Chapter 5.19

VPRS–Based Group Decision– Making for Risk Response in Petroleum Investment

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ABSTRACT

From the perspective of risk response in petroleum project investment, the authors use a group decision-making (GDM) approach based on a variable precision rough set (VPRS) model for risk knowledge discovery, where experts were invited to identify risk indices and evaluate risk exposure (RE) of individual projects. First, the approach of VPRS-based GDM is introduced. Next, while considering multiple risks in petroleum project investment, the authors use multi-objective programming to obtain the optimal selection of project portfolio with minimum RE, where the significance of risk indices is assigned to each of corresponding multi-objective functions as a weight. Then, a numerical example on a Chinese petroleum company's investments in overseas projects is presented to illustrate the proposed approach, and some important issues are analyzed. Finally, conclusions are drawn and some topics for future work are suggested.

INTRODUCTION

In petroleum industry, project investment is characterized by irreversible decision-making with uncertainty (Chapman & Ward, 2004; Chorn & Shokhor, 2006), and risk response measures

should be adopted (Aven & Vinnem, 2007). During the life cycle of a petroleum project, there are multiple risks, such as political and economic risks (Pandian, 2005; Stephens et al., 2008), environmental risks (Bowonder, 1981; Ferreira et al., 2003; Norberg-Bohm, 2000), price volatility and financial risks (Chorn & Shokhor, 2006),

and geological and technical risks (Asrilhant et al., 2007). Hence, it is necessary to implement risk response measures for corresponding risks in petroleum projects.

Many researchers have investigated petroleum project risk management, and some of risk management process and tools have been designed. Aven and Pitblado (1998) discussed the practices in petroleum project risk management, focusing on risk analysis, interpretation, acceptance criteria, and risk communication, besides emergency preparedness. Some decision support tools are developed to support risk management. Proposing a set of multi-disciplinary elements structured with the balanced scorecard's rationale, Asrilhant et al. (2004) explored ways to increase understanding of best practices of decision-making in petroleum project risk management. Kravis and Irrgang (2005) developed a case-based system to support risk assessment in oil and gas well design. In project risk management, risk response measure portfolio was adopted for multiple risks (Xie et al., 2006a), which will be used for risk response in petroleum project investment in this study.

In the practice of petroleum investment, proper portfolio selection is an effective way to reduce nonsystematic risk (Walls, 2004; Ross, 2004). In general terms, portfolio selection is a multi-attribute decision-making (MADM) problem. As a consequence, usually, multi-objective programming methods are used in petroleum project selection (Memtsas, 2003), where we further consider risk preferences and weights of decision-makers in the group decision-making (GDM). Then, managers can implement risk response measures for selected projects.

In general terms, due to relativity and complexity of risk management, the risks are usually identified and analyzed by group of managers and experts (Walls & Dyer, 1996). Moreover, petroleum investment is a so important issue that multiple objectives should be involved in. As a result, GDM is a usual way for petroleum project investment (Van Groenendaal, 2003). In

the methodology proposed in this paper, experts are invited to identify risk indices and to evaluate the risk exposure (RE) of the petroleum projects in a region. In GDM, decision-makers often have different risk preferences (Walls & Dyer, 1996) and weights (Xie et al., 2006b, 2008). However, how to measure the risk preference and the weight of experts in GDM is a problem yet.

The rough set theory (RST) is a good tool to measure risk preferences of the decision-maker. RST extracts the knowledge based on quality of classification (QoC), and can discover knowledge from data sets automatically (Pawlak, 1982, 1991). In particular, RST does not need any priori information such as probability distribution in statistics, which is suitable for the rather small sample size of the available petroleum projects in this paper. However, due to uncertainty, ambiguity, and complexity that exist in project risk management (Ross, 2004; Goumas & Lygerou, 2000), it is hard to avoid misclassification caused by decision-makers, which cannot be treated well by RST. Variable precision rough set (VPRS) is an extension of RST with a confidence threshold value set at β ($0.5 < \beta \leq 1$), which means misclassification rate of up to $1 - \beta$ is tolerated in decision tables (Ziarko, 1993; Xie et al., 2006c). Though a VPRS model has been used for petroleum project investment risk management (Xie et al., 2010), a group decision-making scenario has not been considered as yet. Therefore, we propose an application of VPRS-based GDM for risk response in petroleum project investment.

For the above problems, we design a mechanism that knowledge is discovered for risk response in petroleum project investment based on VPRS-based GDM. Firstly, we introduce the approach of VPRS-based GDM. Next, we use multi-objective programming to obtain the optimal selection of projects with minimum RE. Then, a numerical example on a Chinese petroleum company's investments in overseas projects is presented to illustrate the proposed approach. Moreover, some important issues are analyzed

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