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Measuring investment distortions arising from stockholder–bondholder conflicts[☆]

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Abstract

We examine the importance of stockholder–bondholder conflicts in capital-structure choice. Numerical techniques are used to compute the expected wealth transfer between stockholders and bondholders when a firm adopts a new project. We characterize the set of positive NPV projects that stockholders prefer to ignore and the set of negative NPV projects that stockholders want to accept. The results illustrate how these distortions vary with firm and project characteristics. We also estimate the impact of stockholder–bondholder conflicts on investment decisions for 23 different firms and examine

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the extent to which stockholder-bondholder conflicts explain observed cross-sectional variation in capital structures.

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1. Introduction

The finance profession has been struggling to explain the financing choices that firms make since before Modigliani and Miller published their seminal paper on the topic 40 years ago (Modigliani and Miller, 1958). Firms use surprisingly large amounts of equity in their capital structures even though the deductibility of interest payments at the corporate level gives debt a tax advantage over equity. A number of explanations, including bankruptcy costs, stockholder–bondholder conflicts, and manager–stockholder conflicts have been suggested to resolve this puzzle, but no consensus has been reached as to their relative importance.

One commonly discussed 'cost' of debt arises from the differing objectives of stockholders and bondholders.[2] Managers, whose ultimate responsibility is to the stockholders, are likely to make investments that maximize stockholder wealth rather than total firm value. In particular, managers will tend to avoid safe positive net present value (NPV) projects in which the value increase consists of an increase in the value of the debt and a smaller (in absolute value) decrease in the value of the equity (the underinvestment problem). In addition, managers will tend to accept risky negative NPV projects in which the value decrease consists of a decrease in the value of the debt and a smaller increase in the value of the equity (the overinvestment problem). Because the expected cost of such opportunistic behavior on the part of managers is incorporated into the price of the debt when it is issued, the ex ante solution to this problem is to use less debt in the firm's capital structure. By this logic, the optimal capital structure for a firm occurs when the incremental increase in the cost of debt due to agency problems equals the tax benefits from such an increase in leverage.

While the impact of stockholder–bondholder conflicts on investment decisions has been widely discussed for two decades, the literature has largely been silent on the magnitude of this effect. Perhaps because of the limited evidence on

[2] See Fama and Miller (1972), Jensen and Meckling (1976), Merton (1977), and Myers (1977).

the magnitude of the agency costs of debt, no consensus has been reached on their overall importance. Fama and Miller (1972), in the first discussion of the effects, conclude that they are 'probably unimportant' (p. 180). Brealey and Myers (1996) emphasize that these problems are 'most serious when firms land in financial distress' (p. 493), and Myers (1984) barely mentions them in his presidential address on capital structure. On the other hand, Smith and Watts (1992) suggest that stockholder–bondholder conflicts are important determinants of capital structure. Despite, or perhaps because of, the lack of consensus on the importance of these conflicts, they are widely discussed in the capital structure literature. Two early papers that discuss these concepts, Jensen and Meckling (1976) and Myers (1977), are among the most highly cited papers in finance.[3] In addition, much of the recent corporate theory literature discusses applications of the underinvestment and overinvestment ideas to different settings.[4] The importance of the ideas in these papers ultimately depends on the magnitude of the stockholder–bondholder conflicts underlying them.

Numerical simulations are used to show the impact of debt on the investment decision-making process when decisions are made to maximize stockholder wealth rather than overall firm value. We compute the magnitude of the wealth transfers between stockholders and bondholders in a levered firm that result from the adoption of projects with known characteristics. We then characterize the positive NPV projects that will be ignored and the negative NPV projects that will be accepted by stockholders in a firm with specified leverage and cash flow characteristics. Finally, sensitivity analyses show how the agency costs of debt vary with firm and project characteristics.

Consider a hypothetical firm constructed to be typical of large public U.S. firms. For a range of potential projects, the distortion from stockholder–bondholder conflicts can be represented as the difference between the minimum rate of return for the project to be in the interest of stockholders and the minimum rate of return for the project to have a zero NPV. Consistent with arguments in the literature, the simulation results show that levered firms have incentives to turn down positive NPV projects with stable cash flows and to accept negative NPV projects with risky cash flows. For example, stockholders at a hypothetical firm with a 20% debt to total capital ratio will not want to accept an

[3] According to Schwert (1993), Jensen and Meckling (1976) was cited 1132 times between 1974 and 1989 and Myers (1977) was cited 233 times. While many of the Jensen and Meckling cites refer to the paper's contributions to the theory of the firm, the Myers (1977) paper is exclusively about corporate finance. The impact of both papers clearly documents a large interest in the topic by the profession.

[4] See for example Berkovitch and Kim (1990), Berkovitch et al. (1996), Gertner and Scharfstein (1991), John and Nachman (1985), Kim and Maksimovic (1990), and Maksimovic and Zechner (1991).

equity-financed low-risk project unless the rate of return on the project exceeds the return that yields a zero NPV by 0.14%.[5] The same stockholders would be willing to accept a project whose cash flows have eight times the volatility of the firm's cash flows if the annualized return on this project is 2.35% below the rate that yields a zero NPV. Furthermore, these agency problems increase with leverage. The stockholders of a firm with 95% debt to total capital will not accept a low-risk equity-financed project unless the return is 1.60% above the rate that yields a zero NPV. They will, however, accept a return that is 10.93% below the rate that yields a zero NPV when the project's cash flows are eight times as volatile as the firm's cash flows.

To determine when these conflicts are more or less important, numerical comparative statistics are used to measure the extent to which a number of factors affect these distortions. First, a large correlation between project and firm cash flows leads to more overinvestment, while a small correlation between project and firm cash flows leads to more underinvestment. Second, the relative importance of the underinvestment and overinvestment problems varies greatly with the volatility of the firm's cash flows. Overinvestment is likely to be more of a problem at firms with stable cash flows while underinvestment is more severe for firms with volatile cash flows. Third, the distortions from both underinvestment and overinvestment increase with the duration of the debt in the firm's capital structure. Finally, both underinvestment and overinvestment distortions are negatively related to the firm's marginal tax rate.

Estimation of the magnitudes of these agency problems for representative firms in 23 non-financial industries show how these problems vary cross-sectionally. While it is clear that there was considerable overinvestment in the savings and loan industry during the 1980s, there is little direct evidence of these problems in other industries.[6] Numerical methods provide a flexible means of estimating the magnitude of agency costs of debt and comparing them directly to other costs and benefits of debt, such as bankruptcy costs and tax shields.

This numerical approach is complimentary to a growing literature that uses contingent-claims analysis to examine agency problems in corporate finance (see, e.g., Brennan and Schwartz, 1984; Mello and Parsons, 1992; Leland, 1998). The contingent-claims approach has the advantage of yielding closed-form

[5] Throughout the paper we use the term 'low-risk project' to describe a project that has constant cash flows from operations as long as the firm remains in business. The project is not riskless because it is assumed to be integrated with the firm's other projects and the value of future cash flows from the project is assumed to be lost if the firm goes out of business.

[6] In the savings and loan industry, the overinvestment effect is exacerbated by deposit insurance (Buser et al., 1981), so it is not clear what inference to draw from this evidence for firms without such insurance. For empirical evidence on overinvestment in the savings and loan industry, see Esty (1997a,b), Hendershott and Kane (1992), and Kane and Yu (1995).

solutions. However, to get those solutions, this approach necessarily imposes restrictive assumptions on the models that are examined. For example, Leland (1998) assumes that a constant fraction of debt is retired at every time and that all debt has equal priority. While this is a useful starting point, and indeed we make similar assumptions for our base case results in Section 3, our analysis applies to actual firms with 'irregular' capital structures, as shown in Section 4. Such estimates would be much more difficult, if not impossible, to obtain using a closed-form approach. In addition, our approach is flexible enough to handle *any* error structure for the noise terms in both project and firm cash flows. This flexibility allows us, for example, to examine how the covariance between the returns from a potential project and the firm's existing assets affects agency problems. The numerical approach can handle any problem with a closed-form solution, but also many more problems that do not have closed-form solutions.[7]

The remainder of the paper is structured as follows. Section 2 describes the valuation model used in the simulations. Section 3 estimates the magnitude of the distortion in investment incentives that arises due to stockholder–bondholder conflicts for a typical firm and the sensitivity of this distortion to various project and firm characteristics. Section 4 reports estimates of the magnitude of stockholder–bondholder conflicts for actual firms in non-financial industries. Section 5 considers whether the size of the distortion is sufficient to explain cross-sectional variation in capital structure. Finally, Section 6 concludes with a discussion of the implications of the analysis.

2. Modeling the under- and overinvestment problems

Monte Carlo analysis is used to calculate the expected change in the value of both equity and debt when the firm adopts a project with a specified distribution of cash flows. To operationalize this analysis, we begin by assuming, without loss of generality, that the firm has an initial pre-tax operating cash flow of $1000. This cash flow follows a random walk without drift and has a normally distributed error term.[8] The firm is considering investing in a project that generates annual cash flows that also follow a random walk without drift. The

[7] See Graham and Smith (1998) for a similar approach to understanding the role of taxes in explaining hedging behavior.

[8] An alternative specification would be one in which cash flows increase with inflation according to $\text{Cash Flow}_t = (1 + r)\text{Cash Flow}_{t-1}e^{\varepsilon t}$ where r is the expected rate of inflation and ε_t is the error term in period t. We prefer the model without drift because it is more consistent with the assumption that the value of the long-term debt outstanding is constant in dollar terms. In addition, the assumption of no drift biases the estimates of the magnitude of the stockholder–bondholder problem upward to the extent that cash flows ordinarily exhibit positive drift.

expected annual pre-tax operating cash flow from the project is $100, and the error term of the project's cash flow process is distributed normally with a standard deviation that varies across simulations. The correlation between the cash flows from the firm and the project is assumed to be 0.50.[9] The cash flows for the firm and the project follow these processes for 30 years, after which they remain constant. We assume that the project is financed entirely with equity.

We use standard techniques to value the equity and debt of the firm, both with and without the project. These valuations require knowledge of interest rates, the magnitude and maturity structure of the debt outstanding at the time that the project is adopted, and the distributions of the operating cash flows from the firm and the project. Values for these variables are based on current market data and data from public firms. For each simulation, we take 5000 draws from the cash-flow distributions for both the firm and the project. For each draw, we compute the value of the debt and equity. Ex ante changes in the values of the debt and equity equal the mean of the changes in these values across the 5000 draws.

2.1. The value of the debt

For each draw, we compute the value of the debt outstanding at the time that the project is adopted by discounting the cash flows that the bondholders can expect to receive by the expected return on debt with comparable risk at the time that the project is adopted. Algebraically,

$$V_{\mathrm{D}} = \sum_{t=1}^{n} \frac{(\text{Interest} + \text{Principal}_t)}{(1 + k_{\mathrm{d}})^t}, \tag{1}$$

where V_{D} is the value of the debt, n is the maturity of the debt, and k_{d} is the expected return on debt.

Given a draw from the distribution of cash flows, we first calculate the interest and principal payments that the bondholders will receive during each year remaining in the life of the debt. For each year, the cash flows from operations are compared with the firm's total interest expense to determine the cash flows that the original bondholders receive in that year. If the cash flows from operations exceed the firm's total interest expense, the bondholders receive the interest payment that they are due. The remaining after-tax cash flows are first used to repay any additional debt (discussed below), and then the residual is distributed to the stockholders. If the cash flows from operations are less than the firm's total interest expense, the firm incurs additional debt sufficient to make its contractual interest payments. The firm can add additional debt, at the

[9] The implications of different correlations and project sizes are considered below.

market rate of interest, to the point where the firm is forced into bankruptcy (discussed below). The additional debt that is incurred to cover cash flow shortfalls is assumed to be temporary debt that must be repaid with future earnings before any subsequent distributions can be made to stockholders. Also, the firm refunds any of the original debt that matures through new long-term borrowings. The bondholders receive any principal payments that they are due from the proceeds of these refundings as long as the firm remains in business. The original bondholders are assumed to lose all of their remaining investment if the firm goes out of business before they are fully repaid.[10]

Bankruptcy occurs if the present value of the future cash flows from a particular draw is less than the value of the total outstanding debt and the value actually recovered by the creditors exceeds the liquidation value of the firm's assets. The original bondholders receive their last payment in the year before bankruptcy occurs. This bankruptcy criterion is consistent with the assumptions concerning the distribution of cash flows to equityholders, which mimic common dividend restrictions that prevent the distribution of assets that are in place at the time that the debt is issued. Effectively, the debtholders force the firm into bankruptcy when prospects for recovery are poor and the orderly liquidation value of the firm's assets is just sufficient to repay the debtholders what they receive. The liquidation value of the assets is set equal to the value of the firm in year zero. This assumption is equivalent to assuming that, at the time the project is accepted, the market value and book value of assets are equal, the liquidation value of the assets equals the book value, and the liquidation value of the individual assets remains constant. We use this simplistic assumption concerning the value that would be realized in liquidation because the relation between firm value and liquidation value is likely to vary considerably across firms, making it difficult to identify a point estimate that is reasonable for the 'typical' firm. However, we do examine the sensitivity of our results to the liquidation value assumption.

The total interest expense of the firm changes from year to year as debt is refunded and as additional debt is issued or retired. Total interest expense in each year equals the sum of the interest expense associated with the original debt that remains outstanding, interest on new long-term debt that has been issued to replace maturing debt, and interest on additional debt that has been issued to cover negative cash flows and interest expense in previous years, but has not yet been retired. The interest rate at which debt is refunded and additional debt is issued changes from year to year depending on the financial condition of the firm.

[10] We also run simulations in which the percentage of the bondholder investment that is lost when the firm goes out of business is less than 100%. These simulations lead to lower distortions in investment than those reported below. Thus, the assumption that bondholders receive nothing in bankruptcy biases our estimates of the distortions upward.

2.2. The value of the equity

The value of the equity equals the discounted value of all distributions to stockholders over a 30-year period plus the present value of a terminal value at the end of 30 years. The terminal value is computed by assuming that the distributions to stockholders after year 30 are a perpetuity with an annual value equal to the distribution in year 30. The distribution to stockholders in each of the first 30 years equals zero when the firm's net income (calculated as the cash flow from operations less interest expense and taxes) is not positive. In years when it is positive, net income is first used to pay down any additional debt that was issued to cover negative cash flows and interest expense in prior years, but which has not yet been retired. Stockholders receive all profits once the additional debt has been repaid.[11] The levered cost of equity, which is used to discount distributions to stockholders, is computed using the relation:

$$k_{e,L} = k_{e,U}\frac{V_F}{V_E} - k_d\tau\left[\frac{1+k_{e,U}}{1+k_d}\right]\frac{V_D}{V_E} - k_d(1-\tau)\frac{V_D}{V_E}, \tag{2}$$

where $k_{e,L}$ is the levered cost of equity, $k_{e,U}$ is the unlevered cost of the equity, V_F is the value of the firm, V_E is the value of the equity, and τ is the tax rate. Eq. (2) is derived from the formula for the weighted average cost of capital (WACC),

$$\text{WACC} = k_{e,L}\frac{V_E}{V_F} + k_d(1-\tau)\frac{V_D}{V_F} \tag{3}$$

and the formula for WACC proposed by Miles and Ezzell (1980),

$$\text{WACC} = k_{e,U} - \frac{V_D}{V_F}k_d\tau\left[\frac{1+k_{e,U}}{1+k_d}\right]. \tag{4}$$

The unlevered cost of equity is estimated with the Capital Asset Pricing Model (CAPM) using the firm's asset beta.

2.3. Calibrating the model

To perform the above calculations we calibrate the model using data on the distributions of operating profits, capital structures, corporate tax rates, and asset betas for public firms with capital-market data. The medians and means of these variables are presented in Panel A of Table 1.

First, the standard deviation of the year-to-year percentage change in operating profits is computed for every firm with sufficient data on the Standard and

[11] We allow firms to utilize interest tax shields only to the extent that they have taxable income. Consistent with the tax code, firms can carry unused tax shields forward to offset future income. However, we do not allow tax loss carrybacks.

Table 1
Simulation parameters for the typical firm. The standard deviation of the percentage change in operating profit is estimated using data for all firms on *Compustat* that have income statement data for all years from 1981 through 1995. The debt to market value of total capital ratio (book debt/(book debt + market equity)) is calculated with 1995 data and is based on the same set of firms. The median and mean values for the marginal tax rate are computed using 1995 marginal tax rates estimated by John Graham for 5187 public firms. Asset beta median and mean values are large firm composite estimates reported in the *1996 Cost of Capital Yearbook*, published by lbbotson Associates. Minimum coverage ratios for BB through AAA debt are median values for industrial long-term debt reported in the 1996 *Standard & Poor's Corporate Ratings Criteria* report. Premiums over long-term Treasury yields, as of the end of July, 1996, are estimated from yields reported in the August 7, 1996 edition of *The Outlook*, published by Standard & Poor's

Panel A: Operating profit volatility, leverage, tax rates, and asset betas for public firms

	Median	Mean
Standard deviation of percentage change in operating profit	72.38%	223.42%
Debt to market value of total capital	19.18%	23.67%
Marginal tax rate	34.40%	27.82%
Asset beta	0.76	0.71

Panel B: Minimum pretax interest coverage and promised premiums over Treasury yield by debt rating

Credit rating	Minimum pretax interest coverage	Promised premium over Treasury yield
AAA	21.39	0.52%
AA	10.02	0.61%
A	5.67	0.80%
BBB	2.90	1.14%
BB	2.25	3.00%
B	< 2.25	4.60%

Poor's Compustat database for all years from 1981 to 1995. We assume that the actual standard deviation of cash flows from operations equals the median value of these standard deviations in the simulations. The long-term debt to total capital ratios, equal to 1995 leverage, are computed for the same firms that are used to estimate the standard deviation of the percentage change in operating profit. We use tax rates estimated by Graham (1996a,b) and obtain asset betas from the *1996 Cost of Capital Yearbook* (published by Ibbotson and Associates). For all cost of equity calculations, the risk-free rate equals 7.16%, which is the closing yield on long-term U.S. Treasury Bonds on July 30, 1996, and the risk premium is 7.40%, the historical average premium reported in the *1996 SBBI Yearbook* (also published by Ibbotson and Associates) for the 1926–1995 period.

The interest expense in each of the 30 years following the adoption of the project is based on the amount of debt outstanding and the cost of the firm's outstanding debt. The coupon rate of the original debt is set equal to 9.00%, approximately the average cost of A-rated debt during the 1981–1995 period. At the end of each year, the firm refunds an amount equal to one-fifteenth of its original outstanding debt with a 15-year, fixed rate issue, in which the rate equals the prevailing market rate for debt having comparable risk. Any additional debt that is issued to cover shortfalls in operating cash flows is also assumed to yield this market rate.

The promised return on debt, for new debt that is issued in each year, is a function of the firm's financial position. We first obtain coverage ratios and reported premiums over the long-term Treasury rate as of the end of July 1996 for AAA, AA, A, BBB, BB, and B rated debt.[12] The ratios and premiums are listed in Panel B of Table 1. We estimate the relation between these premiums and the coverage ratios by regressing the log of the premium values against the log of the coverage ratios. The resulting equation, which fits these data well (adjusted R-squared = 0.86), provides an estimate of the promised premium for any firm as a function of its coverage ratio.[13]

The expected return on debt, which is used to discount the interest and principal payments at the time that the project is adopted (Eq. (1)), is based on the promised premiums in Panel B of Table 1, the default rates on debt with different initial credit ratings (from the April 15, 1996 issue of Standard and Poor's *CreditWeek*), recovery rates on defaulted bonds reported by Carty and Lieberman (1996), and realized yield spreads reported by Altman (1989). We first use simulations to estimate the expected returns on the individual classes of investment grade debt. Using a 15-year model, for each credit class, the probability of default in each year equals the corresponding default frequency reported in *CreditWeek* and the recovery rate equals 51.15% of face value, the figure reported by Carty and Lieberman for senior unsecured debt. For each credit class, we then compute, for 5000 draws from the default frequency distribution, the mean realized premium for 15-year debt with a coupon payment of 9% and a market value implied by the corresponding premium in Panel B of Table 1. This process yields expected risk premium estimates of 0.45%, 0.51%, 0.64%, and 0.79% for AAA, AA, A, and BBB debt, respectively. The risk premiums for BB and B debt as proportions of the BBB risk premium are based on the relative realized yield spreads reported by Altman. We use this approach to

[12] Premiums are obtained from Standard and Poors (S&P) *The Outlook*, and coverage ratios are obtained from the 1996 *Standard & Poor's Corporate Ratings Criteria* report.

[13] This model is used in all simulations except those for FPL Group, Inc., a utility. Because typical utility coverage ratios differ substantially from those at other industrial firms, we estimate a separate relation for the cost of debt for the FPL Group, Inc. simulations. This relation is based on minimum coverage ratios in the utility industry from the 1996 *Standard & Poor's Corporate Ratings Criteria* report.

estimate the expected premiums for the high yield debt because, unlike empirical estimates of default frequencies for investment grade debt, estimated default frequencies for high yield debt vary greatly across data sources.[14] The expected premiums for BB and B debt are estimated to be 1.36% and 1.83%. Finally, the natural log of the expected returns is regressed on the natural log of the coverage ratios reported by S&P for each asset class. This model yields the expected risk premium consistent with the coverage ratio at the time that the project is adopted.

3. Measuring distortions in investment from stockholder–bondholder conflicts

Simulations are used to measure the stockholder–bondholder conflicts in a typical public firm. First, we examine whether a typical firm will accept or reject various equity-financed projects, given the firm's leverage, the levels of the firm and project cash flows, and the volatilities of those cash flows. Model parameters are then varied to show how a firm's willingness to accept a project is affected by the leverage of the firm, by the correlation between project cash flows and the firm's other cash flows, by the volatility of the firm's cash flows, by the size of the project relative to the firm, by the maturity of the debt, and by the corporate tax rate. We also show how the results change if investors are risk neutral. Finally, potential sources of model bias and misspecification are discussed.

3.1. Which projects does a typical firm accept or reject?

Simulations are first used to estimate the magnitude of stockholder–bondholder conflicts when a typical firm adopts a project. In the model for the 'typical' firm, firm parameters are selected to equal median values for public firms in the United States. We use median values rather than means because a number of the relevant variables, especially the standard deviation of firm cash flows, are skewed across firms (see Panel A of Table 1). This calibration process leads to a standard deviation of firm cash flows equal to 72.38% of initial cash flows, a marginal tax rate of 34.40%, and an asset beta of 0.76. The long-term debt to capital ratio is initially set equal to 20%, which is close to the median market-value based long-term debt ratio of 19.18% from Compustat for 1995.

Table 2 summarizes the output from a series of simulations in which the expected annual operating cash flow without the project equals $1000, the

[14] Estimates of default frequencies for high yield debt are highly sensitive to the set of bonds examined and to the methodology used to estimate them. For example, according to Fridson (1997), Edward Altman estimated the default rate for high yield debt in 1997 to be 1.25% on a par value basis while Moody's Investors Service reported an estimate of 2.84% for its principal amount series. One important reason for this difference is that Moody's estimate includes defaults on noninvestment grade debt sold by issuers based outside of the United States, while Altman's does not.

Table 2
Debt and equity values for varying project cash flow standard deviations. The simulations are for a firm with 20% debt, a zero net present value equity-financed project with cash flows that have a 0.50 correlation with the cash flows of the firm, a standard deviation of the firm's cash flows equal to 72.38% of initial cash flows, and a tax rate of 34.40%. Each simulation is based on 5000 draws from the cash-flow distributions for both the firm and the project

	Standard deviation of project cash flows from operations as a percent of initial cash flow level							
	0%	40%	80%	120%	160%	200%	240%	280%
E(Operating cash flow without project)	$1000.00	$1000.00	$1000.00	$1000.00	$1000.00	$1000.00	$1000.00	$1000.00
E(Project operating cash flow)	$100.00	$100.00	$100.00	$100.00	$100.00	$100.00	$100.00	$100.00
Investment	$709.86	$740.30	$819.64	$887.17	$916.45	$902.57	$887.29	$870.99
Value of debt with project	1010.47	1006.96	1002.92	999.28	994.81	990.40	986.44	981.92
Value of debt without project	997.14	997.14	997.14	997.14	997.14	997.14	997.14	997.14
Change in debt value	$13.33	$9.81	$5.78	$2.13	$(2.33)	$(6.74)	$(10.70)	$(15.23)
Value of equity with project	6725.94	6759.90	6843.28	6914.45	6948.20	6938.73	6927.41	6915.63
Value of equity without project	6029.42	6029.42	6029.42	6029.42	6029.42	6029.42	6029.42	6029.42
Change in total equity value	$696.53	$730.49	$813.86	$885.04	$918.78	$909.31	$897.99	$886.22
Change in existing equity value	$(13.33)	$(9.81)	$(5.78)	$(2.13)	$2.33	$6.74	$10.70	$15.23
Number of draws	5000	5000	5000	5000	5000	5000	5000	5000

	Standard deviation of project cash flows from operations as a percent of initial cash flow level							
	320%	360%	400%	440%	480%	520%	560%	600%
E(Operating cash flow without project)	$1000.00	$1000.00	$1000.00	$1000.00	$1000.00	$1000.00	$1000.00	$1000.00
E(Project operating cash flow)	$100.00	$100.00	$100.00	$100.00	$100.00	$100.00	$100.00	$100.00
Investment	$854.07	$839.32	$825.08	$812.58	$799.78	$788.08	$776.40	$765.65
Value of debt with project	977.46	973.09	968.75	964.19	959.82	955.77	951.31	947.14
Value of debt without project	997.14	997.14	997.14	997.14	997.14	997.14	997.14	997.14
Change in debt value	$(19.69)	$(24.05)	$(28.39)	$(32.95)	$(37.32)	$(41.38)	$(45.83)	$(50.00)
Value of equity with project	6903.17	6892.79	6882.89	6874.95	6866.52	6858.87	6851.64	6845.07
Value of equity without project	6029.42	6029.42	6029.42	6029.42	6029.42	6029.42	6029.42	6029.42
Change in equity value	$873.76	$863.38	$853.47	$845.53	$837.10	$829.45	$822.23	$815.65
Change in existing equity value	$19.69	$24.05	$28.39	$32.95	$37.32	$41.38	$45.83	$50.00
Number of draws	5000	5000	5000	5000	5000	5000	5000	5000

expected annual project operating cash flow equals $100, and the volatility of the project's cash flows from operations varies. Each column summarizes the output from one simulation for this typical firm in which an equity-financed project with a particular standard deviation of cash flows from operations is adopted. In the first column, an initial investment of $709.86 is required to make the NPV of the project equal zero. This initial investment equals the present value of the after-tax cash flows from operations for the project, plus the change in the value of usable tax shields, plus the change in total interest expense attributable to the project. The systematic risk of the cash flows from operations for the project as a percentage of total risk equals that percentage for the unlevered firm without the project, times the correlation between the cash flows for the firm and the project. The systematic risk of the incremental tax shields and incremental interest expense are assumed to equal that for the levered firm.

With adoption of this project, the value of the debt increases $13.33 because the overall firm becomes less risky. Since the NPV of the project is zero, this increase represents a wealth transfer from the stockholders. Although the value of the equity rises by $696.53, the project costs the stockholders $709.86, so existing stockholders lose $13.33. Thus, as Myers (1977) originally argued, stockholders would be worse off from this project even though it is value-neutral.

As the volatility of the project's cash flows increases, the initial investment required for a zero NPV project varies because the discount rate increases with the project's systematic risk and the expected cash flows from the project change. As the risk of the project increases, the wealth transfer from bondholders to stockholders falls, because the source of this transfer is the decrease in the overall risk of the firm. When the standard deviation of the cash flows reaches 139%, there is no wealth transfer. Above 139% we observe the over-investment effect, in which the zero NPV project transfers wealth from bondholders to stockholders so that stockholders are willing to accept projects even if they have a negative NPV.

Another way to look at the results is, for any risk level, there is a 'cutoff' NPV such that a project with a payoff less than the cutoff is unattractive to stockholders, regardless of the project's overall value. This cutoff NPV is positive for relatively safe projects and declines with the project's risk, eventually becoming negative as the projects become very risky. Fig. 1 presents a graph of this cutoff for the typical firm as a function of the risk of the project's cash flows. The 20% debt/total capital curve illustrates the NPV required by the stockholders of a firm with a debt to total capital ratio of 20% for projects of varying risk. The vertical intercept of this graph, which indicates the value for the low-risk project, demonstrates that the project would have to have an NPV of $13.33 to induce the stockholders to accept the project. In other words, the initial cost of the project would have to be $13.33 less than the initial cost of a zero NPV project with the same payoff distribution for stockholders to accept it. As the line moves to the right, corresponding to projects with more volatile cash flows, the NPV of

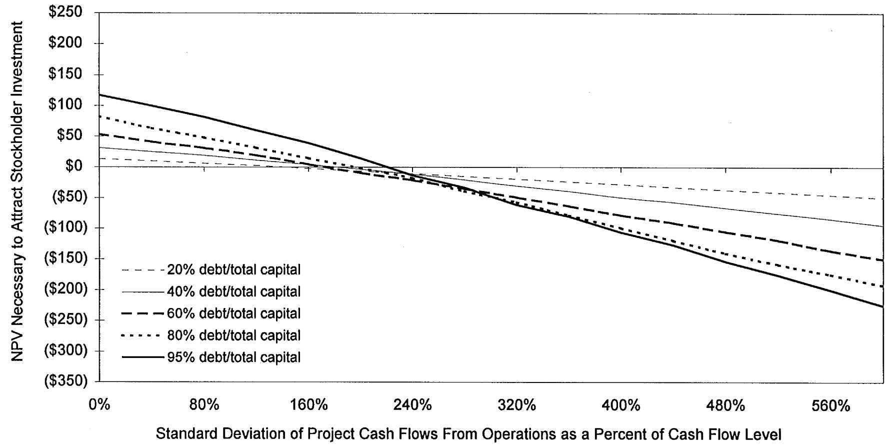

Fig. 1. Project NPV necessary to attract additional stockholder investment as a function of the volatility of project cash flows from operations for firms with varying debt to total capital ratios. Project cash flows from operations have a 0.50 correlation with the firm's cash flows from operations. Project cash flows from opearations have an expected annual value of $100 and firm cash flows have an expected annual value of $1000. The project is financed with equity, the standard deviation of the firm's cash flows equals 72.38% of initial cash flows, and the firm's tax rate equals 34.40%.

the minimum acceptable project falls. The line crosses the horizontal axis when the standard deviation reaches 139%, indicating that, at this point, the stockholders will take all positive NPV projects and no others. When the standard deviation is above 139%, the stockholders are willing to accept some negative NPV projects because the value loss is borne by the bondholders.

The remaining lines on Fig. 1 illustrate the effect of varying the quantity of debt in the initial capital structure. This figure documents that the distortion in investments resulting from stockholder–bondholder conflicts increases with additional debt. The NPV necessary for a low-risk project to be acceptable to stockholders increases from $13.33 to $31.04, $53.37, $82.22, and $117.11 as the debt to total capital ratio increases from 20% to 40%, 60%, 80%, and 95%, respectively.

A useful way of characterizing the above results is to express them in terms of incremental required rates of return. When the NPV necessary for a project to be acceptable to stockholders is positive, stockholders require a rate of return greater than that implied by traditional asset pricing models to undertake a project. When the NPV necessary to attract stockholder investment is negative, stockholders require a lower rate of return. We define the incremental return as the difference between the rate of return implied by CAPM and the rate of return required by the stockholders to undertake the investment.

Panel A of Table 3 reports incremental rates of return and the rates of return computed using CAPM (in parentheses) for simulations where the volatility of

Table 3
Incremental required rates of return and rates of return required for a project to have a zero NPV (in parentheses) at an unlevered firm. Returns are reported for varying firm leverage, correlation between firm and project cash flows from operations, volatility of firm cash flows, project size, maturity structure of debt, tax rates, and project cash flow standard deviations. Incremental required rates of return equal the difference between the required rate of return for an equity financed project at a levered firm and the required rate of return for the same project at an unlevered firm. All simulations assume, unless otherwise noted, 20% debt, a zero NPV equity-financed project with cash flows from operations that have a 0.50 correlation with the cash flows from operations of the firm, a standard deviation of the firm's cash flows from operations equal to 72.38% of initial cash flows, and a tax rate of 34.40%. Each simulation is based on 5000 draws from the cash-flow distributions for both the firm and the project

	Standard deviation of project cash flows from operations as a percent of initial cash flow level															
	0%	40%	80%	120%	160%	200%	240%	280%	320%	360%	400%	440%	480%	520%	560%	600%
Panel A: Incremental required rates of return and rates of return required for zero NPV (in parentheses) for different levels of firm leverage																
Debt/Capital																
20%	0.14%	0.12%	0.07%	0.03%	– 0.03%	– 0.12%	– 0.21%	– 0.34%	– 0.50%	– 0.68%	– 0.89%	– 1.13%	– 1.40%	– 1.68%	– 2.01%	– 2.35%
	(7.67%)	(9.08%)	(10.49%)	(11.91%)	(13.56%)	(15.61%)	(17.65%)	(19.70%)	(21.74%)	(23.79%)	(25.83%)	(27.88%)	(29.92 %)	(31.97%)	(34.01%)	(36.06%)
40%	0.36%	0.31%	0.25%	0.15%	0.06%	– 0.06%	– 0.23%	– 0.47%	– 0.77%	– 1.11%	– 1.54%	– 1.94%	– 2.46%	– 3.04%	– 3.67%	– 4.42%
	(7.87%)	(9.23%)	(10.58%)	(11.94%)	(13.56%)	(15.61%)	(17.65%)	(19.70%)	(21.74%)	(23.79%)	(25.83%)	(27.88%)	(29.92%)	(31.97 %)	(34.01%)	(36.06%)
60%	0.65%	0.54%	0.41%	0.26%	0.06%	– 0.17%	– 0.42%	– 0.79%	– 1.23%	– 1.77%	– 2.42%	– 3.07%	– 3.90%	– 4.77%	– 5.86%	– 6.96%
	(8.03%)	(9.34%)	(10.66%)	(11.97%)	(13.56%)	(15.61%)	(17.65%)	(19.70%)	(21.74%)	(23.79%)	(25.83%)	(27.88%)	(29.92%)	(31.97%)	(34.01%)	(36.06%)
80%	1.06%	0.87%	0.66%	0.43%	0.21%	– 0.04%	– 0.36%	– 0.89%	– 1.46%	– 2.23%	– 3.11%	– 4.12%	– 5.26%	– 6.44%	– 7.67%	– 9.08%
	(8.17%)	(9.45%)	(10.72%)	(12.00%)	(13.56%)	(15.61%)	(17.65%)	(19.70%)	(21.74%)	(23.79%)	(25.83%)	(27.88%)	(29.92%)	(31.97%)	(34.01%)	(36.06%)
95%	1.60%	1.43%	1.16%	0.86%	0.61%	0.25%	– 0.28%	– 0.78%	– 1.61%	– 2.35%	– 3.44%	– 4.49%	– 5.93%	– 7.37%	– 9.04%	– 10.93%
	(8.28%)	(9.52%)	(10.77%)	(12.01%)	(13.56%)	(15.61%)	(17.65%)	(19.70%)	(21.74%)	(23.79%)	(25.83%)	(27.88%)	(29.92%)	(31.97%)	(34.01%)	(36.06%)
Panel B: Incremental required rates of return and rates of return required for zero NPV (in parentheses) with different correlations between firm and project cash flows from operations																
Correlation																
0.00	0.15%	0.14%	0.11%	0.08%	0.06%	0.05%	0.04%	0.03%	0.02%	0.01%	0.00%	0.00%	– 0.01%	– 0.01%	– 0.01%	– 0.02%
	(7.67%)	(7.67%)	(7.67%)	(7.67%)	(7.67%)	(7.67%)	(7.67%)	(7.67%)	(7.67%)	(7.67%)	(7.67%)	(7.67%)	(7.67%)	(7.67%)	(7.67%)	(7.67%)
0.25	0.15%	0.14%	0.10%	0.08%	0.05%	0.03%	0.00%	– 0.03%	– 0.06%	– 0.10%	– 0.15%	– 0.20%	– 0.25%	– 0.31%	– 0.38%	– 0.45%
	(7.67%)	(8.37%)	(9.08%)	(9.79%)	(10.49%)	(11.20%)	(11.91%)	(12.62%)	(13.56%)	(14.59%)	(15.61%)	(16.63%)	(17.65%)	(18.67%)	(19.70%)	(20.72%)
0.50	0.14%	0.12%	0.07%	0.03%	– 0.03%	– 0.12%	– 0.21%	– 0.34%	– 0.50%	– 0.68%	– 0.89%	– 1.13%	– 1.40%	– 1.68%	– 2.01%	– 2.35%
	(7.67%)	(9.08%)	(10.49%)	(11.91%)	(13.56%)	(15.61%)	(17.65%)	(19.70%)	(21.74%)	(23.79%)	(25.83%)	(27.88%)	(29.92%)	(31.97%)	(34.01%)	(36.06%)
0.75	0.14%	0.11%	0.05%	– 0.03%	– 0.18%	– 0.40%	– 0.67%	– 1.03%	– 1.45%	– 1.96%	– 2.55%	– 3.23%	– 4.01%	– 4.82%	– 5.77%	– 6.80%
	(7.67%)	(9.79%)	(11.91%)	(14.59%)	(17.65%)	(20.72%)	(23.79%)	(26.85%)	(29.92%)	(32.99%)	(36.06%)	(39.12%)	(42.19%)	(45.26%)	(48.32%)	(51.39%)
1.00	0.15%	0.11%	0.02%	– 0.19%	– 0.56%	– 1.07%	– 1.72%	– 2.55%	– 3.61%	– 4.77%	– 6.12%	– 7.69%	– 9.50%	– 11.45%	– 13.56%	– 15.76%
	(7.67%)	(10.49%)	(13.56%)	(17.65%)	(21.74%)	(25.83%)	(29.92%)	(34.01%)	(38.10%)	(42.19%)	(46.28%)	(50.37%)	(54.46%)	(58.55%)	(62.64%)	(66.73%)

Panel C: Incremental required rates of return and rates of return required for zero NPV (in parentheses) for firms with different cash flow volatilities

Standard deviation of firm cash flows as a percent of initial cash flows																
26.54%	0.03%	0.03%	0.01%	− 0.08%	− 0.32%	− 0.74%	− 1.44%	− 2.43%	− 3.84%	− 5.52%	− 7.70%	− 10.25%	− 13.20%	− 16.49%	− 20.38%	− 24.77%
	(7.67%)	(11.52%)	(16.54%)	(22.11%)	(27.69%)	(33.27%)	(38.84%)	(44.42%)	(50.00%)	(55.57%)	(61.15%)	(66.73%)	(72.30%)	(77.88%)	(83.45%)	(89.03%)
72.38%	0.14%	0.12%	0.07%	0.03%	− 0.03%	− 0.12%	− 0.21%	− 0.34%	− 0.50%	− 0.68%	− 0.89%	− 1.13%	− 1.40%	− 1.68%	− 2.01%	− 2.35%
	(7.67%)	(9.08%)	(10.49%)	(11.91%)	(13.56%)	(15.61%)	(17.65%)	(19.70%)	(21.74%)	(23.79%)	(25.83%)	(27.88%)	(29.92%)	(31.97%)	(34.01%)	(36.06%)
130.71%	0.20%	0.16%	0.12%	0.09%	0.06%	0.04%	0.01%	− 0.02%	− 0.05%	− 0.09%	− 0.14%	− 0.18%	− 0.23%	− 0.28%	− 0.33%	− 0.40%
	(7.67%)	(8.45%)	(9.23%)	(10.02%)	(10.80%)	(11.58%)	(12.36%)	(13.31%)	(14.44%)	(15.57%)	(16.71%)	(17.84%)	(18.97%)	(20.10%)	(21.24%)	(22.37%)

Panel D: Incremental required rates of return and rates of return required for zero NPV (in parentheses) for different project sizes

Annual project cash flow																
$50	0.16%	0.12%	0.09%	0.04%	− 0.02%	− 0.09%	− 0.18%	− 0.31%	− 0.45%	− 0.60%	− 0.80%	− 1.01%	− 1.27%	− 1.56%	− 1.88%	− 2.20%
	(7.68%)	(9.09%)	(10.50%)	(11.91%)	(13.56%)	(15.61%)	(17.65%)	(19.70%)	(21.74%)	(23.79%)	(25.83%)	(27.88%)	(29.92%)	(31.97%)	(34.01%)	(36.06%)
$100	0.14%	0.12%	0.07%	0.03%	− 0.03%	− 0.12%	− 0.21%	− 0.34%	− 0.50%	− 0.68%	− 0.89%	− 1.13%	− 1.40%	− 1.68%	− 2.01%	− 2.35%
	(7.67%)	(9.08%)	(10.49%)	(11.91%)	(13.56%)	(15.61%)	(17.65%)	(19.70%)	(21.74%)	(23.79%)	(25.83%)	(27.88%)	(29.92%)	(31.97%)	(34.01%)	(36.06%)
$250	0.13%	0.11%	0.07%	0.03%	− 0.03%	− 0.10%	− 0.21%	− 0.33%	− 0.48%	− 0.65%	− 0.84%	− 1.06%	− 1.28%	− 1.54%	− 1.82%	− 2.12%
	(7.64%)	(9.06%)	(10.48%)	(11.90%)	(13.56%)	(15.61%)	(17.65%)	(19.70%)	(21.74%)	(23.79%)	(25.83%)	(27.88%)	(29.92%)	(31.97%)	(34.01%)	(36.06%)
$500	0.10%	0.08%	0.05%	0.00%	− 0.05%	− 0.12%	− 0.21%	− 0.31%	− 0.43%	− 0.57%	− 0.73%	− 0.88%	− 1.06%	− 1.25%	− 1.45%	− 1.66%
	(7.60%)	(9.03%)	(10.46%)	(11.90%)	(13.56%)	(15.61%)	(17.65%)	(19.70%)	(21.74%)	(23.79%)	(25.83%)	(27.88%)	(29.92%)	(31.97%)	(34.01%)	(36.06%)

Panel E: Incremental required rates of return and rates of return required for zero NPV (in parentheses) for different debt maturity structures

Debt maturity																
3 yr straight line	0.01%	0.01%	0.01%	0.01%	0.01%	0.02%	0.01%	0.01%	0.01%	0.01%	0.01%	0.01%	0.01%	0.01%	0.00%	− 0.01%
	(7.78%)	(9.16%)	(10.54%)	(11.93%)	(13.56%)	(15.61%)	(17.65%)	(19.70%)	(21.74%)	(23.79%)	(25.83%)	(27.88%)	(29.92%)	(31.97%)	(34.01%)	(36.06%)
15 yr straight line	0.14%	0.12%	0.07%	0.03%	− 0.03%	− 0.12%	− 0.21%	− 0.34%	− 0.50%	− 0.68%	− 0.89%	− 1.13%	− 1.40%	− 1.68%	− 2.01%	− 2.35%
	(7.67%)	(9.08%)	(10.49%)	(11.91%)	(13.56%)	(15.61%)	(17.65%)	(19.70%)	(21.74%)	(23.79%)	(25.83%)	(27.88%)	(29.92%)	(31.97%)	(34.01%)	(36.06%)
30 yr straight line	0.18%	0.15%	0.11%	0.06%	− 0.01%	− 0.09%	− 0.22%	− 0.37%	− 0.55%	− 0.76%	− 0.98%	− 1.25%	− 1.56%	− 1.86%	− 2.22%	− 2.64%
	(7.66%)	(9.07%)	(10.49%)	(11.91%)	(13.56%)	(15.61%)	(17.65%)	(19.70%)	(21.74%)	(23.79%)	(25.83%)	(27.88%)	(29.92%)	(31.97%)	(34.01%)	(36.06%)
15 yr zero	0.21%	0.20%	0.13%	0.06%	− 0.02%	− 0.13%	− 0.31%	− 0.52%	− 0.76%	− 1.03%	− 1.30%	− 1.61%	− 1.99%	− 2.39%	− 2.78%	− 3.22%
	(7.66%)	(9.07%)	(10.49%)	(11.91%)	(13.56%)	(15.61%)	(17.65%)	(19.70%)	(21.74%)	(23.79%)	(25.83%)	(27.88%)	(29.92%)	(31.97%)	(34.01%)	(36.06%)

Table 3. Continued.

	Standard deviation of project cash flows from operations as a percent of initial cash flow level															
	0%	40%	80%	120%	160%	200%	240%	280%	320%	360%	400%	440%	480%	520%	560%	600%
Panel F: Incremental required rates of return and rates of return required for zero NPV (in parentheses) for different tax rates																
Tax rate																
0.0%	0.14%	0.12%	0.08%	0.03%	− 0.02%	− 0.09%	− 0.19%	− 0.30%	− 0.45%	− 0.62%	− 0.83%	− 1.05%	− 1.30%	− 1.57%	− 1.90%	− 2.24%
	(7.76%)	(9.15%)	(10.54%)	(11.92%)	(13.56%)	(15.61%)	(17.65%)	(19.70%)	(21.74%)	(23.79%)	(25.83%)	(27.88%)	(29.92%)	(31.97%)	(34.01%)	(36.06%)
34.4%	0.14%	0.12%	0.07%	0.03%	− 0.03%	− 0.12%	− 0.21%	− 0.34%	− 0.50%	− 0.68%	− 0.89%	− 1.13%	− 1.40%	− 1.68%	− 2.01%	− 2.35%
	(7.67%)	(9.08%)	(10.49%)	(11.91%)	(13.56%)	(15.61%)	(17.65%)	(19.70%)	(21.74%)	(23.79%)	(25.83%)	(27.88%)	(29.92%)	(31.97%)	(34.01%)	(36.06%)
60.0%	0.14%	0.11%	0.07%	0.02%	− 0.04%	− 0.13%	− 0.23%	− 0.36%	− 0.53%	− 0.70%	− 0.94%	− 1.19%	− 1.50%	− 1.82%	− 2.14%	− 2.50%
	(7.57%)	(9.01%)	(10.45%)	(11.89%)	(13.56%)	(15.61%)	(17.65%)	(19.70%)	(21.74%)	(23.79%)	(25.83%)	(27.88%)	(29.92%)	(31.97%)	(34.01%)	(36.06%)
Panel G: Incremental required rates of return and rates of return required for zero NPV (in parentheses) for different levels of firm leverage with risk neutral investors																
Debt/Capital																
20%	0.15%	0.09%	0.05%	0.01%	− 0.01%	− 0.02%	− 0.04%	− 0.04%	− 0.05%	− 0.06%	− 0.06%	− 0.06%	− 0.07%	− 0.07%	− 0.07%	− 0.08%
	(7.16%)	(7.16%)	(7.16%)	(7.16%)	(7.16%)	(7.16%)	(7.16%)	(7.16%)	(7.16%)	(7.16%)	(7.16%)	(7.16%)	(7.16%)	(7.16%)	(7.16%)	(7.16%)
40%	0.39%	0.24%	0.12%	0.04%	− 0.01%	− 0.04%	− 0.07%	− 0.09%	− 0.11%	− 0.12%	− 0.13%	− 0.14%	− 0.15%	− 0.15%	− 0.16%	− 0.16%
	(7.16%)	(7.16%)	(7.16%)	(7.16%)	(7.16%)	(7.16%)	(7.16%)	(7.16%)	(7.16%)	(7.16%)	(7.16%)	(7.16%)	(7.16%)	(7.16%)	(7.16%)	(7.16%)
60%	0.76%	0.49%	0.28%	0.14%	0.05%	− 0.01%	− 0.06%	− 0.10%	− 0.12%	− 0.15%	− 0.17%	− 0.19%	− 0.20%	− 0.21%	− 0.22%	− 0.23%
	(7.16%)	(7.16%)	(7.16%)	(7.16%)	(7.16%)	(7.16%)	(7.16%)	(7.16%)	(7.16%)	(7.16%)	(7.16%)	(7.16%)	(7.16%)	(7.16%)	(7.16%)	(7.16%)
80%	1.24%	0.81%	0.46%	0.24%	0.10%	− 0.02%	− 0.09%	− 0.15%	− 0.19%	− 0.23%	− 0.25%	− 0.28%	− 0.29%	− 0.31%	− 0.32%	− 0.33%
	(7.16%)	(7.16%)	(7.16%)	(7.16%)	(7.16%)	(7.16%)	(7.16%)	(7.16%)	(7.16%)	(7.16%)	(7.16%)	(7.16%)	(7.16%)	(7.16%)	(7.16%)	(7.16%)
95%	1.85%	1.26%	0.76%	0.44%	0.24%	0.11%	− 0.02%	− 0.10%	− 0.16%	− 0.21%	− 0.25%	− 0.28%	− 0.31%	− 0.33%	− 0.35%	− 0.36%
	(7.16%)	(7.16%)	(7.16%)	(7.16%)	(7.16%)	(7.16%)	(7.16%)	(7.16%)	(7.16%)	(7.16%)	(7.16%)	(7.16%)	(7.16%)	(7.16%)	(7.16%)	(7.16%)

the project's cash flows and firm leverage are varied. For these parameters, the adoption of any low-risk project with a return of at least 7.67% increases firm value, but stockholders would not accept the project unless the return is 7.67% + 0.14% = 7.81%. The incremental required return decreases with cash flow volatility, but remains positive until the standard deviation reaches 139%. Beyond this point, stockholders are willing to accept a return that is lower than that computed using CAPM, meaning the incremental return is negative.

The five rows in Panel A of Table 3 illustrate how the distortion in investment incentives increases with the amount of debt in a firm's capital structure. The incremental required rate of return on a low-risk project increases from 0.14% to 0.36% when the debt to total capital ratio increases from 20% to 40%. As the debt to total capital ratio is increased still further to 60%, 80%, and 95%, the incremental required rate of return increases to 0.65%, 1.06%, and 1.60%, respectively. The agency costs of this additional debt come from the value lost from foregone projects with rates of return greater than the return for an all-equity firm, but less than these hurdle rates. These results are consistent with the common intuition that the agency costs of debt are small for most firms, but can be substantial for firms that are highly levered.

The above results are based on the assumption that the liquidation value in bankruptcy equals the initial value of the firm. Under reasonable alternative liquidation assumptions, the required rates of return are modestly higher. For example, if the liquidation value equals 50% of the initial firm value, the incremental rates of return for a low-risk project are 0.18%, 0.45%, 0.90%, 1.45%, and 1.99% for debt to total capital ratios of 20%, 40%, 60%, 80%, and 95%, respectively. These rates are higher because a lower liquidation value limits the ability of a poorly performing firm to issue additional debt to finance interest payments.

3.2. The project's correlation with the firm's other assets

The impact of a particular project on the overall volatility of a firm's cash flows, and hence on any potential wealth transfers, depends on the correlation between the project's cash flows and the cash flows from the firm's existing assets. In the simulations discussed above, with a correlation of 0.50, it is necessary for a project to have operating cash flows with a standard deviation above 139% to get overinvestment. There are two reasons that this level of volatility is substantially larger than the standard deviation of 72.38% for the rest of the firm's cash flows. First, because the project is financed entirely with equity, the adoption of the project increases the level of assets securing the original bondholder claims. Consequently, the curves in Fig. 1 shift upward, relative to the curves for a project financed with debt and equity, thereby moving the intercept with the horizontal axis to the right. Second, and more important, is a diversification effect. Since the project's cash flows are not

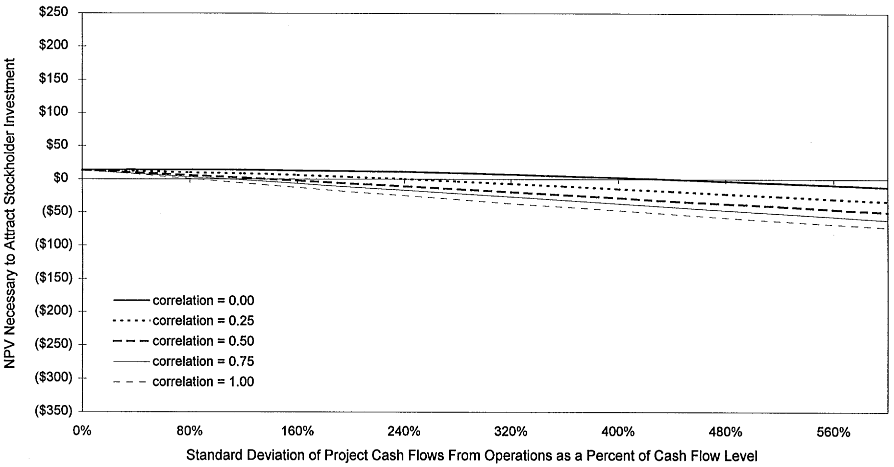

Fig. 2. Project NPV necessary to attract additional stockholder investment as a function of volatility of project cash flows from operations for varying correlations between project and firm cash flows. The firm has a debt to total capital ratio of 20%. Project cash flows from operations have an expected annual value of $100 and firm cash flows from operations have an expected annual value of $1000. The project is financed with equity, the standard deviation of the firm's cash flows equals 72.38% of initial cash flows, and the firm's tax rate equals 34.40%.

perfectly correlated with the rest of the cash flows from the firm, the cash flows from the project provide a diversification benefit.

It is likely that there will be some degree of positive correlation between the cash flows of a typical project and those of the firm. First, each set of cash flows is likely to contain a market-wide component affecting each similarly. Second, most new projects are likely to have some element of complimentarity with existing projects. Without such complimentarity, Coasian considerations suggest that there would be no benefit to adopting a project. However, it is not clear exactly how much correlation one should expect a priori between the firm's existing assets and a new project. We therefore present simulation results for the median firm for a variety of different correlations in Fig. 2 and in Panel B of Table 3.

The results are consistent with the diversification arguments. All of the lines in Fig. 2 intersect the vertical axis at the same point, since correlation is not an issue for projects with constant cash flows from operations. The lines representing higher degrees of correlation slope downward more steeply. Because the diversification effect is smaller with higher correlations, firm risk increases faster with project risk when correlations are high. Projects with operating cash flows that are highly correlated with firm cash flows thus enter the overinvestment

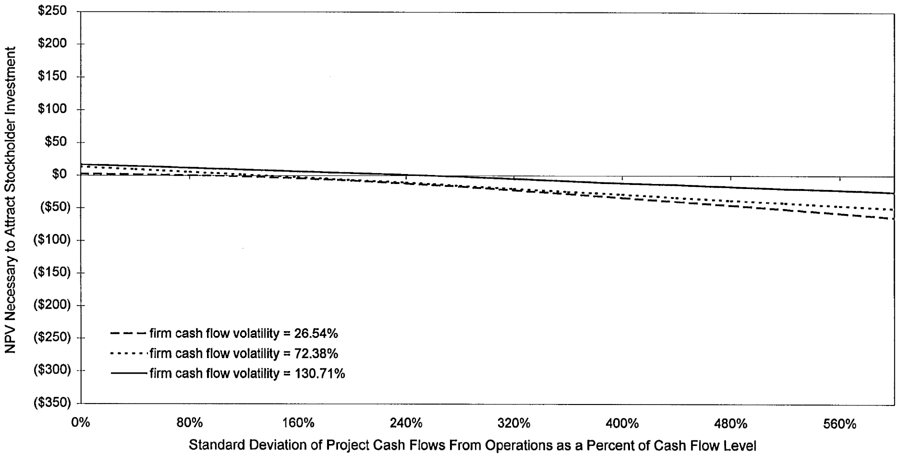

Fig. 3. Project NPV necessary to attract additional stockholder investment as a function of volatility of project cash flows from operations for firms with varying cash flow volatilities. The firm has a debt to total capital ratio of 20%. Project cash flows from operations have a 0.50 correlation with the firm's cash flows from operations. Project cash flows from operations have an expected annual pretax value of $100 and firm cash flows have an expected annual pretax value of $1000. The project is financed with equity and the firm's tax rate equals 34.40%.

region more quickly than projects with less correlated cash flows.[15] These results suggest that overinvestment is a more important issue for scale-expanding projects, which are likely to have high correlations with existing projects, while underinvestment is more of an issue for diversifying projects.

3.3. The volatility of the firm's cash flows

There is considerable cross-sectional variation in the volatility of firm cash flows. Fig. 3 and Panel C of Table 3 present results for simulations in which the volatility of the firm's cash flows is set equal to the cash flow volatility for the median firm in the gas and electric utility industry (26.54%), the median firm on Compustat (72.38%), and the median firm in the primary metals industry (130.71%). Because the gas and electric and primary metals industries both tend to have relatively few growth opportunities, the resulting variation in underinvestment and overinvestment problems comes from differences in cash flow volatility, and not from the asset-in-place versus growth opportunity distinction.

[15] The curve in Fig. 2 for the case in which the correlation between the operating cash flows for the firm and the project equals 1.00 crosses the horizontal axis when the standard deviation of the operating cash flows from the project is 85%. The difference between this 85% value and the 72.38% standard deviation for the cash flows for the rest of the firm is due to the additional security provided bondholders by the decision to finance the project entirely with equity.

The simulation results in Fig. 3 and Panel C of Table 3 suggest that a firm with low cash flow volatility, such as a gas and electric utility, is not severely affected by underinvestment considerations. The incremental required return for a low-risk project is only 0.03%. However, such a firm faces a potentially greater overinvestment problem than a firm with greater cash flow volatility. The incremental required return for a project with a standard deviation of cash flows equal to 600% is a relatively large −24.77%. The reverse is true for firms with relatively high cash flow volatilities, such as those in the primary metals industry. A firm with high cash flow volatility has a considerably higher incremental rate of return for a low-risk project (0.20%) but a substantially lower incremental return for high-risk projects (−0.40%) when compared to a firm with low cash-flow volatility. Intuitively, if a firm has assets generating cash flows with high volatility, not many projects will increase this volatility, so overinvestment is not much of a problem. However, it is relatively easy to decrease such a firm's cash flow volatility, so underinvestment is a larger problem for firms with high initial cash flow volatility.

3.4. *The size of the project relative to the size of the firm*

The size of the project relative to the size of firm also affects the magnitude of the distortion. To investigate how the distortion from stockholder–bondholder conflicts varies with project size, we calculate the magnitude of the distortion for projects of various sizes. The results of these simulations are summarized in Fig. 4 and Panel D of Table 3.

Fig. 4 shows that, not surprisingly, the magnitude of the wealth transfer is positively related to project size. A low-risk project with annual EBIT of $500 requires an NPV of $48.10 to be acceptable to the stockholders, while a low-risk project with annual cash flows of $50 requires an NPV of $7.21. Large projects enter the overinvestment region with considerably lower cash flow volatility than small projects. For example, the line in Fig. 3 for the project with annual cash flows from operations of $500 crosses the horizontal axis at 122% as compared with 170% for a project with annual cash flows from operations of $50. For projects with a sufficiently high risk to induce overinvestment, the minimum NPV for stockholders to accept the project is more negative for large projects than for small ones.

However, when we convert these NPVs to rates of return in Panel D of Table 3, the distortion appears to be slightly larger for small projects than for large projects. A low-risk project that pays $50 per year requires an incremental return of 0.16% to entice the stockholders to invest, compared to an incremental return of 0.10% for a project with cash flows of $500 per year. At high levels of risk, the (overinvestment) distortion is larger for small projects, but the distortion is not strictly decreasing with project size.

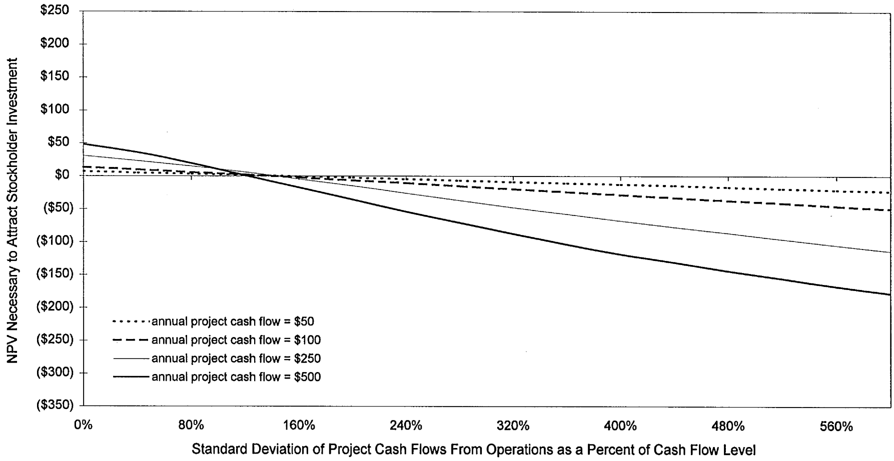

Fig. 4. Project NPV necessary to attract additional stockholder investment as a function of volatility of project cash flows from operations for varying project sizes. The firm has a debt to total capital ratio of 20% and cash flows from operations have an expected annual value of $1000. Project cash flows from operations have a 0.50 correlation with the firm's cash flows. The project is financed with equity, the standard deviation of the firm's cash flows equals 72.38% of initial cash flows, and the firm's tax rate equals 34.40%.

3.5. The maturity of the debt

The simulations discussed to this point assume that the firm refunds one-fifteenth of its debt each period. We choose this debt maturity structure to be typical of a firm that is financing relatively long-term assets. However, it is important to know the extent to which our results are sensitive to this assumption. In addition, we wish to evaluate the argument that longer-maturity debt is more subject to stockholder–bondholder conflicts (see, e.g., Myers, 1977; Barclay and Smith, 1995; Guedes and Opler, 1996).

Fig. 5 and Panel E of Table 3 present simulation results for the typical firm with varying maturity structures of the debt. In addition to the case of the firm with debt that matures uniformly over 15 years (which is repeated for convenience), we also report results for a firm with debt that matures uniformly over 30 years, a firm with one issue of 15-year zero-coupon debt, and a firm with debt that matures uniformly over a three-year period. The durations of the 30-year amortizing and 15-year zero-coupon debt are longer than that of the 15-year amortizing debt (5.75 years for the debt maturing uniformly over 15 years, compared to 8.37 years for the debt maturing uniformly over 30 years and 15.00 years for the 15-year zero-coupon debt), while the duration of the three-year debt, 1.90 years, is shorter.

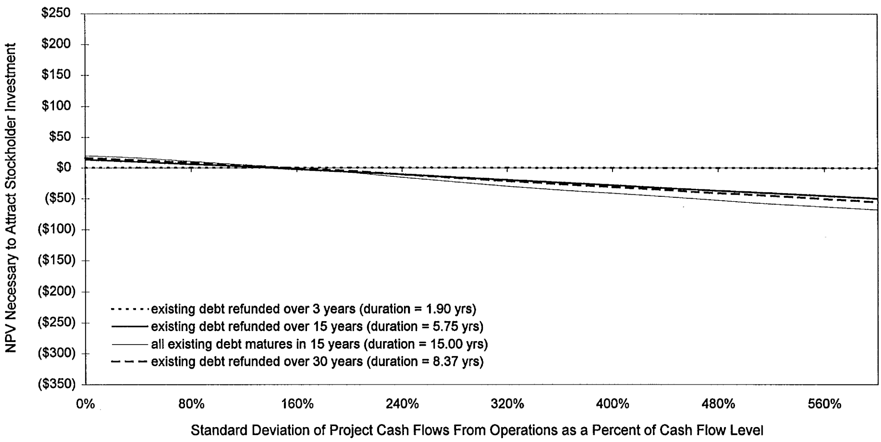

Fig. 5. Project NPV necessary to attract additional stockholder investment as a function of the volatility of project cash flows from operations for firms with varying debt maturity structures. The firm has a debt to total capital ratio of 20%. Project cash flows from operations have a 0.50 correlation with the firm's cash flows from operations. Project cash flows from opearations have an expected annual value of $100 and firm cash flows from operations have an expected annual value of $1000. The project is financed with equity, the standard deviation of the firm's cash flows equals 72.38% of initial cash flows, and the firm's tax rate equals 34.40%.

It is clear from Fig. 5 and Panel E of Table 3 that longer duration debt leads to larger agency problems. The lines for debt with longer durations slope downward more steeply than those for debt with shorter durations. In addition, the line representing the firm with three-year debt is extremely close to the horizontal axis, indicating that, for a firm with relatively short-term debt, there are essentially no agency costs from stockholder–bondholder conflicts.[16] The intuition for this effect is that the probability of cash flows going sufficiently negative to cause the firm to default is positively related to the duration of the debt. As the duration of the debt increases, the value of the debt becomes more sensitive to the firm's asset structure. Consequently, the adoption of a project with cash flow characteristics that differ from those of the firm has a greater impact on the value of longer-term debt.

3.6. *The marginal tax rate*

Fig. 6 and Panel F of Table 3 repeat the base-case analysis with varying marginal tax rates. Fig. 6 shows that the dollar value of the wealth transfer is

[16] This result also provides justification for ignoring short-term liabilities in the analysis in the previous section.

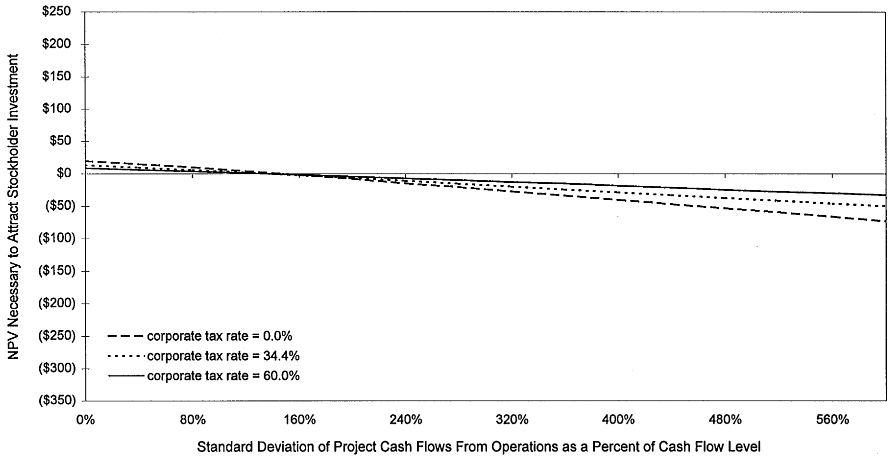

Fig. 6. Project NPV necessary to attract additional stockholder investment as a function of volatility of project cash flows from operations for firms with varying tax rates. The firm has a debt to total capital ratio of 20%. Project cash flows from operations have a 0.50 correlation with the firm's cash flows from operations. Project cash flows from opearations have an expected annual pretax value of $100 and firm cash flows have an expected annual pretax value of $1000. The project is financed with equity and the standard deviation of the firm's cash flows equals 72.38% of initial cash flows.

negatively related to the marginal corporate tax rate. This result occurs because a lower tax rate effectively increases the size of the project relative to the size of the firm. While after-tax cash flows from operations for the project and the firm increase in the same proportion with a decrease in the tax rate, the value of the tax shields realized by the firm decreases, causing the value of the firm to decline relative to that of the project. Despite the larger wealth transfer at lower tax rates, Panel F shows that the incremental rates of return do not vary substantially with changes in tax rates. The change in the dollar value of the cash flows from the project is proportionate to the change in the magnitude of the wealth transfer.

3.7. *Risk-neutral investors*

The way that we adjust for risk also affects the simulation results. There are two key assumptions regarding risk-adjustments implicit in the model. First, we assume that the CAPM holds. Second, we assume that the systematic risk of the project cash flows increases with their overall volatility. The extent to which our analysis rests on these assumptions is important, especially given the recent literature critical of this approach to computing the cost of capital (see, for example, Fama and French, 1992,1997).

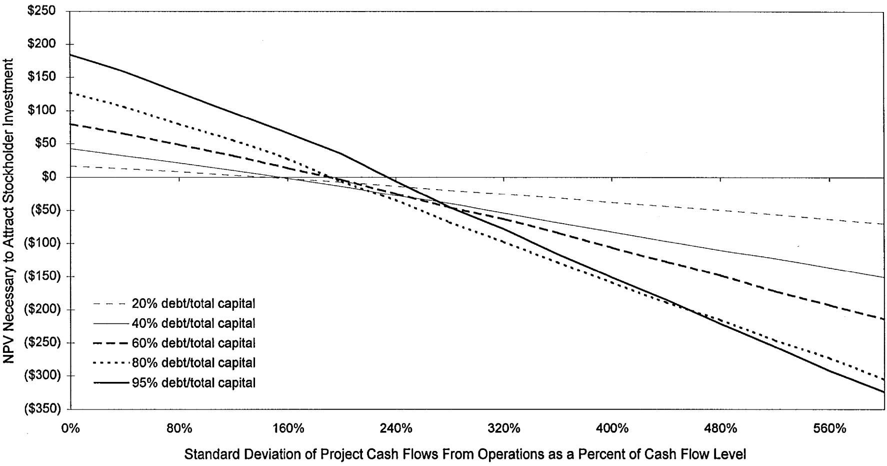

Fig. 7. Project NPV necessary to attract additional stockholder investment as a function of volatility of project cash flows from operations for firms with varying debt to total capital ratios. Stockholders are assumed to be risk neutral. Project cash flows from operations have a 0.50 correlation with the firm's cash flows from operations. Project cash flows from opearations have an expected annual value of \$100 and firm cash flows have an expected annual value of \$1000. The project is financed with equity, the standard deviation of the firm's cash flows equals 72.38% of initial cash flows, and the firm's tax rate equals 34.40%.

To assess the extent to which our results are affected by this approach to risk-adjustment, we recalculate the base-case results from Fig. 1 for the case of a risk-neutral investor.[17] This recalculation is based on the assumption that investors discount all cash flows at the risk-free rate of 7.16%. The results of these simulations are presented in Fig. 7 and Panel G of Table 3. The lines in Fig. 7 generally intersect the vertical axis at higher points and slope downward more quickly than the corresponding lines in Fig. 1. When we express the distortion as a rate of return (Panel G of Table 3), the distortion is generally smaller for the risk-neutral case than for the base case. Overall, these simulation results suggest that the investment distortions from stockholder–bondholder conflicts are similar to those in the base case even if all investors are risk-neutral. Therefore, it is unlikely that alternative discount factors would lead to qualitative conclusions that are different from those discussed above.

3.8. Is the model likely to overstate or understate the agency cost of debt?

The simulations require that we make a number of modeling choices that affect the size of stockholder–bondholder conflicts. We have tried to make

[17] An alternative approach would be to contrast the results with results obtained using a different approach to computing the cost of capital, such as the Fama and French three-factor model.

assumptions that generally lead to the largest possible estimate of the distortion from stockholder–bondholder conflicts. Three such assumptions are that absolute priority holds in bankruptcy, that any additional debt that is sold to cover the difference between cash flows and interest obligations is senior to the original debt, and that the original bondholders lose all of their remaining investment if the firm goes out of business. These assumptions lead to larger distortions because they maximize the potential loss to the original bondholders and thereby the potential gain (loss) from the underinvestment (overinvestment) problems.

We also assume that the indenture agreements covering the original debt do not contain some common covenants, such as those restricting investments, conversion features, or security clauses. Each of these provisions helps to control the overinvestment (asset substitution) problem (see Smith and Warner, 1979). These considerations suggest that the magnitudes of the distortions reported above can be viewed as upper bounds on the true magnitudes of stockholder–bondholder conflicts. However, as the approach we use is relatively new, it is possible that some parameters in the model or model misspecification cause the magnitude of these conflicts to be understated. For example, the estimates will be low to the extent that we over-estimate the liquidation value of the firm's assets.

Two potential sources of misspecification are the assumption that cash flows follow a random walk and the focus on a single investment decision. The assumption that cash flows follow a random walk does not allow for the possibility that changes in a firm's revenue and cost structure in a particular year are systematically related to prior performance. If a firm's performance declines, managers may make decisions that make matters worse in subsequent years. Advertising may be cut back dramatically, staffing levels may be reduced beyond the optimal level, or important investments may be postponed. In addition, decisions by other parties that contract with the firm, such as suppliers and customers, are likely to be affected by the performance of the firm. For example, in the computer industry, poor performance by a hardware manufacturer may prompt suppliers to tighten credit terms, software firms to reduce the variety of compatible software that they produce for the firm's products, and customers to reduce the quantity of the firm's products that they purchase. These sorts of decisions can increase the likelihood of bankruptcy and thereby the magnitudes of the distortions that we are trying to quantify.

Similarly, the model does not take into account interactions between investments over time. The decision to accept or reject a project today may impact future investment decisions. This, in turn, can affect both the level and the riskiness of future cash flows from the firm. An investment in risky assets today may lead to more or less risky or more or less profitable investments in the future, depending on factors such as project complementarities and the realized level of subsequent cash flows. Modeling such interactions is likely to yield estimates of the magnitudes of underinvestment and overinvestment problems that are different from those that we report.

4. Cross-sectional differences in stockholder–bondholder conflicts

The analysis to this point illustrates how project and firm characteristics determine the magnitude of stockholder–bondholder conflicts. The sensitivity analyses presented in Figs. 1–7 and in Table 3 examine how a change in an individual characteristic affects the magnitude of stockholder–bondholder conflicts at a 'typical firm'. However, it is unlikely that the characteristics of an individual firm and its projects will mirror those of the 'typical firm' used in the above analysis, so it is not evident how the estimates presented above apply to actual firms. This section calibrates the model to reflect the characteristics of individual firms and presents estimates of the stockholder–bondholder conflict for these firms. Results show how the characteristics of both existing assets and potential projects affect the magnitude of stockholder–bondholder conflicts at actual firms.

4.1. Firm-level estimates

The firms used in this analysis are selected to be representative of the firms from a broad cross-section of 23 non-financial industries. Panel A of Table 4 summarizes characteristics of the specific firms selected for this analysis. We calibrate the model for each firm as follows:

(1) *Cash flows of the firm*: The initial pretax cash flow is set equal to the 1996 operating profits of the firm, and the cash flow distribution is assumed to follow a random walk with drift. The standard deviation of the percentage change in the cash flows from operations is set equal to the standard deviation of the percentage change in operating profits for the firm over the 1981–1995 period. The drift term is selected, after all other parameters, so that the expected value of the equity without the project equals the market value of the firm's equity as of July 30, 1996.

(2) *Maturity structure and cost of debt*: Data on the actual maturity structure of the firm's outstanding debt and the interest rates on that debt are obtained from the financial footnotes in the firm's 1997 Annual Report. We set the maturity structure of the firm's debt equal to the dollar value of the debt maturing in each year from 1997 through 2026.[18] The effective interest rate on the debt that remains outstanding in each year is used to compute the interest expense in the model.

(3) *Project size*: The value of the project equals the sum of the firm's capital expenditures plus its after-tax research and development expenditures

[18] Two firms have debt that matures after 2026. For these firms, all of the original debt that remains outstanding at the end of 2025 is assumed to mature in 2026.

(CAPEX + R&D) in 1996. Annual cash flows from the project are computed by multiplying the ratio of CAPEX + R&D to the sum of the book value of the firm's debt and the market value of its equity as of July 30, 1996 by the firm's 1996 operating profits.

(4) *Other parameters*: The marginal tax rate is obtained from Graham (1996a,b), and the firm's asset beta is estimated by unlevering the beta reported by Value Line in late 1996.

These calibrations effectively turn our general model into a detailed valuation model for each of the 23 firms.

The results of the firm-level simulations are presented in Panels B–D of Table 4. Panel B presents the results in terms of the dollar values of the wealth transfers, Panel C interprets them in terms of incremental rates of return (assuming the projects have no systematic risk), and Panel D illustrates the impact of the wealth transfers on the firms' cost of debt. The results show that the distortions vary substantially across firms, but are generally consistent with the estimates in Fig. 1 and in Panel A of Table 3. Chiquita Brands, which has the highest leverage (63.01% debt to total capital) in the sample and relatively high cash flow volatility (standard deviation of 87.11%), also has the largest underinvestment problem. For Chiquita, the wealth transfer from the adoption of a low-risk project equals 14.6% of the value of the firm's CAPEX + R&D ($10.89/$74.64).[19] When this wealth transfer is restated as an incremental required rate of return, the 1.30% figure (Panel C of Table 4) is considerably larger than the 0.65% figure for the low-risk project at a firm with 60% debt in Panel A of Table 3. The difference between the 1.30% and 0.65% figures is attributable to the higher leverage and cash flow volatility for Chiquita Brands relative to our hypothetical firm, as well as a substantially lower cash flow coverage ratio in the early years. These factors combine to result in a greater likelihood of default, particularly in the early years, relative to the typical firm. Although the potential distortions in investment decisions at Chiquita are particularly large, the median value of the incremental required rate of return for low-risk projects in Panel C of Table 4 is reasonably close to the value estimated in our base case calculations (0.15% versus 0.14% in Panel A of Table 3).

One factor whose importance is particularly well illustrated by the calculations for the individual firms is maturity of the debt. For example, Ethyl Corporation, despite an above-average long-term debt to total capital ratio of 23.76%, has virtually no stockholder–bondholder distortion. This occurs because Ethyl's debt, while long-term by the accounting definition, has a relatively short duration of 3.44 years. Similar results are evident for Dravo, Media General, and Chrysler. Although the debt to total capital ratio at each of these

[19] Chiquita Brands does not have the highest overinvestment distortion listed in Table 4 because it enters the 'overinvestment region' at the highest level of project cash flow volatility.

Table 4

Simulation parameters, magnitude of wealth transfers, incremental required rates of return on equiity, and incremental costs of debt for individual firms. Based on the parameters shown in Panel A, simulations are run for each of these 23 firms. Results are shown in Panels B, C, and D

Company	1996 operating profit ($)	Standard deviation of percentage change in operating profit from 1981 to 1995 (%)	Book debt/ (book debt + market equity) on July 30, 1996 (%)	Duration of outstanding debt (y)	1996 expenditures on capital expenditures and research and development/ (book debt + market equity) (%)	1995 marginal tax rate before interest (%)	Value Line Beta
Panel A: Simulation parameters							
Agriculture							
Chiquita Brands Intl.	(16,728)	87.11	63.01	5.62	4.14	35.02	0.70
Mining							
Cleveland–Cliffs Inc.	95,500	74.80	14.06	6.62	7.37	35.07	0.90
Dravo Corp.	14,128	68.12	25.24	3.10	8.19	29.22	0.80
Manufacturing							
Archer–Daniels–Midland Co.	1,054,413	41.95	18.14	8.22	6.34	35.00	0.80
Phillips Van Heusen	24,574	62.03	40.19	7.28	4.55	35.00	1.00
Georgia–Pacific Corp.	296,000	88.06	40.88	7.63	9.33	34.99	0.90
Westvaco Corp.	335,956	66.14	28.85	7.83	13.28	35.02	0.90
Media General	109,738	54.62	26.24	3.61	2.82	35.01	1.00
Eli Lilly & Co.	2,031,300	53.96	8.15	7.37	3.73	34.72	1.20
Colgate–Palmolive Co.	954,600	75.76	20.01	6.05	3.90	35.00	1.05
Ethyl Corp.	145,772	37.17	23.76	3.44	5.43	35.08	0.65
Quaker State Corp.	24,223	74.77	41.96	3.34	5.97	35.26	0.75
Goodyear Tire & Rubber Co.	122,300	56.01	14.61	4.22	10.27	35.06	1.25
Bethlehem Steel Corp.	89,200	52.67	33.57	6.08	16.61	23.22	1.20
Cummis Engine	190,000	65.12	17.83	3.49	24.13	35.00	1.00
Motorola Inc.	1,775,000	62.17	5.81	9.92	12.58	34.99	1.30
Chrysler Corp.	6,092,000	84.03	33.90	2.66	18.89	35.02	1.20
Mattel Inc.	545,741	77.00	6.75	4.15	3.89	35.00	1.05
Transportation							
Burlington Northern Santa Fe	1,440,000	80.80	27.69	7.25	13.13	35.02	1.20
UAL Corp.	970,000	67.60	54.27	5.82	24.51	35.02	1.25
Utility							
FPL Group Inc.	873,312	54.00	28.37	8.66	3.61	35.20	0.80
Retail							
J C Penney Co.	1,286,000	41.77	29.98	7.81	4.38	33.53	1.00
American Stores Co.	504,552	66.86	33.55	4.79	11.21	34.99	0.90

Company	Dollar value of 1996 capital expenditures and research and development (millions of dollars)	Standard deviation of project operating profit as a percent of initial operating profit level															
		0%	40%	80%	120%	160%	200%	240%	280%	320%	360%	400%	440%	480%	520%	560%	600%
Panel B: Magnitude of the wealth tranfers (millions of dollars)																	
Agriculture																	
Chiquita Brands Intl.	$74.64	$10.89	$10.54	$9.27	$8.07	$8.08	$5.66	$4.84	$3.40	$1.93	$1.24	($0.47)	($1.03)	($2.80)	($4.07)	($5.56)	($7.13)
Mining																	
Cleveland–Cliffs Inc.	36.70	1.00	0.81	0.55	0.33	0.04	(0.22)	(0.54)	(0.87)	(1.17)	(1.46)	(1.77)	(2.07)	(2.45)	(2.74)	(3.05)	(3.35)
Dravo Corp.	22.63	0.08	0.08	0.07	0.05	0.03	0.03	0.02	0.01	(0.02)	(0.04)	(0.05)	(0.07)	(0.09)	(0.13)	(0.15)	(0.20)
Manufacturing																	
Archer–Daniels–Midland Co.	739.99	13.87	8.89	2.25	(4.09)	(11.25)	(18.29)	(24.82)	(30.45)	(37.60)	(44.52)	(51.04)	(57.42)	(65.32)	(72.51)	(79.15)	(85.40)
Phillips Van Heusen	22.58	0.95	0.70	0.46	0.18	(0.06)	(0.24)	(0.56)	(0.76)	(1.06)	(1.25)	(1.50)	(1.65)	(1.87)	(2.07)	(2.32)	(2.53)
Georgia–Pacific Corp.	1069.00	57.53	46.99	37.10	27.56	17.74	7.27	(3.43)	(13.61)	(23.80)	(33.81)	(43.10)	(54.95)	(62.36)	(73.26)	(83.82)	(94.86)
Westvaco Corp.	546.48	19.53	14.90	9.34	3.42	(2.98)	(9.41)	(14.91)	(21.09)	(27.19)	(33.09)	(40.15)	(45.61)	(51.20)	(57.46)	(63.64)	(68.72)
Media General	28.51	0.18	0.13	0.09	0.06	(0.01)	(0.04)	(0.07)	(0.11)	(0.14)	(0.17)	(0.21)	(0.26)	(0.31)	(0.36)	(0.43)	(0.44)
Eli Lilly & Co.	1209.25	9.31	5.62	2.80	0.23	(2.74)	(5.23)	(7.59)	(9.88)	(12.16)	(14.92)	(18.25)	(20.57)	(23.20)	(26.19)	(29.63)	(32.62)
Colgate–Palmolive Co.	564.75	10.75	8.41	6.63	4.02	1.76	(0.59)	(2.30)	(4.55)	(7.35)	(10.11)	(12.60)	(15.50)	(17.44)	(19.65)	(22.21)	(24.46)
Ethyl Corp.	75.97	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16
Quaker State Corp.	57.17	1.22	1.02	1.04	0.82	0.65	0.56	0.18	0.15	(0.12)	(0.25)	(0.61)	(0.80)	(0.81)	(1.09)	(1.20)	(1.34)
Goodyear Tire & Rubber Co.	814.79	4.54	3.86	2.89	1.72	0.70	(0.45)	(1.72)	(3.28)	(5.04)	(6.64)	(7.95)	(9.45)	(10.84)	(11.96)	(13.33)	(14.44)
Bethlehem Steel Corp.	270.49	7.83	5.52	3.19	0.92	(2.19)	(4.84)	(7.80)	(10.90)	(13.82)	(16.70)	(20.00)	(23.03)	(25.71)	(28.92)	(31.77)	(34.62)
Cummis Engine	435.75	2.62	1.96	1.20	0.24	(0.88)	(2.27)	(3.59)	(4.90)	(6.39)	(8.15)	(9.85)	(11.38)	(12.78)	(14.37)	(16.10)	(17.57)
Motorola Inc.	4284.64	37.56	25.15	14.27	3.01	(6.64)	(16.51)	(26.82)	(35.55)	(45.46)	(53.86)	(61.90)	(70.18)	(78.44)	(85.86)	(93.10)	(101.05)
Chrysler Corp.	5674.61	63.93	53.29	39.71	24.60	9.43	(9.02)	(30.04)	(49.08)	(73.20)	(96.93)	(124.15)	(152.82)	(181.48)	(209.44)	(241.76)	(275.19)
Mattel Inc.	285.06	1.10	0.85	0.58	0.33	0.05	(0.19)	(0.44)	(0.72)	(1.01)	(1.27)	(1.65)	(1.90)	(2.23)	(2.50)	(2.78)	(3.13)
Transportation																	
Burlington Northern Santa Fe	2234.00	71.47	55.26	38.78	22.75	5.74	(10.14)	(28.28)	(46.25)	(61.58)	(78.06)	(93.30)	(110.95)	(127.78)	(144.13)	(159.73)	(173.35)
UAL Corp.	1483.00	101.26	80.24	53.90	27.11	(2.41)	(34.24)	(66.15)	(98.24)	(132.44)	(164.82)	(197.89)	(226.54)	(255.42)	(285.35)	(312.38)	(338.27)
Utility																	
FPL Group Inc.	418.77	13.91	12.13	7.31	3.23	(2.90)	(9.26)	(12.97)	(15.93)	(21.39)	(25.56)	(32.46)	(35.15)	(39.88)	(46.32)	(49.58)	(53.90)
Retail																	
J C Penney Co.	704.00	23.16	15.50	5.87	(5.01)	(12.42)	(21.40)	(31.93)	(40.48)	(50.93)	(61.72)	(70.28)	(80.01)	(90.81)	(98.91)	(107.87)	(117.54)
American Stores Co.	895.41	16.66	13.72	10.26	6.59	2.99	(0.81)	(4.38)	(8.03)	(12.26)	(16.49)	(20.69)	(25.68)	(30.35)	(34.64)	(38.73)	(43.21)

Table 4. Continued.

Company	Rate of return required for 0 NPV	Standard deviation of project operating profit as a percent of initial operating profit level															
		0%	40%	80%	120%	160%	200%	240%	280%	320%	360%	400%	440%	480%	520%	560%	600%
Panel C: Incremental required rates of return																	
Agriculture																	
Chiquita Brands Intl.	8.91%	1.30%	1.26%	1.11%	0.96%	0.96%	0.68%	0.58%	0.41%	0.23%	0.15%	− 0.06%	− 0.12%	− 0.33%	− 0.49%	− 0.66%	− 0.85%
Mining																	
Cleveland–Cliffs Inc.	7.56%	0.21%	0.17%	0.11%	0.07%	0.01%	− 0.05%	− 0.11%	− 0.18%	− 0.24%	− 0.30%	− 0.36%	− 0.43%	− 0.50%	− 0.57%	− 0.63%	− 0.69%
Dravo Corp.	8.00%	0.03%	0.03%	0.02%	0.02%	0.01%	0.01%	0.01%	0.00%	− 0.01%	− 0.01%	− 0.02%	− 0.03%	− 0.03%	− 0.04%	− 0.05%	− 0.07%
Manufacturing																	
Archer–Daniels–Midland Co.	7.78%	0.14%	0.09%	0.02%	− 0.04%	− 0.12%	− 0.19%	− 0.26%	− 0.32%	− 0.39%	− 0.46%	− 0.53%	− 0.60%	− 0.68%	− 0.76%	− 0.83%	− 0.89%
Phillips Van Heusen	8.14%	0.34%	0.25%	0.17%	0.06%	− 0.02%	− 0.09%	− 0.20%	− 0.27%	− 0.38%	− 0.45%	− 0.54%	− 0.59%	− 0.67%	− 0.75%	− 0.84%	− 0.91%
Georgia–Pacific Corp.	8.26%	0.44%	0.36%	0.29%	0.21%	0.14%	0.06%	− 0.03%	− 0.11%	− 0.18%	− 0.26%	− 0.33%	− 0.42%	− 0.48%	− 0.57%	− 0.65%	− 0.73%
Westvaco Corp.	7.92%	0.28%	0.21%	0.13%	0.05%	− 0.04%	− 0.13%	− 0.21%	− 0.30%	− 0.38%	− 0.47%	− 0.57%	− 0.65%	− 0.72%	− 0.81%	− 0.90%	− 0.97%
Media General	7.84%	0.05%	0.04%	0.03%	0.02%	0.00%	− 0.01%	− 0.02%	− 0.03%	− 0.04%	− 0.05%	− 0.06%	− 0.07%	− 0.09%	− 0.10%	− 0.12%	− 0.12%
Eli Lilly & Co.	7.68%	0.04%	0.03%	0.01%	0.00%	− 0.01%	− 0.02%	− 0.04%	− 0.05%	− 0.06%	− 0.07%	− 0.09%	− 0.10%	− 0.11%	− 0.12%	− 0.14%	− 0.15%
Colgate–Palmolive Co.	7.88%	0.14%	0.11%	0.08%	0.05%	0.02%	− 0.01%	− 0.03%	− 0.06%	− 0.09%	− 0.13%	− 0.16%	− 0.20%	− 0.22%	− 0.25%	− 0.28%	− 0.31%
Ethyl Corp.	7.79%	0.01%	0.01%	0.01%	0.01%	0.01%	0.01%	0.01%	0.01%	0.01%	0.01%	0.01%	0.01%	0.01%	0.01%	0.01%	0.01%
Quaker State Corp.	8.50%	0.18%	0.15%	0.15%	0.12%	0.10%	0.08%	0.03%	0.02%	− 0.02%	− 0.04%	− 0.09%	− 0.12%	− 0.12%	− 0.16%	− 0.18%	− 0.20%
Goodyear Tire & Rubber Co.	8.11%	0.04%	0.03%	0.02%	0.01%	0.01%	0.00%	− 0.01%	− 0.03%	− 0.04%	− 0.06%	− 0.07%	− 0.08%	− 0.09%	− 0.10%	− 0.11%	− 0.12%
Bethlehem Steel Corp.	8.06%	0.23%	0.16%	0.09%	0.03%	− 0.06%	− 0.14%	− 0.23%	− 0.32%	− 0.40%	− 0.49%	− 0.58%	− 0.67%	− 0.75%	− 0.84%	− 0.93%	− 1.01%
Cummis Engine	7.71%	0.04%	0.03%	0.02%	0.00%	− 0.01%	− 0.03%	− 0.05%	− 0.07%	− 0.10%	− 0.12%	− 0.15%	− 0.17%	− 0.19%	− 0.21%	− 0.24%	− 0.26%
Motorola Inc.	7.62%	0.06%	0.04%	0.02%	0.00%	− 0.01%	− 0.02%	− 0.04%	− 0.05%	− 0.07%	− 0.08%	− 0.09%	− 0.10%	− 0.12%	− 0.13%	− 0.14%	− 0.15%
Chrysler Corp.	7.71%	0.08%	0.07%	0.05%	0.03%	0.01%	− 0.01%	− 0.04%	− 0.06%	− 0.09%	− 0.12%	− 0.15%	− 0.19%	− 0.22%	− 0.26%	− 0.30%	− 0.34%
Mattel Inc.	7.59%	0.03%	0.02%	0.01%	0.01%	0.00%	0.00%	− 0.01%	− 0.02%	− 0.02%	− 0.03%	− 0.04%	− 0.04%	− 0.05%	− 0.06%	− 0.06%	− 0.07%
Transportation																	
Burlington Northern Santa Fe	7.92%	0.25%	0.20%	0.14%	0.08%	0.02%	− 0.04%	− 0.10%	− 0.16%	− 0.22%	− 0.28%	− 0.33%	− 0.39%	− 0.45%	− 0.51%	− 0.57%	− 0.61%
UAL Corp.	7.87%	0.54%	0.43%	0.29%	0.14%	− 0.01%	− 0.18%	− 0.35%	− 0.52%	− 0.70%	− 0.87%	− 1.05%	− 1.20%	− 1.36%	− 1.51%	− 1.66%	− 1.80%
Utility																	
FPL Group Inc.	7.61%	0.25%	0.22%	0.13%	0.06%	− 0.05%	− 0.17%	− 0.24%	− 0.29%	− 0.39%	− 0.46%	− 0.59%	− 0.64%	− 0.72%	− 0.84%	− 0.90%	− 0.98%
Retail																	
J C Penney Co.	7.96%	0.26%	0.18%	0.07%	− 0.06%	− 0.14%	− 0.24%	− 0.36%	− 0.46%	− 0.58%	− 0.70%	− 0.79%	− 0.90%	− 1.03%	− 1.12%	− 1.22%	− 1.33%
American Stores Co.	8.08%	0.15%	0.12%	0.09%	0.06%	0.03%	− 0.01%	− 0.04%	− 0.07%	− 0.11%	− 0.15%	− 0.19%	− 0.23%	− 0.27%	− 0.31%	− 0.35%	− 0.39%

Company	Expected return on debt	Standard deviation of project operating profit as a percent of initial operating profit level															
		0%	40%	80%	120%	160%	200%	240%	280%	320%	360%	400%	440%	480%	520%	560%	600%
Panel D: Incremental costs of debt																	
Agriculture																	
Chiquita Brands Intl.	8.91%	− 0.22%	− 0.22%	− 0.19%	− 0.16%	− 0.16%	− 0.12%	− 0.10%	− 0.07%	− 0.04%	− 0.03%	0.01%	0.02%	0.06%	0.08%	0.11%	0.15%
Mining																	
Cleveland–Cliffs Inc.	7.56%	− 0.23%	− 0.18%	− 0.13%	− 0.08%	− 0.01%	0.05%	0.12%	0.20%	0.27%	0.33%	0.41%	0.47%	0.56%	0.63%	0.70%	0.77%
Dravo Corp.	8.00%	− 0.04%	− 0.04%	− 0.03%	− 0.03%	− 0.02%	− 0.02%	− 0.01%	0.00%	0.01%	0.02%	0.02%	0.04%	0.05%	0.06%	0.07%	0.09%
Manufacturing																	
Archer–Daniels–Midland Co.	7.78%	− 0.09%	− 0.06%	− 0.01%	0.03%	0.07%	0.12%	0.16%	0.19%	0.24%	0.28%	0.32%	0.36%	0.41%	0.46%	0.50%	0.54%
Phillips Van Heusen	8.14%	− 0.08%	− 0.06%	− 0.04%	− 0.02%	0.00%	0.02%	0.05%	0.06%	0.09%	0.11%	0.13%	0.14%	0.16%	0.18%	0.20%	0.21%
Georgia–Pacific Corp.	8.26%	− 0.20%	− 0.17%	− 0.13%	− 0.10%	− 0.06%	− 0.03%	0.01%	0.05%	0.08%	0.12%	0.15%	0.19%	0.22%	0.26%	0.29%	0.33%
Westvaco Corp.	7.92%	− 0.23%	− 0.17%	− 0.11%	− 0.04%	0.03%	0.11%	0.17%	0.24%	0.32%	0.38%	0.47%	0.53%	0.59%	0.67%	0.74%	0.80%
Media General	7.84%	− 0.03%	− 0.02%	− 0.01%	− 0.01%	0.00%	0.01%	0.01%	0.02%	0.02%	0.03%	0.03%	0.04%	0.05%	0.05%	0.07%	0.07%
Eli Lilly & Co.	7.68%	− 0.05%	− 0.03%	− 0.01%	0.00%	0.01%	0.03%	0.04%	0.05%	0.06%	0.08%	0.10%	0.11%	0.12%	0.14%	0.16%	0.17%
Colgate–Palmolive Co.	7.88%	− 0.07%	− 0.05%	− 0.04%	− 0.03%	− 0.01%	0.00%	0.01%	0.03%	0.05%	0.06%	0.08%	0.10%	0.11%	0.13%	0.14%	0.16%
Ethyl Corp.	7.79%	− 0.02%	− 0.02%	− 0.02%	− 0.02%	− 0.02%	− 0.02%	− 0.02%	− 0.02%	− 0.02%	− 0.02%	− 0.02%	− 0.02%	− 0.02%	− 0.02%	− 0.02%	− 0.02%
Quaker State Corp.	8.50%	− 0.12%	− 0.10%	− 0.10%	− 0.08%	− 0.06%	− 0.05%	− 0.02%	− 0.01%	0.01%	0.02%	0.06%	0.08%	0.08%	0.10%	0.11%	0.13%
Goodyear Tire & Rubber Co.	8.11%	− 0.11%	− 0.09%	− 0.07%	− 0.04%	− 0.02%	0.01%	0.04%	0.08%	0.12%	0.15%	0.19%	0.22%	0.25%	0.28%	0.31%	0.34%
Bethlehem Steel Corp.	8.06%	− 0.27%	− 0.19%	− 0.11%	− 0.03%	0.08%	0.17%	0.27%	0.37%	0.47%	0.57%	0.69%	0.79%	0.88%	0.99%	1.09%	1.19%
Cummis Engine	7.71%	0.25%	− 0.18%	− 0.11%	− 0.02%	0.08%	0.21%	0.34%	0.46%	0.60%	0.76%	0.92%	1.07%	1.20%	1.35%	1.51%	1.65%
Motorola Inc.	7.62%	− 0.23%	− 0.15%	− 0.09%	− 0.02%	0.04%	0.10%	0.16%	0.21%	0.27%	0.33%	0.37%	0.42%	0.47%	0.52%	0.56%	0.61%
Chrysler Corp.	7.71%	− 0.26%	− 0.21%	− 0.16%	− 0.10%	− 0.04%	0.04%	0.12%	0.20%	0.29%	0.39%	0.50%	0.61%	0.73%	0.84%	0.97%	1.11%
Mattel Inc.	7.59%	− 0.06%	− 0.04%	− 0.03%	− 0.02%	0.00%	0.01%	0.02%	0.04%	0.05%	0.07%	0.08%	0.10%	0.11%	0.13%	0.14%	0.16%
Transportation																	
Burlington Northern Santa Fe	7.92%	− 0.23%	− 0.18%	− 0.13%	− 0.07%	− 0.02%	0.03%	0.09%	0.15%	0.20%	0.25%	0.30%	0.36%	0.41%	0.47%	0.52%	0.56%
UAL Corp.	7.87%	− 0.57%	− 0.45%	− 0.30%	− 0.15%	0.01%	0.19%	0.37%	0.55%	0.75%	0.93%	1.11%	1.28%	1.44%	1.61%	1.76%	1.91%
Utility																	
FPL Group Inc.	7.61%	− 0.06%	− 0.05%	− 0.03%	− 0.01%	0.01%	0.04%	0.05%	0.07%	0.09%	0.11%	0.14%	0.15%	0.17%	0.20%	0.21%	0.23%
Retail																	
J C Penney Co.	7.96%	− 0.07%	− 0.05%	− 0.02%	0.01%	0.04%	0.06%	0.09%	0.12%	0.15%	0.18%	0.21%	0.24%	0.27%	0.29%	0.32%	0.35%
American Stores Co.	8.08%	− 0.15%	− 0.12%	− 0.09%	− 0.06%	− 0.03%	0.01%	0.04%	0.07%	0.11%	0.15%	0.18%	0.23%	0.27%	0.31%	0.35%	0.38%

firms is above 25%, the magnitude of the stockholder–bondholder conflicts at these firms is small because a relatively high percentage of the debt matures quickly.

The incremental cost of debt values reported in Panel D of Table 4 represent the change in the cost of debt attributable to agency problems, should one of the 23 firms adopt a zero NPV project with a specified cash flow volatility. The incremental cost of debt is higher at firms, like Cummins and UAL, which make larger investments. This is consistent with growth opportunity arguments. At both firms, adopting a project with a standard deviation of operating cash flows of 600% would increase the cost of debt by more than 150 basis points relative to a project that keeps the firm's cash flows equally risky. These results also suggest that there is considerable variation across firms in the likely impact of underinvestment and overinvestment problems on borrowing costs. Presumably, the firms with the largest potential agency problems will benefit most from restrictive debt covenants.

4.2. Asset risk and investment opportunities

The analysis presented above demonstrates how stockholder–bondholder conflicts distort a firm's investment decisions, taking into account the attributes of both the firm's existing assets and its potential projects. In contrast, the stockholder–bondholder literature predominately focuses on the total value of potential projects, usually summarized as the level of 'growth opportunities' available to firms (see Myers, 1977; Smith and Watts, 1992). The evidence reported here shows that the value of investment opportunities alone is not sufficient to assess the extent of stockholder–bondholder conflicts. Other factors, such as the riskiness of the firm's and the projects' cash flows and the correlations between the cash flows of the firm and projects, must be considered as well.

For example, the generally high leverage at utility firms is often explained by noting that because the regulatory process limits the growth opportunities available to these firms, utility executives have limited opportunities to invest in projects that transfer wealth from bondholders. Consequently, underinvestment and overinvestment are not of great concern in the utility industry. However, the analysis in this paper suggests that the characteristics of both the investment opportunities available to utility firms and their existing assets also affect the magnitude of stockholder–bondholder conflicts. Since utility firms tend to have assets with low cash flow volatility, the incentives that utilities have to engage in underinvestment are small (see Section 3.3.). As long as there are restrictions on the ability of utilities to engage in overinvestment, stockholder–bondholder conflicts will be small in this industry.

5. To what extent can stockholder–bondholder conflicts explain capital structure?

The analysis so far has quantified the nature of the distortion in investment induced by stockholder–bondholder conflicts. However, the overall importance of these conflicts to the firm depends on the number of available projects that are affected by this distortion. For example, the analysis shows that for a typical firm, the equityholders will require a 0.14% return premium with a 20% debt to total capital ratio and a 0.36% return premium with a 40% debt to total capital ratio (Panel A of Table 3) to invest in a low-risk project. Unfortunately, since there is no way for an outsider to know exactly how many positive NPV projects do not meet these higher hurdle rates, we do not know exactly how many potential projects a typical firm has that will be affected by underinvestment. The value lost because of overinvestment is similarly unknown.

We can, however, get some idea of the importance of the value lost because of these conflicts by comparing the value loss to the tax shields that would be created by using additional debt. Suppose, as in Myers (1977), that the optimal capital structure is determined by a tradeoff between the tax advantages of debt and underinvestment considerations. This implies that stockholders will increase leverage to the point where the marginal foregone positive NPV projects have a value equal to the tax shields from the incremental debt. Because the results presented above provide the rates of return on the foregone projects, we can calculate how much the firm must be investing to achieve this value and examine the feasibility of this level of investment.

To illustrate, suppose a firm is considering increasing its debt to total capital ratio from 20% to 40%.[20] For the hypothetical firm in our simulations, the expected change in the value of the tax shields to investors would be \$118.71 (the expected value of \$226.64 with 40% debt less the expected value of \$107.93 with 20% debt).[21] The level of investment necessary to offset this tax shield, from the stockholder's perspective, is $\$118.71(r_{20\%\ \mathrm{debt}}/(\mathrm{Ir}_{\mathrm{project}} - \mathrm{Ir}_{20\%\ \mathrm{debt}}))$ where $\mathrm{Ir}_{\mathrm{project}}$ is the incremental required return on the average project that is foregone because of the increase in leverage, $r_{20\%\ \mathrm{debt}}$ is the return at which the stockholders of a firm with 20% debt are indifferent with regard to the project and $\mathrm{Ir}_{20\%\ \mathrm{debt}}$ is the incremental required return with 20% debt.[22] For example,

[20] This assumes that the firm can make this change costlessly or, more realistically, that the firm has historically examined these issues when making financing or payout decisions that could affect capital structure.

[21] These tax shields are computed using the numerical model, so they incorporate the probability that the firm will not be able to utilize the shields it generates. They also account for differential rates at the personal and corporate level. They assume that that interest income is taxed at 39.6% (the top federal marginal individual rate in 1996) and that returns to equity holders are taxed at an average rate of 28% (the top federal capital gains rate in 1996).

[22] This calculation assumes that the cash flows from the project are realized in perpetuity.

assume that the average project foregone is a low-risk project with an incremental required return of 0.25% (which is midway between the 0.14% incremental required return for the firm with 20% leverage and the 0.36% incremental required return on equity for the firm with 40% leverage).[23] In this example, the firm would have to be planning to invest at least $8428.41 [equal to $118.71(0.0781)/(0.0025 − 0.0014)] in these low-risk projects for underinvestment considerations to offset the value of the tax shields. Since $8428.41 is 1.58 times the expected value of the firm ($5349 with 20% debt) and 12.85 times the annual after-tax cash flow from operations, it is unlikely that the firm is investing that much in positive NPV projects with incremental rates of return in the ranges indicated in Table 3.[24]

While these calculations suggest that underinvestment considerations are not sufficient to offset the value of the tax shields, it is important to recognize that this conclusion is sensitive to our assumptions concerning the effective marginal corporate tax rate and the tax rates that investors must pay on returns from debt and equity. For example, Miller (1977) points out that if the personal tax rate on interest income equals the marginal corporate tax rate and the personal rate on equity is effectively zero, then there are no purely tax gains from financial leverage.[25] Similarly, DeAngelo and Masulis (1980) show that the presence of alternative tax shields can reduce the effective marginal corporate tax rate and, thereby, the net value of the incremental tax shields from an increase in leverage. On the other hand, the value of tax shields from debt to a tax-exempt investor is likely to be larger than our estimate if alternative tax shields do not substantially reduce corporate tax rates.

Another way to see how small these estimates of the incremental returns required by a typical firm are is to compare them to the *noise* in traditional estimates of the cost of capital. Fama and French (1997) report that the standard errors of state-of-the-art estimates of the cost of capital are typically more than 3% per year. This value is more than twenty times the maximum distortion from underinvestment for the typical firm. Relative to both the estimated tax shields and the measurement error in traditional cost of capital estimates, the estimated

[23] The value of the foregone projects depends on the wedge between the hurdle rates for the current debt level and the rates for the debt level in question. This wedge is slightly higher for moderate risk projects than for low-risk projects. Nonetheless, the basic conclusion of this section, that the effect is too small to explain the majority of debt/equity choices, still holds.

[24] Moyen (1997), using a contingent claims approach, examines this issue as well and reports similar conclusions.

[25] The personal tax rate on equity income can be zero if the firm pays no dividends and the individual investor defers the unrealized capital gain into his or her estate. Graham (1998) finds that the value of corporate tax shields are approximately equal to 10% of firm value, which suggests that there is a substantial tax advantage to debt.

distortion in investment from stockholder–bondholder conflicts appears to be small.

Results imply that distortions for the projects in these simulations are not large enough to explain capital structure decisions in most cases. As discussed in Section 3.8, it is possible the model is misspecified. However, consistent with the idea that the incentives to transfer wealth are relatively small, Andrade and Kaplan (1998) find that, even for firms in financial distress, there is little evidence of stockholders transferring wealth through risk-shifting. Nonetheless, the possibility of extreme gambles much riskier than the projects considered here can potentially lead to substantially larger distortions and to a different interpretation. The existence of covenants restricting certain kinds of investment suggests that this possibility is a serious issue to purchasers of bonds.

6. Conclusions

Despite over 40 years of research, we still know surprisingly little about the determinants of capital structure. There is general agreement that debt has a tax advantage over equity, but disagreement over the magnitude of this tax advantage and the relative importance of the costs of debt that offset this tax advantage at the margin.[26] One explanation for the relatively low debt levels in American corporations is that agency problems inherent in the differing objectives of stockholders and bondholders offset the tax advantages of debt. It has been argued that stockholder–bondholder conflicts are an important determinant of capital structure (Smith and Watts, 1992), have major consequences for the ways distressed firms reorganize (Gertner and Scharfstein, 1991), and even have macroeconomic implications (Lamont, 1995).

We numerically estimate the magnitude of these stockholder–bondholder conflicts using a Monte Carlo simulation approach. Our approach uses standard valuation techniques to value the firm's debt and equity, and, for specified firm parameters, calculates the magnitude of the agency costs of debt. This approach is an improvement on contingent-claims methods because it imposes no restrictions on cash flow distributions or on the firm's capital structure.

These simulations produce estimates of the distortion in investment arising from stockholder–bondholder conflicts. These estimates are based on parameters selected to reflect market rates of return, actual capital structures, and the most recent estimates of corporate tax rates. We emphasize, however, that the estimates are preliminary. Improvements are likely to come from using more

[26] Jensen (1986,1993) and Stulz (1990), among others, also propose non-tax advantages of debt. In particular, they argue that debt reduces the agency problem between managers and stockholders by lowering their incentives to waste the firm's excess cash on negative NPV projects. To the extent that these arguments are correct, they reinforce the basic puzzle of why firms do not use more debt.

sophisticated models of cash flow and project interactions and from the explicit consideration of direct and indirect bankruptcy costs. Improvements are also likely to come from examination of more complex projects such as those requiring a series of investment decisions over time. The willingness of managers to make additional investments later in a project's life depends on the project's performance. In such a project, the compound-option characteristics result in a path dependence that is likely to affect the magnitude of the potential wealth transfer and therefore the incentives of managers to adopt these projects ex ante. Modeling these other factors may materially change our estimates of the distortion.

Notwithstanding the above caveats, our estimates imply that the stockholder–bondholder distortion exists and that it increases with debt levels. In addition, they suggest a number of 'numerical comparative statics' results, characterizing the effect of various factors on the magnitude of this distortion. These factors include the risk of the project, the duration of the firm's debt, the correlation between potential projects' cash flows and those of the firm, the size of the investment, the volatility of the firm's cash flows, and the firm's tax rate. Our estimates suggest that these agency costs of debt vary extensively across actual firms and can be substantial. However, they also suggest that for most firms these conflicts are likely to be too small to offset the tax shields of debt on their own, and are considerably smaller than the measurement error in the underlying cost of capital.

An examination of historical stock returns suggests that incorporating intertemporal considerations into the model is not likely to alter the basic conclusions. For example, given historical data on U.S. stock returns between 1930 and 1981, a five-year total (unadjusted) return of -38% would place a firm in the bottom 5% with regard to stock performance.[27] Even if a firm with such a negative return took no action to control its capital structure, such as paying down its debt, this return would only increase the firm's overall debt to total capital ratio from 20% to about 29%. Since the simulation results imply that the increase in investment distortion due to stockholder–bondholder conflicts from such an increase in leverage will be small, this increase does not appear important enough to justify the loss of the tax shields associated with a moderately higher debt level. This is especially true given the small likelihood of debt levels increasing 'involuntarily' because of poor stock returns. About 90% of firms had positive five-year returns over the 1930–1981 period, with the median firm approximately doubling the value of its equity.

To the extent that the estimates accurately reflect the magnitude of investment distortions from stockholder–bondholder conflicts, they imply that these distortions are too small to explain the observed cross-sectional variation in

[27] The return calculations are taken from Ball and Kothari (1989), Table 1.

capital structures. These results are inconsistent with the conventional interpretations of the evidence reported by Smith and Watts (1992), Gaver and Gaver (1993), Barclay and Smith (1995), and Rajan and Zingales (1995). These papers find that high growth option firms tend to use lower quantities of debt and that their debt tends to be of shorter duration than the debt of firms with more assets in place. Our results suggest that factors other than investment distortions from stockholder–bondholder conflicts are responsible for these regularities and that, at a minimum, we should re-examine the conventional explanations.

References

Altman, E., 1989. Measuring corporate bond mortality and performance. Journal of Finance 44, 909–922.

Andrade, G., Kaplan, S., 1998. How costly is financial (not economic) distress? Evidence from highly leveraged transactions that became distressed. Journal of Finance, forthcoming.

Ball, R., Kothari, S., 1989. Nonstationary expected returns: implications for tests of market efficiency and serial correlation in returns. Journal of Financial Economics 25, 51–74.

Barclay, M., Smith, C., 1995. The maturity structure of corporate debt. Journal of Finance 50, 609–632.

Berkovitch, E., Israel, R., Spiegel, Y., 1996. Managerial compensation and capital structure. Unpublished working paper. University of Michigan.

Berkovitch, E., Kim, E., 1990. Financial contracting and leverage induced over- and underinvestment incentives. Journal of Finance 45, 765–794.

Brealey, R., Myers, S., 1996. Principles of Corporate Finance, fifth ed. McGraw-Hill, New York.

Brennan, M., Schwartz, E., 1984. Optimal financial policy and firm valuation. Journal of Finance 39, 593–607.

Buser, S., Chen, A., Kane, E., 1981. Federal deposit insurance, regulatory policy, and optimal bank capital. Journal of Finance 36, 51–60.

Carty, L., Lieberman, D., 1996. Corporate Bond Defaults and Default Rates 1938–1995. Moody's Investor Service, Global Credit Research, Special Report.

DeAngelo, H., Masulis, R., 1980. Optimal capital structure under corporate and personal taxation. Journal of Financial Economics 8, 3–29.

Esty, B., 1997a. Organizational form and risk taking in the savings and loan industry. Journal of Financial Economics 44, 25–56.

Esty, B., 1997b. A case study of organizational form and risk shifting in the savings and loan industry. Journal of Financial Economics 44, 57–71.

Fama, E., French, K., 1992. The cross-section of expected returns. Journal of Finance 47, 427–465.

Fama, E., French, K., 1997. Industry costs of equity. Journal of Financial Economics 43, 153–194.

Fama, E., Miller, M., 1972. The Theory of Finance. Dryden Press, Hinsdale, IL.

Fridson, M., 1997. Default rate remained modest in 1997. In: McHugh, C. (Ed.), The 1998 Bankruptcy Yearbook and Almanac. New Generation Research, Boston, pp. 149–155.

Gaver, J., Gaver, K., 1993. Additional evidence on the association between the investment opportunity set and corporate financing, dividend, and compensation policies. Journal of Accounting and Economics 16, 125–160.

Gertner, R., Scharfstein, D., 1991. A theory of workouts and the effects of reorganization law. Journal of Finance 46, 1189–1222.

Graham, J., 1996a. Debt and the marginal tax rate. Journal of Financial Economics 41, 41–73.
Graham, J., 1996b. Proxies for the marginal tax rate. Journal of Financial Economics 42, 187–222.
Graham, J., 1998. How big are the tax benefits of debt? Unpublished working paper. Duke University.
Graham, J., Smith, C., 1998. Tax incentives to hedge. Unpublished working paper. University of Rochester.
Guedes, J., Opler, T., 1996. The determinants of the maturity structure of corporate debt issues. Journal of Finance 51, 1809–1834.
Hendershott, P., Kane, E., 1992. Causes and consequences of the 1980s commercial construction boom. Journal of Applied Corporate Finance 5, 61–70.
Jensen, M., 1986. Agency costs of free cash flows, corporate finance, and takeovers. American Economic Review 76, 323–329.
Jensen, M., 1993. The modern industrial revolution, exit, and the failure of internal control systems. Journal of Finance 48, 831–880.
Jensen, M., Meckling, W., 1976. Theory of the firm: managerial behavior, agency costs, and capital structure. Journal of Financial Economics 3, 305–360.
John, K., Nachman, D., 1985. Risky debt, investment incentives, and reputation in a sequential equilibrium. Journal of Finance 40, 863–878.
Kane, E., Yu, M.-T., 1995. Measuring the true profile of taxpayer losses in the S&L insurance mess. Journal of Banking and Finance 19, 1459–1478.
Kim, M., Maksimovic, V., 1990. Technology, debt, and the exploitation of growth options. Journal of Banking and Finance 14, 1113–1131.
Lamont, O., 1995. Corporate-debt overhang and macroeconomic expectations. American Economic Review 85, 1106–1117.
Leland, H., 1998. Agency costs, risk management, and capital structure. Journal of Finance 53, 1213–1244.
Maksimovic, V., Zechner, J., 1991. Debt, agency costs, and industry equilibrium. Journal of Finance 46, 1619–1644.
Mello, A., Parsons, J., 1992. Measuring the agency cost of debt. Journal of Finance 47, 1887–1904.
Merton, R., 1977. An analytic derivation of the cost of deposit insurance and loan guarantees: an application of modern option pricing. Journal of Banking and Finance 1, 3–11.
Miles, J., Ezzell, J., 1980. The weighted average cost of capital, perfect capital markets, and project life: a clarification. Journal of Financial and Quantitative Analysis 15, 719–730.
Miller, M., 1977. Debt and taxes. Journal of Finance 32, 261–275.
Modigliani, F., Miller, M., 1958. The cost of capital, corporation finance and the theory of investment. American Economic Review 48, 261–297.
Moyen, N., 1997. Dynamic investment decisions with a tax benefit and a default cost of debt. Unpublished working Paper. University of British Columbia.
Myers, S., 1977. Determinants of corporate borrowing. Journal of Financial Economics 5, 147–175.
Myers, S., 1984. The capital structure puzzle. Journal of Finance 39, 575–592.
Rajan, R., Zingales, L., 1995. What do we know about capital structure? Some evidence from international data. Journal of Finance 50, 1421–1460.
Schwert, W., 1993. The Journal of Financial Economics: a retrospective evaluation (1974–91). Journal of Financial Economics 33, 369–424.
Smith, C., Warner, J., 1979. On financial contracting: an analysis of bond covenants. Journal of Financial Economics 7, 117–161.
Smith, C., Watts, R., 1992. The investment opportunity set and corporate financing, dividend, and compensation policies. Journal of Financial Economics 32, 263–292.
Stulz, R., 1990. Managerial discretion and optimal financing choices. Journal of Financial Economics 26, 3–28.