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Capital budgeting: a "general equilibrium" analysis

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Abstract
As presented in leading corporate finance textbooks, the predominant method for making capital budgeting decisions is discounted cash flow analysis. The primary benefit of this approach is that it allows for different discount rates to be used for different projects. In this paper, I argue that this alleged benefit is, in fact, a detriment for two reasons. First, the betas that determine the differing discount rates are not only measured with significant error, but tend to drift substantially over the life of typical capital budgeting projects. Second, introducing differential discount rates is likely to conflict with other "general equilibrium" management objectives related to developing a successful corporate culture that promotes collaboration and innovation. This explains why many companies, particularly companies that have a large number of growth options, choose alternatives to discounted cash flow, such as the internal rate of return.

[1] I would like to thank Ivo Welch for ongoing discussions regarding the capital budgeting decision.

1. Introduction

As presented in leading corporate finance textbooks[2], the capital budgeting decision is a mathematical exercise involving two steps: (1) a procedure for estimating expected future cash flows and (2) an assessment of the required return associated with those cash flows provided by the application of an asset pricing model (most commonly the CAPM, but also the Fama–French three-factor model). The capital budgeting decision rule is to take projects for which the net present value (NPV) of the expected cash flows discounted at the required return is greater than zero.

A surprising empirical result is that sophisticated managers, often educated at elite business schools, fail to follow the standard procedure. For example, based on an extensive survey, Gompers et al. (2014) report that few private equity investors use discounted cash flow or net present value techniques to evaluate investments. They also observe that few private equity investors use the capital asset pricing model, or any asset pricing model, to determine the cost of capital. Instead, those investors typically target an internal rate of return in the range of 20% to 25%, a return well above what would have been produced by an asset pricing model.

The purpose of this short paper is to offer an explanation for this observed behavior that also leads to a cross-sectional prediction regarding when the textbook discounted cash flow (DCF) approach will be employed and when it will not. The key to the analysis is what I refer to as the "general equilibrium" factors involved in capital budgeting. The factors come into play because capital budgeting decisions are not exogenous financial exercises, but are a critical component of the overall operation of the firm.

[2] See for example, Berk and DeMarzo (2014) or Brealey et al. (2013).

Finding and exploiting profitable opportunities requires that the firm be managed in a manner that provides proper incentives and contributes to cooperation among employees. More specifically, successful capital budgeting typically will involve issues including:

- Motivating, rewarding and retaining employees
- Promoting collaboration and discouraging infighting and empire building within the company
- Avoiding the appearance of management favoritism
- Nurturing creative thinking
- Monitoring excessive optimism with regard to projects in which employees are involved and other behavioral biases

As a result, the choice between different capital budgeting decision criteria, such as DCF versus the internal rate of return (IRR), or even the multiple of invested capital (MOIC), will depend not only on the financial calculations, but also upon the manner in which capital budgeting interacts with the other general equilibrium factors.

2. DCF versus IRR in a general equilibrium context

The fundamental distinction between the DCF and IRR decision rules is that DCF takes account of the possibility that different capital projects may have different required rates of return. This distinction arises because the stochastic process of returns for different projects potentially have differential covariances (betas) with either the market or the priced factors. If the firm chooses to ignore these distinctions, then the IRR and DCF decision rules become essentially equivalent with regard to the accept/reject decision of capital budgeting. The only remaining benefit of the DCF approach is that the net present provides an estimate of the value wealth created by the project.

Whereas the ability to take account of differential required returns for different projects may appear to be a benefit of the DCF approach, in general equilibrium it may in fact be a detriment. In doing this research, I was fortunate to have a detailed interaction with the CFO of a major technology company.

His view was that using differential required returns for different projects was something to be specifically avoided. The reason was that choosing among different projects proposed by separate teams raised all the general equilibrium issues delineated above. There were risks of internal strife, claims of favoritism, and so forth. In such a situation, adding a complex and not particularly transparent calculation of differential risk premia to the mix, a procedure that would favor some projects over others, was particularly ill advised. A far better solution, according to the CFO, was to set a relatively high IRR that applies to all projects and provides a cushion that takes account of the tendency of teams to be overly optimistic regarding their own projects.

It is worth noting that the foregoing concerns would be moot if the discount rate could be measured with precision. But that is not the case, particularly over longer horizons that match the life of most capital budgeting problems. The betas that are the source of differential discount rates are not only measured with significant error, but drift markedly over time horizons on the order of most capital budgeting projects. Following a detailed study designed to assess the effectiveness of using financial models to assess differential discount rates in a capital budgeting context, Levi and Welch (2014) conclude that "the capital asset pricing model and the Fama–French three-factor model have very little ability to discriminate across similar maturity far-away expected cash flows. This renders the models of little use for practical capital budgeting for cash flows beyond a few years. There is little evidence that the model predictions were even directionally correct, much less quantitatively correct, for corporate users who had to estimate exposures and risk premia."

In light of the deficiencies that Levi and Welch identify, and setting aside consideration of the general equilibrium factors, the marginal benefit of the DCF approach is likely to be small, if it exists at all. Taking account of the general equilibrium factors, which all point in the direction of avoiding attempting to distinguish between discount rates based on different betas for competing projects, it is not surprising that many firms use alternative criteria.

3. Cross-sectional predictions

The importance of the general equilibrium factors is not independent of the type of projects being considered. For routine projects at companies with long histories, such as a railroad replacing a locomotive or a utility building a gas-fired power plant, the internal management issues associated with the capital budgeting decision are likely to be much more muted. In addition, for projects like those that are repeated over time estimating betas is more feasible, although the drift problem documented by Levi and Welch remains. Nonetheless, the DCF approach should be a relatively more attractive alternative for evaluating such projects.

At the other end of the spectrum are companies like Facebook whose future projects are growth options that in many cases have not even been identified. For such companies, developing a "creative culture" that encourages collaboration and promotes innovation is critical. As the CFO I interacted with noted, the last thing senior management wants is that the process of capital budgeting interferes with the company's effort to develop the proper corporate culture. In such an environment, the general equilibrium factors predominate when choosing among investment decision rules and the details of financial calculations are second order. Diverting attention to largely unresolvable and speculative issues related to estimating betas and required returns is at best an unrewarding distraction and at worst an added source of potential divisiveness.

In light of the foregoing, the analysis predicts that as one moves from projects that have the characteristics of routine replacement at one end of the spectrum to projects that are pure growth options at the other end, the frequency with which the DCF method is used will decline. This offers one possible explanation for the different survey results reported by Gompers et al. (2014) compared to those reported by Graham and Harvey (2001), who found more frequent adoption of the DCF method. Whereas Gompers et al. (2014) surveyed private equity managers, Graham and Harvey (2001) surveyed corporate CFOs.

Because private equity investors are generally attempting to transform firms and create value, their capital budgeting decisions will skew more toward growth options and less toward normal replacements than those decisions faced by a typical corporate CFO. The analysis predicts, therefore, that private equity managers will pay more attention to the general equilibrium factors and be less likely to use a DCF approach.

To make the analysis more concrete, consider the case of Amazon, which has a history of investing in a variety of growth options. Table 1 lists some of the major capital budgeting projects undertaken by Amazon in the last 18 years.

Table 1: Selected Amazon capital budgeting projects

Date	Project	Description
Sep 1997	1- Click Ordering	1-Click Ordering allows users to store preferred payment and shipping information so that purchases can be completed with one click.
Sep 1999	zShops	zShops allows third parties to sell merchandise through Amazon for the first time.
Oct 2001	Look Inside the Book	Look Inside the Book enables customers to discover books by searching and previewing the text inside.
Jul 2002	AWS	AWS allows developers to outsource their online and application infrastructure needs at commodity prices.
Feb 2005	Amazon Prime	Amazon introduces a unique, membership-based, express shipping program.
Sep 2007	Amazon MP3	Amazon's first foray into direct digital entertainment sales.
Nov 2007	Kindle	Amazon introduces the first eInk specialized digital reader.
Sep 2011	Kindle Fire, Kindle Touch	Amazon introduces full featured mini tablet computers designed to interface specifically with their stores.
Sep 2013	Mayday Button	Amazon develops a new help service by which pushing a button immediately connects the user to live video chat support.
Apr 2014	Fire TV	Amazon introduces a streaming media player tied to its digital video store.
Jun 2014	Fire Phone	Amazon introduces a new cell phone with innovative features geared to electronic commerce.

The list is not meant to be complete. It includes only large, and what I would consider successful, projects that were publicly disclosed. To be fair, Amazon undertook numerous smaller projects, some of which were not successful.

The point here, however, is not to assess the success of Amazon's decision making, but to consider the problems that Amazon faced when evaluating capital budgeting projects. In the context of Table 1, for example, would it be reasonable for Amazon to apply a different discount rate to Amazon Price than Amazon Web Services (AWS) or the Kindle? Remember that at the time Amazon was considering these projects, they were largely new undertakings. This makes it even more difficult to estimate betas than even Levi and Welch suggest because there are no direct historical proxies for the stochastic properties of the projected cash flows. If differential betas were to be adopted, management would have to explain to say the Kindle team why the beta for their project was greater than that applied to AWS. Given the immense uncertainty associated with the beta calculations, the wisdom of avoiding making such determinations is largely self-evident.

4. Caveats and extensions

The prediction that IRR is preferable to DCF in capital budgeting situations in which the general equilibrium factors are predominant should not be taken to imply that the IRR approach solves the political problems associated with capital budgeting decisions, only that it does not exacerbate them in the way the DCF approach could. To be fair, most of the internal disputes regarding choice among competing projects involves the level of the cash flow forecasts, not their betas. Because all the capital budgeting procedures use the same cash flow forecasts, there is no reason to choose between them on this basis. The point of the previous analysis was to demonstrate that in the context of debates regarding the level of cash flow forecasts, there is little to be gained, and potentially much to be lost, by allowing side disputes about differential risk premiums to complicate the conversation.

To conclude, there is one caveat worth mentioning. The foregoing has focused on differential discount rates associated with differential betas. However, discount rates also vary with term as well as with systematic risk. Unlike betas, the term premium can be measured with greater precision and with fewer disputes directly from the yields on government securities. For that reason, it may make sense for managers to divide projects into different buckets according to their duration. The longer duration projects would then be assigned slightly higher hurdle rates to take account of the term premium. Such a procedure, if undertaken transparently, should not run afoul of the general equilibrium factors.

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