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On timetable assumptions in railway investment appraisal

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ABSTRACT

The benefits captured in an appraisal of a railway investment are determined by what timetables the analyst assumes in the scenarios with and without the investment. Without an explicit, objective and verifiable principle for which timetables to assume, the appraisal outcome is virtually arbitrary. This means that appraisals of railway investments cannot be compared to each other, and opens the door for strategic behaviour by stakeholders conducting seemingly objective cost-benefit analysis. We explain and illustrate the nature and extent of the problem, discuss possible timetable construction principles, and show that current practice is likely to exaggerate appraisal benefits.

1. Introduction

Railway investments are substantial financial commitments. In most countries, developing and maintaining the railroad network is a public responsibility. As with all public transport policy decisions, benefits can be weighed against costs and the cost-efficiency of different investments can then be compared. This makes well-developed and well-structured cost-benefit analysis (CBA) methods indispensable. The increasing interest for investments in high-speed railways makes this even more important, considering the huge costs at stake.

The outcome of a public railway investment appraisal depends on the assumed timetables with and without the investment. Yet principles for timetable design in appraisal are not explicitly discussed in the literature, neither in national appraisal guidelines nor in the research literature. The purpose of this paper is to explain and illustrate the crucial importance of timetable assumptions in public railway investment appraisal, why explicit principles for appraisal timetable construction are necessary, discuss the potential problems that the lack of such principles creates, discuss different such principles, and explain why current practice will tend to exaggerate investment benefits.

The key insight is that without an explicit principle governing the choice of appraisal timetables both with and without an investment, the social benefit of a railway investment is not defined. It is meaningless to speak of the benefits of a railway investment as such – it is the use of the investment, that is, the timetable, which decides what benefits a railway investment will generate.

Railway investments are different from most other transport investments in that its use is often planned and decided by society to a large extent, through capacity allocation, regulations, track access charges, subsidies, public transport provision, etc., and by commercial operators, who strive to maximize profits, often with some monopolistic power. This stands in contrast to most other transport investments, such as roads or bicycle paths, where the use of the physical infrastructure is mainly decided by individual decisions made by large numbers of travellers. Which timetable principle is most appropriate to use in an appraisal will depend on the institutional setting – which stakeholders decide the use of the railway in question and their incentives, goals and constraints, and how potential conflicts between stakeholders are resolved. Hence, this paper cannot prescribe *what* principle should govern the construction of appraisal timetables. The purpose is merely to describe the problem, illustrate its potential consequences, and discuss some principles which may be appropriate. There is a multitude of possible institutional settings, and in this paper we only illustrate a few examples. The insight is quite general, however, and occurs in any institutional setting. However, it is likely to be especially problematic when the responsibilities for financing investments, capacity allocation and running the trains are separated between different stakeholders.

The importance of timetable assumptions becomes particularly evident when appraising capacity improvements, since an increase in capacity can be used in any combination of increased frequencies, decreased travel times, and reduced delays. Depending on how the new capacity is used, an appraisal will give different results. The appraisal outcome will also depend on what is assumed about the use of the existing capacity in the do-nothing case. It is not only the

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social benefits that depend on timetable assumptions; forecasts of revenues and passenger volumes obviously also do so.

This means that the analyst responsible for carrying out an appraisal can influence how large benefits an investment will generate in the analysis by choosing more or less socially efficient timetables.[1] This influence can be conscious or subconscious. It is usually difficult or impossible to gauge the social efficiency of a timetable for outside observers and decision-makers, and sometimes even for the analyst. Clearly, this means that CBA results may become misleading and to some extent even arbitrary. Even worse, if the analyst represents a stakeholder with an interest in discrediting or promoting certain investments, there is an opportunity for strategic behaviour, with very little possibility for outsiders to discover this.

Appraisal timetables for long-term strategic investment planning are typically simplified down to its essentials. The timetables are typically defined only by frequencies and travel times of different train types (e.g., regional, long distance and freight trains), and we will follow this convention in the examples in this paper. However, the level of detail of the timetables does not influence the main insight that the social benefit of an investment depends on the assumptions regarding them.

The intended audience for this paper is not primarily railway planners but people working with appraisal methodology. Appraisal methodology covers all sorts of inputs, valuations and processes, from future fuel prices to the value of a statistical life. To ensure that CBAs for different investments can be compared and ranked consistently, there are often national guidelines for appraisal methods, inputs and parameters. In contrast, principles for timetable construction are surprisingly neglected. The ultimate objective of this paper is to start a discussion about such principles. Again, which timetable principle is appropriate depends on the prevailing institutional setting – the incentives of the involved stakeholders and the process for resolving capacity conflicts. The principle needs to capture the essential interactions between demand, supply, capacity constraints and the capacity allocation process. Once such a principle is established, it can be used to calculate timetables both in the do-nothing and in the investment scenario.

In Section 2, a simple model is formulated, which captures the main features of applied transport CBA. The model is a simplified version of the current Swedish appraisal practice and guidelines. Section 3 shows, by way of examples, why the social benefits of a railway investment cannot be defined without a principle for choosing timetables before and after the investment, and that this opens the door for both honest confusion and strategic behaviour by the analyst. In Section 4, we discuss advantages and disadvantages of different timetable principles, what the (implicit) principles are in current appraisal practice, and what consequences these are likely to have. Section 5 concludes.

1.1. Literature and practice

Despite the obvious importance of timetables in appraisal, we have failed to find any mentioning in appraisal guidelines of how analysts should construct timetables. For example, the extensive guideline RAILPAG (Railway Project Appraisal Guidelines), intended to be "a common framework for the appraisal of railway projects across the EU", does not mention how appraisal timetables should be designed, what stakeholder should have the responsibility for it, or how appraisal results might be affected by it. Neither of the national appraisal guidelines of Sweden, Norway, UK or the Netherlands mentions the topic, despite having detailed formal appraisal guidelines covering virtually all other parameters and dimensions.

Even if there seems to be an understanding that the timetables determine investment benefits among many practitioners and in the gray literature, the practice in most railway appraisals is to treat the timetable as an exogenous variable outside the analyst's control or responsibility. This is both strange and problematic, since comparability of appraisals of different investments is essential. For this reason appraisal guidelines devote substantial efforts to forecast and harmonize assumptions regarding virtually all other variables entering the CBA, from future oil prices and population growth to transit fares and vehicle operating costs.

It is true that the future timetable – the timetable which the appraised project will enable – often attracts interest, even if there is seldom any explicit principle guiding its construction. However, much less thought is usually put into constructing the timetable in the do-nothing scenario, despite the fact that it is well known that the definition of the do-nothing scenario is always crucial in any CBA exercise. That scenario should be the best possible alternative if the project is not carried out. Although this principle is often difficult to apply in practice, the idea can be operationalized by evaluating many alternatives and rank them mutually. Van Wee (2007) discusses the importance of the do-nothing alterative in the context of railway CBA further.

There is no research literature that explicitly deals with the specific problem of how the social benefit of a rail investment depends on the assumed timetables in the scenarios with and without the investment. But there are several branches of literature dealing with related problems.

First, there is a body of research literature on demand modelling, showing that behaviour changes in response to levels of rail service and timetables (e.g., Hensher, 1997; Hensher and Ton, 2002), but in this literature the timetables arrive by assumption. This literature does not consider the problem of the present paper – how the choices of timetables influence appraisal.

Second, there is a developing literature concerning different aspects of railway operations optimization, such as crew and vehicle scheduling and train scheduling and routing. This literature typically uses engineering objectives such as minimizing total operations cost (see Caprara et al. (2007) for an overview). Social welfare or any other economic objective function, however, is typically not considered in this literature. Demand is usually handled simplistically, and if passenger welfare is taken into account, this is done in a crude or heuristic fashion such as maximizing the number of passengers able to reach their destination without an interchange. A rare example of an economic objective function is Brännlund et al. (1998), who present an algorithm that schedules a set of trains to obtain a profit-maximizing timetable without violating track capacity constraints.

Third, there is some literature that at least implicitly indicates the specific problem of the present paper. Adler et al. (2010) study how competition between airlines and high-speed rail may affect service levels, and how this affects the benefits of high-speed rail investments. There is an insight of the problem that the assumed timetables affect the utility of rail investments although no explicit discussion of or solution to it, such as an explicit principle for timetable construction in appraisal, is suggested. Bristow et al. (1998), Nash and Preston (1991) and Nash (1992) all touch upon related issues when discussing and analyzing appraisal principles in the partially deregulated British railway industry. However, there is no explicit formulation of the problem or suggestions on how it can be solved.

Fourth, ex-post studies of rail investments confirm the importance of timetable assumptions, concluding that they are essen-

[1] A socially efficient timetable is the timetable that maximizes the sum of all social benefits and costs, including external costs and benefits. This includes, e.g., passenger costs and benefits, producer costs and revenues, emissions and accidents.