The Inefficiency of Travel Passes with Crowding in Public Transport

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Introduction

Travel passes, often labeled as season tickets or travelcards, are widely used in large public transport networks globally. Economic theory considers a tariff structure with single tickets and travel passes as a form nonlinear pricing. It has been proven in the literature that under standard conditions, nonlinear pricing allows the supplier to generate revenues in an efficient way through second degree price discrimination (Carbajo, 1988). Travel passes are popular among frequent travelers as well, as they provide a cheaper alternative compared to single tickets or pay-as-you-go fares for everyday commuting. The scientific literature of nonlinear pricing in transport, and especially in public transport, is remarkably scarce. Our research community does not express clearly whether the use of travel passes should be promoted or persecuted in transport policy. This may be surprising given that travel passes are very popular in Europe and North America, for example, but have been left out from the tariff portfolio in many South American and Asian cities.

Research questions

This resarch is motivated by the vague suspicion that travel passes may cause troubles in the presence of consumption externalities. In case of public transport, the inconvenience of crowding is a particularly important consumption externality that can now be measured with advanced demand modelling techniques (Hörcher et al., 2017, Wardman and Whelan, 2011). Economic theory suggests that in the presence of consumption externalities, the price of a service should be equal to the marginal externality imposed on fellow passengers and other

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agents in society. This implies that the optimal fare in public transport should be equal to the marginal external crowding cost, neglecting all other adverse effects of travelling.

Travel pass users, on the other hand, face zero marginal fare before an additional trip as long as they posess a valid season ticket. Therefore they do not consider any externalities in their personal decision about consumption. We must suspect that travel pass holders overconsume public transport. Some of their trips generate less net personal benefits than social costs. As a consequence, a purely welfare maximising operator, that does have the possibility to cover its losses under optimal pricing with public subsidies, should not supply travel passes at all.

In this research project we investigate three potential reasons to explain why so many agencies in the world still do apply nonlinear pricing.

1. Some operators are facing a budget constraint, so that subsidies are insufficient to cover the financial loss associated with the welfare maximising prices,
2. Some operators are simply unaware of the crowding externality and the adverse impact of overconsumption by travel pass holders,
3. Some operators intend to maximise demand instead of social welfare, which may be the result of political pressure or the lack of awareness to economic efficiency.

From an economic point of view, we have to consider these possibilities as market failures, that either legitimise the existence of travel passes (1st case) or urge policy makers to rationalise their tariff strategies (2nd and 3rd cases). The ultimate goal of this research is to improve our understanding of the economics of nonlinear tariff structures in public transport, and determine under what conditions may the availability of travel passes be justified from an efficiency point of view.

Methodology

Due to the analytical complexity of modelling nonlinear pricing with demand-dependent user costs, our reseach method is based on a numerical partial equilibrium simulation experiment. We extend the analytical framework of Carbajo (1988) with crowding on the demand side. Based on the general literature of nonlinear pricing (Brown and Sibley, 1986, Littlechild, 1975, Oi, 1971), Carbajo formulated an individual demand function with a heterogenous taste parameter. He expressed the critical value of this taste parameter for which the consumer surplus is the same with both tariff product. Thus, for a given set of fare levels, the taste of the indifferent consumer as well as the equilibrium market share of single tickets and travel passes can be derived. In our extension, individual demand is also sensitive with respect to the ratio of aggregate demand and capacity. This implies the presence of consumption externalities. Further extensions may also take into account the income effect of travel pass purchases (Jara-Díaz et al., 2016).

To perform a numerical simulation we apply the method of Wang et al. (2011). We assume that (1) the taste parameter is uniformly distributed in a predetermined population of potential users, and (2) the generalised cost of travelling has a one-to-one impact on individual demand. This allows us to quantify aggregate demand and social welfare with simple expressions and thus optimise the model's decision variables numerically.

We split the analysis into two parts. In the first part capacity is exogenous and we investigate how capacity shortages (and the resulting crowding) may affect the revenue generating power of nonlinear pricing, as well as its efficiency in welfare maximisation subject to a budget constraint. In the second part, capacity (more precisely service frequency) is also an endogenous decision variable that may react to the availability of travel passes. In this case we explore whether the Mohring effect, which is essencially the indirect positive externality on waiting times through capacity adjustment, may compensate for the effects of the unpriced crowding externality.

Early results

Preliminary simulation results reinforce the hypothesis that welfare maximising operators should not offer travel passes, even if they face a moderate subsidy constraint. We found evidence that a demand maximising objective and neglecting crowding both lead to higher than optimal market share for travel passes. These results seem to hold with endogenous capacity as well. The welfare gain that travel passes provide may be significant (up to 135% of social welfare with single tickets only) in case of a private monopolist. However, as soon as the revenue constraint for a public operator is just 80% of what a private monopolist could achieve, the benefit of nonlinear pricing drops to 3 to 4%.

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