EVALUTATING THE IMPACT OF OIL PRICE VOLATILITY ON INVESTOR AND FISCAL REVENUES

Akil Zaimi, KAPSARC, +966 11 261 3035, akil.zaimi@kapsarc.org
Baltasar Manzano, KAPSARC and Universidade de Vigo, +34 986 81 35 22, baltasar.manzano@kapsarc.org

Overview

Understanding how oil price volatility can affect the timing and economic performance of upstream oil projects is crucial for both international oil companies (IOCs) and host governments. This factor is at least as important as the more commonly recognized geological and other technical uncertainties. But oil prices are still modelled in a simple way by the industry which mainly uses a subjective central price scenario or low medium and high price scenarios without volatility or structural breaks.

We propose a complementary approach and also depart from the real options approach by taking a more operational methodology. We model the investment decisions made by the IOCs based on a single subjective oil price scenario. In the base case, this scenario is a constant real oil price for all the project years. It is equal to the oil price of the decision year. We allow the IOCs to delay their investment destination when their 10% after tax Net Present Value (NPV) is negative. In case of delay, in every subsequent year the constant oil price is revised to the new current oil price generated by a stochastic process. The financial outcomes of both IOCs and governments, once a field is developed, are simulated under stochastic price sequences.

We use the planned development of three onshore blocks in Uganda currently at the predevelopment stage as a case study and develop results that are applicable more generally across the industry. Uganda provides an interesting case study for two reasons. First, the oil blocks are at the threshold of economic viability in the current price environment. Second, the Ugandan fiscal terms integrate all the components of upstream contracts: national oil company (NOC) participation, royalty, production sharing, tax on profit and withholding tax.

We first perform, in the base case, a statistical analysis of IOC, State NPVs and of the development delays. We also look at the structure of the State revenues, the rent sharing and the value of the right to extend the allowed time to delay development. We then run sensitivity cases with technical costs dependent on oil prices, using an elasticity, an alternate geometric random walk oil price stochastic process and a pure proportional fiscal regime. We finally run different decision price strategies for all the sensitivities cases and identify a kind of efficient frontier for the IOC in the more conservative risk averse decision price scenarios.

Methods

The production profiles of the Ugandan blocks and their associated costs were estimated internally in collaboration with PEPD of Uganda. The fiscal terms are representative of the Ugandan production sharing agreement. To analyse the sole impact of oil price uncertainty, we keep all the other inputs of the financial model constant.

We set the parameters of a two regime Markov switching process oil price based on Brent historical yearly prices from 1987 to 2016. We control the price process of each sequence and let it fluctuate between $20 and $300/bb with a volatility not exceeding three times the historical volatility of Brent prices. We generate by Monte Carlo simulations 6000 stochastic oil prices sequences.

In the base case, we keep constant the IOC decision real price over time and equal to the market price during the decision year. If the IOC NPV under this subjective price scenario is positive, it develops a field. If not, the IOC postpones the development decision by a year and repeats the decision exercise with the simulated price of this next year.

IOC development decisions with up to 25 years allowed delays, cash flows and resulting State and IOC NPVs are simulated for each of the 6000 stochastic sequences.

We analyse the distributions of development delays, State and IOC NPVs at the same 10% discount rate under the different sensitivity cases.

Results

In the base case, there is only an 8% chance of having immediate development and a 20% probability of no development at all during the 26 years we simulated. The range of NPVs is wide for both the State (-0.6 to 70 with a 9.6 mean in $ billion) and the IOC (-6 to 16 with a 1.3 mean in $ billion). The IOC is exposed to extreme negative values when the prices during the first production years crash and lead to an early abandonment of the blocks. Surprisingly, although the structure of the contract provides most revenues of the State from non-negative taxes, the State is also exposed to global negative outcomes in these cases through its NOC participation. But overall the IOC encounters negative NPVs in 29% of the cases more frequently than the 3% probability of negative State NPVs. The shape of the IOC NPV distribution is rather symmetric as it is equally exposed to favourable and non-favourable outcomes. While the State NPV distribution is positively skewed due to dominant non negative taxes against the sometimes negative NOC returns from its participation.

The IOC mean-standard deviation curves under different decision price strategies show a kind of efficient frontier. “Risk averse” lower decision price strategies allow to reach the same mean than “risk tolerant” higher decision price strategies with a lower standard deviation.

Changing the fiscal terms to a “Brown tax” or proportional tax considered in the literature as a non-distortionary fiscal mechanism provides an equal risk sharing between the State and the IOC with more frequent and earlier development decisions. But, surprisingly it generates more negative outcomes for the IOC than the supposedly less favourable Ugandan upstream fiscal regime. The after tax breakeven prices are lower under a Brown tax. The blocks are developed earlier and more often. The IOC becomes more exposed to less favourable price sequences and resulting negative NPVs. Finally, we move away from Ugandan example by reducing costs and fiscal terms and find the same type of efficient frontier where prudent decision prices lead to lower volatility.

Conclusions

While still making decisions based on constant real oil price scenarios, the IOCs can use our approach to optimize their development decision process, but also the puzzling abandonment decision process.

Our approach might as well be useful to governments of the host countries. The timing and levels of these revenues depend on how IOCs operating in their country make development decisions and on the oil price fluctuations during the production period after these assets are developed. Governments can use our proposed method for a probabilistic analysis of their future revenues and the choice of an adapted macroeconomic policy. Our method can also be useful for the design of upstream fiscal terms. Taking into account development delays introduces a dynamic dimension to the static Net Present Value and zero sum rent sharing traditional tools. While IOCs and governments see each other as agents with conflicting interests, changes to the fiscal regime reducing development delays could benefit both parties.

References

Bagabo, P. and Lassourd, T. (2015). “Low Oil Prices Impose Difficult Choices in Uganda”. Natural Resource Governance Institute (http://www.resourcegovernance.org/blog/low-oil-prices-impose-difficult-choices-uganda).

Fong,W.M. and See, K.H. (2002). “A Markov Switching Model of the conditional volatility of crude oil futures prices”. *Energy Economics* 24, 71-95.

Kellogg, R. (2014). “The Effect of Uncertainty on Investment: Evidence from Texas Oil Drilling”. *American Economic Review*. 104(6), 1698-1734.

Paddock, J.L., Siegel, D.R. and Smith, J.L. (1988). “Option Valuation of claims on Real Assets: The Case of Offshore Petroleum Leases”. *Quarterly Journal of Economics*, (103(3), 479-508.

Smith, J.L. (2014). “A parsimonious model of tax avoidance and distortions in petroleum exploration and development”. *Energy Economics*, 43(C), 140-157.