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Optimal pricing for travelcards under income and car ownership inequities

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ABSTRACT

Travelcards are used in many parts of the developed world as a form of payment for public transport that is convenient for frequent users. In essence it involves a one-time payment T at the beginning of a period that covers all trips within that period. Carbajo (1988) applies the two-part tariff approach to find the optimal (welfare maximizing) value for T assuming a nil effect of T on the demand schedule of each and every individual (no income effect). Here we deal with an urban area where individual trips increase with income, but where car ownership – correlated with income – makes the public transport share diminish towards high income segments. A theoretical model is developed to find the optimal values (maximum social welfare with a budget constraint) for T and, simultaneously, for a single ticket P, considering the effect of T on available income as well as differences across individuals regarding car ownership. The model is applied using parameters associated with monthly travel in Santiago, Chile, where both income and car ownership are highly concentrated and correlated, and where travelcards do not exist. We obtain that the two richest segments choose to pay for the single ticket and the other eight choose to buy the travelcard, increasing equity. Sensitivity analysis regarding public transport quality, increased car ownership and poverty reduction show relatively marginal changes regarding optimal prices and preferred form of payment.

1. Introduction

Pricing public transport is an interesting tool for urban transport planning. Travelcards are used in many parts of the developed world as an alternative to the single ticket that consists of a fixed fee that allows unlimited trips within its validity period, a year, a month, a week, a day. It is a method to induce the use of public transport (PT) and to facilitate the access to transport services to captive users, like students or elders. The intention is also to take advantage of scale economies, environmental friendliness and the efficient use of the urban space, among other aspects. Generally, this ticket type is convenient for most of the city residents (and even for visitors if they stay long enough), because users compares the travelcard value (T) in a given period with the necessary expenditure associated with the expected number of trips during the same period using the single ticket (P); in addition, avoiding the time it takes to make the transaction on the vehicle is considered a plus. Once the travelcard is acquired, users will make more than the expected mandatory trips.

Experiences around the world have been studied by White (1981), FitzRoy and Smith (1998, 1999), Pucher and Kurth (1996), Matas (2004) and Gschwender (2007), among others. As evident, the larger the number of trips made by the

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Table 1
Comparison between single ticket and monthly travelcard.

City	Madrid	Paris	Rome	Berlin	London
Travelcard [€/month]	54.6	70	35	79.5	170
Single ticket [€/trip]	1.5–2	1.8	1.5	1.6–2.7	6.7
Equivalent trips	36–27	39	23	50–29	26
PT trips with travelcards [%]	64	77	56	85	83

Source: London Travel Report (2005), EMTA (2004), Pucher and Kurth (1996), ATAC (2016), and Verkehrsverbund Berlin-Brandenburg (2010).

individual the more attractive the travelcard is. Just to have an idea, the monthly price of a travelcard in some European capital cities is equivalent to 23–36 monthly trips, i.e. less than two trips per working day, such that most citizens would find it convenient to buy it (and use it).

Table 1 contains the monthly travelcard values (there are also daily, weekly and annual) and the single ticket price for the metropolitan area of five European cities; the fourth row shows the number of equivalent trips that users can make if they spent the value of the travelcard in single tickets, such that in all five cities the travelcard is worth buying even if individuals travel only twice a day. The last row confirms that usage of the travelcard dominates as form of payment in PT (most of the trips are paid with it).

Why this tool is not applied in most of the Latin American cities (only Sao Paulo has recently implemented it) is somewhat a mystery; if it gets implemented, though, there is a methodological problem that has not been yet solved: its effect depends on users' behavior, particularly on the marginal utility of income (how money is valued by different individuals) and car ownership, which vary significantly in the population. Prevailing theories to put optimal prices on travelcards do not take these aspects into account properly. The theoretical basis for travelcard pricing developed by Carbajo (1988) follows the two-part tariff theory (Oi, 1971; Feldstein, 1972; Brown and Sibley, 1986; Wilson, 1997), dismissing income effects. This theory is applied to the PT market to find the optimal P and T using a taste parameter to differentiate across users. We postulate that income should enter the theoretical framework to calculate optimal values for travelcards, and that this can be applied to a context of high income inequality where travelcards do not exist.

In this paper we develop and apply a theoretical model to find the optimal values (maximum social welfare with a budget constraint) for a travelcard and, simultaneously, for a single ticket, considering the effect of T on the available income as well as differences across individuals regarding car ownership. As these effects work in opposite direction, the single taste parameter approach is not applicable.

In the next section the approach developed by Carbajo (1988) is summarized, showing its limitations regarding income. In Section 3 an analytical model that captures both effects mentioned above is developed. Next the model is applied to Santiago, Chile, a city where both income and car ownership are highly concentrated and correlated. The final section contains a synthesis, conclusions and directions for further research.

2. Taste or income

2.1. Carbajo's (1988) model

A two part tariff (P, T) consists in separating the charge for a product into an entry fee T (to be allowed into the market) and a payment P for each unit consumed, as used in water, electricity and telecommunication markets. This structure allows gains in efficiency due to the possibility of lowering the price to get P near the marginal cost, but it also can induce consumers to exit the market because they refuse to pay the entry fee. With this approach, the lower the price P is, the higher T should be in order to cover the producers' costs, causing different reactions in consumers (assuming they are not all equal).

The differences among consumers are mainly treated in two forms in the two-part tariffs literature: by means of their income, as in Oi (1971) and Feldstein (1972), or by means of a taste parameter that is distributed in the population and that represents consumption intensity, as done by Brown and Sibley (1986) and Wilson (1997). In both treatments, however, the effect of T on the individual income (and, therefore, on the demand curve) is considered negligible; Oi assumes that demands are invariant to changes in income or in the entry fee and Feldstein considers that the effect is negligible because T is only a little fraction of the consumers income. No author considers the possibility that there could be markets (like public transport) or segments of the population where this assumption might not be reasonable.

Aiming at finding the optimal value of travelcards, Carbajo (1988) extends the Brown and Sibley model to the PT market, representing both the travelcard and the single ticket as special cases of a two part tariff (P, T): the travelcard as $(0, T)$ and the single ticket as $(P, 0)$. Under this consideration, each user will choose the alternative that yields the largest consumer's surplus. Following the demand scheme represented in Fig. 1a, the surplus CS_P gained by a user who chooses single ticket is A, with Q_P trips per period. With the travelcard the surplus CS_T will be $A + B - T$, making Q_T trips **regardless the value of** T; the choice will depend on the sign of $B - T$.

In Fig. 1b we represent three individuals (Active, Middle and Passive) with different PT demands schemes. For any single ticket price, their trips will fulfill the condition $Q_{act}(P) > Q_{mid}(P) > Q_{pas}(P)$. Then Carbajo notes that if $T = d + e$ each user will choose as shown in Table 2.