Real option valuation in a Gollier/Weitzman world: the effect of long-run discount rate uncertainty

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Executive summary

Oil & gas capital budgeting decisions are challenging because investments are large-scale, projects frequently have long horizons and oil price uncertainty is considerable in the long term. For example, the Yacuiba-Rio Grande Gas Pipeline and the Ital Gas Storage Facility have concession periods of 40 years and the Zeri-Chirag-Gunashli oil fields plausibly have a 45-year project life. Given irreversibility, uncertainty and some degree of decision flexibility, real option value is important to incorporate as accurately as possible. Indeed, the value of real options is consistent with practical evidence on decision-making, including the use of hurdle rates that are well above the project cost of capital, or the reluctance to abandon "loser" projects.

This study bridges the oil & gas real options literature with the broader literature on long-run discount rate uncertainty (declining discount rates, or DDR). The purpose is to better understand the impact of DDR on oil & gas investment under uncertainty, and specifically on the optimal timing of investment, optimal project abandonment, and real option value. Our first contribution is to derive under DDR the solution to the Ingersoll-Ross real option model. This model shows how optimal investment timing is affected by discount rate uncertainty. We show that projects with long-term horizons will be undertaken *earlier* than comparable projects with short-term horizons. Indeed, under DDR, the option to wait is exercised earlier. This finding is contrary to Ingersoll and Ross's (1992) original result.

Our second contribution is to show the impact, using stochastic simulations, of DDR on real option value for a stylized large-scale crude oil investment project with an abandonment option. This problem is highly relevant as many long-run investments initiated before 2014 are no longer profitable just a few years later. Our model allows for the stochastic evolution of oil prices, interest rates, and costs. We find that although static NPV project value is always higher under DDR, real option value may not be. The simulations show that real option value is *lower* under DDR when the horizon is 45 years or less, but it is *higher* under DDR when the horizon is 60 years. This finding suggests the effect of long-run discount rate uncertainty may differ for private and public investments. We also conduct sensitivity analysis on the interest rate and cost parameters. Overall, the results show that real option value and optimal investment under uncertainty behave differently under DDR than standard time-varying discount rate models. The findings for DDR are also consistent with recent evidence concerning corporate decision-making under incomplete preferences or ambiguity, namely that that long-run uncertainty leads to more "optimistic" decisions.

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