Payback Adjusted Net Present Value

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INTRODUCTION

In most discussions of capital budgeting, the net present value (NPV) method is hailed as the best method for ranking mutually exclusive projects. The NPV approach uses the firm specific weighted cost of capital (WACC) as the discount rate to evaluate the present value of the future cash flows of a project. Subtracting the cost of the investment from this present value yields the net benefit of the project, above and beyond the cost of the capital invested in the project. Managers rarely rely upon a single method of evaluating projects. The NPV method is generally accompanied by several other methods. One method commonly included in the analysis is the payback method. The payback method measures the length of time it takes for the future cash flows of the project to return the initial capital that is invested in the project. Longer payback periods are viewed as an indication of a less favorable project. Most discussions of payback methods have focused upon its shortcomings and the dangers of relying upon it. These limitations range from ignoring the time value of money to omitting the cash flows beyond the payback period. It is often illustrated that a project with a short payback can have a negative NPV, meaning that the project would pass the payback test, but even so, be unacceptable.

In practice, we see the payback method being commonly used, even given its well known shortcomings. Explanations for this persistence are that payback is a simple technique that is easily understood by most managers and that its calculation is relatively simple. These explanations require that we accept two very unlikely conclusions. First, we must believe that managers are unable to understand the "complex" calculations incorporated in the net present value (NPV), even though these same managers routinely deal with hedging transactions using derivatives, the tax and risk issues associated with international operations, and many more challenging issues. Second, we are asked to accept that managers who have computers on the desks, in their briefcases, and even in their pockets; are concerned with the difficulty of calculating NPV. Neither of these conclusions seems reasonable, so we must look elsewhere for an explanation of payback's persistent use in practice. The model proposed in this paper is based upon the conclusion that managers continue to use payback because it provides them with useful information that is not embedded in the NPV method.

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Our paper begins with a brief literature review, then compares and illustrates the NPV and payback methods. Our model is then presented with its application to an example of two mutually exclusive projects and we end the paper with a conclusion with some practical advice to the managers.

LITERATURE REVIEW

Just as the textbooks on corporate finance do not devote much space to the subject of risk adjusted cost of capital, the scholarly work in this area has also been hard to find. One of the earlier papers by Bhandari, N. (1981) basically framed the issue in terms of the uncertainty associated with forecasting all components of cash flows and presents a summary of five generally accepted methods to account for the uncertainty. These methods include the Certainty Equivalent, the risk adjusted Weighted Average Cost of Capital (WACC), the simple average method incorporating probabilities of varying economic conditions, the expected value method, and the sensitivity analysis. The second paper that has relevance to our work summarizes the survey results of 313 European CFOs on their use of capital budgeting evaluation techniques among other related issues. Not surprisingly, Brounene, Jong, and Koedijk (2004) reported that despite the ease at which NPV and internal rate of return (IRR) methods can be applied to an investment decision, many small firms and firms managed by older CFOs rely on the payback method (survey reported a range of 50.9% to 69.2% of the firms) to select the best project. The paper by Soares and Coutinho (2007) focuses on the post-audit study of capital budgeting forecasts. Using a large database, collected by the Portuguese government to award investment incentives, the authors report that one of the main variables often overestimated (by an average of 9%) by managers was sales with its resulting impact on the profit level. On the other hand, the managers were able to predict the operating costs accurately but could not estimate the investment expenses correctly probably due to the delays in initial starting of the projects. They observed that other firm specific variables such as type of industry or size had no effect on the error rate.

The closest research paper to our work was published in 1989 by Butler and Schachter. After presenting an example to illustrate the bias in the net present value calculations and extending it to a general case, they showed how the bias can be corrected. They discussed four approaches which include:

a. An ad-hoc approach

   Managers reduce the NPV by arbitrarily reducing the expected cash flows or increasing the discount rate.

b. An options-based approach

   This is an application of the certainty equivalent method which is commonly covered in most texts on advanced corporate finance.

c. Analytical expectations and numerically evaluated expectations

In this method, a ratio of the expected value of the estimated present value to the true value is calculated. This conversion factor is used to adjust the present value of the cash flows. The correction factor is project specific.

d. Unbiased estimation of present value: An analytical approximation

In this method, the authors proposed using the Taylor Series expansion to identify the corrected discount rate. Although this method is more complex it may be preferred by managers who may be less familiar with the properties of sampling distribution.

In summary, the work so far confirms the uncertainty that managers need to acknowledge in their cash flow forecasting but offers no solution to handle such risk in the evaluation procedure used.

MODEL

The documented use of payback method by managers implies that there are factors affecting the value of capital budgeting projects, related to time, other than the time value of money. One such factor is undoubtedly risk. Most textbooks describe the adjustment of the WACC to reflect different levels of risk associated with various projects as a footnote. If a chapter is devoted to the topic of risk analysis, explanations include sensitivity analysis, scenario analysis, & Monte Carlo simulation. These methods yield results that indicate using risk premium to account for the type of project being considered but not the risk premium associated with time. Rarely any mention is made of the reality that most managers are unable to estimate long term cash flows with accuracy and must therefore use a higher discount rate which should be adjusted to increase with successively longer time periods.

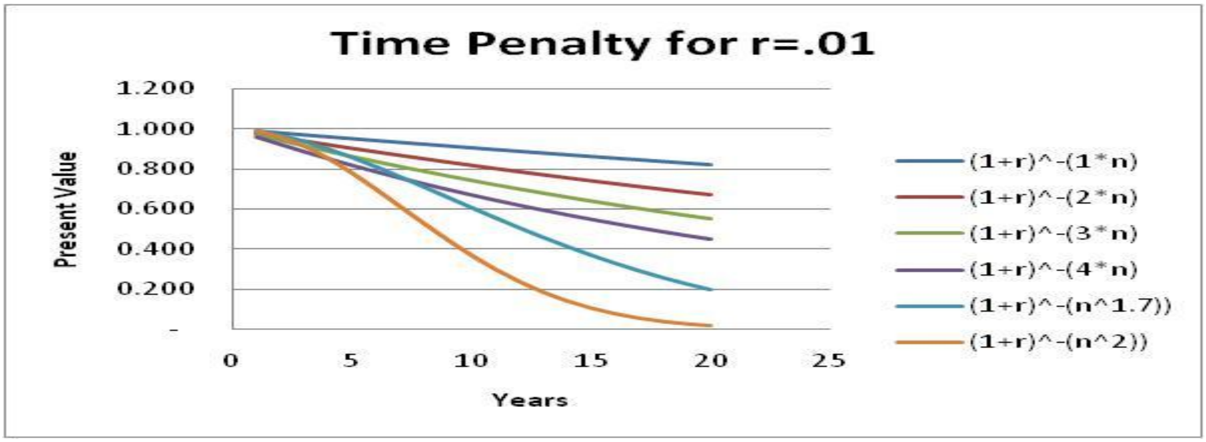
To illustrate this, let's consider four projects that a hypothetical firm with a cost of capital of 14% is considering. Each of these projects requires an initial investment of $100 and results in single future cash flow. Each project's cash flow occurs at a different time.

TABLE I

Project	**1**	**2**	**3**	**4**
Future Cash Flow	143	212	408	1512
Year Until Future Cash Flow	2	5	10	20
Present Value of a $ Factor	0.7695	0.5194	0.2697	0.0728
Present Value of Cash Flow	110	110	110	110
Cost of Project	100	100	100	100
Net Present Value	10	10	10	10

In the end we show that the application of this technique to an example of two mutually exclusive projects with significantly different expected lives.

CHART I



The net present value model incorporating payback can be implemented in many ways. The standard discount rate used in the NPV method is usually a sum of risk-free rate, risk premium, maturity and liquidity premium. The rate expressing time preference (penalty rate, r) is additional premium that needs to be incorporated in the calculations over and above the standard discount rate. The chart I above demonstrates several formulations for the additional discount factor with several different levels of severity. It shows the relationship between years and present value of the cash flow to be received at any given time. For any given formulation as the penalty rate (r) increases, the penalty becomes more severe. In addition, as we select a model with a larger magnitude exponent for (1+r), the model becomes more severe.

The process for choosing the correct formulation of the graph is very subjective. Examining the chart above, we can see that using a value of .01 for the rate and n for the power, after 20 years, the decay reduces the present value of the cash flow to about 80% of its unadjusted value. By increasing the exponent 3*n, after 20 years the present value of the cash flow is reduced to only about 40% of its unadjusted value. Using an exponent of n^2, after twenty years of decay the cash flows are worth close to nothing. This may seem extreme to some, but many managers that are sensitive to payback would probably agree that a project should not depend upon cash flows that are more than 20 years out to make it successful. This chart demonstrates the effect of changing the exponent. The appendix includes several additional charts that demonstrate the effect of varying the rate used.

One can visually choose both a rate and an exponent that captures payback preferences of the decision maker by examining these graphs, or the decision maker can be presented with a series of hypothetical projects and asked to make choices between them. An analysis of these choices can then yield values for both the proper rate and exponent. While this process for selection is subjective, application of the decay function on a consistent basis across individual projects will result in uniform application of the subjective preferences. When considering the weakness of the subjective process used to develop the decay function, it should be remembered that managers are currently making very subjective tradeoffs when they separately consider payback and net present value to arrive at a decision. This method is explicit and uniform, which gives it an advantage over the traditional approach.

CAPITAL BUDGETING CASE

We will now consider a case where a company is considering two mutually exclusive capital projects. These projects have cash flows as listed below.

TABLE II

Cash flows	**Project 1**	**Project 2**
Investment	(50,000)	(50,000)
1	10,000	16,000
2	10,000	16,000
3	10,000	16,000
4	10,000	16,000
5	10,000	16,000
6	10,000	
7	10,000	
8	10,000	
9	10,000	
10	10,000	
11	10,000	
12	10,000	
13	10,000	
14	10,000	
15	10,000	
16	10,000	
17	10,000	
18	10,000	
19	10,000	
20	10,000	

Using traditional capital budgeting techniques with a cost of capital of 10%, we can analyze these projects and get the following results:

TABLE III

Project	**1**	**2**
Net Present Value	35,136	10,653
Internal Rate of Return	19%	18%
Payback	5	3.1
Discounted Payable	6.3	3.9

Project 1 is better in terms of both NPV and IRR, but trails in both payback and discounted payback. Project 1 is inviting, but given the very long duration of the project it is unwise to ignore the payback. Detailed calculations are presented in appendix I.

CONCLUSION

There is little doubt that the decision process still requires a significant subjective component. In choosing both r and the model, we greatly affect the results. Appendix II presents results under three levels of r. However, it is much easier to implement a firm wide policy using this approach. Just as a company specifies a cost of capital for the firm or sometimes by division, they can also specify both model and r.

REFERENCES

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APPENDIX I

					Traditional		Payback Adjusted	
Cash flows	**Project 1**	**Project 2**	**PV$**	**pvr$**	**pvp1**	**pvp2**	**pvp1r**	**pvp2r**
Investment	(50,000)	(50,000)						
1	10,000	16,000	0.909091	0.990099	9,091	14,545	9,001	14,401
2	10,000	16,000	0.826446	0.96098	8,264	13,223	7,942	12,707
3	10,000	16,000	0.751315	0.91434	7,513	12,021	6,870	10,991
4	10,000	16,000	0.683013	0.852821	6,830	10,928	5,825	9,320
5	10,000	16,000	0.620921	0.779768	6,209	9,935	4,842	7,747
6	10,000		0.564474	0.698925	5,645		3,945	
7	10,000		0.513158	0.614119	5,132		3,151	
8	10,000		0.466507	0.528971	4,665		2,468	
9	10,000		0.424098	0.446651	4,241		1,894	
10	10,000		0.385543	0.369711	3,855		1,425	
11	10,000		0.350494	0.299995	3,505		1,051	
12	10,000		0.318631	0.238628	3,186		760	
13	10,000		0.289664	0.186075	2,897		539	
14	10,000		0.263331	0.142236	2,633		375	
15	10,000		0.239392	0.106584	2,394		255	
16	10,000		0.217629	0.078294	2,176		170	
17	10,000		0.197845	0.05638	1,978		112	
18	10,000		0.179859	0.039799	1,799		72	
19	10,000		0.163508	0.027541	1,635		45	
20	10,000		0.148644	0.018683	1,486		28	
	19.43%	18.03%			85,136	60,653	50,770	55,167
					50,000	50,000	50,000	50,000
		Net Present Value			35,136	10,653	770	5,167

	Traditional		Payback Adjusted	
	1	**2**	**1**	**2**
Present Value of Future Cash Flows	85,136	60,653	50,770	55,167
Cost of Investment	50,000	50,000	50,000	50,000
Net Present Value	35,136	10,653	770	5,167

APPENDIX II

Alternative values for r and their Graphs