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Achieving political acceptability for new transport infrastructure in congested urban regions

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Abstract

This paper analyzes the efficiency and political acceptability of road pricing and infrastructure policies targeted at relieving urban congestion. It combines a stylized transport model of an urban road network with a model of the political process that incorporates interactions between voters, citizen interest groups and politicians to explore the possibilities to reach political acceptability for efficient transport policies. In a numerical illustration, the paper compares a set of pricing and investment policies in terms of efficiency and acceptability. The illustration shows how conflicting interests can lead to non-efficient policies being chosen.

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Keywords

road tolls, user charges, political economy of road pricing, transport infrastructure, welfare effects, acceptability of transport pricing

1.0 Introduction

Many urban regions contemplate investing in peripheral roadways that bypass the city center in order to alleviate congestion, improve the local environment and facilitate more efficient travel across the greater metropolitan area. Increasingly, such proposals are accompanied by tolling as a means of finance. Indeed, an optimal policy from an efficiency point of view would be to consider tolling both the bypass and the existing central roadway that is relieved. However, stakeholders and voter groups may block tolls on existing roads, or indeed never propose them to begin with. One reason for this being the difficulty of constructing a compensation scheme to distribute the welfare gains.

The purpose of this paper is to analyze the efficiency and political acceptability of road pricing and infrastructure policies targeted at relieving congestion and improving urban environment, using a stylized model of an urban network inspired by the Lyon, France metropolitan area. When assessing acceptability, we distinguish between two concepts of acceptability that are frequently used in literature. The first is “individual acceptability”: how do individuals or groups perceive a given transport policy in interviews or when casting a vote. The second type is “political acceptability”: can a transport policy proposal achieve approval within the applicable political process? There are many reasons, institutional as well as psychological, why both types of acceptability can differ. Moreover, individual acceptability has been quite thoroughly researched using stated preference studies, opinion surveys, and voting records. Hence, this paper turns the focus toward political acceptability.

A difficulty when analyzing political acceptability of urban road pricing initiatives is that only a few successful implementations exist where tolls are placed on existing roads, hence it is difficult to analyze the question empirically. Instead, we develop and analyze a stylized model of an urban area that captures some essential structural features of the network geography, spatial voter demographics, travel demand, traffic congestion, political process,

citizen interest groups, and transport policy options. Through simulation, we assess the economic efficiency, revenue generation, and political acceptability of road pricing policies targeted at relieving urban congestion, allowing us to identify the range of feasible policies. We subsequently use an agenda setter model of the political process to characterize which policies are most likely to be selected. We use this two-stage procedure to analyze a number of possible explanations for the apparent difficulty in reaching political consensus around the policy options that are the most economically efficient.

The main methodological innovation of the paper is to embed the voting game in a richer empirical setting. We specify the transport, environmental and budget impacts of each group in function of their localization with respect to the planned infrastructure. This allows both to make better use of the information from transport models and to study more realistic coalition and cooperation structures in the political decision making process

In Section 2.0 we present the model and describe the political economy framework. A numerical illustration is analyzed in Section 3.0. Section 4.0 discusses the model results in a political context and Section 5.0 concludes with a discussion of policy implications and limitations to the transferability of the results.

1.1 Literature review

Although pricing on existing roads is often an efficient way of reducing urban congestion, few successful implementations of such urban road pricing schemes can be found. In the literature on individual acceptability of transport pricing, several factors have been identified ranging from aversion of pricing and perceived loss of freedom to uncertainty about revenue use and awareness of problems caused by car traffic (see Schade and Schlag 2003). Since the purpose of road pricing is to reduce the demand for travel to an economically efficient level, some individual travelers are likely to be worse off compared to the no-toll situation. In many countries transport pricing also goes against the legal tradition where direct

intervention using rules and regulations have been the traditional way to deal with problems in the transport sector (Frey 2003). Equity and fairness considerations are also often identified as important factors for the individual acceptability of road pricing. Raux and Souche (2004) identify several dimensions of equity that are relevant for transport pricing policies and Raux, and Souche and Croissant (2009) show in an empirical study that the perception of fairness depends on context and varies according to the economic and social situation of the individuals.

Although individual acceptability is important for the overall public acceptance of a transport policy, political acceptability is a prerequisite for a policy to be implemented. In the literature, political acceptability of road pricing has most often been studied using political equilibrium models. A common assumption in the approach is that a reform will only be accepted if a sufficiently large majority of the voters gain (or at least do not lose) from the policy compared to the initial situation (de Borger and Proost 2011). The analysis is hence based on the assumption that people are primarily concerned about their own well-being and not the benefits to society as a whole (see Jaensirisak et al. 2003 for an empirical analysis of the influence of selfish and social perspectives to individual acceptability). Ideology and political principles also have a limited role in this approach.

De Borger and Proost (2011) use a simple majority model to study how uncertainty regarding modal substitution costs and revenue use affects the support for a road pricing policy. The analysis suggests that the support for road pricing in many situations can be higher after than before its introduction. This was the case in London and Stockholm. One reason was the individual uncertainty regarding the costs of modal substitution for the car users: some drivers will actually gain from the road pricing despite an ex ante expectation of a small individual loss. This results in all drivers forming a majority ex ante against road pricing. The problem is that there will also be a majority against a trial, which prevents

expectations from being replaced by experiences. Hensher et al (2013) uses a SP survey to confirm the role of ex ante beliefs for the acceptability of road pricing. Another approach is taken by Westin et al. (2012) who study how acceptability constraints protecting certain interest groups can lead to inefficient tolling. Special interest groups will press for policies that are most likely to benefit their members, which can lead to the use of less efficient instruments. Russo (2013) brings in the multi-government dimension and considers the conflicts that exist when policies need to be approved by the city and the wider region where commuters live. De Borger and Proost (2016) analyze in a generic model how local and federal majorities may be formed for the introduction of road pricing.

The difficulty of achieving acceptability for transport pricing has led some authors to discuss the tension between acceptability and economic efficiency in terms of a paradox, where efficient instruments in the transport sector are not acceptable while acceptable policies in general are less efficient (Steg 2003). Other studies have tried to measure the cost of acceptability in terms of reduced efficiency in a similar way to the traditional equity-efficiency trade off (Mayeres and Proost 2001; Westin et al. 2012).

1.2 Review of previous implementations

There are few successful implementations of urban road pricing policies on existing infrastructure. This is mainly because road pricing has not been seriously considered in most cities, but in many other cases road pricing has been seriously considered and subsequently rejected. Table 1 shows a review of several such previous attempts to implement urban road user charges. Interest groups such as environmental organizations and groups associated with public transport riders often support road pricing, whereas auto clubs are found among its opponents. In the New York case, individual acceptability appeared to be contingent on the revenue use: support was higher under the assumption that revenues would be re-invested in the transport system, compared to surveys where the revenue use was more uncertain. Yet,

even in cities where road tolls were eventually approved, the same kinds of opposition groups arose.

This variation in outcomes makes it difficult to draw a clear conclusion regarding the influence of the political process in achieving support for urban road user charges, based simply on the observed cases. Nor could any clear pattern concerning left-leaning versus right-leaning political party positions be found, other than that green parties seem to be in favor of tolling car traffic. The difficulty of reaching efficient policies in urban transport is also not limited to pricing policies.

[TABLE 1 AROUND HERE]

2.0 Methodology

We combine a stylized transport model of the road network in a metropolitan area with a stylized model of the decision making process. In all assessments of individual utility, the effects of tolls, travel time changes, revenues and local environment are taken into account. The road network is inspired by the traffic situation in Lyon, France, but is also reminiscent of many other cities with a main urban road and a proposed bypass through suburbs. By using a simplified traffic model instead of a more detailed one, we can search the policy space more efficiently and obtain insights into the effects of different policies and ways of representing the negotiations between various actors in the political decision making process.

We employ the transport model to address a series of questions. First to find the welfare-maximizing policy and to analyze which geographical areas, which types of travelers and which special interests are winners and losers of different policies. Next to study what transport policies can be politically acceptable and, in combination with a model of the political process, which are the most likely outcomes of the political decision making process. To analyze the political process itself we use a stylized model inspired by Baron and Ferejohn (1989) where a number of delegates negotiate over a combination of policies, in this case to

alleviate road congestion and improve local environment. In the model, each delegate represents the constituency in a distinct geographical area in the city. Figure 1 depicts an illustration of the model framework.

[FIGURE 1 AROUND HERE]

2.1 Model of the transport system

We model the transport system using a simple network model with four parallel roads: two main roads, (an eastern city road and a western bypass) and two back roads (one to the east and one to the west). To capture road congestion, we assume that the travel time on each road is an increasing function of the total traffic volume on the road. The bypass is not available in the initial situation. Figure 2 shows the road network.

[FIGURE 2 AROUND HERE]

Similar abstract models have been used to examine related issues such as pricing with an un-tolled alternative (Verhoef et al. 1996), tolling by neighboring states (Levinson 2001), and games between parallel (de Borger et al. 2005) and serial (de Borger et al. 2007, 2008) roadway operators. Our model includes a richer representation of the population groups and the political decision making process.

To capture the conflicting interests in the city, we model a number of different groupings of citizens: travelers, residents and taxpayers. Travelers are first divided into four geographic categories depending on what subset of roads they can use: city travelers, western travelers, north-south transit travelers and external travelers. City travelers are traveling to, from and within the city center and can therefore only use the main city road or the city back road. Western travelers are similarly only allowed to use the western back road and, if built, the bypass. The north-south transit travelers and the external travelers both pass through the city and can therefore use all four roads. The difference between transit travelers and external travelers is that the external travelers are assumed to be less cost sensitive since they travel a

longer distance. The travelers are secondly separated into two value of time classes: one for travelers with a high value of time and one for travelers with a low value of time, resulting in a total of eight traveler groups. The reason for using multiple values of time is to capture the self-sorting mechanism among the travelers when facing both tolled and un-tolled alternatives. When choosing transport routes, we assume that all travelers choose the route with the lowest generalized cost and that the transport flows in the network have reached a user equilibrium. To simplify the analysis, we only consider car travel in the model. Table A.2, in the Appendix, lists all traveler groups.

In addition to the effects on travelers we also consider the effects on local residents that are affected by the negative environmental effect from the traffic. We distinguish between residents living in the city center that are affected by traffic on the main city road and on the city back road, and residents living in the western part of the city affected by traffic on the western back road and on the bypass. We assume the environmental external cost to be proportional to traffic volume and the same for all roads. Finally, we consider the effect on local taxpayers who, by assumption, pay for the construction of the bypass and receive the revenues from the road tolls. Table 3 provides a summary of all citizen interest groups and their assumed geographical distribution.

2.2 Welfare and political preferences

Before moving on, we need to define welfare and efficiency more precisely. We begin with the individual utility that encompasses all dimensions: utility derived from travel as well as from consumption and environmental quality. We measure individual utility in equivalent income after redistribution of toll revenues and investment costs. Welfare is understood as global efficiency and is computed as the un-weighted sum of equivalent income changes for the whole population. An “efficient solution” is one that maximizes this welfare measure.

To maximize welfare, the decision makers have a number of policy instruments at their disposal. We consider a combination of three different policy instruments: a road toll on the main city road t_C , the construction of a western bypass, and (if the bypass is built) a road toll on the bypass t_B . A first-best tolling policy targeted at maximizing social welfare would in general involve marginal cost pricing on all roads. By equating the cost of travel with its marginal social cost, an efficient outcome can be reached. However, since tolling on the back roads can be expensive or politically infeasible, a second-best policy would instead include only tolls on the main city road and the bypass. To simplify the analysis we also assume that the design of the bypass and the corresponding investment cost are fixed and therefore independent of the choice of tolling policy. We also assume that the decision makers do not have access to any lump-sum transfers¹ for compensating losers.

Verhoef et al. (1996) have analyzed second-best congestion pricing in the case of an un-tolled parallel alternative. Using a simple model with two parallel roads, one tolled and one un-tolled, they find that the optimal toll depends both on the marginal external cost on the tolled route and on the negative “spill-over” effects from the shift in traffic onto the un-tolled road. Small and Yan (2001) also show that the benefits of only tolling one of the roads may increase as a function of the heterogeneity in the user groups. This is also the motivation for using multiple value-of-time classes in our model.

To differentiate between preferences across the population, we divide the city into four geographical areas: North, South, City Center (including East) and West. We also include an External area representing travelers from outside the city. Each area is represented by a representative voter who wants to maximize aggregate welfare for the population in his or her

¹ As long as the tolling policy is a Kaldor-Hicks improvement, it is always possible to theoretically design a compensation policy making everyone better off. In practice, policy makers may neither have the information nor the policy instruments (e.g. lump-sum transfers) to create such a compensation policy.

area. We assume that aggregate welfare in each area is a sum of the utility for the different individuals in the area. This implies that each representative voter has multiple objectives: the representative voter in the City Center, for instance, considers the effect on city travel, the local environmental effect in the city and the city center's share of the collected toll revenues and bypass construction cost, but ignores the effect on western back roads and the travel on the bypass. We assume that the net revenues from the project (the collected toll revenues minus the cost for constructing the bypass) are distributed proportionally among the citizens within the four geographical areas in the city.

The preferences of the representative voters are hence linear combinations of the preferences of the different types of interests. Table 3 shows the conversion matrix. We base the matrix loosely on travel and population data for Lyon (see section 3.1).

2.3 Model of the Political System

In the political process, the preferences of the voters inform a preference function for policies. To construct this function we can rely on different political decision mechanisms: Nash bargaining model, median voter, agenda setter or citizen candidate model. Here, we choose to rely on the agenda setter model (Baron and Ferejohn 1989), which is well-suited for decision making over several dimensions with more than two players. In this model a number of representative voters decide on bargain over a policy through majority voting. First, we must appoint one of the representative voters as the agenda setter. The agenda setter proposes a policy, on which delegates vote in comparison to the status quo. If the policy receives majority support, the decision-making process ends; otherwise, the status quo prevails. In the Nash equilibrium of the game, each agenda setter will propose a policy that maximizes the welfare for his or her constituency subject to the constraint that the policy can get support from a majority of the representative voters compared to status quo. We provide below a formal definition of the voting game and the equilibrium.

We assume that the constituency in each geographical area is represented by a representative voter and that the number of votes (or voting power) is proportional to the constituency's share of the total population in the city. We assume that 40 per cent of the population lives in the city center, compared to around 15-30 per cent in the other areas. A majority can hence either be formed by the city center in collaboration with one additional area, or by the three other areas (West, North and South) if they cooperate. External travelers are assumed to have no influence in the local decision making process.

Let Y be the set of all policies (all possible combinations of the three policy instruments, that is, a road toll on the main city road, the construction of a western bypass, and if the bypass is built, a road toll on the bypass) that the representatives can choose. To facilitate the analysis we discretize the policy space into a finite set of policies $y \in Y$. We assume that a representative for area $i = 1, \dots, N$ will vote for all policies that does not make the constituency in his or her area worse off compared to the initial situation, that is, if $W_i(y) \geq W_i(0)$ where $W_i(y)$ is the welfare for area i under policy y and $W_i(0)$ is the area's welfare in the initial situation 0. Let p_i be representative i 's share of the total number of votes where $\sum_{i=1}^N p_i = 1$. The support $S(y)$ for a policy y compared to status quo is then:

$$S(y) = \sum_{i=1}^N p_i \cdot I_i(y) \quad (1)$$

where $I_i(y)$ is an indicator function that equals one if representative i supports the policy, $W_i(y) \geq W_i(0)$ and is zero otherwise. From $S(y)$ we can define the subset of policies $Y_0 \subset Y$ that has majority support against status quo as:

$$Y_0 = \left\{ y \in Y : S(y) > \frac{1}{2} \right\} \quad (2)$$

Y_0 is therefore the subset of all policies $y \in Y$ that can win a pairwise election against status quo.

In the agenda setter model we consider a voting procedure that Baron and Ferejohn (1989) denote as a closed rule. Under a closed rule, once the agenda setter has made a

proposal, a vote is immediately taken in comparison to the status quo; if it is approved, no further proposals can be made. If it is rejected, status quo prevails. This implies that once an agenda setter is appointed, he or she will consider the subset of policies Y_0 that can get support from a majority of the voters against the current policy (in this case the initial no-toll situation) and choose the policy y^i within the subset Y_0 that maximizes his or her utility $W_i(y)$, that is:

$$y^i = \operatorname{argmax}_{y \in Y_0} W_i(y) \quad (3)$$

We assume that the probability that representative voter i is appointed agenda setter is equal to his or her population share p_i . The outcome of the political process can therefore be described with a function $P(y)$ that gives the probability that policy y is chosen. In addition to the standard model, we also consider a modified version of the agenda setter model where hypothetical citizen interest (or lobby) groups representing special interests are allowed to set the agenda by making a proposal for the representative voters to vote on.

Finally, the welfare maximizing policy y^{max} is defined as:

$$y^{max} = \operatorname{argmax}_{y \in Y} \sum_{i=1}^N W_i(y) \quad (4)$$

In section 3.4.3 we also consider an alternative version of the agenda setting model where the agenda setters can make counterproposals to the previously accepted policy in a repeated game.

We are aware that this is a strongly simplified representation of the political process and that a policy that is “acceptable” according to our simple framework may never get approved in the real world. The reasons may be diverse: there can be logrolling with other issues, linking to national political issues, other coalitions of pressure groups, repeated games, reputation effects etc. Were we to accommodate trade-offs between transport policy and other issues, this would increase the dimensionality such that it is difficult to make conclusions regarding equilibria (a consequence of Arrow’s theorem). Moreover, we lack a sufficient

basis for incorporating individual voters' preference structures between transport policy and other issues.

Our stylized approach does however help to identify some of the "objective" factors that may make some policies unacceptable, and it represents a significant improvement on previous literature in its accommodation of two simultaneous dimensions of policy within the transport system.

3.0 Numerical illustration

We base our numerical illustration on a stylized model of the Lyon, France metropolitan region. Lyon is the second largest urban community in France with 1.300.000 inhabitants. The city has a typical European urban form in which the central area contains approximately half the inhabitants and jobs. Like similar agglomerations, Lyon is subject to urban sprawl, with both population and jobs having a long-term tendency to move into the suburbs. The main French North-South motorway (A6 and A7/E15) runs across Lyon city center implying clashes between transit and local traffic, and thus congestion, pollution, noise and other harmful effects. The problems are reinforced by Lyon's geographical location between several major cities (Paris and Marseille, St-Etienne and Geneva).

In response to these problems, various institutional actors have proposed several projects in order to divert a part of the traffic to outside the Lyon city center. At a local level, Lyon's conurbation authority Grand Lyon has proposed the construction of a western motorway bypass named TOP for "Tronçon Ouest Périphérique" (more recently renamed "Anneau des Sciences") to divert traffic from the city center. The project includes the possibility of a toll on the new bypass and either a reduction of capacity or a toll on the current motorway through the center, and the project is estimated to cost between 2 and 2.5 billion Euros. Financing is under the responsibility of the local governments.

A public debate was held from the end of 2012 for a duration of 6 months and, if the project is approved, the infrastructure may open by 2025. The two main political parties are divided on this subject, and the Green party is thoroughly opposed to the project, which makes it difficult to reach an agreement. A conventional toll on this new road is considered in order to at least cover the operation of the infrastructure (Grand Lyon 2012). Because of a new law from 2010, large cities in France may try out implementation of a cordon or area road-user charging scheme, but until now none has made use of this opportunity. Different tolling alternatives are hence an issue that could emerge in the public debate.

3.1 Data and model parameters

In the numerical illustration, we use a stylized transport model inspired by the traffic situation in Lyon, France. The model is calibrated using data from travel surveys and census data from the Lyon metropolitan area. The purpose of the calibration is to create a stylized model that captures key features of the traffic situation in Lyon. We use the data to specify volume delay functions for the roads, demand functions for the travel groups and a matrix for aggregating the surplus of different interest groups into welfare for the constituency in each geographical area. Since the model is limited to car trips, this implies that we ignore any potential external effects from modal shift towards other transport modes as a result of the proposed policy. This is justified if the other modes are priced at social marginal cost²

² In welfare analysis, one can neglect related markets as long as they are priced at marginal social cost. There are two related markets that can be distorted. The first is public transport (PT). PT is heavily subsidized in Lyon, this is justified because of increasing returns to scale and because of positive side-effects on road congestion. On the other hand, the PT fees should internalize the congestion. In theory, when road pricing is introduced, it is justified to decrease the subsidy on PT because cars are priced more correctly, on the other hand congestion in PT and economics of scale of an extended frequency may call for other corrections in the fare. So our assumption covers a lot of second order effects and may need explicit correction in a follow up exercise. The second assumption is the relation with the labor market. Labor supply is heavily taxed and therefore not paid by its marginal product. There are two mitigating factors. First it is not clear what is the net effect on the supply of labor of a change in pricing and accessibility, this could be negative. Second, the pricing of road use may generate positive agglomeration effects as it could allow the higher income to find better matches on the labor market.

In the model, the city is divided into four geographical areas: City (including East), West, North and South. The division is based on the D34 zoning in the 2006 Lyon's Household Travel Survey (EMD Lyon 2006). From the population and income statistics in Table 2 we see that the city center has both the largest share of the population (42 per cent) and the highest average income. The lowest average income is found among people living in the South. To estimate the median income we use the after tax income per consumption unit. See (INSEE 2012) for a definition.

[TABLE 2 AROUND HERE]

We use the transport model to calculate the welfare effect on a number of citizen interest groups, that is, travelers, residents and taxpayers. The travel patterns are based on data from two different travel surveys, the local trips are based on (EMD Lyon 2006) and the external trips are based on data from the 2006 cordon line survey "Enquête Cordon" (EC Lyon 2006).

Based on the travel patterns we estimate the initial travel demand from the different areas. Since we do not know the residential location of the travelers in the survey, we assume that all travelers live in the area where the trip starts. To capture that travelers have different values of time, we divide the travelers into two different value-of-time classes: 11.1 €/h for travelers with a high value of time and 8.8 €/h for travelers with a low value of time. To simplify the analysis we further assume that the share of travelers with high and low value of time in each area is proportional to the average income in the area³. These two rather strong assumptions enable us to transform the origin-destination data from the travel surveys into travel demand functions for eight different traveler groups and a conversion matrix for

³ The values of time are in line with the French surveys and correspond with the values used in the Lyon disaggregated traffic model. We know that the value of time has an elasticity with respect to income smaller than one. In the voting game we use the median income per zone but in the transport simulations we use for each zone drivers with lower income and drivers with higher incomes as the corresponding differences in values of time generate a more realistic driver behaviour.

aggregating the welfare of the interest groups into welfare for the representative voters from the different geographical areas. Table 3 shows the conversion matrix.

[TABLE 3 AROUND HERE]

A resident in the Lyon metropolitan area spends on average 68 minutes per day travelling an average of 21 km (SYTRAL 2007). Assuming all roads in the network have roughly the same length, this implies that an average trip in the initial congested situation without a bypass is 10.5 km and takes 34 minutes. With an average car cost of 0.4 €/km we get a monetary trip cost of 4 €. We choose the slopes of the volume delay functions such that they give reasonable travel times given certain traffic volumes. The parameters in the demand functions for each origin-destination pair are in a similar way calibrated to give reasonable responses to changes in the generalized travel costs. We assume that the generalized price elasticity of demand is -0.8 for local travelers and -0.6 for external travelers. Assuming a construction cost of 2.5 billion Euro, an interest rate of 5 per cent, a depreciation period of 100 years and 250 days/year; the cost of the bypass is 400.000 €/day. In the summary of the results in Table 5 we also take into account costs for toll collection in a scenario with toll collection costs of the order of 15% of total revenues. A summary of the model parameters is given in the Appendix.

3.2 Decomposition of the welfare effects

In the model we consider policies involving a combination of three different policy instruments: a western bypass, a toll on the main city road t_C and a toll on the western bypass t_B . We first study the effect of a number of illustrative policies involving different combinations of the policy instruments. Table 4 lists the policies.

[TABLE 4 AROUND HERE]

In Table 5, we provide a comparison of the change in total welfare, net revenue, environmental external effects and traveler surplus compared to the initial situation for seven

illustrative policies⁴. A table with the travel times on the four roads for the representative policies is shown in Table A.3 in the Appendix. Without a bypass, total welfare is maximized for a toll on the city road equal to 2.9 € (policy A) and the collected revenue is maximized for a toll equal to 4.3 € (policy B). With a bypass, the decision makers can set tolls on both the bypass and on the main city road. Total welfare is in this situation maximized for a bypass toll equal to 3.3 € and a matching toll on the city road equal to 3.0 € (policy F). In the example, we can decompose total welfare into three parts: toll revenues, traveler surplus and environmental effects. To maximize total welfare, the decision makers must balance these effects against each other. Since the environmental effect is small compared to the effect on traveler surplus and toll revenues, the main motivation for using the road toll from a welfare perspective is to reduce congestion. An important factor for the optimal toll levels is the interaction with the un-tolled back roads and how large the negative external effects are on the un-tolled back roads.

[TABLE 5 AROUND HERE]

Comparing the policy alternatives, we see that the un-tolled bypass (policy C) has a negative effect on total welfare. The reason is that even though the bypass reduces congestion on the main city road, it does so by shifting transit traffic to the bypass, which causes congestion on the bypass. In combination with a relatively high investment cost, the effect on total welfare is therefore negative. Allowing a toll on the bypass can achieve a more efficient allocation of traffic between the roads. With efficient tolling (policy F), the bypass has the potential to nearly double total welfare compared to efficient tolling with no bypass (policy A). However, the effect in the example depends critically on both the investment cost and the travel time gains from the bypass. With a higher investment cost, the optimal policy would

⁴ Change in total welfare = change in net revenue + change in traveler surplus – change in external costs.

instead be not to build the bypass and only toll the city road. Because the bypass generates an induced demand for travel, the bypass also has a negative effect on the local environment. In this example, the environmental effect is small compared to the effect on travelers' surplus.

To analyze the distributional impact of the different policies we also decompose the welfare effect into the effect on functionally specialized interests. We hence analyze two decompositions: one by type of benefit or cost (citizen interest group) and one by geographical area. Observe that the sums of welfare effects are the same in both decompositions. By decomposing the total welfare effect into the effect on special interests that might be taken up by different citizen interest groups or individuals, we can start to identify winners and losers from different policies. From Table 5 we see that the welfare gain with efficient tolling mostly comes in the form of tax revenues, while traveler surplus is highest for policies where the travelers do not have to pay any tolls. All policies also have a positive local environmental impact in the City but a negative effect in the Western part of the city since both the city toll and the bypass shifts traffic from the City center to the Western part of the city. By decomposing the total effect into functionally specialized interests, we see that none of the analyzed policies makes all interests better off compared to the initial situation. There are thus no policy that is Pareto improving and all policies therefore run the risk of opposition by stakeholders or lobby groups.

To analyze the effect on spatial distribution we also study the change in welfare of the illustrative policies for the constituencies in the different geographical areas: City, West, North, South and the area representing External travelers. Without a bypass, the toll on the city road increases welfare in the City and in the Northern and Southern parts of the city. Travelers in these areas benefit from the reduced congestion and receive a share of the collected toll revenues. Residents in the City also benefit from the reduced local environmental externality. For the Western area, the toll reduces welfare even though western

travelers are not directly affected by the city toll and receive toll revenues from the other travelers. The reason is that the toll on the city road shifts transit traffic from the main city road to the western back roads, which increases congestion and the environmental external costs in the Western parts of Lyon close to the bypass. The effect is also negative for external travelers who do not receive any toll revenues.

Without tolls, the bypass only improves welfare for West and External travelers. The reason is that since the construction cost is not covered by any tolls, the local residents have to bear the full cost of the bypass. Since the City and the South areas have the largest population, they pay most of the construction cost. The City and the South do in a similar way benefit most from policies resulting in higher net revenues. Conflicting interests between different geographical areas or stakeholders representing different special interests can therefore be an important factor for the low acceptability of transport pricing policies. Without a reasonable compensation scheme where the revenues are used to compensate the losers, we can therefore expect disadvantaged groups to oppose the policy. However, although the representative voters prefer different policies, many policies do increase welfare for a majority of the areas and hence could win a pairwise election against the initial situation.

3.3 Political Acceptability

The analysis so far revealed conflicting interests between different special interests and geographical areas. These conflicting interests may therefore help explain some of the observed difficulties of achieving political acceptability for the most efficient transport pricing policies. In this and the following section, we examine this idea further by studying how these conflicting interests interact in the decision making process.

To analyze the effect on political acceptability we start by identifying the subset of policies Y_0 in the policy space Y that can win a pairwise election against the initial no-toll no-bypass situation. Figure 3 depicts this subset.

[FIGURE 3 AROUND HERE]

The figure shows all combinations of policy instruments that can get majority support against the initial situation when voted on by the four representative voters in the city. In the left subfigure, the gray bar shows all toll levels of the city road with no bypass that can win a pairwise election against status quo. The right-hand subfigure shows the corresponding combinations of toll levels on the city road and on the bypass, given that the bypass is built. Without a bypass, all toll levels below 6.5 € on the main city road can get support of a majority of the representative voters from the four geographical areas in the city. From scenario A and B in Table 5 we see that a toll on the city road with no bypass benefit the representative voters in City, North and South, whereas welfare decreases in the Western part of the city because of increased congestion on the western back roads. The largest share of the toll revenues also goes to the City, which also has the largest population. With a bypass, many different combinations of road tolls improve welfare for a majority of the representative voters compared to the initial situation. Observe that the un-tolled bypass (lower left corner of the right subfigure in Figure 3) in this example is not included in the set of supported policies because the bypass costs have to be paid by the inhabitants of the city. This indicates that the locals need to extract at least some benefits from the external travelers in order to gain from the policy.

When we assume that the net revenues are distributed back to the voters in the city, the analysis indicates that a relatively large set of policies can win a pairwise election against status quo. Since the optimal policy from an efficiency point of view is included in the set of policies with majority support compared to the initial situation, the analysis suggests that an efficient tolling policy could be politically acceptable given that the revenues are properly included.

An important assumption in the analysis is that all net revenues are distributed back to the population. Since efficient road tolls imply large toll revenues, the revenue use can have a large effect on the political acceptability of the project. If the decision makers do not receive the net revenues from the project, tolling will only be accepted when in combination with a bypass. Figure 4 shows all combination of policy instruments that can get support from a majority of the representative voters compared to status quo if the net revenues are exogenous, that is, if the local population neither pay for the bypass nor receive any of the toll revenues. The preferred policy by all representative voters is in this situation an un-tolled bypass. This is also the welfare maximizing policy from a local perspective when both the construction cost and toll revenues are exogenous. We can compare this result to the previous situation where the un-tolled bypass was not included in the set of policies with majority support. This deviation can therefore provide a possible explanation for low acceptability of road pricing and preferences for un-tolled infrastructures. If the local decision makers believe that they will not be able to keep the collected toll revenues, they will be reluctant to road tolls as a way of financing new infrastructures.

[FIGURE 4 AROUND HERE]

3.4 The Role of Political Process

In previous section we saw that many different policies could conceivably get support from a majority of the representative voters when compared against the initial no-toll no-bypass situation, given that the toll revenues and construction cost was shared among the constituency in the city. In this section we analyze the political economy of urban road pricing by comparing and identifying the most likely policies that can achieve majority support in the political equilibrium, given a particular political process for making and voting on proposals.

We examine three cases: in the first, the agenda setters are chosen among the representative voters from the different geographical areas and vote on a single policy against

status quo; in the second, we consider the outcome of allowing hypothetical citizen interest (or lobby) groups representing special interests to set the agenda; in the third, we consider a repeated game where the agenda setters can make counterproposals to previously accepted policies.

3.4.1 Agenda setting model with representative voters

We first study the outcome of the agenda setter model when the agenda setters are chosen among the representative voters from the different geographical areas: City, West, North and South. Remember that the external travelers have no representation in the local constituency. In the model, the representative voters vote on a single proposal against status quo. If the policy is approved, no further proposals can be made, if the policy is rejected, status quo prevails.

The political equilibrium is given by the preference function $P(y)$ that gives the probability that policy y is the outcome of the political process given the initial situation 0. Since the agenda setter will propose the policy that 1) maximizes the welfare for his or her geographical area and 2) can receive majority support among the representative voters, the preference function will have a positive probability for at most four different policies (one per geographical area). Table 6 shows the policies that each representative voter would propose if appointed as agenda setter.

[TABLE 6 AROUND HERE]

The representative voter in the City will propose a low toll on the main city road and a high toll on the bypass. By proposing this policy, the city travelers avoid the direct cost of the road toll. The policy can for instance be motivated by the user-pays-principle, that is, travelers who use the bypass should also pay for its construction.

The representative voter in the West will propose a high toll on the city road and a low toll on the bypass. This way, the western travelers avoid paying the direct cost of constructing

the bypass. The proposal can for instance be motivated with the polluter-pays-principle; that is, since the purpose of the bypass is to reduce congestion and improve the local environment in the city center, then one should place the toll on the main city road to further enhance that effect. One can similarly see placing the toll on the bypass as counter-productive, since we cannot obtain the full traffic-diversion effect of the bypass if it is tolled.

The representative voters in the North and in the South prefer more balanced toll levels. Compared to the representative voters from the City and the West, the representative voters from the North and the South get utility from trips on both the main city road and on the bypass. They therefore have stronger preferences for tolling both the bypass and the main city road. Which overall toll level they prefer depends on their relative share of travel surplus compared to their share of tax revenues. Since the South has a larger population and makes proportionally somewhat less trips than the North, the representative voter in the South prefers higher toll levels than the representative voter in the North.

3.4.2 The influence of lobbying by special interests

We now study a modified version of the agenda setting model where hypothetical citizen interest (or lobby) groups representing different special interests can propose policies. We still assume that the representative voters from the four geographical areas have the final vote on whether the policy is accepted or rejected in favor of status quo. This means that for the policy to get approval, it must either gain the support of the representative voter in the City and at least one other area or by the representative voters in the West, the North and the South. We assume that each citizen interest group has an equal probability of being appointed. If a citizen interest group is appointed agenda setter, it will propose a policy that maximizes the welfare for its special interest within the set of policies that can receive majority support.

[TABLE 7 AROUND HERE]

Table 7 shows the policies proposed by citizen interest groups representing different special interests. Interest groups representing travelers would, if not constrained by a political acceptability constraint, propose an un-tolled bypass. Since this policy cannot get majority support from the representative voters in this example, their second-best alternatives are instead to propose policies involving the lowest feasible toll levels for their travel group. A citizen interest group representing city travelers will therefore propose a toll-free city road and the lowest possible toll on the bypass that can get support from a majority of the representative voters. A citizen interest group representing western travelers will in a similar way propose a toll-free bypass and the lowest possible toll on the city road such that the policy can win a pairwise voting against status quo among the representative voters, that is, policies within the policy subset Y_0 .

Citizen interest groups representing different environmental interests will similarly propose politically acceptable policies that reduce traffic in their area of concern the most. A citizen interest group representing taxpayers will finally propose the policy that maximizes the net revenues.

When the appointed agenda setters are chosen among citizen interest groups representing different special interests, a different picture of likely outcomes emerges compared to when the agenda setters are chosen among geographical representatives with multiple objectives.

[FIGURE 5 AROUND HERE]

Figure 5 shows the policies that the representative voters from different geographical areas and citizen interest groups representing different special interests would propose, if appointed agenda setter. The figure reveals that when special interests are allowed to set the agenda, more extreme policies will be proposed compared to when geographically based representatives with multiple goals are agenda setters. The requirement that the proposed policies must have support from a majority of the voters prevents the interest groups from

proposing too extreme policies. Instead, the proposals are constrained to the border of the set of political acceptable policies Y_0 , that is, the set of policies that can get majority support compared to the initial situation. Without this constraint, environmental groups would for instance propose toll levels that reduce traffic in their area to zero and automobile organizations would argue that all roads should be free of charge.

Since the environmental effects are small compared to the effect on traveler surplus and the value of the collected revenues, the difference in preferences between the traveler groups and the geographically based representative voters mostly depends on the allocation of the net revenues. The revenue use is therefore an important factor for the ability of the decision making process to agree upon an efficient transport policy.

3.4.3 Agenda-setting model under an open rule

To analyze the impact of negotiations between the representative voters, we also consider the agenda setter model under an open rule, in addition to the single round voting procedures presented above. Under an open rule, once a policy is approved, a new voting round is initiated where a new agenda setter is randomly selected and allowed to make a counterproposal to the previously accepted policy. We assume that the probability that a representative is appointed as agenda setter is independent of previous appointments and equal to the representative's voting share p_i . To simplify the analysis we further assume that the agenda setters are non-strategic and memory-less in the sense that they neither consider the effect their proposal can have on subsequent counterproposals nor the outcome of previous elections when making a proposal or voting on a policy. Instead, every appointed agenda setter proposes the policy that maximizes welfare for the constituency in his or her area given that the policy can receive support from a majority of the representative voters against the previously accepted policy.

This allows us to represent the political process as a time-homogeneous Markov chain with a finite state space where the probability of going from policy y_m to policy y is given by the function $P_m(y)$. By analyzing the asymptotically stationary distribution of the Markov chain, we can identify the most likely policies in the political equilibrium when a sequence of proposals and counter-proposals are discussed and voted on in a series of pairwise elections.

Depending on the preference structure, the process can either have in a single absorbing Condorcet winner that can beat every other proposal in a pairwise election, or have a stationary distribution where multiple policies form a voting circle. In case no clear winner can be identified, we consider the whole set of policies in the commuting class of the stationary distribution as feasible outcomes of the political process. Figure 6 shows the policies in the stationary distribution.

[FIGURE 6 AROUND HERE]

When allowing the representative voters to make counterproposals, no Condorcet winner is found. Instead, the outcome of the political process under an open rule is a voting circle where every proposed policy can be defeated by at least one other policy in a pairwise election. By comparing the outcome of the three voting procedures, we can analyze the impact of negotiation and lobbying on the outcome of the political process in the model.

3.4.4 *Comparison of expected welfare gain*

To measure the effect of the political process on economic efficiency we can compare the expected gain in welfare in the political equilibrium under different processes with the gain in welfare with efficient tolling. Table 8 shows the expected efficiency of the tree voting procedures. To calculate the expected efficiency gain when different interest groups are allowed to set the agenda, we simply assume that all six citizen interest groups in Table 7 have an equal probability of being chosen as agenda setter. In a similar way, we use the

stationary distribution of the agenda-setting model under an open rule as a measure of the expected efficiency of the political process with negotiation.

When the agenda setters are chosen among the representative voters, the expected welfare gain reaches 85 per cent of the welfare maximizing gain. If the agenda setter is chosen among the citizen interest groups, the expected welfare gain only reaches 13 per cent of the welfare maximizing level. The model hence indicates that lobbying from special interests can reduce the welfare effect of a transport policy considerably by putting too much weight on a single interest.

When the decision makers are allowed to negotiate and make counterproposals to the previously selected policy, the expected welfare gain is even higher compared to when the decision makers only are allowed to vote on a single proposal against status quo.

[TABLE 8 AROUND HERE]

Since the representative voters only consider the effects on their own constituencies, the outcome of a political process will typically deviate from the economically efficient policy. The more aligned the agenda setters are to single interests, the more extreme policies they will propose. How the citizens are apportioned into representative voters can therefore have a large impact on the outcome of the political process as shown in (Aidt, 1998). As a result, the outcome of the political process may therefore diverge from the economic efficient policy that requires that the preferences of the agenda setter coincide with the preferences for the population as a whole. Through repeated negotiations, the numerical analysis indicates that the diverging effect can be reduced.

4.0 Discussion

In the introduction we discussed potential explanations why efficient road pricing is so seldom used. Urban road pricing is characterized by conflicting interests between stakeholders and constituencies from different geographical areas. Road pricing policies do

therefore not only raise considerations about fairness and equity at a structural or principal level, they are also likely to trigger opposition from unfavored groups.

In the numerical illustration, we examined a political process where representative voters from different geographical areas in Lyon voted on a single proposal against status quo. The analysis showed that a majority of the representative voters could accept policies involving many different toll combinations, both with and without a bypass, in a pairwise comparison to the initial do-nothing situation, given that the net revenues are distributed back to the representative voters. However, for a policy to be the outcome of the political process, some agenda setter must first propose it. Conflicting interests between potential agenda setters can therefore have a strong influence on the political equilibrium. For the political process to result in an efficient pricing policy, the appointed agenda setter must represent a balanced mix of interests. If the agenda setter instead represents special interests, the outcome of the political process can be more extreme, since too much weight is placed on single interests.

From a political perspective, this is related to how the problem is framed in the political discourse and the arguments and principles that are used in the public debate. An urban road pricing policy can be seen as an environmental policy, a way of raising revenues for infrastructure investments or as an instrument for more efficient allocation of road space etc. Different policies can be motivated by different arguments and principles: the user-pays-principle can motivate a toll on the new bypass, the polluter-pays-principle can motivate a toll on the existing city road, a revenue neutral toll can be motivated with self-financing arguments, increased accessibility can motivate an un-tolled bypass, and environmental arguments can be used for not building the bypass at all and only toll existing road network. A

transport economist can similarly argue for economic efficiency, and fairness and equity concerns can lead to other outcomes depending on the concept of equity or fairness used.⁵

To reach an efficient outcome the political decision making process must be able to balance these conflicting interests against each other. If unable to do so, representatives for different geographical areas, influential lobby groups or functionally specialized planners may steer the agenda away from efficient policies towards policies that mostly benefit their interest. Since the benefits of the road tolls primarily come in the form of toll revenues, the perceived revenue use and compensation schemes between different stakeholders and geographical areas can be crucial for the ability of the political process to implement an efficient pricing policy. The model hence suggests that efficient road pricing is so rare in practice, not because efficient policies cannot be accepted, but rather because most interest groups or agenda setter prefer other non-efficient policies.

On the other hand, we should not forget two related factors of another order. First that the participation of the public in the discussions (a legal obligation in France) has a value as such and is important for the final acceptability of any proposal. Second, the functioning of democratic institutions is complex, slow and generates mostly second best solutions, but it is still the best guarantee against very bad solutions (Acemoglu and Robinson, 2012).

5.0 Conclusions

In a numerical illustration of a stylized bypass, we compared a set of potential policies in terms of efficiency and political acceptability. In the analysis, a relatively large number of

⁵ The model only focus on transport policies where the only interaction with non-transport policies is through the net revenues. In the real world, transport policies are often included in, and voted on, as part of a broader policy package. The relative position of a voter group on transport will help to define what sacrifice they want to make in another dimension. Although the framework used in the paper can be extended to include more dimensions, this will in general case not change the outcome of the model; that conflicting interests makes it difficult for decision makers to agree on a single policy. More dimensions will also make it more difficult to visualize the policy space.

policies, including the efficient one, could get majority support compared to the initial no-toll situation. The analysis therefore suggests that the difficulty to achieve political support for efficient road pricing policies is not to get majority support; instead, the difficulty arises because conflicting interests may make other non-efficient policies more attractive to many decision makers. Even though it is possible for an efficient road pricing policy to get majority support, the political process may not lead to it. In order to achieve political acceptability for efficient road pricing, more attention therefore needs to be placed on how the political process can resolve the inherent conflicting interests associated with efficient transport pricing policies. The numerical analysis indicates that repeated negotiations, in some situations, can be a way for the political process to reach a more efficient outcome. As we model political acceptability in a very simple way, the conditions we derive are to be considered as a minimum for acceptability.

To be sure, the chosen framework where a political economy model is combined with a transport model is sensitive to variations in the underlying model assumptions. Model parameters such as the initial congestion level, volume delay functions, bypass construction cost and capacity can have a large effect on both the optimal toll levels and the set of policies that is politically acceptable compared to status quo. The geographical structure of the road network, such as the existence of un-tolled back roads, can also have a strong impact on the efficiency and acceptability of a road toll as it allows travelers to avoid the direct cost of the road toll by changing to an un-tolled alternative road. Public transport is also important to consider since it can have a similar role in providing travelers with an alternative to car travel. The existence of conflicting interests between different geographical areas and special interests are however more robust to changes in the model setup.

Since the parameters used in the illustration are based on many simplifying assumptions, for instance regarding the geographical location of the travelers in the travel survey and the

associated preferences of the geographically based representative voters, the key results from the model are mainly illustrative. The study therefore serves more as an illustration of the role of conflicting interests for explaining the difficulty of reaching political support for efficient transport policies pricing rather than being an analysis of efficient transport policies in Lyon.

This is a first attempt to analyze political acceptability of urban road pricing policies by applying an agenda setter model where multiple dimensions can be considered, and comparing geographic versus special-interest approaches to the political process. The analysis can be extended in many directions. First, the simple transport model can be replaced with a full-scale transport model and a more sophisticated representation of the voters and special interests that for instance also include public transport users and non-travelers. Using the full-scale transport model we can simulate the effect of a grid of policies and estimate the effect of intermediate policies through interpolation in order to identify optimal policies and generate preference functions for the political economy model. We could also represent congestion more finely as a bottleneck problem rather than as a set of volume/delay functions, and this may strongly increase the benefits of road pricing. The political economy framework can also be extended in many direction to include more complex political processes. The political economy model can for instance be extended by incorporating negotiation between the agenda setters by allowing agenda setters to make counterproposals. The negotiations can also be modeled using bargaining concepts from cooperative game theory as in Westin et al. (2012). The model can also be extended by allowing the decision makers to choose between different transport infrastructure investments or more complex distribution schemes for the revenues.

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Appendix

Volume delay functions

The travel time in the model is assumed to be a linear function of the link demand and is described by the function $t_i = t_i^0 + \Delta t_i \cdot (D_i^0 - D_i)$ where the travel time t_i on road i is a function of the link demand D_i , the initial travel time t_i^0 , the initial link demand D_i^0 and the slope Δt_i . The initial travel time t_0 are assumed to be 34 minutes on all roads. The parameter values in the volume delay functions for the four roads are shown in Table A.1.

[TABLE A.1 AROUND HERE]

Travel demand

The model uses linear demand functions for the eight traveler groups in the model. The price-point elasticity of demand is assumed to be -0.8 for the city travelers, western travelers and north-south transit travelers and -0.6 for the external travelers. The motivation for this difference is that since the external travelers travel a longer distance they are assumed to be less cost sensitive to changes in the generalized cost of travel. The initial demand for travel for the traveler groups divided by which constituencies they belong to are shown in Table A.2.

[TABLE A.2 AROUND HERE]

Figures and tables

Figure 1: Illustration of the model framework.

Figure 2: Illustration of the city road network with four parallel roads and four geographical areas.

Figure 3: Political acceptability measured as the set of policies that can get majority support from the representative voters in the four geographical areas compared to the initial situation.

Figure 4: Political acceptability measured as the set of policies that can get majority support from the representative voters in the four geographical areas compared to the initial situation with exogenous net revenues.

Figure 5: Preferred policies by representatives for the different geographical areas and citizen interest groups representing special interests.

Figure 6: Asymptotic stationary distribution of the agenda-setting model under an open rule. The figure shows the policies in the asymptotic stationary distribution of the voting circle.

Table 1: Review of selected implementation attempts of urban road user charges.

City	Tolling Configuration	Decision Process	Political Party Positions	Interest Groups	Popularity	Outcome	References
London	Central Area	City leadership	Stable political leadership	Opponents: Residents against charge without exemption		Tolls installed: 5£ charge for all users (initial 15£ for hgv) 90% discount for residents within CC area	Ison and Rye 2005
Stockholm	Cordon	Party negotiation of a package; National enabling legislation; Trial and referendum	Green for; Social democrats first against, then for; Conservative for, then against, then for	Supporters: environmental interests; Opponents: one high-income central city district, far-suburban Stockholm, and suburban municipalities against, auto clubs	Survey: initial majority against, opinion changed in favor during trial	Referendum won (52% support); tolls installed nearly the same as in the trial	Hårsman and Quigley 2010
Hong Kong	Cordon			Opponents: auto clubs		Trial between July 1983 and March 1985; no permanent installation	Ison and Rye 2005
Edinburgh	Double-cordon	Scottish enabling legislation; City leadership; Public consultation; Referendum	Disagreements within ruling Labour group in the City Council	Referendum: car owners had higher voter turnout, were more opposed (24.7% for); non-owners supported it 64.0% for	Surveys: 34% support, then 36% support before referendum	Referendum Lost (25% support); no installation	Gaunt et al 2007; McQuaid and Grieco 2005; Rye, Gaunt and Ison 2008
New York	Cordon	City proposal; State authorization	Multi-party support, but certain Democrats (left) from outer boroughs in key leadership positions blocked the plan	Supporters: regional planning association, public transport riders, pedestrians and cyclists, business, labor and environmental groups; Opponents: politicians and civic groups in boroughs outside cordon	Surveys: 67% support in NYC as a whole if revenues to public transport; 40% support if revenues unclear	Not passed by legislature; no installation	Schaller 2010

Table 2: Population and income data for the different geographical study areas in Lyon (EMD Lyon 2006; EC Lyon 2006).

Area	Population (share)	Income/UC
City	273 000 (42%)	20 600 €
West	91 000 (14%)	18 500 €
North	86 000 (13%)	17 300 €
South	202 000 (31%)	16 200 €

Table 3: Conversion matrix for aggregating the surplus for the different interest groups into welfare for the constituency in each geographical area.

		Geographical area				
		City	West	North	South	External
Citizen interest group	City travelers (High VoT)	0.86		0.11	0.03	
	City travelers (Low VoT)	0.73		0.19	0.08	
	Western travelers (High VoT)		0.90	0.07	0.03	
	Western travelers (Low VoT)		0.87	0.09	0.04	
	North-south transit travelers (High VoT)			0.52	0.48	
	North-south transit travelers (Low VoT)			0.46	0.54	
	External travelers (High VoT)					1.00
	External travelers (Low VoT)					1.00
	City environment	1.00				
	Western environment		1.00			
	Taxpayers	0.42	0.14	0.13	0.31	

Table 4: List of representative policies

Policy	Bypass	Toll on city road	Toll on bypass
A - Welfare maximizing toll on city road with no bypass	No bypass	2.9 €	–
B – Revenue maximizing toll on city road with no bypass	No bypass	4.3 €	–
C – Bypass without any toll	Bypass	–	–
D – Welfare maximizing toll on bypass with bypass	Bypass	–	3.0 €
E – Welfare maximizing toll on city road with bypass	Bypass	3.0 €	–
F – Welfare maximizing toll with bypass	Bypass	3.0 €	3.3 €
G – Revenue maximizing toll with bypass	Bypass	4.3 €	4.2 €

Table 5: Comparison of change in total welfare, net revenue, environmental external effect and traveler surplus compared to the initial situation for the seven illustrative policies. The welfare is also decomposed into welfare for the different citizen interest groups and for the constituencies in the different geographical areas.

		A - Welfare maximizing toll on city road with no bypass	B – Revenue maximizing toll on city road with no bypass	C – Bypass without any toll	D – Welfare maximizing toll on bypass with bypass	E – Welfare maximizing toll on city road with bypass	F – Welfare maximizing toll with bypass	G – Revenue maximizing toll with bypass
Citizen interest groups	City trips	-67 000 €	-116 000 €	124 000 €	106 000 €	-45 000 €	-45 000 €	-116 000 €
	Western trips	-71 000 €	-91 000 €	214 000 €	113 000 €	214 000 €	90 000 €	57 000 €
	Transit trips	-8 000 €	-10 000 €	23 000 €	12 000 €	23 000 €	10 000 €	6 000 €
	External trips	-7 000 €	-9 000 €	21 000 €	11 000 €	21 000 €	9 000 €	6 000 €
	City environment	51 000 €	69 000 €	49 000 €	42 000 €	63 000 €	63 000 €	69 000 €
	Western environment	-39 000 €	-50 000 €	-79 000 €	-61 000 €	-80 000 €	-68 000 €	-65 000 €
	Taxpayers	345 000 €	374 000 €	-400 000 €	-35 000 €	-59 000 €	324 000 €	373 000 €
Geographical areas	City	142 000 €	131 000 €	-18 000 €	114 000 €	1 000 €	162 000 €	131 000 €
	West	-54 000 €	-78 000 €	55 000 €	34 000 €	103 000 €	58 000 €	38 000 €
	North	26 000 €	21 000 €	-7 000 €	25 000 €	14 000 €	48 000 €	40 000 €
	South	97 000 €	102 000 €	-99 000 €	4 000 €	-2 000 €	106 000 €	115 000 €
	External	-7 000 €	-9 000 €	21 000 €	11 000 €	21 000 €	9 000 €	6 000 €
	Traveler surplus	-153 000 €	-226 000 €	382 000 €	242 000 €	213 000 €	64 000 €	-47 000 €
	Environmental external effect	12 000 €	19 000 €	-30 000 €	-19 000 €	-17 000 €	-5 000 €	4 000 €
	Net revenue	345 000 €	374 000 €	-400 000 €	-35 000 €	-59 000 €	324 000 €	373 000 €
	Total welfare without toll collection cost	204 000 €	167 000 €	-48 000 €	188 000 €	137 000 €	383 000 €	330 000 €
	Toll collection cost (15%)	-52 000 €	56 000 €	- €	-55 000 €	-51 000 €	-109 000 €	-116 000 €
	Total welfare with toll cost	152 000 €	111 000 €	-48 000 €	133 000 €	86 000 €	274 000 €	214 000 €

Table 6: Proposed policies by the representative voters in the four geographical areas.

Agenda setter	Bypass	Toll on city road	Toll on bypass	Probability	Total welfare
City	Bypass	1.9 €	4.2 €	42%	336 000 €
West	Bypass	4.3 €	0.5 €	14%	187 000 €
North	Bypass	2.9 €	3.3 €	13%	381 000 €
South	Bypass	4.1 €	3.9 €	31%	350 000 €

Table 7: Proposed policies by citizen interest groups representing different special interests.

Interest group	Bypass	Toll on city road	Toll on bypass	Total welfare
City travelers	Bypass	0 €	1.2 €	99 000 €
Western, Transit and External travelers	Bypass	0.5 €	0 €	17 000 €
Environment City	Bypass	7.1 €	3.4 €	49 000 €
Environment West	No bypass	0 €	-	0 €
Environment Total	No bypass	6.5 €	-	-42 000 €
Taxpayer	No bypass	4.3 €	-	167 000 €

Table 8: Comparison of the expected efficiency of the political process under three different voting procedures.

Agenda setter	Expected total welfare gain	Relative welfare gain
Welfare maximum	382 000 €	100% (base)
Agenda setting model with representative voters under a closed rule	325 000 €	85%
Agenda setting model with representative voters under an open rule	362 000 €	95%
Agenda setting model with citizen interest groups	48 000 €	13%

Table A.1: Parameter values in the volume delay function.

Road	Initial link demand (trips)	Slope (minutes/1000 trips)
Main city road	190 000	0.2
Western bypass	215 000	0.2
City back roads	126 000	0.8
Western back roads	278 000	0.4

Table A.2: Initial travel demand and elasticity of demand for different travel groups. The initial travel demand is measured as the average number of daily trips in the initial situation. Allowed roads refer to the roads that the traveler group are allowed to use (CR = Main city road, WB = Western bypass, CBR = City back roads, WBR = Western back roads). (EMD Lyon 2006; EC Lyon 2006).

Traveler group	Initial demand	Elasticity of demand	Allowed roads
City travelers (High VoT)	152 310	-0.8	CR, CBR
City travelers (Low VoT)	104 690	-0.8	CR, CBR
Western travelers (High VoT)	139 380	-0.8	WB, WBR
Western travelers (Low VoT)	138 620	-0.8	WB, WBR
North-south transit travelers (High VoT)	12 990	-0.8	All

North-south transit travelers (Low VoT)	18 010	-0.8	All
External travelers (High VoT)	14 000	-0.6	All
External travelers (Low VoT)	14 000	-0.6	All

Table A.3: Travel time in minutes on the four roads for the representative policies.

Representative policy	Main city road	Western bypass	City back roads	Western back roads
A - Welfare maximizing toll on city road with no bypass	19.9	-	35.5	35.5
B - Revenue maximizing toll on city road with no bypass	13.5	-	36.7	36.0
C - Bypass without any toll	31.2	29.5	31.2	29.5
D - Welfare maximizing toll on bypass with bypass	31.6	15.4	31.6	31.6
E - Welfare maximizing toll on city road with bypass	18.8	29.5	35.0	29.5
F - Welfare maximizing toll with bypass	18.8	14.2	35.0	32.1
G - Revenue maximizing toll with bypass	13.5	10.1	36.7	32.8