and the chosen set of parameters empirical estimates are consistent with the value of the coefficient in my data set.

There are several possible interpretations of this result. First, the parameter set may be unrepresentative because, for example, I do not allow for correlation between volatility and distress/bankruptcy costs. Indeed, in a number of robustness checks that I performed, starting with different set of parameters, under different assumptions (see section IV that describes some of them), the coefficient is smaller in magnitude. In particular, smaller renegotiation costs and more disperse firms' loadings on systematic risk result in the larger coefficient. Under many other changes, the result is unchanged. In a nutshell, these checks suggest that at the very least the model can explain a large part of the negative relationship.

[32]Fama and French report several profitability coefficients, ranging from −0.42 to −0.96, since they study both book and market leverage, divide samples in two groups – dividend payers and nonpayers, and include in some regressions simultaneously estimated target payout ratio. Coefficient −0.9 is for the regression on market leverage for dividend payers not allowing for the target payout ratio. Rajan and Zingales report the coefficient for quasi-market leverage for the U.S. In Baker and Wurgler, market leverage ratio is for 1980-1999 COMPUSTAT firms.

Second, I used the quasi-market leverage ratio (results for the market leverage ratio are very similar). Fama and French (2002) argue that the profitability-leverage relationship holds theoretically only for book leverage. In their regressions, however, the values of the slope are very similar. Furthermore, one would expect that using market leverage would produce a smaller slope than when book leverage is used. In their result for non-dividend payers, however, the opposite is observed. Therefore, while for book leverage the result is likely to hold under a broader set of conditions than for market leverage, it is unlikely that this drives the observed difference.

Third, in my model as well as in most dynamic models of optimal structure, the investment process is fixed, in other words, it is independent of the process that determines the leverage ratio. In deriving the value of book assets I make an assumption that book assets grow at a rate equal to the growth rate of the net payout under actual distribution – the only rate under which market-to-book ratio has a finite non-zero expected value. I choose a conservative value of one for an initial market-to-book ratio since my firms can be characterized as value firms. Increasing the market-to-book ratio, however, would lead to an increase in profitability via a decrease in book assets and therefore to a decrease in the magnitude of the profitability-leverage coefficient.

Fourth, the profitability effect may be due to misspecification of the regression equation, for example, because of the correlation structure between profitability and other regressors. However, the correlation between profitability and volatility, as Table V demonstrates, is very low at 0.04. The correlation between profitability and distress and bankruptcy costs are even of smaller significance. And a univariate regression of profitability (unreported) shows that the results are robust to a regression specification.

All other coefficients in Table VI retain their sign in dynamics. The coefficient on volatility is smaller than in the regression in Column 1.[33] Note also, perhaps somewhat unexpectedly, that restructuring costs become significant in a dynamic economy. A possible explanation is that higher restructuring costs lead to an increase in the level of the refinancing boundaries and thus the average waiting times between adjustment and the corresponding change in leverage is larger.

III.4.2 Leverage and stock returns

In a recent paper, Welch (2004) obtains empirical results that to some extent parallel my explanation. Welch's main finding is that U.S. corporations do not change their capital structure to offset the mechanistic effect on leverage of changes in their stock price. As I have emphasized above, the absence of a response by the firm to these mechanistic changes in leverage may, indeed, be optimal in the presence of restructuring costs. It is instructive, therefore, to investigate to what extent the mechanistic effect observed by Welch is reflected in my simulated economies. To this end, I replicate, using simulated data, the regression test that he performs on the COMPUSTAT data set (Welch (2004), Table 3). For each year t I run a cross-sectional regression of the market leverage ratio level against the implied ("inert")market debt ratio, $IDR_{t-k,t}$ in Welch's notation,

[33] Volatility is rarely used in empirical studies since it is hard to estimate and thus direct comparisons with the literature are not possible. Fama and French (2002) propose using firm size as a proxy for volatility since large firms are likely to have less volatile earnings.

i.e. what the market leverage ratio would have been if the firm had not issued any securities between years $t-k$ and t, and actual observed market leverage ratio in year $t-k$, ML_{t-k} in my notation. The regression, therefore, can be represented as[34]

$$QML_t = f_0 + f_1 IDR_{t-k,t} + f_2 QML_{t-1} + \epsilon. \tag{20}$$

Note an important difference between this regression and those replicated earlier. Unlike the case of the cross-sectional regressions reported in Table VI, where some variables of interest such as firm size and research and development expense cannot be included they are not present in the model, in this case I am able to construct regression (20) that is exactly parallel to those studied by Welch. The only point of departure between my simulations and the empirical procedure followed by Welch is that the number of firms that is used in the empirical study declines as maturity increases while in simulations the number of firms is fixed.

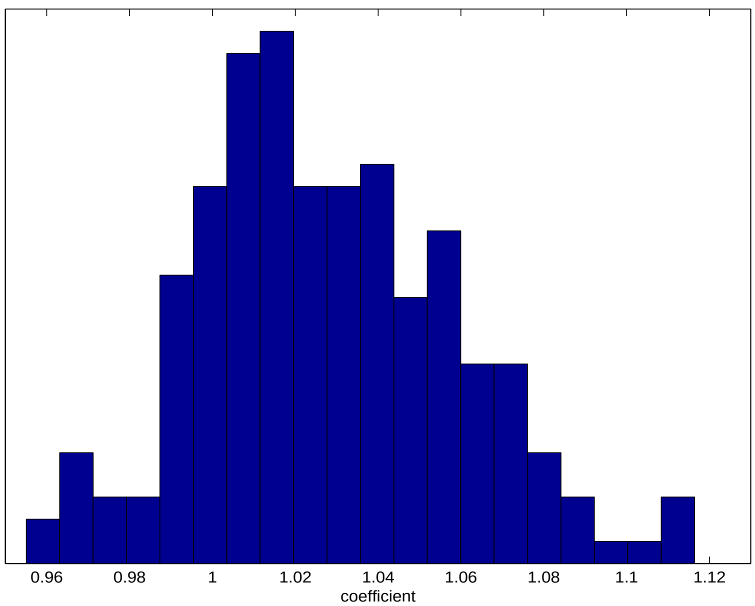

Figure 3: $IDR_{t-1,t}$ **coefficient.**

Implied debt ratio shows the response of leverage only to changes in equity. Thus, if the coefficient f_1 is equal to one, firms do not readjust at all. Alternatively, a value of f_2 equal to one would imply that firms perfectly offset any change in equity.

To replicate the procedure followed by Welch I compute the average of time-series of the cross-sectional regression coefficients a la Fama-MacBeth. Then, as usual, the results are averaged over many simulated economies. Table VII shows that for all four choices of k, – 1, 3, 5, and 10 years, – the results appear to conform very closely to those obtained by Welch. The slope of nearly one for the implied debt ratio for the one-year regression (the average slope of 1.01 in Welch and 1.04 in the model) indicates that financing is very passive, in other words, corporations do not react

[34]Welch also reports the result of the estimation of the same equation without a constant. Both his and mine results are robust to such change in specification and therefore I do not report the results.

to changes in the value of their equity by adjusting leverage. The term structure of coefficients is also very similar with the coefficient on the implied debt ratio decreasing to between 0.6 and 0.7 at ten years. Figure 3 demonstrates that Welch coefficient for the implied debt ratio is well within the observed frequency of average coefficients in the model for the one-year regression, and Table VII shows the same for other regressions. Overall, my main finding is that my model would not reject the Welch coefficient on the implied debt ratio over a short horizon and that the term structure patterns of the coefficients are very similar as well. The simulations clearly show that a model with relatively small adjustment costs can produce results on the persistence on leverage that are consistent with those observed in reality.

There is one particular feature that deserves special attention. Welch (2004) points out that while corporations are very active in debt issuance, the motives "remain largely a mystery" given that mechanistic change in equity value is not offset. My framework allow to illustrate the same point from a different perspective. A coefficient close to one is interpreted above as extreme passivity on the part of shareholders in their debt decisions. However, it seems to contradict the result reported in Table IV that, on average, about 8% of firms restructure every year. In fact, there is a simple reconciliation of this puzzle because the Welch's (2004) main result also obtains if firms issue debt quite frequently, but the contemporaneous covariance between new debt issues and equity returns over the chosen period k is zero. And this is exactly what happens in the model. Since debt is issued in response to long-term equity returns, short-term returns on equity are unlikely to trigger a financing decision. However, if the covariance between changes in outstanding debt and equity returns over $t-k$ to t is weakly positive, then the coefficient on $IDR_{t-k,t}$ will be slightly larger. For $k = 1$ year, it slightly exceeds one. Observe that in the model, while the equity return over the last year does not trigger debt issuance by itself, debt will be issued only if equity returns are positive (otherwise the refinancing barrier would not be reached) and so a positive covariance exists. In addition, a liquidity crisis followed by debt reduction occurs only if the last period equity return was negative. This explains why an average value of one-year coefficient is slightly higher than 1 at 1.04. Figure 3 shows that for the one-year regression coefficients across all economies are greater than 1. At the same time it is also consistent with empirical results reported by Welch. It also provides an explanation why over a long horizon my coefficients are smaller than the Welch's ones: in reality firms also issue debt for reasons unrelated to the trade-off arguments but also unrelated to changes in equity value.

It is tempting to suggest that adjustments costs are entirely responsible for the results reported by Welch (2004). However, as Welch himself point out, there are some drawbacks of this explanation: (1) direct transaction costs are small; (2) readjustment patterns are similar across firms while transaction costs are very different; and (3) firms do not seem to lack the inclination to be capital structure active, but they seem to lack the proper inclination to readjust when equity value changes. My analysis can shed light on some of these concerns but is silent on others. First, we have seen that even small transaction costs can lead to stickiness in the firm's debt policy. Robustness checks in Section IV show that even taking the highly conservative estimate of transaction costs leaves the results qualitatively essentially unchanged. Second, in the model debt issuance costs are smaller than equity issuance costs, thus the firms who reduce debt when they are in distress experience relatively higher transaction costs. In other words, after substantially negative equity returns firms face higher transaction costs. However, these firms are no more eager to readjust. Third, as I have explained above, the framework accounts for both the capital structure activity of firms and their lack to readjust in response to past equity returns. At the same time, at least two issues raised by Welch (2004) can not be addressed satisfactorily in the present framework. There is no difference between small and large firms, and no richer set of debt instruments is allowed that would enable corporations to avoid paying transaction costs.

III.4.3 Changes in leverage and mean reversion

I turn next to studying the question of the extent to which leverage is mean-reverting in simulated economies. Table VIII summarizes estimates of a number of partial adjustment models where the dependent variable in all cases is the changes in the quasi-market leverage ratio. Columns 1 and 2 of the table follow studies by Hovakimian, Opler, and Titman (2001), Shyam-Sunder and Myers (2001) and Fama and French (2002) and report the results of a two-stage cross-sectional regression estimation. In the first stage, target leverage, TL, is estimated using equation (19) and the estimated value is then used in estimating the following regression for changes in leverage:

$$QML_t - QML_{t-1} = h_0 + h_1 TL_{t-1} + h_2 QML_{t-1} + h_3 X_{t-1} + \epsilon, \tag{21}$$

where X_{t-1} represents other possible lagged regressors. A partial adjustment model predicts that h_1 is positive and h_2 is negative and, furthermore, that they are equal in absolute value. Coefficient h_2 measures the speed of adjustment of leverage to its target level.

Not surprisingly, we find that leverage is mean-reverting. A coefficient of -0.16 indicates that the mean reversion of leverage is 16% per year. Fama and French (2002) report a similar mean reversion speed of 7-10% for dividend payers and 15-18% for non dividend payers which they refer to as “snail’s pace”. My firms may be better characterized as “crouching tiger”: most of the time firms do nothing to the level of their book debt, but when they do make changes it is by a large amount. Also, in line with the results reported by Fama and French (2002), the average slopes on lagged leverage are similar in absolute value to those on target leverage that is consistent with the prediction of the partial adjustment.

Column 4 adds change in earnings as an additional regressor. While the results are very similar to those of Fama and French (2002), my interpretation is slightly different. They suggest this result shows that short-term variation in earnings is largely absorbed by debt. In the model that has been developed here a change in profitability that effects the leverage ratio is due exclusively to persistent change in earnings.

Columns 3 and 4 of Table VIII report estimations of regressions of change in the leverage ratio of the type studied by Welch (2004). The regression can be written as:

$$QML_t - QML_{t-k} = l_0 + l_1(IDR_{t-k,t} - QML_{t-k}) + l_2\pi_{t-k} + l_3\pi_{t-k}(IDR_{t-k,t} - QML_{t-k}) + \epsilon. \tag{22}$$

An idea is that when a coefficient on profitability, π_{t-k}, is significant it incrementally helps to explain leverage controlling for equity returns. If the cross-term is significant, then profitability incrementally helps to explain leverage adjustment.

Estimates in Table VIII indicate that once stock returns are controlled for, profitability looses most of its power in explaining market leverage level, but is still able to account for the adjustment behavior of firms in cross-section. It is interesting to observe that profitability is significantly negative in Welch (2002) and the result on the cross-term are similar to mine. That the coefficient on profitability is negative suggests that there exist factors not present in the model (not related to direct adjustment costs) and as such this provides another piece of support for the hypothesis proposed in Section III.4.1 that the coefficient on profitability in the cross-sectional regressions is partially explained by non-adjustment costs factors.

IV Robustness Tests

In this section I describe the results of a number of robustness tests that I conduct to see to what extent my results are sensitive to changes in parameter values and estimation procedure. They fell into two categories. First, using the benchmark data set, I investigate whether the results are influenced by the way the sample is constructed. In particular, outliers in the simulation of the evolution of firm asset value may have an undue influence. Second, I study whether perturbating the parameters has a significant impact on the results. For each robustness check I recalculate the whole analysis but, to limit the usage of computer power, the results are calculated using 300 firms and 100 simulated economies. Other features of simulation design are not changed.

The key question is whether the main results of the paper survive the robustness tests. These include: (1) the relation between the average level of leverage at refinancing points and in a dynamic economy; (2) the average slope of the leverage-profitability relationship; (3) the Welch's (2004) finding on capital structure and stock returns; (4) the degree of mean-reversion. To save the space, I report in Table IX only a summary of the results.

The evolution of a dynamic economy leads to some outliers. While there is no measurement error in my benchmark data set, an empiricist using the generated data of any simulated economy might be concerned that some observations dominate the results and would therefore exclude them. Following the approach used in the empirical capital structure literature, I examine how the results are changed when: (i) the true volatility of the firm cash flows is trimmed at 5% and 95% percentile thresholds; (ii) in a dynamic economy, the time-series volatility in each year is estimated for each firm over the previous 5 years and estimates outside 5% and 95% percentiles are excluded; (iii) in a dynamic economy, only firms with combined market value of equity and debt more than 10 are included; (iv) in a dynamic economy, for each year firms whose profitability lies outside 5% and 95% percentiles are excluded; (v) firms that experience default over the previous five years are excluded. I find that none of the changes in procedure that is when market values of debt are used instead of book values of debt influence main results in any significant way.

The next tests examine the dependence of the results on changes in the parameters. First, for each exogenous parameter that varies across firms, I consider five cases. For the first two, the distribution of the parameter is identical to the benchmark case except that its mean is changed: in one case increases and in the other decreased. In the remaining three cases, the parameter value is set equal across firms at upper and lower boundaries of the benchmark distribution and, finally, to a value equal to the mean in the base case. I find that qualitatively the main results are unchanged. Changing the volatility parameters results in a noticeable changes in the cross-sectional leverage distribution. Changes in distributions of renegotiation costs and betas produces noticeable quantitative changes to profitability coefficients. Overall, mean profitability coefficient changes between -0.61 and -0.13. The implied debt ratio coefficients are found to be more stable.

Third, I investigate the effect of changes in macroeconomic and tax parameters. Unsurprisingly, decreasing the tax advantage to corporate debt results in lower leverage in the economy. One result not shown in the Table IX is that a decrease in τ_i from 0.35 to 0.3 lowers the average market leverage ratio from 0.32 to 0.24. The difference between the average leverage ratio in dynamics and at the refinancing point is, however, not significantly affected.

Finally, I consider the effect of measurement errors. In particular, a stochastic component in the evolution of book assets and a measurement error in market leverage are introduced. Note that these measurement errors do not effect the optimal decisions by firms.

Overall, the results appear to be quite robust with respect to changes in firm-specific and environmental parameters and to changes in empirical procedure. This applies particularly to the cross-sectional results which are also the most important.

V Concluding Remarks

This paper is the first to describe a methodology for assessing the quantitative implications of the cross-sectional properties of leverage in a dynamic economy. The methodology also provides a greater insight into the qualitative aspects of these properties. It compares the findings from studying a cross-section in dynamics to the results of the empirical literature by replicating these same empirical methods to data generated by a dynamic model of optimal capital structure. It also compares properties of leverage in dynamics with those at refinancing points, i.e., where firms take active financial decisions. The main findings are that (i) the properties of leverage in the cross-section are dramatically different in dynamics and at refinancing points, and (ii) the model gives rise to data that, using methodologies commonly used in the literature, would lead to its rejection. These findings provide a clear signal of the need for further research in this area.

There are two principal directions in which the framework developed in this paper could most usefully be extended. First, because the dynamics of financing decisions have such profound influence on the empirical properties of the cross-section, it is important that competing theories of capital structure – beyond the trade-off theory – are developed in fully dynamic form. The most obvious candidates at this stage are the pecking order theory and, more generally, models based on asymmetric information. First attempts already have been made (Dasgupta and

Sengupta (2002), for example, develop a dynamic model with moral hazard where, interestingly, dynamic interaction leads to an alternative explanation for a positive relationship between leverage and profitability), but development of asymmetric information models and models that lead to quantitative predictions is still largely a subject of future research.

Second, a proper study of the evolution of capital structure in a dynamic economy requires a model that combines both real investment and dynamic capital structure decisions. Berk, Green, and Naik (1999) may provide an excellent basis for the first of these requirements while the model developed here – for the second. Research that combines these two strands is likely to be a fruitful avenue for future in capital structure, and more generally, corporate finance.

Appendix A Details of Simulation Analysis

The process for δ is discretized using the following approximation:

$$\delta_t = \delta_{t-\Delta t} e^{\left(\mu_A - \frac{\sigma^2}{2}\right)\Delta t + \sigma\sqrt{\Delta t} z_t}, \tag{A1}$$

where Δt is one quarter, 1/4, z_t is a standard normal variable, and μ_A is the growth rate of the net payout ratio under the physical measure. The benchmark estimation 300 quarters of data for 3000 firms are simulated. Note that while I discretize the model for the purpose of simulation, firms still operate in a continuous environment. In particular, it must happen now that firms will sometimes "overshoot" over boundaries and make their financial decisions not exactly at the prescribed optimal times. Unreported robustness checks show that increasing the frequency of observations does not produce any significant changes in the results.

To choose the number of observations that will be dropped to minimize the impact of initial conditions the following procedure has been implemented. I simulate the panel data set for 500 firms with the benchmark set of parameters. Then, I choose 24 randomly selected initial leverage ratios for each firm within the feasible range. Using the same systematic shock realization, 24 economies are simulated. The economy is defined as converged to its steady state if the difference between maximum and minimum values of average leverage across simulated economies is less than 2% for at least 10 quarters. I repeat the same analysis for 250 different systematic shock realizations. The resulting distribution of steady state times has a value of 95% percentile of 122 quarters. For a conservative estimate I add another 30 quarters. Observe that while the impact of initial firms' financial condition disappears, the presence of systematic shocks means that the economy state differs across simulated economies at the truncated date.

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Table I
Comparative Statics of Financial Variables at the Refinancing Point

The table gives the comparative statics behavior at the refinancing point of the following variables: the optimal market leverage ratio (ML), bankruptcy boundary (δ_B), restructuring boundaries (δ_U and δ_{UL}), total firm value ($E(\delta_0)$), the liquidity barrier (δ_L), and credit spread (CS). τ_c is the corporate tax rate, τ_d is the dividend tax rate, τ_i is the interest tax rate, r is the pre-tax risk-free interest rate, σ is the volatility of the net payout ratio growth, α is the fraction of asset value lost of bankruptcy occurs, q_{RC} are the restructuring costs, q_A are the costs of selling assets in a liquidity crisis, q_E are the costs of equity issuance, and k is the fraction of asset value that remains after the asset sale.

		Sign of Change in Variable for an Increase in:								
Variable	Shape	τ_c,τ_i	τ_i	r	σ	α	q_{RC}	q_A	q_E	k
ML	Invariant to δ	> 0	< 0	< 0	< 0	< 0	> 0, q_{RC} small < 0, q_{RC} large	< 0	< 0	> 0
δ_B	Linear in δ	> 0	< 0	< 0	< 0	< 0	> 0, q_{RC} small < 0, q_{RC} large	< 0	< 0	> 0
δ_U,δ_{UL}	Linear in δ	< 0	> 0	< 0	> 0	< 0	> 0	> 0	> 0	< 0
$E(\delta_0)$	Linear in δ	< 0	< 0	> 0	< 0	< 0	< 0	< 0	< 0	> 0
c,δ_L	Linear in δ	> 0	< 0	> 0	< 0	< 0	> 0, q_{RC} small < 0, q_{RC} large	< 0	< 0	> 0
CS	Invariant to δ	> 0	< 0	< 0	> 0	< 0	< 0	< 0	< 0	> 0

Table II
Parameter Values for Simulations

Listed are the values and sampling distributions chosen for all parameters required to simulate the model. RP_A is the asset risk premium. All other parameters are defined in the text.

Parameter	Distribution	Mean	Std.dev
V_0	constant	100	
A_0	constant	100	
β	empirical	0.993	0.47
σ_E	constant	0.155	
σ_D	constant	0.081	
σ_{ED}	constant	0.023	
L_{av}	constant	0.314	
σ_I	$a_0 + a_1\chi^2(n)$	0.22	0.107
	$\{a_0, a_1, n\} = \{-.05, \frac{1}{30}, 5\}$		
σ	empirical	0.255	0.10
q_{RC}	$\mathcal{U}[0.0005, 0.0025] + 0.001s$	0.002	0.0006
q_E	$\mathcal{U}[0.02, 0.06] + 0.02s0.04$	0.013	
α	$\mathcal{U}[0.03, 0.077] + 0.023s$	0.06	0.026
q_A	$\mathcal{U}[0.05, 0.183] + 0.067s$	0.15	0.043
s	$\mathcal{U}[0, 1]$	0.5	0.29
k	$\mathcal{U}[0.6, 1]$	0.8	0.116
κ	$\mathcal{U}[0.7, 0.9]$	0.8	0.058
g	constant	$\mu + RP_A$	
a	$\mathcal{U}[0.03, 0.04]$	0.035	0.003
RP_A	constant	0.065	
τ_κ	constant	0.5	
τ_c	constant	0.35	
τ_i	constant	0.351	
τ_d	constant	0.122	
r	constant	0.05	

Table III
Descriptive Statistics

The table reports descriptive statistics for the following variables: market leverage (ML), Quasi-market leverage (QML), EBIT to interest expense (the ratio of earnings before interest and taxes, δ, to coupon, c), tax advantage to debt (that measures a gain in firm value if the firm moves from no-leverage to its optimal leverage ratio and is given by the formula $\frac{E(\delta_t)+D^{RT}(\delta_t)-(1-\tau)(E+D)}{(1-\tau)(E+D)}$), and credit spread ($CS$).Ref. point refers to the case when all firms are at their refinancing points. All other statistics are given for dynamics. 200 data sets are generated, each containing 75 years of quarterly data for 3000 firms. For each dataset statistics first are calculated for each year in the last 35 years of data and then are averaged across years. Then, they are averaged over datasets. Min and Max gives the minimum and maximum annual averages across datasets.

		percentiles						
	Mean	1%	50%	90%	95%	99%	st. dev.	N
Market leverage, ML								
Ref. point	0.27	0.03	0.26	0.42	0.47	0.53	0.11	3000
Average	0.32	0.05	0.29	0.53	0.63	0.85	0.16	3000
Min	0.28	0.04	0.26	0.46	0.54	0.77	0.15	3000
Max	0.37	0.06	0.34	0.64	0.76	0.93	0.19	3000
Quasi-market leverage, QML								
Average	0.32	0.05	0.29	0.55	0.67	0.89	0.17	3000
Min	0.29	0.04	0.26	0.47	0.57	0.83	0.15	3000
Max	0.38	0.06	0.34	0.69	0.81	0.95	0.21	3000
EBIT to interest expense								
Ref. point	4.04	1.58	3.27	6.13	7.80	19.51	3.94	3000
Average	3.66	0.74	3.03	6.09	7.77	13.77	3.10	3000
Tax advantage to debt								
Ref. point	0.05	0.01	0.05	0.08	0.09	0.10	0.02	3000
Average	0.04	0	0.04	0.07	0.08	0.09	0.02	3000
Credit spreads, CS								
Ref. point	0.79	0.04	0.69	1.47	1.86	2.70	0.56	3000
Average	1.22	0.03	0.78	2.59	3.83	7.75	1.54	3000
Min	1.05	0.03	0.70	2.09	3.08	6.68	1.32	3000
Max	1.47	0.04	0.90	3.34	4.80	8.96	1.78	3000

Table IV
Frequency of Events

The table reports the frequency of various events in generated datasets. Restructure_U refers to restructuring at the upper boundary when no liquidity crisis has occurred in the current refinancing cycle. Restructure_{UL} refers to the case where asset sale has occurred. 200 data sets are generated, each containing 75 years of quarterly data for 3000 firms. For each dataset frequencies are computed across the last 35 years of data and then averaged over datasets. Min, 25%, 75%, and Max give, correspondingly, the minimum, 25% percentile, 75% percentile, and maximum annual averages over all datasets. All frequencies are annualized and given in percentages.

	Default	Restructure_U	Restructure_{UL}	Asset Sale	Equity Issuance
Mean	0.51	6.59	0.14	1.09	3.82
Median	0.46	6.46	0.13	1.03	3.47
Std. Dev.	0.23	1.93	0.08	0.35	1.66
Min	0.21	3	0.05	0.49	1.42
25% percentile	0.35	5.16	0.08	0.83	2.64
75% percentile	0.65	7.71	0.16	1.35	4.99
Max	1.38	12.28	0.50	2.14	9.68

Table V
Correlation Structure

The table reports correlations for the following model variables: market leverage (ML), profitability (π), credit spreads (CS), volatility of cash flows (σ), bankruptcy costs (α), asset sale costs (q_A), restructuring costs (q_{RC}), equity issuance costs (q_E), and the fraction of assets that remain after asset sale (k). Panel A gives correlations for the case when all firms are at their refinancing points and Panel B in generated datasets (dynamics). 200 data sets are generated, each containing 75 years of quarterly data for 3000 firms. For each dataset correlations are computed across the last 35 years of data and then averaged over datasets.

Panel A: Correlations at refinancing point									
	ML	π	CS	σ	α	q_A	k	q_{RC}	q_E
ML	1.00								
π	0.44	1.00							
CS	-0.45	0.29	1.00						
σ	-0.89	-0.26	0.74	1.00					
α	-0.11	-0.04	-0.06	0.00	1.00				
q_A	-0.09	-0.03	-0.09	-0.02	0.21	1.00			
k	0.17	0.03	0.36	0.04	-0.00	-0.02	1.00		
q_{RC}	-0.02	-0.03	-0.08	-0.03	0.20	0.19	-0.00	1.00	
q_E	-0.03	-0.00	-0.03	-0.01	0.18	0.20	-0.02	0.22	1.00
Panel B: Correlations in dynamic economies									
	ML	π	CS	σ	α	q_A	k	q_{RC}	q_E
ML	1.00	-0.08	0.48	-0.26	-0.08	-0.08	0.14	-0.06	-0.03
π		1.00	-0.08	-0.04	0.00	-0.00	-0.00	0.00	0.00
CS			1.00	0.59	-0.02	-0.04	0.16	-0.05	-0.01

Table VI
Cross-sectional Regressions

The table reports the results of cross-sectional regressions on the level of the quasi-market leverage ratio, QML. Independent variables are profitability (π), volatility of cash flows (σ), bankruptcy costs (α), asset sale costs (q_A), restructuring costs (q_{RC}). The Ref.Point column gives the results obtained by running the regression at the refinancing point. The BJL, RZ, FF columns report the result of regressions that replicate the empirical procedures used, respectively, by Bradley, Jarrel, and Kim (1985), Rajan and Zingales (1995), and Fama and French (2002). Coefficients and t-statistics are means over 200 simulations. The last three columns report additional information on the FF regression: the standard deviation of coefficients and t-statistics, and the 10% and 90% percentile values of these coefficients across simulations.

	Ref.Point	BJK	RZ	FF	std	10%	90%
Constant	0.49	0.52	0.51	0.54	0.03	0.50	0.59
	(74.30)	(26.55)	(26.37)	(35.66)		(50.03)	(145.93)
Profitability	2.31	-0.13	-0.08	-0.32	0.14	-0.89	-0.02
	(29.77)	(-3.71)	(-2.80)	(-12.37)		(-22.06)	(-4.45)
Volatility	-1.02	-0.39	-0.39	-0.38	0.04	-0.46	-0.30
	(-118.03)	(-12.64)	(-12.58)	(-37.89)		(-52.55)	(-19.38)
Bank. Costs	-0.34	-0.36	-0.36	-0.36	0.08	-0.47	-0.22
	(-11.11)	(-3.07)	(-3.06)	(-8.71)		(-37.25)	(-8.61)
Restr. Costs	-0.30	-2.72	-2.71	-3.30	0.69	-4.35	-2.19
	(-0.80)	(-1.95)	(-1.94)	(-4.34)		(-27.10)	(-9.84)
Liq. Costs	-0.23	-0.24	-0.24	-0.25	0.04	-0.30	-0.18
	(-12.44)	(-3.45)	(-3.45)	(-11.23)		(-42.05)	(-12.90)
R^2	0.86	0.07	0.07	0.07	0.02	0.04	0.10
	(1)	(1)	(1)	(35)	(35)	(35)	(35)
N	3000	3000	3000	3000	3000	3000	3000

Table VII
Leverage and Stock Returns

The table reports the results of cross-sectional regressions on the level of the quasi-market leverage ratio, QML. Independent variables are implied debt ratio ($IDR_{t-k,t}$) and past quasi-market-leverage ratio (ML_{t-k}). Coefficients and t-statistics in Panel A are means over 200 simulations. Row 1 of Panel B reports the Welch estimates for IDR coefficients. Other rows report the mean, and 5% and 95% percentiles of my estimates, respectively.

	Panel A			
	k years			
	1	3	5	10
Constant	0.03	0.07	0.10	0.16
	(26.48)	(51.09)	(63.85)	(65.61)
$IDR_{t-k,t}$	1.04	0.90	0.79	0.61
	(191.30)	(146.31)	(121.71)	(85.43)
ML_{t-k}	-0.12	-0.09	-0.07	-0.03
	(-15.16)	(-11.05)	(-8.03)	(-4.29)
R^2	0.92	0.80	0.70	0.52
	(37)	(35)	(33)	(28)
N	3000	3000	3000	3000
	Panel B: IDR coefficients			
	1	3	5	10
Welch	1.014	0.944	0.869	0.708
This paper	1.039	0.896	0.792	0.612
5%	1.011	0.860	0.753	0.572
95%	1.082	0.948	0.846	0.671

Table VIII
Cross-sectional Regressions for Leverage Changes

The table reports the results of cross-sectional regressions on changes in the quasi-market leverage ratio, $QML_t - QML_{t-1}$. Independent variables are the target quasi-market leverage ratio ($TargetQML$), past leverage (QML_{t-1}), implied debt ratio adjustment ($IDR_{t-k,t} - ADR_{t-k}$), profitability (π), change in profitability ($\Delta Profit_{t-1} = \pi_{t-1} - \pi_{t-2}$), the cross-term ($\pi_{t-1} \times (IDR_{t-k,t} - ADR_{t-k}$). Coefficients and t-statistics are means over 200 simulations.

	(1)	(2)	(3)	(4)
Constant	0.01	0.01	0.03	0.11
	(1.12)	(1.13)	(24.12)	(51.98)
$Target\ QML_{t-1}$	0.15	0.15		
	(9.73)	(9.14)		
QML_{t-1}	-0.16	-0.16		
	(-20.09)	(-20.01)		
$IDR_{t-k,t} - ADR_{t-k}$			1.03	0.77
			(168.41)	(132.11)
$Profit_{t-1}$			-0.00	0.00
			(-1.58)	(-0.81)
$\Delta Profit_{t-1}$		-0.39		
		(-7.45)		
$Profit_{t-1} \times \Delta IDR$			0.08	0.31
			(21.92)	(49.95)
R^2	0.09	0.10	0.73	0.68
	(36)	(36)	(36)	(31)
N	3000	3000	3000	3000

Table IX
Robustness Tests

[THIS TABLE IS INCOMPLETE]
The table reports the summary of some robustness tests. Column (1) reports the difference between average leverage in dynamics and at Ref. Point (See Table III). Column (2) reports the average value of the profitability coefficient in Fama-French regressions (Table VI). Column 3 reports the average value of $IDR_{t-1,t}$ coefficient (Table VII). Column 4 reports the average value of the mean reversion coefficient f_2 (Table VIII). Tests are as follows: 1: distribution of σ is trimmed at the 5% and 95% percentiles; 2: 5-year time-series of cash flow volatility is estimated and 5% and 95% percentiles are excluded; 3: excluding observations with the sum of market value of equity and debt higher than 10; 4: excluding observations with profitability, π_{t-1}, outside 5-95% range; 5: excluding firms that experience default over previous five years; 6: substituting market leverage, ML, for quasi-market leverage, QML; 7:distribution of σ is changed to having mean of 0.15 and st.dev. of 0.07 by changing the distribution of σ_I; 8: the value of σ is fixed at 0.25; 9: the value of equity issuance costs, q_E, is fixed at 0.3; 10: the value of restructuring costs, q_{RC} is fixed at 0.005; 11: benchmark economy is taken from Goldstein, Ju, and Leland (2001) (all firms are identical at Ref.Points); 12: the corporate tax rate, τ_c, is 0.3; 13: before-tax interest rate, r, is 0.08; 14: the standard deviation of systematic shock, σ_m, is 0.15; 15: the standard deviation of systematic shock, σ_m, is 0. In all tests, other parameter values and empirical procedures are unchanged.

Test	Description	(1)	(2)	(3)	(4)
0	Benchmark	0.05	-0.32	1.04	-0.15
1	σ, no outliers	0.05	-0.30	1.04	-0.16
2	est. σ, no outliers	0.05	-0.38	1.04	-0.18
3	$E^D + D^{RT} > 10$	0.04	-0.31	1.04	-0.14
4	π_{t-1}, no outliers	0.05	-0.31	1.04	-0.14
5	no default	0.05	-0.30	1.03	-0.16
6	ML	0.05	-0.35	1.05	-0.16
7	σ: new distr	0.02	-0.20	1.02	-0.25
8	$\sigma = 0.25$	0.07	-0.26	1.04	-0.18
9	$q_E = 0.03$	0.05	-0.31	1.04	-0.17
10	$q_{RC} = 0.005$	0.03	-0.25	1.06	-0.26
11	GJL	0.07	-0.23	1.05	-0.18
12	$\tau_c = 0.3$	0.04	-0.21	1.01	-0.20
13	$r = 0.08$	0.04	-0.2	1.05	-0.18
14	$\sigma_m = 0.15$	0.07	-0.45	1.04	-0.12
15	$\sigma_m = 0$	0.11	-0.02	1.01	-0.13