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基于实物期权的研发项目动态投资决策模型

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R&D Project Dynamic Investment Decision-making Model Based on Real Option

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摘要 本文基于实物期权理论,针对研发项目阶段性特点,结合博弈论的思想,分析了多个研发项目组成的投资状态组合,构建了研发项目动态选择模型。首先,根据研发项目多阶段的特征,利用孪生证券的思想,基于实物期权理论,建立了项目中止决策准则;在此基础上分析研发项目的投资决策状态,建立了二十五个状态的切换场景;然后通过实际算例对模型进行验证和分析,得出了研发项目投资的影响范围概念图,最终实现两个项目的最优投资决策目标。
关键词： 研发项目 实物期权 博弈 动态选择 投资决策

Abstract : R&D project is an important means for enterprises to gain continuously a competitive advantage in the fierce market. The key during R&D investment decision-making problems is project selection. Compared to normal engineer projects, it is more difficult to accomplish R&D project evaluation and selection since it has complex, dynamic and innovation features. In this paper, we focus on multiple R&D projects selection problem in the same enterprise and build a dynamic selection model. Within this dynamic selection model, the effect on the under-going project by other R&D projects after their stage success is considered according to game philosophy. Then investment decision points will be conducted to avoid game risk, and finally the optimal investment decision objectives for multiple research projects will be realized.R&D projects considered in this paper have market risk, technology risk, unexpected risks, and game risk in the same enterprise. Firstly, according to the characteristic of multi-stages for R&D project, project termination decision criterions are built by using twin securities theory under real options perspective. Within each stage, the potential cash flow of R&D project follows a movement combination by geometric Brownian motion and Poisson motion. According to the non-arbitrage equilibrium principle, risk-neutral probability can be constructed. Then the cash flow of R&D projects can be converted to the investment point based on option pricing model. For the game risk among multiple R&D projects, the project which has accomplished more success stages will have more first-mover advantage than the project which has less success stages, thus the dominant project will have greater probability to get investments, and vice versa. The success stages numbers for different R&D projects will be observed and recorded. The project which has a greater success stage number will be assigned with a greater influence coefficient and the project that has a relatively smaller success stage number will be assigned with a smaller game factor. Thus the multiple R&D projects selection problem based on game theory can be quantized to values. According to the combination for R&D projects different success stages, a dynamical R&D projects multi-states selection scenario has been established. The transition between different states depends on investment decisions and game effects. By analyzing all of the transition conditions among different states, a corresponding software tool has been designed, which can be used to demonstrate multipleR&D projects dynamical selection results.
Atypical case has two typical R&D projects: one basic research project and one applied research project. The basic research project has along development cycle with great investment and low probability of success, however, it can bring in huge cash flow for enterprises after the success; the applied research project has a short development cycle with small investment and high success probability, however, the benefit reflected by cash flow is also small after success. Through dynamic game observation and sensitivity analysis by our tool, a R&D project investment impact concept map is established, and ultimately the optimal investment decision objectives of the two projects have been obtained.

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