Beyond NPV

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1 Introduction

Net Present Value is a deceptively simple prescription that has dominated academic advice. Discount all expected cash flows at a risk adjusted discount rate and if the result is positive, invest, otherwise do not invest. It is still possible to read the following in textbooks: "NPV considers all of the costs and benefits of each investment opportunity" and "we have seen that NPV is a totally logical way of assessing investment opportunities" and even that it is the academically preferred method. Nowadays, few academics and, we suspect, no practitioners support this view.

In this article we present a schema that summarizes the more recent theoretical developments. Their effect is to change the whole approach to investment analysis from just trying to predict expected cash flows to a far more business like analysis of the investment problem. Such is the extent of the change when going beyond NPV that it is something of a puzzle that many accounts still maintain that NPV is a complete answer.

Of course, businessmen have known that there were problems with NPV all along; surveys over the years reveal that they simply included NPV in a list of valuation techniques that continually expanded. This is not really surprising as NPV limits investment to just the initial investment decision and assumes no specific reaction to the investment. In the real world, businessmen think of decisions that depend on the outcome of the investment (the so-called real options); they also think of the reactions of competitors and other significant parties such as government and regulators.

2 How we got hooked on NPV

The net present value equation has been known at least from the 1600s and was used for borrowing and lending calculations such as bond valuation. It was never considered as a method of valuing projects until the 20th Century. Even then, an early text in the 1950s advocated NPV as a tool of practical importance only when there are distinctive cash flows.

The major advance for NPV came with the development of financial economics in the late 50s and 60s. One of its main aims was to explain asset pricing in markets. Shares in the stock market were the most transparent example; but valuing all assets in all markets, including seeing investment projects as assets was the scope. The misapplication of NPV to projects arose because at the market level, the more detailed aspects of investment cancel out and the NPV model serves as a reasonable approximation of share price behaviour.

Analysis appropriate at the highly aggregated level of the share came to be seen as appropriate for the disaggregated level of the individual investment. Often this is not the case, psychology differs from sociology; quantum theory explains the small, general relativity the large. The market view differs from the project view.

Such was the elegance of a theory that went from shareholder risk preferences to valuing individual projects that the academic world was very reluctant to let go of the NPV model and began to view practice as in some way deficient. NPV was the "way the world should work" and evidence to the contrary was dismissed and labeled the "gap between theory and practice".

3 Then came the doubts

Ironically, doubt came not from practice but from theory itself. In the late 1970s Stuart Myers suggested that the latest developments in option pricing could be applied to real investments rather than just shares. He coined the term real options. The analysis revealed large flaws in the NPV model. NPV failed to in-

clude the possibility of delay. Worse than that, it failed to include any future decision that depended on the outcome of the project – post investment decisions. Yet undeniably, delay and decisions down the line are part of many if not most large investments.

At the turn of this century, academics, notably Stephen Grenadier in Chicago, pointed out that as well as post investment decisions, competition was very poorly represented being no more than background noise – unresponsive to the particular investment. To include competitor responses he turned to a huge area of the economic literature termed game theory. Perhaps this title is unfortunate, competition theory might have been more appropriate. However, the gravitas of game theory should not be underestimated, with 5 Nobel laureates, it rivals those of finance.

Game theorists call NPV and options "games against nature". Also relevant are games against competitors - chess rather than golf, playing the man rather than the ball.

The famous prisoner's dilemma illustrates the kind of issues. Suppose your firm and a competitor can invest in a new development, but profits will be lower than if you both do not invest. So do not invest? The worst outcome is if your competitor invests and you do not. So you invest to avoid the worst outcome – even if the NPV is negative. This is just one of a number of "games" or competitive scenarios where the solution is a strategy that is more complex than the simple NPV model.

4 Piecing it all together

Businessmen do not have the luxury of being selective about the world they face. Academics forget this. Indeed, we are not aware of any major textbook that addresses all the developments we have outlined – these we summarize Figure 1.

Although NPV appears in all the Figure 1 boxes, its importance varies greatly. In low competition environments the main considerations are NPV and decisions that depend on the outcome - real options. As competition increases, so game theory considerations become critical. Here, the differences in value between strategies are such that the niceties of NPV are not relevant.

	Only consider the investment decision: invest or do not invest *now*	Includes decisions after initial investment decision (including delay)
Assuming no reaction from competitors and regulators	NPV	NPV + Real options
Including reaction from competitors and regulators	NPV + Strategy/Games	NPV + Real options + Strategy/Games

Figure 1: A decision model classification

5 The way ahead

So what can a businessman take from this? Certainly the dominance of NPV is no longer. Investment is now seen as part of a sequence of decisions that depend on outcomes and reactions.

Some examples will help. Firstly, an investment by a train company to increase capacity may not have a positive net present value. It might seem that it is a monopoly supplier, yet, there can be a reaction from the air industry. Failure to invest may mean losing out and losing opportunities created by greater capacity. The isolated consideration of NPV is not sufficient.

A second example is when an organisation develops new products and markets or both at the same time. Apple's creation of the IPad is one such instance. Before its launch, there was no product or market in existence. Undertaking net present value analysis would be difficult based on an evidential approach. However, when seen as part of a dynamic game with other high-tec companies, the value of innovating, or indeed, the cost of not innovating is much clearer. The differences are so great that detailed NPV calculations are irrelevant.

Applying the wider set of academic valuation models outlined here will hopefully lend clarity to practice and close any gaps between the two. What we can say for now is that there is no argument to support the view that NPV is completely logical or that it is academically preferred. The new models are more demanding and more difficult to implement, but are much closer to a world that businessmen would recognise.