Construction Management and Economics ›
Volume 31, 2013 - Issue 5

Articles

Decoupled NPV: a simple, improved method to value infrastructure investments

David Espinoza & Jeremy W.F. Morris

Pages 471-496 | Received 23 Jan 2013, Accepted 26 Apr 2013, Published online: 27 Jun 2013

Cite this article https://doi.org/10.1080/01446193.2013.800946

Abstract

Despite its shortcomings, because of its simplicity, the net present value (NPV) technique (or its close relative, the internal rate of return) remains the valuation method most widely used by investors. In this method, all risks associated with a project are lumped into a single parameter (i.e. the risk premium) that is added to the risk-free interest rate to obtain a risk-adjusted discount rate; thus, in essence, the time value of money is adjusted for risk. However, because risk and time are two separate variables, accounting for risk in this manner can lead to substantial valuation errors, particularly for long-term investments which are typical for large infrastructure projects. In this paper, an alternative valuation method that decouples the time value of money from the risk associated with a project is presented. The proposed method, termed decoupled net present value (DNPV), is also simple yet flexible, consistent and robust. The method allows investors to integrate heuristic (i.e. experience based) techniques with sophisticated probabilistic and stochastic techniques to price the risk associated with the value of the asset created and/or the investment needed to create the asset. The proposed method results in a consistent valuation free from the problems typically associated with traditional net present value applications and, more importantly, allows a seamless integration of project risk assessment/management performed by technical experts into the project financial valuation.

Keywords:

DNPV project finance real options risk management valuation

Acknowledgements

The seeds of the proposed ideas were sown on a National Science Foundation (NSF) funded research project funded under the Small Business Innovative Research (SBIR) Grant No. 0340171, Phase I. The authors are also grateful to Mr Javier Rojo of Sustainability Strategic Advisors Ltd, Mr Robert Graber of EnergyPath Corporation and Dr Ranjiv Gupta of Geosyntec Consultants for their kind review of the initial draft of this manuscript and their valuable comments.

Notes

1. Nowadays, many corporations compile large amounts of data related to their business and process this information using business analytic tools to improve their operations and better forecast results.

2. The size of the infrastructure project market is currently estimated to be $17–20 trillion (Francis, 2011) and it is expected to grow to $41 trillion in the next two decades.

3. A squiggle symbol over a variable is used to represent the random nature of these quantities and, unless specified otherwise, these variables are represented by their expected values.

4. Note that the squiggle is not used to represent these variables as they are assumed to be known quantities (i.e. only the cash inflow is uncertain).

5. This assumption is not a requirement for the method to work, it is only made to simplify the discussion.

6. In promoting use of the proposed DNPV method, this paper aims to promote a rational and consistent approach that is already in use in the insurance industry and that allows for a proper and consistent risk quantification. However, it should also be noted that even if every project uncertainty could be identified and modelled using the techniques described below, this does not imply that these real-world uncertainties have been captured, they have simply been modelled.

7. For simplicity, the PDFs in Figures 1a and 2a are represented as a triangle distribution; however, several other distributions that better represent the available data and/or experts' experience could be assigned.

8. Insurance fair premiums can be derived from utility theory (Embretchts, 2001). For the simplest case of a linear utility function, the fair premium is equal to the expected loss.

9. The expected value of a triangular distribution is equal to one-third of the sum of the minimum, maximum and mode. The probability is the area of the triangle to the left of the expected expenditure in Figure 2.

10. The parameter was estimated based on Approach 2 (probability based methods) along with the guidance provided in Table 2. More reliable values can be obtained by combining data from different sources (e.g. literature, similar projects, or sensitivity analyses).

11. Although ROV expressions that better represent the landfill gas (LFG) extraction/decay processes can be derived and used in this example (e.g. Espinoza et al., 2007), the focus of this article is the application of the proposed DNPV methodology. Thus, for the sake of simplicity, the expressions derived by Black and Sholes (1973) and presented in Appendix A to estimate the value of European options are used in these examples to estimate the price of risk associated with the production of LFG. The remaining parameters used are: $T = 1$ year, $r = 3\%$, $\delta = 0$, $S = 1$, and $X = 1$. The values of $S = X = 1$ were selected to obtain a normalized priced of risk for fixed-term contracts. The meaning of each parameter is described in Appendix A.