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# **Improve the Economics of your Capital Project by Finding its True Cost of Capital**

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# Improve the Economics of your Capital Project By Finding its True Cost of Capital

By Tom Schmal  
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## Abstract

Evaluating the risk behind capital projects can be one of management's toughest calls. One reason is project risks are presented subjectively or as a metric without a practical relationship to return. The author addresses the problem by using a Monte Carlo simulation to find a project's risk and uses that metric to find the project's cost of capital.

In this system, risk is determined by variation in free cash flow. Since every project in your company's pipeline will have a free cash flow, every project, including those with financial leverage, can be evaluated using the same economic yardstick. Other benefits include better value projects, better presentation and accurate discount rates for NPV.

*Keywords: cost of capital, IRR, NPV, cash flow, Monte Carlo, capital project economics, risk-adjusted return, M-P5, variability, pure play, leverage, hurdle rate. JEL: D81, G32*

## 1. Introduction

This paper will show the reader how to build the chart in Figure 1. Such a chart should accompany capital appropriations requests. It puts proposed projects in context with past projects and helps confirm their place in management's overall strategy.

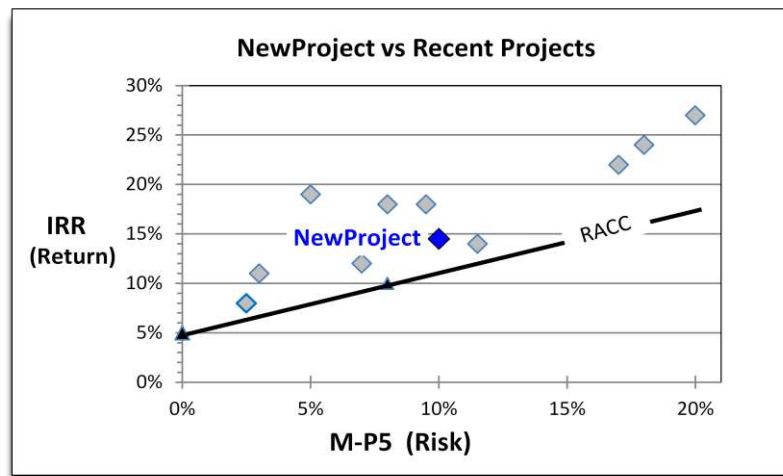


Figure 1. The M-P5 Chart.

Here "NewProject" has about a three percent premium above its risk-adjusted cost of capital (RACC). Horizontally, it is near in the middle of the pack.

The chart reflects a truth we already know: there are two ways to increase that premium. First, the developer could increase IRR, perhaps by negotiating a higher price. The second way is to reduce risk; a longer contract, for example, would move the NewProject to the left. Either way - increasing return or reducing risk - will increase the relative vertical space over the project's RACC and improve its net present value.

Until now, there has been no structured way for managers to correctly decide between a reduction in risk and an increase in return. The author uses a risk metric (M-P5) to change that decision from (basically) a gut call to a numbers-to-numbers comparison.

The author was inspired by the familiar Efficient Frontier chart, equating risk to variability, and the Capital Market Line, both cornerstones of modern portfolio theory (Markowitz, 1952; Tobin, 1958). From there, however, the differences quickly add up. For example, in portfolio theory the diagonal line represents the best capital allocation. Here, it represents the worst.

## 2. Finding M-P5

After modeling a capital project in the usual manner, concluding in cash flow and IRR, you will run it through a Monte Carlo simulation. This can be a one-man operation or a multifunctional undertaking. In a nutshell: readily available Monte Carlo software allows the project's variables (cost of pipe, inflation, sales volume) to be replaced with ranges. The software uses random points within these ranges to calculate the thousands of possible outcomes, with the result that instead of a single IRR for the project you are presented with a histogram of thousands, manifested in a bell-shaped curve (Figure 2).

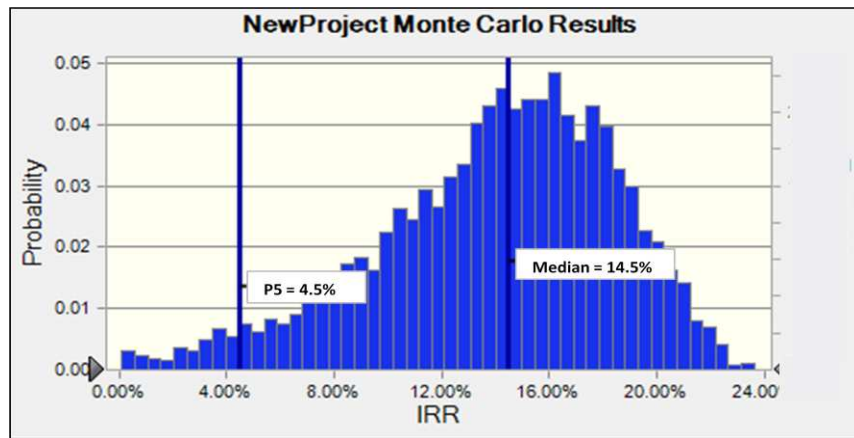


Figure 2. Results of a Monte Carlo simulation for NewProject

Of these thousands, our M-P5 chart will use only two, the median and the 5<sup>th</sup> percentile, also known as the P5. The coordinates for NewProject are (14.5%, 10%), i.e., the Monte Carlo IRR *median* and *median minus P5*, or M-P5.

### 3. Plotting the RACC Line

Two points define the company's risk-adjusted cost of capital line. The first, the triangle shown on the y-intercept of Figure 1, is the IRR of repurchasing the company's long term debt, in our example, 5% after tax. This is our risk-free investment opportunity. It has an M-P5 of zero because the cash flow that will result from it has zero variability.

Note that the interest rate for borrowing and investing are the same. This will be useful for evaluating leveraged projects, as we will see later. If the company has no LTD, an alternative could be devised although I do not have a good recommendation.

The second point of the line reflects the minimum acceptable IRR for the company's "average risk" project. To plot it, the most straightforward approach is to use the company's hurdle rate (10% after tax in our example). More meticulous would be a variation of the company's weighted average cost of capital. A third idea is to plot all projects approved by management and draw the RACC line through the worst one. This last approach may be the best way to start off, at least until the M-P5 of an "average" project can be established.

However they are placed, realize that these two points and the line they define are going to move as interest rates, taxes and goals of the company change. Their placement should be straightforward enough to respond to events more or less automatically.

### 4. Finally... NPV

The cost of capital, or discount rate, for NewProject is 11.25%. This can be seen in Figure 1 by reading up from its M-P5 of 10% to the company's RACC line. Or simply calculated:  $y = mx + b$ ,<sup>1</sup> where m equals the slope of the line.

For Net Present Value aficionados frustrated by subjective, universal-type discount rates,<sup>2</sup> this model will be a breakthrough. Now every project can have its own discount rate, properly earned from its own intrinsic risks.<sup>3</sup> If your capital budgeting process depends on NPV, or you would like it to, having good discount rates can improve the process.

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<sup>1</sup> Calculating a cost of capital for non-average risk projects has been a challenge (Reimann, 1989). However, in our equation, "m" and "b" are constants that describe the company's RACC line. "x" is the M-P5 from the project's Monte Carlo. These three numbers solve for "y," the project's cost of capital.

<sup>2</sup> Universal-type rates are often developed from a WACC or a CAPM used to evaluate a portfolio of existing assets (Whitehead, 2010). They rarely represent the risks of capital projects *still on the drawing board*. The problem, in the opinion of the author, comes when we try to force a cost of capital down onto a project. Instead, we should listen to the project. Let the variation in its cash flows tell us what the risk is.

<sup>3</sup> Intrinsic risks, meaning those that could affect a project's cash flow: cost overruns, strikes, permitting delays, design failure, dry holes, supply/demand miscalculation, contractor bankruptcy, hurricanes, etc.

## **5. Choice of P5 and Median**

P5 considers only left side (downside) variance as risk. This is the area of interest with capital projects. While P5 is a common “worst case” measure, depending on the business, P2 or even P10 could be a better choice.

M-P5 provides a ready answer to “value at risk” type questions. From Figure 1 you can state that NewProject has a 5% chance of an IRR below 4.5% (IRR minus M-P5). With only a little more effort a value at risk (Dowd, 1998) expressed in dollars of Present Value can be calculated.

For the skewed distributions typical of capital projects, median is a better choice for “average” than mean (Pagano and Gauvreau, 2000). Median, however, lessens the impact of “black swan” events. If these are critical features of your projects, consider using mean instead of median, and a left-side semi-standard deviation instead of M-P5.

## **6. Project Optimization**

When management incents its project developers to beat fixed hurdle rates, it can inadvertently be incensing some pretty risky stuff (Rappaport, 1981). Change the incentive to “beat the project’s RACC” and everyone’s interests will be better aligned.

A project might also be improved by building the model with members of the development team early on, as the key decisions are being made. When project managers can immediately check how their choice to pay more or take a chance will affect the project’s overall value, better decisions can be the result.

## **7. Applicability**

A conglomerate-type company gives value to investments that diversify its overall asset portfolio. The model presented here does not appreciate that flavor of risk mitigation. To use it, your company needs to be a pure play.

Further, the projects to be evaluated should be facing some significant unknowns. When they all start returning the same M-P5s, risk is not the issue.

Most nonbusiness organizations - school boards, nonprofits, NASA - are pure plays and face the same economic choices faced by the firm: how to best allocate the scarce resource of capital. The M-P5 model might improve their project selections as well.

## **8. Works with Leveraged Cash Flows**

It is well known that when financing is added to a project, the range of possible IRR outcomes widens. In other words, the project becomes more risky.

Let us say Bad Project's IRR is below the hurdle rate. If we run it through old school economics again, this time with financing, the IRR will increase; with enough financing the IRR will exceed the hurdle rate. Of course, economists know that the financing has increased the project's cost of capital, but we can't quantify it, a deficiency that can create the impression that the project has actually increased in value.

As a result, companies often will not consider deals or analyses that include leverage.<sup>4</sup>

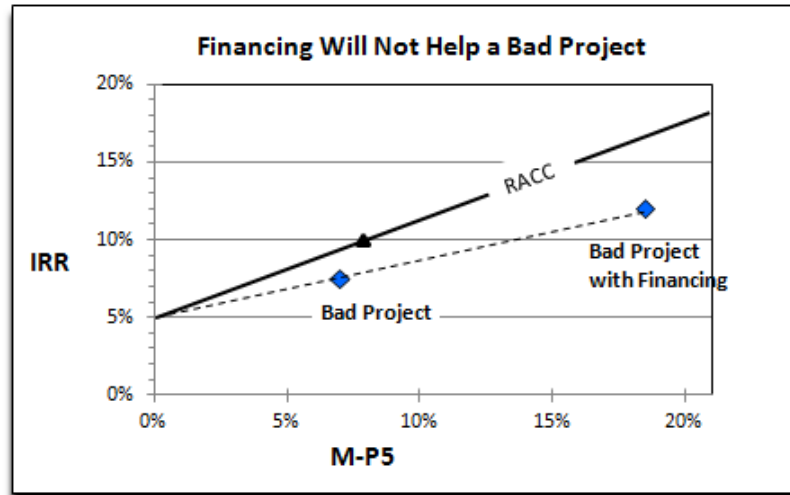


Figure 3. The M-P5 model correctly evaluates the risk of project financing

In our model, when Bad Project is run through the Monte Carlo, financing increases the variability of cash flow, which increases the M-P5, which increases the cost of capital. Visually it pushes the project out along its capital allocation line<sup>5</sup> (Figure 3). The IRR of the financed project is higher, but not high enough to reach its new cost of capital.

If your company looks, or wants to look, at joint ventures, acquisitions, take-or-pay contracts, non-recourse project financing or other investments that use leverage in some form, this model will let you evaluate them all.

## 9. Getting it down to a single number

For those times when a graph is unwieldy, risk and return information can be converted to a single number, paralleling what a Sharpe ratio does for stock evaluation (Sharpe, 1994). We do this by (hypothetically) leveraging and deleveraging each project along its capital allocation line, in anticipation of the company's future efforts to maintain its

<sup>4</sup> Except in the real estate business, which usually has the opposite issue.

<sup>5</sup> CAL is a line drawn from the risk free rate to and through the project's IRR.

overall target risk level. In Figure 4, competing projects have been indexed to a common risk level (M-P5 of 8%) and then re-ranked based on risk-adjusted IRR.

<b>Project#</b>	<b>Original</b>		<b>Risk-adjusted</b>	
	<b>IRR</b>	<b>M-P5</b>	<b>IRR</b>	<b>M-P5</b>
A	12%	6%	14%	8%
B	18%	15%	12%	8%
C	9%	5%	11%	8%
<b>Hurdle</b>	<b>10%</b>	<b>8%</b>	<b>10%</b>	<b>8%</b>
D	12%	18%	8%	8%

Figure 4. Project ranking after adjusting for risk

A one-number assessment is not much to go on for sure, but if one is all you are allowed, it should be the risk-adjusted IRR.

## 10. Summary

The author uses Monte Carlo analysis to supply a metric for risk (M-P5) that solves for a capital project’s true cost of capital. This result can help optimize outcomes for pure play companies, just as thousands of books and journals have helped optimize portfolios for diversified companies. The model is simple to build and implement and comes with many additional benefits, including a clear contextual chart presentation for management, project-specific discount rates for better NPV, ability to evaluate leveraged projects alongside equity projects and, if desired, a one-number risk-adjusted evaluation of project returns.

## 11. Acknowledgments

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## 12. Reference

- Dowd, Kevin. (1998) *Beyond Value at Risk: the New Science of Risk Management*. London: John Wiley.  
 Markowitz, Harry M. (1952) Portfolio selection, *Journal of Finance*, 7, 77-91.  
 Pagano and Gauvreau, (2000) *Principles of Biostatistics*. Pacific Grove, CA: Duxbury Press  
 Rappaport, A. (1981) Selecting Strategies that create Shareholder Value. *HBR*, 3,142.  
 Reimann, Bernard C. (1989) *Managing for Value*. Oxford, OH. The Planning Forum, 127.  
 Sharpe, W. F. (1994) The Sharpe Ratio. *Journal of Portfolio Management*: Vol. 21, No. 1, 49–58  
 Tobin, J. (1958) Liquidity preference as behavior towards risk, *The Review of Economic Studies*, 25, 65-86.  
 Whitehead, Judy A. (2010) *Microeconomics: A Global Text*. New York, NY. Routledge, 16, 463-489.