

# The Challenges of Regulation Using Real Options – A Response to Peter Monkhouse

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*Abstract:* The regulation of infrastructure by the ACCC and other economic regulators in Australia is based around net present value estimation techniques. Recently, Monkhouse (2007) suggested that real options valuation would provide better incentives for investment in infrastructure, but did not elucidate how a regulatory system based on real options valuation should operate. This paper endeavours to sketch the outlines of such a system, and finds that it has considerable promise as an alternative to the status quo, provided an appropriate technique for addressing monopoly rents can be developed.

## I. INTRODUCTION

At a recent ACCC conference, the Vice President of BHP-Billiton's Iron Ore Division, Peter Monkhouse (2007) attacked the use of net present value (NPV) approaches in economic regulation, suggesting it systematically undervalues investment returns by up to half its true value, providing poor incentives for new investment. Rather than simply criticise the approach, however, he proposed an alternative; the use of real options to value infrastructure assets.

However, he leaves unanswered the question of precisely how one might apply a real options framework to economic regulation, and what issues might arise when one does. This paper represents an exploration of how real options valuation (ROV) might operate in a regulatory context and the challenges it would face in doing so.

Section One of this paper outlines the basic notions of ROV, and how it differs from NPV. Section Two explores how ROV might be used to value an existing asset and price its outputs, with a simple example. It also discusses some problems associated with the model. Section Three examines how future investment could be brought into an ROV regulatory framework. Section Four concludes.

## II. REAL OPTIONS VALUATION

Financial options are contracts which give the holder the right, but not the obligation, to buy or sell a stock at a particular time for a particular price (the strike price). Whilst options have

existed at least since Ancient Greece, a rigorous means of valuing them was only developed in 1973, in pioneering work by Black and Scholes (1973) and Merton (1973). The Black-Scholes Model is now a mainstay of financial markets.

A financial option is a special case of contingent claims analysis, and thus the approach developed by Merton, Black and Scholes has wide application in any endeavour involving uncertain futures (Dixit and Pindyck, 1994). Of particular interest here is its use in valuing investment proposals. Myers (1977) realised that an allegory to financial market options existed in the investment planning undertaken by firms. In assessing its future growth, a firm can choose the optimal time to invest. Just as a financial (call) option is the right but not the obligation to buy a stock, firms making investment decisions have the right, but not the obligation to make the relevant investments. This right has a value for the firm and the insight has led to a substantial body of literature. Lander and Pinches (1998) summarise approaches undertaken in almost 200 papers written in the two decades between Myers' original work and their own review, and Merton (2001) explores the breadth of applications of ROV since his own seminal contribution.

The actual real options which a firm can undertake are many and varied. There is first and most obviously the option to invest or defer investment. There is also the option to abandon a given asset, or to switch between inputs or outputs. Related to this are the option to increase scale or grow the business, say by engaging in research development which might be later commercialised, or establishing a beach-head presence in a foreign marketplace. Finally, options may be compounded.

There are a wide variety of approaches used to value real options (see Trigeorgis 2001). Each is subtly different, but all share one common element; they specify an underlying asset, or portfolio of assets which replicate the risk profile of the investment project and utilise the price(s) and volatility(ies) of this asset(s) to determine the value of the project. In many cases, these underlying assets are traded commodities; Dimitrakopoulos and Abdel-Sabour (2007) present an example of a valuation of a gold mine based on the price of gold for example. However, they need not be; Rose (1998) presents an example of the valuation of a toll-road, where traffic forecasts form the source of volatility.

It is possible to divide valuation methods into three groups (Lander and Pinches 1998). The first value real options in the same manner as financial options are commonly valued, with some variant of the Black-Scholes (1973) model. However, these models rely upon continuous time, and finding closed-form solutions can be difficult with multiple sources of uncertainty. Other models utilise discrete time, back-solving from a set of final outcomes through the time periods examined by the model. This requires the solution of a number of simultaneous equations, which can be computationally demanding. The simplest types of models are lattice models, such as the binomial lattice model of Cox, Ross and Rubenstein (1979) used later in this paper. Lattice models are discrete-time approximations to continuous-time stochastic processes. A binomial lattice model, for example, approximates the Brownian motion assumed to underpin stock prices in the Black-Scholes (1973) model. Despite their simplicity when sources of volatility are few, lattice models can become complex when they increase. Schwartz and Trigeorgis (2001) suggest they work best for cases where there are two state variables providing sources of volatility, and suggest that Monte-Carlo methods are more appropriate where there are more such variables.

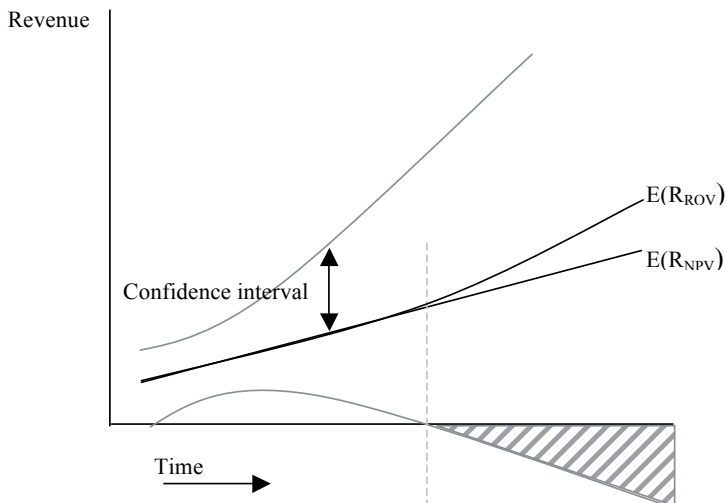
The topic of this paper is the use of ROV in a regulatory setting, where NPV is currently used to derive asset values and access prices. Thus, it is important to consider the differences between NPV and ROV that Monkhouse (2007) highlights and, in particular, the reasons why an ROV valuation will always be equal to or greater than a correctly-specified NPV valuation. Before going further, it is worth noting that the two will be equal in perfect competition, when information is perfect, but that ROV will otherwise be greater than NPV. Regulated firms, of course, are regulated precisely because of how far they depart from perfect competition, and regulators endeavour to emulate its conditions as best they can.

Conceptually, there are two key differences between ROV and NPV. The first of these is an underlying assumption. NPV implicitly assumes that when an investment is made, production follows at a predetermined rate. No allowance is made for changes in future production in response to changing circumstances. ROV, on the other hand, assumes that a manager has flexibility both in choosing when to invest and in choosing subsequent production levels. ROV is able to make this assumption because it uses more of the information available when the investment decision is made, and this is the second difference between the two approaches.

All investment involves uncertainty. When examining future investment opportunities, for example, a group of managers might each forecast revenues, and then reach a consensus view. NPV uses that consensus view. ROV uses the additional information generated by the process; the differences between each individual forecast, or the variance of the distribution of forecasts.

A simple example may shed further light on how this translates into extra value. Consider an investment opportunity whereby, for simplicity, the investment is made tomorrow, and which has an expected future return, and variance around that expected return which can be used to construct a confidence interval as shown in *Figure 1*.

*Figure 1: A Simple Comparison of ROV and NPV*



In *Figure 1*, the lower bound of the confidence interval crosses the horizontal axis, meaning that at some possible future prices, the value of production is negative. Losses result if production occurs at these low prices; the shaded triangle. NPV analysis ignores the information in the variance of revenue forecasts, and an investment planner using NPV thus cannot see the shaded triangle. This, in turn, means that she can make no predictions about how the shaded triangle might affect the production decisions of manager in the future. ROV analysis, by contrast, does not ignore the variance, and hence an investment planner using ROV can see the shaded triangle. Moreover, she recognises that a rational manager will not produce when revenues are negative, and hence, instead of production having a negative value, the lower bound of production value becomes zero. This changes the shape of the distribution, and means that the expected value of returns increases, from  $E(R_{NPV})$  to  $E(R_{ROV})$ . The increased value represents the value of the flexibility which ROV includes and NPV does not, and is the reason why, in even this simplest of examples, ROV gives a larger value for an asset than NPV.

In essence information is valuable, and an NPV approach which ignores information gives rise to erroneous conclusions about the value of investment. In a competitive marketplace, it seems unlikely that firms would ignore valuable information, and hence a regulatory process which aims to emulate the stimuli of a competitive market should arguably not ignore it either.<sup>1</sup>

### III. REGULATING RAIL ACCESS PRICES USING REAL OPTIONS

This section uses a simple case study of a railway track connecting a coal mine to a port in order to explore how one might use real options valuation in a regulatory framework. It is important to note that, unlike ROV used to decide whether or not to invest in a project, the purpose here is to obtain a price cap for third party access. Thus, some aspects of the analysis will differ from the literature discussed above. The analysis proceeds under a number of assumptions. Some of these assumptions abstract considerably from likely real-world situations faced by a track-owner. The assumptions are made for two reasons. Firstly, because they simplify the model considerably and allow one to focus on how a regulatory price cap is determined in the simplest case. Secondly, they are made because they mirror, to the extent that this is possible, many of the assumptions made by the regulator under existing approaches.

The first assumption is that the railway is the residual claimant to the revenue streams of the logistics chain which delivers coal into the market. That is, after the mine and the above-rail operators have recovered their economic costs, any excess revenue is ascribed to the railway track owner. That is not to say that, in real life, the track owner should receive all of these revenues, but rather that any price cap should allow it recover no more than this. The railway track is the real option by which the logistics chain unlocks the value associated with the coal deposit. The revenue stream generated by selling the coal thus becomes the basis for valuing the railway track.

Using the revenue stream associated with the coal allows one to circumvent problems of circularity faced by regulators endeavouring to value a regulated asset based on a revenue

<sup>1</sup> Although it should be noted that in perfect competition, information about the future is perfect, so the variance of forecasts is zero, and hence NPV and ROV would coincide.

stream which is itself based on the regulatory decision. Circularity does not occur because the value of the coal, set in global markets, is independent of regulatory action. This is perhaps the most useful element of a real options approach, for it allows one to move away from a cost-based approach, such as the ACCC's 'building block approach' (see ACCC 1995), and to value an asset as economic theory suggests it should be valued, with reference to an expected revenue stream.

The second underlying assumption is that the costs of the mine and the costs of the above-rail operator are both known and truthfully revealed by each party. This allows them to be easily subtracted from the overall revenue stream to obtain the residual to be ascribed to the railway track. In reality, neither may be true. This issue is addressed in the following section, but ignored in this simple model.

The third assumption is that there are no plans to either expand the railway line or to close it down, one is concerned solely with the capacity of the line as it is. Allowing for asset expansion and contraction adds an extra layer of complexity to the analysis, and is thus addressed in some detail in a following section of the paper.

A fourth assumption is that the railway track itself does not exist as yet. In just the same way as regulators endeavour to find an 'optimised replacement cost' for the infrastructure on the ground under current regulatory practice, this allows one to consider what an entrant would do, and to regulate accordingly. The difference is that, rather than asking the question, 'what infrastructure would an entrant put in place to service the (single forecast of) most likely future demand and how much would this cost?', one asks the question, 'what value would a new entrant place on the revenue stream available from investing in the relevant rail link and how might it thus invest to capture this revenue stream?'

Finally, no assumptions are made about railway construction costs. In a standard ROV, these construction costs (the exercise price of the option) would be compared to the expected revenue stream in order to assess when it is optimal for the project proponent to go ahead with the scheme. There is nothing in the real options approach outlined here which precludes the use of some measure of the efficient cost of the provision of railway track as the exercise price of the option to invest in it. Indeed, if one did, and one was correct in one's estimate of the asset base, one would have a neat estimate of the potential monopoly rent in the relevant rail link. However, the aim here is to develop a price cap. Cost information is not a necessary part of price cap formation in the same way that it is for the building-block approach.

We now examine the case study at hand; a coal railway serving a single mine. It is assumed that the costs of mining the coal are \$50 per tonne, and the costs of rail haulage are \$10 per tonne. The railway line has a fixed capacity of 50 million tonnes per annum and it is assumed to operate at full capacity.<sup>2</sup> The simple methodology by which we assess an appropriate access price is based upon that of Cox, Ross and Rubenstein (1978). This is a binomial model where the value of the underlying asset, here the coal, can increase ( $u$ ) or decrease ( $d$ ) in value by a set proportion each period with a given (pseudo) probability dependent upon the volatility

<sup>2</sup> One might also include demand volatility, effectively meaning that the track owner would absorb some of the risk associated with future traffic. However, the aim here is to explore how the model would operate in its simplest manifestation. Moreover, it is worth noting that current regulatory approaches do not incorporate demand volatility either.

of the price. It is this probability of being in a given state which drives the model; the more likely it is that one is in the increased state, the more valuable is the option. The model can be expressed as follows:

$$C = \left[ \sum_{j=0}^n \left( \frac{n!}{j!(n-j)!} \right) \times p^j (1-p)^{n-j} \times \max \left( 0, u^j d^{n-j} S_j - K_j \right) \right] \quad (1)$$

Where:

- $C$  = the value of the option.
- $n$  = the total number of periods  $j$ .
- $p$  = the pseudo-probability of being in the upward ( $u$ ) or downward ( $d$ ) state.
- $S_t$  = the per-period NPV of the coal which remains after each period of mining
- $K_t$  = the per-period NPV of the expected future sum of operating costs associated with the mine and port.

and  $p$ ,  $u$  and  $d$  are determined as follows:

$$p = \frac{\exp(r^f \times dt) - d}{u - d} ; u = \exp(\sigma \times \sqrt{dt}) ; d = \frac{1}{u} \quad (2)$$

Where:

- $dt$  = the length of the time period between states(one, in this model).
- $r^f$  = the risk free rate (expressed without being added to one).
- $\sigma$  = the volatility of the underlying stock, expressed as a percentage of its price.

Recent data from the New York metals exchange suggests an expectation of future coal prices of US\$73.15 per tonne, over the next three years. This expectation has a standard deviation of US\$4.87, or roughly 6.6 percent.<sup>3</sup> Applying these numbers to Equation (2) gives a pseudo probability of 0.95, an upward movement factor of 1.07 and a downward factor of 0.94.

If one assumes a risk free rate of six percent, commonly used by Australian regulators (Allens Consulting Group, 2007), and a mine and railway life of 25 years, the real options valuation of the revenue stream associated with the railway track and net of mine and train costs is roughly \$6.98 billion dollars.<sup>4</sup> Apportioning this across the annual haulage task of 50 million tonnes gives an access price of \$10.30 for each tonne of coal hauled. If the length of the track and relative weight of trains to hauled product are specified, this can be easily turned into a price cap expressed in terms of net or gross tonne kilometres. Alternatively, if it is multiplied by the annual capacity of the railway track, one has a revenue cap of \$515 million per annum.

<sup>3</sup> In fact the volatility is slightly lower, but the CRR model requires  $d < r < u$  to prevent costless arbitrage opportunities from arising, and this is violated for very low values of volatility.

<sup>4</sup> This is roughly \$1 billion larger than the NPV of the expected revenue stream, when it is discounted at the nominal pre tax weighted average cost of capital recently suggested for use by the WA ERA (see Allens Consulting Group 2007) of 11.5 percent. This is what one would expect if the WACC and asset valuation was correct. However, if  $NPV > ROV$ , this would suggest (presuming that the ROV approach has been undertaken correctly) one has an error in the regulatory determination which produced this result. This suggests an objective method for testing the results obtained by the building block method, and assessing claims often made by industry that regulated prices are too low.

### *3.1. Advantages Over Building Block Approach*

The real options approach outlined above does not consider the capital costs of the railway track. This means it avoids two of the most controversial and time-consuming parts of the current regulatory process; the determination of the asset base and the determination of beta (representing systematic risk) in the weighted average cost of capital.<sup>5</sup>

Determination of a regulatory asset base is time-consuming and difficult because regulators cannot value an asset based on its expected revenue stream, due to the previously mentioned circularity problem. They must instead rely upon a subjective assessment of what costs ‘should’ be, which is essentially a debate amongst competing groups of engineers as to how they would construct the relevant plant, if given the chance to do so. The issue is not a new one; when ‘scientific’ determination of asset values was first instituted by the US Interstate Commerce Commission in 1913, it took 20 years and many hundreds of millions of dollars to undertake what today would be called a DAC and DORC valuation of US rail assets (Hooegnboom and Hoogenboom, 1976). At the end of the process, the Commission found that the rail assets were worth roughly the same as the share prices of the rail companies suggested they were worth.

The other input in the building-block approach which is problematic is the estimation of beta. Here, the problem faced by the regulators is that the assets are generally either owned by non-traded companies or are part of a much larger portfolio of assets within a publicly traded company. There is thus no stock market information with which one can calculate beta,<sup>6</sup> and regulators must endeavour to reverse-engineer a beta based upon comparisons with like traded assets. This is an inexact process.

Whilst avoiding the need to deal with asset valuation and the cost of capital is useful, this does not mean that a real options approach does not have problems of its own. These are addressed below.

### *3.2. Issues*

The major issue associated with the approach is obvious from the case study example outlined above; it doesn’t explicitly address monopoly rents. In the case study, the railway track operator received the residual revenues after the costs of the mine and the above-rail operator were accounted for. However, these residual revenues may contain monopoly rents, and there is nothing in the methodology as stated above which allows one to calculate their value.

Two potential approaches might be used in order to address this issue.<sup>7</sup> Firstly, one could adopt an exogenous approach, determining a monopoly rent component and subtracting it from

<sup>5</sup> One cannot avoid the issues associated with beta entirely, as much of the information needed to calculate it is similar to the information needed to calculate forward risk curves and risk-neutral prices under ROV. However, the ROV approach allows one to make many of these uncertainties more explicit, and to base them on more objective information; something which in principle should also occur in the determination of beta but which in practice, often does not.

<sup>6</sup> Even in cases where there is, the markets assessment of risk before and after a regulatory decision are often quite different, and the regulator does not necessarily know how the market will react to its decisions. If a regulatory decision represents a structural break in the risk profile of an asset, then past beta are not useful predictors of future relative risk.

<sup>7</sup> A third is obviously based upon efficient costs but, as discussed previously, cost estimation is a rather inexact process.

the residual revenue stream in the same way that mine and train costs were subtracted. Real options valuation methods which incorporate dividends payments could be readily adapted for this purpose. Secondly, one could adopt an endogenous approach whereby monopoly rents are removed as part of the process of determining the residual revenue stream.

If one treats monopoly rents as being exogenous, one is immediately faced with the issue of how they are determined. One approach might be to determine a pro-forma rate to the revenue stream, estimated from the empirical literature on the size of such rents in various parts of the economy (see Cowling and Mueller 1978 for an early example). This is unlikely to be particularly accurate, but it is easily applied.

Alternatively, one could endeavour to ensure that the monopoly rents are removed from the revenue stream before it is calculated, by changing the model. One means of doing this might be to assume that, rather than there being one potential railway track owner seeking to build the track in question, there are two. This would mean each would consider the investment strategies of its rival in determining its investment profile, and one may be able to construct a duopolistic game framework in which this strategic interaction results in neither railway claiming any monopoly rents.

Alternatively, one might view the investment process as a principal-agent problem, whereby the firm is the agent and government is the principal. The agent wishes to maximise rents whilst the principal wishes to maximise social welfare. Wonder (2006) presents an example of a principal-agent problem framed within a real options valuation context, whereby the agent is a manager with the power to invest who dissipates some of the investment returns through perks, and the principal is the owner of the firm in question seeking to maximise returns. A similar model might be used in a regulatory framework, although it should be made clear that Wonder's model represents an optimal second best solution whereby perks are minimised, not a first-best one where they are eliminated.

Clearly, establishing a suitable treatment for monopoly rents is the major issue associated with a real options valuation approach to economic regulation. However, it is not the only issue. Three more issues are also pertinent, although each is more easily solved than the monopoly rents issue above.

The first of these is the assumption made in the above case study that the costs of the mine and above-rail operator can be known and will be revealed truthfully. If they are not known perfectly, then it is a relatively simple extension of the model above to incorporate an extra source of uncertainty pertaining to the costs of the mine and above-rail operator. The truthfulness with which the mine and above-rail operator reveal their own costs is a more difficult issue. However, Smith and Tsur (1997) suggest an approach using Myerson's (1979) incentive compatible regulation which might ensure such truthful revelation. However, as Crew and Kleindorfer (2006) point out, these incentive compatible methods raise their own problems in terms of the ability of a regulator to commit to not using information which they reveal.

The second difficulty concerns the mix of commodities carried by the railway. If a railway track is used primarily to carry one or two commodities, then it is relatively simple to incorporate the volatility of the prices of the commodities. However, when a railway carries intermodal traffic, there are many thousands of commodities, and one could not hope to incorporate all of them. Fortunately, one does not have to. Instead, one can use the share prices of the shippers

of intermodal freight as a proxy for the market estimation of the revenue stream associated with their haulage task.

The final issue is untraded state elements; not all of the volatility associated with a given railway track can necessarily be tied to a traded asset with market prices and volatility, nor to some objective model such as geological risk in a mining investment. For example, railway investment is often dependent upon government policy initiatives which can be difficult to predict in a probabilistic manner. Slade (2001) suggests dealing with these untraded state variables by adjusting the drift component of the transition equation of the relevant asset being used to value the asset. This modification is a general form of the mean reversion processes widely used in valuing options. However, regulators would need to be wary of ascribing too much ‘project specific risk’ to a given railway, as its opacity provides scope for rent seeking.

#### IV. LOOKING FORWARD TO FUTURE ASSET INVESTMENT

The previous section examines the valuation of an existing railway line. However, regulated firms also derive value from the investments they could make in the future. This section examines how to incorporate future investment into the regulatory assessment process. This is a challenging exercise, because of two key aspects of the regulatory setting.

Assets which are subject to third party access are different from other assets, because the property rights associated with them are diluted. An unregulated firm can invest and divest as it pleases, but if the firm owns an asset which subject to third party access, then the third parties obtaining access have some property rights associated with its use. For example, if a railway track owner has a five year access contract with a train operator over a track, it is unlikely to be able to pursue options associated with that track which result in its being abandoned within that five year period. Untangling the ramifications of diverse property rights may be a complex exercise for a regulator, particularly as it may be difficult to predict the actions of all parties.

A regulator is also different from an investment analyst because the agents from which it is collecting data to be used in its analysis have an incentive to lie to it. Essentially, if a regulated firm can convince the regulator that it plans more investment than it actually has planned, it may be able to game the system and increase any revenue caps associated with its operations.

Each of these challenges, and the opportunities they create, are discussed further below. However, it is useful first to touch upon a third risk which many hold to be pervasive under the current regulatory framework; regulatory risk associated with the fact that a regulator’s future decisions are unknown, and that a future, more well informed regulator, might make different decisions to those which underpin investment currently being undertaken. This is an issue which affects existing regulatory approaches as well, and indeed, Crew and Kleindorfer (2006) suggest that the trade-off between efficient prices and information rents represents an impossibility theorem of economic regulation.

##### *4.1. Uncertainty about Access Seekers*

Three potential solutions seem possible to address uncertainty associated with a dilution of property rights and an inability to know how future negotiations with access seekers will proceed when conflict occurs. The first is to simply ignore the issue, or assume that the relevant

volatility follows a normal distribution. Empirical studies of stock prices shows that their volatility does not follow a stationary, log-normal process (see, for example, Pagan 1996 or Kim, Nelson, and Startz 1991), but the assumption does not adversely impact the utility of the Black Scholes model as a valuation tool. Moreover, the number and impact of such instances of property rights diminution may be small, and unworthy of complex corrective moves.

The second approach is for the regulator to endeavour to ‘prune the tree’; to take out those expansion or contraction options which it believes will be infeasible due to opposition from access seekers, or ascribe to them a value of zero, as one would to an outcome with negative returns. This seemingly simple solution is, however, highly problematic. The regulator might be wrong, and remove some of the flexibility which is one of the real virtues of the real options approach. This would increase downside risk for the firm. Worse still, the regulator might be right; by virtue of its decision to not allow certain options, it might shape the path which the regulated industry takes, engaging in quasi-industry policy, rather than regulation.

The final approach could be to create a market in ‘pruning options’. That is, if a third party access seeker wished to prevent a certain path from being followed (or favour a certain path over others), it could negotiate with the asset owner a contract by which this could occur.<sup>□</sup> The contract could involve an up-front payment by the access seeker, followed by a penalty paid by the asset owner if it pursues the option adverse to the access seeker. This makes them similar to a financial option. Obviously, the access seeker would only pay a price for such an option which reflects its expected losses should the adverse event occur and a track owner would only accept a contract where the upfront payment is greater than its own assessment of the benefits of the investment plans precluded by the contract terms. Such contracts provide certainty about future actions of the opposing parties, whilst retaining an ability to react in a dynamically efficient manner to unforeseen changes in the future environment.

At first glance, pruning options appear to give access seekers an opportunity to play a greater role in investment decisions made by the asset owner, further diminishing its property rights. However, in reality, it merely monetises what happens already. At present, access seekers can stymie expansion or contraction plans through court action. This is inefficient, because the cost of court action is unlikely to be related to the benefits which the defendant might receive from undertaking the actions to which the plaintiff is objecting. Taking the ability to object out of the courts and into a contractual/options framework forces the plaintiff to value its objections truthfully, and to pay for those objections fairly and efficiently.

#### *4.2. Uncertainty about the Regulated Firm*

The second type of uncertainty faced is the uncertainty the regulator itself has concerning the potential investment plans of the regulated entity; as mentioned, the regulated firm has an incentive to lie to the regulator about its future investment plans and the regulator finds it difficult to perceive these lies. The problem occurs because making claims about future investment is free for the regulated asset owner.

The simplest solution could be for the regulator to only include in the asset base, track which has actually been constructed. However, this ignores the fact that investment opportunities are a legitimate source of value for the company, and failure to include them may undervalue the company, making it harder to invest.

An alternative could be to address the issue of costless claim-making directly, by giving access seekers the right to seek access on proposed track, and creating property rights which are costly to break. However, giving access seekers a costless ability to seek access creates a problem for the railway track owner if a genuine investment proposal proves unviable as future information becomes available. This can be addressed by extending the previously mentioned pruning options to proposed track, meaning that seeking access is also costly. The UK Office of Rail Regulation is currently considering a system of track access options which would operate in a roughly similar fashion (see ORR 2007).

It is difficult to predict, in a generalisable sense, the extent to which uncertainty about the future investment plans of regulated firms will become an issue. It is thus perhaps most appropriate for regulators to begin with a relatively simple approach, like ignoring the issue or only regulating assets as they are built, and then adding complexity as the situation warrants.

## V. CONCLUSIONS

Real options valuation offers some significant advantages over the current building-block methodology. Not only, as Monkhouse (2007) suggests, does it provide greater returns for regulated entities and thus improve incentives to invest, but it also provides scope to decouple economic regulation from its focus on costs as a proxy for efficient valuation of the regulated firm. Given the difficulties in objective estimation of many of the costs used in the building block approach, this is a useful step forward.

Moreover, the introduction of the concept of options into the framework within which regulatory assessment occurs also provides some interesting and potentially useful tools for regulated firms and access seekers, such as the ‘pruning options’ addressed briefly above. It also provides some scope to test regulatory outcomes developed under the current regulatory approach, an area of useful future research.

However, the Achilles Heel of the approach as it stands at present is a suitable means of addressing monopoly rents. This paper outlines some approaches which might be successful in addressing the issue, but it is clear that significant further work is required before a real-options approach can replace the status quo.

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