A real options based assessment on coalbed methane investment

with a case study in China

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Overview

Coalbed methane (CBM) is a kind of unconventional nature gas found in coal seams. As relatively clean energy, CBM is an important supplement to natural gas demand in China. The development of CBM benefits a lot. The exploration and development of CBM will not only decrease the probability of coal mining accidents, but also reduce GHG emissions, since the greenhouse-effect of methane is 20 times of CO_2.

China has abundant CBM resource, and the geological CBM resource volume is the third largest in the world next to Russia and Canada. The methane-bearing area is of 41.54×10^4 km^2 under the buried depth less than 2000m in 45 coal-accumulating basins and the geological reserves is 36.8×10^{12} m^3(D.K. Luo etal, 2010). According to the 11th Five-Year Plan, great efforts should be made so as to have production volume to reach 100×10^8m^3 per year, and the utilization volume to reach 80×10^8m^3 per year in 2010. However, these targets had not been achieved at the end of 2010 (the end year of the 11th Five-Year Plan). Therefore, it is important to explore why CBM industry development was so slow from 2006 to 2010, how to attract more investment to CBM development aera and promote the development of the CBM industry in the future.

In this paper, the investment of the CBM industry is investigated from the perspective of real options. Han Cheng CBM area in Shanxi province, which has the great exploitation potential in China, is taken as a case study. The project value and real options value are evaluated, and related policies such as subsidy and tax, and price uncertainty are analized. As a result, the policy mix to stimulate the investment on CBM area is proposed.

Methods

A CBM project requires huge investment, with long-term lifecycle and high risks. The validity of investment profit in CBM projects is affected by many uncertain factors, such as resource conditions, capital need, operation and maitaintance cost, product price, market demand, tax, subsidy and so on. Confronted with the uncertainties, investors have options to invest or to wait for the emerge of favourable conditions and delay their investment decisions(also called timing option)(Johnathan Mun, 2002). As a consequence, the CBM industry may develop slower if the prevailing circumstances are unfavourable. Real option evaluation(ROE) methods have the advantage to describe and solve the investment problem (Avinash K. Dixit and Robert S. Pindyck, 1994).

Binomial decision trees is used to solve real-option valuation problems because it not only could compute the real option value(ROV) but also exhibit the decision process(Tom Copeland and Tufano, 2004). The earliest time when the investment opportunity turns up and the corresponding probability are estimated with this method. According to the current concrete conditions, gas price is the most important uncertain factor among factors refered above, especially when the natural resource pricing systerm is under reform. We assume gas prices and the market demand follow non-stationary stochastic processes, and Geometric Brownian Motion (GBM) models are used to describe the evolution of the two factors. Based on the parameters, which are carefully dertermined, related to the binomial decision trees, bidimensional binominal lattices are employed to solve the model (Paolo Brandimarte, 2006).

Finally sensitivity analysis is made to analyze how policies affect investment behaviers, including subsidy and corporate income tax, as well as price uncertainty.

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Results

At the business as usual (BAU) scenario, the real option value to invest in Han Cheng CBM area is 4.3 billion yuan and the investment should be delayed for at least 4 years before the investment opportunity turns up when the price and the market demand are favourable enough. While the Net Present Value(NPV) is estimated as 1.5 billion yuan.

The effects on the ROV and the investment decision of the the intial price, price uncertainty, subsidy and corporate income tax are investimaged respectively. When the intial price increases from $0.7yuan/m^3$ (the BAU price in 2006) to 1.4 $yuan/m^3$, the ROV increases from 4.3 billion yuan to 15.6 billion yuan accordingly and it's better to excute the investment immediately. When the subsidy increases from $0.2yuan/m^3$ (BAU) to $0.6yuan/m^3$, the ROV increases from 4.3 billion yuan to 8.5 billion yuan and the investment could be excuted without waiting. When the price volatility increase, the ROV increases accordingly, which indicates that the option to delay becomes more important when the price risk increased and the time to invest may be moved up because the critical price may turn up earlier with the volatility increasing. When the corporate income tax decreases from 25%(BAU) to 0, the ROV increases accordingly from 4.3 billion yuan to 6.6 billion yuan and the time to wait only decreases from 4 years to 3 years.

The comparison of the effects of different policies shows that the ROV is most sensitive to the initial price, followed by corporate income tax, price uncertainty and subsidy policy. The earliest possible investment time when an investment opportunity turns up is most sensitive to the initial price, followed by susidy, corporate income tax, price uncertainty.

Conclusions

1) According to the NPV rules, the investment could be executed immediately(NPV>0), while it's better to delay investment decisions according to the ROE evaluation. The ROE method provides an explanation why the investment in the CBM aera is delayed and why GBM industry in China developed slowly in the past five years from the perspective of investment.

2) The initial price is the most important factor that affects the ROV and the investment decision compared to other policy factors. Along with the intial price increasing, the ROV increases rapidly, the time needed to wait for the investment opportunity turning up is shortened significantly and the corresponding probability to invest increases rapidly, so increasing the initial price is necessary and also most effective to promote the investment in the CBM industry in China under current conditions.

Acknowledgments

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