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A game-based analysis of freight paths allocation with a case study on Great Britain Brighton Main Line

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Abstract

In recent years the rail sector has experienced significant demand growth that leads to increased competition for the scarce resource of railway capacity. In Great Britain, the current policy tends to favour passenger trains to freight operators. This study explores how existing railway capacity allocation process can be improved in order to strengthen the competitiveness of freight train operators. A decision that is faced by the Infrastructure Manager herein is to determine how the scarce resource should be allocated among the different operators such that the overall social welfare can be maximised. In particular, we are interested to look at the implications on social welfare, system efficiency, and (re-)distribution of benefits among operators should more capacity be allocated for freight trains. The research questions were investigated through a set of simulation games based on a real world scenario collected from the Brighton Main Line (BML) in Southeast England. To the best of our knowledge, this is the first attempt to model and analyse impacts of the hypothesised preferential treatment of freight operators under several sets of regulations and bidding frameworks on efficiency, equity, and social welfare. Our findings reveal improvements in social welfare and equity among different operators, but loss of rail system efficiency due to the increased level of heterogeneity seen in the train mix. From the perspective of infrastructure utilisation, on heavily congested mixed traffic lines, investments for freight train services should be prioritised in order to reduce the speed differentials between slower freight and faster passenger trains and increase flexibility of scheduling and reduce capacity loss. It is also found that infrastructure managers' expertise has an important impact on the quality of the initially proposed timetabling solution. We conclude with a list of suggested improvements to the current Great Britain policy so that the needs of freight operators and hence their customers are better represented.

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1. Introduction

In recent years the rail sector has experienced significant demand growth that leads to increased competition for the scarce resource of railway capacity. In the United Kingdom, the existing allocation policy tends to favour passenger to freight train operators. This study explores how this process can be improved to strengthen the competitiveness of freight operating companies. A decision faced by the Infrastructure Manager herein is to determine how scarce infrastructure resource should be allocated such that the overall social welfare is maximised. In particular, we look at the implications on social welfare, system efficiency, and (re-)distribution of benefits among operators should more capacity be allocated for freight trains.

2. Background

The beginning of the 20th century on most European railways was the time when several railway companies were competing for the same passengers or freight consignments by providing services on the national railway infrastructure. For various reasons, the competitors were nationalised and became nationwide monopolies. During the last few decades vertical separation of operations from infrastructure has again been seen as a remedy for improving efficiency, social welfare² or providing higher quality of services. Typically, the Infrastructure Manager (IM) is a single provider of track infrastructure (rails, sleepers, switches, signalling, power supply etc.) and the Railway Undertakings (RUs) run services in competition with each other, or serve different market segments or geographical areas over the common track infrastructure, for which they have to pay access charges³.

From the economic point of view separation gave rail some natural-monopoly characteristics which makes it similar to other utilities such as roads or telecommunication networks. In contrast to roads, capacity shortages cannot be overcome by dissolving queues in real time (Nilsson 2002). Decisions about how the trains are run are taken well before their departures and therefore the IM's strategic task is to allocate the scarce resource among different users to resolve train path conflicts, assure efficiency and provide non-discriminatory access, which is not easy a task.

This project is concerned about how to improve the railway capacity allocation process in the United Kingdom to strengthen the competitive position of Freight Operating Companies (FOCs) and hence their customers in relation to other RUs (mainly Passenger Train Operating Companies TOCs) and alternative modal competitors (primarily road transport). The research question is what the implications for the social welfare, efficiency and fairness of the solution would be if more capacity was to be allocated for freight rail by applying changes to existing UK administrative procedure of capacity allocation (such as to priorities and freight-passenger trains mix ratios). This will be investigated by developing a set of simulation games based on real world case study of the Brighton Main Line (BML) and applying different set of 'game rules' in each of the scenarios.

3. Literature review

3.1. Definition and calculation of railway capacity

There are different approaches to how railway capacity should be defined. Mussone and Calvo (2013) defined it as the maximum number of trains that can traverse the network in a given time window, subject to management constraints like junction capacity. Burdett and Kozan (2006) described it as the maximum volume of customers and goods that can be transported within a network in a given time period. EU Directive 2001/14/EC defined capacity as the potential to schedule train path requests on a railway system. A train path is described as the railway capacity

² This paper, similar to Nilsson's approach (2002), is not going to justify whether vertical separation of railways per se is welfare enhancing. It will focus on how to improve the tools for capacity allocation if vertical separation is to stand any chance of enhancing sector efficiency.

³ Interestingly, at the core of The European Commission's (1998) policy are the benefits of competition within the traditionally closed market, however, the EC provides no advice on how to practically charge for scarce capacity and how to divide it among different uses.

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