

Real Options, Business Valuation, and Dynamic Decisions

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This paper surveys recent theoretical developments on real options, and discusses its applications in business valuations and dynamic corporate decisions. In particular, the paper highlights the issues in the timing and design of sales of real options, as often observed in the auctions of natural resources, real estate sales, patents and licenses, and start-up companies. The choice of payment security and seller's commitment all play integral roles in shaping equilibrium outcomes for option exercise, revenue, and social welfare.

INTRODUCTION

A standard view of investment is characterized by the computation of the net present value and/or Tobin's Q in order to decide whether or not one should invest. However, this approach relies on very strong assumptions: either the investment is completely reversible or it is irreversible and the firm has to invest right now (it cannot delay the investment). In reality, many investments are irreversible, but can be timed. In this case, the company which chooses to invest is holding a call option, with the investment being the goods to be bought. To invest, the value of investment must exceed the cost by the continuation value. Thus, one needs a premium over breakeven NPV to invest, and one needs hefty losses to opt out of business. Real options theory thus provides a useful framework for modeling managerial flexibility and understanding dynamic investment under uncertainty (for a formal introduction, please see Dixit and Pindyck (1994)).

Two Kinds of Real Options

There are two kinds of real options a company is typically concerned with. The first one is the aforementioned investment option. Suppose a manufacturing company can incur an investment cost to open a new plant, but the potential profit stream is uncertain at the moment. Even if the NPV of the expansion is positive today, the manager may not want to invest because she could delay incurring the cost and wait for the uncertainty to resolve. If the profitability is indeed high, she can then invest; if the profitability deteriorates, she can keep waiting. The option value lies in optimally timing her investment. McDonald and Siegel (1986) pioneered formal modeling of these managerial flexibilities.

The second type involves default options. A manager can default on loans and debts if the cash flows from operations do not exceed the interest payment - an abandonment option. Merton (1974) and Leland (1994) study such default options on corporate debts and valuation of firms.

Real Options as an Alternative Valuation Tool

Real-options theory can be applied to business valuation. Valuation methods come in two forms: relative valuations use financial multiples of comparable companies; direct valuation structurally estimates the firm value. While the balance sheet approach and forecasted cash flow approach constitute canons in direct valuation, the former ignores value of assets-in-use and intangibles, while the latter is model-dependent and subjective. Real options approach treats a firm as a basket of real options. The main assumptions are the expected growth rate of revenues and the expected cost structure of the company, which include development costs, probabilities to have a successful project and profitability of these new projects. One should note that several other valuation methods such as the Decision Tree method, the Influence-Diagram method, and the Binomial-Lattice method all fall in this category. While broadly appealing, the real options framework does face practical problems with parameter estimation because equity claims are on non-expiring, non-tradable assets. Nevertheless, it complements existing valuation methods and adds insights to business decision-making. Schwartz and Moon (2000) and Kellogg and Charnes (2000) are some illustrations.

Selling Real Options

Governments and companies frequently sell assets with underlying real options. Examples include the possibility (and not the obligation, which makes it an option) to explore and drill on tracts of land or sea for oil or other natural resources, privatization of state-owned companies, patent licensing, and mergers and acquisitions. Oftentimes, sales of real options involve both cash and contingent securities. For its efficient price discovery mechanism, both formal auctions and auction-like procedures are frequently used to sell real options. Therefore, many recent studies, such as Grenadier (1996, 2002), Board (2007a,b), and Cong (2014, 2017a,b), have focused on agents' strategic interactions and selling mechanisms of real options.

While contingent securities can help sellers extract more rents from the bidders, they often distort incentives to efficiently exercise the real options. For example, if a government requires a royalty of 90 percent from leasing an oil field, the operating company would inefficiently delay drilling because it has to bear the cost yet the profit mostly goes to the government. Therefore, a revenue-maximizing seller should use a combination of cash and securities to best align option exercise incentives.

Endogenous auction timing is another oft-neglected issue. As shown in Cong (2014, 2016b), strategic auction timing often affects auction initiation, security ranking, bidding, and investment. Indeed, by delaying auctions, sellers benefit from alternative uses of the asset and can wait for more bidders in future. Moreover, sellers care about virtual valuations and due to the irreversible nature of time, delaying auctions beyond what is socially optimal on average forces winning bidders to exercise the option closer to the seller's preference. Many seemingly simple auctions are thus inefficiently delayed, even when bidders use cash to bid.

Finally sellers' commitment level matters as well, as seen in Cong (2017a). While many economic interactions such as takeovers, and bidding for contracts have characteristics of auctions, they differ from formal auctions in that instead of restricting bids to a pre-specified ordered set, bidders often come up with their own offers. When sellers cannot commit to auction timing, if the seller is not too-biased towards accelerating the option exercise, bidders initiate and accelerate the sale, which may improve social welfare, as shown in Cong (2017b). Otherwise, auction timing does not affect option exercise on average, reminiscent of Grenadier, Malenko, and Malenko (2016), which shows that delegation adds value only when agents (bidders) prefer early decision making relative to the principal (seller). In a nutshell, sellers and buyers face fundamentally different real options given their contractual agreements, and often inefficiently time the auction or the option exercise. A social planner or seller must carefully consider the level of commitment, strategic timing, rent extraction, and incentive provision when designing the sale of real options, and this area remains important for future research.

Case Study: Oil and Gas Auction and Drilling in the Gulf of Mexico

Offshore drilling activities in the Gulf of Mexico date back to the 1940s. The US Congress passed the Outer Continental Shelf Lands Act (OCSLA) in 1953 to grant the Department of the Interior the authority for conducting lease auctions, collecting royalties, and overseeing all activities associated with the drilling in federal waters. The Minerals Management Service (MMS) traditionally conducted the lease auctions, but due to a reorganization in response to the Deepwater Horizon oil spill in 2010, it was replaced by the Bureau of Ocean Energy Management (BOEM) and the Bureau of Safety and Environmental Enforcement (BSEE). Most leases were sold in “Bonus-bid” auctions, where the royalty rate on future revenue is fixed and the bidders bid upfront cash. The current royalty rate is standardized at 18.75%, but has historically taken on different values at various times and for different leases.

Utilizing policy changes as exogenous shocks, I empirically illustrate the two phenomena discussed earlier: (1) contingent securities in such auctions distort option exercise; (2) when bidders can initiate, option exercise is accelerated.

To see the royalty payment distort exercise incentives, let us focus on the Deep Water Royalty Relief Act of 1995 (DWRRA) that expanded the Secretary of Interior’s royalty relief to leases issued in the Gulf of Mexico between 1996 and 2000 at depths greater than 200 meters located wholly west of 87 degrees, 30 minutes West longitude. Interest in deep water surged after the enactment of the act (August 8, 1995), with 3,000 deep-water leases bid between 1996 and 1999. There is also significant increase in annual deep-water oil production. Cong (2017a) uses a difference-in-difference identification strategy and finds suggestive causal evidence that the lowering of royalty (mostly from 1/6 and 1/8 to zero) on average leads to 10.8% greater likelihood of exploratory drilling. Opaluch, Grigalunas, Anderson, Trandafir, and Jin (2010) also conclude that increased royalty rates would have a net negative effect on the social value of offshore development.

For the second point, I rely on the introduction of Area Wide Leasing (AWL) in May 1983, which marks the end of bidder initiation for nearshore tracts. Opaluch, Grigalunas, Anderson, Trandafir, and Jin (2010) provide more details. Cong (2017b) uses a Cox hazard model to estimate that the removal of bidder initiation reduces the likelihood of exploratory drilling by at least 10%, and up to 40%, even after controlling for tract and lease characteristics, and the dynamics of oil price and drilling costs.

CONCLUSION

The real option framework is intuitively appealing, because it captures the dynamic nature of decision-making and the irreversibility of actions. It serves as a powerful valuation tool, with the caveat that strong parametric assumptions have to be made. It is best to use real options model to value early stage companies, and to complement other discounted cash flow valuations. Moreover, one should pay particular attention to the exercise timing and moral hazard issues in selling real options, which has broad implications for auction designs in selling natural resources and contracting in mergers and acquisitions.

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