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Modeling managerial behavior in real options valuation for project-based environments

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Abstract

Project valuation, as a decision-making tool for initiating investments in projects, should be able to value project flexibilities and incorporate reasonable risk preferences of relevant decision makers. Real options valuation methods are the available approaches for valuing project flexibilities, whereas they have shortcomings in considering managers' reasonable risk preferences in project decisions. Therefore, researchers have suggested approximating the perspective on risk of real options methods and practitioners in project management. This study proposes a fair real options valuation for project-based environments by a behavioral economic approach, which adopts binomial lattice method, Monte-Carlo simulation, and cumulative prospect theory. The results show that behavioral factors such as 'risk attitude' and 'loss aversion' should be accepted in project investment decisions while limited to an acceptable amount depending on the project conditions (e.g. uniqueness of decision-making scenarios). This research contributes to the project management domain by enhancing project investment decisions that include project flexibilities.

Keywords: Project investment decisions; Project valuation; Flexibility; Managerial behavior; Fair real options valuation; Cumulative prospect theory; Loss aversion; Risk attitude; Price adjustment clause

1. Introduction

Project investment valuations should embrace the value of project flexibilities due to their essential role in coping with uncertainties of the project management environment. The project management environment is characterized by incomplete information (Cleden and Dalcher, 2012; Zwikael and Smyrk, 2011) and generally firm- or industry-specific products. It is impossible to know circumstances and needs more than ten years ahead for long-lasting engineering projects, and uncertainties (e.g. technological changes) disrupt previous assumptions and forecasts (De Neufville and Scholtes, 2011). Furthermore, overwhelmingly costs are often needed to reverse (if possible) the adopted decisions in this environment (Guariglia et al., 2012). Therefore, flexibility is built into projects (e.g. planning and design stages) through adapting to circumstances as they arise, to deal best with project eventualities and maximize the project's expected value. Project flexibility is the capability to adjust the project to prospective consequences of uncertain circumstances within the context of the project (Husby et al., 1999). When the project investment is irreversible and the project environment is highly uncertain, project flexibility becomes so vital to the project investment success that it must be addressed seriously (Olsson, 2006). If the project (investment) valuation ignores project flexibility particularly when a high degree of uncertainty is involved, then a potential investment may be understated and lead to an incorrect decision (Block, 2007). Neglecting the value of flexibility in project valuation, discourages its adoption in projects and distorts decisions to favor the shorter time-horizon and limited perspective alternatives (Pender, 2001). Therefore, project valuation techniques must involve the value of project flexibilities whenever they exist.

Project valuation techniques developed for valuing project flexibilities should be consistent with the project management environment; otherwise, they may not become fully applicable in

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that environment. These techniques may require advanced analytical tools in high-risk projects (Zwikael et al., 2014; Zwikael and Sadeh, 2007). Neither classic net present value (NPV) analysis (Copeland and Antikarov, 2001; Trigeorgis, 1993) nor risk management tools (Pender, 2001) are able to analyze or value project flexibilities in project investment decisions, whereas real options methods (ROM) have this ability. Real options are the mechanisms for building flexibility into projects; they are the right (but not the obligation) to sell/buy an asset in the future. This mechanism eliminates the downside risk associated with the future value of the asset, thus, increases its value. Since the available ROMs were originated in the finance industry, they need developments to become fully applicable in project-based environments (PBE). These developments are necessary because currently there is a gap between the theory and practice of real options valuation (ROV) in PBEs (Garvin and Ford, 2012; Herder et al., 2011; Triantis, 2005). Practitioners in PBEs claim that this gap is a result of simplifications and assumptions made in ROMs, whereas researchers argue that it is due to practitioners' irrationalities such as cognitive biases. For example, consider the valuation of price adjustment clauses (PAC), as a type of real option. PACs are risk-sharing contractual mechanisms that guarantee an adjustment in payment to contractors based on the size and direction of the material price change. Empirical studies show no evidence that offering PACs would reduce the submitted bid prices (Ilbeigi et al., 2016a), whereas valuations performed by available ROMs prescribe a considerable (4%–10%) reduction in project costs (Mirzadeh and Birgisson, 2016). Therefore, there is an inconsistency between the valuation of project flexibilities resulted from available techniques and the valuations performed in practice, which should be resolved in developing new valuation methods.

Available methods for valuing project flexibilities do not deal with risks and uncertainties in a compatible manner with PBEs. Researchers develop ROMs based on a reductionist school of thought, which adopts a strictly positivist, objectivist, and realist view. The reductionist school determines a 'normative ideal' as a rationally right trajectory or decision, and labels the deviations from that normative ideal as biases and errors (Stingl and Geraldi, 2017). The ROVs proposed by such ROMs are named prescriptive ROVs (PROV) in this study. PROVs are based on probability theory, which makes two main assumptions. First, there are sufficient amount of relevant information from past projects for estimating probabilistic parameters in PROV. Second, the choices on adopting the real option will be repeated enough times that their outcomes tend to the average of possible events. Researchers in project management domain have criticized both these two assumptions for ROVs (Garvin and Ford, 2012; Herder et al., 2011; Triantis, 2005). The first assumption is in question because most projects are unique endeavors and they involve a large amount of uncertainties rather than risks (predictable), (Collan et al., 2016; Pender, 2001). The second assumption is debated because most opportunities to use a specific option occur infrequently and often only once per project (single-play gamble) in contrast to the repeated bets in the finance industry (multiple-play gamble), (Camilleri and Newell, 2013; Sun et al., 2014; Wulff et al., 2015). The first assumption leads practitioners to 'risk aversion', whereas the second one leads them to 'loss aversion' (i.e. 'exposure-based perspective of risk') in real options' evaluation (Garvin and Ford, 2012). Past empirical studies on risk conceptions in project management provide compelling evidence to this discrepancy between practitioners' perspectives on risk and the probabilistic principles on which project valuation tools are based (Hartono et al., 2014). Therefore, there is an apparent need for new project valuation methods that can overcome the shortcomings of common ROMs in PBEs.

Project valuation methods used for valuing project flexibilities will be more fair and applicable in PBEs if they get closer to the practitioners' perspective on risk. Hartono et al. (2014) and Triantis (2005) suggest developing ROMs that are closer to the practitioners' perspective on risk in order to reduce the resistance towards implementing those proposed methods and broaden the application of real options in practice. Garvin and Ford (2012) claim that risk behaviors such as 'risk aversion' and 'loss aversion' should be partially accepted to reach a fair ROV (FROV) in PBEs. To illustrate this idea on developing new ROMs, the PROV and actual ROV are represented by 'P' and 'D' in Fig. 1, respectively. By accepting the deviation of 'P' and 'D' resulted from modeling assumptions (Fig. 1, F-P), a FROV can yield (Fig. 1, F). The remaining deviation is attributed to irrationalities in decision-making (Fig. 1, D-F), which should be minimized by effective means discussed in the Conclusion section.

This study aims to propose a fair real options valuation for the project management domain by a behavioral economic approach. Behavioral economic studies, which model real-life choices descriptively, help us model the actual ROVs systematically. This systematic model, named descriptive real options valuation (DROV) in this study, enables the analysis of behavioral factors causing the difference between DROV and PROV. These behavioral factors have different elements (Appendix A) including loss aversion and risk aversion, and were first termed by Triantis (2005) as 'managerial behavior' (MB). By illuminating the difference between PROV and DROV, the basis for a FROV is readily available. This new perspective and modeling approach for valuing project flexibilities in the PBEs is expected to increase the adoption of flexibility in projects and the applicability of ROMs for valuing those flexibilities. This proposed method is very effective for project valuations that are affected by high uncertainties and embody flexibilities for dealing with their irreversible investments. For example, project contracts often have these conditions and include many contractual real options (i.e. real options embedded in contracts) which are designed to deal with the relevant uncertainties. These contractual real options include minimum revenue guarantees (Ashuri et al., 2012), maximum expense limits (Park et al., 2013), restrictive competitions (Liu et al., 2014b), options to abandon (Huang and Pi, 2014), renegotiation options (Xiong and Zhang, 2016), PACs (Ilbeigi et al., 2016a), etc. Considering that, the volatility of material prices is a main uncertainty for construction contractors with fixed-price contracts and PACs are the contractual real option mechanisms for dealing with this uncertainty, this study applies its proposed method on PACs.

The remainder of the article is structured as follows. The literature on the objective of this study is reviewed in Section 2.