Individual uncertainty and the political acceptability of road pricing policies

Marcucci, Edoardo and Marini, Marco

C.R.E.I ., University Roma Tre

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Edoardo Marcucci [*], Marco Marini

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Abstract

This paper investigates the issue of political feasibility of a road pricing policies (RPP). Referring to a literature developed in international trade theory (Fernandez, Rodrick, [1]), this paper presents a model regarding the role and relevance of individual specific uncertainty in explaining the political acceptability of RPP. It is shown that: a) without money transfers, i.e., reimbursements of the tax levied, and with no uncertainty, RPP might not be accepted thus giving rise to an evident trade-off between economic efficiency and political acceptability; b) when individual specific uncertainty is assumed, optimal level of RPP, may, under given conditions concerning the number of voters and people' preferences, become politically acceptable. Two different strategies can be envisaged to render RPP politically feasible: gradual and radical. The first strategy foresees a low corrective tax that eliminates only a small proportion of the excessive use of the public good and provides an acceptable balance between monetary loss and environment improvement. Alternatively, a radical strategy would foresee a much higher level of tax substantially reducing the number of people consuming the public good and providing a potentially higher and concentrated payoff to those still consuming it after the policy is implemented. This latter policy appears more easily sustainable under majority than unanimity voting.

[*] Corresponding author: Istituto di Scienze economiche, Università degli Studi di Urbino, Via Saffi, 42, 61029 Urbino (PU), Italy, tel.: +39 0722 305563, fax: +39 0722 305550, E-mail: marcucci@uniurb.it.

1. Introduction

The relevance of the acceptability problem when considering road pricing policies (RPP) is testified by the uneasiness it provokes within the economic community. In fact, the fundamental problem facing politicians and economists alike is the acceptability of such kind of policies This has clearly been stated by Lave [2] when he writes: "[it] has been a commonplace event for transportation economists to put the conventional diagram on the board, note the self-evident optimality of pricing solutions, and then sit down waiting for the world to adopt this obviously correct solution. Well, we have been waiting for seventy years now, and it's worth asking what are the facets of the problem that we have been missing. Why is the world reluctant to do the obvious?"

Numerous contributions in the literature as well as projects financed by the EU, national and local governments testify the importance attributed to this problem. The analysis concerning the justification of the scarce implementation of RPP has followed different avenues. Take, for instance, Jones [3,4,5] who enumerates a number of issues that should be taken care of in order to make road pricing acceptable: i) make sure the objectives of the scheme meet the main public concerns; ii) demonstrate that there are no effective alternative solutions; iii) hypothecate the revenues and provide alternatives; iv) keep the scheme as simple as possible; v) consider carefully all technological issues; vi) address equity issues.

Starting from a psychological perspective Schade and Schlag, [6] suggest that road pricing acceptability is strictly intertwined with the following issues: i) problem perception; ii) mobility related social norms; iii) importance of the aims to be reached by the measures; iv) perceived effectiveness and efficiency of the policy; v) equity; vi) revenue allocation; vii) attribution of responsibility; viii) information and awareness.[1]

Although all the above mentioned issues have undoubtedly an important role to play in explaining the practical implementation of RPP, we believe that further insights could be gained by looking at a different framework on which to base the political acceptability analysis, one based on uncertainty. Even if interesting theoretical considerations explaining the present implementation level of RPP can be traced within the wide public choice

[1] See also AFFORD, 1998-2000 [7], as well as other contributions included in this volume.

literature,[2] this paper will try to complement these explanations by looking at the interrelations among uncertainty, voting, and political acceptability. It is safe to say that there is no one single reason capable of explaining the political and social diffidence towards this kind of policy and its scarce implementation; however, we believe that models based on uncertainty can help explaining the actual degree of political acceptability of RPP.

This paper presents a model regarding the role and relevance of individual specific uncertainty in explaining the acceptability of RPP. The main assumptions of the model are: (a) the decisions concerning the adoption of RPP are taken by politicians that operate under a re-election constraint and have perfect foresight on the aggregate voting intentions of their constituency. Such politicians will, therefore, promote only those policies that would pass an election test; (b) the agents of the economy are perfectly rational and informed but uncertain about their personal evaluation of the public good (e.g., environment quality) after a RPP is adopted. The first assumption stresses the obvious concern of politicians about the acceptability of a policy by the majority of citizens. The second indicates that the paper focuses on the individual specific uncertainty arising once the policy is adopted. This is an ex post type of uncertainty, assumed here to concern each individual's evaluation for the environment. This is a simple way to represent different ex ante inviduals' evaluations of a RPP that is expected to hurt consumers differently according to their ex post preferences. This latter assumption is sufficient to provide many interesting results on the ex ante political acceptability of a RPP under no reimbursement of the revenues raised by the policy. As unusual as this assumption might seem, this paper will argue that the results of the model similarly hold if an individual specific form of uncertainty is put on the reimbursement that each individual's expects by the government once the RPP is adopted.

We list the main results of the paper. These are: without money transfers, i.e., reimbursements of the tax levied, and with no uncertainty, RPP will not be accepted, thus giving rise to an evident trade-off between economic efficiency and political acceptability; when assuming a high degree of individual specific uncertainty, the optimal level of RPP, may, under given

[2] The failure in adopting potentially Pareto-improving policies could be explained, for instance, via: the different organizational ability of lobbies (Goldestein [7]), pressure groups (Denzau and Munger, [8]), policy time inconsistency (Kydland and Prescott [9]; Brennan and Buchanan [10]; Zax, [11]), policy spatial inconsistency (Weingast, Shepsle and Johnsen, [12]), polticians' credibility (Persson and Tabellini, [13,14]).

conditions concerning the number of voters and people' preferences, become politically acceptable. Two different strategies can be envisaged to render RPP politically feasible: gradual and radical. The first strategy foresees a low corrective tax that eliminates only a small proportion of the excessive use of the public good and provides an acceptable balance between monetary loss and environment improvement. We show that such a policy can be made acceptable ex ante. Alternatively, a radical strategy would foresee a much higher level of tax thus substantially reducing the number of people consuming the public good but providing a potentially higher payoff to those still consuming it after the policy is implemented. Even in this case we show that, under specific conditions, the policy might be accepted ex ante. This policy appears more easily sustainable under majority than unanimity voting.

2. Political acceptability

In this paper we adopt a simplified definition of political acceptability. In particular, the political acceptability of a policy is just determined by the voting choice of those affected by it. Since the politicians have a perfect perception of the aggregate voting intentions and they operate under a re-election constrain, they adopt only those policies that guarantee an ex ante majority. Only those policies that will guarantee at least a 50% plus one vote perceived benefit for the electorate will be promoted. The individuals, on their part, have, except for the policy influences on their personal evaluation of the environment, a perfect knowledge and foresight of the effects of the policy. The voting mechanism is very simple: agents will vote in favor of the policy only if its effects, evaluated ex ante, will be favorable for them compared to the initial situation. In other words, the expected utility derived by the policy will have to be greater than the utility enjoyed before the policy is adopted.

Our paper focuses on the role and effects of individual specific uncertainty in determining the political viability of the policy when facing a voting test. In fact we concentrate our attention on the role that individual specific uncertainty might have in explaining why even an ex post potentially-Pareto-improving manoeuvre might not be adopted were it to undergo a voting test. We argue that in presence of individual specific uncertainty the political viability of RPP cannot be properly evaluated by a simple interpretation of the aggregate policy effects. This would, in fact, provide no indications on the specific individual voting intentions. Were aggregate welfare improving policies to undergo a voting test (e.g., referendum) before adoption they could fail a majority vote test. In the literature on political acceptability of RPP, the models adopted usually focus only on the general aggregate effects of such policies thus allowing only for normative prescriptions for an ideal policy rather than descriptions of policy implementation paths. Just to give an example, in an interesting paper, Evans [15] evaluates the desirability of a congestion pricing scheme, under both homogeneous and mixed traffic, according to the effects the policy has on consumer's surplus, government surplus and on the difference of these two aggregate values. However, the considerations reached by the author are silent on the actual incentive a generic consumer would have in voting pro or against its adoption and, therefore, the conclusions drawn cannot explain whether a politician would or would not be inclined to adopt the policy.

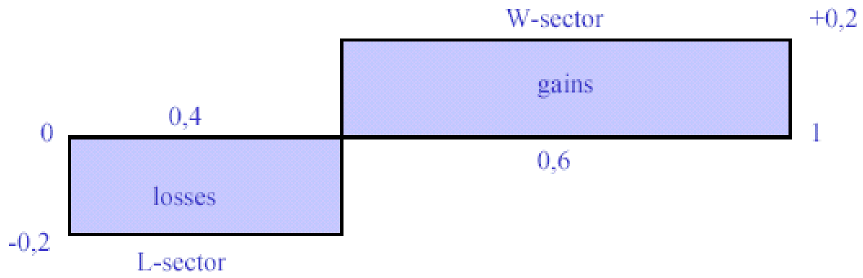
The relevance of our approach to the analysis is reinforced by the fact that a welfare improving RPP with complete transfers is usually only a highly theoretical benchmark that may possess scarce practical relevance. We believe that there is a need to look at the political acceptability of RPPs before transfers and under uncertainty.

2.1 Two simple numerical examples

In this paragraph we will illustrate two simple numerical examples showing what are the effects provoked by the introduction of individual specific uncertainty when having to decide on the adoption of a welfare improving policy. The example, borrowed from the literature developed in international trade (see, for example, Rodrik and Fernandez [1]) shows how, under given assumptions, there can be a bias towards the status quo. On the other hand, we show that, in other cases, the presence of individual specific uncertainty can also facilitate the adoption of RPP. In other words, there can be both opposition and support to the adoption of efficiency improving reforms when some of the individual gainers and losers affected cannot be clearly identified beforehand. The main point is that there can both be policies supported by a majority ex post that could fail a voting test ex ante as well as policies that are supported ex ante but would not be voted for ex post.[3]

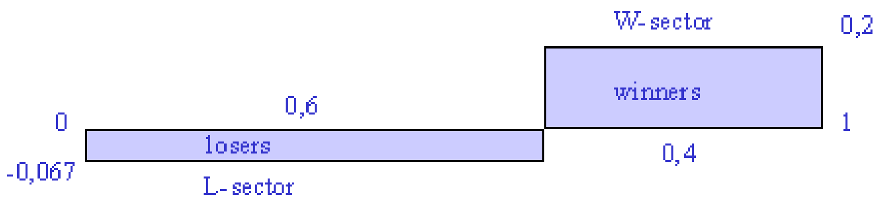
[3] The failure in adopting potentially Pareto-improving policies could be explained, for instance, via: the different organizational ability of lobbies (Goldestein [7]), pressure groups (Denzau and Munger, [8]), policy time inconsistency (Kydland and Prescott [9]; Brennan and Buchanan [10]; Zax, [11]), policy spatial inconsistency (Weingast, Shepsle and Johnsen, [12]), polticians' credibility (Persson and Tabellini, [13,14]).

Suppose that a continuum of risk neutral individuals are distributed along a line of length 0-1. Initially, a proportion 0,6 of the individuals are assumed to belong to the L-sector (on the left side of the segment) and 0,4 to the W-sector (on the right side of the segment). Moreover, in a first example, we assume that the adoption of the policy: a) increases the return to the individuals in the W-sector of the economy (+ 0.2); b) lowers the returns to 2/3 of the L-individuals (-0.2); c) increases the returns to 1/3 of the L-individuals that, thus, move from the L-sector to the W-sector. In figure 1 we represent the ex post distributional outcome with the boxes describing the gains and losses occurring to the individuals belonging to the different parts of the segment.



The majority is better off with the reform *ex post*

The individuals already in the W sector will gain but there will also be a part of the individuals, previously belonging to the other sector (L) that will gain after the policy is adopted. Since the policy improves efficiency, there is an overall net gain of 0,04 (an amount of 0.2 gained by 0.2 of the losers that have become winners). The majority gains from the adoption of the policy and, in the case of complete certainty, the policy would be voted for.

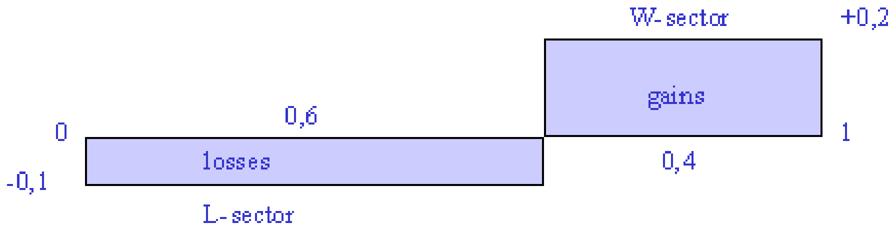


The majority votes against the reform *ex ante*

Let us see whether there would still be a majority under uncertainty concerning who, among the losers, would move to the winners' group. Let us assume that there is an equal probability for any single individual belonging to the L-sector to move to W-sector. All individuals in the L-sector are ex ante identical. The uncertainty concerns the precise identity, not the total number of winners. When asked to cast their vote the individuals will calculate their personal expected payoff, calculated as a weighted average of gains and losses. The weights will depend on the probability of each outcome taking place (see figure 2).

A simple calculation shows that the losers constitute the majority ex ante and the efficiency-enhancing policy will not be adopted. [4] Only members of the winners' group have positive utility, and the policy will not pass an ex ante voting test. In this example, the presence of individual-specific uncertainty distorts aggregate preferences.

To illustrate the second example let us suppose an ex post situation as in figure 3 whereas the ex ante situation is described by figure 4. In this case, a proportion 0,4 of the individuals are assumed to initially belong to the L-sector (on the left side of the segment) and 0,6 to the W-sector (on the right side of the segment).



The majority is worse off with the reform *ex post*

The ex ante calculation is as follows. Every member of the W-sector knows that 0.2 of them (0.2/0.6 = 1/3) will move to the L-sector, while 0.4 of them (0.4/0.6 = 2/3) will stay at the W-sector, even though not knowing who, among them, will actually change status.[5] In this case, a potentially *ex*

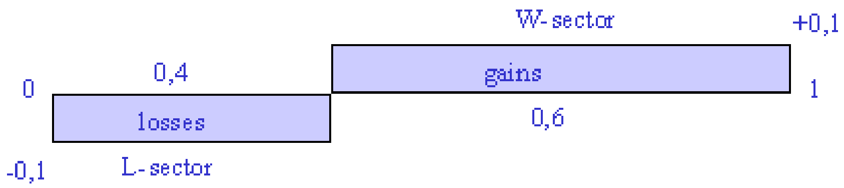
[4] The expected payoff of one representative (risk-neutral) loser can be calculated as

$$EU = \frac{0.4}{0.6} - (-0.2) + \frac{0.2}{0.6} - (+0.2) \cong 0.067$$

[5] The expected payoff of one (risk-neutral) representative winner can be calculated as

$$EU = \frac{0.4}{0.6}(+0.2) + \frac{0.2}{0.6} - (-0.1) \cong 0.1$$

post undesirable situation gathers an *ex ante* support.



The majority votes in favour of the reform *ex ante*

The opposite results shown in the two examples mainly depend on two elements: payoffs of the agents and probability of the events.

In the next section we focus our attention on a model possessing some of the features illustrated in the previous examples.

3 The basic model

We introduce a simple economy with a finite set of agents $N = \{1,..i,..n\}$ possessing preferences over a public good $z \geq 0$ (e.g. environment) and a private good $x \geq 0$ (e.g. car). Let agents' preferences be described by a Cobb-Douglas utility function:

$$u_i(z_i, x_i) = z_i^a x_i^\beta \tag{1}$$

The consumption of the private good originates a polluting emission $P \geq 0$.The emission technology is described by the following linear production function:

$$x_i = P_i \tag{2}$$

and emissions accumulate according to the following linear additive law:

$$z_i = a_i - \sum_{i \in N} P_i \tag{3}$$

where a_i is a parameter expressing every agent's i evaluation of the quality of the pollution-free environment.[6] This parameter will play an important role

[6] Note that in the model, the agents' only constraint for the consumption of the private good is represented by the emission technology (2) that, through the cumulative law (3), reduces the quality of the public good available to all consumers. A part from this, agents will always be assumed endowed with a sufficient income to purchase, before any taxation takes place, a non negative equilibrium

in modelling the behavior of heterogenous agents. We associate to this economy the strategic form game $G=\left(N,\{X_i,U_i\}_{i\in N}\right)$, with players set N, every agent's strategy space $X_i=\left[0,\overline{P_i}\right]$ where $\overline{P_i}$ is such that $\sum_{i\in N}\overline{P}\leq a_i$, and payoff functions are given by:

$$U_i\left(P_i,\ldots,P_n\right)=\left(a_i-\sum_{i\in N}P_i\right)P_i \qquad (4)$$

where, for simplicity, $\alpha=\beta=1$.[7] In this way, the model possesses the well known strategic features of a $n-$player Cournot model with the choice variable given by the consumption of the private good and, consequently, a pollution level P_i for every agent.

3.1 Homogeneous agents

We introduce as a benchmark the case in which all agents possess the same evaluation of the quality of a free-pollution environment $a_i=a$. From expression (1)-(3) it is straightforward to derive the level of pollution (and private good) selected by every agent at the unique interior Nash equilibrium as:

$$P_i^*=\frac{a}{n+1} \qquad (5)$$

with associated the corresponding equilibrium payoff:

$$U_i\left(P_1^*,\ldots,P_n^*\right)=\frac{a^2}{(n+1)^2} \qquad (6)$$

As usual for economies characterized by negative externalities, each agent's Nash equilibrium level of pollution is greater than the corresponding Pareto-efficient one (for $n>1$), obtained by maximizing the sum of all agents' utilities[8] and equal to:

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quantity of the private good. Regarding the assumption on each individual's concern for the enviroment a_i, we postpone its discussion in section 3.2.

[7] Qualitatively similar results can be obtained for other values of α and β as long as they are equal.

[8] Note that every agent's utility function is transferable and hence can be summed over all agents.

$$P_i^o = \frac{a}{2n} \qquad (7)$$

giving rise to the corresponding equal-split payoff:

$$U_i\left(P_1^o,...,P_n^o\right) = \frac{a^2}{4n} \qquad (8)$$

Now, let us suppose that the government, in order to reduce the inefficiency due to the excessive consumption of the private good arising at the Nash equilibrium, aims at introducing a RPP denoted as t (that works as a Pigouvian tax) proportional to the use of the private good. Under certainty, the level of t needed to yield the Pareto optimum emission (7) can be obtained by solving the following equation:

$$P_i^{*t} = \frac{a-t}{n+1} = P_i^o = \frac{a}{2n}, \qquad (9)$$

with solution given by:

$$t^o = \frac{a}{2}\frac{n-1}{n}, \qquad (10)$$

where in (9) P_i^{*t} represents the Nash equilibrium level of pollution after the tax is levied. The after tax level of utility for each agent, using (6) and (9) is given by:

$$U_i\left(P_1^{*t},...,P_n^{*t}\right) = \left(\frac{a-t}{n+1}\right)^2 \qquad (11)$$

Note that the after-tax level of utility (11) is lower than its corresponding level before the tax is levied (6). This happens because the reduction of utility due to the lower consumption of the private good and the lower amount of money are not sufficiently compensated by the enhanced environmental quality. In a deterministic context, as the one described above, the social acceptability of such a RPP would require a reimbursement of the revenues raised by the tax. However, it can be argued that, in presence of perfect far sighted individuals, able to discount future stream of utilities, such a policy could loose some of its desired corrective effects. These considerations lead us to focus throughout the paper on the pre-transfer political acceptability of the policy.[9]

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[9] It is well known that, if agents' utilities are quasi-linear, a lump sum reimbursement does not affect the

3.2 Heterogeneous agents

In this section we introduce a simple form of heterogeneity in a_i, the agents' evaluation of the initial quality of the environment. To keep things simple, let a_i distribute uniformly within the interval $[\underline{a}, \overline{a}]$, where $\underline{a}$ and $\overline{a}$ represent, respectively, the lowest (pessimistic) and highest (optimistic) evaluation of the environment across agents.[10] When agents maximize non cooperatively their payoff function (4), and there is perfect information on every a_i as well as on the distribution of a_i across the agents, each consumer's first order condition is given by:

$$P_i = a_i - \sum_{i \in N} P_i, \qquad (12)$$

that, summed up (12) over all agents, yields:

$$\sum_{i \in N} P_i = \sum_{i \in N} a_i - n \sum_{i \in N} P_i \qquad (13)$$

from which:

$$\sum_{i \in N} P_i = \frac{\sum_{i \in N} a_i}{n+1} \qquad (14)$$

Inserting (14) into (12) and noting that, for the uniform distribution:

$$\sum_{i \in N} a_i = \frac{(\underline{a} + \overline{a})n}{2}, \qquad (15)$$

we obtain, for every $i \in N$,:

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desired corrective effect of the tax. However, if individuals are assumed to know in advance that their after-tax reimbursement will be in some way proportional to the amount of tax levied, they could just marginally change their consumption. The extent of this change could depend, for instance, on each individual's expectation over the share of the tax that will be reimbursed. We will see that some of the model results can be put forward in terms of uncertainty over the reimbursement obtained after the RPP is levied.

[10] In the model a pessimistic/optimistic evaluations of the pollution-free environment (low/high level of a_i) respectively imply a high/low individuals' concern for the environment. As mentioned above, a_i can be interpreted as $a_i = a + r_i$, where $r_i \in [0, \overline{r}]$ represents the amount of taxation reimbursed *ex post* to individual *i*. In this way all results reached below can be interpreted as referred to individuals with an identical environment concern and different expectations over the future reimbursement policy.

$$P_i^* = a_i - \frac{(\underline{a} + \overline{a})n}{2(n+1)} \qquad (16)$$

with an equilibrium payoff:

$$U_i\left(P_i^*, \sum_{i \in N} P_i^*\right) = \left(a_i - \frac{(\underline{a} + \overline{a})n}{2(n+1)}\right)^2. \qquad (17)$$

It has to be noticed that, although individuals are uniformly disposed within the support $[\underline{a}, \overline{a}]$, the higher the density of consumers, the lower is their Nash equilibrium payoff. Compared to the continuous case, discrete distributions are able to capture this "crowding effect" as due to the presence of more polluting consumers in the economy.

Now, assuming that the government wants to impose a proportional pricing policy on the consumption of the private good, the following equilibrium payoff is obtained:

$$U_i\left(P_i^{t*}, \sum_{i \in N} P_i^{t*}\right) = \left(a_i - \frac{(\underline{a} + \overline{a})n}{2(n+1)} - \frac{t}{n+1}\right)^2 \qquad (18)$$

Here, again, the RPP reduces individuals' equilibrium utilities and, without redistribution and under certainty, it will not be accepted by consumers.

Is this still the case under individual specific uncertainty? Could individuals accept an efficient pricing policy *ex ante* although they reject it *ex post?*

In the following section we test the acceptability of a RPP before transfers can occur, in two different cases: in the first, individuals are assumed to possess initially identical evaluation of the environmental quality while, in the second, they are characterized by different initial evaluations of the environment. We explore the political acceptability of a RPP in these two cases under the assumption that individuals are uncertain over their post-policy evaluations of the environment: although everybody knows that *ex post*, after the policy has been imposed, a_i will distribute uniformly within $[\underline{a}, \overline{a}]$ each agent is uncertain on what will be her own evaluation a_i after the policy is imposed.

3.3 Unanimity road pricing with initially homogeneous agents

In this section we introduce a form of individual specific uncertainty regarding the individuals' perception of the environmental quality.[11] This uncertainty is assumed to be individual specific since, when the politician announces the policy, each individual is uncertain of what will be her own actual post-policy evaluation of the environment a_i, only knowing that a_i will distribute uniformly across individuals within $[\underline{a}, \overline{a}]$. This is a symmetric form of individual uncertainty, because each initially identical agent possesses equal probability to end up with one of the n concerns $a_i \in [\underline{a}, \overline{a}]$. Therefore, to verify the *ex ante* unanimous acceptability of the policy, [12] we need to calculate each consumer's expected payoff when there is equal probability to end up with one of the n different individual evaluations a_i, given that their final distribution is known *ex ante* to everybody and equal to $[\underline{a}, \overline{a}]$.

We know that with a proportional road pricing t, every agent's *ex post* equilibrium payoff will be:

$$U_i\left(P_i^{t*}, \sum_{i \in N} P_i^{t*}\right) = \left(a_i - \frac{(\underline{a} + \overline{a})n}{2(n+1)} - \frac{t}{n+1}\right)^2 \qquad (19)$$

Given that each individual has equal probability to end up with any of the environmental concerns $a_i \in [\underline{a}, \overline{a}]$, the expected payoff of a risk neutral agent will be given by:

$$EU_i\left(P_1^{t*},.P_n^{t*}\right) = \sum_{i \in N} \frac{1}{n}\left(a_i - \frac{(\underline{a} + \overline{a})n}{2(n+1)} - \frac{t}{n+1}\right)^2 \qquad (20)$$

Now, the level of congestion price required for a unanimous *ex ante* acceptance of the policy by all agents will require that the expected payoff (20) be greater or equal than the *status quo* Nash equilibrium utility (6):

$$EU_i\left(P_1^{t*},.P_n^{t*}\right) \geq U_i\left(P_1^*,...,P_n^*\right) \qquad (21)$$

that is:

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[11] This uncertainty could also be thought of as the effect of a costless information campaign against the intensive use of the private good (car) accompanying the introduction of the RPP.

[12] Since in this case individuals are initially identical, if a policy is accepted by one individual, it will be accepted *unanimously*.

$$\sum_{i=1}^{n}\frac{1}{n}\left[a_i-\left(\frac{((\underline{a}+\overline{a})n+2t)}{2(n+1)}\right)\right]^2 \geq \frac{a^2}{(n+1)^2} \tag{22}$$

that, after some manipulations can be written as:

$$\frac{1}{\sqrt{n}}\left[\frac{(\underline{a}+\overline{a})n}{2}-n\left(\frac{((\underline{a}+\overline{a})n+2t)}{2(n+1)}\right)\right] \geq \frac{a}{(n+1)} \tag{23}$$

whose unique solution, for any initial a, is:

$$\bar{t}=\frac{1}{2}\frac{\underline{a}+\overline{a}\sqrt{n}-2a}{\sqrt{n}} \tag{24}$$

In figure 5 we plot the level of the *ex ante* unanimously accepted $\bar{t}$ for different number of individuals. A greater number of individuals mean in the model lower pre-policy Nash equilibrium payoff (6) and also lower after-tax *ex ante* expected payoff (20), but the latter decreases less than the former with respect to n. This implies that, within a given range, higher levels of t become unanimously politically acceptable, the greater is the number of individuals (voters) in the economy. The density of consumers matters. It can also be seen that *ex ante* acceptability requires in general a lower level of pricing policy (so implying a higher level of pollution) than the initial deterministic Pareto optimal pricing (10) (thin line in the graph).

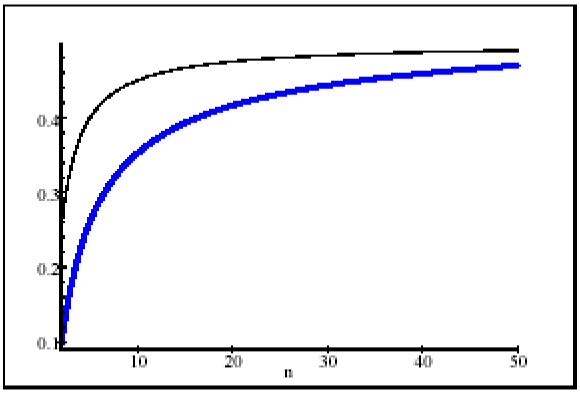

Figure 5 - Levels of $\tilde{t}(a,\overline{a},\underline{a},n)$ and t^o for an initial $a = 2.5$

The other clear effect on $\bar{t}$ is that of a, the initial concern for the environment before the tax: higher initial concern for the environment (lower a) means higher chance to make the RPP politically acceptable. This is in line with intuition: when individuals are initially highly concerned with the environment, they are also prone to accept high level of pricing to reduce pollution. In figure 6, we can see that $\bar{t}$ becomes higher than t^o when the initial concern become higher than that in figure 1, and equal to $a = 1.5$. This suggest the need, before proposing a RPP in a context characterized by individual specific uncertainty, to prepare appropriate information campaigns (i.e., campaigns able to appropriately change people' initial concern a).

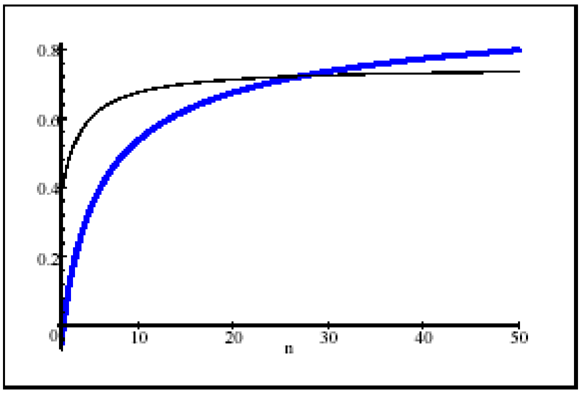

Figure 6 – Levels of $\tilde{t}(a, \overline{a}, \underline{a}, n)$ and t^o for an initial $a = 1.5$

Further simulations show that, when a high pricing policy is imposed, a large number of consumers and, in particular, the ones with high concerns for the environment, will stop consuming the private good and then polluting. Therefore, from (17), their payoff will be equal to zero and every voter's expected payoff will be scaled down as a result. According to this fact, the model suggests that the policy makers can basically adopt different policies to make the RPP politically acceptable: they can either select a gradual and low level of pricing that keeps most of private good consumers in the market and that, with appropriate information campaigns, can receive a sufficiently high political acceptability; or, alternatively, they can choose a radical policy pushing out some of the consumers (the most concerned with the environment) thus guaranteeing a reasonably high payoff for the remaining ones (the less concerned for the environment) and, then, in probability, for all consumers. Again, also this type of policy might require a given amount of investments in information campaigns against pollution (to move people' initial concern a toward more favorable levels). [13]

[13] Notwithstanding the limitations imposed by the utility function adopted, only depending on one private and one public good, we believe that the dichotomous policy result reported above would still hold under other specification of people preferences, since Cobb-Douglas utility function does not easily give rise to corner solutions.

3.4 Majority road pricing with initially heterogeneous agents

We consider here the case in which, before the RPP is announced, each individual possesses a different concern for the environment a_i. Again, also here there is uncertainty, and the agents consider equally likely to end up with one of the n different concern a_i after the RPP has been adopted. However, the main difference is that, in this case, the concern a_i that is *politically relevant* is that of the median voter, i.e., with uniform preferences, the individual with a concern a_i located just to the right of the mid point of the distribution, $\frac{(\underline{a}+\overline{a})}{2}$. In fact, to be accepted the policy has to convince the majority of voters and this, by the median voter theorem, is equal to say that the voter with median concern a_m has to possess an expected payoff higher than her own *status quo* Nash equilibrium payoff. Under the assumption of an even number of individuals, the median concern is equal to:

$$a_m = a_{\left(\frac{n}{2}+1\right)} = \left(\frac{\underline{a}+\overline{a}}{2}+\frac{\overline{a}-\underline{a}}{n-1}\right). \qquad (25)$$

Using this fact and (19) and (20), the condition for gaining the majority of votes becomes:

$$EU_i\left(P_1^{t*},..,P_n^{t*}\right) \geq U_m\left(P_1^*,...,P_n^*\right) \qquad (26)$$

that can be written as:

$$\sum_{i=1}^{n}\frac{1}{n}\left[\frac{((\underline{a}+\overline{a})n+2t)}{2(n+1)}\right]^2 \geq \left(\left(\frac{\underline{a}+\overline{a}}{2}+\frac{\overline{a}-\underline{a}}{n-1}\right)-\frac{(\underline{a}+\overline{a})n}{2(n+1)}-t\right)^2 \qquad (27)$$

whose solution is:

$$\hat{t}_m = \frac{\left(\left(\sqrt{n}\right)^3-\sqrt{n}\right)(\underline{a}+\overline{a})+3(\underline{a}-n\overline{a})+n\underline{a}-\overline{a}}{2\sqrt{n(n-1)}} \qquad (28)$$

In this case, an interesting comparison can be made between the road pricing level accepted by majority voting (28) and the average Pareto tax t_M^o :[14]

$$t_M^o = \frac{(\underline{a}+\overline{a})}{4}\frac{n-1}{n} \qquad (29)$$

In figure 7, the *ex ante* majority acceptable congestion price (28) (thick line) and the average optimal price (29) (thin line) are plotted for $\underline{a}=1$, $\overline{a}=7$, and $n=1,..50$. It is purposedly shown that a *radical policy* against the excessive consumption of the private good (a tax that would push out of the market a high percentage of people but, of course, not the median) can be made
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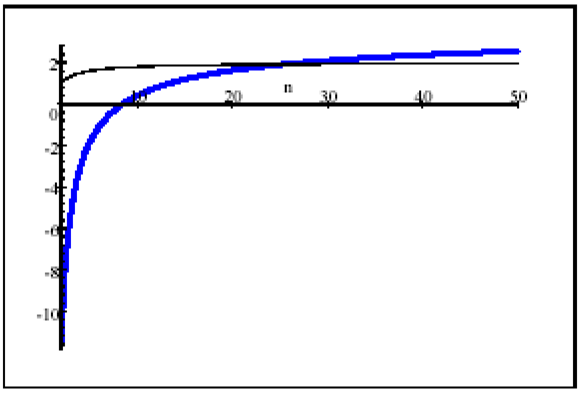

Figure 7 - Levels of $\hat{t}$ and t_M^o for $\underline{a}=1$, $\overline{a}=7$, and $n=1,..50$.

Many other simulations can be performed. However, the message of the model presented here is clear: the existence of individual specific uncertainty can either be an advantage or a disadvantage for the policy makers that intend to propose a RPP. Information campaigns in favor of the environment as well as a high density of people consuming the public good are both factors that make *ex ante* political acceptability, *ceteris paribus*, relatively easier. The possibility for the policy makers to make acceptable a *radical tax*, excluding from the consumption of the polluting good a high percentage of population appears to increase under majority voting: here it can be clearly envisaged a tax that, although excluding all consumers having a concern for the environment higher than the median one, still can be made *ex ante* acceptable to the majority of population. The policy maker does not even need to know each individual's preferences, but only their final distribution across its potential electorate (here made of all population n).

[14] The policy maker cannot ascertain ex ante each individual's *ex post* concern for the environment a_i, but what will be the aggregate distribution. Therefore she cannot impose a personalized Pareto tax but only its average value, based on the average concern $\frac{\overline{a}+\underline{a}}{2}$. The Pareto tax t_M^o can thus obtained as before, $t^o = \frac{a}{2}\frac{n-1}{n}$, with $a = \frac{(\overline{a}+\underline{a})}{2}$.

4 Concluding remarks

In this paper we have considered the problem of the political acceptability of RPP. This is widely considered as a major problem, given the almost unanimous agreement on the efficiency properties of such a kind of policies.

Why politicians do not adopt policies that are considered welfare-improving by economists? The political feasibility has been evaluated in a context characterized by a re-election constraint of the policy-maker adopting the policy. We have tested the acceptability of the policy proposal both via a unanimity as well as a majority voting rules. The politicians were supposed to be willing to adopt policies that would prove to be ex ante beneficial for either all or a majority of the individuals affected by it. The innovative aspect of the analysis relates to the introduction, in the political acceptability evaluation process, of an individual specific uncertainty about the effects of the RPP on individuals' evaluation of the quality of the environment.

We have introduced our argument by presenting two generic numerical examples illustrating the impact of the adoption of an individual specific uncertainty hypothesis on the distribution of gains and losses among individuals. When a RPP is implemented in a context of individual specific uncertainty a case can be made to explain, that it is both possible to have ex post welfare improving policies that are not voted for ex ante as well as welfare decreasing policies ex post that are voted for ex ante. The presence of individual specific uncertainty distorts aggregate preferences.

We have then presented a simple model in which individuals are uncertain about the effects of a RPP on their future environmental concern.

Our results show that the RPP passing a unanimity voting test possesses the following features: it depends both positively on the number of the individuals involved and on their initial environmental concern. Moreover, in general, the ex ante acceptability of the policy may require a lower level of pricing than the Pareto optimal one. More in detail, we have shown that this is true when individuals are initially characterized by a low concern for the environment.

When every individual is initially characterized by a non homogeneous concern of the environment and considers equally likely ending up with one of the many concerns after the policy is implemented, the political feasibility is determined by the preferences of the median voter. Even in this situation an average Pareto optimal tax could be made acceptable through an appropriate taxation path progressively moving towards efficiency, where information campaigns in favour of a non polluted environment could play a relevant role.

Future extensions of the model might be, among others, to address the following issues: look more in detail at the effects of an information campaign, explore the effects produced by different distributions of preferences, assume different transition patterns for individuals' preferences as effect of a RPP.

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