Default Risk, Shareholder Advantage, and Stock Returns*

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First draft: March 2005
This draft: March 2006

*We are grateful to *Moody's KMV* for providing us with the data on *Expected Default Frequency*™ (EDF™) and to Jeff Bohn and Shisheng Qu of *Moody's KMV* for help with the data and for insightful suggestions. We appreciate useful comments and suggestions from Jonathan Berk, Jason Chen, Sanjiv Das, Sergei Davydenko, Mara Faccio, Andras Fulop, Raymond Kan, Hayne Leland, Mahendrarajah Nimalendran, George Oldfield, Hernan Ortiz-Molina, Ramesh Rao, Jacob Sagi, Matthew Spiegel, Sheridan Titman, Stathis Tompaidis, Raman Uppal, two anonymous referees, and seminar participants at George Washington University, Hong Kong University of Science and Technology, University of California at Berkeley, University of Hong Kong, University of Lausanne, University of South Carolina, University of Texas at Austin, University of Toronto and the Third UBC Summer Conference. We are responsible for all errors in the paper. The U.S. Securities and Exchange Commission disclaims responsibility for any private publication or statement of any SEC employee. This study expresses the authors' views and does not necessarily reflect those of the Commission, the Commissioners, or other members of the staff.

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Abstract

In this paper, we study the relationship between default probability and stock returns. Using the market-based measure of *Expected Default Frequency*™ (EDF™) constructed by *Moody's KMV*, we first demonstrate that higher default probabilities *are not necessarily* associated with higher expected stock returns, a finding that complements the existing empirical evidence. We then show that the puzzling and complex relationship between stock returns and default probability is consistent with the implications of existing structural models that account for possible negotiated benefits for equity-holders upon default. Adapting the setting of the Fan and Sundaresan (2000) model that explicitly considers the bargaining game between equity-holders and debt-holders in financial distress, we are able to obtain a theoretical relationship between expected returns and default probability that resembles the empirically observed pattern. Our analysis indicates that, depending on the level of shareholder advantage, the relationship between default probability and equity return may be either upward sloping (low shareholder advantage) or humped and downward sloping (high shareholder advantage). Moreover, we show that distressed firms in which shareholders have a stronger advantage in renegotiation exhibit lower expected returns, and that their default probabilities do not adequately represent the risk of default born by equity. We test these implications using several proxies for shareholder advantage and find strong support in the data.

Keywords: Default Risk, Stock Returns, Debt Renegotiation, Bankruptcy, Liquidation.
JEL Classification Codes: G12, G14.

1 Introduction

Default is an important aspect of every company's life. Default refers to various events of financial distress including missing debt payments, debt reorganization, filing for bankruptcy protection, and liquidation. Default (or distress) risk usually refers to the possibility that one of these events may happen in the future. Several studies have argued for a "default risk component" within the well-known factors that have successfully accounted for the cross section of stock returns.[1] This argument implies that investors would demand a premium for investing in firms with high risk of default and, consequently, high default risk should be associated with high expected returns in the cross section.

Using different measures of probability of default, the existing empirical literature has failed to produce consistent evidence to confirm the above conjecture. In fact, some studies have documented the opposite result, i.e., stocks of companies with a higher probability of default usually earn *lower* returns.[2] A common interpretation of this empirical evidence is that, when it comes to default, markets seem to be less capable of fully assessing the risk embedded in a company and do not demand a sufficiently high premium to compensate for the risk of default. While this mispricing argument may be plausible, we believe that it is important to exert extra effort in trying to understand more clearly the underlying (micro-) economic forces at play during distress and investigate their potential impact on the cross section of equity returns.

In this paper, we provide an explanation of the connection between default probability and equity returns that does not appeal to market mispricing and is in fact consistent with the risk-return trade-off. We achieve this objective in three steps. First, we revisit the empirical

[1] Chan, Chen, and Hsieh (1985) show that a default factor constructed as the difference between high- and low-grade bond return can explain large part of the size effect. Fama and French (1992) and Chen, Roll, and Ross (1986) document the power of a similarly defined default factor in explaining the cross section of stock returns. Fama and French (1992) link the book-to-market effect to the risk of distress. Chan and Chen (1991) justify the role of distress risk by arguing that the size premium is primarily driven by "marginal firms" i.e., firms with low market value, cash flow problems and high leverage that are more sensitive to adverse economic fluctuations. Similarly, Fama and French (1996) suggest that, if distress events are correlated across firms, a firm's "relative distress" can act as a state variable affecting investors' human capital and ultimately asset prices in the cross section.

[2] Using both Altman (1968) Z-score and Ohlson (1980) O-score, Dichev (1998) documents a negative relationship between stock return and default probability. Griffin and Lemmon (2002) confirm this results on a larger sample using O-scores. More recently, this pattern has been recently confirmed by Campbell, Hilscher, and Szilagyi (2005) using a hazard model to predict default probability.

relationship between default probability and stock returns by directly employing a database of *Expected Default Frequencies*™ (EDF™) produced by *Moody's KMV*, which is widely used by financial institutions as a predictor of default probability. Using the EDF measure, we find that higher default probabilities do not consistently lead to higher expected stock returns. In particular, small firms and/or firms with low-priced stocks exhibit different behavior than large firms. While this finding complements the existing evidence, it is also suggestive of cross-sectional variations in the relationship.

Second, we illustrate the point that, in order to understand the empirically observed pattern, it is essential to recognize that the assessment of the risk to equity associated with default should also take into account the potential recovery for *shareholders*, which can be an outcome of the renegotiation between debt-holders and shareholders in the event of financial distress. The importance of considering explicitly the strategic interaction between claimants is underscored by the fact that firms in financial distress often try to reorganize their debt obligations either through private workouts or under the protection of Chapter 11 bankruptcy filings. A number of theoretical models have explicitly considered these strategic interactions and investigated their implications for optimal capital structure and credit spreads on corporate bonds.[3] Our innovation in this paper is to show that this consideration is also important for explaining the puzzling behavior of stock returns. For this purpose, we adapt the model of Fan and Sundaresan (2000), whose parsimonious setup captures the essence of the bargaining game between debt-holders and shareholders and allows us to derive explicitly the link between default probability and expected stock returns.

Our analysis highlights the crucial role of *shareholder advantage*—defined as the combination of shareholders' bargaining power and the efficiency gained through bargaining—in the determination of equity returns. We show that the ability of shareholders with a stronger advantage to extract value from debt-holders leads to lower risk for equity, and hence lower expected returns, as the probability of default increases. On the other hand, for firms whose shareholders have a

[3] See, for example, Anderson and Sundaresan (1996), Mella-Barral and Perraudin (1997), Fan and Sundaresan (2000), Acharya, Huang, Subrahmanyam, and Sundaram (2004), and François and Morellec (2004).

weaker advantage, there exists a positive relationship between default probability and expected equity returns, consistent with the original intuition that default risk should be compensated by a return premium. Our analysis indicates that, in the presence of shareholder advantage, default probability does not adequately represent the risk of default to equity, since higher default probability is associated with a potential reduction in debt burden and hence in equity risk. In fact, the trade-off between the risk of default to equity and the likelihood of bargaining gains in renegotiation results in a hump-shaped relationship between expected returns and default probability.

Third, through the "lenses" of the model, we are able to refine our empirical analysis by taking a fresher look at the data. We hypothesize that the negative relationship between default probability and expected returns is more pronounced for firms with (i) a large asset base, which can make their shareholders more powerful in renegotiations; (ii) low R&D expenditures, which, *ceteris paribus*, reduce the likelihood of a liquidity shortage and hence strengthen shareholders' bargaining position; (iii) high liquidation costs—proxied by asset specificity—which give debtholders a strong incentive for a negotiated settlement; and (iv) a low book-to-market ratio, which, similarly, would make all claimholders of such firms keen to renegotiate in order to avoid liquidation and the ensuing destruction of valuable growth options. On the other hand, the relationship turns positive for firms at the opposite extreme of these variables. Furthermore, all else being equal, shareholder advantage will be stronger either because their bargaining power in debt renegotiation is stronger or because benefits from renegotiation to avoid liquidation are greater.

Using the above variables as proxies for shareholder advantage, we empirically study the relationship between stock returns and EDF through both a sub-portfolio analysis and a multivariate regression analysis. To isolate the effect of shareholder advantage on stock returns from other characteristics that might be correlated with our variables, we follow Daniel, Grinblatt, Titman, and Wermers (1997) and examine excess returns relative to corresponding benchmark portfolios matched by size, book-to-market ratio, and past momentum.

Our empirical findings are strongly supportive of the conjecture that shareholder advantage plays a key role in the link between default probability and stock returns. In particular, returns decrease in EDF (i) for firms with large asset size and low R&D expenditure (proxies for bargaining power) and (ii) for firms with high asset specificity—i.e., in a concentrated industry or with low asset tangibility—and low book-to-market ratio (proxies for bargaining surplus). Moreover, we find that the cross-sectional divergence in the relationship for firms with strong vs. weak shareholder advantage is both statistically significant and economically meaningful.

Compared to the large body of work devoted to modelling default risk for valuing corporate debt,[4] the literature has so far paid relatively less attention to the relationship between stock returns and default probability, except for the few papers cited above that have documented an inverse relationship. Vassalou and Xing (2004), using a default measure based on equity prices that mimics *Moody's KMV* EDF measure, argue for a *positive* relationship between stock returns and default probability, which seems at odds with the earlier evidence. Our study helps reconcile these seemingly incongruent results and offers a new economic perspective for understanding the subtleties of the relationship between default risk and equity returns.

The mechanism we use to explain the link between stock returns and default probability—shareholder advantage in debt renegotiation—has been initially proposed in the literature on optimal capital structure and bond pricing. Several recent theoretical papers also examine specific features of bankruptcy codes and their effects on the valuation of corporate debt.[5] None of these papers, however, focus on the relationship between stock returns and default probability examined in this paper. On the empirical side, Davydenko and Strebulaev (2004) investigate the significance of shareholders' strategic actions for credit spreads and find that while the effect is statistically significant, its economic impact on credit spreads is minimal.

In this paper we show that, conversely, the economic impact of shareholders' strategic actions can be very significant to *shareholders*, who would have received nothing in liquidation.

[4]See the book by Duffie and Singleton (2003) for a comprehensive overview of the literature on credit risk and the pricing of corporate debt.

[5]See, for example, Broadie, Chernov, and Sundaresan (2004), Galai, Raviv, and Wiener (2003), François and Morellec (2004), and Paseka (2003). Alternatively, von Kalckreuth (2005) proposes an explanation based on non-financial reward from corporate control.

Our study demonstrates that this economic mechanism can help explain the complex effect of default risk on stock returns and highlights the importance of strategic interactions in a setting where it matters the most—to the residual claimants. Our analysis also clarifies the distinction between default risk and default probability and illustrates that the observed patterns are in fact consistent with the risk-return tradeoff.[6]

The rest of the paper proceeds as follows. In Section 2 we review the existing empirical evidence on the relationship between default probability and stock returns and present our own empirical results. In Section 3, we explicitly derive the relationship between returns and default probability in the context of the Fan and Sundaresan (2000) model, and in Section 4 we test its empirical implications in the cross section. We conclude in section 5. We provide technical details and describe the model simulation procedure in the Appendix.

2 Default probability and stock returns: empirical evidence

In this section, we first review the previous evidence in the literature on the relationship between stock returns and default probability. We then report the results of our own preliminary empirical investigation relying on the market-based measures of default probability obtained from *Moody's KMV* (MKMV hereafter).

2.1 Previous empirical evidence

Using Ohlson's (1980) O-score and Altman's (1968) Z-score to proxy for the likelihood of default, Dichev (1998) documents an inverse relationship between stock returns and default probability.[7] This result is confirmed by Griffin and Lemmon (2002) who argue that the phenomenon is driven by the poor performance of the firms with low book-to-market ratio and high distress risk, and attribute it to market mispricing of these stocks.

[6] In an unreported analysis, we find no discernible difference in the relationship between default probability and equity returns among firms with different levels of information asymmetry, trading liquidity and institutional ownership. This casts doubts on the argument that market mispricing drives the observed relationship between default probability and stock return.

[7] There is, however, a discernable hump in the relationship documented by Dichev (1998), which is not discussed in the paper.

Campbell, Hilscher, and Szilagyi (2005) study the determinants of corporate bankruptcy using a hazard model approach, similar to that in Shumway (2001) and Chava and Jarrow (2002). Using the resulting forecasting measure of default probability, they also find that firms with a high probability of bankruptcy tend to earn low average returns and suggest that this evidence is indicative of equity markets mispricing distress risk.

Hillegeist, Keating, Cram, and Lundstedt (2004) show that both O-score and Z-score are limited in their forecasting power and advocate the use of a measure based on the Black and Scholes (1973) and Merton (1974) option pricing framework, similar to the EDF measure provided commercially by MKMV. Vassalou and Xing (2004) construct a metric for default probability to mimic the EDF measure and find that high-default-probability firms with a small market capitalization and a high book-to-market ratio earn higher returns than their low-default-probability counterparts and conclude that default risk is systematic and positively priced in stock returns. This result is contrary to the other evidence in the literature and has been challenged on the ground of return attribution.[8]

In the remainder of this section, we present our own evidence on the relationship between stock returns and default probability using a measure of default likelihood that relies on information included in market prices.

2.2 Our empirical findings

2.2.1 Data and summary statistics

In our empirical investigation we use the *Expected Default Frequency* (EDF) obtained directly from MKMV. This measure is constructed from the Vasicek-Kealhofer model (Kealhofer (2003a,b)) which adapts the Black and Scholes (1973) and Merton (1974) framework to make it suitable for practical analysis.[9]

[8]Da and Gao (2005) argue that some of the very high returns earned by small stocks with high default risk and a high book-to-market ratio are attributable to the illiquidity of these stocks.

[9]See Crosbie and Bohn (2003) for details on how MKMV implements the Vasicek-Kealhofer model to construct the EDF measure. In addition, as indicated by Jeff Bohn of *Moody's KMV*, the EDF measure is constructed based on extensive data filtering to avoid the influence of outliers due to data errors, a sophisticated iterative search routine to determine asset volatility and access to a comprehensive database of default experiences for an empirical distribution of distance-to-default.

To be included in our analysis using the EDF measure, a stock needs to be present simultaneously in the CRSP, COMPUSTAT and MKMV databases. Specifically, for a given month, we require a firm to have an EDF measure and an implied asset value in the MKMV dataset, price, shares outstanding and returns data from CRSP, and accounting numbers from COMPUSTAT. We limit our sample to non-financial US firms.[10] We drop from our sample stocks with a negative book-to-market ratio. Our baseline sample contains 1,430,713 firm-month observations and spans from January 1969 to December 2003.[11]

Summary statistics for the EDF measure are reported in Table 1. The average EDF measure in our sample is 3.44% with a median of 1.19%.[12] The table shows that there are time-series variations in the average as well as in the distribution of the EDF measure, and that the majority of the firms in our dataset have an EDF score below 4%.

Since the EDF measure is based on market prices, in order to mitigate the effect of noisy stock prices on the default score, we use an exponentially smoothed version of the EDF measure, based on a time-weighted average. Specifically, for default probability in month t, we use

$$\overline{EDF_t} = \frac{\sum_{s=0}^{5} e^{-s\nu} EDF_{t-s}}{\sum_{s=0}^{5} e^{-s\nu}}, \tag{1}$$

where ν is chosen to satisfy $e^{-5\nu} = 1/2$, such that the five-month lagged EDF measure receives half the weight of the current EDF measure. The empirical results are reported based on $\overline{EDF_t}$, which we will still refer to as EDF for notational convenience. Our results, however, are robust to the use of the original EDF measure.

2.2.2 Equity returns and default probability

In this section we analyze the relationship between equity returns and default probability measured by EDF. As Table 1 illustrates, the EDF measure exhibits substantial variation over time.

[10] Financial firms are identified as firms whose industrial code (SIC) are between 6000 and 6999.

[11] We follow Shumway (1997) to deal with the problem of delisted firms. Specifically, whenever available, we use the delisted return reported in the CRSP datafile for stocks that are delisted in a particular month. If the delisting return is missing but the CRSP datafile reports a performance-related delisting code (500, 520-584), then we impute a delisted return of -30% in the delisting month.

[12] MKMV assigns an EDF score of 20% to all firms with an EDF measure larger than 20%.

The time variation in the EDF score can cause problems if we want to compare the cross-sectional relationship between default probability and returns in different time periods. To avoid such problems, when linking returns to default probabilities we use the EDF *rank* in the cross section, instead of the EDF score itself.

We start our analysis by forming portfolios of stocks according to each firm's EDF rank in month t. We then analyze the returns of these portfolios in month $t + 2$, i.e., we skip a month between portfolio formation and return recording. There are two reasons for this choice. First, as suggested by Da and Gao (2005), skipping a month is important to alleviate the microstructure issues that notoriously affect low-priced firms near default.[13] Second, and perhaps more importantly, since the EDF measure is based on equity prices, skipping a month helps alleviate the concern of detecting a spurious relationship between EDF and returns.[14]

The results are presented in Table 2 where we report equally- and value- weighted portfolio returns when using both the full sample of stocks (Panel A) and the subsample of stocks with a price per share higher than two dollars (Panel B). To isolate the effect of the EDF measure on stock returns from other characteristics known to affect stock returns, we follow the methodology suggested by Daniel, Grinblatt, Titman, and Wermers (1997) (DGTW henceforth) and adjust the return of each stock by subtracting the return of a benchmark portfolio that matches the stock's size, book-to-market ratio and momentum (see also Wermers (2004)).[15] The sample period of DGTW-adjusted returns spans from June 1975 to June 2003 due to the availability of the benchmark portfolio returns. The adjusted returns are reported under the label "DGTW returns" in both panels of Table 2.

The first two rows of Panel A (full sample) demonstrate an intriguing pattern in the relationship between raw stock returns and measures of default probability. While equally-weighted portfolio returns are positively related to default probability, for value-weighted portfolio returns, this relationship is almost flat and slightly humped. With DGTW-adjusted returns, Panel A in Table 2 shows that the relationship for equally-weighted returns is now strongly positive and

[13] We also repeat our analysis with quarterly, instead of monthly, returns and obtain qualitatively similar results.

[14] We thank an anonymous referee for pointing this out.

[15] We thank Kent Daniel and Russ Wermers for providing data on characteristics benchmark portfolio returns.

statistically significant, while the relationship for value-weighted returns remains mostly flat and slightly humped. The difference in the behavior of equally- and value-weighted portfolio returns is statistically significant both for raw returns and for DGTW-adjusted returns.

The results for the equally-weighted portfolios with raw returns are similar to those obtained by Vassalou and Xing (2004) who use their own EDF-mimicking measure for default likelihood.[16] Vassalou and Xing (2004) claim that such a pattern is indicative of positively priced default risk and dismiss the previous evidence of a negative association between stock returns and default probability as a result of imperfect, accounting-based, measures of default likelihood. However, the distinct behavior of value- and equally-weighted portfolios reported in panel A of Table 2 suggests caution in drawing conclusions concerning how default risk is priced.

The difference between value- and equally-weighted returns is traditionally argued to be caused by the size effect. Because equally-weighted returns give each of the small firms, which number in thousands, the same weight as each of large firms, which number in hundreds, equally-weighted returns are more representative of the behavior of small firms, while value-weighted returns are dominated by large firms. This size effect, however, should be mostly accounted for and disappear in DGTW-adjusted returns if the difference is purely due to this effect. The fact that this difference persists and is even more significant with DGTW-adjusted returns defies a simple explanation.

To see the effect of extremely low-priced stocks on this return pattern, we report in Panel B the results obtained by excluding stocks with price per share less than two dollars. The absence of low-priced stocks takes away the positive relationship between equally-weighted returns and EDF while keeping the result for value-weighted returns qualitatively similar. As suspected, the positive relationship for equally-weighted returns in Panel A is attributable to low-priced stocks. More importantly, note that the difference between equally- and value-weighted returns is no longer statistically significant for DGTW returns. This finding is particularly important when

[16]While Vassalou and Xing (2004) construct their own market-based default probability measure using the Merton (1974) model, we use the EDF measure directly obtained from MKMV. Because results can be heavily impacted by outliers in these measures due to data errors, by using MKMV's EDF measure directly we benefit from the extensive data cleaning and the rich empirical default database reflected in MKMV's EDF measure.

compared with the results for the full sample in panel A. It suggests that the DGTW correction for size/book-to-market/momentum works quite well for stocks in the subsample of stocks with a price larger than two dollars but fails to account for those low-priced stocks. Since stocks in distress are more likely to have low prices, these results imply that the effect of default is not subsumed by size, book-to-market ratio and momentum.

To understand these potential cross-sectional variations in the relationship between equity returns and default probability it is necessary to take a closer look at the microeconomic forces at play for firms facing financial distress. In the next section, we propose a plausible economic mechanism that produces predictions consistent with the patterns we observe in the data without upsetting the risk-return trade-off.

3 Default probability and stock returns: a theoretical model

The Merton (1974) model that characterizes equity as a call option on the firm's assets implicitly assumes that default equals liquidation. In reality, liquidation is only one of the possibilities open to a firm in financial distress and it is usually a last-resort option. Frequently, firms choose to renegotiate outstanding debt either in a private workout or under the protection of the U.S. Bankruptcy Code (Chapter 11). In principle, the decision to renegotiate is a choice of the manager and, if accepted by the debt-holders, entails a bargaining game between the parties involved. There is substantial evidence in the literature (e.g, Franks and Torous (1989), Weiss (1991), Eberhart, Moore, and Roenfeldt (1990), and Betker (1995)) on direct and indirect costs of bankruptcy as well as on the fact that bankruptcy procedures frequently allow for opportunistic behavior of claimholders and subsequent violation of the absolute priority rule. Anderson and Sundaresan (1996), Mella-Barral and Perraudin (1997), Fan and Sundaresan (2000), Acharya, Huang, Subrahmanyam, and Sundaram (2004) explicitly evaluate corporate claims within a model that allows for the possibility of out-of-court renegotiation while François and Morellec

(2004) develop a model designed to capture the unique features of Chapter 11 renegotiation (automatic stay and exclusivity period).[17]

In this section, we show how the strategic framework proposed by these theoretical models can be used to reconcile the puzzling empirical relationship between default probability and stock returns documented earlier. The main intuition is that in a renegotiation game there is room for strategic default and shareholders can extract rents from bondholders in the form of lower payments on their debt obligations. This "shareholder advantage" is a function of their bargaining power and has to ultimately affect the riskiness of equity. The stronger is the bargaining power of shareholders in the renegotiation game, the higher is their rent extraction ability, the lower is the risk and hence the expected return of equity.

For the purpose of our argument, we adapt the model of Fan and Sundaresan (2000) which, we believe, is the most parsimonious setup in which we can fully highlight "the implication of the *relative bargaining power of claimants* on optimal reorganization and debt valuation." (p. 1050, their emphasis). As it will become clear, the implication of our analysis can also be obtained in the context of other models that allow for a bargaining game in renegotiation.

3.1 Equity returns in a model of strategic debt service

We briefly review the basic elements of the renegotiation model of Fan and Sundaresan (2000) (FS hereafter) and derive expressions for expected returns on equity and default probabilities. The model is set in continuous time and makes the following assumptions:

1. A firm has equity and a single issue of perpetual debt outstanding with a promised coupon rate c per unit time.

2. The default-free term structure is flat with instantaneous riskless rate r per unit time.

3. The payment of the contractual coupon c entails the firm to a tax benefit τc ($0 \leq \tau \leq 1$). Such benefit is lost during the default period.

[17] Other papers analyzing the effect of the bankruptcy codes on debt valuation include Acharya, Sundaram, and John (2005), Broadie, Chernov, and Sundaresan (2004), Galai, Raviv, and Wiener (2003), and Paseka (2003).

4. Firms cannot sell assets to pay dividends.

5. There are dissipative liquidation costs, measured as a fraction α of the value of the assets upon liquidation. The absolute priority rule is strictly followed upon liquidation. That is, upon liquidation, equity-holders get nothing and debt-holders get a fraction $(1-\alpha)$ of the firm's assets.

6. The asset value of the firm, V_t, follows the geometric Brownian motion

$$\frac{dV_t}{V_t} = (\mu - \delta)\, dt + \sigma\, dB_t, \tag{2}$$

where $\mu > \delta$ is the instantaneous rate of return on assets, δ is the payout rate, σ is the instantaneous volatility and B_t is a standard Brownian motion. With the tax-shield, the value of the firm, $v(V)$, is always larger than the value of the assets, V.

Although FS also consider extensions to allow for fixed liquidation costs and finite-maturity debt, we maintain the assumptions outlined above to keep our analysis tractable.

FS analyze two types of exchange offers occurring during debt workouts: (i) *debt-equity swaps*, in which shareholders offer debt-holders a fraction of the firm's equity in replacement of their original debt obligations and leave the control of the firm in the hands of debt-holders, and (ii) *strategic debt service*, in which shareholders stop making the agreed-upon payments to bondholders when the asset value falls below a threshold but keep control of the firm, servicing the debt "strategically" until the asset value returns above this threshold. In the absence of taxes, the two types of exchange offers are identical. In the presence of taxes, however, the strategic default service is the dominating alternative since under this arrangement shareholders can capture the future tax benefits that are foregone in the debt-equity swap. We will, henceforth, limit our analysis to the case of strategic debt service.

3.1.1 The bargaining game

Upon entering the default state, a bargaining game ensues between the firm's claimants. The parties will bargain over the total value of the firm, $v(V)$, and the sharing rule is determined as an equilibrium of a Nash bargaining game between shareholders and debt-holders. More specifically, if $\widetilde{V}_S$ denotes the trigger point in asset value for which strategic debt service is initiated, for any $V \leq \widetilde{V}_S$ the firm value $v(V)$ is split between equity-holders and debt-holders as follows

$$\widetilde{E}(V) = \tilde{\theta} v(V), \;\; \widetilde{D}(V) = (1 - \tilde{\theta}) v(V), \tag{3}$$

where $\widetilde{E}(\cdot)$ and $\widetilde{D}(\cdot)$ are the values of equity and debt, respectively, and $\tilde{\theta}$ is the sharing rule.

To determine the equilibrium sharing rule, FS consider a Nash bargaining game in which η represents the bargaining power of shareholders and $1 - \eta$ the bargaining power of bondholders. The incremental value for shareholders by bargaining is $\tilde{\theta} v(V) - 0$, because the alternative to bargaining is liquidation, in which case shareholders receive nothing. The incremental value of bargaining to debt-holders is $(1 - \tilde{\theta}) v(V) - (1 - \alpha) V$, since the alternative again is liquidation, which entails a dissipative cost α. The solution of this standard Nash bargaining game is, therefore,

$$\begin{aligned} \tilde{\theta}^* &= \arg\max \left[\tilde{\theta} v(V) - 0\right]^{\eta} \left[(1 - \tilde{\theta}) v(V) - (1 - \alpha) V\right]^{1-\eta} \\ &= \eta \left(1 - \frac{(1 - \alpha) V}{v(V)}\right), \end{aligned} \tag{4}$$

which shows that shareholders get more of the renegotiation surplus, the higher is their bargaining power η and/or the larger is the liquidation cost α. The effect of bargaining power on the sharing rule is obvious. The role of liquidation costs is more subtle and derives from the fact that higher liquidation costs generate a stronger incentive for debt-holders to participate in the bargaining game, and thus indirectly increases shareholders' bargaining power.

The model is particularly suited to capture the fact that, once a firm defaults, it enters into negotiation with its creditors. The parameter α captures the loss of asset value that shareholders can potentially impose on creditors. This cost may be inflicted either through liquidation that occurs when negotiations fail or through the cost of legal battles in a bankruptcy court, or both.

3.1.2 Valuation

The valuation of claims follows standard techniques of contingent claim analysis (see, for example, Dixit and Pindyck (1994)). Proposition 3 in FS gives the following value for equity,

$$\widetilde{E}(V) = \begin{cases} V - \frac{c(1-\tau)}{r} + \left[\frac{c(1-\tau)}{(1-\lambda_1)r} - \frac{\lambda_1(1-\lambda_2)\eta}{(\lambda_2-\lambda_1)(1-\lambda_1)}\frac{\tau c}{r}\right]\left(\frac{V}{\widetilde{V}_S}\right)^{\lambda_1} & \text{if } V > \widetilde{V}_S, \\ \theta^* v(V) & \text{if } V \leq \widetilde{V}_S, \end{cases} \quad (5)$$

where θ^* is the optimal sharing rule from the Nash bargaining game (4), $\widetilde{V}_S$ is the endogenous level of asset values that triggers strategic debt service,

$$\widetilde{V}_S = \frac{c(1-\tau+\eta\tau)}{r}\frac{-\lambda_1}{1-\lambda_1}\frac{1}{1-\eta\alpha}, \quad (6)$$

$v(V)$ is the total firm value,

$$v(V) = \begin{cases} V + \frac{\tau c}{r} - \frac{\lambda_2}{\lambda_2-\lambda_1}\frac{\tau c}{r}\left(\frac{V}{\widetilde{V}_S}\right)^{\lambda_1} & \text{if } V > \widetilde{V}_S, \\ V + \frac{-\lambda_1}{\lambda_2-\lambda_1}\frac{\tau c}{r}\left(\frac{V}{\widetilde{V}_S}\right)^{\lambda_2} & \text{if } V \leq \widetilde{V}_S, \end{cases} \quad (7)$$

$\lambda_1 = \left(\frac{1}{2} - \frac{r-\delta}{\sigma^2}\right) - \sqrt{\left(\frac{1}{2} - \frac{r-\delta}{\sigma^2}\right)^2 + \frac{2r}{\sigma^2}} < 0$, and $\lambda_2 = \left(\frac{1}{2} - \frac{r-\delta}{\sigma^2}\right) + \sqrt{\left(\frac{1}{2} - \frac{r-\delta}{\sigma^2}\right)^2 + \frac{2r}{\sigma^2}} > 1$.

From equation (5), the value of equity when the firm is not in default ($V > \widetilde{V}_S$) is equal to its asset value V net of debt plus an adjustment term accounting for tax shields and the probability of default.[18] After renegotiation, equity-holders receive $\theta^* v(V)$ which, from (4), corresponds to the quantity $\eta(v(V) - V) + \eta\alpha V$. Since, from (7), in the presence of taxes the total firm value $v(V)$ is always larger than the asset value V, the proceeds $\theta^* v(V)$ obtained by shareholders are increasing in the bargaining power η and liquidation costs α. Moreover, from equations (5) and (6) it is immediate to see that an increase in bargaining power and/or liquidation cost increases the value of equity and of the default threshold.

[18] The quantity $(V/\widetilde{V}_S)^{\lambda_1}$ is the Arrow-Debreu price of a security that pays one dollar in the event that V ever reaches the theshold $\widetilde{V}_S$.

3.1.3 The role of cash flow-based debt covenants

Both public bonds and bank debt usually come with covenants which require, at minimum, that the borrower honor the payment obligations specified in the debt contract. MKMV regards default as triggered by any missed or delayed payment of interest or principal on the debt. FS extend their bargaining model to consider the case in which *hard cash flow covenants* are in place. Under hard cash flow covenants, if the firm is not able to meet the contractual obligation on the debt, the debt-holders will take over or liquidate the firm.

FS show that the main effect of introducing hard cash flow covenants in a debt renegotiation model is to separate *strategic default*, leading to bargaining in debt renegotiation, from *liquidity default*, leading to forced liquidations. Specifically, given the payout ratio δ and the contractual debt coupon rate c, a covenant is binding if the cash flow is not enough to cover debt service, that is, if $\delta V < c$. If the endogenous renegotiation trigger (6) is such that $\delta \widetilde{V}_S > c$, the covenant is never binding and the value of equity is the same as the one reported in (5). If, however, $\delta \widetilde{V}_S < c$, the covenant can be binding before strategic default takes place. When this happens, the firm is forced to liquidate in which equity-holders receive a zero payoff. In essence, liquidity default triggered by hard cash flow covenants may be thought of as a special case of strategic default where shareholders have no bargaining power.

3.2 Equity returns and default probability

For its empirical relevance, we are most interested in the connection between equity returns and default probability. In order to analyze this relationship, we need to derive both the expected returns on equity and the cumulative default probability implied by the above model.

The closed-form expression for equity value in (5) is our starting point for deriving implications of the bargaining game for expected returns. The quantity in the FS model that closely resembles the MKMV EDF measure is the probability of hitting the renegotiation boundary $\widetilde{V}_S$ in (6) under the *true* probability measure governing the underlying process V. In the following proposition, we formally derive the expected returns and default probability implied by the FS model.

Proposition 1 *Let the assumptions of the FS model be satisfied. The annualized t-period continuously compounded expected return on equity is given by*

$$r^E_{(0,t]}(V_0) = \frac{1}{t}\log\left(\frac{\mathbb{E}_0(\widetilde{E}(V_t))}{\widetilde{E}(V_0)}\right), \tag{8}$$

where $\mathbb{E}_0(\widetilde{E}(V_t))$ *is the conditional expectation at* $t = 0$ *taken with respect to the true probability measure governing the asset value process in (2), and is derived in equation (A3) of Appendix A. The cumulative real default probability* $\Pr_{(0,T]}$ *over the time period* $(0, T]$ *calculated with information available at time 0, is given by*

$$\Pr_{(0,T]}(V_0) = \mathcal{N}\left(h(T)\right) + \left(\frac{V_0}{\widetilde{V}_S}\right)^{-\frac{2\gamma}{\sigma^2}} \mathcal{N}\left(h(T) + \frac{2\gamma T}{\sigma\sqrt{T}}\right), \tag{9}$$

with $\gamma = \mu - \delta - \frac{1}{2}\sigma^2 > 0$*,* $h(T) = \frac{\log\left(\widetilde{V}_S/V_0\right) - \gamma T}{\sigma\sqrt{T}}$ *and* $\mathcal{N}(\cdot)$ *the cumulative standard normal function.*

Proof: See Appendix A.

The empirical analysis in Section 2 highlighted a complex relationship between default probability and equity returns. Given that we are able to obtain these two quantities explicitly within a plausible model of the default process, we can now analyze the implications of the model with the objective to derive testable empirical predictions.

3.3 Empirical implications

Since expected returns and default probability are determined by a common set of variables and parameters, the link between these two quantities is multi-dimensional. Instead of arbitrarily fixing a set of parameters and deriving an analytical relationship between expected returns and default probability, we simulate the model over a cross section of firms, differing in their initial asset value V_0, coupon rate c, asset growth μ and asset volatility σ, similar to the empirical sample. We compute the expected return and default probability for each firm, according to equations (8) and (9), respectively. Finally, we classify each firm in quintiles according to their default probability and, for each quintile we report the equally-weighted return. Details of the simulations are contained in Appendix B.

The main objective of this exercise is to highlight the role of the bargaining power coefficient η and of the liquidation cost coefficient α in determining how default probability and expected returns are related to each other. An important caveat to this exercise is the fact that, since both bargaining power and liquidation costs can potentially be endogenous variables, we cannot make a sensible causality statement about the relationship between default probability and equity returns. More specifically, it is possible that since higher shareholders' bargaining power can induce higher loss to lenders, this will affect the level and the terms of the debt that the firm can obtain and, in turn, the probability of default itself. To fully account for such an endogeneity, we would need to extend the model to consider the optimal capital structure decision, a worthy objective which is beyond the scope of the current paper. In the spirit of the Merton (1974) model which inspired the construction of the MKMV EDF measure, we instead take the debt level as given and analyze, in a partial equilibrium setting, the strategic effects of debt workout on equity returns.

In Figure 1 we plot the simulated relationship between expected returns and default probability. The horizontal axis reports probability of default quintiles, while the vertical axis reports the annualized average returns on equity in each quintile. To match our empirical results, in the figure we take the horizon t for returns to be one month and the horizon T for the default probability to be one year. Panel A analyzes the effect of the bargaining power coefficient η on the relationship of interest while keeping the liquidation cost at a constant level ($\alpha = 0.5$). Panel B, on the other hand, considers the effect of a changing level of liquidation cost α while assuming equal bargaining power ($\eta = 0.5$) between claimants.

The left graph in Panel A shows the relationship between expected returns and default probability when shareholders have no bargaining power ($\eta = 0$). In this case the relationship is monotonically increasing and "explodes" when default becomes certain. The case of no-bargaining power corresponds to the situation in which default triggers immediate liquidation. Shareholders are getting nothing in the event of default. Therefore, a higher probability of default is associated with higher risk to shareholders. Note also that in this case the liquidation cost does not play any role. This is because if shareholders have no bargaining power, they will not be able to initiate a renegotiation and default will automatically lead to liquidation. In this case, the default boundary and default probability are independent of α.

The picture is dramatically different in the right graph of Panel A. The three sets of bars shown here refer to situations when shareholders have (i) low bargaining power ($\eta = 0.2$, darker bars); (ii) the same bargaining power as the debt-holders' ($\eta = 0.5$, middle bars); and (iii) high bargaining power ($\eta = 0.8$, lighter bars).[19] Two patterns clearly emerge from this figure. First, in the presence of shareholder bargaining power, the relationship between equity return and default probability is hump-shaped, and for sufficiently high bargaining power, the relationship between expected return and default probability becomes downward sloping. Second, keeping everything else constant, high bargaining power is associated with low expected returns.

The hump-shaped relationship results from the fact that now default is not synonymous with liquidation and shareholders receive a fraction of the assets as an outcome of the renegotiation process. The riskiness of equity, therefore, should correctly account for this. At low levels of default probability, the likelihood of strategic renegotiation is low. In such cases, the default probability adequately captures the leverage effect, and expected returns are positively associated with default probabilities. On the other hand, at high levels of default likelihood, because the potential settlement for equity-holders in the renegotiation with debt-holders is a fraction of the underlying assets, the risk of equity is then converging to the risk of the unlevered assets. Therefore, conditional on shareholders having a strong advantage, a high probability of default means a high likelihood of debt relief. Since equity is a levered position on the asset, debt relief

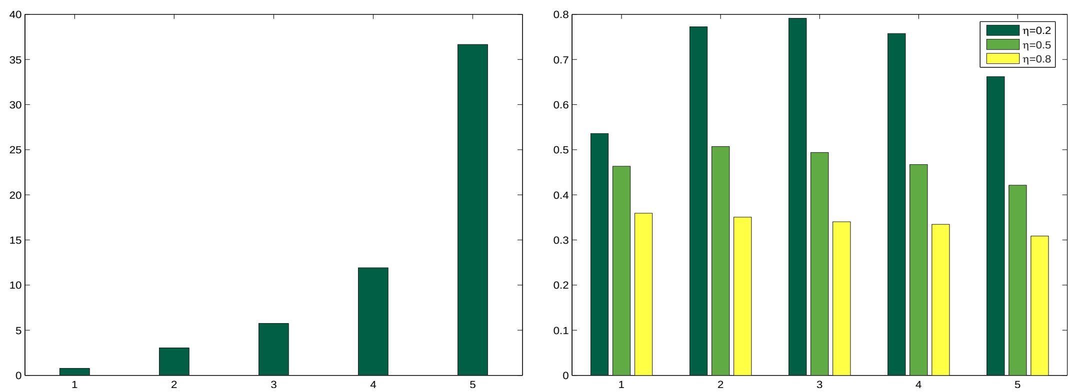
[19]Empirical evidence, e.g., Eberhart, Moore, and Roenfeldt (1990) finds that the amount recovered by shareholders in bankruptcy proceedings is usually less than 25% of the asset value. Since, in the absence of taxes, the sharing rule $\tilde{\theta}$ in (4) is equal to $\eta\,\alpha$, the choice of parameters η and α in Figure 1 implies that the share of asset received by shareholder in renegotiation for the bulk of our simulated firms is less than 25%.

Figure 1: Default probability and expected returns

For each decile of default probability within a year, the graph reports the average annual realized return obtained by simulating the FS model. We draw 50 values each of c, μ and σ for a total of 125,000 firms. Simulation details are provided in Appendix B. The left figure in Panel A is obtained by assuming no bargaining power for shareholders while the right figure in the same panel analyzes three three different levels of bargaining power while fixing the liquidation cost at the level $\alpha = 0.5$. Panel B reports the case of three different levels of liquidation costs while fixing the bargaining power at $\eta = 0.5$.

Panel A: Effect of bargaining power η

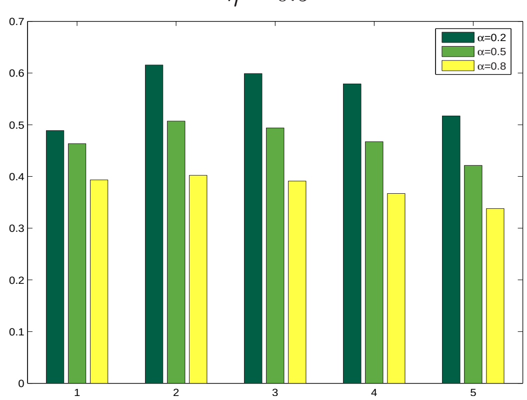
$\eta = 0$, any α $\qquad$ $\alpha = 0.5$



Probability of Default Quintiles $\qquad$ Probability of Default Quintiles

Panel B: Effect of liquidation cost α

$\eta = 0.5$



Probability of Default Quintiles

reduces leverage and hence risk. Default probability in this case does not measure the risk of default to equity. This intuition also helps explain the second interesting pattern emerging from the figure, that is, the higher the bargaining power, the lower the expected return. A higher bargaining power translates into a higher equilibrium sharing rule $\tilde{\theta}$ in the Nash bargaining game (see equation (4)), and hence into a higher fraction of the asset value received by shareholders upon default. This leads to lower risk of default to equity and reduces the expected return.

Panel B of Figure 1 demonstrates the relationship between default probability and expected returns as the level of liquidation costs changes while the bargaining power of claimholders is fixed at a common level $\eta = 0.5$. The three sets of bars represent the cases of (i) low liquidation costs ($\alpha = 0.2$, darker bars); (ii) medium liquidation costs ($\alpha = 0.5$, middle bars) and (iii) high liquidation costs ($\alpha = 0.8$, lighter bars). The patterns emerging from this figure are similar to the ones obtained earlier by varying η for a given α and the hump-shape is now pervasive across all levels of liquidation costs. We note that, in the solution of the optimal sharing rule (4) for the Nash bargaining game, the liquidation cost coefficient α enters with the same sign as the bargaining power coefficient η. Since the liquidation cost is a dissipative cost that affects the bargaining surplus to be divided between shareholders and debt-holders, a larger liquidation has a similar effect as a larger shareholders' bargaining power. The similarity is, however, not complete and there is a meaningful role for liquidation costs that is not subsumed by bargaining power. For example, a zero liquidation cost does not correspond to a zero sharing rule, $\tilde{\theta}$, in the presence of taxes, as (4) clearly shows. Equity-holders are always getting something in default as long as they have *some* bargaining power.[20] Moreover, high liquidating costs are associated with low expected returns, all else being equal.[21]

The discussion above suggests the following testable implications:

[20]Note that this is true only in the case of strategic debt service. In the case of debt-equity swap, the absence of a tax shield implies that the effect of α and η are observationally equivalent, as it can be inferred from equation (5) by setting $\tau = 0$.

[21]Note that a higher bargaining power η or liquidation cost α increases both the sharing rule (4) and the probability of default, since the default threshold (6) increases. Both these effects, however, contribute to a reduction of risk, since a higher probability of default, for a shareholder who has a large advantage, is equivalent to a higher chance of debt relief.

Hypothesis 1 *The relationship between default probability and expected returns should be (i) upward-sloping for firms with minimal shareholder advantage and (ii) hump-shaped and downward sloping for firms with substantial shareholder advantage.*

Hypothesis 2 *For a given default probability, expected returns should be lower for firms in which (i) shareholders have stronger bargaining power and/or (ii) the economic gains from renegotiation, i.e., liquidation costs, are larger.*

The discussion of cash flow-based covenants in Section 3.1.3 allows us to further refine the above hypotheses. Since in the presence of binding cash flow-based covenants default triggers liquidation, the implication for the relationship between default probability and expected returns is qualitatively similar to the case of no shareholders' bargaining power. This suggests that, when cash flow-based covenants are binding it is more likely to expect a positive relationship between default probability and expected returns.

4 Empirical analysis

The theoretical argument presented above shows that both bargaining power and liquidation costs contribute to shareholder advantage when a firm is in financial distress. The model predicts that for firms in which shareholders are capable of obtaining a large advantage, expected returns are declining or hump-shaped in default probability, while for firms in which shareholders are disadvantaged, a higher probability of default is associated with a higher probability of liquidation and hence a higher expected return. In order to assess the validity of these theoretical predictions, in this section we conduct an empirical analysis of the effect of shareholder advantage on expected returns of levered stocks.

4.1 Data construction

We first construct variables that proxy for the advantage of shareholders in financially distressed firms.

Shareholders' bargaining power

An important determinant of the advantage of shareholders in a financially distressed firm is shareholders' bargaining power. In our study we use two proxies for shareholder bargaining power: (i) a firm's asset size and (ii) its ratio of R&D expenditure to assets.

Small firms, because of information asymmetry, usually have a concentrated group of debt-holders, mostly banks, which may have an advantage at monitoring the firm (see, e.g., Diamond (1991) and Sufi (2005)). This concentration of, and close monitoring by, creditors severely weakens shareholders' bargaining power in the event of financial distress. Consistent with this notion, Franks and Torous (1994) and Betker (1995) find that firm size is a persistent determinant of deviation from the absolute priority rule for a sample of workouts and bankruptcies.

We measure firm size by the market value of assets instead of the market value of equity in our test for two reasons. First, this corresponds closely to the theoretical formulation as the bargaining is over the remaining assets. Second, this can mitigate the potential bias caused by small equity values of firms close to bankruptcy even though they have a substantial asset base and a diffuse group of debt-holders. The market value of assets is obtained from MKMV. This variable is available on a monthly basis and is calculated, together with the EDF measure, as a function of the market value of equity, outstanding liability, and historical default data. Alternatively, we have also used the book value of assets from COMPUSTAT and obtained qualitatively similar results, which are omitted here for brevity.

The second measure we use to proxy for shareholders' bargaining power is the ratio of R&D expenditure to assets. We choose this quantity because, as it has been documented in the literature, firms with high costs of research and development are particularly vulnerable to liquidity shortage in financial distress. Opler and Titman (1994), for example, find that in terms of corporate performance, highly leveraged firms that engage in research and development suffer the most in economically distressed periods. This implies that these firms are more likely to encounter cash flow problems that can put them in a disadvantaged position in renegotiation with creditors. This interpretation is also consistent with the observation that cash flow-based covenants preclude debt renegotiation, as discussed in Section 3.1.3, and effectively reduce shareholders' bargaining power to nil. In our test, the variable is calculated as a ratio of a firm's R&D expense (COMPUSTAT item # 46) to the book value of assets. To allow time for accounting information to be incorporated into stock prices, we attribute the R&D ratio computed at the end of fiscal year t to the one-year period starting from July of year $t+1$.

Liquidation costs

In the renegotiation between debt-holders and equity-holders, the cost of liquidation figures prominently in the bargaining surplus. We use two types of proxies for liquidation cost: (i) the specificity of a firm's assets and (ii) the potential loss of growth options.

The existing literature suggests that the specificity of a firm's assets is important in determining a firm's liquidation value in bankruptcy (e.g., Acharya, Sundaram, and John (2005)). The argument is that if a firm's assets are highly specific, or unique, then they are likely to suffer from "fire-sale" discounts in liquidation auctions. Shleifer and Vishny (1992) argue that if demand of a firm's assets from its competitors in the same industry is weak, then the liquidation costs will be high because of the likelihood of a fire-sale of the assets to industry outsiders. If there is a greater number of firms in an industry, then the likelihood for finding a buyer of the assets within the same industry is greater. This motivates us to choose the Herfindahl index, which captures the degree of industry concentration, as our first proxy for asset specificity.

We use the Herfindahl index on sales, defined as

$$Hfdl_j = \sum_{i=1}^{I_j} s_{i,j}^2, \tag{10}$$

where $s_{i,j}$ represents the sales of firm i as a fraction of the total sales in industry j and I_j is the number of firms belonging to industry j.[22] To compute the above quantity, at the end of fiscal year t we first categorize firms according to the two-digit SIC code classification and obtain their sales data from COMPUSTAT (item # 12). The choice of a two-digit SIC code for industry

[22] We have also used the Herfindahl index on asset values, which is constructed similarly, and obtained similar results.

classification is motivated by the necessity to have an appropriate measure of the market for asset liquidation. Under the two-digit SIC code classification, the average number of industries each year in our sample period (1969-2003) is 75, the median number of firms in an industry per year is 82, and three quarters of the industries have more than 14 firms.[23] We then apply the calculated Herfindahl index to the one-year period starting from July of year $t + 1$.

Our second, firm-level, proxy for asset specificity is the asset tangibility measure introduced by Berger, Ofek, and Swary (1996), who use proceeds from discontinued operations of a sample of COMPUSTAT firms in the period 1984-1993 to evaluate the expected asset liquidation value. This measure has also recently been used by Almeida and Campello (2005) to investigate the effect of financial constraints on corporate investments. Berger, Ofek, and Swary (1996) find that a dollar of book asset value generates, on average, 71.5 cents in exit value for total receivables, 54.7 cents for inventory and 53.5 cents for capital. We compute the tangibility measure by using these coefficients for the firms in our sample:

$$Tang = 0.715 \times Receivables + 0.547 \times Inventory + 0.535 \times Capital, \tag{11}$$

where *Receivables* is COMPUSTAT item #2, *Inventory* is item # 3 and *Capital* is item # 8. As in Berger, Ofek, and Swary (1996) we add value of cash holdings (item #1) to the tangibility measure and scale it by the total book asset value.

The potential loss of growth options in liquidation is measured by the book-to-market equity ratio. Shareholders' advantage in renegotiation is stronger the stronger are the economic gains from bargaining. For a given level of default probability, such gains are likely to be higher for firms with a low book-to-market equity ratio. The reason is that for both shareholders and debt-holders of these firms, renegotiating the debt is particularly attractive since it can prevent the loss of potentially valuable growth options in liquidation. As reported by Gilson, John, and Lang (1990), firms with a high Tobin's Q ratio, which is similar in construction and highly

[23] Both the three- and four-digit SIC code classifications provide too "fine" industry classifications, since they artificially separate similar companies into different industries. Under the four-digit SIC code, the median number of firms in an industry is 2 while twenty-five percent of industries have one firm or less. For the three-digit SIC code classification, the median number of firms in an industry is 6, while twenty-five percent of industries have only two firms or less.

correlated with the book-to-market equity ratio, tend to restructure their claims out of court. The high liquidation costs faced by this type of firms provide creditors with strong incentives to renegotiate and settle with shareholders and thus imply a strong shareholder advantage in these firms. We have used both the Q ratio and the book-to-market equity ratio in our empirical analysis and obtained similar results. We therefore report only the results based on the book-to-market equity ratio to facilitate comparisons with the existing studies.

We follow Fama and French (1992) in calculating the book-to-market ratio. Specifically, we first add a firm's book value of common equity (COMPUSTAT item # 60) and deferred taxes (item# 74) at the end of fiscal year t, and then divide it by the firm's market capitalization of equity at the end of calendar year t to obtain its book-to-market ratio. We apply the calculated book-to-market ratio to the one-year period starting from July of year $t+1$.

4.2 Sub-portfolio analysis

We examine the relationship between returns and default probability (EDF) for subsets of stocks grouped by one of their characteristics described above. Specifically, each month we sort stocks into quintiles according to their exponentially-weighted EDF measures over the preceding six-month period and, independently, into triplets according to one of the characteristics: asset size, R&D expense ratio, Herfindahl index of sales, tangibility measure, and book-to-market equity ratio, all calculated based on the respective accounting numbers at the end of the prior fiscal year. We then calculate the value-weighted monthly return in the second month after portfolio formation, i.e., we skip a month before accumulating returns, to avoid potential liquidity issues and a possible artificial correlation between EDF measure and equity return. In addition to raw monthly returns, we also calculate the DGTW-adjusted returns to control for the known effects of size, book-to-market ratio and momentum. The results with proxies for shareholders' bargaining power are reported in Tables 3 and 4 while those with proxies for liquidation costs are in Tables 5–7.

Asset size

Table 3 presents the results based on firm asset size. In Panel A, which reports quintile sorts on the EDF measure, raw portfolio returns exhibit no discernible patterns in the relationship between returns and EDFs except for slight humps for medium and large firms. While small firms seem to exhibit higher returns than large firms for the same level of EDF measures, the pattern is not statistically significant except for the highest-EDF group (at the 10% level). The reason for this finding is that there are two offsetting forces at work. While our theory predicts that shareholders' bargaining power leads to a positive relationship for small firms and a negative (and hump-shaped) relationship for large firms, return momentum may act as an opposing force. For small firms, the slow transmission of bad news has been shown to contribute to negative momentum in stock returns (Hong, Lim, and Stein (2000)). It has also been reported that momentum and credit quality are closely related (Avramov, Chordia, Jostova, and Philipov (2005)), and many small firms are in fact "fallen angels" going through a series of credit deterioration. This confounding influence of negative momentum offsets the conjectured effect of bargaining power on returns.

To mitigate the confounding effects of momentum and control for other known effects of characteristics such as equity size and book-to-market equity ratio, we report the result with the DGTW-adjusted returns in Panel A. The adjustment reveals a positive association between DGTW-adjusted returns and EDFs for small firms and a negative relationship for large firms. The divergence in the relationship—difference in slopes—is statistically significant with a t-statistic of 1.99, consistent with Hypothesis 1. Moreover, for firms with high EDFs, small firms outperform large firms by statistically significant amounts (0.42% and 0.76% per month, respectively, for the fourth and fifth quintiles of the EDF measure). This conforms to the implication of Hypothesis 2.

While the results based on quintile sorts of EDF are broadly consistent with model predictions, the statistical significance level seems lacking, especially for the slope in the relationship between equity return and default probability within each asset-size sub-sample. To investigate further, we repeat the same exercise using decile sorts on the EDF measure. The results, presented in Panel B, show substantial improvement in statistical significance for both raw returns and DGTW-adjusted returns. For raw returns, the slope difference is now statistically significant with a t-statistic of 2.07, even though the slopes themselves have not reached desired levels of statistical significance. With DGTW-adjusted returns, however, not only is the difference in slopes strongly significant with a t-value of 3.14, but also the slopes of the relationship between equity return and EDF measure are positive for small firms and negative for large firms, respectively, and both are statistically significant (at the 10% level). These results provide stronger statistical support for our hypotheses as we regard shareholders of larger distressed firms as having stronger bargaining power, hence facing lower equity risk.

R&D expenditures

Panel A of Table 4 presents the results related to R&D expenditures. Firms with low R&D expense ratios exhibit a negative relationship between EDF measures and future raw returns, and firms with high R&D expense ratios show a positive relationship. This difference in the slope of the relationship is statistically significant with a t-statistic of 3.40, consistent with Hypothesis 1, despite the lack of statistical significance for the respective slopes. With DGTW-adjusted returns, we observe that the divergence in the relationship for top and bottom groups is robust both in magnitude and in statistical significance. Moreover, the slope of this relationship is significantly positive (at the 10% level) for firms with high levels of R&D expense ratio, as predicted.

For firms in the highest EDF quintile, those with high R&D expense ratios earn monthly returns 1.14% higher than those with low R&D expense ratios, consistent with Hypothesis 2 when we regard shareholders in high R&D firms as being disadvantaged in renegotiation with creditors. With a t-value of 3.03, this finding may suggest a viable, yet risky, trading strategy to capture this substantial premium. The return difference between the portfolio of high R&D–high EDF firms and that of low R&D–high EDF firms remains essentially unchanged after the

DGTW-adjustment. This indicates that this return premium is associated with the changing risk profile related to shareholder advantage.

Fan and Sundaresan (2000) explicitly model cash flow-based covenants of debt which diminish the opportunity for shareholders to negotiate with creditors once the cash flow constraints bind. The R&D expenditure ratio is a natural proxy for the possibility of cash flow shortfall in distress and the ensuing reduction in shareholders' bargaining power. To specifically test the intuition that the effect of the R&D expenditure ratio is due to the potential cash flow shortfall, we stratify the sample between firms with low cash holdings and those with high cash holdings and report the results in Panels B and C of Table 4.[24] Specifically, in each month, we sort stocks independently along three dimensions: five EDF quintiles, three R&D terciles, two cash flow groups, and measure the average value-weighted returns of these thirty portfolios over time. We find that for firms with low cash holdings, the positive relationship between EDF measures and returns for high R&D firms is stronger and more statistically significant (the t-value for the slope itself is 2.20), confirming the intuition that firms with greater R&D expenditures are more vulnerable to default due to lack of liquidity. On the contrary, in the subsample of firms with high cash holdings the R&D effect almost vanishes.

Industry concentration

Table 5 examines the effect of industry concentration, as a proxy for asset specificity, on the relationship between EDF measures and stock returns. As we described before, industry concentration is measured by the Herfindahl index defined in (10). The results with DGTW-adjusted returns for the full sample (Panel A) show that the relationship is significantly downward sloping for firms in highly concentrated industries, where asset specificity, and hence liquidation costs, may be particularly high. The difference in this relationship between firms with high and low Herfindahl indices is statistically significant, consistent with Hypothesis 1. Moreover, among firms with a high default probability (in the fifth EDF quintile), stocks with low Herfindahl in-

[24] Cash holdings are defined as cash (COMPUSTAT item# 1) divided by book asset (item #6).

dices earn significantly larger returns than stocks with high Herfindahl indices, with a difference of 0.60% per month that is statistically significant with a t-statistic of 1.90.[25]

It is important to realize that liquidation of a firm's assets depends not only on the presence of potential bidders within an industry for the assets but also on the capacity of the industry, i.e., whether possible buyers within the same industry have the capability of bidding for the assets at the time.[26] In a high-growth industry, the distress a firm experiences is likely to be idiosyncratic, and hence its asset sale should be more affected by the number of potential bidders in the industry. Therefore, the effect of industry concentration should be more pronounced in the subsample with high sales growth. On the other hand, for industries with low, and possibly negative, sales growth, the capacity constraint faced by competitors in the same industry may overshadow the effect of industry concentration.

To address this point, we examine the role of the Herfindahl index in two subsamples, one with low industry sales growth and another with high industry sales growth.[27] Specifically, we sort firms independently in three dimensions: five EDF quintiles, three industry concentration terciles, and two industry sales growth groups, and measure the average returns of the thirty portfolios of stocks over time. Consistent with the intuition above, Panel B shows that for industries with high sales growth the effect of the Herfindahl index is stronger than that in the full sample, while for low-growth industries (Panel C) the Herfindahl index effect disappears.

Asset tangibility

Table 6 reports the results using the asset tangibility measure defined in (11) as an alternative, firm-level, proxy for asset specificity. As before, in the table we document the relationship between the EDF measure and stock returns for different degrees of asset tangibility by independently sorting stocks along the EDF and tangibility dimensions. Panel A shows that, for the full sample, firms with low asset tangibility, and hence high liquidation costs, tend to have a

[25] Our results also are consistent with the findings of Hou and Robinson (2005) that firms in more concentrated industries earn lower returns, after controlling for size, book-to-market and momentum.

[26] We thank Matt Spiegel for this insight.

[27] To compute sales growth, at the end of fiscal year t, we divide the total sales of an industry (COMPUSTAT item # 12) by its total sales in the previous fiscal year. As before, we use a 2-digit SIC industry classification. We then apply the obtained sales growth to the one-year period starting from July of year $t + 1$.

downward sloping relationship between stock returns and the EDF measure, and firms with high asset tangibility, i.e., low liquidation costs, tend to have a positive relationship. Even though none of the slopes in these relationships is statistically significant, a t-test still finds that the difference in these relationships is statistically significant (e.g., a t-value of 2.37 for DGTW-adjusted returns), consistent with the implication of Hypothesis 1. Moreover, for firms in the highest quintile of the EDF measure, firms with low liquidation costs earn higher returns than firms with high liquidation costs, as implied by Hypothesis 2.

For a growing industry, intangible assets, such as brand names and patents, are just as valuables as tangible assets for peer companies in the same industry. For a declining industry, however, the marginal value of tangible assets is much greater than that of the intangibles. Therefore, the asset tangibility measure, which is a gauge of the expected liquidation value of assets, is a particularly useful indicator of liquidation costs for a distressed firm in a troubled industry. To test this intuition, we sort firms independently in three dimensions: five EDF quintiles, three asset tangibility terciles, and two industry sales growth groups, and measure the average returns of the thirty portfolios of stocks over time. The results for firms in low growth industries, reported in Panel B, show indeed a stronger role for asset tangibility. Based on DGTW-adjusted returns, firms with low asset tangibility show a significant downward sloping relationship between stock return and default probability. Panel C, on the other hand, demonstrates that, for firms in high growth industries, asset tangibility becomes less relevant as a measure of liquidation costs.

Book-to-market ratio

The final proxy of liquidation costs we use is the book-to-market equity ratio. The results based on this measure are reported in Table 7. For firms with a low book-to-market ratio, higher probabilities of default, measured by EDF scores, lead to lower stock returns. This trend appears monotonic and the difference in monthly returns between the top and bottom quintiles of the EDF measure is economically and statistically significant at 1.05% with a t-statistic of 2.31. This is consistent with the finding reported in Griffin and Lemmon (2002) who use O-score and Z-score to measure default probability. For firms with a medium level of the book-to-market equity ratio, we observe a hump-shaped relationship between returns and EDF, and for firms with a high book-to-market ratio, stock returns are positively related to EDF measures. This statistically significant divergence in the slope of the return-EDF relationship for firms with high or low book-to-market ratios, with a t-statistic of 4.53, is consistent with Hypothesis 1. Moreover, for a given EDF group (except for the one with lowest EDFs), stocks with higher book-to-market ratios consistently earn higher returns than those with lower book-to-market ratios, as predicted by Hypothesis 2.

Similar to firm size, when we use a firm characteristic like the book-to-market ratio to proxy for shareholder advantage, one has to make sure that the result is not driven or contaminated by its own known effect on stock returns. This concern is mitigated by examining the return pattern using DGTW-adjusted returns, which is also presented in Panel B. The result shows that the return pattern with respect to EDF measures for different book-to-market ratio firms is robust with similar economic and statistical significance. This also implies that the observed return pattern is independent of the book-to-market ratio effect on stock returns, but consistent with our interpretation of large shareholder advantage in low book-to-market-ratio firms.

It is interesting to note that the empirical results using the R&D expenditure ratio and the book-to-market ratio are opposite to each other, even though firms with high R&D expenditure tend to be growth firms with low book-to-market ratios (as indicated in the correlation matrix in Table 8). To further investigate the cause of these different empirical results, we regress R&D expenditure ratios on book-to-market ratios in the cross section and verify that the result for the R&D expenditure ratio is driven by the residual component that is orthogonal to the book-to-market ratio. This exercise further confirms that the empirical results using these two variables are coming from different mechanisms, as suggested earlier: the R&D expenditure ratio captures the bargaining power aspect of the shareholder advantage, and the book-to-market ratio proxies for the potential gains from renegotiations.

Summary

To summarize, the evidence presented in our sub-portfolio analysis is strongly supportive of the predictions of the strategic bargaining model developed in Section 3. Shareholder advantage, in its multiple manifestation as either the bargaining power in debt renegotiations with creditors or the threat of imposing liquidation and bankruptcy costs on debt-holders, plays a crucial role in the link between default probability and stock returns. The economic magnitude of this effect is significant. For example, based on DGTW-adjusted returns which control for the known effects of other firm characteristics on returns, for firms with high default probability (i.e., in the fifth EDF quintile), the *annualized* return differentials between firms with strong shareholder advantage and those with weak shareholder advantage range from 7.2% to 15.8%, all of them statistically significant.

4.3 Multivariate regression analysis

To further examine the evidence we have presented thus far, we now turn to a regression analysis. While the sub-portfolio analysis presents a non-parametric examination of the cross-sectional difference in the relationship between default probability and stock returns, a regression analysis provides a structural and multivariate view of this cross-sectional difference and further illuminates the role of shareholder advantage. We carry out our analysis using the methodology of Fama and MacBeth (1973): First, in each month, we regress monthly returns on a set of firm characteristics, and then we average the time-series of regression coefficients and calculate corresponding t-statistics, which are adjusted for auto-correlation and heteroscedasticity (Newey and West (1987)).

The explanatory variable associated with default probability is the *rank* of a firm's EDF, normalized between 0 and 1.[28] Similarly, for the characteristics that proxy for shareholder advantage, we use a firm's rank (normalized between 1 and 10) for the Herfindahl index, the

[28] This variable is constructed by ranking firms in each month according to their EDF score. In case of more firms having the same score we assign the median rank to all the firms with the same EDF score. Then all ranks are normalized to be between 0 and 1. We use EDF rank instead of the EDF measure itself to mitigate the problem due to its skewed and time-varying distribution.

tangibility measure, and the R&D expense ratio. The asset value and the book-to-market ratio are represented by their natural logarithmic values. The set of independent variables also contains characteristics, such as beta (obtained from CRSP), book-to-market ratio, and momentum measured by past six-month returns, that are known to affect returns. We do not include the equity market capitalization, because it is highly correlated with the asset size. The main test of our hypotheses rely on examining the interaction terms between the EDF rank with asset size, book-to-market equity ratio, ranks for for Herfindahl index, tangibility measure and R&D expense ratio, respectively.

Table 8 presents pairwise Pearson correlation coefficients between these explanatory variables. There is a significantly negative correlation between the asset size and the EDF rank variable. The EDF rank variable is also substantially correlated with the book-to-market ratio and with momentum measured by past six-month returns. The Herfindahl index rank is not substantially correlated with other variables except for the R&D rank variable, while the R&D rank variable is also significantly correlated with the book-to-market ratio. The tangibility rank is negatively correlated with asset size and positively correlated with the R&D rank. Interestingly, the tangibility measure has very little correlation with the Herfindahl index, implying that these two measures capture different facets of asset specificity. These correlations suggest that it is important to examine the respective roles of these proxies in a multivariate regression. We report the results from both univariate and multivariate regressions in Table 9.

Model 1 in Table 9 is the basic benchmark known in the literature—although we replace the equity size with asset size without qualitatively affecting the results—presented to facilitate comparisons with other models in the table as well as with the above portfolio results. The result is consistent with those established in the literature: size enters with a significant and negative coefficient and the book-to-market ratio has a significant and positive coefficient. Model 2 shows that the likelihood of default also matters, but it has a marginally significant negative relation with stock returns, consistent with our empirical evidence presented earlier. The inclusion of default probability does not qualitatively impact the effects of other characteristics except for strengthening the size effect. Models 3 through 7 present evidence on the five individual proxies for shareholder advantage used in the sub-portfolio analysis. The interaction terms in these models are all statistically significant. Combined with the coefficient for the EDF rank variable, these results represent a conditional dependence of stock returns on default probability. For instance, Model 3 implies that for firms with an asset size less than $\exp(0.1026/0.0058) = \$48$ million, their stock returns will generally have a positive relationship with it EDF rank. For firms with a larger asset base, this relation will turn negative. Individually, these results are all consistent with those presented in Tables 3-7.

Finally, Model 8 in Table 9 provides a multivariate examination of the individual variables that we have used separately so far. The result shows that these variables capture different aspects of shareholder advantage in financial distress, as each variable maintains its statistical significance in the multivariate context. The only exceptions are the interaction effects of the Herfindahl index and of the book-to-market ratio, which diminish in magnitude while still retaining statistical significance at the 10% level. In summary, the results from our regression analysis further demonstrate the multifaceted nature of the effect of shareholder advantage on stock returns.

4.4 Robustness tests

To check the robustness of our results, we carry out additional tests along two dimensions. First, we verify that the results we presented above are not sensitive to the holding period over which returns are measured. This is an important concern because many stocks with high default risk are not very liquid, and therefore, illiquidity may bias returns. Because of this concern, the reported results so far are based on the returns in the second month after the formation of portfolios, i.e., we skip a month before we measure the return. However, we verify that our reported results are qualitatively similar, even if we use the return in the month immediately after portfolio formation. This is also true if we form portfolios every quarter, instead of every month, and measure returns over the following quarter.

The second dimension along which we check the robustness of our results is to examine additional proxies related to the strategic interaction between shareholders and creditors that have been used in the literature. Several variables are related to the ones that we have used. These include book-to-market *asset* ratio, as opposed to book-to-market equity ratio, Tobin's Q, book value of assets, as opposed to (implied) market value of assets, and the ratio of R&D expenditure to total capital expenditure, as opposed to the ratio of R&D expenditure to total assets. We have verified that all of these variables produce qualitatively similar results as those by their counterparts discussed before.

Davydenko and Strebulaev (2004), in a study that tries to empirically assess the effect of shareholders' strategic defaults on credit spreads, use (i) managerial holding in a company's share as a proxy of shareholders' bargaining power and (ii) the ratio of non-fixed assets as a proxy for liquidation costs. The rationale for using managerial holdings is that the more shares managers hold in the company, the more effort they will exert in extracting rents from creditors in the case of financial distress, hence reducing the risk of the equity. Although intuitive, this measure can be clouded by another offsetting force that may be at work as well. As documented by Core and Larcker (2002), an increase in executive stock holdings is associated with an improvement in a firm's financial performance, and hence, a higher future stock return. This *cash flow effect* offsets the *discount rate effect* of shareholder advantage, thus leaving the net effect ambiguous. This is what we find when we group stocks according to the relative stock holdings by top five executives.[29] As shown in Panel A of Table 10, while, as expected, low levels of executive holdings are associated with a positive relation between stock returns and default probability, for firms with high levels of executive stock holdings the relationship is essentially flat, consistent with the argument above about the opposing effects.

The rationale that motivates Davydenko and Strebulaev (2004) to use non-fixed assets as a proxy of liquidation costs is based on the empirical evidence in Alderson and Betker (1995) that fixed assets are a good proxy for the lack of costs of liquidation. Again, although intuitive, this argument may be problematic if non-fixed assets include liquid assets, such as short-term securities, that can be easily liquidated. In fact, in our test using this proxy, we fail to find any

[29]We obtain managerial holdings from the CompuStat Executive Compensation database.

discernible change in the relation between stock returns and default probability across firms, as demonstrated in Panel B of Table 10.

5 Conclusion

Using the market-based EDF measure of *Moody's KMV* as an indicator of default probability, we analyze the relationship between default probability and equity returns. Complementing the evidence in existing studies, we find that, in general, expected returns are not positively related to default probability.

We argue that such a result is not necessarily violating the risk-return trade-off and we show how these patterns can be consistent with a model in which shareholders of financially distressed firms are capable of extracting rents from other claimholders. Specifically, through a simple strategic bargaining model built on Fan and Sundaresan (2000), we show that the opportunity for equity-holders of distressed firms to renegotiate and extract benefits, in violation of the absolute priority rule, is essential for explaining the counter-intuitive empirical regularity in a rational context without upsetting proper risk-return trade-offs. In general, firms in which shareholders have higher bargaining power earn lower returns, after controlling for size, book-to market and momentum. Moreover these returns are usually decreasing with default probability. On the contrary, firms in which shareholders have little or no bargaining power exhibit higher returns which tend to increase with default probability.

Our empirical investigation, using a variety of proxies for shareholder advantage, has provided consistent support for the cross-sectional implications of our model. Moreover, we have documented that the economic significance of shareholder advantage is substantial.

Our study is among the first to systematically examine the effect of strategic interaction between equity-holders and debt-holders on equity returns and illustrates the importance of considering such features in the analysis of expected returns on equity. Our findings not only help to reconcile some of the puzzling evidence documented in the empirical literature but also, perhaps more importantly, point in the direction that to fully understand the dynamics of returns around such exceptional corporate events as defaults and liquidations, it is essential to acknowledge and properly account for the role of shareholder advantage in distress.

Appendix

A Proof of Proposition 1

Let $\mathbb{P}$ be the probability measure governing the dynamics of asset values in (2). Straightforward application of Itô's lemma yields

$$V_t = V_0 e^{\left(\mu-\delta-\frac{1}{2}\sigma^2\right)t+\sigma(B_t-B_0)}, \tag{A1}$$

where B_t is a standard Brownian motion under $\mathbb{P}$. Hence, V_t is log-normally distributed with mean $V_0 e^{(\mu-\delta)t}$ and variance $V_0^2 e^{2(\mu-\delta)t}\left(e^{\sigma^2 t}-1\right)$. The expected value of $\mathbb{E}_0(\widetilde{E}(V_t))$ is given by

$$\mathbb{E}_0(\widetilde{E}(V_t)) = \int_0^\infty \widetilde{E}(V_t) f(V_t) dV_t, \tag{A2}$$

where $f(V_t)$ is the log-normal density of V_t. From the expression (5) for the value of equity, using a suitable change of variables to deal with integrals involving lognormal distributions, we arrive at the following expression,

$$\begin{aligned}\mathbb{E}_0(\widetilde{E}(V_t)) \;=\; & \eta\alpha V_0 e^{(\mu-\delta)t}\mathcal{N}\left(h(t)-\sigma\sqrt{t}\right) - \eta\frac{\lambda_1}{\lambda_2-\lambda_1}\frac{\tau c}{r}\left(\frac{V_0}{\widetilde{V}_S}\right)^{\lambda_2} e^{\lambda_2(\gamma-\lambda_2)t}\mathcal{N}\left(h(t)-\lambda_2\sigma\sqrt{t}\right) \\ & + V_0 e^{(\mu-\delta)t}\mathcal{N}\left(-h(t)+\sigma\sqrt{t}\right) - \frac{c(1-\tau)}{r}\mathcal{N}\left(-h(t)\right) \\ & + \left[\frac{c(1-\tau)}{(1-\lambda_1)r} - \frac{\lambda_1(1-\lambda_2)\eta}{(\lambda_2-\lambda_1)(1-\lambda_1)}\frac{\tau c}{r}\right]\left(\frac{V}{\widetilde{V}_S}\right)^{\lambda_1} e^{\lambda_1(\gamma-\lambda_1)t}\mathcal{N}\left(-h(t)+\lambda_1\sigma\sqrt{t}\right),\end{aligned} \tag{A3}$$

with $\gamma = \mu-\delta-\frac{1}{2}\sigma^2$, $h(t) = \frac{\log\left(\widetilde{V}_S/V_0\right)-\gamma t}{\sigma\sqrt{t}}$ and $\mathcal{N}(\cdot)$ the cumulative standard normal function.

The cumulative default probability over $(0,T]$ is defined as follows

$$\Pr_{(0,T]} = 1 - \Pr\left\{\inf_{0<t\leq T} V_t \geq \widetilde{V}_S \;\middle|\; V_0 > \widetilde{V}_S\right\}. \tag{A4}$$

Let $X_t = \log(V_t)$. By (A1), X_t follows the following arithmetic Brownian motion

$$dX_t = \gamma dt + \sigma dB_t, \quad X_0 = \log(V_0), \tag{A5}$$

where $\gamma = \mu - \delta - \frac{1}{2}\sigma^2$. The probability in (A4) is equivalent to the following

$$\Pr_{(0,T]} = 1 - \Pr\left\{\inf_{0<t\leq T} X_t \geq \log(\widetilde{V}_S) \;\middle|\; X_0 > \log(\widetilde{V}_S)\right\}. \tag{A6}$$

Let $y = \log(\widetilde{V}_S)$. After some simple manipulation we can write

$$\Pr_{(0,T]} = 1 - \Pr\left\{\sup_{0<t\leq T} -(X_t - X_0) \leq X_0 - y \mid X_0 > y\right\}. \tag{A7}$$

This probability can be computed from the hitting time distribution of the Brownian motion (Harrison, 1985, equation (11), p.14) and is equal to

$$\Pr_{(0,T]} = \mathcal{N}\left(\frac{y - X_0 - \gamma T}{\sigma\sqrt{T}}\right) + e^{\frac{2\gamma(y-X_0)}{\sigma^2}}\mathcal{N}\left(\frac{y - X_0 + \gamma T}{\sigma\sqrt{T}}\right). \tag{A8}$$

Replacing $y = \log(\widetilde{V}_S)$ and $X_0 = \log(V_0)$, we arrive at equation (9). ∎

B Simulations details

Below we provide a detailed description of our choice of parameters.

1. *Return and EDF horizon.* We choose the return horizon to be one month and the default probability horizon to be one year to match the design of our empirical study.

2. *Risk-free rate.* In the model, the risk free rate, r, refers to the instantaneous short rate. We select r to be 4% per annum, to roughly match the typical value of the short rate. We have verified that the results are not qualitatively sensitive to the choice of this parameter.

3. *Corporate tax rate.* The corporate tax rate, τ, is set to 35% which is the highest of the four basic federal tax rates on income for "C corporations", according to the IRS. We have also verified that the results are not qualitatively sensitive to the choice of this parameter.

4. *Payout rate.* The payout rate, δ, is set to 4% per annum, consistent with the historical average of dividend yield (1927-2001). We have verified that the simulation results are qualitatively similar under different specifications of this parameter.

5. *Coupon rate.* To mimic the cross section of possible coupon rates, c, we run simulations by drawing c from a uniform distribution with support $[0.05, 0.10]$. The support is chosen to capture the spectrum of possible coupon rates ranging from AAA-rated bonds to high-yield bonds.

6. *Asset volatility.* We use *Moody's KMV* estimates of asset volatility, σ, to obtain the empirical distribution and draw σ from this distribution.

7. *Asset growth rate and initial asset value.* The selection of the asset growth rate, μ, has to satisfy the condition $\mu > \delta + \frac{1}{2}\sigma^2$, in order to guarantee that the long run probability of default is between zero and one (see equation (9)). Given this restriction and the notorious difficulty in estimating expected returns, μ is chosen in conjunction with the initial value of the asset V_0 in order to match the magnitude of empirically observed default probabilities. In our simulation, we draw μ from a symmetric "tent-like" distribution centered around

$2\left(\delta + \frac{1}{2}\sigma^2\right)$ and with support $\left[\delta + \frac{1}{2}\sigma^2, 3\left(\delta + \frac{1}{2}\sigma^2\right)\right]$. To guarantee that we do not draw firms that are already in default, the initial asset value V_0 is chosen in each simulation from a uniform distribution with support $[V_S, V_S + 1.25]$, where V_S is the endogenous default threshold define in equation (6). The value 1.25 is chosen to obtain model-generated default probabilities that closely match the empirically observed EDF measures.

In our simulations, we draw 50 values each of σ, μ and c from the above mentioned distributions, for a total of 125,000 firms. We consider four values of η: $\{0, 0.2, 0.5, 0.8\}$ and three values of α: $\{0.2, 0.5, 0.8\}$. The median EDF measure observed in our data is 1.19% (see Table 1). Our choice of asset growth rate μ and initial asset value V_0 described in point 7 above, together with the other parameter choice, produces model-generated EDFs whose median across the full sample of simulated firms is equal to 1.13%, close to the observed median of 1.19%.

Table 1: Summary statistics of the EDF measure

Our sample period spans from January 1969 to December 2003. At the beginning of every three-year interval (starting from January 1970), the table reports the number of firms in our sample, the mean, standard deviation, median, first and third quartile of the EDF distribution. EDF quantities are expressed in percent units.

Month	# Firm	Mean	Std.	Median	Quart 1	Quart 3
Jan-70	1,455	1.19	1.76	0.56	0.17	1.50
Jan-73	1,894	2.00	3.20	0.83	0.23	2.25
Jan-76	2,945	3.87	4.77	2.06	0.88	4.58
Jan-79	3,149	2.57	4.21	0.97	0.31	2.56
Jan-82	3,116	3.19	4.60	1.42	0.59	3.40
Jan-85	3,566	3.21	5.17	0.98	0.34	3.18
Jan-88	3,745	4.25	5.83	1.68	0.48	5.02
Jan-91	3,627	5.48	7.11	1.80	0.37	8.08
Jan-94	3,916	2.73	4.56	0.85	0.22	2.82
Jan-97	4,541	2.72	4.61	0.78	0.18	2.82
Jan-00	4,246	3.68	5.11	1.53	0.52	4.26
Jan-03	3,572	5.23	6.52	2.03	0.59	7.39
Full Sample	1,430,713	3.44	5.22	1.19	0.35	3.75

Table 2: Equity returns and default probability

At the end of each month t from June 1969 to October 2003, we sort stocks into quintiles based on their weighted EDF measures (1). We then record the returns of these portfolios in the month $t+2$, i.e., two months after the portfolio formation. In the table we report the time series averages of returns of these portfolios. Both equally-weighted and value-weighted quantities are reported. The "High−Low" column is the difference between a quantity of the high EDF quintile and that of the low EDF quintile, and the t-value is the t-statistic of this difference. EW−VW represents the difference in the slopes between equally- and value-weighted returns. In each panel we report results with both raw returns and with return adjusted with the methodology suggested by Daniel, Grinblatt, Titman, and Wermers (1997) (DGTW-adjusted returns). The sample period of DGTW-adjusted results spans from June 1975 to June 2003 due to the availability of the DGTW benchmark portfolio returns. * indicates statistical significance at the 10% level, ** at the 5% level and *** at the 1% level.

	Low 1	2	EDF 3	4	High 5	High−Low	t-value
Panel A: Full sample							
Raw returns							
EW	1.14	1.23	1.26	1.25	1.65	0.51	1.50
VW	0.96	1.11	1.08	0.95	0.82	-0.14	-0.38
EW−VW						0.65***	3.66
DGTW returns							
EW	0.03	0.08	0.08	0.09	0.74	0.72***	2.95
VW	-0.01	0.07	-0.02	-0.18	-0.23	-0.22	-0.84
EW−VW						0.94***	5.79
Panel B: Stocks with price ≥ $2							
Raw returns							
EW	1.14	1.22	1.23	1.19	1.05	-0.09	-0.38
VW	0.97	1.05	1.11	0.95	0.82	-0.15	-0.48
EW−VW						0.05	0.35
DGTW returns							
EW	0.04	0.06	0.04	0.03	-0.11	-0.15	-1.07
VW	0.01	0.03	-0.02	-0.12	-0.33	-0.34*	-1.72
EW−VW						0.19	1.52

Table 3: EDF and stock returns in the cross section: Asset size

At the end of each month t from June 1969 to October 2003 (June 1975 to June 2003 for calculating the DTGW-adjusted returns), we sort stocks into five equally populated groups (Panel A) or ten equally populated groups (Panel B) according to their weighted EDF measures(1) and, independently, into three equally populated groups according to their asset size. The returns are recorded in month $t+2$, i.e., one month after the portfolio formation. We present the time series averages of the value-weighted portfolio returns (both raw and DTGW-adjusted). The column "High−Low" reports the differences in returns between the high EDF quintile and low EDF quintile and the corresponding t-statistics. The rows "Large−Small" report the differences in returns between top and bottom groups in asset size and their corresponding t-statistics. * indicates statistical significance at the 10% level, ** at the 5% level and *** at the 1% level.

	Low				EDF					High		
	1	2	3	4	5	6	7	8	9	10	High−Low	t-value
Raw Returns												
Small	1.31	1.18	1.31	1.25	1.31						-0.01	-0.03
Medium	1.21	1.23	1.17	1.08	0.73						-0.49	-1.51
Large	0.96	1.10	1.07	0.93	0.68						-0.28	-0.65
Large−Small	-0.35	-0.09	-0.24	-0.32	-0.63*						-0.28	
t-value	-1.52	-0.44	-1.08	-1.35	-1.85						-0.77	
DGTW Returns												
Small	-0.01	0.14	0.19	0.16	0.29						0.30	1.05
Medium	0.11	0.06	0.07	-0.07	-0.26						-0.37	-1.32
Large	0.00	0.08	-0.01	-0.26	-0.47						-0.47	-1.20
Large−Small	0.01	-0.07	-0.20	-0.42**	-0.76**						-0.77**	
t-value	0.04	-0.41	-1.23	-2.13	-2.14						-1.99	
Raw Returns												
Small	1.02	1.44	1.22	1.18	1.33	1.29	1.18	1.33	1.25	1.41	0.39	0.97
Medium	1.22	1.19	1.23	1.24	1.16	1.19	1.09	1.07	0.76	0.66	-0.56	-1.31
Large	0.94	1.08	1.06	1.14	1.09	1.01	0.97	0.89	0.72	0.25	-0.68	-1.16
Large−Small	-0.09	-0.36	-0.16	-0.04	-0.24	-0.28	-0.20	-0.44	-0.54	-1.16**	-1.07**	
t-value	-0.34	-1.35	-0.69	-0.20	-0.93	-1.18	-0.83	-1.51	-1.34	-2.46	-2.07	
DGTW Returns												
Small	-0.21	0.04	0.04	0.22	0.06	0.29	0.07	0.25	0.16	0.52	0.73*	1.89
Medium	0.14	0.10	0.06	0.06	0.01	0.13	0.00	-0.16	-0.14	-0.55	-0.69*	-1.69
Large	0.00	0.05	0.05	0.09	0.04	-0.11	-0.27	-0.19	-0.31	-1.02	-1.02*	-1.89
Large−Small	0.21	0.01	0.01	-0.13	-0.03	-0.40**	-0.34	-0.44	-0.47	-1.54***	-1.74***	
t-value	0.84	0.03	0.04	-0.72	-0.15	-1.99	-1.51	-1.61	-1.13	-3.05	-3.14	

Table 4: EDF and stock returns in the cross section: R&D expenses

At the end of each month t from June 1969 to October 2003 (June 1975 to June 2003 for calculating the DTGW-adjusted returns), we sort stocks independently into five equally populated groups according to their weighted EDF measures (1) and three equally populated groups according to their R&D expense ratio. Panel A reports the returns of each portfolio for the full sample. Panel B and C consider, respectively, firms with low and high cash holdings, defined as cash (COMPUSTAT item #1) divided by book asset (item #6). The returns are recorded in month $t+2$, i.e., one month after the portfolio formation. We present the time series averages of the value-weighted portfolio returns (both raw and DTGW-adjusted). The column "High−Low" reports the difference in returns between the high EDF quintile and low EDF quintile and the corresponding t-statistics. The rows "Large-Small" and "High−Low" report the difference in returns between top and bottom groups in asset size or R&D expense ratio as well as the corresponding t-statistics. In addition, we also report in the "High−Low" column the difference of the top and bottom differences and its t-statistic. * indicates statistical significance at the 10% level, ** at the 5% level and *** at the 1% level.

	Low 1	2	EDF 3	4	High 5	High−Low	t-value
Panel A: R&D–Full sample							
Raw Returns							
Low	1.12	1.09	0.96	0.84	0.55	-0.57	-1.44
Medium	0.97	1.35	1.21	1.23	1.16	0.19	0.39
High	1.02	1.39	1.27	1.36	1.69	0.67	1.30
High−Low	-0.10	0.30	0.31	0.52	1.14***	1.24***	
t-value	-0.47	0.90	1.05	1.64	3.03	3.40	
DGTW Returns							
Low	-0.02	-0.02	-0.24	-0.58	-0.44	-0.42	-1.38
Medium	0.05	0.19	0.28	0.06	-0.03	-0.08	-0.20
High	0.11	0.42	0.46	0.19	0.89	0.78*	1.74
High−Low	0.13	0.44	0.70**	0.77**	1.32***	1.19***	
t-value	0.99	1.56	2.37	2.45	3.13	2.83	
Panel B: R&D–Low cash holdings							
Raw Returns							
Low	1.10	1.10	1.07	0.99	0.52	-0.57	-1.41
Medium	1.03	1.36	1.16	1.36	0.99	-0.04	-0.08
High	0.77	1.36	1.16	1.12	1.84	1.07**	1.99
High−Low	-0.33	0.27	0.09	0.13	1.31***	1.64***	
t-value	-1.24	0.70	0.24	0.37	3.28	3.64	
DGTW Returns							
Low	-0.04	-0.04	-0.07	-0.41	-0.55	-0.51	-1.62
Medium	0.00	0.22	0.06	0.27	-0.03	-0.03	-0.07
High	-0.02	0.42	0.14	0.04	1.02	1.04**	2.20
High−Low	0.01	0.47	0.22	0.46	1.57***	1.55***	
t-value	0.08	1.28	0.63	1.23	3.25	3.06	
Panel C: R&D–High cash holdings							
Raw Returns							
Low	1.09	1.04	0.83	0.18	0.67	-0.41	-0.84
Medium	1.07	1.36	1.14	1.27	1.70	0.64	1.20
High	1.21	1.43	1.32	1.46	1.61	0.40	0.69
High−Low	0.12	0.39	0.51	1.29***	0.94**	0.81	
t-value	0.48	1.33	1.52	3.21	1.82	1.50	
DGTW Returns							
Low	-0.08	0.02	-0.46	-0.98	-0.17	-0.08	-0.19
Medium	0.22	0.27	0.40	0.20	0.43	0.21	0.44
High	0.20	0.45	0.51	0.37	0.73	0.52	0.99
High−Low	0.29	0.43	0.97***	1.35***	0.89	0.61	
t-value	1.32	1.28	2.82	3.23	1.61	1.05	

Table 5: EDF stock returns in the cross section: Herfindahl index

At the end of each month t from June 1969 to October 2003 (June 1975 to June 2003 for calculating the DTGW-adjusted returns), we sort stocks independently into five equally populated groups according to their weighted EDF measures (1) and three equally populated groups according to their Herfindahl index (10). Panel A reports the returns of each portfolio for the full sample. Panel B and C consider, respectively,firms with high and low sales growth, defined as the total sale of an industry (COMPUSTAT item #12) in a year divided by its value in the previous year. The returns are recorded in month $t+2$, i.e., one month after the portfolio formation. We present the time series averages of the value-weighted portfolio returns (both raw and DTGW-adjusted). The column "High−Low" reports the difference in returns between the high EDF quintile and low EDF quintile and the corresponding t-statistics. The row "High−Low" reports the difference in returns between top and bottom groups in Herfindahl index or book-to-market as well as the corresponding t-statistics. In addition, we also report in the "High−Low" column the difference of the top and bottom differences and its t-statistic. * indicates statistical significance at the 10% level, ** at the 5% level and *** at the 1% level.

	Low 1	2	EDF 3	4	High 5	High−Low	t-value
Panel A: Herfindahl Index–Full sample							
Raw Returns							
Low	0.95	0.98	1.13	1.10	0.94	-0.01	-0.03
Medium	1.00	1.22	1.13	1.08	0.90	-0.10	-0.23
High	0.98	1.15	1.14	0.84	0.58	-0.40	-1.10
High−Low	0.02	0.17	0.01	-0.26	-0.36	-0.39	
t-value	0.18	1.11	0.07	-1.38	-1.31	-1.40	
DGTW Returns							
Low	-0.01	-0.05	0.06	-0.04	-0.03	-0.02	-0.06
Medium	0.05	0.18	-0.01	-0.19	-0.07	-0.12	-0.39
High	-0.04	0.12	0.00	-0.17	-0.63	-0.59**	-2.33
High−Low	-0.03	0.17	-0.06	-0.13	-0.60*	-0.57*	
t-value	-0.26	1.15	-0.31	-0.55	-1.90	-1.85	
Panel B: Herfindahl Index–High sales growth							
Raw Returns							
Low	0.86	0.94	1.09	0.96	1.06	0.20	0.45
Medium	1.12	1.01	1.07	0.82	0.59	-0.53	-1.12
High	0.83	0.94	0.91	0.64	0.39	-0.43	-1.13
High−Low	-0.04	0.00	-0.18	-0.32	-0.67**	-0.63*	
t-value	-0.22	-0.01	-0.60	-1.14	-2.02	-1.80	
DGTW Returns							
Low	-0.10	-0.01	-0.11	-0.17	0.12	0.23	0.64
Medium	0.17	0.31	0.03	-0.41	-0.16	-0.33	-0.72
High	-0.17	-0.04	-0.27	-0.26	-0.90	-0.72**	-2.38
High−Low	-0.07	-0.03	-0.16	-0.09	-1.02***	-0.95**	
t-value	-0.52	-0.16	-0.57	-0.24	-2.75	-2.45	
Panel C: Herfindahl Index–Low sales growth							
Raw Returns							
Low	1.07	0.93	1.21	1.29	1.03	-0.04	-0.09
Medium	1.15	1.56	1.22	1.48	1.52	0.37	0.87
High	1.20	1.39	1.41	1.21	0.83	-0.37	-0.93
High−Low	0.13	0.45	0.21	-0.07	-0.20	-0.33	
t-value	0.74	2.38	0.85	-0.27	-0.56	-0.92	
DGTW Returns							
Low	0.10	-0.21	0.16	0.06	-0.18	-0.28	-0.84
Medium	0.13	0.31	0.01	0.10	0.18	0.05	0.15
High	0.05	0.25	0.22	0.12	-0.30	-0.34	-1.10
High−Low	-0.05	0.46**	0.07	0.07	-0.11	-0.06	
t-value	-0.38	2.50	0.25	0.22	-0.29	-0.15	

Table 6: EDF stock returns in the cross section: Asset tangibiliy

At the end of each month t from June 1969 to October 2003 (June 1975 to June 2003 for calculating the DTGW-adjusted returns), we sort firms independently into five equally populated groups according to their weighted EDF measures (1) and three equally populated groups according to their assets' tangibility (11). Panel A reports the returns of each portfolio for the full sample. Panel B and C consider, respectively, firms with high and low sales growth, where sales growth is defined as the total sale of an industry (COMPUSTAT item #12) in a year divided by its value in the previous year. The returns are recorded in month $t+2$, i.e., one month after the portfolio formation. We present the time series averages of the value-weighted portfolio returns (both raw and DTGW-adjusted). The column "High−Low" reports the difference in returns between the high EDF quintile and low EDF quintile and the corresponding t-statistics. The row "High−Low" reports the difference in returns between top and bottom groups in Herfindahl index or book-to-market as well as the corresponding t-statistics. In addition, we also report in the "High−Low" column the difference of the top and bottom differences and its t-statistic. * indicates statistical significance at the 10% level, ** at the 5% level and *** at the 1% level.

	Low 1	2	EDF 3	4	High 5	High−Low	t-value
Panel A: Asset tangibility–Full sample							
Raw Returns							
Low	0.99	1.11	1.04	0.79	0.62	-0.37	-0.91
Medium	0.97	1.07	1.15	1.10	0.75	-0.22	-0.54
High	1.08	1.12	1.03	0.96	1.37	0.29	0.73
High−Low	0.09	0.01	-0.01	0.17	0.75***	0.66**	
t-value	0.42	0.04	-0.03	0.72	2.64	2.24	
DGTW Returns							
Low	-0.02	0.02	-0.07	-0.39	-0.48	-0.46	-1.55
Medium	-0.03	0.06	0.03	-0.02	-0.45	-0.42	-1.27
High	0.22	0.21	0.09	0.01	0.52	0.30	0.88
High−Low	0.24*	0.18	0.16	0.41	1.00***	0.76**	
t-value	1.81	0.93	0.74	1.56	3.21	2.37	
Panel B: Asset tangibility–Low sales growth							
Raw Returns							
Low	1.11	1.17	1.18	1.04	0.76	-0.35	-0.86
Medium	1.13	1.33	1.36	1.58	0.96	-0.17	-0.43
High	1.23	1.33	1.29	1.36	1.74	0.51	1.16
High−Low	0.28*	0.35	0.28	0.35	1.15***	0.88***	
t-value	1.66	1.54	1.14	1.21	3.63	2.63	
DGTW Returns							
Low	0.03	-0.07	0.03	-0.03	-0.45	-0.48*	-1.71
Medium	0.14	0.26	0.18	0.23	-0.30	-0.44	-1.49
High	0.31	0.29	0.31	0.32	0.71	0.40	1.15
High−Low	0.12	0.16	0.11	0.32	0.98***	0.86***	
t-value	0.53	0.61	0.40	1.17	3.01	2.57	
Panel C: Asset tangibility–High sales growth							
Raw Returns							
Low	0.86	1.03	0.97	0.61	0.58	-0.28	-0.64
Medium	0.80	0.85	0.94	0.73	0.66	-0.14	-0.32
High	0.98	0.95	0.94	0.69	1.07	0.10	0.23
High−Low	0.11	-0.09	-0.03	0.08	0.49	0.38	
t-value	0.52	-0.33	-0.12	0.30	1.45	1.05	
DGTW Returns							
Low	-0.08	0.14	-0.11	-0.69	-0.50	-0.42	-1.17
Medium	-0.24	-0.16	-0.17	-0.28	-0.63	-0.40	-0.98
High	0.17	0.21	0.04	-0.21	0.22	0.05	0.13
High−Low	0.25	0.07	0.14	0.48	0.71**	0.47	
t-value	1.46	0.28	0.57	1.64	1.85	1.18	

Table 7: EDF stock returns in the cross section: Book to Market ratio

At the end of each month t from June 1969 to October 2003 (June 1975 to June 2003 for calculating the DTGW-adjusted returns), we sort firms independently into five equally populated groups according to their weighted EDF measure (1) and three equally populated groups according to their book-to-market ratio. The returns are recorded in month $t+2$, i.e., one month after the portfolio formation. We present the time series averages of the value-weighted portfolio returns (both raw and DTGW-adjusted). The column "High−Low" reports the difference in returns between the high EDF quintile and low EDF quintile and the corresponding t-statistics. The row "High−Low" reports the difference in returns between top and bottom groups in Herfindahl index or book-to-market as well as the corresponding t-statistics. In addition, we also report in the "High−Low" column the difference of the top and bottom differences and its t-statistic. * indicates statistical significance at the 10% level, ** at the 5% level and *** at the 1% level.

	Low		EDF		High		
	1	2	3	4	5	High−Low	t-value
Raw Returns							
Low	0.97	0.69	0.63	0.00	-0.09	-1.05**	-2.31
Medium	1.05	1.19	1.17	1.17	0.71	-0.34	-0.81
High	1.06	1.35	1.31	1.58	1.51	0.46	1.20
High−Low	0.09	0.66***	0.68***	1.58***	1.60***	1.51***	
t-value	0.49	2.76	2.80	5.65	4.79	4.53	
DGTW Returns							
Low	0.04	-0.04	-0.22	-0.59	-0.87	-0.91**	-2.37
Medium	-0.04	0.12	0.15	0.04	-0.22	-0.18	-0.55
High	-0.09	0.06	0.09	0.06	0.24	0.34	1.17
High−Low	-0.13	0.10	0.31	0.65**	1.11***	1.24***	
t-value	-1.16	0.52	1.53	2.42	3.16	3.47	

Table 8: Correlations among independent variables used in regressions

In this table, we report the time-series average of the cross-sectional correlation coefficients between independent variables used in the regression analysis. *Beta* is calculated at the end of the previous year and obtained from CRSP; *Ln(AVL)* is the natural log of a firm's implied market value of assets at the end of month t, provided by *Moody's KMV*; *Ln(BM)* is the natural log of a firm's book-to-market ratio; *Ret* $(-6,-1)$ is the six-month average monthly returns from month $t-5$ to month t; *EDF*, is a normalized EDF rank variable between 0 and 1 obtained in month t; *R&D* is the rank of R&D expense ratio of a firm measured at the previous fiscal year end ranging from 1 to 10; *Hfdl* is the rank of Herfindahl index 10 of a firm measured at the previous fiscal year end ranging from 1 to 10 and *Tang* is the rank of the asset tangibility measure (11) of a firm measured at the previous fiscal year end ranging from 1 to 10.

	Beta	Ln(AVL)	Ln(BM)	Ret(-6,-1)	EDF	R&D	Hfdl	Tang
Beta	1.0000							
Ln(AVL)	0.2014	1.0000						
Ln(BM)	-0.2271	-0.1095	1.0000					
Ret(-6,-1)	-0.0455	0.0634	0.0678	1.0000				
EDF	-0.0735	-0.4661	0.2111	-0.1126	1.0000			
R&D	0.1937	-0.0716	-0.3024	0.0274	-0.0619	1.0000		
Hfdl	-0.0874	0.1043	-0.0149	0.0024	-0.0322	-0.2278	1.0000	
Tang	0.0678	-0.2405	-0.1708	0.0191	-0.0827	0.2795	-0.0824	1.0000

Table 9: EDF and stock returns: Regression analysis

This table presents the results from the Fama-MacBeth regression analysis of the cross-sectional variation of the relationship between EDF measures and stock returns. For each model, we first run a cross-sectional regression every month from June 1969 to October 2003. Next, we calculate and report the time series averages and Newey-West adjusted t-statistics of regression coefficients. We also report the time-series average of the adjusted R^2 for each model. For cross-sectional regressions, the dependent variables are monthly returns measured in month $t+2$, and the independent variables are as follows: *Beta*, calculated at the end of the previous year and obtained from CRSP; *Ln(AVL)*, the natural log of a firm's implied market value of assets at the end of month t, provided by *Moody's KMV*; *Ln(BM)*, the natural log of a firm's book-to-market ratio; *Ret* $(-6,-1)$, the six-month average monthly returns from month $t-5$ to month t; *EDF*, a normalized EDF rank variable between 0 and 1 obtained in month t; *R&D*, the rank of R&D expense ratio of a firm measured at the previous fiscal year end ranging from 1 to 10; *Hfdl*, the rank of Herfindahl index of a firm measured at the previous fiscal year end ranging from 1 to 10; *Tang*, the rank of asset tangibility index measured at the previous fiscal year end ranging from 1 to 10; the interaction terms of *Ln(AVL)*, *R&D*, *Hfdl*, *Tang* and *Ln(BM)* with *EDF*, respectively. * indicates statistical significance at the 10% level, ** at the 5% level and *** at the 1% level.

Models	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8
Beta	-0.0009	-0.0007	0.0001	-0.0024*	-0.0007	-0.0011	-0.0008	-0.0019
t-stat	-0.58	-0.55	0.08	-1.86	-0.50	-0.88	-0.62	-1.49
Ln(AVL)	-0.0014**	-0.0019***	0.0005	-0.0012***	-0.0017***	-0.0017***	-0.0019***	0.0011**
t-stat	-2.32	-4.36	1.25	-3.02	-4.18	-4.28	-4.33	2.32
Ln(BM)	0.0041***	0.0045***	0.0047***	0.0053***	0.0044***	0.0045***	0.0023**	0.0040***
t-stat	5.41	5.68	5.94	7.42	5.37	5.98	2.12	3.89
Ret(-6,-1)	0.0207*	0.0179	0.0208*	0.0194*	0.0175	0.0166	0.0174	0.0193*
t-stat	1.67	1.59	1.86	1.75	1.54	1.50	1.48	1.75
EDF		-0.0051	0.1026***	-0.0107***	0.0040	-0.0154***	-0.0025	0.0855***
t-stat		-1.60	5.62	-3.12	0.97	-3.98	-0.79	4.06
R&D				0.0001				0.0005**
t-stat				0.32				2.42
Hfdl					0.0007***			0.0001
t-stat					4.74			0.08
Tang						-0.0006***		0.0001
t-stat						-2.98		0.54
Ln(AVL)×EDF			-0.0058***					-0.0051***
t-stat			-6.14					-4.86
R&D×EDF				0.0019***				0.0031**
t-stat				4.44				2.04
Hfdl×EDF					-0.0016***			-0.0007*
t-stat					-5.28			-1.85
Tang×EDF						0.0021***		0.0020***
t-stat						6.41		4.29
Ln(BM)×EDF							0.0039***	0.0007*
t-stat							3.06	1.92
Average Adj. R^2	0.0388	0.0430	0.0461	0.0548	0.0492	0.0471	0.0441	0.0575

Table 10: EDF and stock returns: Managerial holdings and non-fixed assets

At the end of each month t from December 1992 to October 2003 (from June 1969 to October 2003), we sort stocks independently into five groups of equal size according to their weighted EDF measures and three groups of equal size according to their top-five managerial stock holdings in Panel A (their ratios of non-fixed assets in Panel B). The returns are recorded in month $t + 2$, i.e., one month after the portfolio formation. We present the time series averages of the value-weighted portfolio returns (both raw and DTGW-adjusted). The column "High−Low" reports the difference in returns between the high EDF quintile and low EDF quintile and the corresponding t-statistics. The row "High−Low" reports the difference in returns between top and bottom groups in managerial holdings or non-fixed asset ratios as well as the corresponding t-statistics. In addition, we also report in the "High−Low" column the difference of the top and bottom differences and its t-statistic. * indicates statistical significance at the 10% level.

	Low		EDF		High		
	1	2	3	4	5	High−Low	t-value
			Panel A: Managerial Holdings				
Raw Returns							
Low	0.84	1.21	1.26	1.26	2.23	1.39*	1.88
Medium	0.95	1.28	1.06	1.12	1.32	0.36	0.56
High	0.88	1.55	0.85	1.36	1.58	0.70	0.92
High−Low	0.04	0.34	-0.41	0.10	-0.65	-0.69	
t-value	0.11	0.63	-0.89	0.23	-1.17	-1.26	
DGTW Returns							
Low	-0.13	0.19	0.08	0.43	0.83	0.96	1.55
Medium	0.13	0.22	0.02	0.03	0.00	-0.13	-0.26
High	0.03	0.54	0.12	0.13	0.40	0.37	0.55
High−Low	0.16	0.35	0.04	-0.30	-0.43	-0.59	
t-value	0.58	0.94	0.12	-0.91	-0.84	-1.12	
			Panel B: Non-Fixed Asset				
Raw Returns							
Low	0.98	1.12	1.16	0.92	0.71	-0.27	-0.69
Medium	1.01	1.04	1.10	1.10	1.17	0.15	0.35
High	0.97	1.09	0.96	0.84	0.83	-0.14	-0.35
High−Low	-0.01	-0.03	-0.20	-0.08	0.12	0.13	
t-value	-0.06	-0.14	-1.05	-0.32	0.47	0.45	
DGTW Returns							
Low	-0.04	0.02	-0.08	-0.35	-0.49	-0.46	-1.43
Medium	0.04	0.10	0.09	0.04	0.09	0.05	0.16
High	0.08	0.08	0.01	-0.25	-0.08	-0.16	-0.52
High−Low	0.12	0.05	0.08	0.10	0.42	0.30	
t-value	0.97	0.28	0.43	0.39	1.43	0.98	

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