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A new view of telecommunications economics

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1. Overview

The Telecommunications Act of 1996 required that charges for interconnection, universal service and unbundled network elements should be based on cost, and directed the Federal Communications Commission to implement this legislation.

The parties developed engineering process models to estimate forward-looking costs. Both the engineering economics and the cost model approaches were unsatisfactory. Neither handled uncertainty nor dynamics, or else did so in an awkward manner. The economic and financial literature has moved beyond these static concepts.[2] This literature has methods to handle uncertainty and dynamics in a satisfactory manner. Moreover, it can link the "real" market with the financial market. This has immediate implications for both engineering economics and cost modelling methodologies.

Engineering economics uses the tools of discounted cash flow (DCF) with little or no emphasis on how the "proper' discount rate is obtained.[3] The more sophisticated analysis may use a risk-adjusted discount rate determined by the capital asset pricing (CAPM) model; however, some managers, intuitively, may raise the discount rate above this level to account for "risk". This lowers the cash flow values in later periods, distorts the results and gives incorrect conclusions. Certainty of the cash flow is assumed. Decision tree analysis (DTA) is used to address multiple possible outcomes. The DCF of the expected value of this tree is used for the evaluation. However, neither of these methods adequately deals with management's flexibility. Real options, on the other hand, does have this capacity.

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[2] See Dixit and Pindyck (1994) and Trigeorgis (1996) and the references cited therein. For direct applications in the telecommunications industry, see Alleman and Noam (1999).

[3] Most engineering economics texts, for example, Steiner (1996), do not address in detail how the discount rate used in the DCF analysis is determined. Uncertainty is handled by sensitivity analysis. Financial texts, such as Bodie and Merton (2000), have an extensive discussion of the proper discount rate, but only briefly cover the DCF analysis.

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This paper attempts to indicate how real options theory can be useful for the telecommunications industry in a wide variety of applications including capital budgeting, strategic planning, and the current cost modelling efforts being undertaken by the industry.

Business is beginning to recognize the value of real options analysis as demonstrated by various articles in the *Harvard Business Review* (Dixit & Pindyck, 1995; Luehrman, 1998a, b). Moreover, the non-telephone utility industry and many other industries facing decisions on R&D spending, project/asset evaluation, mergers, acquisitions and other investments have utilized real options valuation for some time.[4]

The first paper explains what real options are, gives a flavour of the methodology, and then indicates what can be gained from the methodology.

2. What are real options?

The traditional approach to project evaluation and investments uses DCF methods.[5] These methods explicitly assume that the project will meet the expected cash flow with no intervention by management in the process. All the uncertainty is handled in the (risk-adjusted) discount rate. The traditional approach is static. At most, the expected value of the cash flow is incorporated into the analysis. The methodology assumes that management has no flexibility to make decisions as states-of-nature are revealed. However, management's discretion has a value, which is not incorporated into the DCF. The real options methodology goes beyond this simple view of valuation and more closely matches the manner in which firms operate. It allows for the flexibility the firm has to defer, abandon, contract, expand or otherwise modify its actions after nature has revealed itself. This is the first lesson for the policymakers—if they wish to emulate the competitive process by constructing cost models, for example, they cannot rely on application of DCF methods.[6,7]

The second lesson is the recognition that well-developed financial-options theory applies to asset/project evaluation. Rather than considering the expected value of outcomes, option-pricing theory captures the asymmetry of the return of an option just as management can limit the loss of the firm—variations of potential outcomes and their uncertainty are captured with the estimation of the variance. That is, while uncertainty is not eliminated, the uncertainty is accounted for with the estimation of the variance, thus determination of a risk-adjusted discount rate is not

[4] See http://www.puc-rio.br/marco.ind/bibliogr.html#petroleum and http://www.puc-rio.br/marco.ind/bib_pet1.html for citations to applications in the petroleum industry. For an example of real options used in the pharmaceutical industry, see Nichols (1994).

[5] Various techniques, discounted present value (DPV), annual worth or furture value methods are virtually the same time-value-of-money techniques. We will use the term discounted cash flow or DCF thoughout the remainder of the paper to refer to this method of asset valuation.

[6] CAPM as well as many of the traditional approaches to dealing with uncertainty such as simulations, decision-tree analysis and sensitivity analysis have their limitations in the DCF context—some of which real options can overcome.

[7] Using the firm's opportunity cost of capital is inappropriate if the project does not correlate with the company's cost of capital—another lesson for the telecommunications industry. Unbundled network elements (UNEs) have different levels of risk. For example, the operator services (considered a network element by the Federal Communications Commission in the United States) element's risk/return is much different from the local loop element. To calculate the cost/price of these elements using the same discount rate would be incorrect.

necessary. The construction of a portfolio equivalent to the asset in question can be evaluated with the techniques that have been developed for financial options, for example, the Black–Scholes method of option valuation (Black & Scholes, 1973. See Hull, 1999 for a complete description of options methods).[8]

3. Real options

Real options methodology provides a means of capturing the flexibility of management to address uncertainties as they are resolved. Traditional capital budgeting fails to account for this flexibility and, moreover, it fails to integrate with strategic planning. The flexibility that management has includes: defer, abandon, shutdown and restart, time-to-build, contract, switch, expand and growth (see Table 1).

The key valuation concept is that a real asset can be priced based on the well-developed method of option pricing. Real options methodologies can take the best features of DCF and DTA without their failings. The real options method can make a significant difference in the valuation; however, a simple linear addition to the valuation of a traditional DCF analysis cannot correct for the real options impact. Real options expand the notion of management's flexibility and strategic interaction in skewing the results of the traditional DCF analysis which, as with financial options, allows for gains on the upside, and minimizes the downside potential, thus changing the valuation. (In general, the valuation may increase, but it may also decline.) Strategic considerations are magnified or made explicit by the analysis. Viewed in light of traditional economic theory, real options methodology suggests that the traditional theory needs re-evaluation.

> No ad hoc, exogenously provided, single risk-adjusted discount rate properly captures the interdependencies between current and future decisions in the presence of managerial flexibility, since risk changes endogenously in time, with the underlying uncertain variable, and with managerial response. Since the value of a flexible project and the optimal operating (exercise) schedule must generally be determined concurrently, the discount rate must, in effect, be imputed *endogenously* within a forward-looking dynamic programming process.
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> An option-based (expanded-DCF) analysis bypasses the discount-rate problem by relying on the notion of a comparable security to properly price risk while still being able to capture the dynamic interdependencies between cash flows and future optional decisions (Trigeorgis, 1996, p. 200).

4. Relevance to telecommunications

Although real options theory is increasingly used in other industries, it has not widely been applied in the telecommunications industry.[9] But telecommunications is ripe for this

[8] A financial option is the right to buy (a call) or sell (a put) a stock, but not the obligation, at a given price within a certain period of time. If the option is not exercised, the only loss is the price of the option, but the upside potential is large. The asymmetry of the option—the protection from the downside risk with the possibility of a large upside gain—is what gives the option value.

[9] Hausman's application of options theory to value unbundled network elements is as close as the industry has come to my knowledge (Hausman, 1998a, b. See also Hausman, 1999) and Small's application to access pricing (Small, 1998).

Table 1
description of real options

Defer	To wait to determine if a “good” state-of-nature obtains
Shutdown and restart	To wait for a “good” state-of-nature and re-enter
Time-to-build	To delay or default on project—a compound option
Contract	To reduce operations if state-of-nature is worse than expected
Switch	To use alternative technologies depending on input prices
Expand	To expand if state-of-nature is better than expected
Growth	To take advantage of future, interrelated opportunities

methodology. The literature is relevant to telecommunications in several areas: strategic evaluation, estimation and cost modelling.

4.1. Strategic evaluation

The relevance to strategic planning is obvious. The bulk of ‘strategic’ planning in the telecommunications industry has revolved around budget projections and scenario analysis based on DCF analysis. Concerns such as price elasticity, uncertainty and other economic considerations came late to the industry. Indeed, in the era of monopoly control and rate-of-return regulation, strategic planning or the lack of it was not critical. The whole game was in the regulatory strategy. Times have now, obviously, changed and so must the analysis in order for telecommunications companies—emerging, new and old—to become or remain viable. The real options approach will aid in this endeavour.

4.2. Estimation

Many behaviour assumptions are embedded in econometric structures that are necessary for the interpretation of the estimates, but real options invalidate these assumptions with the resulting consequence for the veracity of the estimations. Little, if any, work that I am familiar with has addressed this issue, although the consequences have been reported (Dixit & Pindyck, 1994). For example, real options theory changes the nature of the shutdown point in the theory of the firm. It may no longer be optimal for the firm to close when revenues go below variable costs because, in the dynamic world, it may be optimal to keep the option open to serve the market when demand is more robust. Closing down might preclude this option. Allowing for the incorporation of the dynamics of real options into traditional economic theory, in addition to the obvious integration of finance into the models, could dramatically change the outcomes of traditional theory.

4.3. Telephony cost modelling

Attempts to estimate forward-looking costs in the United States and around the world are based on cost models whose foundation is traditionally applied to (DCF) analysis—exactly the method that real options methodology has shown can give incorrect results.[10] These cost models are ideal vehicles to adapt to the real options methodology (Alleman, 1999 and Hausman, 1999). All the data are in a form to which real options considerations can be applied. However, it should be cautioned that the results are non-linear, that is, the modellers cannot simply add an 'additive' to the results of their DCF models to 'correct' for the real options impact.

Valuation analysis has been enhanced with real options theory to account for the investment uncertainties via the probability distribution of outcomes modelled with the variance, which are fundamental in the DCF analysis. Applying the real options methodology to DCF analysis can make a significant change in the valuation—as much as a factor of two.[11] All current cost models ignore this enhancement.

These cost models are to serve a variety of purposes: the calculation of universal service obligations, access charges or pricing of unbundled network elements. Given the major methodological problems, it would be irresponsible to use these cost models for determining access/interconnection prices and unbundled network elements, as well as universal service obligations.

5. Conclusion

Managers cannot afford to ignore the implications and methods developed by real options analysis.

Effective policy dealing with costs cannot be made without a fundamental understanding of the implications of real options theory, particularly, for policymakers who attempt to model the market behaviour of firms in competition.

Real options offer the possibility to integrate major analytical methods into a coherent framework that more closely approximates the dynamics of the firm's behaviour without heroic assumptions regarding the dynamics of the environment.

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[10] While these cost models go into great detail on the engineering aspect of the telephone network, many lack a fundamental understanding of economics and finance, i.e., they fail to apply the appropriate, traditional techniques of engineering economics. Some do not use present discounted value or DCF techniques to evaluate the capital investments. They simply use a revenue requirement method, based on arbitrary cost allocations. Many of the cost models have ignored DCF's major contribution to asset valuation (e.g., NERA 1999, pp. 80ff.)

[11] Dixit and Pindyck (1994, p. 153) achieve this result with numerical analysis of a reasonable set of parameters that compares traditional DCF with the real options approach.

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