Transportation Research Part A 46 (2012) 1359–1371

Contents lists available at SciVerse ScienceDirect

Transportation Research Part A

journal homepage: www.elsevier.com/locate/tra

To kill a real option – Incomplete contracts, real options and PPP

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ARTICLE INFO

Article history:
Received 25 May 2011
Received in revised form 11 February 2012
Accepted 18 April 2012

Keywords:
Real option analysis
Incomplete contract theory
Investment under uncertainty
PPP
Transportation

ABSTRACT

This paper is concerned with the implications of public–private partnership agreements for the execution of expansion options in road infrastructure. More specifically, it analyzes the expansion of an existing two-lane road in Sweden, and examines the real options created by an intermediate type of road with three lanes. Interpreting the results from real option analysis in the light of incomplete contract theory, this paper finds that external congestion costs might necessitate public ownership to ensure a social optimal outcome in public–private partnerships.

1. Introduction

Investments in road network capacity, like all investments, are subject to uncertain future developments and hence the theory of investment under uncertainty, the so-called real option analysis, should be applied in this area as well. Notwithstanding, real options are seldom considered in societal cost benefit analysis of road projects. Real option analysis takes the impact of uncertainty on future decisions into account and thus helps us value the managerial flexibility of different alternatives. More specifically, real option analysis considers the value of the opportunities that risk creates. A certain road may soon become obsolete because of unforeseen traffic increases. Choosing a flexible alternative from the beginning might provide us with the possibility of adapting the road at a low cost, thus softening the impact of uncertainty and prolonging the road's economic lifespan. Public investments in major infrastructure projects are dynamic in nature, and decision making must take into account the uncertainty, irreversibility and potential for future learning. There are multiple sources of uncertainty, such as uncertainty with regard to traffic demand, deterioration and costs. However, cost estimates for standard road projects are relatively certain, because they are mainly construction costs, which can be derived from previous experiences and secured by contractual arrangements in public–private partnerships. Road deterioration may well be described as a deterministic function dependent on (heavy) traffic, implying that road deterioration inherits the stochastic properties from traffic flow and is not an independent stochastic process. Hence, future traffic demand is the main source of uncertainty for real life applications of real option models for infrastructure investments.

Infrastructure planning in most countries is based on two principles: cost-benefit analysis of projects based on the net present value criterion and on political considerations like regional development. Even if the value of flexibility is sometimes understood and implemented heuristically, no quantitative model for road planning based on real options has yet been considered by the Swedish authorities responsible for the evaluation of transport projects.

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0965-8564/$ - see front matter © 2012 Published by Elsevier Ltd.
http://dx.doi.org/10.1016/j.tra.2012.04.009

The issue of dynamic decision making is now even more complex because of the increased usage of public–private partnership arrangements (PPP), which can contain either explicit contractual options or implicit options not stated in the contract. If the public sector is unaware of the option values in the road project, it is likely that considerable option values will be transferred from the public sector to private firms. This study tries to disentangle the complexity embodied in dynamic decision making in PPP-settings and demonstrate the use of the real option model for road planning. We want to examine the real option value during the operating phase of a road, how ownership affects the timing of expansion options and under what conditions it is not socially optimal to transfer physical ownership of the road in a PPP to the private party. In order to achieve this, we combine insights from incomplete contract theory and real option analysis to analyze the incentive structure in a PPP for road projects.

The paper is structured as follows. Section 2 gives a general introduction to the concepts of real options and PPP that are used in the analysis of road projects. Section 3 examines a typical, operative road-project decision: road expansion from two to four lanes. Applying real option analysis and the fact that the Swedish 2 + 1-road model can be seen as a feasible intermediate solution, we identify and value the options inherent in the expansion plan given that there are multiple exercise times for the expansion options. The results of the real option analysis are interpreted in the context of incomplete contract theory and public private partnerships. Since the point of PPP is more optimal risk sharing leading to higher benefits for both parties, we find that real option analysis can contribute here. Since real options value the opportunities that risk creates, risk sharing might also lead to the transfer of option values between parties. A short discussion in Section 4 concludes this paper.

2. Real options, infrastructure and PPP

A financial call option is defined as the right, but not the obligation, to buy a certain asset at a certain time for a predetermined price.[1] The real-option approach views an investment opportunity in real capital as an option; the right, but not the obligation, to invest a certain amount and thereby claim the future cash flows from the investment. One real option is the timing decision; we can, but we do not have to, invest immediately. The possibility of delaying the investment is a real option and the associated flexibility has a positive value if uncertainty exists about future cash flows. This is not always the case, though, as the following example shows. An investment in an ordinary machine is not per se a real option. Despite the fact that we can buy, but are not obliged to buy, the machine, we cannot sell this right to someone else, since everybody else could buy the machine as well. Hence, we have no option in an economic sense, and the net present value criterion will lead to an optimal decision. Under certain conditions the investment opportunity still has a value even if the right to invest cannot be sold in the marketplace; it might be optimal to wait instead of investing as soon as the benefits exceed the costs. If investing immediately implies the lost opportunity to do so in the future, the possibility of waiting has a value for us even if it is of no value to anyone else. Thus, if investment capital is scarce or if the investment consumes an exhaustive asset, it can be optimal to wait (Andersson, 2003).

This paper focuses on an infrastructure investment; you pay an amount for an asset, such as a new road, now in order to get a return, such as increased traffic flow, time savings and increased safety, from it in the future. In order to illustrate the importance of the option concept in road investments, let us assume the following example: We want to build a new road with societal benefits solely dependent on future traffic demand. At present, the future state of the economy, and therefore traffic demand, is uncertain. For the coming year we estimate the road's societal benefits to be about 2 million Euro, but thereafter the estimated benefits are either 1 million Euro or 3 million Euro per year for the remaining lifetime of 20 years, with a probability of 50% for either case. The construction costs are 40 million Euros and construction time is zero. According to the standard net present value (NPV) rule we expect that (assuming real interest rates are zero):

$$\mathrm{NPV} = -40 + 2 + 0.5 \cdot 20 + 0.5 \cdot 60 = 2$$

Hence, since the net present value is positive, we should start construction immediately. However, it might be possible to postpone construction for one year so that the uncertainty is resolved. In that case, we only construct the road if we face the 3 million per year outcome. The expected net present value is thus:

$$\mathrm{NPV} = 0.5 \cdot (-40 + 60) = 10$$

The result is that the road investment has a larger expected value if we can postpone construction for 1 year. The so-called real option value of waiting is thus 8 million Euros. The real option approach has been criticized for leading to postponement of investment, since, instead of investing now, we wait and see and maybe invest in the future. However, even if some investments are made later when considering the option value, it is clearly optimal to do so. Considering the option value increases the threshold for investing immediately since we need compensation for the lost opportunity of waiting for more information. Moreover, for certain kinds of real options the opposite is true, since investing may sometimes be the only way to gain important information and hence leads to early investment compared to the net present value criterion. Thus, investing now can be seen as the price to pay for gaining a real option; that is, the continuation of the project (sometimes this is called a learning option). Starting a road project often gives us a new option. For example, building a motorway between big city A and small city B will give us the option to build a motorway between small city B and big city C later, thus connecting A and C

[1] A financial put option is defined as the right, but not the obligation, to sell a certain asset at a certain time for a predetermined price. A call option increases in value as the value of the underlying asset exceeds the exercise price, whereas the put option decreases in value.