

Making optimal decisions for real option portfolios under exogenous and endogenous uncertainties

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Although the value of portfolios of real options is often affected by both exogenous and endogenous sources of uncertainty, most existing valuation approaches consider only the former and neglect the latter. In this work we present a new approach for modelling and approximating the value of portfolios of interdependent real options under both types of uncertainty. In particular, we study a large portfolio of options under conditions of four uncertainties. Two of the underlying uncertainties, decision-dependent cost to completion and state-dependent salvage value, are endogenous, the other two, operating revenues and their growth rate, are exogenous. The stochastic processes describing the dynamics of all four uncertainties and the set of constraints modelling the options' interdependencies are integrated in a multi-stage stochastic integer program. Combining a simulation-and-regression approach with a reachability analysis to approximate the value of this optimisation problem, we present an efficient valuation algorithm that exploits the problem structure to explicitly account for the (sub)sets of sample paths in which resource states can actually be reached. The applicability of the approach to complex investment projects is illustrated by valuing an infrastructure investment. We find that while the total number of reachable resource states, as expected, increases in both the number of paths simulated and the degree of the decision-dependent uncertainty, the percentage share of paths available per resource state in the valuation algorithm decreases not only in the latter, but, somewhat paradoxically, also in the former. This means that, in contrast to simulation-based approaches for standard problems, generating more sample paths will in general not improve the algorithm's approximation accuracy when addressing problems with endogenous, decision-dependent uncertainty. In addition, we investigate the way in which the value of the portfolio and its individual options are affected by the operating revenues, and by the degrees of exogenous and endogenous uncertainty.