How Important is Financial Risk?

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Abstract

This paper examines the determinants of equity price risk for a large sample of non-financial corporations in the United States from 1964 to 2008. We estimate both structural and reduced-form models to examine the endogenous nature of corporate financial characteristics such as total debt, debt maturity, cash holdings, and dividend policy. We find that the observed levels of equity price risk are explained primarily by operating and asset characteristics such as firm age, size, asset tangibility, as well as operating cash flow levels and volatility. In contrast, implied measures of financial risk are generally low and more stable than debt-to-equity ratios. Our measures of financial risk have declined over the last 30 years even as measures of equity volatility (e.g. idiosyncratic risk) have tended to increase. Consequently, documented trends in equity price risk are more than fully accounted for by trends in the riskiness of firms' assets. Taken together, the results suggest that the typical U.S. firm substantially reduces financial risk by carefully managing financial policies. As a result, residual financial risk now appears negligible relative to underlying economic risk for a typical non-financial firm.

Keywords: Capital structure, financial risk, risk management, corporate finance

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Abstract

This paper examines the determinants of equity price risk for a large sample of non-financial corporations in the United States from 1964 to 2008. We estimate both structural and reduced-form models to examine the endogenous nature of corporate financial characteristics such as total debt, debt maturity, cash holdings, and dividend policy. We find that the observed levels of equity price risk are explained primarily by operating and asset characteristics such as firm age, size, asset tangibility, as well as operating cash flow levels and volatility. In contrast, implied measures of financial risk are generally low and more stable than debt-to-equity ratios. Our measures of financial risk have declined over the last 30 years even as measures of equity volatility (e.g. idiosyncratic risk) have tended to increase. Consequently, documented trends in equity price risk are more than fully accounted for by trends in the riskiness of firms' assets. Taken together, the results suggest that the typical U.S. firm substantially reduces financial risk by carefully managing financial policies. As a result, residual financial risk now appears negligible relative to underlying economic risk for a typical non-financial firm.

1 Introduction

The financial crisis of 2008 has brought significant attention to the effects of financial leverage. There is no doubt that the high levels of debt financing by financial institutions and households significantly contributed to the crisis. Indeed, evidence indicates that excessive leverage orchestrated by major global banks (e.g., through the mortgage lending and collateralized debt obligations) and the so-called “shadow banking system” may be the underlying cause of the recent economic and financial dislocation. Less obvious is the role of financial leverage among non-financial firms. To date, problems in the U.S. non-financial sector have been minor compared to the distress in the financial sector despite the seizing of capital markets during the crisis. For example, non-financial bankruptcies have been limited given that the economic decline is the largest since the great depression of the 1930s. In fact, bankruptcy filings of non-financial firms have occurred mostly in U.S. industries (e.g., automotive manufacturing, newspapers, and real estate) that faced fundamental economic pressures prior to the financial crisis. This surprising fact begs the question, “How important is financial risk for non-financial firms?” At the heart of this issue is the uncertainty about the determinants of total firm risk as well as components of firm risk.

Recent academic research in both asset pricing and corporate finance has rekindled an interest in analyzing equity price risk. A current strand of the asset pricing literature examines the finding of Campbell et al. (2001) that firm-specific (idiosyncratic) risk has tended to increase over the last 40 years. Other work suggests that idiosyncratic risk may be a priced risk factor (see Goyal and Santa-Clara, 2003, among others). Also related to these studies is work by Pástor and Veronesi (2003) showing how investor uncertainty about firm profitability is an important determinant of idiosyncratic risk and firm value. Other research has examined the role of equity volatility in bond pricing (e.g., Dichev, 1998, Campbell, Hilscher, and Szilagyi, 2008).

However, much of the empirical work examining equity price risk takes the risk of assets as given or tries to explain the trend in idiosyncratic risk. In contrast, this paper takes a different tack in the investigation of equity price risk. First, we seek to understand the determinants of equity price risk at the firm level by considering total risk as the product of risks inherent in the firms operations (i.e., economic or business risks) and risks associated with financing the firms operations (i.e., financial risks). Second, we attempt to assess the relative importance of economic and financial risks and the implications for financial policy.

Early research by Modigliani and Miller (1958) suggests that financial policy may be largely irrelevant for firm value because investors can replicate many financial decisions by the firm at a low cost (i.e., via homemade leverage) and well-functioning capital markets should be able to distinguish between financial and economic distress. Nonetheless, financial policies, such as adding debt to the capital structure, can magnify the risk of equity. In contrast, recent research on corporate risk management suggests that firms may also be able to reduce risks and increase value with financial policies such as hedging with financial derivatives.[1] However, this research is often motivated by substantial deadweight costs associated with financial distress or other market imperfections associated with financial leverage. Empirical research provides conflicting accounts of how costly financial distress can be for a typical publicly traded firm.[2]

We attempt to directly address the roles of economic and financial risk by examining determinants of total firm risk. In our analysis we utilize a large sample of non-financial firms in the United States. Our goal of identifying the most important determinants of equity price risk (volatility) relies on viewing financial policy as transforming asset volatility into equity volatility via financial leverage. Thus, throughout the paper, we consider financial leverage as the wedge between asset volatility and equity volatility. For example, in a static setting, debt provides financial leverage that magnifies operating cash flow volatility. Because financial policy is determined by owners (and managers), we are careful to examine the effects of firms' asset and operating characteristics on financial policy. Specifically, we examine a variety of characteristics suggested by previous research and, as clearly as possible, distinguish between those associated with the operations of the company (i.e. factors determining economic risk) and those associated with financing the firm (i.e. factors determining financial risk). We then allow economic risk to be a determinant of financial policy in the structural framework of Leland and Toft (1996), or alternatively, in a reduced form model of financial leverage. An advantage of the structural

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[1] Allayannis and Weston (2002), Jin and Jorion (2006), Bartram, Brown, and Conrad (2009).

[2] See, for example, Jensen (1991) which argues that the deadweight costs of financial distress of failed highly levered transactions are large and Andrade and Kaplan (1998) which suggests the expected deadweight costs are fairly small. Almeida and Philippon (2007) find larger risk-adjusted costs of financial distress that are on par with estimated tax-benefits of leverage and conclude that this may explain low debt ratios.

model approach is that we are able to account for both the possibility of financial and operating implications of some factors (e.g., dividends), as well as the endogenous nature of the bankruptcy decision and financial policy in general.

Our proxy for firm risk is the volatility of common stock returns derived from calculating the standard deviation of daily equity returns. Our proxies for economic risk are designed to capture the essential characteristics of the firms' operations and assets that determine the cash flow generating process for the firm. For example, firm size and age provide measures of line-of-business maturity; tangible assets (plant, property, and equipment) serve as a proxy for the 'hardness' of a firm's assets; capital expenditures measure capital intensity as well as growth potential. Operating profitability and operating profit volatility serve as measures of the timeliness and riskiness of cash flows. To understand how financial factors affect firm risk, we examine total debt, debt maturity, dividend payouts, and holdings of cash and short-term investments.

The primary result of our analysis is surprising: factors determining economic risk for a typical company explain the vast majority of the variation in equity volatility. Correspondingly, measures of implied financial leverage are much lower than observed debt ratios. Specifically, in our sample covering 1964-2008 average actual net financial (market) leverage[3] is about 1.50 compared to our estimates of between 1.03 and 1.11 (depending on model specification and estimation technique). This suggests that firms may undertake other financial policies to manage financial risk and thus lower effective leverage to nearly negligible levels. These policies might include dynamically adjusting financial variables such as debt levels, debt maturity, or cash holdings (see, for example, Acharya, Almeida, and Campello, 2007). In addition, many firms also utilize explicit financial risk management techniques such as the use of financial derivatives, contractual arrangements with investors (e.g. lines of credit, call provisions in debt contracts, or contingencies in supplier contracts), special purpose vehicles (SPVs), or other alternative risk transfer techniques.

The effects of our economic risk factors on equity volatility are generally highly statistically significant, with predicted signs. In addition, the magnitudes of the effects are substantial. We find that volatility of equity decreases with the size and age of the firm. This is intuitive

[3] Market leverage is market value of equity plus total debt (net of cash) as a percent of the market value of equity. Thus a value of 1.0 represents no financial leverage.

since large and mature firms typically have more stable lines of business, which should be reflected in the volatility of equity returns. Equity volatility tends to decrease with capital expenditures though the effect is weak. Consistent with the predictions of Pástor and Veronesi (2003), we find that firms with higher profitability and lower profit volatility have lower equity volatility. This suggests that companies with higher and more stable operating cash flows are less likely to go bankrupt, and therefore are potentially less risky. Among economic risk variables, the effects of firm size, profit volatility, and dividend policy on equity volatility stand out. Unlike some previous studies, our careful treatment of the endogeneity of financial policy confirms that leverage increases total firm risk. Otherwise, financial risk factors are not reliably related to total risk.

Given the large literature on financial policy, it is no surprise that financial variables are, at least in part, determined by the economic risks firms take. However, some of the specific findings are unexpected. For example, in a simple model of capital structure, dividend payouts should increase financial leverage since they represent an outflow of cash from the firm (i.e., increase net debt). We find that dividends are associated with lower risk. This suggests that paying dividends is not as much a product of financial policy as a characteristic of a firm's operations (e.g., a mature company with limited growth opportunities). We also estimate how sensitivities to different risk factors have changed over time. Our results indicate that most relations are fairly stable. One exception is firm age which prior to 1983 tends to be positively related to risk and has since been consistently negatively related to risk. This is related to findings by Brown and Kapadia (2007) that recent trends in idiosyncratic risk are related to stock listings by younger and riskier firms.

Perhaps the most interesting result from our analysis is that our measures of implied financial leverage have declined over the last 30 years at the same time that measures of equity price risk (such as idiosyncratic risk) appear to have been increasing. In fact, measures of implied financial leverage from our structural model settle near 1.0 (i.e., no leverage) by the end of our sample. There are several possible reasons for this. First, total debt ratios for non-financial firms have declined steadily over the last 30 years, so our measure of implied leverage should also decline. Second, firms have significantly increased cash holdings, so measures of net debt (debt minus cash and short-term investments) have also declined. Third, the composition of publicly traded firms has changed with more risky (especially technology-oriented) firms becoming publicly listed. These firms tend to have less debt in their capital structure. Fourth, as mentioned above, firms can undertake a variety of financial risk management activities. To the extent that these activities have increased over the last few decades, firms will have become less exposed to financial risk factors.

We conduct some additional tests to provide a reality check of our results. First, we repeat our analysis with a reduced form model that imposes minimum structural rigidity on our estimation and find very similar results. This indicates that our results are unlikely to be driven by model misspecification. We also compare our results with trends in aggregate debt levels for all U.S. non-financial firms and find evidence consistent with our conclusions. Finally, we look at characteristics of publicly traded non-financial firms that file for bankruptcy around the last three recessions and find evidence suggesting that these firms are increasingly being affected by economic distress as opposed to financial distress.

In short, our results suggest that, as a practical matter, residual financial risk is now relatively unimportant for the typical U.S. firm. This raises questions about the level of expected financial distress costs since the probability of financial distress is likely to be lower than commonly thought for most companies. For example, our results suggest that estimates of the level of systematic risk in bond pricing may be biased if they do not take into account the trend in implied financial leverage (e.g., Dichev, 1998). Our results also bring into question the appropriateness of financial models used to estimate default probabilities, since financial policies that may be difficult to observe appear to significantly reduce risk. Lastly, our results imply that the fundamental risks born by shareholders are primarily related to underlying economic risks which should lead to a relatively efficient allocation of capital.

Before proceeding we address a potential comment about our analysis. Some readers may be tempted to interpret our results as indicating that financial risk does not matter. This is *not* the proper interpretation. Instead, our results suggest that firms are able to manage financial risk so that the resulting exposure to shareholders is low compared to economic risks. Of course, financial risk is important to firms that choose to take on such risks either through high debt levels or a lack of risk management. In contrast, our study suggests that the typical non-financial firm chooses not to take these risks. In short, gross financial risk may be important, but firms can manage it. This contrasts with fundamental economic and business risks that are more difficult (or undesirable) to hedge because they represent the mechanism by which the firm earns economic profits.

The paper is organized at follows. Motivation, related literature, and hypotheses are reviewed in Section 2. Section 3 describes the models we employ followed by a description of the data in Section 4. Empirical results for the Leland-Toft model are presented in Section 5. Section 6 considers estimates from the reduced form model, aggregate debt data for the non-financial sector in the U.S., and an analysis of bankruptcy filings over the last 25 years. Section 6 concludes.

2 Motivation, Related Literature, and Hypotheses

Studying firm risk and its determinants is important for all areas of finance. In the corporate finance literature, firm risk has direct implications for a variety of fundamental issues ranging from optimal capital structure to the agency costs of asset substitution. Likewise, the characteristics of firm risk are fundamental factors in all asset pricing models.

The corporate finance literature often relies on market imperfections associated with financial risk. In the Modigliani Miller (1958) framework, financial risk (or more generally financial policy) is irrelevant because investors can replicate the financial decisions of the firm by themselves. Consequently, well-functioning capital markets should be able to distinguish between frictionless financial distress and economic bankruptcy. For example, Andrade and Kaplan (1998) carefully distinguish between costs of financial and economic distress by analyzing highly leveraged transactions, and find that financial distress costs are small for a subset of the firms that did not experience an "economic" shock. They conclude that financial distress costs should be small or insignificant for typical firms. Kaplan and Stein (1990) analyze highly levered transactions and find that equity beta increases are surprisingly modest after recapitalizations.

The ongoing debate on financial policy, however, does not address the relevance of financial leverage as a driver of the overall riskiness of the firm. Our study joins the debate from this perspective. Correspondingly, decomposing firm risk into financial and economic risks is at the heart of our study.

Research in corporate risk management examines the role of total financial risk explicitly by examining the motivations for firms to engage in hedging activities. In particular, theory suggests positive valuation effects of corporate hedging in the presence of capital market imperfections. These might include agency costs related to underinvestment or asset substitution (see Bessembinder, 1991, Jensen and Meckling, 1976, Myers, 1977, Froot, Scharfstein, and Stein, 1993), bankruptcy costs and taxes (Smith and Stulz, 1985), and managerial risk aversion (Stulz, 1990). However, the corporate risk management literature does not generally address the systematic pricing of corporate risk which has been the primary focus of the asset pricing literature.

Lintner (1965) and Sharpe (1964) define a partial equilibrium pricing of risk in a mean-variance framework. In this structure, total risk is decomposed into systematic risk and idiosyncratic risk, and only systematic risk should be priced in a frictionless market. However, Campbell et al. (2001) find that firm-specific risk has increased substantially over the last four decades and various studies have found that idiosyncratic risk is a priced factor (Goyal and Santa Clara, 2003, Ang, Hodrick, Xing, and Zhang, 2006, 2008, Spiegel and Wang, 2006). Research has determined various firm characteristics (i.e., industry growth rates, institutional ownership, average firm size, growth options, firm age, and profitability risk) are associated with firm-specific risk.[4] Recent research has also examined the role of equity price risk in the context of expected financial distress costs (Campbell and Taksler, 2003, Vassalou and Xing, 2004, Almeida and Philippon, 2007, among others). Likewise, fundamental economic risks have been shown to be to be related to equity risk factors (see, for example, Vassalou, 2003, and the citations therein). Choi and Richardson (2009) examine the volatility of the firm's assets using issue-level data on debt and find that asset volatilities exhibit significant time-series variation and that financial leverage has a substantial effect on equity volatility.[5]

Pástor and Veronesi (2003) link firm characteristics with asset pricing factors, such as market-to-book ratio and the volatility of equity. In their empirical work, the authors estimate

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[4] See Malkiel and Xu (2003), Bennett and Sias (2006), Brown and Kapadia (2007), and Cao, Simin, and Zhao (2008), among others.

[5] This second finding is at direct odds with our finding that implied financial leverage is low. Our conclusions may differ from their conclusions for several reasons. First, they examine only firms with traded debt. Second, they examine primarily time-series properties of firm risk instead of conducting a cross-sectional analysis. Third, the do not consider specific determinants of asset volatility.

firm risk with firm characteristics in a linear model and find support for their model, however some of the empirical findings are counterintuitive. For example, leverage is negatively related to firm risk. Results such as this indicate that financial policy is likely to be affected significantly by other firm factors such as underlying operating characteristics.

Empirical asset pricing studies have yet to comprehensively analyze the specific determinants of total firm risk. As noted already, we attempt to bridge the gap by as carefully as possible decomposing firm risk into two broad sources: economic risk and financial risk. Economic risk can be thought of as uncertainty regarding the value of the firm's assets and the future profits of the company. These are the "real" risks a company faces and include uncertainty about the market for a firm’s products, the cost and availability of factor inputs to production, and the risks of competition and innovation, among others. Prior research has modeled this type of uncertainty in various ways. For example, in the classic setting of Merton (1974), economic risk is modeled as uncertainty in the underlying asset value of the firm. Other research models economic risk as uncertainty about the level of firm profitability. In many ways, these risks are two sides of the same coin since shocks to firm profitability will usually influence the market value of a firm’s assets (and vice versa). However, empirically it may be important to consider risks related to both a firm's assets and a firm's profitability. For example, consider two firms with identical profit characteristics, but the assets of one firm are comprised of a greater proportion of intangible assets. The firm with fewer tangibles may be riskier from a bondholder’s perspective if the recovery value upon bankruptcy is lower. For this reason, we characterize the qualities of both assets and profitability in our analysis.

We hypothesize that larger firms are likely to have a more diversified customer and supplier base and a longer operating history. Both of these features suggest that larger firms should be less risky. As noted already, tangible assets (plant, property, and equipment) serve as a proxy for the ‘hardness’ of a firm’s assets that may lose less of their value upon bankruptcy (Gilson, 1997). The ratio of capital expenditures to total assets serves as a measure of a capital intensity as well as growth potential. Higher capital intensity is typically associated with higher operating leverage (higher proportion of fixed costs in a business) whereas higher growth opportunities imply that firm value depends more on more distant cash flows. Both of these characteristics would tend to magnify variations in operating profits. However, capital expenditures tend to be associated with assets that have a higher liquidation value and thus may be associated with lower risk. As such, the relation between capex and equity volatility is an empirical question.

We characterize the firm's profitability in two ways. First, we consider the level of profitability (operating margin before depreciation) as a measure of economic risk. A firm with a high operating margin is likely to be less risky for several reasons. High profit margins may be a sign of low product market competition. In addition, financial distress is often triggered by an adverse economic shock. As such, a more profitable firm is likely to be far from financial distress, and therefore less likely to have equity returns magnified by variations in expected bankruptcy costs. Higher profit levels may also suggest that more of a firm's value comes from relatively near-term cash flows which are likely to be less uncertain. Second, we consider the volatility of profits. As discussed above, Pástor and Veronesi (2003) show the direct relation between profit risk and equity price risk in a setting where investors must learn about the long-run profitability of a company.

We also use a variety of firm-specific characteristics to describe the financial risks a firm's shareholders face. The most fundamental financial risk stems from debt financing. In a perfect markets setting, debt has a direct effect on volatility of equity returns and therefore on our measure of total firm risk. However, theoretical research suggests that firms choose the optimal amount of debt as a function of economic risk, so the actual relation is again an empirical issue. We also consider cash holdings since they act as liquid reserves, and hypothesize that firm risk should have a negative relation with cash holdings if cash acts as "negative debt." On the other hand, Opler, Pinkowitz, Stulz, and Williamson (1999) and Acharya, Almeida, and Murillo (2007) find that cash is not like "negative debt" and instead serves the role of precautionary savings to ensure against underinvestment. The maturity of debt used by firms may also determine the level of firm risk. For example, firms using relatively more short-term debt may be more exposed to interest rate fluctuations and roll-over risks, and, therefore, have higher levels of total risk.

Dividend policy can also affect the level of firm risk for several reasons. First, Pástor and Veronesi (2003) show that firms not paying dividends have higher return volatility than dividend payers. For dividend payers, equity value depends less on terminal firm value and more on (relatively) near-term dividends, which are less sensitive to operational performance (i.e., average profits). Dividends may also serve as a signaling device for managers that wish to communicate strong prospects, and thus lower risk, for their companies. Intuitively, dividends are more commonly paid by mature firms with more stable lines of business and fewer growth opportunities. In this case, dividends act more as an indicator of economic risk than financial risk.

3 Models of Firm Risk

A simple examination of the effect of financial variables on firm risk often generates counterintuitive results. As noted above, a univariate analysis of leverage can reveal a negative relation between financial leverage (e.g., long term debt as a percent of total assets) and total risk. As discussed above, these results are likely due to the endogenous nature of financial decision making (e.g., firms with low economic risk can better manage high debt levels). As such, we analyze the determinants of equity price risk with a special focus on the endogenous nature of financial policy. We utilize two approaches. Our first approach employs the structural model of Leland and Toft (1996) to provide for estimating a specific functional form of equity volatility. Second, we estimate a general nonlinear regression where we assume a simple form for equity volatility that is a function of underlying asset volatility transformed by financial policy.

The Leland and Toft (1996) model (henceforth the LT model) provides a specific structural form describing total firm risk. The LT model builds upon the observation made by Black and Scholes (1973) and Merton (1974) that the equity of a firm resembles a call option on the firm's assets. In the simple Merton model, a number of assumptions are restrictive (e.g., one class of debt, no coupons, and default only at maturity of the debt) and do not allow for a very rich analysis of optimal capital structure. The LT model examines a richer financial structure. In particular, bankruptcy can occur anytime (similar to Black and Cox, 1976). In addition, bankruptcy is assumed to be an endogenous event triggered by the equity holders to maximize equity value. Furthermore, the model allows a finite average maturity (T) for debt, tax deductible coupon payments (C), default costs (α), and net cash payouts (δ) to security holders. As such, the LT framework combines the Merton model with the tradeoff theory (i.e., tax benefits versus the bankruptcy costs related to leverage) and agency theory (e.g. asset substitution) to provide a means for determining optimal capital structure. In addition to allowing for the endogenous nature of financial decisions, the LT model provides an opportunity to account for factors that could be related to operating characteristics via parameterization of asset volatility.

To estimate the model, we minimize the squared deviations of predicted equity volatility (σ_E) from actual volatility. Following the LT model, we define

$$\sigma_E = l(\sigma_A) * \sigma_A \tag{1}$$

which describes how asset volatility (σ_A) is transformed into equity volatility by a function characterizing financial leverage, $l(\cdot)$, that is also a function of σ_A. Later, we parameterize σ_A in a straightforward, but admittedly ad hoc, fashion as an exponential function of economic risk variables. We use the exponential function to insure positive values of σ_A. In the LT model

$$l(\sigma_A) = \left[1 + \frac{D(V;VB;T)}{E(V;VB;T)}\right] k(\sigma_A) \tag{2}$$

$$k(\sigma_A) = 1 - J(T) \tag{3}$$

where D, E, and V are, respectively, the market value of debt, equity, and the firm's assets; VB is the endogenous bankruptcy trigger; $J(T)$ and $k(\sigma_A)$ are defined in the appendix. Note that $k(\sigma_A)$ is analogous to $N(d_1)$ in the Merton (1974) model. As in the Merton model, asset value V is assumed to follow a diffusion process

$$\frac{dV}{V} = [\mu(V,t) - \delta]dt + \sigma_A dz \tag{4}$$

where the difference between (the value and time dependent function) μ and the dividend payout rate, δ, determines the drift of the process. The market value of equity is simply defined as the difference between total firm value (v) and the market value of debt so that

$$E(V;VB;T) = v(V;VB,T) - D(V;VB;T). \tag{5}$$

In the LT model, v can be expressed in closed form as

$$v(V;VB;T) = V + \frac{\tau C}{r}\left[1 - \left(\frac{V}{VB}\right)^{-x}\right] - \alpha VB\left(\frac{V}{VB}\right)^{-x} \tag{6}$$

where r is the risk-free rate, τ is the corporate tax rate. Intuitively, the market value of equity is equal to firm value minus debt value, where firm value is determined by adding the net of tax benefits and bankruptcy costs to the asset value V (i.e., unlevered firm value). Note that all of these value functions depend on V, VB, and T.

The LT model considers a stationary debt structure where the firm continuously issues a constant principal amount of new debt with maturity T and simultaneously retires the same amount of debt. Consequently, T can be considered the average maturity of debt for a given firm. The market value of debt can also be expressed in closed form as

$$D(V;VB;T) = \frac{C}{r} + \left(P - \frac{C}{r}\right)\left(\frac{1-e^{-rT}}{rt} - I(T)\right) + \left((1-\alpha)*VB - \frac{C}{r}\right)J(T) \tag{7}$$

where P is the face value of debt and VB is defined as

$$VB = \frac{(C/r)(A/(rT) - B) - AP/(rT) - \tau Cx/r}{1 + \alpha x - (1-\alpha)B}. \tag{8}$$

The parameters A and B are constants defined in the appendix.

The price of utilizing the LT model is estimation complexity and the likelihood that the model oversimplifies the relations between variables of interest in ways that affect our inference. The LT model is also limited by construction in its ability to accommodate additional factors that are not explicitly defined in the model, and this results in the ad hoc specification of some input parameters—most importantly σ_A.

Primarily as a robustness check, we estimate an alternative nonlinear model of equity price risk. This largely unstructured approach, which we call our reduced form model (henceforth, the RF model), specifies equity price risk as

$$\sigma_E = \sigma_A(\mathbf{X})\ l(\mathbf{Y}, \sigma_A(\mathbf{X})) \tag{9}$$

where asset volatility (σ_A) is a function of operating characteristics of the firm ($\mathbf{X}$), and financial leverage (l) is a function of financial characteristics, $\mathbf{Y}$, as well as σ_A. Specifying a linear form for asset volatility results in

$$\sigma_E = \mathbf{X}'\beta\ (\mathbf{Y}'\Gamma(\mathbf{X}'\beta)), \tag{10}$$

where β and Γ are vectors of factor loadings for operating (economic) and financial factors, respectively. We specify our RF model with the same simple, yet intuitive, view where financial policy transforms asset volatility into equity price volatility through net financial leverage. As such, the general form we employ allows for flexibility and ease of estimation. The price of this flexibility is an inability to comment on the precise mechanisms relating the variables of interest.

4 Data

Our sample construction begins with firms that have annual accounting data in the CompuStat database for any year between 1964 and 2008 and that have at least 125 non-zero daily stock returns in the CRSP database during the year of the accounting data.[6] We exclude utilities and financial services companies (industries 20 and 29 in the Fama-French's 30 industry classification) because these firms are regulated, and may therefore have different risk-taking incentives. In addition, we apply a variety of screens to our sample to focus on only liquidly traded firms in periods of normal operations. Specifically, we exclude 'micro-cap' companies (less than \$50 million in market capitalization from CRSP[7] or \$1 million in total assets measured in 2008 dollars) and 'penny stocks' with average share price less than \$1.00. We also exclude companies in the year of their initial public offering (IPO) and their delisting. Firms with some missing or exceptional accounting data are also excluded. For example, we require the ratio of cash and short-term investments to market capitalization to be between zero and one, the ratio of debt to market capitalization to be nonnegative and less than ten, and the book value of equity to be positive. We also only consider firms with estimated annual equity volatility (standard deviation) between 1% and 200%. In effect, these screens eliminate firms that are on the verge of bankruptcy or unlikely to be a going concern. Thus, our conclusion that financial risks are not important for a typical firm should not be interpreted as a statement that such risks are unimportant for *all* firms—obviously financial risks for firms on the verge of default are of great importance.

Table 1 shows the impact of constraints on our sample size. The first row (Full Sample) shows the number of firm-years for which we have sufficient returns data in CRSP to calculate equity volatility and a matching firm in CompuStat. The next set of rows shows the importance of independent screens on our sample size. The three most prevalent causes of lost firm-years are low market capitalization (27.9% of firm-years), listing or delisting (10.0% of firm-years), and missing variables of interest in CompuStat (5.5% of firm-years). All other constraints result in losing fewer than 5% of firm-years. Our final sample has 61,531 total firm-year observations. This results in an average of approximately 1,400 non-financial firms per year though the sample

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[6] Because our data were collected in the beginning of 2009, accounting data are not available for all firms in 2008.

[7] Market Capitalization is defined as the average of the product of the absolute value of the closing price per share and the number of shares outstanding.

size tends to grow over time (at about the same rate as the total number of U.S. equity listings). Overall, our sample covers the vast majority of the market value of U.S. non-financial firms – an average of 90.2% of total market capitalization of non-financial firms each year.

Our proxy for firm risk is the volatility of common stock returns (the annualized standard deviation of daily returns). We use total assets (CompuStat field AT) deflated to 2008 dollars as a proxy for firm size. Firm age is based on the minimum of (i) year of listing data from Jovanovic and Rousseau (2001) and (ii) the firm's initial appearance on CRSP monthly database.[8] Our measure of profitability is operating income before depreciation divided by total revenue (OIADP / REVT). We calculate profit volatility as the five-year central standard deviation of our profitability measure.[9] Asset tangibility is calculated as gross property, plant, and equipment divided by total assets (PPEGT / AT). We normalize capital expenditures by total assets (CAPX / AT). Dividend yield is calculated as dividends on common stock (CDVC) divided by market capitalization (from CRSP).

We define the total debt ratio as the sum of current liabilities (LCT), long-term debt (DLTT), and preferred stock divided by market capitalization.[10] Including preferred stock in total debt is a conservative assumption for our analysis because it inflates financial leverage and provides a measure that corresponds more closely with the role of debt in the LT model. Debt maturity is defined as long-term debt plus preferred stock divided by total debt. As our measure of liquid assets we use holdings of cash and short-term investments (CHE) divided by market capitalization. In addition to these variables, we also report net debt (total debt – liquid assets) and the coupon rate, which is defined as interest expense and preferred dividends (XINT + DVP) divided by total debt (including preferred stock). If firms have no debt we set the coupon rate to zero. To obtain convergence for the subsequent LT model estimation in all years we apply maximum values to some variables. Specifically, we cap the coupon rate at 11% and the dividend

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[8] Data source: http://www.econ.nyu.edu/user/jovanovi/

[9] Except for in 2007 and 2008 when we use the volatility of profits from 2004 to 2008.

[10] We have also conducted our analysis using debt in current liabilities instead of total current liabilities. However, since many companies use trade credit as a significant source of funding we feel that using current liabilities provides a more realistic measure of economic debt and is a more conservative assumption. Regardless, our conclusions are unchanged if we use only the debt component of current liabilities for our calculation of total debt. For the value of preferred stock we use redemption value (PSTKRV), unless it is unavailable in which case we use liquidating value (PSTKL), unless it is unavailable in which case we use carrying value (UPSTK).

yield at 7.5%. Upper and lower bounds of +/-50% are applied to profitability because this variable has a small number of very extreme values. Likewise, profit volatility is capped at 50%. We also winsorize other variables at 1% and 99% to reduce the effect of outliers and possible data errors.[11] Below, we also report results of robustness checks for the effect of these restrictions on our inference.

Table 2 provides summary statistics for our economic and financial risk variables, along with market equity volatility. Mean equity volatility is 47.5% with a 5%-95% range of 20.3% to 92.9%. The average firm is about 12 years old with about 290 million (2008) dollars in total assets. Firms are profitable in about 85% of firm years with an average profitability of 10.2%. The volatility (standard deviation) of profits averages 7.0% though the values are positively skewed. The average dividend yield is 1.3%, though the median firm in our sample does not pay a dividend. The total debt to market value of equity ratio averages 71.8% but the 5%-95% range is large (3.7% to 254.0%). The total debt to total assets ratio is less skewed and averages 43.7%. On average, firms hold significant amounts of cash and short-term investments (STI) equivalent to 13.3% of market capitalization. As a result, net debt as a percent of market capitalization is negative at the 5th percentile indicating that quite a few firms have more liquid assets than total debt. On average 36.0% of all debt is long term and the average firm (including those with no debt) has a coupon rate of 3.6%. In general, we observe significant variation for all variables of interest.

5 Results

5.1 Correlations and Quartiles

Table 3 reports the correlations between the variables of interest. The correlation coefficients between equity volatility and economic risk variables are typically large in absolute value (capital expenditures is the exception). For financial risk variables, however, the results are not nearly as strong as economic risk variables, and the coefficients can be counter-intuitive. For example, cash holdings are positively related to equity volatility (consistent with the precautionary savings motive). Likewise, equity volatility is essentially uncorrelated with leverage measures. Divi-

[11] This winzorizing is necessary to estimate the LT model in all years. If it affects our results, the bias should work against our conclusions as discussed subsequently.

dends are strongly negatively related to equity volatility. Since dividends consume cash (i.e. increase financial leverage) this result is potentially counterintuitive. Another interesting finding is that financial risk variables are often highly correlated among each other. For example, the pairwise correlations between net debt, debt maturity, and coupon rate are all greater than 40%.

Table 4 provides summary statistics for variables by equity volatility quartiles allowing us to obtain a feel for the economic significance of the correlations in the first column of Table 3. The results are quite dramatic. When we examine the differences in values between the first and fourth quartile, we see that low risk firms are about 8 times as large (in terms of total assets) and three times as old as high risk firms. In addition, low risk firms have 50% more tangible assets than low risk firms. Low risk firms are highly profitable, whereas high risk firms do not break even. Similarly, profit volatility of low risk firms (0.021) is a very small fraction of that of high risk firms (0.158). The dividend yield of low risk firms is an order of magnitude greater than that of high risk firms. In contrast, there is no clear relation between equity volatility and capital expenditures.

For financial characteristics, there are few obvious patterns across equity volatility quartiles. The only clear relation is the increase in cash holdings for higher volatility firms, which is again contrary to basic intuition (but consistent with cash holdings acting in a risk management capacity). In sum, these results suggest that firm characteristics related to economic risks are more important than financial characteristics for explaining cross-sectional variation in equity volatility.

5.2 Model Estimation and Results

We now turn to estimating the LT model discussed above. Below we describe the exact specifications as well as the results of the estimation. We estimate both pooled regressions and Fama-MacBeth style regressions. Pooled regressions do not assume time-series independence, and are based on full information maximum likelihood. Therefore, they do not suffer from a direct errors-in-variables problem, an issue that is known to plague two-pass procedures like Fama-MacBeth. However, unlike the Fama-MacBeth, pooled regressions require the estimation of the error covariance matrix of the panel, which can be involved. This is usually done by imposing an arbitrary structure on cross-correlation and heteroskedasticity or by simply assuming a time-invariant covariance matrix. In contrast, the Fama-MacBeth procedure suffers from the errors-in-variables problem, but it allows, estimation of the cross-section without imposing any structure on the covariance matrix. In general, the pooled regressions are likely to have more power if the relations between variables are stable, but potentially lead to poor inference if the relations between variables have unmodeled time trends. We subsequently examine trends in the Fama-MacBeth parameter estimates and find that some values appear to exhibit time trends (for example, the affect of firm age). Thus we caution readers when interpreting the pooled estimate results. However, the methods usually provide similar results.

5.2.1 LT Model Empirical Specification

Estimating the LT model requires some additional assumptions. First, we set asset value to 100 and scale other variables to this value when necessary. This standardization simplifies the numerical estimation. We utilize the 10-year constant maturity U.S. Treasury yield (compiled by the Federal Reserve Board) as a proxy for the risk free rate, *r*. For the corporate income tax rate, τ, we use the statutory rate for the highest income group as reported by The Tax Foundation.[12] We assume a value of 0.4 for α, the fraction of firm value lost in bankruptcy.

For other model inputs, we parameterize the values using firm-specific data. Most importantly, we specify

$$\begin{aligned}\sigma_A &= exp\{\beta_0 + \beta_1 Log(Size) + \beta_2 Log(Age) + \beta_3 Tangible\ Assets + \beta_4 Capex \\ &+ \beta_5 Profitability + \beta_6 Profit\ Volatility + \beta_7 Dividend\ Yield\}\end{aligned} \tag{11}$$

where the β_i parameters are estimated coefficients. We parameterize debt maturity to be between 1 and 10 years by defining

$$T = 1 + 9\frac{Long\ Term\ Debt + Preferrred\ Stock}{Total\ Debt}. \tag{12}$$

However our results are not meaningfully affected by this choice of maximum maturity. The face value of all outstanding debt (P) is calculated as net book leverage adjusted by a *leverage factor* to take into account endogenous financial policies not observed by the econometrician (e.g., financial hedging or off-balance sheet financing), so that

[12] See http://www.taxfoundation.org/taxdata/show/2140.html

$$P = Leverage\ Factor * (Total\ Debt - Cash) \tag{13}$$

We do not constrain the leverage factor parameter. Consequently, it is equally able to increase or decrease leverage in an attempt to best fit the data. We use the previously defined variables to define our proxy for the coupon rate (*C*) so that

$$C = \frac{Interest\ Expense + Preferred\ Dividends}{Total\ Debt}. \tag{14}$$

These observable variables allow calculating all other variables as described in the appendix for our optimization problem. Specifically, we note that this estimation procedure calibrates the model in a way that allows for the endogenous nature of the bankruptcy decision and financial policy in general.

5.2.2 LT Model Results

Table 5 reports the results of pooled and Fama-MacBeth regressions for the LT model. The first column reports findings from the pooled regression. The results show that the economic risk factors we consider, except tangible assets and capital expenditures, are statistically significant explanatory variables for equity volatility at better than the 0.001 confidence level. As suggested by the correlation and quartile analysis, the volatility of equity decreases with firm size and age. Lower profitability and higher profit volatility increase equity volatility. Dividend yield is negatively related to equity volatility.

The very low estimated value for the leverage factor is surprising. This value should be interpreted against a benchmark of 1.0, in so far as values greater than 1.0 imply financial leverage greater than that measured by net debt (and vice versa). The value of 0.11 suggests that the actual relation between financial leverage and equity volatility is substantially lower than would be inferred from a casual observation of the total debt ratio. We emphasize that the small value is not the result of low statistical power – the coefficient is significantly different from zero (and 1.0) at better than the 0.001 level.

For Fama-MacBeth regressions the results are qualitatively very similar. We always find the same sign as the significant coefficients in the pooled regression. In addition, capital expenditures are significantly negatively related to equity volatility. However, the magnitudes of some coefficients differ significantly from pooled results in some cases. For example, the coefficient on total assets is much larger and the coefficient on age is much smaller. These results suggest possible time trends in the relations between variables not captured by the pooled regression—an issue we examine in more detail below. The statistical significance of the results is similar as all coefficients except for tangible assets are statistically different from zero at the 0.01 level (and most at the 0.001 level). The estimated value of the leverage factor is again low (0.27) when compared to the benchmark of 1.0, though it is much larger than the pooled regression estimate. This again indicates that implied leverage from the LT model is much lower than observed net debt levels. Marginal effects show that some factors have stronger effects on risk than others and that these effects vary by specification. In the pooled sample, dividend yield has the greatest effect on risk by a factor of two. Firm size, firm age, and profit volatility also have strong effects. In the Fama-MacBeth specification, dividend yield and firm age are somewhat weaker while firm size and profit volatility are somewhat stronger. Many of these effects are quite large. For example, the marginal effect of -0.156 for firm size (log of total assets) in the Fama-MacBeth specification indicates that a firm two standard deviations larger than the mean will have about half the equity risk of an average-sized firm, *ceteris paribus*.

Table 5 also reports estimated values for asset volatility (σ_A) and implied financial leverage (l). The models appear to do a decent job of matching the cross-sectional variation of equity volatility as evidenced by the standard deviation of model estimates of σ_A (0.165 and 0.128) in the vicinity of the actual standard deviation (0.235). As suggested by the leverage factor estimates, the values for market leverage (1.031 and 1.100) are close to 1.0. The implication of this result is that little of observed equity price risk can be attributed to financial leverage, and thus, the implied levels of financial risk are quite low. In addition, about a quarter of firms have implied leverage below 1.0 which suggests that these firms actually reduce their total risk with financial policy. Furthermore, our estimates of asset volatility (0.458 and 0.408) differ only slightly from the average equity volatility of 0.475.

5.2.3 LT Model Other Specifications

To determine the effect of some of our assumptions on the parameter estimates we also conduct additional robustness tests for the LT estimation. In particular, we examine the role of our assumption for financial distress costs (α) and some of the constraints we apply to variables that are necessary to have the model estimation converge in all years of the Fama-MacBeth estimation. Table 6 presents these results. The results for different values of the fraction of firm value lost in bankruptcy (α = 0.2, 0.4, 0.6) suggest that the estimation is not at all sensitive to variation in this parameter. In no case does the parameter estimate vary significantly across different values of α. This is likely the result of our finding that most firms face little (implied) chance of bankruptcy, thus the severity of the loss given default is not an important determinant of overall risk.

The LT estimation is numerically difficult and requires limiting the range of some variables to achieve model convergence in all years. To see the effect of these constraints on parameter estimates we loosen the upper bounds on profit volatility (to 100%), dividend yield (to 20%), and coupon rate (to 20%). The last set of results reported in Table 6 provides the mean values for the years that the estimation convergence criterion was satisfied.[13] These estimated parameter values tend to be similar in size and are always of the same sign as compared to the more constrained sample. However significance declines somewhat for capital expenditures in part because the number of years used to estimate *p*-values is reduced.

In summary, the results of the LT model estimation suggest that financial risk is on average small compared to underlying economic risk and that factors associated with economic risk do a good job of explaining total risk.

5.3 Determinants of Firm Risk over Time

Given documented increases in idiosyncratic equity price risk, it is interesting to attempt a decomposition of this trend into economic risk and financial risk components. In particular, if equity volatility became much more sensitive to certain economic or financial risk characteristics, this or a trend in the characteristic itself could explain the trend in equity volatility. As such, the following analysis of the time series of coefficients from cross-sectional regressions sheds further light into economic and financial factors affecting firm risk.

Figure 1 plots the estimated annual coefficients (with 95% confidence intervals) from the LT model over time with years that contained any part of a recession shaded. In almost every year, larger firms have lower risk though the relation seems to be weaker during the early 1980s

[13] Model convergence is more problematic in recent years. Convergence was not achieved in 7 years: 1995-1996, 2002-2004, 2008.

and late 1990s. Still, there is no apparent long-term trend in the relation between firm size and risk. The relation appears to weaken (coefficients move toward zero) at the beginning of each recession though the effect is not dramatic. Firm age becomes a significant driver of firm risk starting only in the early 1980s. In fact, in some years prior to 1982 firm age was significantly positively related to risk. The trend since the early 1980s is in line with findings documented by Brown and Kapadia (2007) that easier access to financial markets by riskier firms explains the trend in idiosyncratic risk and the disappearance of many risk firms after the bursting of the tech bubble accounts for the decline after 2000. The relation appears to intensify during the last three recessions, suggesting that new firms experience greater changes in risk during economic downturns.

In the previous results, asset tangibility is not significantly negatively related to risk, but Figure 1 shows that between 1995 and 2002 (the "dot-com" era) there was a significant negative relation. For capital expenditures, there are about as many statistically positive coefficients as statistically negative ones and there is no apparent trend. The effect of profitability shows no trend but the negative relation appears more stable during the 1980s and 1990s. Profit volatility has a positive effect on firm risk in all but two years (1966 and 2008). The effect appears to decline substantially in the 1960s and then holds relatively steady. In contrast, the significant negative relation between dividend yield and equity volatility is strong until just recently. None of these factors exhibit reliable correlations with the business cycle.

All together among the economic risk characteristics, only firm age appears to exhibit a trend consistent with the observed trend in idiosyncratic risk. Thus if other factors are related to idiosyncratic risk, it is likely that the effect comes from time trends in the variables themselves versus a time-varying relation to idiosyncratic risk.

Probably the most dramatic trend between risk factors and equity volatility is observed for the leverage factor. Surprisingly, this factor did not increase as firms became riskier in the 1980s and 1990s but instead declined steadily from values near 0.6 in the early 1970s to around 0.1 in the late 1990s. This, combined with the long steady decline in both total and net debt over the same time period,[14] suggest that financial risk actually had a dampening effect on the time trend in equity volatility.

To examine this issue directly, Figure 2 compares actual leverage with LT model implied financial leverage. Actual leverage for net debt is always lower than actual leverage for total debt because of cash holdings. However, the changes in cash holdings are small compared to changes in total debt so that the series track each other closely. Actual leverage increased through the 1960s and early 1970s but then started to trend downward until 2000. Implied leverage exhibits a somewhat different pattern. First, since the late 1960s implied leverage is much lower than either measure of actual leverage. Implied leverage shows neither the big long-term run-up nor the substantial decline of actual leverage in the 1970s and 1980s. At a higher frequency, implied leverage is also more stable than actual leverage during our sample period. For example, during the oil shock and recession of 1973-1974 actual leverage ratios show large spikes whereas implied financial leverage ratios decline somewhat. In 1973, the estimated volatility of assets (plotted in panel B) followed the increase in actual leverage. Given that the oil crisis of 1973 was an exogenous shock on economic risk factors, the fact that implied leverage stayed largely stable is in line with our expectations. Perhaps most surprising is that implied leverage starts declining steadily in 1990 so that values are very close to 1.0 for all of the last decade.

Panel B of Figure 2 plots our estimates of equity volatility and asset volatility from the LT model. Because implied leverage is generally low, the two series track each other closely. The plots show the well-documented upward trend in firm risk from 1964-2000. In fact, asset volatility shows an even stronger trend than equity volatility because implied leverage tends to decline over this period. Thus, *more than all* of the trend in idiosyncratic equity price risk can be attributed to the trend in asset volatility. These results are consistent with previous research findings that growth options, profit volatility, and other characteristics associated with firm assets and economic risk explain the trend in idiosyncratic risk.[15] Over the last decade the two series almost coincide and display a strong V-shaped pattern. Overall, the average decline in leverage (both actual and implied) over the last three decades indicates that any upward trend in equity

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[14] For example, see Bates, Kahle, Stulz (2006) on increasing cash holdings of U.S. firms.

[15] See, for example, Irvine and Pontiff (2007) and Cao, Simin, and Zhao (2008).

volatility was driven entirely by economic risk factors and declines in financial risk actually mitigated the severity of the change.

5.4 Firm Risk at the Industry Level

It is well known that average debt levels vary considerably by industry. This poses a challenge for our analysis because we are not able to estimate our model with additional parameters (e.g., industry dummy variables). Instead we use the French 17 industry classification to partition our sample, and estimate the model at the industry level.[16] Because some industries have a small number of firms in some years we cannot estimate the model year-by-year. However, as shown in Figure 1, some variables exhibit time-varying relations to asset volatility. Consequently, we estimate pooled regressions but for only the 1996-2008 period. These estimates allow us to compare asset volatility, leverage factors, and implied leverage at the industry level as well as with the full sample estimates.

As expected, the results presented in Table 7 show that there is meaningful variation by industry. For example, asset volatilities range from a low of 0.340 in the fabricated products industry to a high of 0.607 in miscellaneous industries. However, the typical values for leverage factors and implied leverage are still quite low.[17] Even the largest leverage factor (0.59 for fabricated products) is much less than 1.0 and average implied leverage is only 1.11. Negative correlation between σ_A and the leverage factor results in variation in implied leverage that is relatively low in comparison. This is as would be expected from trade-off theory of capital structure (e.g., the LT model) where firms with riskier assets take on less financial risk. However, the estimated values of the leverage factor (all below 1.0) indicate that on average firms reduce effective debt levels more than suggested by the trade-off in the LT model. More importantly, the observed strong negative correlation between σ_A and the leverage factor suggests that firms more aggressively find ways to effectively scale back financial risk (in addition to lower actual debt) when

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[16] As before we do not examine utilities or financial services firms, so we are left with 15 industry groups.

[17] Another advantage of conducting the estimation by industry is that it should mitigate problems associated with error measurement of model inputs or even model misspecification. For example, if our low estimates for the leverage factor and implied leverage are the result of an errors in variables problem at the industry level, we should see average levels of these estimates that are higher. In fact, we do find somewhat higher estimates of the leverage factor and implied leverage, but the values are still low compared to 1.0 and actual leverage, respectively. Estimated values for coefficients on other firms specific factors (not reported) vary significantly by industry, but in almost all cases the significant coefficients have the same sign as those reported in Table 5.

they face higher economic risk. As discussed already, this is consistent with firms using other risk management tools or dynamic financial policies to reduce financial risks.

6 Other Tests and Discussion

6.1 Reduced-Form Model

As noted above, one limitation to the LT model is the more rigid structural form of risk, and especially financial risk, which could result in model misspecification and misleading conclusions. For example, the only estimated variable in our specification of financial risk is the leverage factor. Consequently, the LT model may put too much structure on financial risk which leads to the low estimates of market leverage we obtain in the previous section. The reduced form model serves as a check on the LT method by allowing for any number of estimated financial risk factors and a less rigid structure.

As discussed in the previous section, we define our RF model with economic risk as a determinant of financial policy. The general form allows for the flexibility to include all variables of interest but the simple definition of the equity volatility equation provides for straightforward estimation. Recall equation (10), $\sigma_E = \mathbf{X}'\beta\ (\mathbf{Y}'\Gamma(\mathbf{X}'\beta))$, where we define volatility of assets, ($\sigma_A = \mathbf{X}'\beta$), as a function of economic risk factors and allow financial leverage, $l = (\mathbf{Y}'\Gamma(\mathbf{X}'\beta))$, to be a function of both financial and economic risk factors. Much like the LT model we define the volatility of assets as

$$\begin{aligned}\sigma_A = \boldsymbol{X'\beta} &= \beta_0 + \beta_1 Size + \beta_2 Age + \beta_3 Tangible\ Assets + \beta_4 Capital\ Expenditures \\ &+ \beta_5 Profitability + \beta_6 Profit\ Volatility + \beta_7 Dividend\ Yield\end{aligned}, \tag{15}$$

and, we define market leverage as

$$\begin{aligned}l = \mathbf{Y}'\boldsymbol{\Gamma}(\mathbf{X}'\boldsymbol{\beta}) = 1 &+ \beta_8 Total\ Debt\ /\ Market\ Capital + \beta_9 Total\ Debt\ /\ Market\ Capital * \sigma_A \\ &+ \beta_{10} Debt\ Maturity + \beta_{11} Debt\ Maturity * \sigma_A \\ &+ \beta_{12} Cash\ /\ Market\ Capital + \beta_{13} Cash\ /\ Market\ Capital * \sigma_A \\ &+ \beta_{14} Dividend\ Yield\end{aligned} \tag{16}$$

We then solve the nonlinear optimization problem by minimizing the squared deviations of predicted equity volatility from actual volatility subject to the constraint that $\beta_{14} \geq 0$.

Table 8 reports the results for pooled and Fama-MacBeth regressions for our RF model. For our pooled results, all the economic risk factors for σ_A are statistically significant at the 5% and of the same sign as in the LT model. But, the RF model also seems able to account for endogeneity of financial policy in general. For financial risk factors, we find that the total debt has a positive coefficient indicating that higher levels of debt are related to higher total risk. Furthermore, the sensitivity of equity volatility to leverage (interaction term) is smaller for firms with higher economic risks. This is consistent with the hypothesis that firms with risky assets would find other ways to mitigate the effects of financial leverage. Cash remains positively related to equity volatility whereas the interaction term for cash is negative. Debt maturity is negatively related to equity volatility, though the result is not statistically significant at the 5% level. As evidenced by the negative interaction term, the reduction in equity volatility with longer debt maturity is stronger for firms with more economic risk. Dividends do not enter into the financial leverage term.

For Fama-MacBeth regressions, all the significant coefficients have the same sign, albeit magnitudes of coefficients differ from pooled results. Except for capital expenditures, the economic risk factors remain significant at better than the 5% level. In contrast, none of the financial risk determinants are significant at conventional levels except for total debt to market capitalization. As is the case for the LT model, implied asset volatility (σ_A) is similar to observed equity volatility and implied leverage is very low. In fact, the values of 1.034 (for the pooled sample) and 1.081 (for Fama-MacBeth) are within one standard deviation of the LT estimates. This suggests again that there is only a small wedge between asset volatility and equity volatility for the typical firm. It is important to note that the similarity in results between the LT and RF methods suggests that model misspecification arising from the structure of the LT model is not a driver of our results.

Time-series plots of coefficients from the Fama-MacBeth estimation of the RF model (not reported), further suggest that innovations in financial risk management may have helped U.S. firms to better manage financial risks. Neither cash holdings nor debt maturity seems to have a significant impact on firm risk in general. Maturity seems to be increasing firm risk in the late 1970s and early 1980s, the high inflation / high interest rate era. The interaction terms are also not significant in general; however, they show that the sensitivity of equity volatility to leverage is decreasing with asset volatility until the early 1970s, and then increasing starting late 1980s. The sensitivity of firm risk to cash holdings is decreasing in asset volatility after late 1990s, whereas the positive impact of debt maturity on firm risk is declining with asset volatility. These results imply that managers try to find ways to alleviate financial risks.

Another advantage of the RF model is that we can further expand the specification to see if other factors are important determinants of risk. One specific concern is that our economic risk factors may be proxies for unobserved financial risk factors. This may cause us to underestimate the degree of financial risk since it is, in effect, swept into the specification of asset volatility. To test this hypothesis we include all of the economic risk factors in the specification for financial leverage (equation 16) and re-estimate the model. In the pooled regression (results not tabled), we do find that each of the economic risk factors is an important determinant of leverage beyond the effect that each has on asset volatility. In the Fama-Macbeth analysis (also not reported), not all the factors are significant. The significant coefficients are of the same sign as those reported in Table 8 except for profit volatility and capex. However, the effects of these variables on financial risk are about an order of magnitude smaller on average than their effects on economic risk. Consequently, the mean square error declines by only about 7% with the addition of these 7 variables. More importantly, it is unlikely that these variables serve as proxies for factors associated with higher financial risk, because including them reduces the measure of implied market leverage.

In summary, results from the much less restrictive RF model are very similar to those from the structural LT model. Financial risk, including leverage related to total debt, does not appear to have a substantial effect on equity volatility for the typical firm. In other words, the net impact of financial policies seems almost unimportant for understanding the determinants of observed equity volatility. This may be because many aspects of financial policy are hidden from view, and managers have effectively used risk management techniques to reduce financial risk. Alternatively, we may not be properly measuring variables related to financial risk. However, the form of the model we use does not seem to matter much as both methods provide very similar outcomes.

6.2 Flow of Funds Data

Because our result that the typical publicly-listed non-financial firm faces little financial risk, we undertake a two "reality checks" using independent data sources. In this section, we look at aggregate data for the non-financial sector from the Federal Reserve's flow-of-funds database. In the next section we look at bankruptcy filings of publicly traded firms during recent recessions.

The flow-of-funds data provide a comprehensive picture of non-financial corporate financing for all businesses in the U.S., both public and private. Panel A of Figure 3 shows that aggregate borrowing by non-financial firms as a percent of GNP (right axis) hovered in the 12-15% range until the early 1980s when it started to rise steadily to over 25% by 2000. The value of equity as a percent of GNP (left axis) increased a proportionately similar amount over the last 20 years but followed a much more volatile path. Total assets of non-financial firms increased over the full sample period as well, but display a somewhat different pattern. Specifically, assets increased substantially from the early 1970s until about 1980 and then remained fairly flat until the late 1990s when they started to trend up again. Panel B of Figure 3 plots Debt/Equity and Debt/Asset ratios for all non-financial firms. The debt/equity ratio shows a pattern very similar to that plotted in Figure 2 for actual debt (of firms in our sample) until the late 1990s when the debt-equity ratio spikes as the result of increased debt as well as plummeting equity values. The debt/assets ratio exhibits an entirely different pattern—it declines from the mid 1970s to the mid 1980s and then increases steadily until 2004. However, the variation in the debt/assets ratio is small with a standard deviation less than 2%.

The trends of debt/equity ratio up until the late 1990s are consistent with the time-series pattern of our implied leverage variable in Figure 2. However, the magnitudes of the two series are obviously different. The spike in aggregate debt/equity ratios since 2000 is not evident in our implied leverage measure. This could be due to a few factors. First, falling equity values and higher debt levels may have been occurring among firms not in our sample. For example, private firms (especially LBOs) took on increasing amounts of debt over the last 20 years. Second, firms in our sample are less likely to be dot-coms or other nascent technology firms that experienced the largest declines in equity value. Third, our measure is for a typical (average) firm in our sample as opposed to aggregate data which will be more heavily influenced by the largest firms. Finally, and as discussed already, many firms developed active financial risk management policies by 2000 which could result in lower implied leverage in more recent years.

More broadly, it is interesting to note the different patterns in debt/equity and debt/asset ratios. While both show weak long-term trends, the series clearly give different pictures of shorter-term trends in financial risk. Thus another advantage of our method for calculating financial leverage is that it utilizes additional information about the qualities of firms' assets and financial policies to provide a more nuanced measure of financial risk.

6.3 Bankruptcy Data

Our result that financial risk appears to be declining over the last 30 years suggests that public firms are less likely to experience financial distress. However, it is well documented that firms have tended to become riskier overall, and our results indicate that this is likely due to greater economic risks. Consequently, the rate of overall bankruptcy (from financial and economic causes) could even increase over time as financial risk declines.

To examine the effect of leverage on financial distress empirically, we collect data on bankruptcies of publicly listed non-financial firms since 1984. These data are highly cyclical with spikes in filings occurring in the years surrounding the 1990-1991 (gulf-war), 2001 (dot-com) , and current (great) recessions. Consequently, we examine financial distress in 3-year windows around these recessions: 1990-1992, 2000-2002, and 2007-2009.[18] We find the following results reported in Table 9. First, the overall incidence of bankruptcy filings (as a percent of publicly listed non-financial firms) has not changed substantially. In fact, the projected rate for the current recession is about the same as the rate in the gulf-war recession. Over all years from 1984-2009 there is no significant time trend in the rate of bankruptcy filings.

Firms that are economically sound may file for bankruptcy to reorganize their finances; likewise, firms that are not economically viable often attempt reorganization before liquidation. Consequently, it is hard to distinguish economic from financial distress using bankruptcy filings. Examining long-term debt (to assets) and Altman Z-scores in the year before bankruptcy also shows no trend in these financial risk variables. However, operating margins of firms filing for

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[18] We assume that the second half of 2009 will see as many filings as the first half, making it the worst year in the sample for the number of bankruptcies.

bankruptcy were much lower during the dot-com and current recessions than during the gulf-war recession. Across all years from 1984-2009 there is a significant negative trend in operating margins of firms filing for bankruptcy (results not tabled). This trend in operating margins combined with no trend in the rate of bankruptcy filings is consistent with the hypothesis that firms have become more exposed to economic risk (i.e.,σ_A has increased) but less exposed to financial risk (i.e., implied leverage has decreased).

7 Conclusions

Financial policy can be viewed as transforming asset volatility into equity volatility through net financial leverage. In this paper, we study this relationship using data for the U.S. between 1964 and 2008 in a unifying framework suggested by Leland and Toft (1996). This is an important contribution to the current literature since, to the best of our knowledge, no empirical study has attempted to analyze the determinants of firm risk using a structural model with a large number of firm-level variables.

In this respect we consider two general sources of firm risk, economic risk and financial risk, and analyze the relative importance of these risks. With our proxies for economic risk we intend to capture the essential characteristics a firm's operations and assets that determine the underling cash flow generating process for the firm. Simply put, firms have a comparative advantage in bearing these risks, and are compensated for doing so. Financial theory presumes that these risks are magnified through the use of financial leverage. However, firms are unlikely to earn economic rents for bearing these financial risks since they can often be hedged away. As such, we analyze the drivers of equity volatility and are concerned with providing an explanation for the fundamental question, "Do financial risks matter?"

The results of our analysis are striking. Despite the sizable actual leverage ratio of about 1.5, implied leverage is within the range of only 1.03 and 1.11 (for the models we consider). Thus, we measure only a small wedge between asset and equity volatility. In addition, observed leverage seems to be declining over the last three decades in contrast to the upward trend in economic risk.

Results for our coefficient estimates are also interesting. We see that the variation in equity volatility is largely driven by economic risk factors, and that the combined impact of financial risk factors is much weaker. Specifically, we find that larger firms with more mature lines of business, higher profitability, and lower profit volatility have lower firm risk. Financial risk factors do not seem to have a significant impact on firm risk in general. This is consistent with the hypothesis that financial innovation (for example, more common use of financial derivatives) helped U.S. firms to better manage financial risks. This stands in stark contrast to recent policy recommendations that call for limiting the use of many financial risk management products.[19]

In summary, despite some fractured evidence in the literature, we have yet to understand the fundamental drivers of firm risk. As such, our results have important implications for many areas of finance. For example, our analysis informs the corporate finance literature in its attempt to identify relevant risk factors for firm valuation, investment and financing policies. Delineating between economic risk and financial risk, and identifying the drivers of these risks provides a basis for effective risk management. Our results are also important for asset pricing models that attempt to identify and quantify prevalent properties of firm and market-wide risk.

[19] See, for example, President Obama's current proposal " Financial Regulatory Reform. A New Foundation: Rebuilding Financial Supervision and Regulation."

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Table 1: Sample construction

The table shows the independent impact of each constraint on our sample size: the number of observations lost for each screen, total number of observations lost for all screens combined, and the percent of universe market capital of non-financial firms represented in our sample. We consider firms that have annual accounting data in COMPUSTAT for any year between 1964 and 2008 and that have at least 125 non-zero daily stock returns on CRSP for the same year. We exclude utilities and financial services, and apply a variety of screens to focus on only liquidly traded firms in periods of normal operations. Specifically, we exclude 'micro-cap' companies (less than $50 million in market capitalization or $1 million in total assets measured in 2008 dollars) and penny stocks. We also exclude companies in the year of their initial public offering (IPO) and delisting. Firms with some missing or exceptional accounting data and firms likely to be in financial distress are also excluded. For example, we also require the ratio of Cash & STI to Market Capitalization to be between zero and one, Debt / Market Capitalization ratio to be less than one, and Book Value of Equity to be positive. We also only consider firms with estimated annual equity volatilities (standard deviation) that are between 1% and 200%.

	Number of Firm-years	% Lost
Full Sample (CRSP and CompuStat Merged)	106,846	
Firms Lost in Independent Screens		
Real Market Capitalization < $50MM (Year 2008 USD)	29,786	27.9
Real Total Asset < $1MM (Year 2008 USD)	254	0.2
Average Price < $1.00	3,448	3.2
New and Delisted Firms	10,661	10.0
Missing Variables of Interest	5,925	5.5
Cash & Short-term Investments / Market Cap > 1	3,267	3.1
Cash and Short-term Investments < 0	897	0.8
Debt / Market Cap < 0 or > 10	4,441	4.2
Debt / Total Assets > 1	3,544	3.3
Equity (Book Value) < 0	3,388	3.2
Equity Volatility < 1% or > 200%	1,507	1.4
Capex > Total Assets	1,825	1.7
Sales < 0	1,118	1.0
Firms Lost in Combined Screens	45,315	42.4
Final Sample	61,531	57.6
Percent of Full Sample Market Cap (annual average)	90.2%	

Table 2: Summary Statistics of Variables

This table reports summary statistics on equity volatility, economic risk, and financial risk factors for the sample between 1964 and 2008. Equity volatility is annualized standard deviation of daily stock returns from CRSP. Total assets is a proxy for firm size. Age is the difference between the measurement year and the minimum of (i) year of listing data from Jovanovic and Rousseau (2001) and (ii) the firm's initial appearance on CRSP monthly database. Tangible Assets is gross PP&E divided by total assets. Capital expenditures is capital expenditures divided by total assets. Profitability is operating income before depreciation divided by sales. Profit volatility is the five-year central standard deviation of profitability. Dividend yield is common dividends divided by market capitalization (absolute value of closing price*shares outstanding from CRSP). Total debt / market capitalization is long-term debt plus current liabilities plus preferred stock divided by market capitalization. Cash / market capitalization is cash and short-term investments (STI) divided by market capitalization. Net debt / market capitalization is (total debt – cash & STI) divided by market capitalization. Total debt / total assets (BV) is total debt divided by the sum of total debt and equity book value. Debt maturity is long-term debt divided by total debt. Coupon rate is interest expense plus preferred dividends divided by total debt. Upper and lower bounds of +/-50% are applied to profitability because this variable has a large number of extreme values. Likewise, profit volatility is capped at 50%. All accounting data items are from CompuStat.

			Percentiles						
	Mean	Std.Dev.	1st	5th	25th	Median	75th	95th	99th
Equity Volatility (annualized)	0.475	0.235	0.156	0.203	0.305	0.422	0.586	0.929	1.274
Total Assets	289.5	1631.1	9.3	23.6	85.0	237.0	858.3	6,775.0	27,282.5
Age (years)	12.4	2.5	2.0	3.0	6.0	12.0	24.0	58.0	81.0
Tangible Assets	0.546	0.362	0.041	0.095	0.275	0.477	0.748	1.193	1.589
Capital Expenditures	0.073	0.068	0.004	0.010	0.030	0.055	0.093	0.204	0.345
Profitability	0.102	0.183	-0.500	-0.418	0.062	0.116	0.182	0.355	0.500
Profit Volatility	0.070	0.119	0.002	0.005	0.013	0.025	0.059	0.499	0.500
Dividend Yield	0.013	0.019	0.000	0.000	0.000	0.000	0.023	0.054	0.075
Total Debt / Market Capitalization	0.718	0.996	0.014	0.037	0.153	0.386	0.861	2.540	5.059
Total Debt / Total Assets (BV)	0.437	0.198	0.058	0.119	0.284	0.441	0.577	0.769	0.900
Cash/Market Capitalization	0.133	0.151	0.001	0.006	0.032	0.081	0.177	0.448	0.742
Net Debt / Market Capitalization	0.585	0.975	-0.397	-0.169	0.041	0.288	0.752	2.341	4.782
Debt Maturity	0.360	0.272	0.000	0.000	0.079	0.371	0.583	0.801	0.890
Coupon Rate	0.036	0.027	0.000	0.000	0.014	0.035	0.054	0.086	0.110

Table 3: Pearson Correlation Coefficients

This table reports the Pearson correlation coefficients (times 100) among equity volatility, economic risk, and financial risk factors in columns, and various variables of interest in rows for the sample between 1964 and 2008. Equity volatility is annualized standard deviation of daily stock returns from CRSP. Total assets is a proxy for firm size. Age is the difference between the measurement year and the minimum of (i) year of listing data from Jovanovic and Rousseau (2001) and (ii) the firm's initial appearance on CRSP monthly database. Tangible Assets is gross PP&E divided by total assets. Capital expenditures is capital expenditures divided by total assets. Profitability is operating income before depreciation divided by sales. Profit volatility is the five-year central standard deviation of profitability. Dividend yield is common dividends divided by market capitalization (absolute value of closing price*shares outstanding from CRSP). Total debt / market capitalization is long-term debt plus current liabilities plus preferred stock divided by market capitalization. Cash / market capitalization is cash and short-term investments (STI) divided by market capitalization. Net debt / market capitalization is (total debt – cash & STI) divided by market capitalization. Total debt / total assets (BV) is total debt divided by the sum of total debt and equity book value. Debt maturity is long-term debt divided by total debt. Coupon rate is interest expense plus preferred dividends divided by total debt. All accounting data items are from CompuStat.

Variable	Equity Vol	Total Assets (log)	Age (log)	Tang Assets	CapEx	Profit	Profit Vol	Div Yield	Total Debt / MktCap	Total Debt / Assets	Cash / MktCap	Net Debt	Debt Mat
Total Assets (log)	-40.8												
Age (log)	-41.4	49.4											
Tangible Assets	-24.7	22.3	24.3										
Capital Expenditures	-5.9	0.9	-7.9	51.0									
Profitability	-41.3	31.9	15.9	29.0	22.5								
Profit Volatility	49.6	-33.5	-28.1	-16.2	-1.9	-64.2							
Dividend Yield	-43.7	22.0	37.0	25.1	-0.7	15.7	-26.8						
Total Debt / Market Capitalization	0.8	16.7	9.3	11.4	-2.2	1.4	-15.8	17.6					
Total Debt / Total Assets (Book Value)	-9.6	31.4	15.7	16.4	5.3	6.5	-21.1	9.0	59.0				
Cash / Market Capitalization	20.5	-10.8	-8.4	-17.6	-16.1	-24.2	20.4	-4.1	21.4	-7.0			
Net Debt / Market Capitalization	-2.4	18.8	10.8	14.4	0.2	5.2	-19.3	18.7	98.8	61.4	6.3		
Debt Maturity	-15.4	27.5	10.8	34.9	19.0	17.3	-10.3	9.9	37.8	57.8	-10.5	40.3	
Coupon Rate	-6.3	13.1	10.2	28.7	10.9	8.2	-6.6	12.0	39.0	47.8	-10.8	41.5	62.8

Table 4: Summary Statistics of Variables by Volatility Quartiles

The table reports summary statistics on equity volatility, economic risk, and financial risk factors by volatility quartiles in means for the sample between 1964 and 2008. Equity volatility is annualized standard deviation of daily stock returns from CRSP. Total assets is a proxy for firm size. Age is the difference between the measurement year and the minimum of (i) year of listing data from Jovanovic and Rousseau (2001) and (ii) the firm's initial appearance on CRSP monthly database. Tangible Assets is gross PP&E divided by total assets. Capital expenditures is capital expenditures divided by total assets. Profitability is operating income before depreciation divided by sales. Profit volatility is the five-year central standard deviation of profitability. Dividend yield is common dividends divided by market capitalization (absolute value of closing price*shares outstanding from CRSP). Total debt / market capitalization is long-term debt plus current liabilities plus preferred stock divided by market capitalization. Cash / market capitalization is cash and short-term investments (STI) divided by market capitalization. Net debt / market capitalization is (total debt – cash & STI) divided by market capitalization. Total debt / total assets (BV) is total debt divided by the sum of total debt and equity book value. Debt maturity is long-term debt divided by total debt. Coupon rate is interest expense plus preferred dividends divided by total debt. All accounting data items are from CompuStat.

	Equity Volatility Quartile (Means)			
	1st	2nd	3rd	4th
Equity Volatility (annualized)	0.241	0.361	0.497	0.799
Total Assets (MM)	801.1	393.9	208.3	106.8
Age (years)	21.3	14.5	10.4	7.3
Tangible Assets	0.658	0.592	0.517	0.416
Capital Expenditures	0.073	0.077	0.078	0.066
Profitability	0.160	0.144	0.112	-0.007
Profit Volatility	0.021	0.034	0.065	0.158
Dividend Yield	0.026	0.016	0.008	0.002
Total Debt / Market Capitalization	0.640	0.740	0.779	0.713
Total Debt / Total Assets (BV)	0.452	0.455	0.440	0.403
Cash/Market Capitalization	0.097	0.117	0.142	0.178
Net Debt / Market Capitalization	0.543	0.623	0.637	0.535
Debt Maturity	0.390	0.394	0.364	0.294
Coupon Rate	0.037	0.038	0.037	0.033

Table 5: Leland-Toft Model

The table shows Leland Toft (LT) model coefficient estimates, *p*-values, and marginal effects from pooled and Fama-MacBeth regressions for the sample between 1964 and 2008. The table also provides predicted values and standard deviations for σ_A (volatility of assets) and Market Leverage as defined in Equations 7 and 8. Total assets is a proxy for firm size. Age is the difference between the measurement year and the minimum of (i) year of listing data from Jovanovic and Rousseau (2001) and (ii) the firm's initial appearance on CRSP monthly database. Tangible assets is gross PP&E divided by total assets. Capital expenditures is capital expenditures divided by total assets. Profitability is operating income before depreciation divided by sales. Profit volatility is the five-year central standard deviation of profitability. Dividend yield is common dividends divided by market capitalization (absolute value of closing price*shares outstanding from CRSP). Leverage factor is defined in Equation 16. All accounting data items are from CompuStat.

	Pooled Sample			Fama-MacBeth		
Parameter Estimates	Estimate	*p* -value	Marg. Eff.	Mean	*p* -value	Marg. Eff.
Intercept (β_0)	-0.17	<0.001		-0.24	<0.001	
Total Assets (log)	-0.05	<0.001	-0.087	-0.09	<0.001	-0.156
Age (log)	-0.08	<0.001	-0.073	-0.03	<0.001	-0.027
Tangible Assets	-0.05	0.441	-0.018	0.00	0.795	0.001
Capital Expenditures	-0.26	0.269	-0.018	-0.21	0.002	-0.014
Profitability	-0.26	<0.001	-0.048	-0.24	<0.001	-0.044
Profit Volatility	0.69	<0.001	0.082	0.83	<0.001	0.099
Dividend Yield	-10.82	<0.001	-0.206	-8.27	<0.001	-0.157
Leverage factor	0.11	<0.001		0.27	<0.001	
Implied Values	Mean	Std.Dev.		Mean	Std.Dev.	
σ_A	0.458	0.165		0.408	0.128	
Implied Financial Leverage (*l*)	1.031	0.034		1.100	0.082	

Table 6: Leland-Toft Model Robustness Checks

The table shows Leland-Toft (LT) model coefficient estimates and *p*-values from Fama-MacBeth estimates for the sample between 1964 and 2008. The first three sets of results show estimated coefficients and *p*-values for different values of the distress cost parameter alpha. The last set of results shows values when less stringent bounds are applied to profit volatility, dividend yield, and the coupon rate. Values are means for all years for which the estimation procedure converges. The table also provides predicted values and standard deviations for σ_A (volatility of assets) and Market Leverage as defined in Equations 7 and 8. Total assets is a proxy for firm size. Age is the difference between the measurement year and the minimum of (i) year of listing data from Jovanovic and Rousseau (2001) and (ii) the firm's initial appearance on CRSP monthly database. Tangible assets is gross PP&E divided by total assets. Capital expenditures is capital expenditures divided by total assets. Profitability is operating income before depreciation divided by sales. Profit volatility is the five-year central standard deviation of profitability. Dividend yield is common dividends divided by market capitalization (absolute value of closing price*shares outstanding from CRSP). Leverage factor is defined in Equation 16. All accounting data items are from CompuStat.

Fama-MacBeth	$\alpha = 0.2$		$\alpha = 0.4$		$\alpha = 0.6$		$\alpha = 0.4$, Loose Constraints	
Parameter Estimates	Mean	*p* -value	Mean	*p* -value	Mean	*p* -value	Mean	*p* -value
Intercept (β_0)	-0.24	<0.001	-0.24	<0.001	-0.24	<0.001	-0.20	<0.001
Total Assets (log)	-0.09	<0.001	-0.09	<0.001	-0.09	<0.001	-0.10	<0.001
Age (log)	-0.03	0.002	-0.03	<0.001	-0.03	0.002	-0.04	<0.001
Tangible Assets	0.00	0.831	0.00	0.795	0.00	0.759	0.01	0.530
Capital Expenditures	-0.21	0.002	-0.21	0.002	-0.21	0.002	-0.17	0.013
Profitability	-0.24	<0.001	-0.24	<0.001	-0.24	<0.001	-0.29	<0.001
Profit Volatility	0.82	<0.001	0.83	<0.001	0.85	<0.001	0.58	<0.001
Dividend Yield	-8.26	<0.001	-8.27	<0.001	-8.28	<0.001	-7.77	<0.001
Leverage factor	0.27	<0.001	0.27	<0.001	0.27	<0.001	0.26	<0.001
Implied Values	Mean	Std.Dev.	Mean	Std.Dev.	Mean	Std.Dev.	Mean	Std.Dev.
σ_A	0.408	0.128	0.408	0.128	0.408	0.128	0.409	0.128
Market Leverage	1.100	0.082	1.100	0.082	1.100	0.081	1.097	0.085

Table 7: Leland-Toft Model Estimates by Industry

The table shows Leland-Toft (LT) model estimates for asset volatility (σ_A), the empirical model leverage factor (as defined in Equation 16), and implied leverage from estimations of firms partitioned by industry groupings. Estimates are obtained from a using results of pooled regressions with annual data from 1996-2008. Industries are defined using Ken French's 17 industry classification. Model specification is otherwise identical to that used for pooled results in Table 5 though estimates are not reported for other coefficients besides the leverage factor.

	σ_A		Leverage Factor		Implied Leverage	
Industry	Mean	StdDev	Mean	StdDev	Mean	StdDev
Food	0.345	0.118	0.271	0.056	1.12	0.082
Mines	0.433	0.092	0.270	0.078	1.12	0.092
Oil	0.436	0.124	0.250	0.043	1.12	0.072
Clothing	0.464	0.116	0.230	0.067	1.07	0.074
Durables	0.461	0.124	0.200	0.052	1.07	0.065
Chemicals	0.406	0.127	0.180	0.060	1.08	0.062
Consumer Goods	0.509	0.221	0.110	0.030	1.02	0.050
Construction	0.389	0.119	0.330	0.057	1.15	0.101
Steel	0.509	0.229	0.120	0.083	1.06	0.027
Fabricated Products	0.340	0.115	0.594	0.086	1.36	0.278
Machinery	0.601	0.191	0.100	0.019	1.01	0.038
Automobiles	0.380	0.116	0.420	0.073	1.22	0.166
Transportation	0.385	0.102	0.362	0.044	1.16	0.114
Retail	0.452	0.145	0.340	0.035	1.13	0.106
Miscellaneous	0.607	0.218	0.150	0.014	1.02	0.061
Mean of Means	0.448		0.262		1.11	
StdDev of Means	0.082		0.134		0.09	

Table 8: Reduced Form Model

The table reports coefficient estimates and *p*-values from the estimate of the reduced form (RF) model. Results are shown separately for pooled and Fama-MacBeth regressions for the sample between 1964 and 2008. The table also provides predicted values and standard deviations for σ_A (volatility of assets) and Market Leverage as defined in Equations 7 and 8. Total assets is a proxy for firm size. Age is the difference between the measurement year and the minimum of (i) year of listing data from Jovanovic and Rousseau (2001) and (ii) the firm's initial appearance on CRSP monthly database. Tangible assets is defined as gross PP&E divided by total assets. Capital expenditures is defined as capital expenditures divided by total assets. Profitability is operating income before depreciation divided by sales. Profit volatility is the five-year central standard deviation of profitability. Dividend yield is common dividends divided by market capitalization (absolute value of closing price*shares outstanding from CRSP). Total debt / market capitalization is long-term debt plus current liabilities plus preferred stock divided by market capitalization. Cash / market capitalization is cash and short-term investments (STI) divided by market capitalization. Net debt / market capitalization is (total debt – cash & STI) divided by market capitalization. Total debt / total assets (BV) is total debt divided by the sum of total debt and equity book value. Debt maturity is long-term debt divided by total debt. Leverage factor is defined in Equation 16. All accounting data items are from CompuStat.

	Pooled Sample		Fama-MacBeth	
Parameter Estimates	Estimate	*p*-value	Mean	*p*-value
σ_A				
Intercept	0.692	<0.001	0.641	<0.001
Total Assets (log)	-0.019	<0.001	-0.029	<0.001
Age (log)	-0.039	<0.001	-0.017	<0.001
Tangible Assets	-0.015	<0.001	-0.011	0.045
Capital Expenditures	-0.027	0.041	0.031	0.139
Profitability	-0.152	<0.001	-0.124	<0.001
Profit Volatility	0.653	<0.001	0.628	<0.001
Dividend Yield	-3.143	<0.001	-2.365	<0.001
Financial Leverage (l)				
Total Debt / Market Cap	0.039	<0.001	0.092	0.020
Total Debt / Market Cap * σ_A	0.082	0.001	-0.091	0.453
Cash / Market Cap	0.505	<0.001	0.033	0.783
Cash / Market Cap * σ_A	-0.655	<0.001	0.481	0.205
Debt Maturity	-0.031	0.064	-0.066	0.327
Debt Maturity *σ_A	-0.198	<0.001	0.265	0.199
Dividends (restricted to >=0)	0.000		0.000	

Implied Values	Mean	Std.Dev.	Mean	Std.Dev.
σ_A	0.463	0.163	0.410	0.120
Market Leverage	1.034	0.088	1.081	0.063

Table 9: Bankruptcies of Publicly Traded Non-financial Firms

This table reports data for non-financial firms that file for bankruptcy around three recent recessions. Firms are identified if they file for bankruptcy in a three year period around the gulf-war recession (1990-1992), the dot-com recession (2000-2002), or the current “great” recession (2007-2009). The bankruptcy rate is calculated as the annual average number of bankruptcies of non-financial firms as a percent of the annual average number of publicly traded non-financial firms on the CRSP database. Long-term Debt / TA is defined as the ratio of long-term debt (CompuStat item DLTT) to total assets (CompuStat item AT). Altman’s Z-Score is as defined in Altman (1968). Operating margin is defined as operating income before depreciation (CompuStat item OIADP) divided by sales (CompuStat item REVT).

Period	Years	Bankruptcy Rate	Long-Term Debt / TA	Altman’s Z-Score	Operating Margin
Gulf-War Recession	1990-1992	1.7%	15.2%	1.4	0.5%
Dot-com Recession	2000-2002	3.0%	9.7%	0.9	-5.5%
Great Recession	2007-2009	2.5%	16.1%	1.1	-5.3%

Figure 1: Time-Series Patterns of Leland-Toft Model Coefficient Estimates

The figure plots the time-series of coefficient estimates for each of the variables in the Leland-Toft model estimation. Coefficients (dark lines) are from estimations done each year from 1964 to 2008. 95% confidence bounds are indicated by lighter lines. Estimates are reported for total assets (log), age (log), tangible assets, capital expenditures, profitability, profit volatility, dividend yield, and the leverage factor (as defined in Equation 16). NBER-dated recessions are shaded in gray.

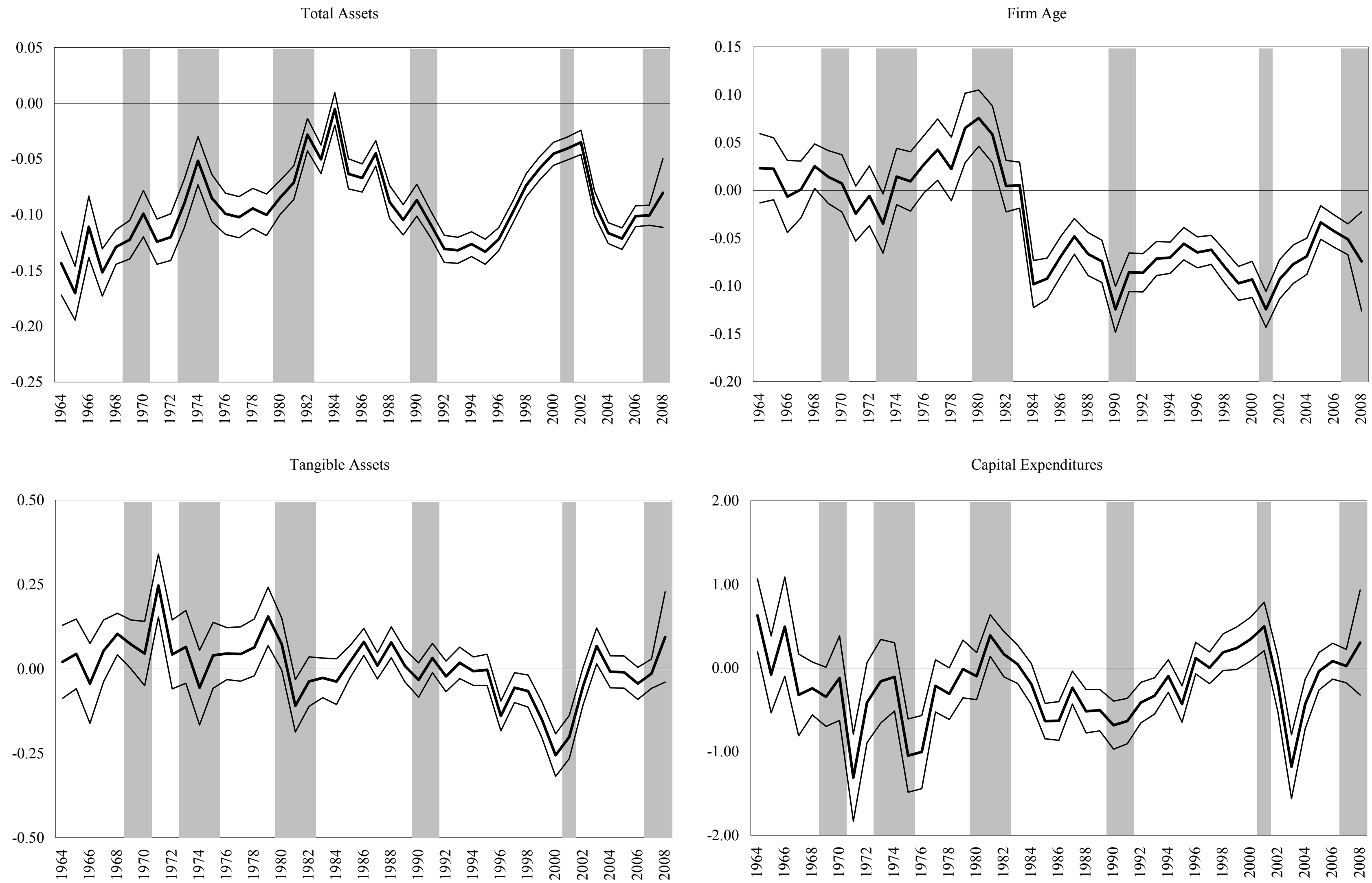


Figure 1: Economic Risk Determinants for LT Model (continued)

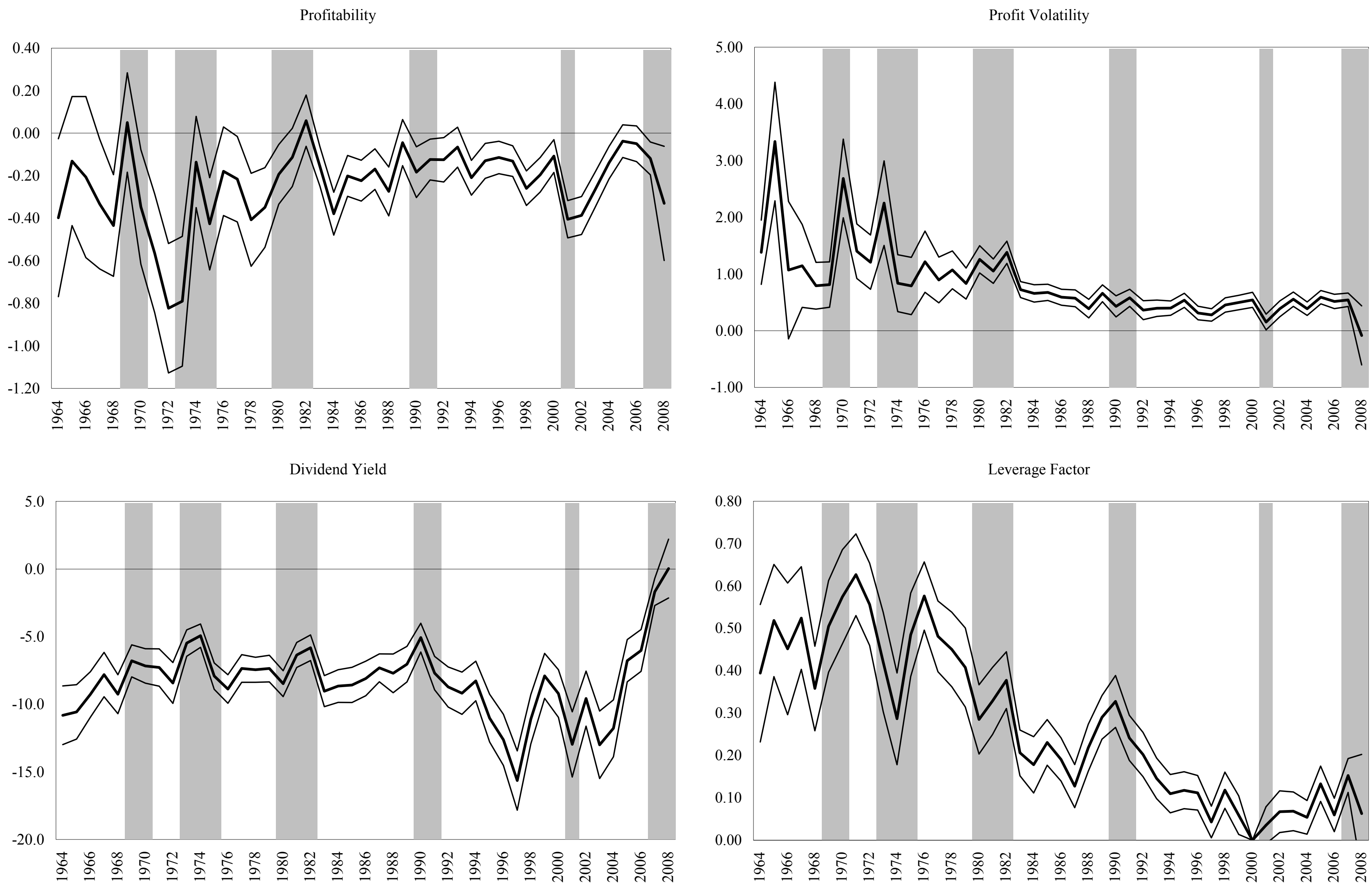


Figure 2: Leverage Ratios and Volatility

Panel A plots average values for implied leverage from the Leland-Toft model estimation presented in Table 5, actual leverage calculated using total debt, and actual leverage using net debt. Total debt and net debt are as defined in Table 2. Leverage is defined as 1.0 plus the relevant debt measure divided by the market value of equity. Panel B plots estimated levels of asset volatility from the LT model and equity volatility. Plotted values are annual estimates from 1964-2008. NBER-dated recessions are shaded in gray.

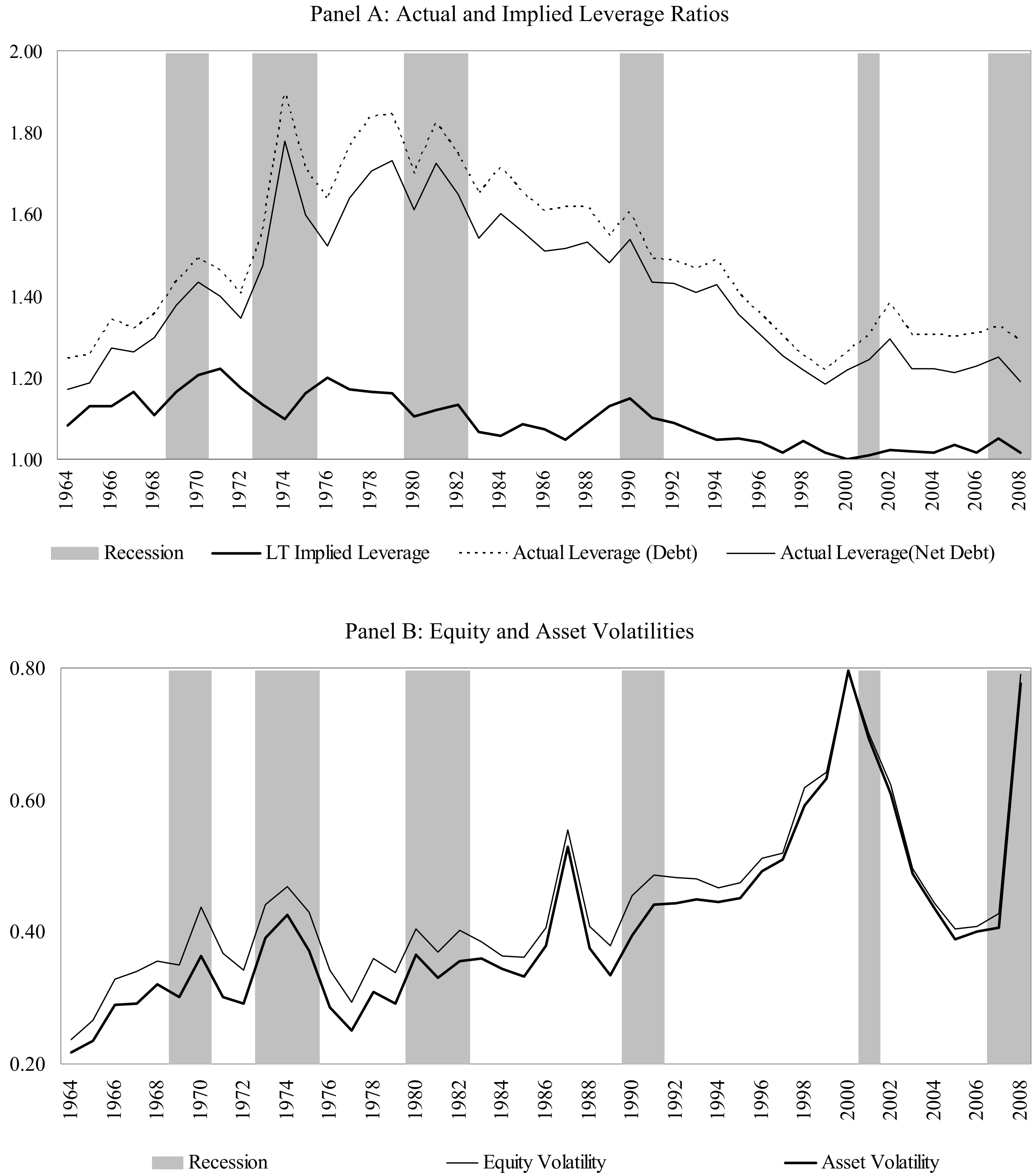
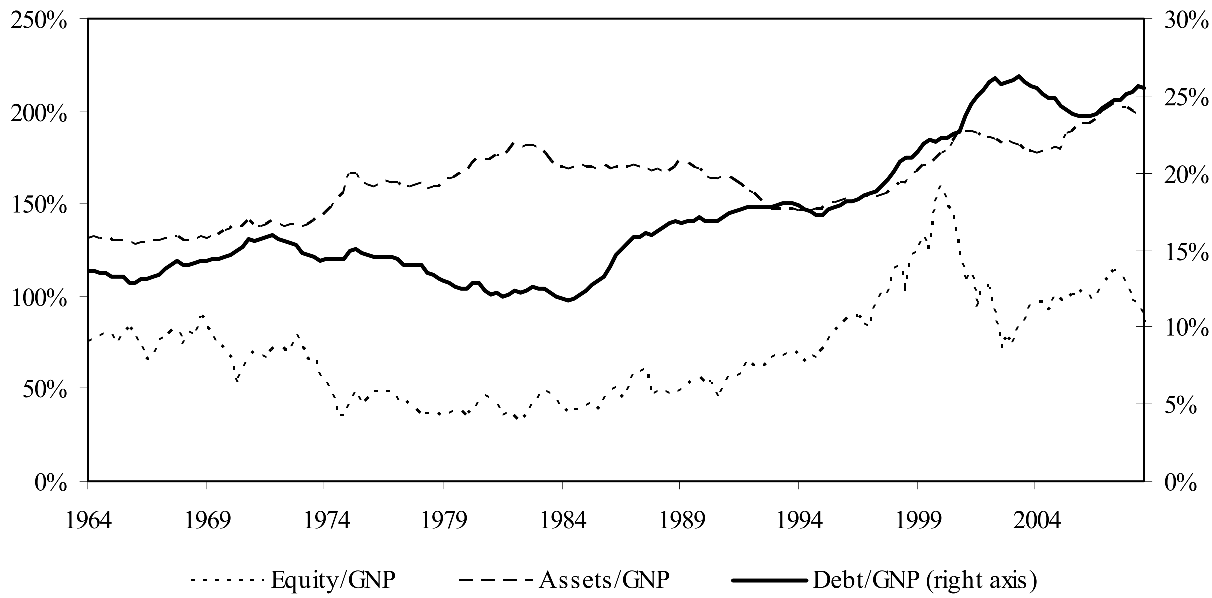


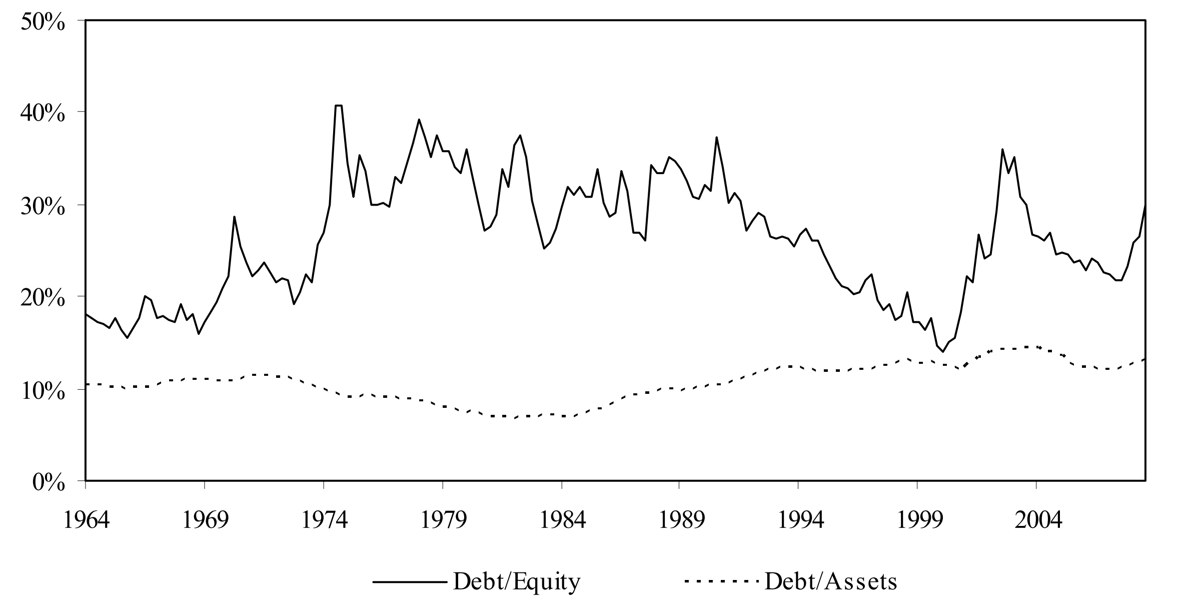
Figure 3: Aggregate Debt Ratios

This figure plots data for aggregate debt, equity and asset values for all U.S. non-financial firms from the Federal Reserve's flow-of-funds database. Values are quarterly from 1964:Q1 through 2008:Q4. Panel A plots values for total equity, assets, and debt (right axis) as a percent of GDP. Panel B plots values for the ratios of total debt to equity and total debt to assets.

Panel A: Debt, Equity and Assets as a Percent of GNP



Panel B: Debt Ratios



Appendix: Leland-Toft Model

The Leland-Toft model builds on the trade off theory of capital structure (i.e. corporate tax benefits versus bankruptcy costs and agency costs). Debt issues provide tax benefits that are balanced with higher probabilities of default. Equity holders aim to achieve the lowest bankruptcy trigger (equity value is maximized at the expense of the debt holders). This is the well-known asset substitution problem where around the optimal bankruptcy trigger, equity holders would want to take on riskier projects. Following Merton (1974), asset value (unleveraged value) follows a diffusion process

$$\frac{dV}{V} = [\,\mu(V,t) - \delta\,]\,dt + \sigma dz, \tag{A1}$$

where $\mu(V,t)$ is the total expected rate of return on value V, δ is the payout rate, and σ is the constant proportional volatility.

Consider a single bond that pays a continuous coupon, $c(t)$, with principal, $p(t)$, where t is the maturity. Upon bankruptcy, debt holders receive ρ fraction of firm value at bankruptcy VB. The value of this bond is given as:

$$\begin{aligned} d(V;V_B,t) &= \int_0^t e^{-rs} c(t)[1 - F(s;V,VB)]\,ds + e^{-rt} p(t)[1 - F(t;V,VB)] \\ &\quad + \int_0^t e^{-rs} \rho(t) VB f(s;V,VB)\,ds \end{aligned} \tag{A2}$$

where $F(s;V,VB)$ and $f(s,V,VB)$ are the cumulative and incremental default probabilities. Integration by part gives:

$$d(V;VB,t) = \frac{c(t)}{r} + e^{-rt}\left[p(t) - \frac{c(t)}{r}\right]\left[1-F(t)\right] + \left[\rho(t)VB - \frac{c(t)}{r}\right]G(t), \tag{A3}$$

$$\begin{gathered} F(t) = N(h_1(t)) + \left(\frac{V}{VB}\right)^{-2a} N(h_2(t)),\ G(t) = \left(\frac{V}{VB}\right)^{-a+z} N(q_1(t)) + \left(\frac{V}{VB}\right)^{-a-z} N(q_2(t)), \\ q_1(t) = \left(\frac{-b - zt\sigma_A^2}{\sigma_A\sqrt{t}}\right),\ q_2(t) = \left(\frac{-b + zt\sigma_A^2}{\sigma_A\sqrt{t}}\right),\ h_1(t) = \left(\frac{-b - at\sigma_A^2}{\sigma_A\sqrt{t}}\right),\ h_2(t) = \left(\frac{-b + at\sigma_A^2}{\sigma_A\sqrt{t}}\right), \end{gathered} \tag{A4}$$

$$a = \frac{r - \delta - 0.5\,\sigma_A^2}{\sigma_A^2},\; b = log\left(\frac{V}{VB}\right),\; z = \frac{\sqrt{(a\sigma_A^2)^2 + 2r\sigma_A^2}}{\sigma_A^2},\; x = a + z.$$

Assuming that the firm continuously issues a constant principal amount of new debt with maturity T and simultaneously retires the same amount of debt, then the debt structure becomes independent of t, and the value of all outstanding bonds $D(V;VB,T)$ can be determined by integrating the debt flow $d(V;VB,t)$, over a period of T:

$$D(V;VB,T) = \int_{t=0}^{T} d(V;VB,t)dt = \frac{C}{r} + \left(P - \frac{C}{r}\right)\left(\frac{1-e^{-rT}}{rT} - I(T)\right) + \left((1-\alpha)VB - \frac{C}{r}\right)J(T) \qquad \text{(A5)}$$

$$I(T) = \frac{G(T) - F(T)e^{-rT}}{rT},\; J(T) = \frac{\left(-\frac{V}{VB}\right)^{-a+z} N(q_1(T))q_1(T) + \left(\frac{V}{VB}\right)^{-a-z} N(q_2(T))q_2(T)}{z\sigma_A\sqrt{T}},$$

Following Leland (1994) total firm value is given by asset value plus the value of tax benefits minus the value of bankruptcy costs:

$$v(V;VB;T) = V + \frac{\tau C}{r}\left[1 - \left(\frac{V}{VB}\right)^{-x}\right] - \alpha VB\left(\frac{V}{VB}\right)^{-x}, \qquad \text{(A6)}$$

Equity value is then given by:

$$E(V;VB;T) = v(V;VB;T) - D(V;VB;T), \qquad \text{(A7)}$$

The optimal bankruptcy trigger, VB, is found by using the smooth pasting condition:

$$\left.\frac{\partial E(V;VB;T)}{\partial V}\right|_{V=VB} = 0 \qquad \text{(A8)}$$

The smooth pasting condition gives the following bankruptcy trigger:

$$VB = \frac{(C/r)(A/(rT) - B) - AP/(rT) - \tau Cx/r)}{(1 + \alpha x - (1-\alpha)B)}, \qquad \text{(A9)}$$

$$A = 2ae^{-rT}N(a * \sigma_A\sqrt{T}) - 2z\,N(z\sigma_A\sqrt{T}) - \frac{2}{\sigma_A\sqrt{T}}n(z\sigma_A\sqrt{T}) + \frac{2}{\sigma_A\sqrt{T}}e^{-rT}n(a\sigma_A\sqrt{T}) + (z - a),$$

$$B = -\left(2z + \frac{2}{z\sigma_A^2 T}\right)N(z\sigma_A\sqrt{T}) - \frac{2}{\sigma_A\sqrt{T}}n(z\sigma_A\sqrt{T}) + (z - a) + \frac{1}{z\sigma_A^2 T}.$$