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Why do firms use high discount rates?☆

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ABSTRACT

We present evidence consistent with operational constraints leading firms to use high discount rates that average twice the firms' cost of financial capital. Based on a survey of Chief Financial Officers matched to archival data, we find that firms with abundant access to capital but limited qualified management or manpower appear to forgo profitable projects in preparation for more profitable future investment opportunities. Consistent with this explanation, firms that use high discount rates have strong balance sheets, low leverage, and large cash holdings. In addition, firms appear to increase discount rates to account for idiosyncratic risk.

1. Introduction

Capital allocation, a crucial business function, is not well understood. While most large U.S. firms have long used discounted cash flow (DCF) methods to evaluate investment opportunities, little is known about what factors determine the discount rates that firms use.[1] In surveys conducted over the past 25 years, firms increasingly respond that their discount rates take into account their weighted average cost of capital (WACC) computed using the capital asset pricing model (CAPM) to estimate their cost of equity. Although WACC and CAPM are the focus of capital budgeting instruction in textbooks and business school classrooms (Womack and Zhang, 2005), firms typically evaluate projects using discount rates above their WACC to account for additional risks or other factors (see Jacobs and Shivdasani, 2012). Firms responding to our survey use, on average, a discount rate of 15% while their WACC is 8%—numbers that are similar to the survey results of Graham and Harvey (2011a, 2012).

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[1] In this article, we use the term "discount rate" to refer to both the discount rate used in net present value (NPV) analysis and the hurdle rate used in internal rate of return (IRR) analysis. For a given project, the two are the same.

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Using higher discount rates may be justified as a form of capital rationing when there are limitations on the investment program that prevent a company from undertaking all projects that have a positive net present value (NPV). Emery, Finnerty, and Stowe (2011, Chapter 11) provide an excellent discussion of possible rationales for capital rationing. Firms' investment may be rationed by their financial capital or by other scarce resources such as skilled workforce, managerial time, or organizational bandwidth. Otherwise, the discount rate should equal the firm's cost of financial capital and a firm should invest in every positive NPV project. We examine various explanations for why firms use discount rates that exceed their cost of financial capital, i.e., why firms forgo some *apparently* profitable investment opportunities. The traditional view is that financially constrained firms have to ration their available capital and forgo some profitable opportunities. In contrast, we find that financially constrained firms—identified in various ways—use discount rates closer to their cost of financial capital, while firms with ample financial flexibility in the form of low debt ratios and high cash balances use higher discount rates.

Rather, we find that nonfinancial (i.e., operational) constraints, such as managerial or organizational requirements, prevent firms from undertaking all opportunities as they arise and lead them to be more selective in making investments. Theory suggests that firms facing such constraints tend to hoard cash while waiting for better investment opportunities to emerge (Asvanunt, Broadie, and Sundaresan, 2011). Consistent with this view, we find that firms with (self-identified) operational constraints and significant cash balances use higher discount rates to screen their investment opportunities.

We find that firms also use higher discount rates to account for idiosyncratic risk. Adding this premium might reflect a truly higher cost of financial capital if the firm's investors are not well-diversified, but it could also reflect an undiversified manager's private interest in safer projects. Using a greater safety margin to select projects can protect the manager from poor corporate performance that could endanger his or her reputation and job security (Holmström, 1999). We find no evidence, however, that the high discount rates result from managerial optimism or myopia (i.e., short-termism).

Academic studies of capital budgeting have long recognized the empirical existence of capital rationing as a market phenomenon (Dean, 1951), a phenomenon that persists even today. For decades, the literature debated optimal decision rules under capital rationing, but never explained why firms were rationing capital in the first place (Weingartner, 1977). Over time, this debate moved from optimal decision rules for capital allocation to examining whether financial constraints were binding on firms, but financial constraints is only one of the reasons firms might ration capital. Our analysis confirms that financial constraints are not the predominant cause for capital rationing among public corporations, but rather that operational considerations, such as managerial and organizational constraints, lead firms to systematically evaluate projects using discount rates that exceed their costs of financial capital.

A distinguishing feature of our study is the analysis of survey responses in combination with accounting and archival data. This combination helps to resolve the longstanding puzzle from Chief Financial Officer (CFO) surveys as to why firms appear to require excessive rates of return when screening investment opportunities (Poterba and Summers, 1995; Arnold and Hatzopoulos, 2000). Our analysis takes a different approach than surveys that have asked CFOs directly why they do not take all projects that have a higher expected return than their cost of financial capital (e.g., Graham and Harvey, 2011b). Whereas the stated preference approach employed in those studies is more direct, our study instead examines firms' actual behavior using a revealed preference methodology. The two approaches are complementary and both point to the importance of operational constraints. Using the identities of our survey respondents to combine their survey responses with archival data, we show (i) that firms with strong balance sheets, low leverage, or large cash holdings tend to use higher discount rates[2] and (ii) that WACC and CAPM explain the cross-section of discount rates after we control for limited managerial bandwidth.

The remainder of the article is organized as follows. In Section 2, we describe the survey design, auxiliary data sources, and self-reported discount rates. We model firms' discount rates as a function of their costs of financial capital in Section 3 and evaluate potential explanations of why firms use high discount rates in Section 4. We conclude in Section 5.

2. Survey design and data description

2.1. Survey design

Because discount rates cannot be observed in archival databases, we surveyed firms directly. To relate firms' discount rates to their cost of financial capital, we then combined their survey answers with data from Compustat, Center for Research in Security Prices (CRSP), and Barra. To our knowledge, aside from Poterba and Summers (1995) and Ben-David, Graham, and Harvey (2013), ours is the only survey on discount rates for capital budgeting that includes the identity of the respondents. This enables us to combine survey responses with information from financial databases to examine the determinants of firms' discount rates.

In designing the questionnaire, we followed standard practices in the fields of psychology and marketing to avoid potential biases (Gillham, 2000; Morgan, 1988). For example, because survey respondents might try to please the conductor of the survey by providing the answers they think the survey's author expects (Singer and Presser, 1989), we tried to avoid using terms, such as "cost of capital" and "CAPM," that could trigger

[2] Although some firms might hoard cash because they have trouble accessing financial markets, the firms that use high discount rates neither describe themselves to be financially constrained in survey responses nor appear to be financially constrained based on typical proxies, including Altman's (1968) Z-score, current ratio, leverage, and Kaplan-Zingales index.

respondents to answer what they recall from their MBA courses on corporate finance.[3] The full survey is reproduced in Fig. OA.4 in the Online Appendix. The survey was sent out in October 2003 with a cover letter from the Dean Emeritus of the Kellogg School of Management, Donald Jacobs, along with a postage-paid return envelope to a total of 4,600 CFOs of U.S. companies listed in the Compustat name file.[4] We asked the participants to return the questionnaire within ten days. A week after the initial mailing we sent a follow-up mailing.

The survey was completed by the CFOs of 127 companies—113 public and 14 private. Almost all surveys returned were filled out completely and there was no decline in the number of responses towards the end of the four-page questionnaire. We also do not observe a change in the average self-reported discount rate, the percentage of firms using WACC, or mean and median firm characteristics between early and late responses (see Table OA.1 in Online Appendix OA.1). We believe that most respondents were the CFOs themselves,[5] and the survey responses appear to be accurate. For example, the self-reported sales figures (Question 30) agree with numbers retrieved from Compustat for 96.9% of the responses. Of the 127 surveys returned, 106 include the firm's identity, and five of these firms are private firms. Among the remaining 101 firms, five did not report a discount rate,[6] and nine do not have matching data in Compustat, CRSP, or Barra because they were traded over the counter at the time of the survey. Finally, we exclude one outlier to obtain our sample of 86 firms, but the results are similar when including this observation (see Table OA.9 in Online Appendix OA.4.1). Compared to the 2,572 firms in the sampling frame with valid data in CRSP, this is a response rate of 3.4%.

2.2. Firm characteristics

Table 1 reports characteristics of the sample firms. Similar to previous surveys on corporate finance (e.g., Graham and Harvey, 2001; Poterba and Summers, 1995), manufacturing firms are the largest industry group in our sample. To assess the sample's representativeness, we compare these firms to the remainder of firms in Compustat and compute *p*-values for differences in means and medians of each characteristic.

In comparison to other firms in Compustat, the average survey firm is larger in size, measured by book value of assets, market value of assets, or total sales.[7] Although the difference in mean book value of assets is not significant, the medians for all three size measures are significantly different. The market-to-book ratios are comparable, with survey firms exhibiting a smaller mean but similar median value.[8] Survey firms have, on average, a somewhat lower ratio of cash to book assets and more capital expenditures. The book assets of survey firms also generate higher operating profits, whereas the median returns on equity are similar. Other important financial variables, including the leverage ratio (total debt divided by book value of assets), the current ratio, and the ratio of sales to book assets, are also comparable.

2.3. Discount rates for capital budgeting

Among our analytic sample, 97% of firms use a discounted cash flow (DCF) method as one of their top two capital budgeting methods.[9] These findings reflect the increased use of DCF-based capital budgeting methods over time (see Fig. OA.1 in Online Appendix OA.2). To obtain the firm's capital budgeting discount rate, the survey asks "In nominal terms (i.e., incorporating future inflation), what is the hurdle rate your company has used for a typical project during the last two years?" The mean discount rate reported is 15.1% (median 15.0%) in nominal terms and 12.7% (median 12.6%) in real terms.[10] This average hurdle rate is remarkably similar to those reported in other surveys. Graham and Harvey (2011a) report an average nominal (real) hurdle rate of 14.8% (12.8%) for the 205 firms responding to their survey in the first quarter of 2011, and Poterba and Summers (1995) report an average nominal (real) hurdle rate of 17.8% (12.2%) for the 228 firms responding to their survey in the fall of 1990.[11] There is also little variation in average discount rates across industry sectors (Panel A of Table A.1 in Appendix A.1).

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[3] We also solicited and received input from numerous finance academics in designing the questions and invited six CFOs from the Chicago area to a focus group meeting to test the survey with practitioners.

[4] We excluded financial firms (Standard Industrial Classification codes 6000–6999), regulated utilities (4900–4999), and services firms and those in industries with sizable not-for-profit or governmental institutional participation (7200+), but the sampling frame included private, over-the-counter, and closed firms that had data in Compustat. Of the 4,600 firms, 2,572 firms have valid data in CRSP.

[5] We received emails from the CFOs of most responding companies requesting an advance copy of the survey results and many respondents provided elaborate comments to open questions.

[6] Four of these firms do not use discounted cash flow (DCF) as their primary capital budgeting technique (two use payback and two return on investment as their primary method).

[7] Jagannathan, Meier, and Tarhan (2011) computed the market value of assets as the book value of debt plus the market value of equity, and reported summary statistics for the 93 firms for which we can merge Compustat data. The figures reported here exclude the six firms for which we cannot match CRSP data to compute beta and the outlier, which reduces the sample we report here to 86. Also, whereas Jagannathan, Meier, and Tarhan (2011) restricted the Compustat sample to firms for which all of the variables in that paper's main model were available, we do not apply that restriction and report the number of observations in Table 1 separately for each variable.

[8] The mean market-to-book ratio in the Compustat universe is sensitive to the choice of percentile for winsorizing. Winsorizing at 5% tails instead of 1% tails decreases the mean value for the Compustat sample from 4.55 to 2.90. Similarly, the ratio operating income-to-book assets changes from −0.20 to −0.05.

[9] In case a firm uses multiple methods, we asked the respondents to identify the two most important ones and rank them. The respondents chose from both discounted cash flow (DCF) methods (net present value, adjusted present value, internal rate of return, and profitability index) and non-DCF methods (payback, discounted payback, return on invested capital, and average rate of return).

[10] To convert to real terms, we subtract the ten-year expected inflation rate from the Cleveland Fed, which is available at http://www.clevelandfed.org/research.

[11] In their second quarter 2012 survey, Graham and Harvey (2012) report an average nominal (real) hurdle rate of 13.5% (12.0%) for 362 responding firms.

Table 1
Sample firm characteristics, 2003.
Mean and median firm characteristics are tabulated for the 86 survey respondents for which we can match data from Barra and Compustat, the subsample of 64 survey respondents that use WACC to assess their discount rate, and comparison firms from Compustat. The Compustat sample excludes the 86 survey firms and firms in SIC industries not included in our sampling frame: Financial firms (SIC codes 6000–6999), regulated utilities (4900–4999), and services firms and those in industries with sizable non-for-profit or governmental institutional participation (7200+). Book assets and sales are Compustat items *at* and *sale* (in millions of dollars), respectively; market value of assets is $at - ceq + csho \times prcc\_f$ (in millions of dollars); current ratio is current assets divided by current liabilities, act/lct; total debt is the sum of debt in current liabilities plus long-term debt, $dlc + dltt$; operating income is before depreciation, *oibd*; return on book equity is the ratio of net income to book common equity, ni/ceq; and number of employees is *emp*. All ratios are winsorized at the 1st and 99th percentiles. N is the number of observations. The last two columns show tests for differences in the firm characteristics between the survey firms and the non-responding firms in Compustat. We report the p-values for difference in means t-tests and Fisher's exact tests for difference in medians under the null hypothesis that the difference is zero.

Variable	Survey firms ($N = 86$)		WACC firms ($N = 64$)		Compustat			Difference tests: Compustat - Survey	
	Mean	Median	Mean	Median	N	Mean	Median	Mean	Median
Book assets	4,781	546	5,490	564	5,256	2,789	151	0.186	0.000
Market assets	9,653	881	11,146	961	4,635	4,615	259	0.021	0.000
Sales	4,484	414	5,164	477	5,228	2,322	130	0.067	0.001
Market-to-book assets	1.92	1.62	1.96	1.67	4,622	4.55	1.65	0.051	1.000
Sales-to-book assets	0.94	0.91	0.98	0.93	5,213	1.05	0.84	0.284	0.747
Cash-to-book assets	0.10	0.06	0.10	0.06	5,199	0.16	0.08	0.013	0.030
Current ratio	2.80	1.79	2.64	1.78	5,130	3.03	1.83	0.723	0.913
Total debt-to-book assets	0.25	0.21	0.25	0.24	5,230	0.38	0.21	0.116	1.000
Capital exp.-to-book assets	0.07	0.04	0.06	0.04	5,196	0.05	0.03	0.048	0.022
Operating inc.-to-book asset	0.10	0.12	0.11	0.12	5,193	−0.20	0.08	0.020	0.005
Return on book equity	0.02	0.07	0.04	0.07	5,209	−0.01	0.06	0.860	0.591
Book assets per employee	0.70	0.29	0.51	0.26	4,607	0.61	0.23	0.702	0.279

Our survey asks firms what their discount rate represents. Three out of four firms (74.4%) in our analytic sample respond that their discount rate represents their weighted average cost of capital (WACC); i.e., they use WACC to determine their cost of financial capital. Seven percent report using the levered cost of equity, three percent report the unlevered cost of equity, and the remaining firms report "other." Although we include all of these firms in our main analytic sample, we also verify that our conclusions are robust to examining only firms that use WACC (see Table OA.10 in Online Appendix OA.4.2).[12]

3. Discount rates and cost of financial capital

Using the identity of the survey respondents, we can compare the firms' discount rates to their cost of financial capital. We begin by examining whether firms use their cost of financial capital to discount cash flows as prescribed by the standard approach in capital budgeting in the absence of constraints. For firms responding in our survey that their discount rate represents their WACC, we model the discount rate, d_i, for firm i as WACC, w_i, plus a constant, π_0, and an idiosyncratic error, ε_i:

$$d_i = \pi_0 + w_i + \varepsilon_i. \tag{1}$$

Firms' use of the CAPM in capital budgeting has grown dramatically over the last 40 years, and most firms now use the CAPM to estimate their cost of equity capital. Graham and Harvey's (2001) survey finds that three out of four CFOs use the CAPM, and Jacobs and Shivdasani (2012) report that 90% do. Furthermore, the average respondent to our survey is larger than in Graham and Harvey's sample, and Graham and Harvey (2001) show that the use of the CAPM is even more widespread among large firms. We therefore follow common practice and compute the cost of equity, $r_{E,\,i}$, using the CAPM.

To analyze the relation between discount rates and costs of financial capital in a linear regression framework, we subtract all components of WACC that are not related to the systematic risk of the firm from both sides of Eq. (1).[13] If firms use WACC as their discount rate, then the self-reported discount rate minus the terms unrelated to the firm's systematic risk is a function of the firm's equity beta scaled by the weight of equity:

$$\begin{aligned} d_i - \frac{D_i}{D_i+E_i} r_{D,i}(1-\tau_i) - \frac{E_i}{D_i+E_i} r_{F,i} \\ = \pi_0 + \frac{E_i}{D_i+E_i}\beta_{MKT,i}\pi_{EP} + \varepsilon_i, \end{aligned} \tag{2}$$

where D_i is the book value of debt, E_i is the market value of equity, τ_i is the before financing marginal tax rate from Graham (1996a, 1996b), $r_{D,\,i}$ is the cost of debt imputed from the firm's estimated credit rating using the model of Jorion, Shi, and Zhang (2009), $r_{F,\,i}$ is the Treasury bond rate that matches firm i's average project life, $\beta_{MKT,\,i}$ is the Barra fundamental beta, and π_{EP} denotes the equity risk premium that firms use when implementing the CAPM. Our estimation of the risk-free rates and firms' cost of debt

[12] Panel B of Table A.1 in Appendix A.1 reports statistics characterizing the distribution of nominal discount rates conditional on what firms say that the discount rate represents. In all cases, the median discount rate is about 15%.

[13] As explained below, this approach allows us to estimate the equity risk premium that firms use. We find similar results if we instead assume that firms use an equity risk premium of either 3.83% (Graham and Harvey, 2005) or 7.50% (Fama and French, 2002), and subtract the entire cost of financial capital from both sides of Eq. (1). See Table OA.12 in Online Appendix OA.4.4.

is described in Online Appendix OA.3.1. As shown in Table OA.3 in Online Appendix OA.3.2, using other estimates of the CAPM beta yields similar results. We refer to the expression to the left of the equals sign in Eq. (2) as firm i's adjusted discount rate, $\tilde{d_i}$, where

$$\tilde{d_i} = d_i - \frac{D_i}{D_i + E_i} r_{D,i}(1 - \tau_i) - \frac{E_i}{D_i + E_i} r_{F,i}. \tag{3}$$

To simplify the notation further, we denote the scaled CAPM beta as $\tilde{\beta}_{MKT,i}$, where

$$\tilde{\beta}_{MKT,i} = \frac{E_i}{D_i + E_i} \beta_{MKT,i}. \tag{4}$$

For firms reporting that they use WACC to compute their cost of financial capital, we then regress the firms' adjusted discount rates on a constant and $\tilde{\beta}_{MKT,i}$ using ordinary least squares (OLS):

$$\tilde{d_i} = \pi_0 + \pi_{EP} \tilde{\beta}_{MKT,i} + \varepsilon_i, \tag{5}$$

where ε_i is an idiosyncratic error term. This regression provides an estimate of π_{EP}, the equity risk premium that managers use when applying CAPM.

There is not yet a consensus about what is the appropriate equity risk premium for capital budgeting. Fama and French (2002) argue that the historical average realized equity premium of about 7% overestimates the average expected equity premium, because discount rates have decreased over time. Fama and French (2002) estimate the expected equity premium to be 2.6–4.3% (see also Blanchard, 1993; Jagannathan, McGrattan, and Scherbina, 2001), and Graham and Harvey (2005) find that the average CFO reports using an equity risk premium in that range as well. Nevertheless, Fernández (2011, Fig. 2) finds that corporate finance textbooks, even after 2002, recommend an equity risk premium that averages around 6%. Given these differences, instead of assuming a particular value, we infer from the data what equity risk premium firms use.

Using equations similar to Eqs. (3) and (4), we transform the discount rates of the nine survey firms that indicate that they use their unlevered cost of equity or their levered cost of equity as their discount rate analogously. Appendix B describes these transformations. Thirteen firms indicate that their discount rate represents something else. Of these firms, those that describe their discount rate in free responses are vague, with about half mentioning perceived opportunities and the other half mentioning some form of risk. We introduce an indicator variable $OTHER_i$ that takes the value one for these firms (and zero otherwise) and set $\tilde{d_i} = d_i$ and $\tilde{\beta}_{MKT,i} = 0$. If we instead exclude firms that do not use WACC or treat all firms as if they use WACC, our conclusions do not change (see Tables OA.10 and OA.11 in Online Appendices OA.4.2 and OA.4.3). Including all firms, we estimate the following linear regression:

$$\tilde{d_i} = \pi_0 + \pi_{EP} \tilde{\beta}_{MKT,i} + \pi_{OTHER} OTHER_i + \varepsilon_i. \tag{6}$$

If our model is correctly specified, we expect the estimated intercept, $\hat{\pi}_0$, to be zero.

Table 2
Relating discount rates to cost of financial capital.
This table summarizes results from linear regressions. Column 1 reports results from regressions of firms' adjusted discount rate, $\tilde{d_i}$, on the firms' scaled CAPM beta, $\tilde{\beta}_{MKT,i}$, and an indicator, *OTHER*, for firms using a cost of financial capital other than WACC or unlevered or levered cost of equity. For the 64 firms using their WACC as their discount rate, the adjusted discount rate and scaled CAPM beta are defined as in Eq. (3) and Eq. (4); for the six firms using their unlevered cost of equity, they are defined as in Eq. (B.1) and Eq. (4); for the three firms using their levered cost of equity, they are defined as in Eq. (B.2) and Eq. (B.3); and for the 13 firms that use other methods to compute their cost of financial capital, $\tilde{d_i} = d_i$ and $\tilde{\beta}_{MKT,i} = 0$. If the model is correctly specified, the coefficient on $\tilde{\beta}_{MKT,i}$ is an estimate of the value that firms use for the equity risk premium. Column 2 reports results from regressions of firms' unadjusted discount rate, d_i, on the firms' unscaled CAPM beta, $\beta_{MKT,i}$. Robust standard errors are reported in parentheses. *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively.

Independent variable	(1) Adjusted discount rate and scaled beta	(2) Unadjusted discount rate and unscaled beta
$\tilde{\beta}_{MKT}$	0.0587***	
	(0.0129)	
β_{MKT}		0.0199
		(0.0123)
OTHER	0.1340***	0.0489***
	(0.0199)	(0.0167)
Constant	0.0550***	0.1242***
	(0.0105)	(0.0118)
N	86	86
R^2	0.424	0.163
Adjusted R^2	0.411	0.143

This specification test casts doubt on this benchmark model, whose estimates are reported in column 1 of Table 2. The estimated intercept, $\hat{\pi}_0$, is 5.50% and statistically different than zero at the 1% level. Although this difference suggests that the model suffers from an omitted variables bias (an issue that we return to address below), the estimates suggest that discount rates used in practice are indeed related to a firm's systematic risk, as the coefficient on scaled beta is statistically significant at the 1% level.

If we regress self-reported discount rates on CAPM beta without any adjustments, the coefficient on the CAPM beta is not significantly different from zero (see column 2 of Table 2).[14] Thus, the relation between d_i and $\beta_{MKT,\,i}$ is not statistically significant, whereas the relation between $\tilde{d_i}$ and $\tilde{\beta}_{MKT,i}$ is significant. This pattern is consistent with most firms indeed using WACC in determining their discount rates, as reported in their survey responses. By regressing discount rates on scaled CAPM betas, our specification takes into account the nonlinearity of the cost of financial capital's dependence on leverage and systematic risk, $\beta_{MKT,\,i}$. This nonlinearity may explain why Poterba and Summers (1995), who regress firms' discount rates on their unscaled CAPM betas, came to the conclusion that the discount rates that firms use are unrelated to beta

[14] As reported in Table OA.6 in Online Appendix OA.3.5, we find similar results if we restrict the sample to the 64 firms that use WACC to compute their cost of financial capital (column 1). In fact, if we include all of the other WACC components in the regression in addition to the CAPM beta, the adjusted R-squared is negative (column 2).

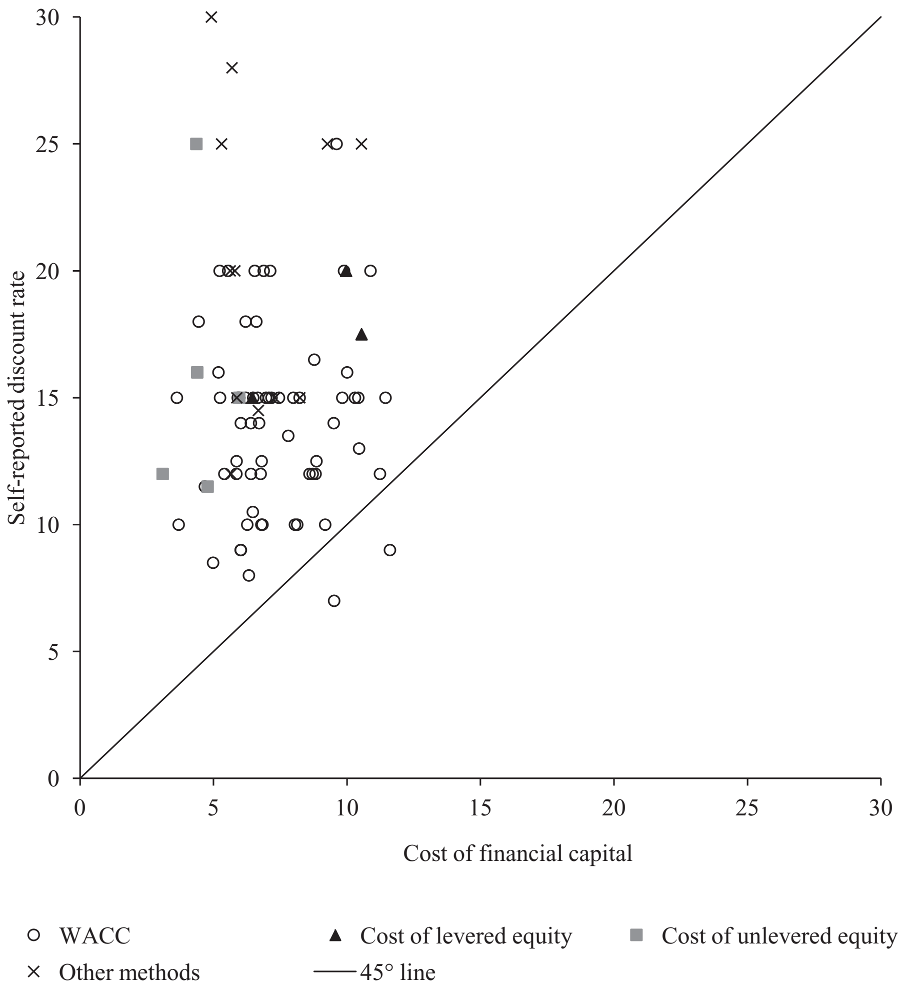

Fig. 1. Self-reported discount rate vs. cost of financial capital. The figure plots each survey firm's self-reported discount rate against its cost of financial capital. Cost of financial capital corresponds to either weighted average cost of capital (WACC), levered cost of equity, or unlevered cost of equity, depending on what method the firm says it uses (Question 15). For firms that use other methods, we compare their self-reported discount rate with the levered cost of equity. We use the capital asset pricing model (CAPM) to compute cost of equity together with the firm's fundamental beta from Barra, an equity risk premium of 3.83% (Graham and Harvey, 2005), a risk-free rate maturity-matched to the typical life of a project (Question 3), and a debt rate predicted using the model of Jorion, Shi, and Zhang (2009).

and, at the same time, three out of four CFOs tell Graham and Harvey (2001) that they account for systematic risk in determining their cost of equity. For the remainder of the analysis, we therefore assume that firms use WACC (or other method they specify) and thus analyze adjusted discount rates and scale betas accordingly.

The results in Table 2 are robust to different estimations of beta coefficients and marginal tax rates.[15] Furthermore, we explore the implications of using the Fama and French (1992) three-factor model, the Chen, Roll, and Ross (1986) macroeconomic factor model, and other multifactor models. The results are reported in Table OA.7 in Online Appendix OA.3.6. Estimating the cost of equity capital using such multifactor models instead of the CAPM does not change our conclusions. This result is consistent with Graham and Harvey (2001), who also find that few firms implement more complex, multifactor models.

Another way to examine the relation between discount rates and the cost of financial capital is to assume an equity risk premium and then compare the rates directly. Fig. 1 plots the discount rates that firms self-report against their cost of financial capital, assuming the equity risk premium that CFOs report in Graham and Harvey (2005). Depending on what each firm says that its discount rate represents, the horizontal axis measures its WACC, levered cost of equity, or unlevered cost of equity. Firms that report using another method to determine their discount rate (i.e., those responding "other") are compared against their levered cost of equity capital, which represents a plausible upper bound for their cost of financial capital.

[15] To compute WACC, we use the Barra fundamental beta. Using historical betas or Bloomberg shrinkage betas, which puts a weight of two-thirds on the historical beta and one-third on the CAPM market beta, yield similar estimates. Assuming a 0% or 34% tax rate, or using the firm's average tax rate, also yield similar estimates. For details, see Tables OA.3 and OA.4 in Online Appendices OA.3.2 and OA.3.3.

Table 3
Ratio of discount rate to cost of financial capital for survey firms.
The table reports summary statistics for the discount rate, the cost of financial capital, and the ratio of a firm's discount rate to its cost of financial capital. Discount rate is the self-reported discount rate from the survey (Question 6). Cost of financial capital is the firm's WACC, unlevered cost of equity, or levered cost of equity, depending on what the firm responds that its discount rate represents (Question 15). We compute the cost of financial capital using Compustat data, Barra fundamental beta, and the CAPM cost of equity. For firms using "other" methods, we use the levered cost of equity as their cost of financial capital. We show the statistics under two different assumptions for the equity risk premium: 3.83% (from Graham and Harvey, 2005) and 7.50% (a plausible upper bound as per Fama and French, 2002).

Panel A: Equity risk premium = 3.83%

	Discount rate (%)	Cost of financial capital (%)	Ratio
Mean	15.08	7.05	2.37
Median	15.00	6.62	2.11
25th percentile	12.00	5.68	1.60
75th percentile	16.50	8.70	2.71

Panel B: Equity risk premium = 7.50%

	Discount rate (%)	Cost of financial capital (%)	Ratio
Mean	15.08	9.85	1.70
Median	15.00	9.26	1.51
25th percentile	12.00	7.69	1.17
75th percentile	16.50	11.56	1.89

As illustrated in Fig. 1, there is much greater dispersion in firms' discount rates than in their costs of financial capital. Almost all firms' discount rates are greater than their cost of financial capital, many by a substantial margin, and consistent with the regression results, there is no apparent relation between the two variables. The two firms below the 45-degree line have high leverage ratios (64.1% and 84.8%, respectively). Due to their weak balance sheets, we estimate debt rates of 14.2% and 17.0% using the model of Jorion, Shi, and Zhang (2009), which coupled with the high leverage ratios lead to relatively high estimates of their cost of financial capital; these firms' self-reported discount rate may reflect plans to reduce their leverage.

To illustrate what fraction of the discount rate remains unexplained, we divide the discount rate that firms use by their cost of financial capital. This ratio is shown in Table 3 for two scenarios: one where we assume an equity risk premium of 3.83% as in Fig. 1, and another using an equity risk premium of 7.5%, which provides a plausible upper bound (Fama and French, 2002). The mean and median discount rates are more than twice as large as the cost of financial capital in the first scenario: although the firms' average cost of financial capital is about 8%, they use a mean (median) discount rate of 15.08% (15.00%). Even when assuming an expected excess return on equity over a risk-free rate of 7.5%, the ratios in Table 3 indicate that the mean and median discount rates are more than one and a half times the cost of financial capital.

Firms using discount rates exceeding their cost of financial capital is not unique to our sample or setting. Academic studies of capital budgeting have long recognized this practice as a market phenomenon (Dean, 1951). More recent surveys confirm this practice as well. In analysis of their first quarter 2011 Duke/CFO Magazine survey, Graham and Harvey (2011a) report an average discount rate of 14.8% and an average WACC of 10.0%. In the second quarter of 2012, firms report an average discount rate of 13.5% and average WACC of 9.3% (Graham and Harvey, 2012). The goal of our article is to shed light on why firms use such high discount rates.

4. Why do firms use discount rates above their cost of financial capital?

Given the above analysis, firms' discount rates appear to be greater than their cost of financial capital. This pattern implies that the average firm engages in capital rationing, whereby it passes over projects that appear to earn a positive financial return. We evaluate various hypotheses—including project portfolio constraints, managerial biases, and aversion to idiosyncratic risk—to explain why firms ration their capital by evaluating projects using discount rates that are substantially higher than their cost of financial capital.

4.1. Project portfolio constraints

The classic explanation for forgoing positive NPV projects is that the projects are mutually exclusive: taking these projects prevents taking other more valuable projects—either today or in the future—due to constraints that may be financial or operational in nature. We examine the extent to which such constraints explain firms' high discount rates.

4.1.1. Financial constraints

We first evaluate whether the firms are rationing capital because of financial constraints. Debt overhang from risky debt in the capital structure can prevent firms from taking all positive NPV projects (Myers, 1977).[16] To what extent do such financial constraints explain the high discount rates firms use in capital budgeting?

We begin by relating firms' discount rates to a self-reported measure of financial constraints. Our survey asks respondents whether they agree, on a scale from −2 (strongly disagree) to +2 (strongly agree), with the statement "There are some good projects we cannot take due to limited access to capital markets" (Question 20). The mean response to this question is −0.21 with a standard deviation of 1.44. Although firms, on average, do not consider themselves to be financially constrained, there is considerable dispersion. Fig. 2 reports the proportion of respondents giving each answer. About 14.1% strongly agree that they forgo positive NPV projects because of financial constraints and another 24.7% somewhat agree. We define an indicator variable, *FINC*, for these firms and test whether they use higher discount rates in capital budgeting. This measure is more direct than proxies that can be constructed from Compustat, such as leverage, Altman's *Z*-score, or the Kaplan-Zingales index.

16 Mello and Parsons (1992), Parrino and Weisbach (1999), Hennessy (2004), and Moyen (2007) estimate the magnitude of these costs.

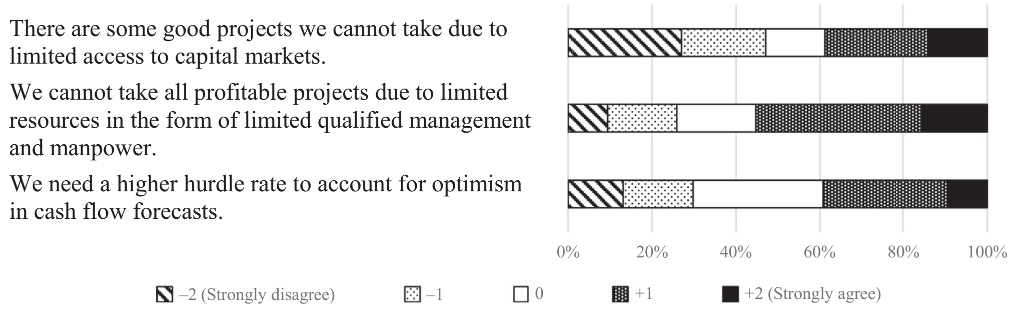

Fig. 2. Survey answers on reasons for using discount rates that exceed cost of financial capital. The figure summarizes the responses to Question 20: "To what extent do these statements agree with your company's views?" For each question, respondents answer on a scale from −2 (strongly disagree) to 2 (strongly agree).

Table 4
Variation in discount rates across survey responses and firm characteristics.

The table reports average discount rates, associated standard errors (in parentheses), and number of observations for various subsamples of firms. In each row, the variable in the first column is used to define the subsamples whose statistics are reported in the second and third columns. The last column reports *p*-values for difference in means *t*-tests between the two subsamples. The first three variables are derived from answers to Question 20 of the survey. For these variables, we divide firms based on whether the firms agree (+2 or +1 on a scale from –2 to +2) or disagree (–2 or –1) with the statement listed. The last four variables are derived from archival sources. *ALTZ* is an indicator variable for firms with an Altman *Z*-score greater than 2.99, *CASH* is the ratio of cash to total capital, *EVOLIND* is a measure of earnings volatility relative to other firms in the industry, and *IDIO* is a measure of the firm's idiosyncratic risk. For the last three variables, we divide firms based on whether they are above or below the sample median. The variables are defined in Table C.1.

Variable used to form subsamples	Agree (+2, +1)	Disagree (–2, –1)	*p*-Value of difference
Financial constraints ("There are some good projects that we cannot take due to limited access to capital markets.")	0.152 (0.009) 33	0.147 (0.007) 40	0.612
Operational constraints ("We cannot take all profitable projects due to limited resources in the form of limited qualified management and manpower.")	0.159 (0.007) 47	0.133 (0.006) 22	0.021
Optimism ("We need a higher hurdle rate to account for optimism in cash flow forecasts.")	0.145 (0.005) 33	0.148 (0.011) 25	0.799
	Financially healthy	Financially weak	
ALTZ	0.158 (0.007) 41	0.145 (0.007) 43	0.210
	Above median	Below median	
CASH	0.166 (0.008) 43	0.136 (0.005) 43	0.002
EVOLIND	0.154 (0.008) 40	0.149 (0.006) 40	0.644
IDIO	0.157 (0.008) 43	0.144 (0.006) 43	0.193

Table 4 reports the average discount rates used by firms who describe their project selection as being limited by financial constraints (answering +2 or +1) and that of those who do not (answering –2 or −1). The difference in average discount rates used by the two sets of firms is small and not statistically significant (p-value = 0.61). This simple difference in means, however, does not account for possible differences in systematic risk, leverage, or other factors between financially constrained and unconstrained firms.

To account for these factors, we estimate the following specification:

$$\tilde{d_i} = \pi_0 + \pi_{EP}\tilde{\beta}_{MKT,i} + \pi_{FINC}FINC_i + \pi_{OTHER}OTHER_i + \varepsilon_i. \tag{7}$$

The results, reported in column 1 of Table 5, also show no evidence of financially constrained firms using higher discount rates. Indeed, the point estimate is negative—opposite to what the hypothesis would predict—and not statistically significant.

We reach a similar conclusion when analyzing commonly used measures of financial constraints constructed from balance sheet data: Altman's Z-score, the current ratio, the market leverage ratio, and the Kaplan-Zingales index (from Lamont, Polk, and Saá-Requejo, 2001). Financial constraints are typically associated with low Z-scores, low current ratios, high leverage ratios, and high Kaplan-Zingales index values. Thus, if financial constraints lead firms to use higher discount rates, we would expect

Table 5
Financial constraints.

This table summarizes the results of linear regressions that include different measures of financial constraints in our baseline model. Column 1 repeats the results of the baseline model, where firms' discount rates are modeled as their cost of financial capital alone. The following specification is used in the remaining columns:

$$\tilde{d}_i = \pi_0 + \pi_{EP}\tilde{\beta}_{MKT,i} + \pi_{Financial\ constraints}Financial\ constraints_i + \pi_{OTHER}OTHER_i + \varepsilon_i.$$

The measures of financial constraints are: *FINC*, an indicator variable constructed from survey responses (column 2); *ALTZ*, an indicator variable for financially healthy firms with an Altman *Z*-score greater than 2.99 (column 3); *CR*, the current ratio (column 4); $D/(D+E)$, financial leverage (column 5); and *KZ*, the Kaplan-Zingales index (column 6). The variables are defined in Table C.1. Robust standard errors are reported in parentheses. *, **, *** indicate significance at the 10%, 5%, and 1% levels, respectively.

Independent variable	(1) Baseline model	(2) Survey answer	(3) Altman *Z*-score	(4) Current ratio	(5) Leverage ratio	(6) Kaplan-Zingales index
$\tilde{\beta}_{MKT}$	0.0587***	0.0596***	0.0527***	0.0463***	0.0361**	0.0535***
	(0.0129)	(0.0123)	(0.0146)	(0.0126)	(0.0145)	(0.0128)
FINC		−0.0129				
		(0.0108)				
ALTZ			0.0284***			
			(0.0101)			
CR				0.0048***		
				(0.0015)		
$D/(D+E)$					−0.0756***	
					(0.0244)	
KZ						−0.0114*
						(0.0061)
OTHER	0.1342***	0.1359***	0.1359***	0.1321***	0.1167***	0.1285***
	(0.0199)	(0.0202)	(0.0210)	(0.0199)	(0.0203)	(0.0209)
Constant	0.0550***	0.0593***	0.0456***	0.0506***	0.0884***	0.0661***
	(0.0105)	(0.0107)	(0.0108)	(0.0103)	(0.0147)	(0.0121)
N	86	85	84	85	86	85
R^2	0.424	0.432	0.479	0.498	0.483	0.432
Adjusted R^2	0.411	0.411	0.459	0.480	0.464	0.411

the coefficient from regressing adjusted discount rates on these variables to be negative for *Z*-score and the current ratio and to be positive for the leverage ratio and the Kaplan-Zingales index.

Table 5 reports the associations between discount rates and these proxies for financial constraints within a regression framework. All four Compustat-based measures are statistically significant but have the opposite sign. We find that firms that are subject to financial constraints inflate their discount rates by *less* than other firms, in contrast to what we would expect if capital constraints were the primary reason why firms inflate their cost of capital when evaluating projects.[17] Of course, financial constraints themselves would not lead a firm to lower its discount rate; but for some reason, financially unconstrained firms appear to add more of a premium to their cost of financial capital. Adding these proxies for financial constraints also does not reduce the estimated intercept, further suggesting that financial constraints do not explain what is missing in the baseline model.

Why would financially unconstrained firms add more of a premium to their cost of financial capital? We conjecture that firms with better investment opportunities are less likely to end up financially constrained. If these firms also face nonfinancial constraints (a possibility we investigate directly below), then they will choose to retain financial flexibility (DeAngelo, DeAngelo, and Whited, 2011) and be more selective in the projects they take so as not to crowd out better opportunities in the future. Indeed, Marchica and Mura (2010) and de Jong, Verbeek, and Verwijmeren (2012) show that conservative financial policy enhances firms' ability to invest. Thus, the negative coefficient that we estimate for the various proxies for financial constraints may reflect financially unconstrained firms' better investment opportunities and their need to inflate their discount rate to limit the number of projects they take due to *nonfinancial* constraints.

4.1.2. Operational constraints

If not financial, the constraints leading firms to ration capital could be operational in nature. Undertaking a project requires not only the financial capacity but also other inputs, including available physical capital, human capital, and managerial bandwidth. Taking on a large number of positive NPV projects can be limited by these factors as well. McDonald (1999) and Jagannathan and Meier (2002) argue that firms with limited managerial or organizational capital will not take every positive NPV project if their managers expect to find even better investment opportunities in the future. These models predict that such firms would screen their investment opportunities using discount rates that exceed their cost of financial capital.

[17] We find similar results when we compare the average discount rates of firms classified as financially healthy and financially weak based on their Altman *Z*-score (see Table 4) and firms with above and below median current ratio, leverage ratio, and Kaplan-Zingales index (see Table OA.8 in Online Appendix OA.3.7). For all four measures, financially healthy firms use higher average discount rates than financially weak firms, although the difference is only statistically significant for the current ratio ($p < 0.05$).

In their third quarter 2011 survey of CFOs, Graham and Harvey (2011b) ask participants whether they forgo positive NPV projects and, if yes, why.[18] More than half of the 420 responding CFOs (52.6%) affirm that they do not invest in all positive NPV projects even during normal economic times.[19] Of the reasons given for forgoing positive NPV projects, more than twice as many relate to operational constraints (shortage of management time and expertise, shortage of employees, shortage of production capacities, or supply chain cannot accommodate the project) than relate to financial constraints (shortage of funding). Human capital, in particular, appears to be an important operational factor. Of CFOs forgoing positive NPV projects, 58.4% cite a shortage of management time and expertise and 24.9% cite a shortage of employees. In contrast, only 7.2% cite a shortage of production capacity and only 3.2% cite supply chain issues.

Results from our survey also support the view that operational constraints are more relevant than financial constraints for most firms. More than half of our survey respondents agree somewhat (40.0%) or strongly (15.3%) with the statement “We cannot take all profitable projects due to limited resources in the form of limited qualified management and manpower” (Question 20). Fig. 2 reports the proportion of respondents giving each answer. The mean response on the −2 to +2 scale is 0.35 with a standard deviation of 1.20. Firms are more likely to self-identify as operationally constrained than as financially constrained, as the mean of 0.35 is significantly different than the mean of −0.21 for the question on financial constraints ($p < 0.01$).

Firms that report their project selection to be limited by operational constraints use higher discount rates than other firms. As reported in Table 4, firms that agree (+2 or +1) to being constrained by “limited qualified management and manpower” use an average discount rate of 15.9%, whereas firms that disagree (−2 or −1) use an average discount rate of 13.3%. The difference between the two is economically sizeable and statistically significant ($p=0.02$).

To explore the relation between operational constraints and discount rates in the regression framework, we construct an indicator variable, *OPC*, that takes the value of one when the firm agrees that their projects are constrained by limited qualified management or manpower, and zero otherwise. We add this variable to our baseline specification (from column 1 of Table 2), which models discount rates as a function of WACC (and other costs of financial capital), and estimate the following specification:

$$\tilde{d}_i = \pi_0 + \pi_{EP}\tilde{\beta}_{MKT,i} + \pi_{OPC}OPC_i + \pi_{OTHER}OTHER_i + \varepsilon_i. \quad (8)$$

As reported in column 1 of Table 6, the coefficient on operational constraints is positive, but noisy and not statistically significant. The point estimate is consistent with organizationally constrained firms using higher discount rates to preserve organizational capacity for future projects, but the results are hardly dispositive.

The concern that operational constraints might bind in the future is most relevant for companies that expect to face better investment opportunities. Such firms also tend to hoard cash to avoid the cost and time of raising external funds. Because firms with many valuable growth options often suffer from asymmetric information between investors and the firm, holding cash assures that they have the financial flexibility to exploit their growth options at short notice without incurring excessive costs. Indeed, Simutin (2010) shows that firms with large cash balances invest more in the future and interprets excess cash holdings to be a proxy for risky growth options. Asvanunt, Broadie, and Sundaresan (2011) show that future investment and growth options provide a strong incentive for accumulating cash balances, and Opler, Pinkowitz, Stulz, and Williamson (1999) document that firms holding high levels of cash indeed subsequently engage in more acquisition activity. Furthermore, Ferreira and Vilela (2004) observe that firms with richer investment opportunities, and firms with high cash flows, exhibit larger cash holdings. Thus, we analyze the ratio of cash to total assets as a measure of investment opportunities. If operational constraints

Table 6
Financial flexibility, financial constraints, and operational constraints.

This table contains the results of linear regressions that include measures of operational constraints, financial flexibility, and financial constraints in our baseline model:

$$\tilde{d}_i = \pi_0 + \pi_{EP}\tilde{\beta}_{MKT,i} + \pi_{OPC}OPC_i + \pi_{CASH}CASH_i + \pi_{FINC}FINC_i + \pi_{OTHER}OTHER_i + \varepsilon_i,$$

where *OPC* and *FINC* are indicator variables of operational constraints and financial constraints, respectively, constructed from survey responses, and *CASH* is the ratio of cash to total capital. The specification reported in column 1 inserts only *OPC* into the baseline model; the specification reported in column 2 inserts only *CASH*; and the specification reported in column 3 inserts all three variables. The variables are defined in Table C.1. Robust standard errors are reported in parentheses. *, **, *** indicate significance at the 10%, 5%, and 1% levels, respectively.

Independent variable	(1) Operational constraint survey answer	(2) Financial flexibility	(3) Operational and financial constraints survey answers
$\tilde{\beta}_{MKT}$	0.0575***	0.0422***	0.0384***
	(0.0127)	(0.0135)	(0.0121)
OPC	0.0127		0.0227***
	(0.0100)		(0.0084)
CASH		0.1698***	0.2130***
		(0.0483)	(0.0503)
FINC			-0.0348***
			(0.0092)
OTHER	0.1322***	0.1243***	0.1231***
	(0.0207)	(0.0185)	(0.0182)
Constant	0.0492***	0.0516***	0.0514***
	(0.0114)	(0.0113)	(0.0107)
N	85	86	85
R^2	0.432	0.512	0.583
Adjusted R^2	0.411	0.494	0.557

[18] The exact formulation of the question is: “During normal economic times, does your company pursue all investment projects that you estimate will have positive net present value (do you pursue all projects that you expect to earn a return that exceeds the project’s hurdle rate)?”

[19] Graham and Harvey (2011a, 2012) report an even higher percentage of firms responding that they forwent a positive NPV project during the recent financial crisis (66.8% and 70.5%).

bind, then we would expect firms with large cash holdings to use high discount rates.

Firms with large cash holdings indeed use high discount rates in capital budgeting. In Table 4, we compare the average discount rates of firms with above and below median cash holdings. The average discount rate of firms with above median cash-to-total capital is 16.6%, and the average discount rate of firms with below median cash-to-total capital is 13.6%. The difference is economically sizeable and statistically significant ($p < 0.01$). Regression analysis that includes cash holdings in our baseline model confirms this finding. As reported in column 2 of Table 6, the coefficient on cash holdings is positive, sizeable, and statistically significant at the 1% level. A one-standard deviation increase in cash holdings (0.109) is associated with firms using a 1.9 percentage point higher discount rate. Including cash holdings also increases the adjusted R-squared of the model from 0.411 to 0.494.[20]

Although firms hoard cash when they expect to have many investment opportunities in the future, they might also hoard cash when they expect to be financially constrained (Almeida, Campello, and Weisbach, 2004; Faulkender and Wang, 2006; Pinkowitz, Stulz, and Williamson, 2006; and Denis and Sibilkov, 2010). Although, based on this result alone, one might wonder whether the importance of cash is actually due to financial constraints, the large set of evidence in Table 5 casts doubt on this interpretation.

Furthermore, in analysis reported in column 3 of Table 6, we examine both financial and operational constraints simultaneously. Controlling for financial flexibility as measured by the cash-to-total capital ratio, the coefficient on the operational constraints indicator variable is positive and statistically significant at the 1% level. Firms with limited qualified management or manpower use higher discount rates by 2.3 percentage points. With these controls, the survey indicator for financial constraints is negatively related to discount rates, similar to the analysis of the other proxies reported in Table 5. The positive coefficient for cash holdings is larger than before and consistent with the view that operationally constrained firms hoard cash in preparation for future investment opportunities. Taken together, these results suggest that investment opportunities and operational constraints lead firms to increase their discount rates.

4.2. Managerial biases

Managerial biases might also affect capital allocation. In this section, we examine whether two biases that have received wide attention in the literature—managers' optimism and myopia—might explain why firms screen projects using discount rates that are higher than their cost of financial capital.

4.2.1. Optimism

One possibility is that firms use high discount rates to guard against overly optimistic cash flow forecasts. Managers may overstate their cash flow forecasts due to a psychological bias or as a strategic response to organizational incentives. Heaton (2002) models optimistic managers who overstate their cash flow forecasts even though they aim to act in the interest of shareholders. Harris, Kriebel, and Raviv (1982), Antle and Eppen (1985), and Harris and Raviv (1996) model information asymmetries and agency conflicts between headquarters and division managers. In these models, division managers' desires either to shirk or to empire build lead to moral hazard. In Harris and Raviv (1996), for example, headquarters has the incentive to ration capital strategically to counter division managers' overstatement of projected cash flows.

We find that this hypothesis does not resonate with most managers. In our survey, only 9.5% of the respondents strongly agree that they adjust their discount rate upward "to account for optimism in cash flow forecasts" (another 29.8% somewhat agree; Question 20).[21] Indeed, on a scale from −2 (strongly disagree) to +2 (strongly agree), the mean is 0.05 with a standard deviation of 1.17. Fig. 2 reports the full distribution of responses. As reported in Table 4, firms that agree (+2 or +1) and firms that disagree (-2 or -1) use similar discount rates (14.5% and 14.8%, respectively; $p=0.80$). To further examine if managerial optimism can explain discount rates, we add an indicator variable, *OPTI*, which takes the value of one when firms agree and zero otherwise, to our baseline regression model. Specifically, we estimate the following specification:

$$\tilde{d}_i = \pi_0 + \pi_{EP}\tilde{\beta}_{MKT,i} + \pi_{OPTI}OPTI_i + \pi_{OTHER}OTHER_i + \varepsilon_i. \tag{9}$$

As reported in column 1 of Table 7, we do not find that the firms expressing some concern about managerial optimism in the survey actually use higher discount rates to evaluate projects. The estimated coefficient $\hat{\pi}_{OPTI}$ is negative and statistically insignificant. Relative to the baseline specification, which is reported in column 1 of Table 2 and models discount rates as a function of the cost of financial capital alone, the adjusted R-squared decreases slightly from 0.411 to 0.403.

To corroborate this survey finding, we also examine the relation between discount rates and the number of business segments. Within a firm with more business segments, there is greater competition among divisional managers to attract funding for their projects and it is often more difficult for headquarters to directly evaluate these projects. Together, these features of multisegment firms can create an incentive to report optimistic cash flow forecasts (Rajan, Servaes, and Zingales, 2000; Stein, 2002; McNeil and Smythe, 2009; and Xuan, 2009). Thus, one might expect CFOs of firms with more business segments to use higher discount rates to guard against inflated cash flow

[20] Financial flexibility can be in the form of unused debt capacity and low debt ratios and/or high cash balances. In further analysis, we find that adding the debt-to-assets ratio to the specification reported in column 2 indeed further increases the adjusted R-squared to 0.544. In this specification, the coefficient for $\tilde{\beta}_{MKT,i}$ decreases to 0.0209; because $\tilde{\beta}_{MKT,i}$ is scaled by one minus the debt-to-asset ratio, $\tilde{\beta}_{MKT,i}$ and the debt-to-asset ratio are highly correlated (−0.397).

[21] This is comparable with the 12.4% of the responses in Graham and Harvey (2011b) that refer to optimistic projections as the reason why their firm does not pursue all available positive NPV projects.

Table 7
Managerial optimism.
This table summarizes the result of linear regressions that include different measures of optimistic cash flow forecasts in our baseline model:

$$\tilde{d}_i = \pi_0 + \pi_{EP}\tilde{\beta}_{MKT,i} + \pi_{Optimism}Optimism_i + \pi_{OTHER}OTHER_i + \varepsilon_i.$$

The measures of optimism are: *OPTI*, an indicator variable constructed from survey responses (column 1); *SEGM*, the firm's number of business segments (column 2); indicator variables, *SEG*4−10 and *SEG*>10, for whether the firm has between four and ten or greater than ten business segments (column 3); *HERF*, the firm's concentration of business segments (column 4); and *SIZE*, the market value of the firm's assets (column 5). The variables are defined in Table C.1. Robust standard errors are reported in parentheses. *, **, *** indicate significance at the 10%, 5%, and 1% levels, respectively.

Independent variable	(1) Survey answer	(2) # Business segments	(3) Categorical business segments	(4) Concentration of business segments	(5) Firm size
$\tilde{\beta}_{MKT}$	0.0567***	0.0585***	0.0588***	0.0589***	0.0570***
	(0.0130)	(0.0128)	(0.0127)	(0.0130)	(0.0128)
OPTI	−0.0136				
	(0.0096)				
SEGM		−0.0008			
		(0.0009)			
*SEG*4−10			0.0027		
			(0.0116)		
SEG>10			−0.0042		
			(0.0121)		
HERF				0.0038	
				(0.0185)	
SIZE					−0.0031
					(0.0025)
OTHER	0.1331***	0.1322***	0.1338**	0.1341***	0.1331***
	(0.0199)	(0.0205)	(0.0205)	(0.0201)	(0.0192)
Constant	0.0624	0.0606***	0.0554***	0.0536***	0.0772***
	(0.0121)	(0.0122)	(0.0120)	(0.0127)	(0.0199)
N	84	86	86	86	86
R^2	0.425	0.428	0.426	0.425	0.437
Adjusted R^2	0.403	0.407	0.398	0.404	0.416

forecasts from divisional managers. We test whether discount rates are related to the number of business segments using either a continuous measure or indicator variables for 4−10 and more than ten business segments. Columns 2 and 3 of Table 7 summarize the results for these two predictors of firms' exposure to optimistic cash flow forecasts. In both specifications, the coefficients are close to zero, and the adjusted *R*-squared is lower than in the baseline model.

We also examine two additional predictors of firms' exposure to optimistic cash flow forecasts: diversification as measured by the Herfindahl index and firm size as measured by the natural logarithm of the market value of assets. One might argue that internal capital markets are more prone to empire-building behavior within diversified firms, because firms that are more diversified tend to be more decentralized, so there is likely a greater scope for reporting inflated divisional cash flow forecasts to compete for funding. Furthermore, irrespective of the number of divisions, competition for funding may be greater in large firms than in small firms, in which case managers of larger firms might be more likely to confront inflated divisional cash flow projections. So if managers adjust for optimism, we would expect a positive coefficient when regressing discount rates on diversification (column 4) or firm size (column 5), but we instead find neither to be sizeable or statistically significant.

In all, these results support the survey's finding that most firms do not systematically add a premium to their cost of financial capital to account for optimistic cash flows.

4.2.2. Myopia

Another possibility is that mangers inflate discount rates because they are myopic. By using discount rates that exceed the cost of financial capital when evaluating investment decisions, myopic managers forgo profitable long-term investment opportunities in order to reduce current expenditures and increase current earnings. Stein (1989) shows that such myopic corporate behavior can persist even though the market is not fooled in equilibrium. Indeed, in Graham, Harvey, and Rajgopal's (2005) survey, CFOs acknowledge myopic corporate behavior: the vast majority of CFOs of publicly traded corporations say they would forgo a positive NPV project if it would entail falling short of the current quarter's consensus earnings forecast (e.g., 80% would decrease discretionary spending and 55% would delay starting a new project). Virtually all CFOs also prefer smooth earnings paths, and 78% admit that they would sacrifice long-term value to smooth earnings (Graham, Harvey, and Rajgopal, 2005).

We use various measures to capture a firm's propensity to adopt myopic behavior when taking investment decisions. First, to explore the role of earnings smoothing, we test whether firms with higher earnings volatility relative to their industry use higher discount rates. Specifically, we examine the variable *EVOLIND*, which is the standard deviation of the firm's changes in annual returns on book

Table 8
Managerial myopia.
This table summarizes the results of linear regressions that include different measures of managerial myopia in our baseline model:

$$\tilde{d_i} = \pi_0 + \pi_{EP}\tilde{\beta}_{MKT,i} + \pi_{Myopia}Myopia_i + \pi_{OTHER}OTHER_i + \varepsilon_i.$$

The measures of managerial myopia are: *EVOLIND*, earnings volatility relative to other firms in the industry (column 1); *ESURPR*, the average absolute percent difference between earnings per share forecasts and actual earnings (column 2); *INDERC*, the observed sensitivity of stock prices to earnings news in the industry (column 3); *INDHHI*, sales concentration of firms in the industry (column 4); and *MKTSHARE*, the firm's market share (column 5). The variables are defined in Table C.1. Robust standard errors are reported in parentheses. ∗, ∗∗, ∗∗∗ indicate significance at the 10%, 5%, and 1% levels, respectively.

Independent variable	(1) Earnings management	(2) Earnings surprises	(3) Industry earnings response	(4) Industry Herfindahl index	(5) Market share
$\tilde{\beta}_{MKT}$	0.0529∗∗∗	0.0562∗∗∗	0.0578∗∗∗	0.0559∗∗∗	0.0598∗∗∗
	(0.0144)	(0.0159)	(0.0130)	(0.0135)	(0.0130)
EVOLIND	0.0086				
	(0.0128)				
ESURPR		−0.0117			
		(0.0144)			
INDERC			−0.0322		
			(0.0355)		
INDHHI				−0.0683	
				(0.0583)	
MKTSHARE					−0.0111
					(0.1110)
OTHER	0.1295∗∗∗	0.1385∗∗∗	0.1315∗∗∗	0.1312∗∗∗	0.1358∗∗∗
	(0.0215)	(0.0228)	(0.0206)	(0.0210)	(0.0202)
Constant	0.0546∗∗∗	0.0614∗∗∗	0.0625∗∗∗	0.0615∗∗∗	0.0535∗∗∗
	(0.0119)	(0.0169)	(0.0140)	(0.0130)	(0.0111)
N	80	71	86	86	86
R^2	0.436	0.448	0.427	0.429	0.431
Adjusted R^2	0.414	0.424	0.407	0.408	0.410

assets (i.e., earnings before interest divided by book assets) over the previous ten years divided by the average standard deviation of changes in annual returns on book assets among other firms in the same two-digit Standard Industrial Classification (SIC) industry. As reported in Table 4, firms with above and below median values for this variable use similar discount rates (15.4% and 14.9%, respectively; $p = 0.64$). To account for differences in firms' costs of financial capital, we estimate:

$$\tilde{d_i} = \pi_0 + \pi_{EP}\tilde{\beta}_{MKT,i} + \pi_{EVOLIND}EVOLIND_i + \pi_{OTHER}OTHER_i + \varepsilon_i. \quad (10)$$

The results, reported in column 1 of Table 8, find no relation between relative earnings volatility and discount rates. We similarly find no relation if we examine the variable's mean absolute deviation from trend using the Hodrick-Prescott filter instead of the standard deviation of annual changes.

Firms' propensities to deviate from consensus earnings forecasts also appear to be unrelated to discount rates. We examine the average absolute value of earnings surprises, measured by the difference between the median consensus earnings forecast from the Institutional Brokers' Estimate System (I/B/E/S) and the actual earnings, scaled by the actual earnings. As reported in column 2, the coefficient on earnings surprises is small and insignificant.

Other business conditions that might lend themselves to short-termism also show little connection to discount rates. For example, a manager's incentive for myopic behavior is exacerbated when the firm's share price reacts sharply to earnings news. Asker, Farre-Mensa, and Ljungqvist (2015) therefore use the earnings response coefficient (ERC) of Ball and Brown (1968), estimated separately for each industry as in Easton and Zmijewski (1989), as a measure for the investment sensitivity of a given industry. When we include the ERC in our model of discount rates, the coefficient estimate is negative and statistically insignificant. In column 3, we report estimates that calculate the ERC using three-day returns and the Fama-French 30-industry classification, but the results are similar when using returns calculated over different periods or different industry classification schemes.

Because investors often evaluate firms based on their performance relative to industry peers, one might expect firms in more competitive industries to be more short-term. We thus use Compustat to define a Herfindahl index that measures market concentration among public companies in the firm's two-digit SIC industry, *INDHHI*. After adding this measure to the benchmark model, the coefficient estimate, reported in column 4, is insignificant. Finally, within an industry, investors are likely to give more leeway to firms with better track records of success, allowing these firms to act less short-term. Thus, if the high discount rates are myopic, one might expect firms that are market leaders to use them less. Using Compustat, we compute each firm's market share within its two-digit SIC industry and add it to our baseline model. But similar to the other tests for managerial myopia, we find that the coefficient estimate, reported in column 5, is statistically insignificant.

In sum, we conclude that managerial myopia is not the primary motivation for firms' capital rationing in our sample.

4.3. Aversion to idiosyncratic risk

A final possible explanation is that firms' high discount rates reflect their idiosyncratic risk in addition to their systematic risk. The preferences of either investors or managers could lead firms to account for idiosyncratic risk in capital budgeting. If investors are not well-diversified, then their required return will increase with their exposure to idiosyncratic risk. In this scenario, the high capital budgeting discount rates could reflect firms' true cost of financial capital being greater than WACC. Goetzmann and Kumar (2008) show that a large fraction of households are indeed poorly diversified, and the market appears to price idiosyncratic risk (e.g., Fu, 2009; Huang, Liu, Rhee, and Zhang, 2010).

Even if a particular firm's shareholders do not price idiosyncratic risk, managers' career concerns might lead them to account for idiosyncratic risk in capital budgeting decisions. Bankruptcy risk and poor corporate performance endanger managers' reputation and job security. The resulting aversion to firm-specific risk could lead managers to make conservative investment decisions and to apply higher discount rates in evaluating projects (Holmström, 1999). If managers' (rather than shareholders') aversion to idiosyncratic risk explains why discount rates are greater than WACC, then this would be a form of capital rationing. Unlike most of the other motivations for rationing explored above, this rationing would benefit managers but not the firm.

Although we cannot distinguish between these possible motivations, both stated and revealed preference suggest that firms appear to consider idiosyncratic risk in capital budgeting. To avoid the technical term idiosyncratic risk, our survey asked about the importance of "project risk that is unique to the firm and unrelated to the state of the economy." Almost two-thirds of respondents report that idiosyncratic risk is important (+2 or +1) in determining their firm's discount rate (65.4%), about the same number as for market risk (63.4%). The complete distributions of these responses are reported in Fig. A.1 in Appendix A.2.

Idiosyncratic risk is a subtle concept to communicate in a survey question. In case some respondents misunderstood the question, we also examine the importance of idiosyncratic risk for capital budgeting directly by analyzing the relation between discount rates and idiosyncratic risk. We measure idiosyncratic risk, *IDIO*, as one minus the *R*-squared from regressing the firm's excess return on the market portfolio's value-weighted return using monthly data over the previous five years. In Table 4, we compare the average discount rates of firms with above and below median idiosyncratic risk. Firms with above median idiosyncratic risk use higher average discount rates (15.7% vs. 14.4%). Although this unconditional difference is not statistically significant ($p=0.19$), it understates the importance of idiosyncratic risk because sample firms with above median idiosyncratic risk also have lower CAPM beta (0.9 vs. 1.0; $p=0.18$) and lower cost of financial capital (6.6% vs. 7.5%, assuming an equity risk premium of 3.83%; $p=0.07$). To examine the importance of idiosyncratic risk while controlling for systematic risk, we add idiosyncratic risk to the baseline model using the following specification:

$$\tilde{d_i} = \pi_0 + \pi_{EP}\tilde{\beta}_{MKT,i} + \pi_{IDIO}IDIO_i + \pi_{OTHER}OTHER_i + \varepsilon_i. \tag{11}$$

The results are reported in Table 9, column 1. The coefficient on idiosyncratic risk is positive and significant at the 1% level and the adjusted *R*-squared increases to 0.438. One-standard deviation greater idiosyncratic risk (0.117) is associated with firms using a 1.1 percentage point higher discount rate. This association is about half that of discount rates' association with systematic risk.[22] We conclude that idiosyncratic risk plays a role in firms' capital budgeting.

4.4. Putting it all together

Based on these findings, we model discount rates as a function of operational constraints, proxies for investment

Table 9
Idiosyncratic risk and a combined model.

This table summarizes the results of linear regressions that add different variables to our baseline model. In column 1, we include *IDIO*, a measure of the firm's idiosyncratic risk:

$$\tilde{d_i} = \pi_0 + \pi_{EP}\tilde{\beta}_{MKT,i} + \pi_{IDIO}IDIO_i + \pi_{OTHER}OTHER_i + \varepsilon_i.$$

In column 2, we report results from the following model:

$$\tilde{d_i} = \pi_0 + \pi_{EP}\tilde{\beta}_{MKT,i} + \pi_{OPC}OPC_i + \pi_{CASH}CASH_i + \pi_{FINC}FINC_i + \pi_{IDIO}IDIO_i + \pi_{OTHER}OTHER_i + \varepsilon_i,$$

where *OPC* and *FINC* are indicator variables of operational constraints and financial constraints, respectively, constructed from survey responses, and *CASH* is the ratio of cash to total capital. The variables are defined in Table C.1. Robust standard errors are reported in parentheses. *, **, *** indicate significance at the 10%, 5%, and 1% levels, respectively.

Independent variable	(1) Idiosyncratic risk	(2) Combined model
$\tilde{\beta}_{MKT}$	0.0602***	0.0418***
	(0.0131)	(0.0116)
IDIO	0.0939***	0.0888**
	(0.0345)	(0.0421)
OPC		0.0222***
		(0.0083)
CASH		0.2031***
		(0.0500)
FINC		−0.0373***
		(0.0094)
OTHER	0.1319***	0.1227***
	(0.0195)	(0.0175)
Constant	−0.0289	−0.0274
	(0.0326)	(0.0397)
N	86	85
R^2	0.458	0.611
Adjusted R^2	0.438	0.582

[22] In our ultimate specification, which accounts for operational constraints and investment opportunities in addition to idiosyncratic risk, one-standard deviation greater systematic risk, as measured by scaled-beta (0.458), is associated with a 1.9 percentage point higher discount rate.

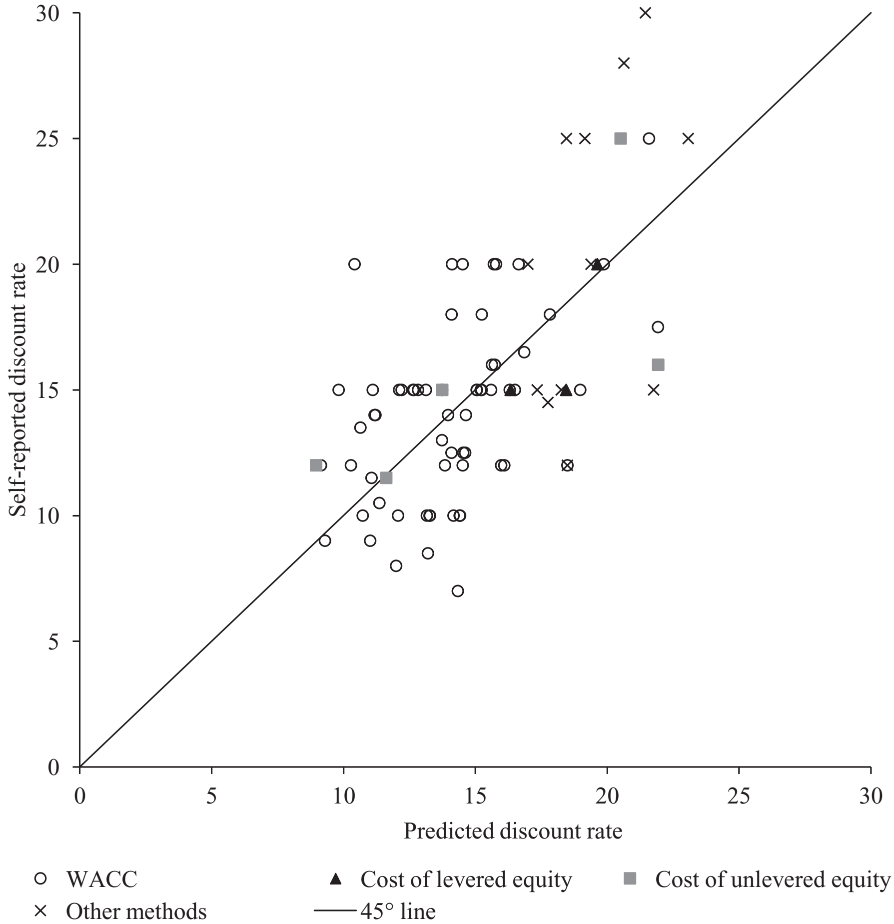

Fig. 3. Self-reported vs. predicted discount rates. The figure plots each survey firm's self-reported discount rate, d_i, against the discount rate implied by the model described by Eq. (12) and reported in column 2 of Table 9.

opportunities, and idiosyncratic risk as follows:

$$\tilde{d}_i = \pi_0 + \pi_{EP}\tilde{\beta}_{MKT,i} + \pi_{OPC}OPC_i + \pi_{CASH}CASH_i + \pi_{FINC}FINC_i + \pi_{IDIO}IDIO_i + \pi_{OTHER}OTHER_i + \varepsilon_i. \quad (12)$$

As shown in column 2 of Table 9, all of the estimated coefficients' signs and significance levels are the same as when we test the hypotheses individually. Including the intercept term, the model estimates seven parameters using 85 observations. An F-test rejects that all six slope coefficients equal zero: the F-test statistic has a value of 15.60 ($p < 0.001$). The model's adjusted R-squared is 0.582 which is almost 1.5 times the adjusted R-squared of 0.411 of the baseline model in which the cost of financial capital is the only explanatory variable (see Table 2, column 1).

The model in Eq. (12) passes the specification test: the estimated regression intercept is small and not statistically different than zero. In absolute value, the estimated intercept is half that of the baseline model. The estimated equity risk premium of 4.18% is statistically indistinguishable from the 3.83% reported in Graham and Harvey (2005) and corroborates their survey finding that CFOs use an equity risk premium that is lower than the historical average.

The model's improved fit is evident from a simple plot of firms' self-reported discount rates against their predicted rates from the model in Eq. (12). In the plot, which is presented in Fig. 3, the data points are aligned closer to the 45-degree line. The pattern provides a stark contrast to Fig. 1, which plots the same discount rates against firms' cost of financial capital and shows that many firms' discount rates are greater than their cost of financial capital by a substantial margin.

In sum, we confirm using archival data that firms' CAPM beta and WACC are important inputs to the capital budgeting process. Nevertheless, although exceeding the cost of financial capital is typically a necessary condition for investment, it is often not sufficient. Firms use higher discount rates, but not all firms add the same "fudge factor." Rather, there is logic in how firms supplement their WACC: firms expecting plentiful investment opportunities, binding operational constraints, and high idiosyncratic risk increase their discount rate the most.

5. Conclusions

In capital budgeting, most firms use discount rates that exceed their cost of financial capital by a wide margin. While firms use discount rates that are on average about twice their cost of financial capital, there is substantial variation in this difference across firms. Using survey data that includes the identities of the responding firms, we match firms' discount rates with their actual cost of financial capital and other data from Compustat, CRSP, and other sources. We use these data to develop a model of the discount rates that firms use in capital budgeting. In the process, we confirm that, in calculating their cost of financial capital, firms use an equity risk premium that is much lower than the realized historical average.

We find that, although most firms use WACC as a basis for their discount rates, they almost always augment it before using it to evaluate projects. The firms adding the biggest premiums are exposed to high levels of idiosyncratic risk and maintain large cash holdings. Because these firms are not financially constrained based on either survey or accounting measures, we conclude that they anticipate valuable investment opportunities to arise in the future and hoard cash to position themselves to exploit those opportunities as soon as they emerge.

But even when firms are not financially constrained, operational issues can prevent them from taking all profitable opportunities. For example, it takes time to expand a workforce, particularly one reliant on firm-specific human capital. Limited managerial bandwidth can also force firms to forgo profitable projects. We find that firms in such circumstances inflate their discount rates above their cost of financial capital to account for such constraints.

While most of the literature on corporate investment focuses on financial constraints to explain why firms forgo positive NPV projects, our findings suggest that operational issues, such as organizational and managerial bandwidth, are more important for many firms. Understanding the nature of these organizational constraints is an important area for further research.

Appendix A. Summary of select survey responses

A.1. Discount rates by industry and by cost of capital method

Table A.1 reports average nominal discount rates separately by industry and by what firms say that the discount rate represents. As reported in Panel A, there is little variation across industries. The lowest industry average discount rate is 12.3% (transportation and communication) and the highest is 15.8% (manufacturing). There is greater variation within industries; for example, firms in the manufacturing sector use discount rates ranging from 7% to 30%. As reported in Panel B, the discount rates of firms using WACC are somewhat lower (14.0%) than those of firms using levered cost of equity (16.7%), unlevered cost of equity (17.4%), or something else (18.9%). As shown in Fig. 1, firms using something else comprise four of the seven firms with the largest self-reported discount rates. In all subsamples, however, the median discount rate is about 15%.

A.2. Self-reported determinants of discount rates

The questionnaire includes questions to assess whether firms use CAPM in determining the discount rate they use to evaluate projects, or whether they use more complex multifactor models and/or adjust for other factors. Fig. A.1 shows the results of three such questions from the survey. Responses were given on a scale from −2 (not important) to 2 (very important).

Appendix B. Adjusting discount rates of firms using their unlevered or levered cost of equity

Six (three) firms indicate in the survey that they use their unlevered (levered) cost of equity as their cost of financial capital (Question 15). For these nine firms we modify our definition of the adjusted discount rate, $\tilde{d}_i$, in

Table A.1
Discount rates by industry and by firms' cost of capital method.
The table shows summary statistics for survey firms' self-reported nominal discount rate (Question 6). Summary statistics are grouped by one-digit SIC industry (from Compustat) in Panel A and by what firms say their discount rate represents (Question 15) in Panel B.

Panel A: Discount rates by industry

Industry	SIC	N	Mean	Median	Std. dev.	25th quantile	75th quantile
Mining, construction	1	10	14.95	14.25	3.86	12.00	20.00
Manufacturing	2, 3	55	15.77	15.00	5.24	12.00	20.00
Transport, communication	4	10	12.30	12.00	2.10	11.50	15.00
Wholesale, retail	5	9	14.22	15.00	2.24	15.00	15.00
Hotels, motels, apartments	6, 7[a]	2	14.50	14.50	0.71	14.00	15.00
Total		86	15.08	15.00	4.62	12.00	16.50

Panel B: Discount rates categorized by what they represent

Method	N	Mean	Median	Std. dev.	25th quantile	75th quantile
WACC	64	14.01	14.50	3.65	11.75	15.00
Unlevered cost of equity	6	17.42	15.50	6.12	12.00	25.00
Levered cost of equity	3	16.67	15.00	2.89	15.00	20.00
Other	13	18.92	15.00	6.23	15.00	25.00
Total	86	15.08	15.00	4.62	12.00	16.50

[a] The four-digit SIC codes are 6513 and 7011.

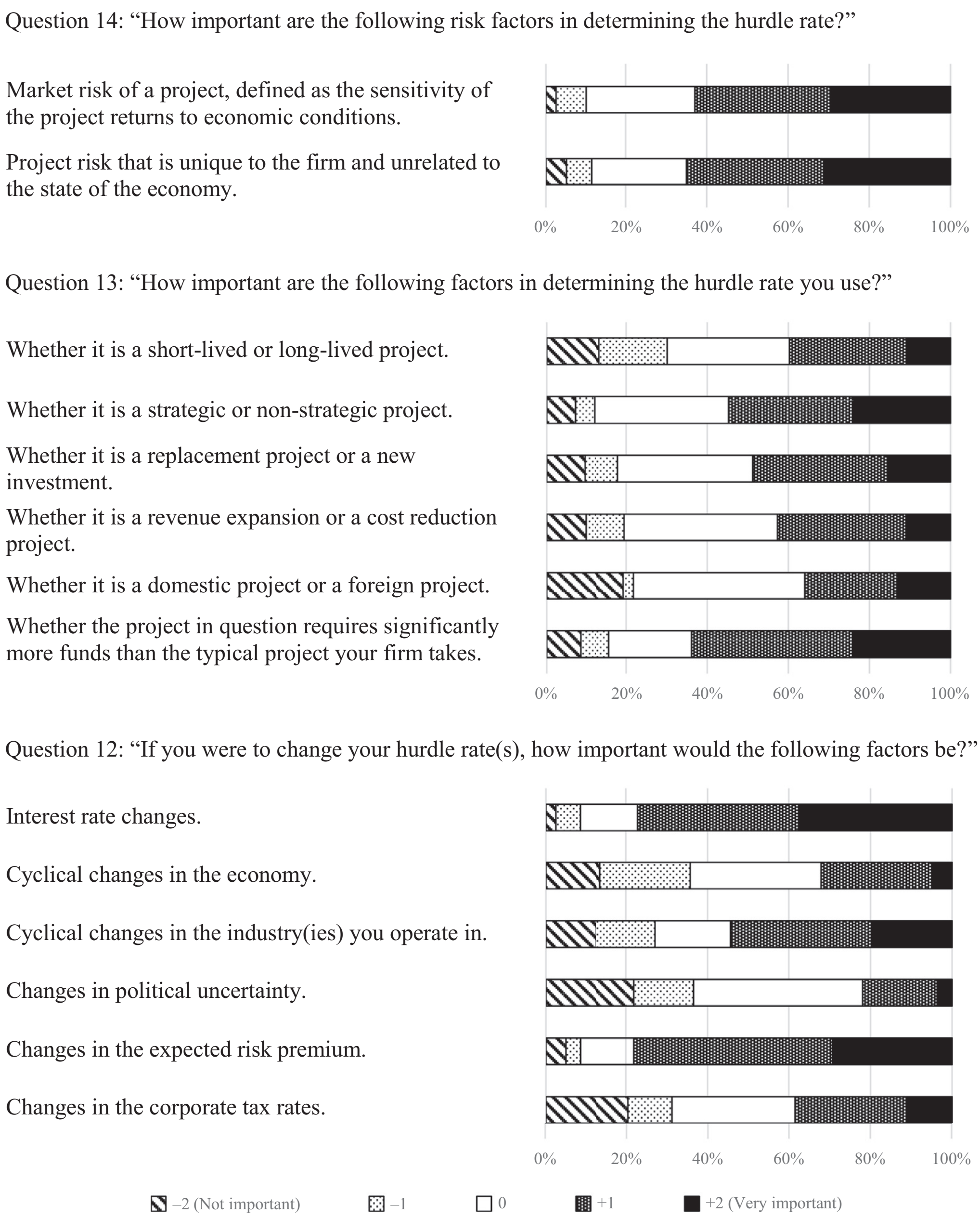

Fig. A.1. Survey answers on determinants of discount rates. The figure summarizes the responses to three survey questions on the determinants of discount rates. For each question, respondents answer on a scale from −2 (not important) to 2 (very important).

Eq. (3) and scaled beta, $\tilde{\beta}_{MKT,i}$, in Eq. (4). The six firms using their unlevered cost of equity presumably adopt an Adjusted Present Value (APV) approach, where tax savings from debt financing are considered separately and thus do not affect their discount rate, unlike for WACC. For these firms, therefore, we define their adjusted discount rate as

$$\tilde{d_i} = d_i - \frac{D_i}{D_i + E_i} r_{D,i} - \frac{E_i}{D_i + E_i} r_{F,i} \tag{B.1}$$

and $\tilde{\beta}_{MKT,i}$ as in Eq. (4).

For the three firms using levered cost of equity, the self-reported discount rate from the survey corresponds to r_E and, therefore, we only need to subtract the risk-free rate to obtain the adjusted discount rate,

$$\tilde{d_i} = d_i - r_{F,i}, \tag{B.2}$$

and the variable $\tilde{\beta}_{MKT,i}$ is equal to beta, without multiplying by the ratio of equity-to-total capital,

$$\tilde{\beta}_{MKT,i} = \beta_{MKT,i}\ . \tag{B.3}$$

Appendix C. Variable definitions

See Table C.1.

Table C.1
Variable definitions.

Variable name	Symbol	Definition
Discount rate	d	Self-reported discount rate from survey Question 6.
Market value of equity	E	Compustat: $pstk + csho \times prcc\_f$.
Total capital	$D+E$	Compustat: $dlc + dltt + pstk + csho \times prcc\_f$.
Cost of debt	r_D	Imputed from the firm's estimated credit rating using the model of Jorion, Shi, and Zhang (2009). See Online Appendix OA.3.1.
Pre-financing marginal tax rate	τ	From Graham (1996a, 1996b).
Risk-free rate	r_F	Treasury bond rate that matches the firm's average project life from survey Question 3. See Online Appendix OA.3.1.
CAPM beta	β_{MKT}	Fundamental beta from Barra.
Equity risk premium	π_{EP}	Estimated from the model(s).
Adjusted discount rate	$\tilde{d}$	Self-reported discount rate minus the portion of the cost of financial capital that is unrelated to beta. $\tilde{d} = \begin{cases} d - \frac{D}{D+E} r_D(1-\tau) - \frac{E}{D+E} r_F & \text{if using WACC;} \\ d - \frac{D}{D+E} r_D - \frac{E}{D+E} r_F & \text{if using unlevered cost of equity;} \\ d - r_F & \text{if using levered cost of equity;} \\ d & \text{if using other methods.} \end{cases}$
Scaled beta	$\tilde{\beta}_{MKT}$	CAPM beta scaled to account for how beta enters the firm's cost of financial capital. $\tilde{d} = \begin{cases} \frac{E}{E+D} \beta_{MKT} & \text{if using WACC or unlevered cost of equity;} \\ \beta_{MKT} & \text{if using levered cost of equity;} \\ 0 & \text{if using other methods.} \end{cases}$
Indicator variable for firms using "other" methods	*OTHER*	Equals one for firms using something other than WACC, unlevered cost of equity, or levered cost of equity; and zero otherwise.
Survey measure of financial constraints	*FINC*	Indicator variable that equals one when firms responded to survey Question 20, "There are some good projects we cannot take due to limited access to capital markets," with +2 or +1; and zero otherwise.
Altman *Z*-score	*ALTZ*	Indicator variable that equals one for firms with an Altman *Z*-score greater than 2.99; and zero otherwise. The *z*-score, which is computed as in Altman (1968), is greater for firms with a lower probability of default.
Current ratio	*CR*	Ratio of current assets to current liabilities. Compustat: *act*/*lct*.
Leverage ratio	$D/(D+E)$	Compustat: $(dlc + dltt)/(dlc + dltt + pstk + csho \times prcc\_f)$.
Kaplan-Zingales index	*KZ*	Kaplan-Zingales index computed as in Lamont, Polk, and Saá-Requejo (2001).
Survey measure of operational constraints	*OPC*	Indicator variable that equals one when firms responded to survey Question 20, "We cannot take all profitable projects due to limited resources in the form of limited qualified management and manpower," with +2 or +1; and zero otherwise.
Financial flexibility	*CASH*	Ratio of the book value of cash and short-term investments to the market value of total capital. Compustat: $che/(dlc + dltt + pstk + csho \times prcc\_f)$.
Survey measure of strategic optimism	*OPTI*	Indicator variable that equals one when firms respond to Question 20, "We need a higher hurdle rate to account for optimism in cash flow forecasts," with +2 or +1; and zero otherwise.
Total number of business segments	*SEGM*	Total number of business segments from the Compustat Business Information File.
Number of business segments between four and ten	$SEG4-10$	Indicator variable that equals one if *SEGM* is between four and ten; and zero otherwise.
Number of business segments greater than ten	$SEG>10$	Indicator variable that equals one if *SEGM* is greater than ten; and zero otherwise.
Concentration of business segments within a firm	*HERF*	Sum of squares of business segments' shares of a firm's net sales, from the Compustat Business Information File.
Natural log of firm's market value of assets	*SIZE*	Compustat: $\ln(at - ceq + csho \times prcc\_f)$.
Measure of earnings smoothing	*EVOLIND*	The standard deviation of changes in annual earnings over the previous ten years as a fraction of total book value of assets (Compustat: *ib* / *at*; minimum of five annual earnings observations is required) divided by the average standard deviation of changes in earnings as a fraction of the book value of assets among all firms in the same two-digit SIC industry.
Measure of earnings surprises	*ESURPR*	Mean absolute value of the percent difference between the median earnings per share consensus forecast and the actual earnings per share. Quarterly earnings forecasts are from the Institutional Brokers' Estimate System (I/B/E/S) database (or, if no quarterly forecast is available, the annual earnings forecast divided by four, which constitutes 15.1% of the observations). Forecasts that are recorded more than 90 days before the announcement date are considered stale and excluded from the analysis. The sample is restricted to firms with at least 12 observations.
Earnings response coefficient	*INDERC*	Three-day industry earnings response coefficient in the firm's Fama-French 30-industry classification, calculated as in Asker, Farre-Mensa, and Ljungqvist (2015).
Market share	*MKTSHARE*	Firm's net sales (Compustat: *sale*) divided by the total net sales in two-digit SIC industry.
Industry concentration	*INDHHI*	Sum of squares of *MKTSHARE* in the two-digit SIC industry.
Idiosyncratic risk	*IDIO*	$1 - R^2$, where R^2 is the *R*-squared of the regression of the firm's monthly return (CRSP: *ret*) in excess of the risk-free rate (Kenneth R. French's data library: *RF*) on the value-weighted return of the market portfolio (CRSP: *vwretd*) over the five-year period 1999–2003.

References

Almeida, H., Campello, M., Weisbach, M., 2004. The cash flow sensitivity of cash. Journal of Finance 59, 1777–1804.
Altman, E., 1968. Financial ratios, discriminant analysis and the prediction of corporate bankruptcy. Journal of Finance 23, 589–609.
Antle, R., Eppen, G., 1985. Capital rationing and organizational slack in capital budgeting. Management Science 31, 163–174.
Arnold, G., Hatzopoulos, P., 2000. The theory-practice gap in capital budgeting: Evidence from the United Kingdom. Jounal of Business Finance and Accounting 27, 603–625.
Asker, J., Farre-Mensa, J., Ljungqvist, A., 2015. Corporate investment and stock market listing: A puzzle? Review of Financial Studies 28, 342–390.
Asvanunt, A., Broadie, M., Sundaresan, S., 2011. Managing corporate liquidity: Strategies and pricing implications. International Journal of Theoretical and Applied Finance 14, 369–406.
Ball, R., Brown, P., 1968. An empirical evaluation of accounting income numbers. Journal of Accounting Research 6, 159–178.
Ben-David, I., Graham, J., Harvey, C., 2013. Managerial miscalibration. Quarterly Journal of Economics 128, 1547–1584.
Blanchard, O., 1993. Movements in the equity premium. Brookings Papers on Economic Activity 2, 75–118.
Chen, N.-F., Roll, R., Ross, S., 1986. Economic forces and the stock market. Journal of Business 59, 383–403.
DeAngelo, H., DeAngelo, L., Whited, T., 2011. Capital structure dynamics and transitory debt. Journal of Financial Economics 99, 235–261.
de Jong, A., Verbeek, M., Verwijmeren, P., 2012. Does financial flexibility reduce investment distortions? Journal of Financial Research 35, 243–259.
Dean, J., 1951. Capital Budgeting: Top-Management Policy on Plant, Equipment, and Product Development. Columbia University Press, New York, NY.
Denis, D., Sibilkov, V., 2010. Financial constraints, investment, and the value of cash holdings. Review of Financial Studies 23, 247–269.
Easton, P., Zmijewski, M., 1989. Cross-sectional variation in stock market response to accounting earnings announcements. Journal of Accounting and Economics 11, 117–141.
Emery, D., Finnerty, J., Stowe, J., 2011. Corporate Financial Management, Fourth ed. Wohl Publishing, Morristown, NJ.
Fama, E., French, K., 1992. The cross-section of expected stock returns. Journal of Finance 47, 427–465.
Fama, E., French, K., 2002. The equity premium. Journal of Finance 57, 637–659.
Faulkender, M., Wang, R., 2006. Corporate financial policy and the value of cash. Journal of Finance 61, 1957–1990.
Fernández, P., 2011. The magnitude and concept of the equity premium in 150 textbooks. Unpublished working paper. University of Navarra.
Ferreira, M., Vilela, A., 2004. Why do firms hold cash? Evidence from EMU countries. European Financial Management 10, 295–319.
Fu, F., 2009. Idiosyncratic risk and the cross-section of expected stock returns. Journal of Financial Economics 91, 24–37.
Gillham, B., 2000. Developing a Questionnaire. Continuum, New York, NY.
Goetzmann, W., Kumar, A., 2008. Equity portfolio diversification. Review of Finance 12, 433–463.
Graham, J., 1996. Debt and marginal tax rate. Journal of Financial Economics 41, 41–73.
Graham, J., 1996. Proxies for the corporate marginal tax rate. Journal of Financial Economics 42, 187–221.
Graham, J., Harvey, C., 2001. The theory and practice of corporate finance: Evidence from the field. Journal of Financial Economics 60, 187–243.
Graham, J., Harvey, C., 2005. The long-run equity risk premium. Finance Research Letters 2, 185–194.
Graham, J., Harvey, C., Rajgopal, S., 2005. The economic implications of corporate financial reporting. Journal of Accounting and Economics 40, 3–73.
Graham, J., Harvey, C., 2011a. Duke/CFO Magazine Global Business Outlook, U.S. topline tables, released March 9, 2011, www.cfosurvey.org/pastresults.htm.
Graham, J., Harvey, C., 2011b. Duke/CFO Magazine Global Business Outlook, U.S. topline tables, released September 13, 2011, www.cfosurvey.org/pastresults.htm.
Graham, J., Harvey, C., 2012. Duke/CFO Magazine Global Business Outlook, U.S. topline tables, released June 6, 2012, www.cfosurvey.org/pastresults.htm.
Harris, M., Kriebel, C., Raviv, A., 1982. Asymmetric information, incentives, and intrafirm resource allocation. Management Science 28, 604–620.
Harris, M., Raviv, A., 1996. The capital budgeting process: Incentives and information. Journal of Finance 51, 1139–1174.
Heaton, J., 2002. Managerial optimism and corporate finance. Financial Management 31, 33–45.
Hennessy, C., 2004. Tobin's Q, debt overhang, and investment. Journal of Finance 59, 1717–1742.
Holmström, B., 1999. Managerial incentive problems: A dynamic perspective. Review of Economic Studies 66, 169–182.
Huang, W., Liu, Q., Rhee, S., Zhang, L., 2010. Return reversals, idiosyncratic risk, and expected returns. Review of Financial Studies 23, 147–168.
Jacobs, M., Shivdasani, A., 2012. Do you know your cost of capital? Harvard Business Review 7/8, 118–124.
Jagannathan, R., McGrattan, E., Scherbina, A., 2001. The declining US equity premium. Quarterly Review, Federal Reserve Bank of Minneapolis 3–19.
Jagannathan, R., Meier, I., 2002. Do we need CAPM for capital budgeting? Financial Management 31, 55–77.
Jagannathan, R., Meier, I., Tarhan, V., 2011. The cross-section of hurdle rates for capital budgeting: An empirical analysis of survey data. NBER Working Paper No. 16770.
Jorion, P., Shi, C., Zhang, W., 2009. Tightening credit standards: The role of accounting quality. Review of Accounting Studies 14, 123–160.
Lamont, O., Polk, C., Saá-Requejo, J., 2001. Financial constraints and stock returns. Review of Financial Studies 14, 529–554.
Marchica, M.-T., Mura, R., 2010. Financial flexibility, investment ability, and firm value: Evidence from firms with spare debt capacity. Financial Management 39, 1339–1365.
McDonald, R., 1999. Real options and rules of thumb in capital budgeting. In: Brennan, M.J., Trigeorgis, L. (Eds.), Project Flexibility, Agency, and Competition: New Developments in the Theory and Application of Real Options. Oxford University Press, London, pp. 13–33.
McNeil, C., Smythe, T., 2009. Division manager lobbying power and the allocation of capital. Financial Review 44, 59–85.
Mello, A., Parsons, J., 1992. Measuring the agency cost of debt. Journal of Finance 47, 1887–1904.
Morgan, D., 1988. Focus Groups as Qualitative Research. Sage Publications, Newbury Park, CA.
Moyen, N., 2007. How big is the debt overhang problem? Journal of Economic Dynamics & Control 31, 433–472.
Myers, S., 1977. Determinants of corporate borrowing. Journal of Financial Economics 5, 147–175.
Opler, T., Pinkowitz, L., Stulz, R., Williamson, R., 1999. The determinants and implications of corporate cash holdings. Journal of Financial Economics 52, 3–46.
Parrino, R., Weisbach, M., 1999. Measuring investment distortions arising from stockholder-bondholder conflicts. Journal of Financial Economics 52, 3–42.
Pinkowitz, L., Stulz, R., Williamson, R., 2006. Does the contribution of corporate cash holdings and dividends to firm value depend on governance? A cross-country analysis. Journal of Finance 61, 2725–2751.
Poterba, J., Summers, L., 1995. A CEO survey of U.S. companies' time horizon and hurdle rates. Sloan Management Review (Fall) 43–53.
Rajan, R., Servaes, H., Zingales, L., 2000. The cost of diversity: The diversification discount and inefficient investment. Journal of Finance 55, 35–80.
Simutin, M., 2010. Excess cash and stock returns. Financial Management 39, 1197–1222.
Singer, E., Presser, S., 1989. Survey Research Methods: A Reader. University of Chicago Press, Chicago, IL.
Stein, J., 1989. Efficient capital markets, inefficient firms: A model of myopic corporate behavior. Quarterly Journal of Economics 104, 665–669.
Stein, J., 2002. Information production and capital allocation: Decentralized versus hierarchical firms. Journal of Finance 57, 1891–1921.
Weingartner, H., 1977. Capital rationing: n authors in search of a plot. Journal of Finance 32, 1403–1431.
Womack, K., Zhang, Y., 2005. Core finance course trends in the top MBA programs in 2005 Unpublished working paper. Dartmouth College.
Xuan, Y., 2009. Empire-building or bridge-building? Evidence from new CEOs' internal capital allocation decisions. Review of Financial Studies 22, 4919–4948.