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Road pricing as a citizen-candidate game

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Abstract

We construct a political economy model to analyze the political acceptability of road pricing policies. We use a citizen-candidate framework with a population composed by three groups differing for their income level. We show that road pricing policies are never applied when there is no redistribution of the resources in favour of other modes of transport or when the congestion of these types of transport is relatively high. The results suggest that the efficiency of the redistribution of resources from road to the alternative types of transport as well as the fraction of the population that uses the road transport are key factors in explaining the adoption of road pricing schemes.

Keywords: Road pricing; Political acceptability; Citizen-candidate.

1. Introduction

This paper studies the political acceptability of a road pricing policy in a context characterized by heterogeneous agents choosing between two distinct congestible infrastructures producing differentiated transport services. One service is fast and expensive (e.g., auto) while the other slow and not expensive (e.g., public transport). By assumption, public transport is slower than private transport, regardless of the modal split. The heterogeneity of agents is accounted for by assuming the existence of three groups. People are homogeneous within each group and the three groups differ for the level of income of the agents. For this reason, we call these groups rich, middle class and poor. No one group has the absolute majority of votes which, therefore, requires the combination of any pair of groups. At the same time, we assume that initially (i.e. at the

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status quo) both modes of transport are always used by at least by one income group. For the political competition, we use a citizen-candidate framework (see Osborne and Slivinski, 1996; Besley and Coate, 1997) in which there is neither uncertainty nor commitment. This in turn means that the elected candidate implements its preferred policy.

The model assumes that a road pricing can be imposed on the private mode of transport by any elected citizen-candidate with or without redistribution in favor of the public transport mode. Redistribution of revenues to car drivers is ruled out. Under these assumptions, the model provides the following results. Road pricing policies on the private mode are never imposed when there is no redistribution of raised revenues towards the public mode of transport. When such redistribution is made, it is possible to obtain equilibria with the adoption of road pricing schemes. In particular, this is the case when the congestion of the alternative mode of transport is relatively low or when the resources from road pricing allow to improve substantially the quality of the alternative mode of transport. Finally, the acceptability of road pricing policies appears to be high when a large fraction of the population does not use road transport in the *status quo*.

The paper is organized as follows. Section 2 presents the related literature. Section 3 defines the basic setup of the problem. Section 4 characterizes the equilibrium of the model when there is no redistribution of the road pricing revenues while Section 5 determines the properties of the equilibrium when such redistribution (in favor of public transport) is allowed. Section 6 concludes.

2. Related literature

This paper combines a recent stream of literature on integrated urban road pricing policies (see, for instance, Glazer and Niskanen, 2000 and Armelius, 2005) with a rather standard version of a citizen-candidate game (Osborne and Slivinski, 1996; Besley and Coate, 1997). The novelty of this approach relates to the analysis of the interaction between the level of the tariff proposed, the eligibility of the candidate proposing it and its political acceptability, given the income distribution and the modes of transport used by the community.

In order to locate our contribution, we can conveniently divide the literature on road pricing in three different streams, as suggested in a recent book by Arnott, Rave and Schöb (2005). In the first stream of literature, urban congestion pricing theory was developed in a first-best transport and capacity perspective. A second stream has began with the literature on second-best pricing and capacity with the aim of making congestion pricing more politically acceptable. Finally a third one, characterized by a more applied attitude, examines in detail all the relevant aspects at a micro level that can foster or hinder the adoption of a pricing scheme. Given the above framework of references on road pricing, one might locate this paper in an embryonic part of the third phase of Arnott's et al. schematization of road pricing literature. In fact, even if, among other weaknesses, the setup proposed is very aggregated with respect to agents heterogeneity (a much more advanced work, under this respect, is de Palma and Lindsey, 2004) and the analytical treatment of the two transport modes (private and public) is rather rough, nonetheless, the paper attempts to provide some new insights concerning the political acceptability of road pricing policies. Previous research has looked into the issue of political acceptability enquiring various issues such as those reported below, but has never interpreted the problem in a citizen-candidate framework.

The politico-economic and fairness considerations of adopting road pricing have recently been addressed in a paper by Oberholzer-Gee and Weck-Hannemann (2002) where the lack of citizens' support for road pricing initiatives is attributed to two factors which are the general lack of will to adopt the price system as an allocation mechanism for scarce resources (Hahn, 1989; Frey et al., 1985) and the difficulty with which the latent support for road pricing schemes translates into actual policy making (Small, 1992). This way of explaining the low practical implementation of road pricing dwells on research interpreting the scarce adoption of road pricing schemes as due to its low political acceptability (see reviews by Jones, 1995; Schlag and Teubel, 1997). Individuals might not accept road pricing due to a misperception of the negative effects as being caused by others rather than by oneself (Sheldon et al., 1993) thus contributing to a feeling of unfairness either perceived or real (Emmerink et al., 1995). Research by Baron and Jurney (1993) and Baron (1995) has shown that people are opposed to coerced reforms even though they sympathize with the intended purpose. The most important reasons for opposing road pricing have been attributed to social or moral norms of fairness and freedom of choice. These considerations had already been raised by Borins as late as 1988 (Borins, 1988). Other issues concerning the acceptability of road pricing policies that have progressively received greater attention have to do with misunderstanding, complexity, equity/fairness, privacy issues or tax resistance (Giuliano, 1994; Goodwin, 1989; Jones, 1998; May, 1992) as well as individual specific uncertainty (Marcucci and Marini, 2003).

Implementation hinges on a political question: will it be politically feasible to impose a road pricing scheme? As it is now strongly remarked in the current literature, this question can hardly be answered in abstract and general terms (Santos and Fraser, 2005).

3. Setup

We consider a population living in a given area composed of three homogeneous groups $\{G_k\}_{k=1,2,3}$ only differing in their income level. We denote by y_k the income level of every agent belonging to a k-th income group. Hence, we assume that $y_1 > y_2 > y_3$, with $y_k^i = y_k^h$ for every $\{i,h\} \in G_k$ [1]. Every group has mass μ_k, with $\sum_k \mu_k = 1$ and $\mu_k < 0.5$. Therefore, it follows that $\mu_g + \mu_l > 0.5$ for every $\{g,l\} = 1,2,3$. In other words, group 1, 2 and 3 correspond to the rich, the middle class and the poor respectively, and the absolute majority of votes requires the combination of any pair of groups.

We also assume that each individual consumes one unit of transport. We denote with t the time spent for the journey and assume that this is positively related to the number (or mass) of agents $\mu \in [0,1]$ using that mode of transport, i.e. $\frac{dt}{d\mu} > 0$. Hence, we denote by $v_k(t_j(\mu_j))$ the value of a journey made by an agent of group k when using a given j-th congestible mode of transport. The journey requires travel time t_j which depends positively on the mass μ_j of the people using the mode of transport j. The willingness to pay of the individuals is decreasing in the time spent for the journey and, therefore,

[1] We make no restrictive hypotheses concerning the income differences between the three groups.

$\frac{dv_k}{dt} < 0$ for every individual in G_k. Moreover, due to the different income of the individuals of the three groups, we can simply assume that for every j^{th} mode of transport and for every level of congestion μ_j:[2]

(1) $$v_1(t_j(\mu_j)) > v_2(t_j(\mu_j)) > v_3(t_j(\mu_j)) \geq 0 .$$

The optimization problem of an individual belonging to a given group *k* is:

(2) $$\max_j \ \sigma_k(t_j(\mu_j), p_j) = \max_j \ \left[v_k(t_j(\mu_j)) - p_j \right]$$

where $\sigma_k(t_j(\mu_j), p_j)$ denotes the net surplus of each consumer in group *k* using the j^{th} transport mode at its price p_j. Thus, by choosing one unit of a given transport mode over a number of alternatives, all individuals aim at maximizing their own *net surplus*, equal to the difference between their willingness to pay for the time spent in the transport mode and its unitary price. To keep things simple, we suppose that in the area under consideration, only two substitute systems of transport exist for a given journey, a *fast* one (auto) *j=f*, and a *slow* one (public transport) *j=s*, with $0 < t_f < t_s$ and $p_f > p_s > 0$. Therefore, at the optimal choice, every $i \in G_k$ will select mode *j* if and only if:

(3) $$\begin{cases} \sigma_k(t_j(\mu_j), p_j) \geq \sigma_k(t_h(\mu_h), p_h) \\ \quad \text{and } \sigma_k(t_j(\mu_j), p_j) \geq 0 \end{cases}$$

for $h \neq j$. At the *status quo*, we expect that, when affordable, rich people $(i \in G_1)$ will always choose auto for any congestion level and poor people $(i \in G_3)$ public transport. Therefore:

(4) $$\begin{cases} \sigma_1(t_f(\mu_f), p_f) \geq \sigma_1(t_s(\mu_s), p_s), \\ \sigma_3(t_f(\mu_f), p_f) \leq \sigma_3(t_s(\mu_s), p_s). \end{cases}$$

[2] The intuition behind this assumption is that for any given time spent in transport, the higher income individuals have a higher willingness to pay for the trip which originates from the higher opportunity cost of time.

As far as the people of middle class are concerned $(i \in G_2)$, two *status quo* are conceivable. In a first one, they all prefer to use auto, and this requires that, at the given prices p_f and p_s:

(5)
$$\begin{cases} \sigma_2(t_f(\mu_f), p_f) \geq \sigma_2(t_s(\mu_s), p_s), \\ \quad \text{and } \sigma_2(t_f(\mu_f), p_f) \geq 0. \end{cases}$$

In the second *status quo*, the sign of the first expression above is reversed, and initially the people of the middle class will, at the given prices, find optimal to select the private mode of transport.

Using the setup described above, we now consider a simple citizen-candidate game in which a road pricing scheme on the auto (with a given distribution of the raised revenues) is decided by a leader elected directly by the people of the area through a majority voting process among the menu of citizen-candidates participating to the election. The menu of candidates is endogenous and one individual runs for office if and only if, in equilibrium, the net gain of doing so - the surplus he gets if he does run, plus an exogenous benefit b - exceeds a given cost c of running for office.[3] We assume the absence of any form of commitment so that the elected candidate implements its preferred policy. We also assume that voting is sincere.[4]

In order to determine the political outcome of the game, we first determine the preferred road pricing policy that a candidate of group G_k would select once elected. Then, we determine which agent will be elected and the policy implemented. We analyze two possible situations. The first is when the road pricing revenues are not redistributed, while in a second situation the revenues from road pricing are redistributed in favor of the public mode of transport.

[3] The existence of an exogenous benefit b of winning the election and of a fixed cost c to run for it, with $b>c$, implies that no candidate will run for an election when there is no probability of winning. When this probability is positive, running for the election provides positive utility.

[4] This assumption can be justified by noting that each individual regards himself as an atomistic subject. Therefore, he considers his vote irrelevant in conditioning the outcome of the elections. Osborne and Slivinsky (1996) assume that voting is sincere while individuals are strategic in Besley and Coate (1997).

4. Road pricing in absence of redistribution

We now consider the benchmark case in which none of the revenues raised by the road pricing are redistributed.[5] We first analyze the case in which at the *status quo* all population of the middle class $\left(i \in G_2\right)$ initially uses the fast mode (i.e. the road). We denote by $\tilde{\tau}_k$ the road pricing under no redistribution decided by a candidate belonging to a group G_k when elected. In what follows we illustrate in detail the level of road pricing set by the running candidate of each group under the no distribution scenario.

The optimal policy of the rich $(i \in G_1)$. A rich candidate would ideally tax positively the auto only if the gain in surplus obtained by excluding the middle class, and thus reducing congestion, exceeds the cost of being tolled. In this case, the tax $\tilde{\tau}_1$ will be just equal to the difference between the surplus of one middle class member when using the auto together with the rich class and the surplus obtained by using the public mode of transport with both the middle and the poor class.[6]

Therefore, if

$$(6) \qquad v_1(t_f(\mu_1)) - v_1(t_f(\mu_1 + \mu_2)) - \tilde{\tau}_1 > 0$$

it follows that

$$(7) \qquad \tilde{\tau}_1 = \sigma_2(t_f(\mu_1), p_f) - \sigma_2(t_s(\mu_2 + \mu_3), p_s) > 0.$$

If, on the other hand, there is no gain for the rich class individuals from the switch, i.e.

$$(8) \qquad v_1(t_f(\mu_1)) - v_1(t_f(\mu_1 + \mu_2)) - \tilde{\tau}_1 \leq 0$$

[5] Such an absence of redistribution can also represent the case in which the taxation system is so inefficient that no money is offered back in any form to the tax payers.

[6] Note that here the toll makes *every* middle class individual indifferent between auto and public transit, according to a standard Wardrop's (1952) concept of equilibrium. In network analysis it has been standard to assume that (a) travellers behave selfishly, and (b) individual travellers are atomless, i.e. have zero mass or measure. Accordingly, the equilibrium can be conceived as a situation stable against *individual* deviations.

every rich candidate will optimally impose a zero road pricing ($\tilde{\tau}_1 = 0$).

The optimal policy of the middle class $(i \in G_2)$. When there is no redistribution of the revenues, there is no reason for the agents of the middle class to impose a positive road pricing as they have already optimally chosen the use of the private mode of transport ($\tilde{\tau}_2 = 0$).

The optimal policy of the poor $(i \in G_3)$. It is clear that also for the poor there is no incentive to impose a positive road pricing given that they would obtain no advantage from it ($\tilde{\tau}_3 = 0$).

It is easy to see that, at the second *status quo*, in which initially all $i \in G_2$ use public transport, the proposed road pricing schemes is $\tilde{\tau}_1 = \tilde{\tau}_2 = \tilde{\tau}_3 = 0$.

The next proposition makes clear that, in absence of redistribution, the political equilibrium implies a zero road pricing scheme.

Proposition 1. *Under no redistribution of the road pricing revenues, the political equilibrium of the citizen-candidate game implies a zero road pricing scheme (i.e.* $\tau^* = 0$*) under both status quo considered.*

Proof. When the game starts with the first *status quo* ($\mu_f = \mu_1 + \mu_2$ and $\mu_s = \mu_3$) and there is no redistribution of the road pricing revenues, the proposed $\tilde{\tau}_1$ will either be positive or equal to zero (depending on the effect of congestion on rich class's surplus), while both middle and poor citizen-candidates will prefer to impose a zero road pricing, since, in absence of redistribution, they both lose from the switch of the middle class. So, for the case in which $\tilde{\tau}_1 > 0$, no rich candidate will run for office as he would be defeated by a poor or middle class candidate. In equilibrium, a middle class or a poor candidate will run for office and win the elections. The choice on which of the two will run only depends on the relative weight of the mass μ_2 and μ_3: in fact, when the policy of different citizen candidates (belonging to different groups) coincides, the voters will always vote for their own candidate. In this case, whoever is the winner, the political equilibrium will always imply a zero road pricing $\tau^* = 0$. Similarly, when $\tilde{\tau}_1 = 0$, the only candidate running for the election will belong to the class with greater mass μ_k, and will decide an equilibrium road pricing $\tau^* = 0$. Starting with the second status quo ($\mu_f = \mu_1$ and $\mu_s = \mu_2 + \mu_3$), all citizen-candidates will propose $\tilde{\tau}_k = 0$, so that the political equilibrium with a $\tau^* = 0$ will, again, be trivially satisfied.

Although the above result is not surprising, it helps to understand the reasons why road pricing policies, without an appropriate scheme of redistribution of the revenues obtained towards public transport, is likely not to be implemented in modern cities. In fact, without an appropriate use of the funds raised, only rich citizens may (sometimes) gain from road pricing. This occurs when the gain from the reduced congestion more than offset the increased price of road transport. All other citizens have no interest, without redistribution, to impose a toll. This in turn implies that no road pricing is the preferred policy of the majority of the population and of the elected politicians. The following section shows that the result can be different when simple forms of redistribution of the resources obtained from road pricing are implemented.

5. Road pricing in presence of redistribution

We now briefly consider a framework where all revenues raised by a road pricing scheme are redistributed in favor of the public transport through a reduction of its price p_s.[7] At the *status quo* at which the middle class uses the auto ($\mu_f = \mu_1 + \mu_2$ and $\mu_s = \mu_3$), a road pricing scheme on the auto decided by an elected candidate of group G_k, here denoted $\hat{\tau}_k$, will be as follows.

The optimal policy of the rich $(i \in G_1)$. Similarly to the previous section, every rich candidate ($i \in G_1$) would ideally tax positively road users only when the gain from excluding the whole middle class from this mode of transport - in terms of reduced congestion - exceeds its increased price as due to such a pricing scheme. In this case, the

[7] The effect on p_s is analogous (and provides a reduced form) to the redistribution of road pricing funds in favour of public transport, which can either reduce its price or increase its quality (in turn rising the willingness to pay of its users), hence increasing their surplus.

tax $\hat{\tau}_1$ will be just equal to the difference between every middle class member's surplus from being in the private mode with the rich class and the surplus by being in the public mode with the poor and the middle class, at the reduced price $p_s^1 = \left(p_s - \frac{\mu_1}{\mu_2 + \mu_3} \hat{\tau}_1 \right)$, including the redistribution. Note that now such a marginal condition is more easily satisfied as before, because in this case the redistribution constitutes an extra incentive for the middle class to switch to the public mode of transport. Therefore, if

(9) $$v_1(t_f(\mu_1)) - v_1(t_f(\mu_1 + \mu_2)) - \hat{\tau}_1' > 0$$

then

(10) $$\hat{\tau}_1' = \sigma_2(t_f(\mu_1), p_f) - \sigma_2(t_s(\mu_2 + \mu_3), p_s^1) > 0,$$

where $p_s^1 = \left(p_s - \frac{\mu_1}{\mu_2 + \mu_3} \hat{\tau}_1 \right)$ denotes the reduced price of public transport after redistribution. However, if condition (9) is not satisfied, then the rich will find optimal to impose a zero road pricing, i.e. $\hat{\tau}_1'' = 0$.

The optimal policy of the middle class $(i \in G_2)$. A candidate of the middle class has no interest to impose a positive tax on the auto, except when a positive gain can be made tolling the rich class and joining the poor class in the use of public transport at the reduced price generated by the redistribution of resources. Therefore, if

(11) $$v_2(t_f(\mu_1)) - p_f < v_2(t_s(\mu_2 + \mu_3)) - p_s + \frac{\mu_1}{\mu_2 + \mu_3} \hat{\tau}_2',$$

we have

(12) $$\hat{\tau}_2' = \sigma_1(t_f(\mu_1), p_f) - \sigma_1(t_s(\mu_2 + \mu_3), p_s^2) > 0,$$

where $p_s^2 = \left(p_s - \frac{\mu_1}{\mu_2 + \mu_3} \hat{\tau}_2' \right)$ denotes the price of public transport after redistribution. However, if condition (11) does not hold, the middle class candidate will impose a zero road pricing $\hat{\tau}_2'' = 0$.

The optimal policy of the poor $(i \in G_3)$. A poor citizen-candidate has two possible choices. The first is to impose a very high tax on the private mode of transport (call it $\hat{\tau}_3'$) up to the point where only the rich class use the auto. This happens if the gain in surplus is so high to exceed the over-congestion in public transport determined by the switch of the middle class from the auto to public transport. Notice that in this case the optimal policy of the poor is exactly the same of the middle class (when the latter wants to impose a positive road pricing), i.e. $\hat{\tau}_3' = \hat{\tau}_2'$. The second possibility for the poor class candidate is to tax all auto users up to the point at which none of the middle class members switch from auto, its *status quo,* to public transport. We denote such a tax as $\hat{\tau}_3''$ and it is clear that $\hat{\tau}_3'' < \hat{\tau}_3'$.

Formally, if the following condition is satisfied

(13) $$v_3(t_s(\mu_2 + \mu_3)) + \frac{\mu_1}{\mu_2 + \mu_3} \hat{\tau}_3' > v_3(t_s(\mu_3)) + \frac{\mu_1 + \mu_2}{\mu_3} \hat{\tau}_3''$$

thus

(14) $$\hat{\tau}_3' = \sigma_1(t_f(\mu_1), p_f) - \sigma_1(t_s(\mu_2 + \mu_3), p_s^{3'}) > 0$$

with $p_s^{3'} = (p_s - \frac{\mu_1}{\mu_2 + \mu_3} \hat{\tau}_3')$. When, instead, (13) does not hold, we have

(15) $$\hat{\tau}_3'' = \sigma_2(t_f(\mu_1 + \mu_2), p_f) - \sigma_2(t_s(\mu_3), p_s^{3''}) > 0$$

with $p_s^{3''} = (p_s - \frac{\mu_1 + \mu_2}{\mu_3} \hat{\tau}_3'')$.

In the framework considered, various equilibria may emerge depending on the combination of the optimal policies of the three groups. To discuss what we consider the most relevant cases, it may be convenient to consider two possible scenarios arising from the first *status quo* and one arising from the second *status quo*.

5.1 Case 1: congestion does not hurt much the poor class

Let us first assume that the congestion of public transport is not a big problem for the poor. This means that, when possible, they would always prefer to impose a road pricing at its maximum level $\hat{\tau}'_3$. This road taxation will be implemented whenever the middle class has the same optimal tax policy $\hat{\tau}'_2 = \hat{\tau}'_3$. Clearly, as before, the citizen-candidate running for office and winning the election will depend on the relative size of these two classes. Here, the preferences of the rich are irrelevant. If, instead, the middle class finds optimal a zero road pricing (i.e. $\hat{\tau}''_2 = 0$), the preferences of the rich become important for determining the equilibrium. As long as also the rich does not want a road pricing ($\hat{\tau}''_1 = 0$), this will be the policy implemented as there are two classes (middle class and rich) which prefer it. If the rich would instead prefer a positive road pricing ($\hat{\tau}'_1 > 0$), because the gains from the reduction in the congestion of the road generated by the switch of the middle class to public transport more than compensate them for the tax paid, then an equilibrium may not necessarily exist.[8]

Therefore, when the middle class uses the auto at the *status quo*, the implementation of road pricing requires that the congestion of public transport is not too costly from the point of view of the poor and the middle class. It is clear that a positive road pricing is more likely to have the support of the population when the possibility of increasing the quality (or reducing the price) of public transport through the revenues of road pricing is substantial. We can summarize some of the above results with the following proposition.

Proposition 2. *When the road pricing income is entirely redistributed in favor of the public mode of transport and at the status quo the middle class uses the road transport, the political equilibrium of the citizen-candidate game will imply two cases:*

[8] This may happen when, in a two-candidate context, there is no group that always wins.

(a) For a very low sensitivity of the poor class to congestion, if

$$\mu_1\left[\sigma_1(t_f(\mu_1),p_f)-\sigma_1(t_s(\mu_2+\mu_3),p_s)\right]>\sigma_2(t_f(\mu_1),p_f)-\sigma_2(t_s(\mu_2+\mu_3),p_s)$$

then $\tau^*=\hat{\tau}_2'=\hat{\tau}_3'>0$.

(b) If, instead

$$v_1(t_f(\mu_1))-v_1(t_f(\mu_2+\mu_3))<(\mu_2+\mu_3)\left[\sigma_2(t_f(\mu_1),p_f)-\sigma_2(t_s(\mu_2+\mu_3),p_s)\right]$$

and

$$\mu_1\left[\sigma_1(t_f(\mu_1),p_f)-\sigma_1(t_s(\mu_2+\mu_3),p_s)\right]<\sigma_2(t_f(\mu_1),p_f)-\sigma_2(t_s(\mu_2+\mu_3),p_s),$$

then $\tau^*=\hat{\tau}_1''=\hat{\tau}_2''=0$.

Proof. See Appendix.

5.2 Case 2: congestion hurts the poor class

Under an alternative scenario, the congestion of public transport can constitute a problem for the poor class. Hence, they should prefer a low road pricing (i.e. they prefer $\hat{\tau}_3''$) that is not enough to induce the middle class' agents to change their mode of transport. As we have seen above, the middle class may have two different optimal policies. However, if congestion is so costly for the poor that they prefer to give up a large redistribution of resources from the private mode to the public one, then it is reasonable to expect that the middle class' optimal policy is to use the auto without imposing a road pricing ($\hat{\tau}_2''=0$). Under these conditions, the policy implemented is no road pricing ($\tau^*=0$) independently on the preferences of the rich. In fact, if the rich prefers no road pricing ($\hat{\tau}_1''=0$), this policy is optimal for two classes and the winner will be a rich or a middle class candidate depending on the relative size of their class. When the rich prefers a positive road pricing ($\hat{\tau}_1'>0$) in order to exclude the middle class from the use of the auto, the elected candidate will be the agent of the middle class as he will get the votes also of the poor. In fact, the poor prefer (by assumption) no road pricing with the middle class using the road to the alternative where public transport is subsidized but it is congested also by the middle class. This is summarized in the following proposition.

Proposition 3. *When the road pricing income is entirely redistributed in favor of public transport and at the status quo the middle class uses auto, for a very high sensitivity of the poor class to congestion, the political equilibrium of the citizen-candidate game will imply a zero road pricing. In particular, if:*

$$v_3(t_s(\mu_3)) - v_3(t_s(\mu_2+\mu_3)) \geq \left[\sigma_2(t_f(\mu_1), p_f) - \sigma_2(t_s(\mu_2+\mu_3), p_s)\right] \geq \\ \geq \mu_1\left[\sigma_1(t_f(\mu_1), p_f) - \sigma_1(t_s(\mu_2+\mu_3), p_s)\right],$$

then $\tau^* = \hat{\tau}_2'' = 0.$

Proof. See Appendix.

5.3 Case 3: the middle class uses the public transport at the status quo

Finally, we can examine the case in which the middle class uses public transport at the *status quo*. In this case, the poor and the middle class have the same preferences. They both want to impose a high taxation on the use of auto since this is used by the rich class only (recall that $\hat{\tau}_3' = \hat{\tau}_2'$). Therefore, a rich citizen-candidate will never be elected as he would be defeated by a middle class or a poor candidate. In equilibrium, the candidate running for office will be from the largest class between middle class and poor and the road pricing policy implemented will involve a tax rate $\tau^* = \hat{\tau}_2' = \hat{\tau}_3'$. The adoption of a road pricing scheme in this scenario arises by the desire of the majority of agents (not using the auto) to raise revenues in order to improve their mode of transport.

The insight provided by the latter result is that a positive road pricing is likely to be implemented when a large fraction of the population uses alternative modes of transport as these individuals have the incentive to tax the use of road in order to improve the alternative types of transport.

The following proposition summarizes this result. It is so easy to grasp that does not require a formal proof.

Proposition 4. *When at the status quo the middle class uses public transport, the only political equilibrium of the citizen-candidate game will imply* $\tau^* = \hat{\tau}'_2 = \hat{\tau}'_3 > 0$.

Finally, notice that, in general, many elements appear to be crucial for the result of an election. First, the price ratio of transport modes when compared to the speed or quality preferences of all three classes. Second, the sensitivity to congestion of the two alternative modes of transport, reflecting a number of structural features of the whole transport network. Third, the way in which the redistribution of a road pricing is assumed to affect people's wealth.

6. Concluding remarks

In this paper, we have proposed a simple framework to explain the reasons why road pricing schemes are not so diffused around the world. We have focused on the political acceptability of such policies using a political economy model where the electoral competition takes place with citizen-candidates. We have found that the redistribution of resources obtained through road pricing policies towards other modes of transport along with less congestion is necessary (even though not sufficient) to make this policy acceptable to the majority of the population. The analysis has also highlighted that road pricing policies are more likely to be accepted by a winning coalition when the redistribution of resources obtained with this form of taxation going to the advantage of other modes of transport allows to increase substantially their quality (or, more generally, the surplus of the agents that use them) or when at the *status quo* a large fraction of the population does not use the auto.

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Appendix

Proof of Proposition 2.

Rearranging expressions (11) and (12) we can rewrite expression (11) as

(A1) $$v_1(t_f(\mu_1)) - v_1(t_f(\mu_2+\mu_3)) > (\mu_2+\mu_3)\left[\sigma_2(t_f(\mu_1), p_f) - \sigma_2(t_s(\mu_2+\mu_3), p_s)\right]$$

which is the condition implying $\hat{\tau}_2' > 0$. Using instead (9) and (10), we can rewrite (9) as

(A2) $$\mu_1\left[\sigma_1(t_f(\mu_1), p_f) - \sigma_1(t_s(\mu_2+\mu_3), p_s)\right] > \sigma_2(t_f(\mu_1), p_f) - \sigma_2(t_s(\mu_2+\mu_3), p_s).$$

which is the condition implying $\hat{\tau}_1' > 0$. Finally, using expressions (13)-(15) we obtain

(A3) $$\mu_1\left[\sigma_1(t_f(\mu_1), p_f) - \sigma_1(t_s(\mu_2+\mu_3), p_s)\right] > v_3(t_s(\mu_3)) - v_3(t_s(\mu_2+\mu_3))$$

where (A3) exactly represents the condition implying $\hat{\tau}_3' > 0$. Note that for a relatively low sensitivity of the poor citizens to congestion, when (A1) holds, also (A3) is satisfied. Therefore, when (A1) holds the equilibrium toll is $\tau^* = \hat{\tau}_2' = \hat{\tau}_3' > 0$. When, instead, neither (A1) nor (A2) hold, the equilibrium toll will be $\tau^* = \hat{\tau}_1'' = \hat{\tau}_2'' = 0$.

Proof of Proposition 3.

By rearranging conditions (11)-(12) and (13)-(15) we have that $\hat{\tau}_2'' = 0$ and $\hat{\tau}_3'' > 0$ are selected for

$$\left[\sigma_2(t_f(\mu_1), p_f) - \sigma_2(t_s(\mu_2+\mu_3), p_s)\right] \geq \mu_1\left[\sigma_1(t_f(\mu_1), p_f) - \sigma_1(t_s(\mu_2+\mu_3), p_s)\right]$$

and

$$v_3(t_s(\mu_3)) - v_3(t_s(\mu_2+\mu_3)) \geq \mu_1\left[\sigma_1(t_f(\mu_1), p_f) - \sigma_1(t_s(\mu_2+\mu_3), p_s)\right]$$

respectively. Note that, whatever the choice of the rich citizen-candidate, the following condition

$$\left[v_3(t_s(\mu_3)) - v_3(t_s(\mu_2+\mu_3))\right] \geq \left[\sigma_2(t_f(\mu_1), p_f) - \sigma_2(t_s(\mu_2+\mu_3), p_s)\right]$$

directly implies

$$v_3(t_s(\mu_3)) - v_3(t_s(\mu_2 + \mu_3)) \geq (\mu_2 + \mu_3)\left[\sigma_2(t_f(\mu_1), p_f) - \sigma_2(t_s(\mu_2 + \mu_3), p_s)\right] = \hat{\tau}_1'.$$

The last expression clearly shows that each poor class candidate will prefer to keep congestion low in the public transport rather than receiving a positive toll $\hat{\tau}_1'$ as redistributed income. Therefore, all members of the poor class will vote for the middle class candidate, and, again, the political outcome will imply a zero road pricing, $\tau^* = \hat{\tau}_2'' = 0$.