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Separating project risk from the time value of money: A step toward integration of risk management and valuation of infrastructure investments

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Abstract

The rationale for using heuristics to establish a risk premium that is added to the risk-free rate to obtain the value of an investment is questioned and an alternative method, termed decoupled net present value (DNPV), is proposed. Rather than using utility theory concepts to decrease the value of uncertain cash flows, the risks associated with project cash flows are discretely quantified using insurance and contingent claim valuation concepts. Synthetic insurance premiums are designed to "protect" the value of expected cash flows which are treated as additional project costs. Because identified project risks are quantified in financial terms and treated as a real cost to the project, DNPV allows business executives to evaluate the effect on the value of the project of different risks and select management techniques that are deemed more effective. Hence, DNPV is both a valuation methodology and a risk management tool.

JEL classification: G31; G32
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1. Introduction

Despite all the work done on investment valuation, there is not a single valuation methodology that is used consistently across different industries. The most popular method to evaluate an investment opportunity such as an infrastructure project is to forecast the project cash flows and discount them by a risk-adjusted discount rate (α) to calculate the project net present value (NPV) or internal rate of return (IRR). A positive NPV (or IRR $\geq \alpha$) is considered a potentially attractive investment opportunity whereas a negative NPV (or IRR $< \alpha$) is considered unattractive. As its name implies, the risk-adjusted discount rate accounts for the project risk by simply adding a risk premium (r_p) to the risk-free rate (r), that is $\alpha = r + r_p$. The general idea behind the use of a risk-adjusted discount rate is that investors need to be compensated in two ways: time value of money and the project risk. The time value of money is represented by the risk-free rate and compensates investors for parking their money in a secure investment that yields a known amount over a period of time. The project risk is represented by the risk premium which is used to estimate the compensation above the risk-free interest rate that a rational (risk-averse) investor would demand for taking on additional risk rather than investing in government treasury bonds. However, lumping risk with the time value of money immediately creates two problems: (i) it disconnects project risks from their actual source (i.e., cash flows); and (ii) it implicitly assumes that risk and time are interchangeable parameters. This apparently innocuous connection, now widely accepted by practitioners, causes two distinct problems: (i) On the valuation side: NPV techniques understates the value of future (positive or negative) cash flows, particularly for long-term investments such as infrastructure projects that have large initial capital outlays and potentially long operational (payback) periods; and (ii) On the management side: NPV techniques makes it extremely difficult to assess the effectiveness of risk management measures to mitigate some of the project risks.

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If future cash flows are positive, the NPV method can grossly undervalue an investment opportunity; more onerously, the opposite is true if future cash flows are negative. Unfortunately, rather than amending the problem (i.e., separating risk and time value of money) and assigning risk to where it belongs (i.e., to the uncertain cash flows), most efforts have been devoted to fine-tuning the discounting method such as the capital asset pricing model (CAPM) to account for the project specific risks (e.g., Butler and Pinkerton, 2006; Butler et al., 2011; Myers and Turnbull, 1977), or to correct (mostly increase) the NPV results by the inclusion of the value of real options embedded in projects (e.g., Cheah and Liu, 2006; Chen et al., 2009; Copeland and Keenan, 1998; Garvin and Cheah, 2004; Liu et al., 2014; Myers, 1984; van Putten and MacMillan, 2004). On the other hand, although good efforts have been made to account for the variability of cash flows, particularly for infrastructure investments, using Monte Carlo simulations (e.g., Chiara and Garvin, 2008; Girmscheid, 2009; Liou and Huang, 2008; Ye and Tiong, 2000, 2003), in most cases, risk is double counted as, in theory, risk is already considered in the choice of the risk adjusted discount rate. In addition, these methods are mathematically complex and difficult to implement in standard valuation tools. More importantly, it is extremely difficult to convey any results in terms that are familiar to decision makers.

NPV (or IRR) users who want to use the discount rate as a proxy for risk generally have one main question: What is the appropriate risk-adjusted discount rate that should be used to estimate the project NPV and, hence, the value of the investment opportunity? Understandably, because risk and time value of money are separate variables (Robichek and Myers, 1966), a unique and consistent answer cannot be provided, as evidenced by guidelines typically found in numerous capital budgeting articles (e.g.,Davies et al., 2012; McDonald, 1997) and investment textbooks (e.g., Trigeorgis, 1999: 39; Campbell et al., 2001:136). As a result, each organization establishes its own set of recommended rates (i.e., hurdle rates) to compare potential projects to in order to assess their financial viability. For instance, some authors promote the use of CAPM to estimate the hurdle rate of the project (e.g., Fama, 1977). CAPM dictates that a risk premium should only be added for taking non-diversifiable risk (i.e., market risks); that is, investors should not be compensated for assuming diversifiable risks because this has already been incorporated into the investment selection (Sharpe, 1964). Hence, an asset (or investment) is correctly priced when future cash flows of the asset are discounted at a rate suggested by CAPM. Extensions of CAPM to value the return on investment on real projects can be found in the literature (e.g., Fama, 1977; Myers and Turnbull, 1977). However, Bhattacharya and Leach (1999) demonstrated that a historical proxy for the discount rate cannot be used even for expansion projects that supposedly should have the same risk profile of the company.

Although CAPM may be a valid model to estimate the return of stocks, bonds, or other liquid financial instruments that can be bought and sold rather easily to create a well-diversified portfolio to the point that non-systematic risks are eliminated (i.e., averaged out), when investing in non-financial (illiquid) assets such as infrastructure investments, such diversification cannot be attained. Rational investors must consider both theoretically diversifiable (i.e., private) and non-diversifiable (market) risks associated with the revenues and the expenditures of the potential investment opportunity. In practice, this means that investors hope to select hurdle rates that account for all risks associated with the project not just market risks. Unfortunately, selection of this "perfect" hurdle rate is further obscured by the manner in which different risks are accounted for. For instance, in the drug industry, to account for the probability of success of new drugs, cash flows from potential new products are adjusted by the estimated probability of success and the adjusted cash flows are then discounted using the industry hurdle rate. This procedure is termed the risk-adjusted NPV or expected NPV (Steward et al., 2001). Similarly, in the construction industry, contractors add contingency budgets to account for project private risks (Baccarini, 2004) and discount future cash flows using an industry-specified hurdle rate. In other industries, private risks are accounted for in the same manner as market risks, that is, by adding a risk premium to the risk free rate. For instance, some business appraisers calculate risk premiums using the Total Beta concept (e.g., Helfenstein, 2009). Others researchers, motivated by the difficulties encountered when evaluating long term public investment projects using constant discount rates, have proposed a decreasing discount rate for longer term projects (e.g., Grollier, 2002). As a result of these often conflicting ideas, investors resort to heuristic arguments to account for the identified risks (systematic and non-systematic) and select the "appropriate" risk premium to estimate the project NPV. Consequently, the selection of an appropriate discount rate that consistently reflects the risk associated with real projects and business valuation[1] remains a guessing exercise at best because correlating identified project risks to a single factor (i.e., the risk premium) using heuristics alone simply cannot be as straightforward as is often hoped. At worst, this may not even be a valid approach, as discussed next.

The difficulties of consistently correlating a risk premium to project risks by lumping the time value of money and risk together in a single number, α, and correlating it to the return on a real investment were examined by Robichek and Myers (1966), who noted that cash flows are the unknown quantities (i.e., uncertain), not the discount rate, and advocated for the use of certainty equivalent (CE) cash flows. Hamada (1977) pointed out that the extension of risk-adjusted discount rates to the valuation of projects with cash flows that do not follow random walk processes can be very dangerous and exhorted the finance profession to use the CE methods. Bhattacharya (1978) showed that although the accuracy of the risk adjusted discount method is good for cash flows that replicate exponentially, the accuracy of the methodology decreases for cash flows that follow mean-reverting processes. Based on CE concepts, Halliwell (2001) listed six inconsistencies associated with the risk-adjusted method and, more recently, (Halliwell, 2011) demonstrated that risk adjusted discount rates are

[1] The lively discussion in the area of business appraisal regarding the use of Total Beta instead of Beta to capture company specific risks (e.g., Butler et. al, 2011) when estimating risk premiums provides testimony of the confusion created by mixing risk and time value of money.