CoAccept : Coordination politique et acceptabilité des péages routiers

Programme ERA-NET SURPRICE

Rapport final

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Table des matières

1. CONTEXTE DU PROJET

Les économistes et les ingénieurs des transports ont promu le péage routier depuis plus de 50 ans, afin de réduire la congestion et d'autres coûts externes de la circulation automobile. Dans certains pays (ex: France, Etats-Unis, Italie et Norvège), les péages routiers ont été principalement utilisés pour financer de nouvelles infrastructures routières. Ce n'est que récemment, avec les progrès dans la technologie de péage, l'introduction des péages urbains à Londres et à Stockholm, et des systèmes de péage en Allemagne, en Autriche et en Suisse, que les propositions de péage ont obtenu le soutien et l'intérêt croissants des décideurs politiques.

En général, la plupart des recherches ont porté sur l'évaluation de l'efficacité économique globale et, parfois, de l'équité (spatiale, par classe de revenu, etc. - cf. Raux et Souche JTEP, 2004) des différents systèmes de péage routier. Toutefois, plusieurs introductions prévues ont échoué (par exemple à Edimbourg) car les péages ont été rejetés à un stade précoce par les décideurs politiques, ou dans leur phase finale par les électeurs lors des référendums. Par conséquent, la question de savoir comment concevoir et mettre en place un système de tarification routière tel qu'il bénéficie d'une acceptation politique est un sujet de recherche important. En outre, la tarification routière pourrait très bien être introduite de bas en haut par les entités qui ont le plus à supporter la congestion et le trafic de transit. Une introduction non coordonnée de la tarification routière pourrait avoir des coûts d'efficacité élevés et en affecter négativement la faisabilité politique dans d'autres zones géographiques.

Ce projet se concentre sur deux aspects : d'une part l'introduction de la tarification routière par différentes entités qui contrôlent chacune une partie du réseau, d'autre part l'acceptabilité de la tarification routière. Le premier aspect est traité dans un premier rapport de l'équipe CoAccept paru en juin 2012 et notamment le papier de Jonas Westin, Joel P. Franklin , Sofia Grahn-Voorneveld et Stef Proost, *How to decide on regional infrastructure to achieve intra-regional acceptability and inter-regional consensus?* (Comment aboutir à un consensus interrégional et à une acceptabilité intra régionale dans le cadre d'une infrastructure régionale ?). C'est au second aspect que nous nous intéressons ici.

Dans le modèle simplifié développé par l'équipe CoAccept, un réseau de transport est utilisé par plusieurs groupes de voyageurs avec des préférences, types de déplacements et itinéraires alternatifs différents. Comme les segments dans le réseau sont utilisés par différents groupes de voyageurs, l'acceptabilité d'un projet variera entre les groupes. Nous supposons qu'une entité juridictionnelle accepte une politique donnée si elle augmente le bien-être d'une majorité qualifiée de la population. En utilisant le modèle nous allons étudier l'acceptabilité politique et l'efficience économique de différentes structures de tarification.

Deux politiques alternatives ou complémentaires sont considérées, à savoir :

- Imposer un péage routier dans la ville pour réduire la congestion et améliorer l'environnement (en utilisant les recettes pour augmenter les subventions aux transports publics locaux ou pour réduire les impôts existants)
- Construire une route de contournement pour détourner le trafic régional, financée entièrement ou partiellement par le péage

Pour ce faire, nous utilisons le cas de la ville de Lyon, dont le centre est victime d'un fort niveau de trafic, qu'il soit interne, d'échange ou de transit, induisant un haut niveau de pollution, de congestion, de bruit et autres effets externes indésirables.

2. L'ÉTUDE DU CAS LYONNAIS

Dans l'étude, nous utilisons un modèle stylisé de transport calibré pour coller au mieux à la situation de trafic de Lyon. La population est divisée en quatre zones géographiques : le Nord (noté "North"), le Sud ("South"), l'Ouest ("West") et le centre-ville ("City").

Le zonage a été adapté du zonage D34 de l'Enquête Ménage Déplacements de 2006, illustrée par la figure 1 présentée ci-dessous. La logique du papier nous a amener à agréger ce zonage en 4 zones principales, permettant d'aboutir à des analyses économiques géographiques : la zone agrégé nommée "City" (composée des zones 1, 2, 4) représente le centre-ville de Lyon, que l'autoroute traverse (dessiné en rouge sur la figure 1). La zone "West" (essentiellement zones 5) est composée des zones que le contournement est supposé traverser (représenté en bleu sur la figure 1). Enfin, les zones "North" (zones 24, 25, 14, 6) et "South" (zones 13, 4, 12, 23) représentent les point d'entrées et de sorties des axes étudiés.

Comme évoqué plus haut, il s'agit d'un modèle stylisé de l'agglomération lyonnaise. Les bases de données ne sont utilisées que comme support pour fournir des ordres de grandeur des trafics et des populations concernés.

La figure 1 représente le zonage en 34 zones de l'EMD06, en rouge est dessinée l'autoroute principale traversant le centre-ville lyonnais et en bleu le contournement proposé pour divertir le trafic

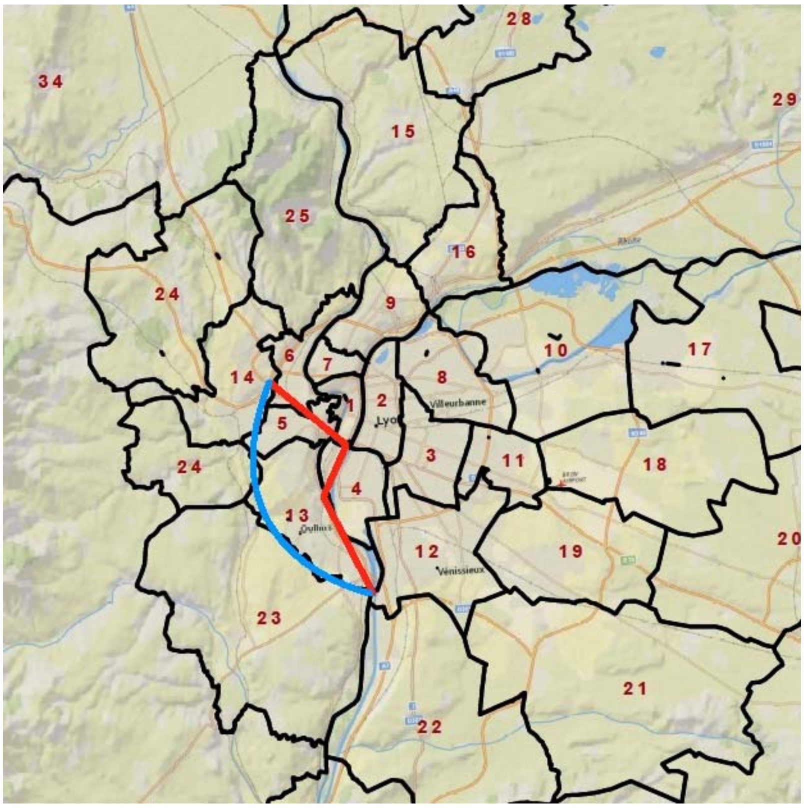


Figure 1. Zonage D34 de l'Enquête Ménage Déplacement 2006 (EMD06)

Les données requises ont été obtenus à partir de l'enquête ménages déplacements 2006 (zonage en 34 zones D34), de l'enquête cordon 2006 et des données de l'INSEE. La figure 2 résume les données relatives à la population et aux revenus de notre zonage agrégé, la figure 3 concentre les données relatives aux nombre de déplacements journaliers moyens entre les zones, pour tous types de motifs et enfin la carte en figure 4 présente le contexte lyonnais :

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

Figure 2. Population et revenus moyens par unité de consommation de Lyon (EMD Lyon 2006)

Average number of daily trips	**City**	**West**	**North**	**South**	**External**
City	158 000	57 000	37 000	13 000	
West	56 000	216 000	22 000	9 000	
North	36 000	22 000	181 000	15 000	
South	13 000	9 000	16 000	15 000	
External					28 000

Figure 3. Configurations des déplacements (nombres journaliers moyens de voyages entre les différentes zones géographiques de Lyon, tous motifs)

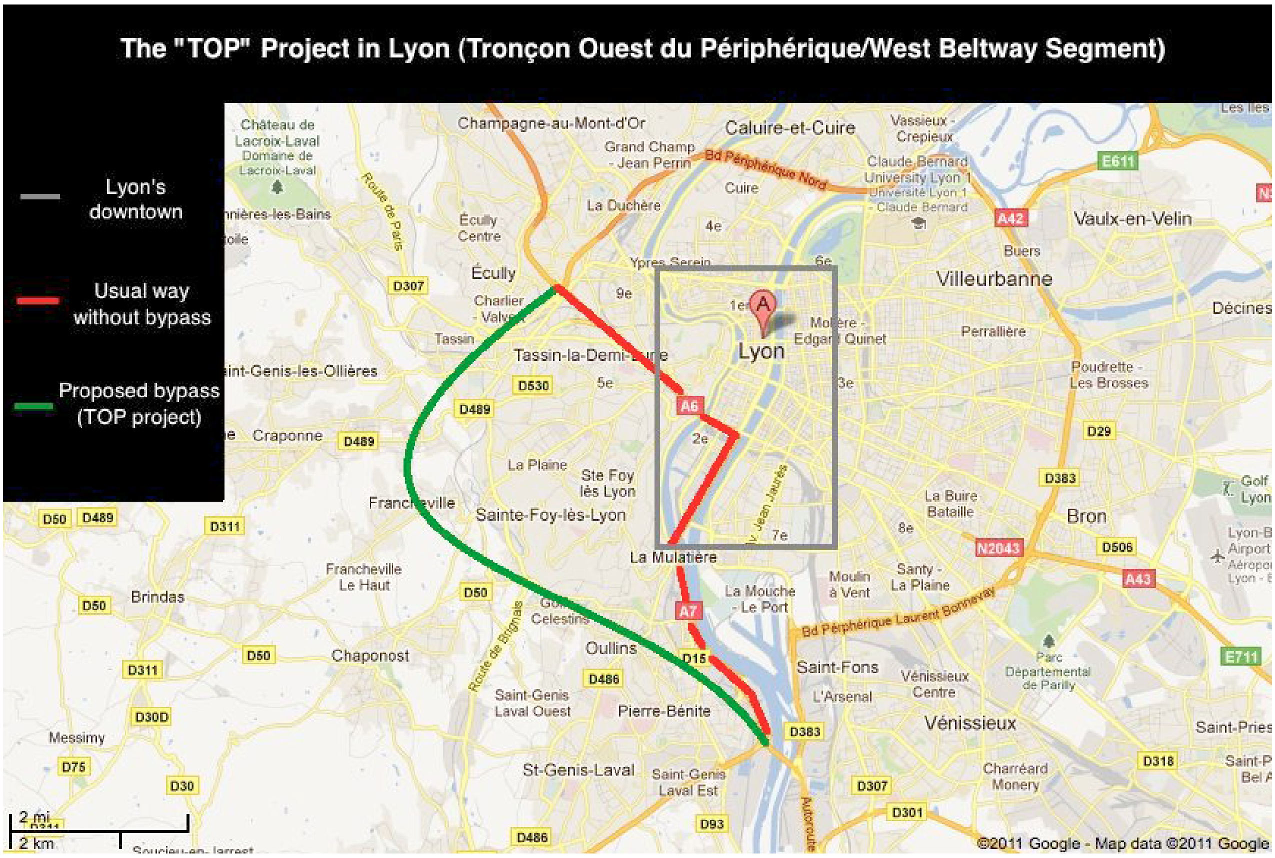
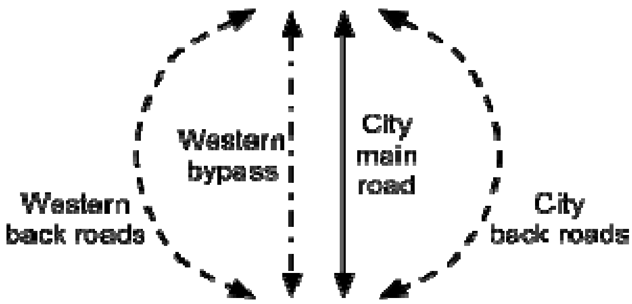


Figure 4. Le contexte lyonnais (contournement proposé/autoroute actuelle)

3. RÉSUMÉ DU PROJET ET PRINCIPAUX RÉSULTATS

L'idée ici est de comparer différents scénarios imaginés à partir de trois options politiques : le fait ou non de construire un contournement (sur la figure ci-dessous dénommé "western bypass"), l'application d'un péage Tc sur la route principale (noté "City main road") et l'application d'un péage Tb sur le contournement. L'illustration du modèle ainsi que les différents scénarios retenus sont décrits ci-dessous :



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	Bypass	–	3.0 €
E – Welfare maximizing toll on city road	Bypass	3.0 €	–
F - Symmetric revenue neutral toll with bypass	Bypass	1.3 €	1.3 €
G – Welfare maximizing toll with bypass	Bypass	3.0 €	3.3 €
H – Revenue maximizing toll with bypass	Bypass	4.3 €	4.2 €

Les scénarios A et B, sans implantation de contournement, décrivent respectivement les niveaux de péage Tc à appliquer sur la route principale afin de maximiser soit bien-être, soit les recettes.

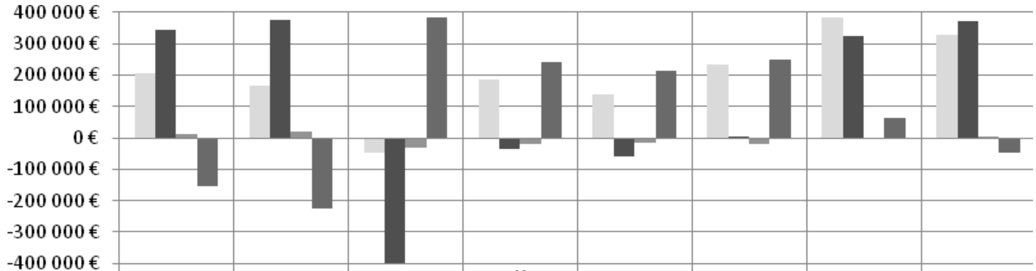
Le scénario C simule l'implantation du contournement sans application de péage (les recettes sont donc substantiellement déficitaires tandis que le surplus du voyageur est maximal).

Les scénarios D et E représentent la maximisation du bien-être en présence d'un contournement avec des niveaux de péage optimaux concernant respectivement à soit la route principale, soit le contournement.

Le scénario F considère des péages égaux sur les deux axes à un niveau tel que les recettes soient équivalentes aux coûts annualisés de construction (i.e. neutre fiscalement).

Enfin, les scénarios G et H représentent les combinaisons de péages optimales à appliquer simultanément sur la route principale et sur le contournement afin d'obtenir respectivement une maximisation du bien-être ou des recettes.

A partir du modèle et des scénarios listés ci-dessus, nous obtenons des résultats en termes d'efficience économique (figure 3), d'équité économique (figure 4) et d'équité spatiale (figure 5) :



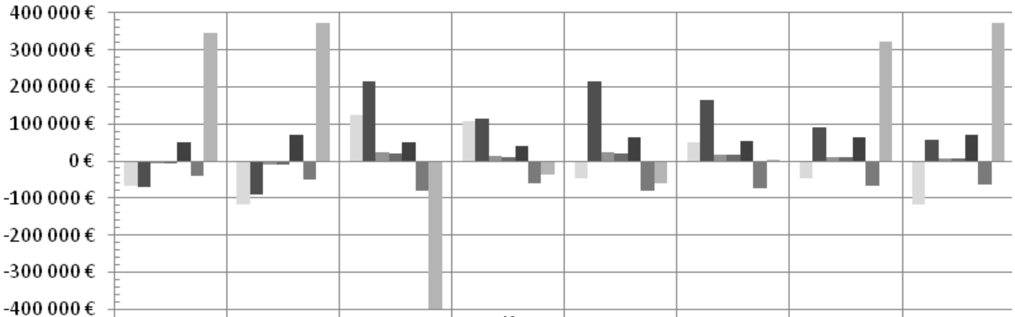
Policy	A	B	C	D	E	F	G	H
	Welfare maximizing toll on city road with no bypass	Revenue maximizing toll on city road with no bypass	Bypass without any toll	Welfare maximizing toll on bypass with bypass	Welfare maximizing toll on city road with bypass	Symmetric revenue neutral toll with bypass	Welfare maximizing toll with bypass	Revenue maximizing toll with bypass
Total welfare	205 000 €	167 000 €	-47 000 €	188 000 €	138 000 €	233 000 €	382 000 €	330 000 €
Net revenue	345 000 €	374 000 €	-400 000 €	-35 000 €	-59 000 €	4 000 €	323 000 €	373 000 €
Environmental effect	13 000 €	19 000 €	-30 000 €	-19 000 €	-17 000 €	-20 000 €	-5 000 €	4 000 €
Traveler surplus	-152 000 €	-226 000 €	383 000 €	242 000 €	214 000 €	249 000 €	63 000 €	-47 000 €

Figure 3. Variations en termes de bien-être total, recettes totales, effets externes et surplus des voyageurs, comparé à la situation initiale pour les 8 politiques représentatives.

Le bien-être total ("Total welfare") peut être décomposé en trois parties : les recettes du (ou des) péage ("Net revenue"), le surplus des voyageurs ("Traveler surplus") et les effets externes ("Environmental effect"). Le décideur doit alors peser ces intérêts entre eux afin de maximiser le bien-être total.

Par exemple, la figure 3 nous montre que la construction d'un contournement sans péage (politique C) va avoir un effet négatif sur le bien-être collectif. Même si une réduction du trafic a lieu sur la route principale, le contournement va attirer le trafic de transit et causer une congestion importante sur son axe. Combiné à un fort coût d'investissement, l'effet sera donc négatif. On peut donc supposer qu'une solution plus efficace peut être trouvée en instaurant un péage sur le contournement, régulant ainsi le trafic entre les deux routes.

Ainsi, on constate que la politique G correspondante à des niveaux de péages optimaux sur les deux axes permet de doubler le bien-être collectif par rapport à une situation de péage sur la route principale seulement (politique A). Cependant, le bilan environnemental reste négatif.



	Welfare maximizing toll on city road with no bypass	Revenue maximizing toll on city road with no bypass	Bypass without any toll	Welfare maximizing toll on bypass with bypass	Welfare maximizing toll on city road with bypass	Symmetric revenue neutral toll with bypass	Welfare maximizing toll with bypass	Revenue maximizing toll with bypass
City trips	-66 700 €	-116 000 €	124 000 €	106 000 €	-45 300 €	50 000 €	-45 300 €	-116 000 €
Western trips	-70 700 €	-90 900 €	214 000 €	113 000 €	214 000 €	165 000 €	90 000 €	57 000 €
Transit trips	-7 700 €	-9 900 €	23 000 €	12 000 €	23 000 €	18 000 €	10 000 €	6 000 €
External trips	-7 100 €	-9 200 €	21 000 €	11 000 €	21 000 €	16 000 €	9 000 €	6 000 €
City environment	51 000 €	69 000 €	49 000 €	42 000 €	63 000 €	55 000 €	63 000 €	69 000 €
Western environment	-38 700 €	-50 000 €	-79 400 €	-61 500 €	-79 400 €	-74 800 €	-67 700 €	-64 500 €
Tax revenues	345 000 €	374 000 €	-400 000 €	-35 500 €	-58 700 €	4 000 €	323 000 €	373 000 €

Policy	A	B	C	D	E	F	G	H

Figure 4. Décomposition du bien-être total selon les catégories spatiales, l'environnement et les recettes fiscales pour les 8 politiques représentatives

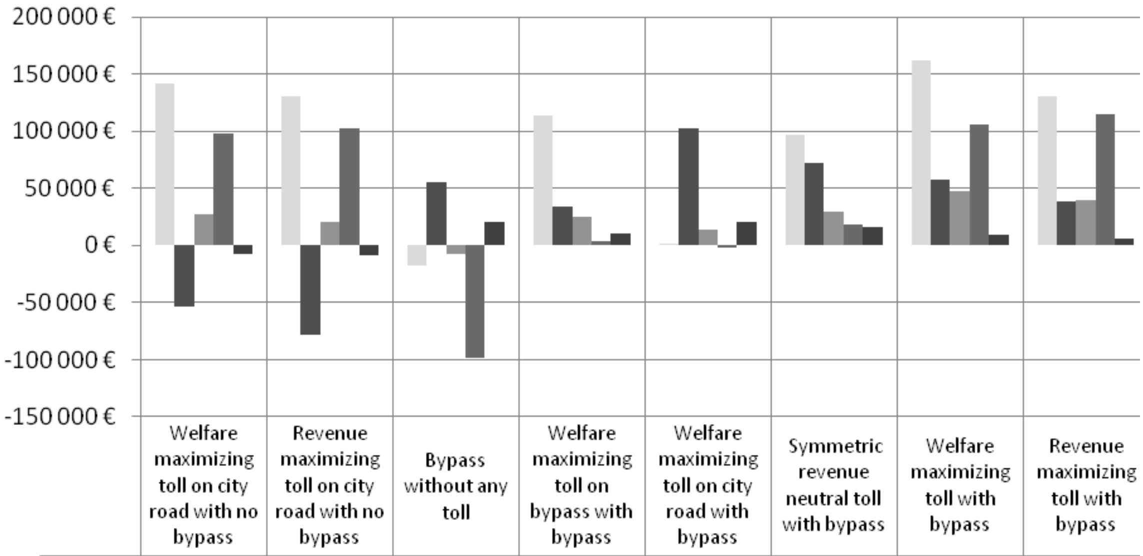
Cette figure permet de cerner les gagnants et les perdants géographiques liés aux différentes politiques testées dans le modèle.

La figure 4 témoigne du fait que les gains de bien-être proviennent principalement des recettes du péage, avec un plus haut niveau de bien-être pour les politiques ou les automobilistes ne payent pas de péage.

Tous les scénarios présentent également un bilan environnemental positif pour les habitants du centre-ville et un bilan négatif pour les voyageurs de l'Ouest en raison du déplacement du trafic de la route principale vers le contournement.

De plus, on voit que 3 des scénarios impliquent une situation positive pour tous les groupes d'automobilistes : le scénario C où aucun péage n'est appliqué, le scénario D où seul un péage sur le contournement est mis en place et le scénario F, neutre fiscalement. Par contre, les politiques A et B disposent de bien-être globaux négatifs pour toutes les catégories d'automobilistes.

Hormis l'impossibilité d'avoir un bilan positif sur l'environnement dans le centre et à l'Ouest, seul le scénario F dispose de recettes positives et de surplus positifs pour *toutes* les catégories d'automobilistes.



	Welfare maximizing toll on city road with no bypass	Revenue maximizing toll on city road with no bypass	Bypass without any toll	Welfare maximizing toll on bypass with bypass	Welfare maximizing toll on city road with bypass	Symmetric revenue neutral toll with bypass	Welfare maximizing toll with bypass	Revenue maximizing toll with bypass
City	142 000 €	131 000 €	-18 000 €	114 000 €	1 000 €	97 000 €	162 000 €	131 000 €
West	-53 000 €	-78 000 €	55 000 €	34 000 €	103 000 €	72 000 €	58 000 €	38 000 €
North	27 000 €	21 000 €	-7 000 €	25 000 €	14 000 €	29 000 €	48 000 €	40 000 €
South	98 000 €	102 000 €	-99 000 €	4 000 €	-2 000 €	18 000 €	106 000 €	115 000 €
External	-7 000 €	-9 000 €	21 000 €	11 000 €	21 000 €	16 000 €	9 000 €	6 000 €

Policy	A	B	C	D	E	F	G	H

Figure 5. Variations spatiales du bien-être pour les 8 politiques représentatives

Les résultats de la figure 5 correspondent aux changements en terme de bien-être des cinq zones géographiques en fonction des politiques appliquées.

En l'absence de contournement (politiques A et B), on voit que le péage appliqué sur la route principale augmente le bien-être de la zone centrale ("City") et des zones au Nord et Sud ("North", "South"). En effet, les voyageurs de ces zones bénéficient de la baisse de la congestion ainsi que d'une part des recettes du péage. En revanche, la zone Ouest ("West") subit une diminution de son bien-être collectif due au fait que le péage implique un déplacement du trafic de la route principale vers les routes secondaires de l'Ouest, d'où une situation plus congestionnée et des impacts environnementaux défavorables. L'effet est également négatif pour le trafic de transit venant de l'extérieur de la zone d'étude ("External") qui ne bénéficie pas d'une redistribution des recettes du péage. La situation est inverse pour la politique C.

Enfin, les politiques D, F, G et H améliorent la situation de chacune des zones mais à des degrés divers.

Au total, au vu de ces résultats, des conflits d'intérêts existent donc entre différents groupes d'électeurs (habitants) et d'automobilistes, pouvant expliquer les variations d'acceptabilité des scénarios.

On définit ici l'acceptabilité politique d'un groupe d'individus comme une variation de surplus du groupe entre deux situations avant et après. Si cette variation est positive, on considère que le groupe acceptera la nouvelle situation.

En simulant différentes combinaisons de péages applicables sur la route principale (Tc) et sur le contournement (Tb), on aboutit à des graphiques représentant les combinaisons de politiques acceptables. Ces combinaisons possibles, obtenant un soutien majoritaire des électeurs par rapport à la situation initiale, sont indiquées en gris dans les graphiques qui suivent.

Dans un premier temps, on simule ces différentes combinaisons dans le cas où les recettes du (ou des) péages sont redistribuées à égalité aux habitants :

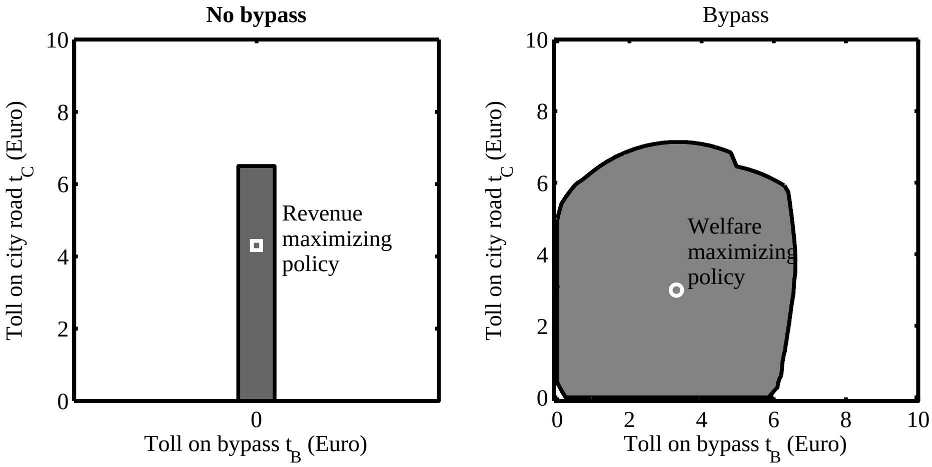


Figure 6. Acceptabilité des différentes combinaisons de péages avec redistribution des recettes

L'analyse montre un nombre important de combinaisons de péages aboutissant à une acceptation des péages, représentées sur la figure 6.

En revanche, si nous levons l'hypothèse de redistribution locale des recettes de péage, un péage tarifant la route principale ne sera accepté que si il y a construction d'un contournement comme le montre la figure 7 (gauche). La situation préférée des électeurs est ici de ne tarifer aucune des deux routes.

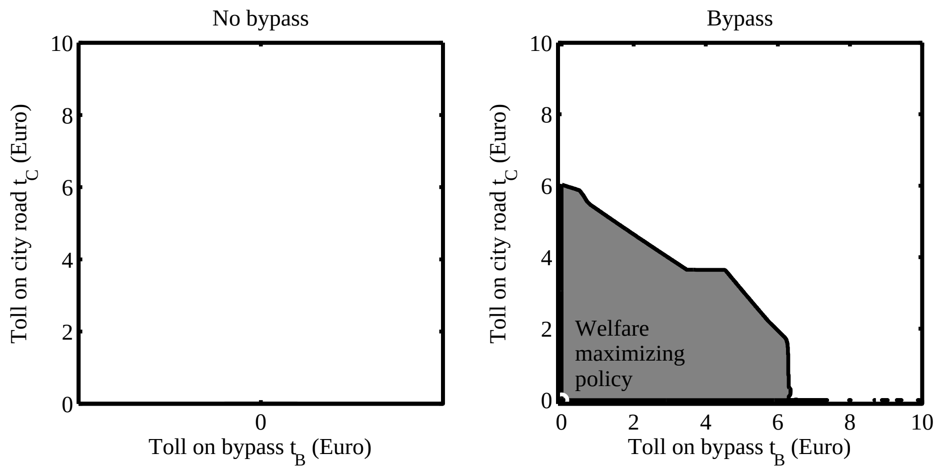


Figure 7. Acceptabilité des différentes combinaisons de péages sans redistribution des recettes

La partie droite de la figure 7 présente un autre cas, où le financement du contournement est entièrement couvert par ailleurs, c'est-à-dire sans impact sur les impôts locaux, et où les recettes du péage contribuent également à la couverture de ce financement (par exemple un contournement pris en charge par le gouvernement central comme pourrait l'être le Contournement Ouest de Lyon).

Dans ce cas, comme l'indique la figure, même si le contournement est construit sans coût pour les finances locales et sans recettes de péage à redistribuer localement, différentes combinaisons de péage peuvent également être acceptées.

4. RÉUNIONS DE TRAVAIL

Une première rencontre a eu lieu à Stockholm les 16 et 17 janvier 2012 (au "Royal Institute of Technology") afin de discuter de la trame du papier, ainsi que des données à fournir pour le cas de l'agglomération lyonnaise. Les participants furent Mr Joel P. Franklin, Mr Jonas Westin et Mr Pierre Basck.

Une deuxième rencontre a été organisée à Lyon début Avril 2012, au sein du Laboratoire d'Economie des Transports, pour finaliser la structure du papier, vérifier les données fournies et possiblement manquantes, élaborer un plan et entamer la rédaction d'une introduction générale. Les participants étaient Mr Charles Raux, Mr Stef Proost, Mr Joel P. Franklin, Mr Jonas Westin et Mr Pierre Basck.

De multiples conférences téléphoniques ont également été organisées pour faire parts des avancées respectives.

5. VALORISATION DU TRAVAIL

Le papier a été présenté lors de la conférence LATSIS Symposium, à Lausanne, en septembre 2012 par Mr Joel P. Franklin. Il a également été présenté par Mr Jonas Westin lors de la "First national conference in Transport economics" (première conférence nationale d'économie des transports) à Stockholm également courant Septembre 2012.

Le papier a été publié comme Working Paper[1] du "Centre for Transport Studies" du KTH (cf. Annexe 2).

[1] Westin Jonas, Basck Pierre, Franklin Joel P., Proost Stef and Raux Charles (2012) Achieving political acceptability for new transport infrastructure in congested urban regions Working papers in Transport Economics, No. 2012:19, CTS Centre for Transport Studies Stockholm Lien HTML : http://swopec.hhs.se/ctswps/abs/ctswps2012_019.htm

6. ANNEXE 1 : LES DONNÉES LYONNAISES

Commuting data

Ratio of trips of **the whole survey** (sample composed only of car and PT users) :
84,5% car users, 15,5% PT users

Ratio of trips **between regions** :

City Center (1, 2, 4) -> **North** (24, 25, 14, 6) = 83% car users, 17% PT users
City Center (1, 2, 4) -> **South** (13, 4, 12, 23) = 83% car users, 17% PT users
North -> **South** = 83% car users, 17% PT users
South -> **North** = 82% car users, 18% PT users

Ratio of trips **within** each zones :

Zones	Number of intra-zones trips (Car+PT ; non-redressed)	Proportion of Car users trips	Proportion of PT users trips
1	**194**	**27,8%**	**72,2%**
2	**430**	**56,7%**	**43,3%**
3	**600**	**62,0%**	**38,0%**
4	**92**	**69,6%**	**30,4%**
5	**117**	**82,1%**	**17,9%**
6	**258**	**72,5%**	**27,5%**
7	**37**	**78,4%**	**21,6%**
8	**685**	**62,8%**	**37,2%**
9	**132**	**93,2%**	**6,8%**
10	**653**	**78,3%**	**21,7%**
11	**474**	**84,4%**	**15,6%**
12	**686**	**80,3%**	**19,7%**
13	**592**	**82,1%**	**17,9%**
14	**447**	**91,3%**	**8,7%**
15	**309**	**94,8%**	**5,2%**
16	**273**	**80,6%**	**19,4%**
17	**855**	**98,6%**	**1,4%**
18	**453**	**98,5%**	**1,5%**
19	**480**	**90,6%**	**9,4%**
20	**315**	**95,9%**	**4,1%**
21	**413**	**95,4%**	**4,6%**
22	**266**	**90,6%**	**9,4%**
23	**602**	**95,2%**	**4,8%**
24	**639**	**97,2%**	**2,8%**
25	**88**	**87,5%**	**12,5%**
26	**1013**	**91,9%**	**8,1%**
27	**793**	**93,1%**	**6,9%**
28	**173**	**91,9%**	**8,1%**
29	**1671**	**92,4%**	**7,6%**
30	**723**	**95,6%**	**4,4%**
31	**4870**	**91,5%**	**8,5%**
32	**4278**	**91,9%**	**8,1%**
33	**1384**	**96,2%**	**3,8%**
34	**4737**	**95,5%**	**4,5%**

Population Data

Estimation of population by INSEE (national institute of french statistics).

City Center (1, 2, 4) = 272.500 inhabitants
North (24, 25, 14, 6) = 86.000 inhabitants
South (13, 4, 12, 23) = 201.500 inhabitants

Various data :

- Population of Lyon = 479.000 inhabitants
- Population of "Grand Lyon" (urban community) = 1.300.000 inhabitants (58 cities).
- Population of **"**Communauté Urbaine de Lyon**"** = 2.118.000 inhabitants (514 cities). Representing *(Urban Community of Lyon)* which can be compared to "metropolitan areas" in United States.

Income Data

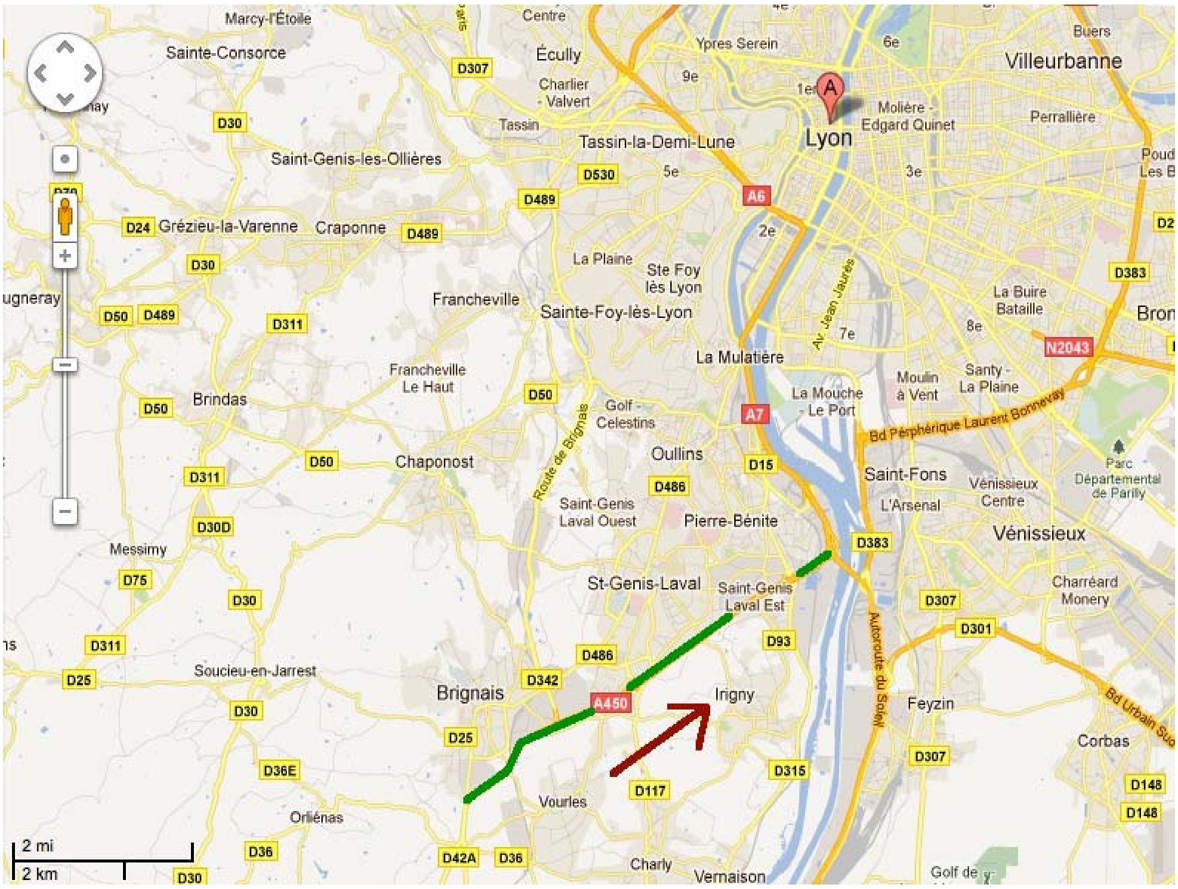
Residence Zone (D34)	Income/UC	Count
1	22873	226
2	20886	467
3	18488	901
4	17967	198
5	18486	387
6	14665	401
7	23105	176
8	15617	794
9	17845	187
10	12765	755
11	16574	304
12	11399	807
13	16648	1012
14	18121	585
15	17416	485
16	15748	342
17	16872	1065
18	18719	739
19	15374	695
20	16772	285
21	16830	622
22	15668	403
23	18930	390
24	19098	821
25	17832	242
26	13459	1271
27	18159	1249
28	16847	318
29	16160	2218
30	13772	789
31	15352	4599
32	15669	4215
33	17003	1776
34	15770	4006
Total	16967	33730

Data collected from **"Enquêtes Menages Déplacements 2006" (EMD06).**
In order to estimate the average income per zones, we use the median revenue that we divide by the unity of consommation of the household (UC, see INSEE). This unity is useful to compare households statistics because its take into account each members of the family. To determine the UC, we use these parameters : the first adult of the household = 1UC ; others persons whose age over 14 = 0,5UC ; other persons whose age under 14 = 0,3UC.

Trafic, vitesses moyennes (source : Observatoire des conditions de circulation sur Lyon, CETE de Lyon, Aout 2011)

Axe 450 (Ouest-Est) entre ST-Genis Laval et Fourvière :

Longueur totale (L): **11,4 km**
Temps de parcours à vide (TPAV) : **8 minutes**
Trafic moyen journalier mensuel (TMJM) : **23.000 V/j**
Vitesse moyenne (VM) : **83 km/h**
Volume d'encombrement (VE) : **1.878 H*KM** *(produit de la longueur du bouchon ou ralentissement multiplié par sa durée et par le nombre de voies de la section d'autoroute concernée)*



Source : Google Map (2012)

A6 entre Limonest et Lyon centre

<u>A6 :</u>

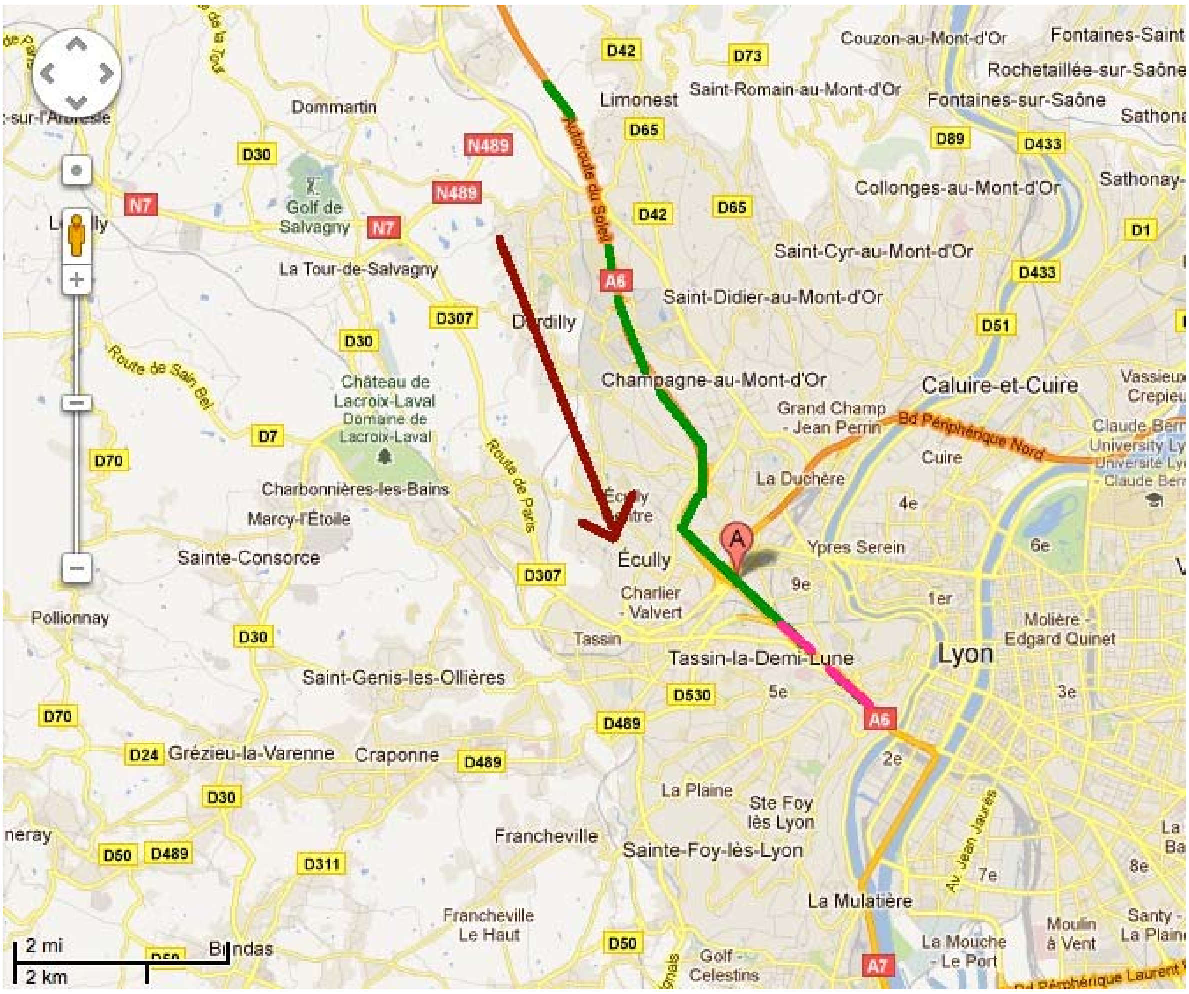
L: **11,4 km**
TPAV : - Entre Limonest et porte de Valvert (7,7kms) : **5 minutes**

Trafic moyen journalier mensuel (TMJM) : **54.200 V/j**
Vitesse moyenne (VM) : **98 km/h**
Volume d'encombrement (VE) :

- Entre Limonest et porte de Valvert (7,7kms) : **3.154 H*KM**
- Entre porte de Valvert et fin du tunnel de Fourviére : **8.326 H*KM**

<u>D306 :</u>

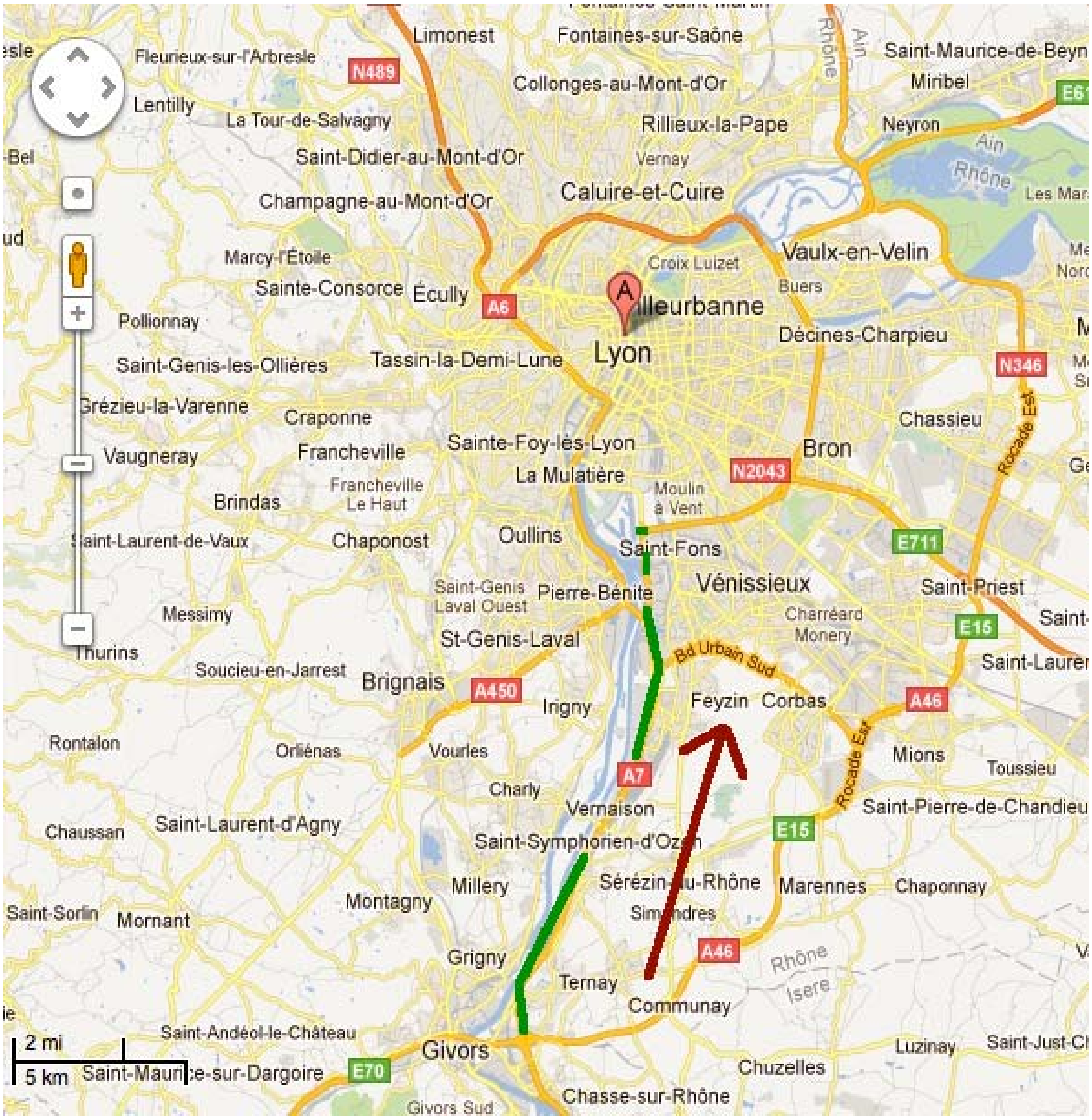
Trafic moyen journalier mensuel (TMJM) : **10.300 V/j**
Volume d'encombrement (VE) : **1.878 H*KM**



Source : Google Map (2012)

A7 entre Ternay et St-Fons

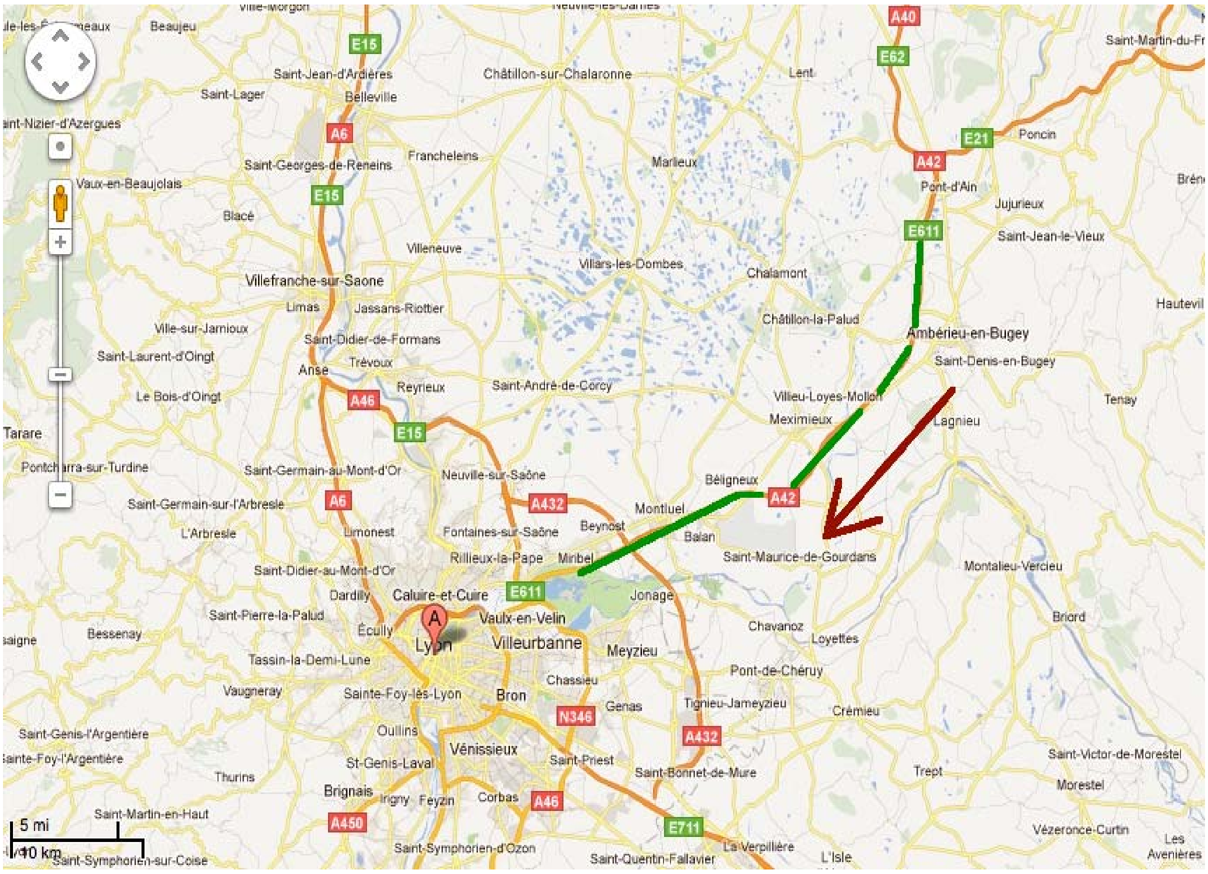
L: **12,4 km**
TPAV : **8 minutes**
Trafic moyen journalier mensuel (TMJM) : **56.900 V/j**
Vitesse moyenne (VM) :**108 km/h**
Volume d'encombrement (VE) : **3.354 H*KM**



Source : Google Map (2012)

A42 dans le sens Est-Ouest (Genève-Lyon)

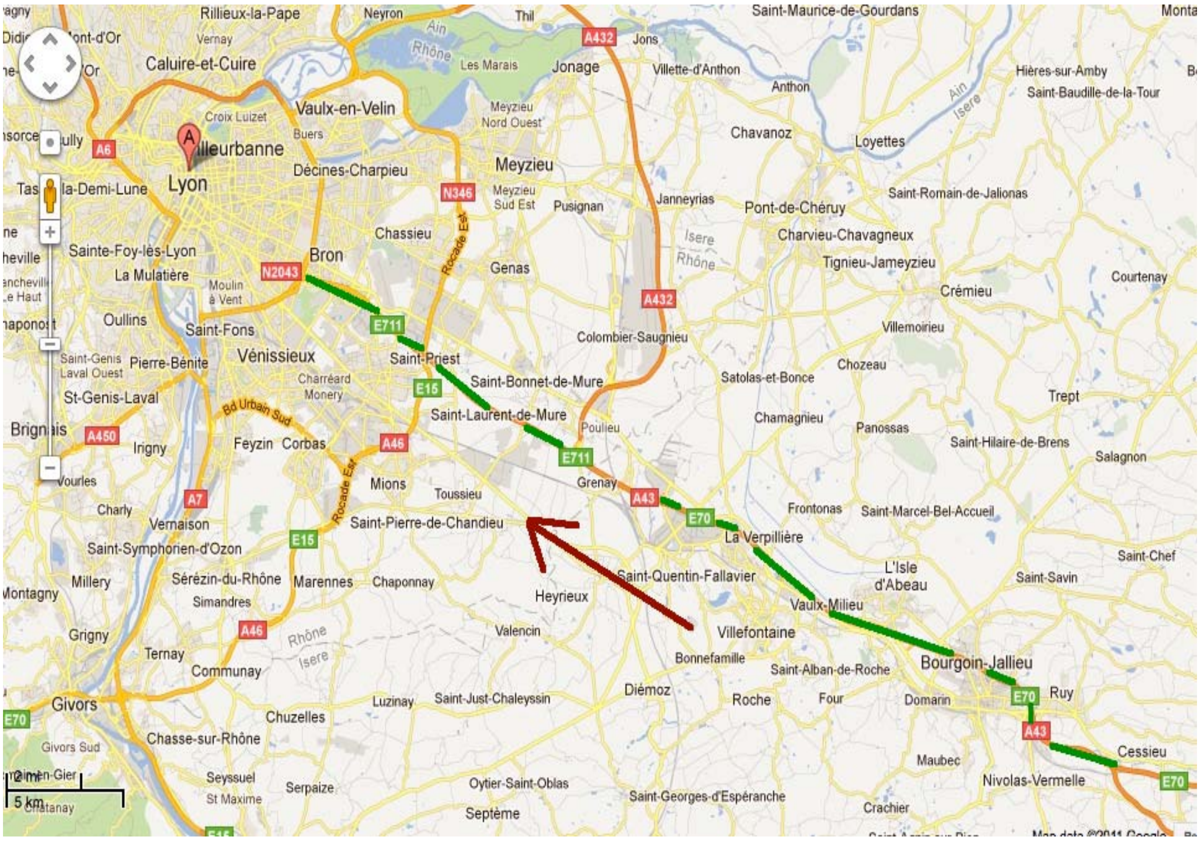
Trafic moyen journalier mensuel (TMJM) : **33.300 V/j**
Vitesse moyenne (VM) :**110 km/h**



Source : Google Map (2012)

A43 dans le sens Est-Ouest (Grenoble-Lyon)

Trafic moyen journalier mensuel (TMJM) : **44.400 V/j**
Vitesse moyenne (VM) :**117 km/h**



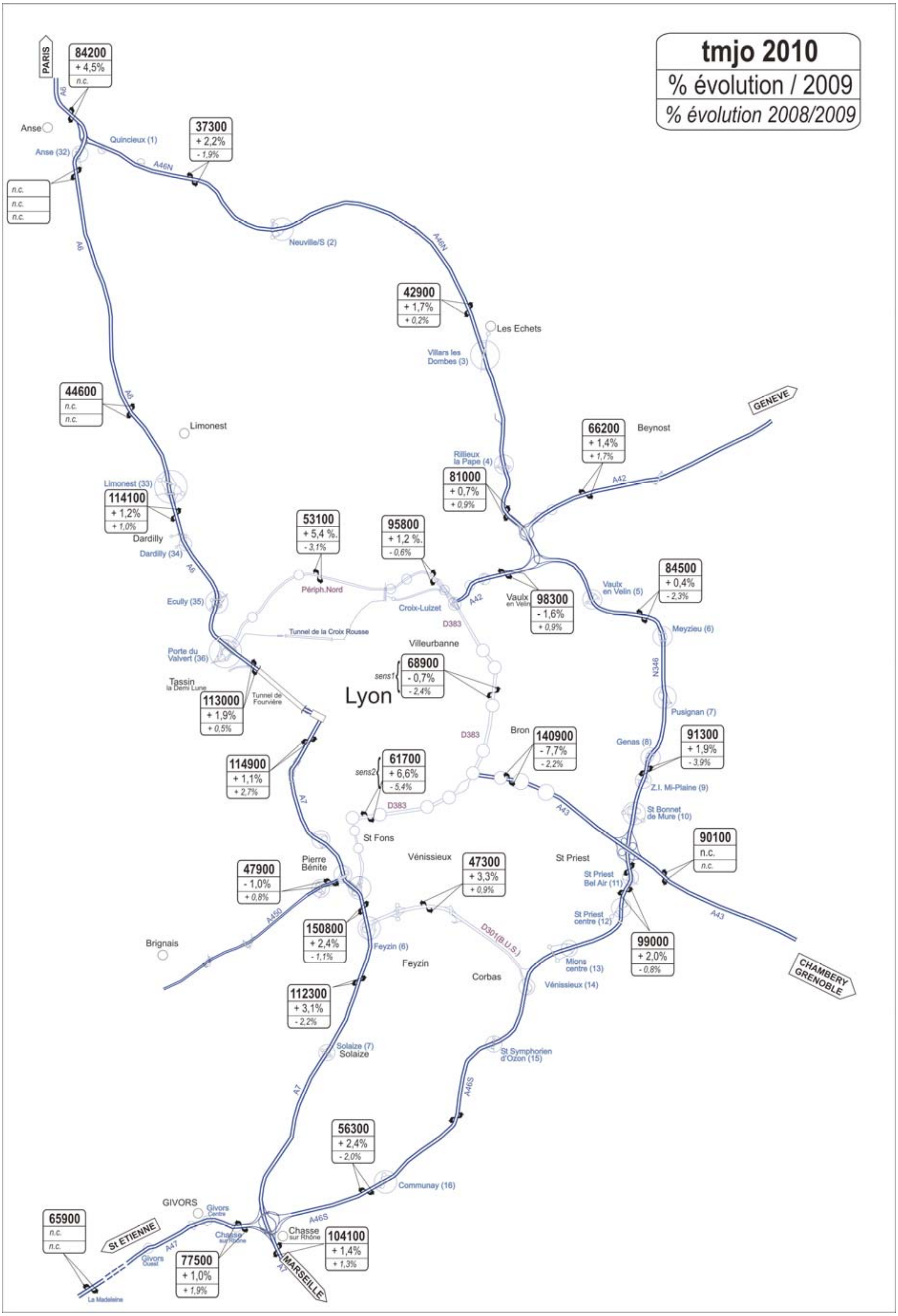
Source : Google Map (2012)

N346 (pas une pénétrante de Lyon) sens Nord-Sud

Note : Surtout utilisé par des poids lourds

L: **12,3 km**
TPAV : **9 minutes**
Trafic moyen journalier mensuel (TMJM) : **42.100 V/j**
Vitesse moyenne (VM) :**95 km/h**
Volume d'encombrement (VE) : **1.196 H*KM**

Source : Google Map (2012)



Source : Observatoire des conditions de circulation sur Lyon, CETE de Lyon, Aout 2011

7. ANNEXE 2 : WORKING PAPER

Westin Jonas, Basck Pierre, Franklin Joel P., Proost Stef and Raux Charles (2012) *Achieving political acceptability for new transport infrastructure in congested urban regions*, Working papers in Transport Economics, No. 2012:19, CTS Centre for Transport Studies Stockholm

Achieving political acceptability for new transport infrastructure in congested urban regions

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CTS Working Paper 2012:19

Abstract
The paper analyzes the political acceptability of policies targeted at relieving urban congestion. The paper combines a stylized model of an urban transport network with a somewhat more detailed model of the political process that incorporates interactions between voters, special interest groups and politicians to explore the possibilities to reach political acceptability for efficient transport policies. In a case study of a proposed bypass in Lyon, France, the paper compares a set of potential policies in terms of efficiency, equity and political acceptability. A possible explanation for the difficulty of achieving political support for efficient transport policies is that since urban road pricing policies are characterized by conflicting interest, the political decision making process must balance different interests against each other to reach an efficient outcome. The analysis suggest that the difficulty to achieve political support for efficient road pricing policies is not a lack of political acceptability; instead the difficulty arises because of low political feasibility for efficient transport pricing since non-efficient transport policies are seen as more attractive to the decision makers.

Keywords: user charges, political economy, transport infrastructure, welfare effects, acceptability of transport pricing

JEL Codes: R42, R48, R48, R53, H76

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1 INTRODUCTION

Many urban regions contemplate investing in peripheral roadways that bypass the city center in order to alleviate congestion, improve local environment and facilitate more efficient travel across the greater metropolitan areas. 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, this may be blocked by stakeholders and voter groups, or indeed never proposed to begin with.

The purpose of this paper is to analyze the efficiency and political acceptability of policies targeted at relieving congestion and improving urban environment. There are two concepts of acceptability used in the literature. The first is "individual acceptability": how do individuals or groups perceive a given transport policy when he or she is interviewed. The second type is "political acceptability": can a transport policy proposal receive a majority in the political process? There are many reasons, institutional as well as psychological why both types of acceptability can differ. The main focus in this paper is on political acceptability.

A difficulty when analyzing political acceptability of urban road pricing is that since only a few successful implementations exist, it is difficult to analyze the question empirically. In this paper we therefore develop a model for studying structural features of the political acceptability and feasibility of road pricing policies targeted at relieving urban congestion. To do this, we combine a stylized model of an urban transport network with a somewhat more detailed model of the political process that incorporates interactions between voters, special interest groups and politicians.

How can we explain the observed difficulties to achieve political support for efficient transport pricing polices? In a case study of a proposed bypass in Lyon, France, we compare a set of potential policies in terms of their effect on efficiency, equity and political acceptability and use the political economy framework to find acceptable and feasible outcomes given the transport system, decision makers, voters, influential lobby organizations and local political process.

We use the case study to analyze a number of potential explanations for why it can be difficult to reach a decision supporting an efficient transport policy:

- Conflicting interests between interest groups
- Conflicting interests between spatial groups
- Uncertainty about revenue use
- Features of the political process
- Ties to other issues

The main contribution of the paper is to illustrate how conflicting interests between different stakeholders and geographical representatives can make it difficult for a political process to achieve an efficient transport policy.

In Section 2 we present the model and describe the political economy framework. The case study is analyzed in Section 3. Section 4 discusses the model results in a political context and Section 5 concludes with a discussion of policy implications and limitations to the transferability of the results.

1.1 Literature review

Although pricing is often an efficient way of reducing urban congestion, few successful implementations of 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 Shade and Schlag 2003).

Equity and fairness considerations are also often identified as important factors for the individual acceptability of road pricing. Since the purpose of road pricing is to reduce the demand for travel to an economically efficient level, some travelers are likely to be worse off compared to the no-toll situation. Raux and Souce (2004) identify three dimensions of equity which are directly relevant for transport pricing policies; *Spatial equity* according to which society should guarantee the right of access to jobs, goods and services from any location; *Horizontal equity* which involves the equality of treatment of different users. The principle can both take the form of an "user pays principle" making the user pay for a good or the "polluter pays principle" where the user pays for the damage he or she causes to society, and; *Vertical equity* which explicitly considers social inequalities and their consequences with regard to transport and can often be assessed by studying the well-being of the most disadvantaged. 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 (Frej 2003).

Although individual acceptability is important for the popular support for a transport policy; political acceptability is a prerequisite for a policy to be implemented. In the literature, political acceptability of road pricing has 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 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).

De Borger and Proost (2011) use a simple majority to study how uncertainty regarding modal substitution costs and revenue use affect 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. The main reason was the individual uncertainty regarding the costs of modal substitution for the car users. Some drivers will actually gain from the road pricing but ex ante they expected 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. Another approach is taken by Westin et al. (2012) that study how acceptability constraints protecting certain interest groups can lead to inefficient tolling. Assuming that special interest groups are only interested in the benefits for their members and not in the welfare gains for society as a whole; they will press for policies that are most likely to benefit their members which can lead to the use of less efficient instruments.

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 as the traditional equity-efficiency trade off (Mayeres and Proost 2001; Westin et al. 2012).

1.2 Review of previous implementations

As a result of the low acceptability, there are few successful implementations of urban road pricing policies. A review of previous attempts to implement urban road user charges is shown in Table 1. Interest groups, environmental organizations and groups associated with public transport riders are found among the supporters of road pricing whereas auto clubs are found among its opponents.

In the New York case, the individual acceptability is also found to be contingent on the revenue use; support is higher if the revenues are re-invested in the transport system compared to if the revenue use is more uncertain. The variation in decision making processes makes it difficult to draw a clear conclusion regarding the influence of the political process in achieving support for urban road user charges. Based on the review no clear pattern concerning political party positions on a left-right scale can be found other than that green parties seem to be in favor of tolling car traffic.

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

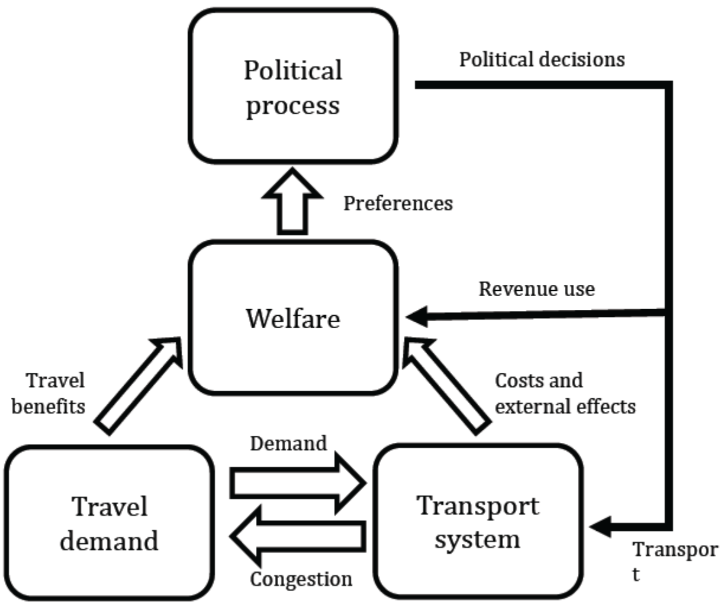
City	Tolling Configuration	Decision Process	Political Party Positions	Interest Groups	Popularity	Outcome	References
London	Central Area	City leadership	Stable political leadership	Opponents: Residents against charge without exemption		5£ charge for all users (initial 15£ for hgv)	Ison and Rye 2005
Stockholm	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: Östermalm, far-suburban Stockholm, and suburban municipalities against, auto clubs	Survey: initial majority against, opinion changed in favor during trial	Referendum won (52% support)	Hårsman & Quigley 2010
Hong Kong Trial	Cordon			Opponents: auto clubs		Trial between July 1983 and March 1985; No permanent installation	Ison and Rye 2005
Cambridge Trial	Distance within Central Area					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)	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	Schaller 2010

2 METHODOLOGY

We combine a stylized transport model of the road network in the Lyon metropolitan area with a model of the political economy of the decision making process. In all assessments of individual utility, tolls, travel time changes, revenues and local environmental effects are taken into account. By using a simplified traffic model, 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 find the welfare-maximizing policy, to analyze which geographical areas, type of travelers and special interests that are winners and losers on different policies, to study what transport policies that can be politically acceptable and, in combination with a model of the political process, to identify likely outcomes of the political decision making process. To analyze the political process we use a model inspired by Baron and Ferejohn (1989) where a number of legislative members or representative voters negotiate over a policy to alleviate road congestion and improve local environment. In the model, each legislative member represents the constituency in a distinct geographical area in Lyon. An illustration of the model framework is shown in Figure 1.

Figure 1: Illustration of the model framework



2.1 Model of the transport system

We model the city of Lyon 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. The road network is illustrated in Figure 2.

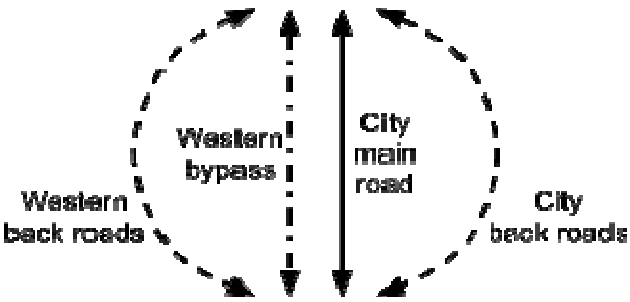


Figure 2: Illustration of the city road network with four parallel roads.

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.

The travelers are divided into four main categories depending on their travel pattern: city travelers, western travelers, north-south travelers and external travelers. City travelers are traveling to, from and within the city center and can therefore only use the main city road and the city back road. Western travelers are in a similar way only allowed to use the western back road and, if built, the bypass. The north-south transit travelers and the external travelers are both passing through the city and can hence choose between all roads. The difference between transit travelers and external travelers are that the external travelers are assumed to be less cost sensitive since they travel a longer distance. To refine the model even further, we separate the travelers 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. When choosing transport routes, all travelers are assumed to choose the route with the lowest generalized cost, i.e. Wardrop's principle holds. To simplify the analysis further, we only consider car travel in the model.

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 Lyon affected by traffic on the western back road and on the bypass. The environmental external cost is assumed to be proportional to traffic volume and the same for all roads. Finally, we consider effect on local tax payers who pay for the construction of the bypass and in return receive the revenues from the road tolls.

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 monetary terms after redistribution of toll revenues and investment costs. Welfare is simply the un-weighted sum of utility of the whole population. An efficient solution is a solution that maximizes welfare.

To maximize welfare, the decision makers have a number of policy instruments at their disposal. Following the political discussion in France 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 be to only toll the main city road and the bypass. Verhoef et al. (1996) analyze welfare maximizing second-best congestion pricing in the case of an un-tolled alternative. Analyzing 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.

The welfare maximizing toll levels also depend on the marginal cost of public funds which is related to the efficiency of the tax system. If the marginal cost of public funds ($MCPF$) is above one, the welfare maximizing tolls will in general deviate from its Piguovian levels towards the toll levels that maximize revenue. Depending on the situation, this can mean both higher and lower tolls compared to when $MCPF = 1$ (Westin et al. 2012). In this model we assume that $MCPF = 1$.

For the purpose of differentiating between preferences across the population, we divide it into five geographical areas: North, South, City Center (including East), West and an External area for travelers from outside the Lyon Urban Area. The external travelers do not vote. Each area has a representative voter who wants to maximize aggregate welfare for the population in the area. We assume that aggregate welfare in each area is a weighted sum of the utility for the different individuals in the area. This implies that each representative voter has multiple goals; the representative voter in the city center does for instance both consider 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 costs. We assume that the net revenues from the project (the collected toll revenues minus the cost for constructing the bypass) are distributed equally among the citizens within the four geographical areas in Lyon. The distribution is hence assumed to be proportional to the size of the population in each area.

2.3 Model of the Political System

In the political process the preferences of the voters are transformed into a preference function for policies. To construct this function we can rely on different political decision mechanisms: 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. In this model, one of the representatives is appointed agenda setter and proposes a policy with majority support that maximizes his own welfare.
We assume that the constituency in each geographical area is represented by a single representative voter and that the number of votes for each representative voter is proportional to the constituency's share of the total population in Lyon. Around 40% of the population lives in the city center compared to around 15-30% 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. The external travelers are assumed to have no influence in the local decision making process.

In the analysis of the political process, we make a distinction between "political acceptability" and "political feasibility". The main difference between the concepts is that while a policy is political acceptable if it can win in a pairwise election against status quo, a political feasible policy must also be a likely outcome of the political process.

2.3.1 Political acceptability

Let Y be the set of all policies (all possible combinations of the three policy instruments) 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 $i = 1, \dots, I$ supports a proposed policy y compared to a current policy y_m if his or her area does not lose on the policy compared to the current situation, that is, if $W_i(y) \geq W_i(y_m)$ where $W_i(y)$ is the welfare for area i under policy y and $W_i(y_m)$ is the area's welfare under policy y_m. Let p_i be representative i's share of the total number of votes where $\sum_{i=1}^{I} p_i = 1$. The support $S(y, y_m)$ for a policy y compared to a policy y_m is then:

$$S(y, y_m) = \sum_{i=1}^{I} p_i \cdot 1_i(y, y_m) \qquad (1)$$

where $1_i(y, y_m)$ is an indicator function that equals one if representative i supports the policy, i.e. $W_i(y) \geq W_i(y_m)$ and is zero otherwise. From $S(y, y_m)$ we can define the subset of policies $Y_m \subseteq Y$ that has majority support against policy y_m:

$$Y_m = \left\{ y \in Y : S(y, y_m) > \frac{1}{2} \right\} \qquad (2)$$

Y_m is therefore the subset of all policies $y \in Y$ that can win a pairwise election against policy y_m.

2.3.2 Political feasibility

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 a proposal is made, 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_m that can get support from a majority of the voters against the current policy on the table y_m (in this case the initial no-toll situation) and choose the policy within the subset that maximizes his or her utility y_m^i, that is:

$$y_m^i = \mathrm{argmax}_{y \in Y_m} W_i(y) \qquad (3)$$

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 $P_m(y)$ that gives the probability that a policy y is chosen given an initial policy y_m.
In addition to the standard model, we also consider a modified version of the agenda setter model where lobby groups representing special interests are allowed to set the agenda by making a proposal that the representative voters are asked to vote on.

3 CASE STUDY

We base our case study on the Lyon, France metropolitan region. Lyon is the 3rd largest city in France and the 2nd largest conurbation after Paris 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) runs across Lyon city center implying clashes between long distance 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, several projects have been proposed by different institutional actors 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 "Troncon Ouest Périphérique" (more recently renamed "l'Anneau des Sciences") to divert traffic from the city center. The project includes a possible toll on the new bypass and either a reduction of capacity or a toll on the current motorway and is estimated to cost between 2 and 2.5 billion Euros. Financing is under the responsibility of the local governments, who have agreed on a common management of the decision procedure.

A public debate is scheduled to take place in 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 environmental party is thoroughly opposed to the project, which makes it difficult to reach an agreement. A conventional toll on this new road is planned in order to at least partially cover the financing of the project (Grand Lyon 2012). There is no previous case of such a toll system applied in France, however, since 2010 and "loi Grenelle II", cities of 300.000 inhabitants and more can experiment with implementation of a cordon or an area road-user charging scheme. Different tolling alternatives are hence an issue that could emerge in the public debate.

3.1 Data and model calibration

In the case study, we use a stylized transport model calibrated to resemble the traffic situation in Lyon, France. The model is calibrated using data from travel surveys, census data and output from a VISUM-based transportation model of 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 to generate input into the political economy framework. We use the data to specify volume delay functions for the roads, demand functions for the eight travel groups and a matrix for aggregating the travel surplus of the representative travel groups into welfare for the geographical areas.

In the model the population in Grand Lyon is divided into four geographical areas; North, South, East and City Center (including West). 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%) and the highest average income. The lowest average income is found among people living in the South.

Table 2: Population and income data for Lyon (EMD Lyon 2006; EC Lyon 2006).

Area	**Population (vote share)**	**Income/UC[1]**
City	273 000 (42%)	20 600 €
West	91 000 (14%)	18 500 €
North	86 000 (13%)	17 300 €
South	202 000 (31%)	16 200 €

In Table 3 the estimated number of daily trips between each geographical area is shown. The travel patterns are based on data from two different travel surveys, the figures for the local trips are based on (EMD Lyon 2006) and the figure for external trips is based on data from the 2006 Enquête Cordon study (EC Lyon 2006).

[1] To estimate the median we use the after tax income per consumption unit. See (INSEE 2012) for a definition.

Table 3: Travel patterns measured as the average number of daily trips between different geographical areas in Lyon (EMD Lyon 2006; EC Lyon 2006)

Average number of daily trips	City	West	North	South	External
City	158 000	57 000	37 000	13 000	
West	56 000	216 000	22 000	9 000	
North	36 000	22 000	181 000	15 000	
South	13 000	9 000	16 000	15 000	
External					28 000

Based on the travel pattern we estimate the initial travel demand for the eight traveler groups. To capture that travelers have different value of time, we consider two different values of time: 11.1 €/h for travelers with a high value of time and 8.8 €/h for travelers with a low value of time. The share of travelers with high and low value of time in each area is based on the average income in each area.

A resident in the Lyon metropolitan area spend on average 68 minutes per day on travel, travelling an average of 21 km (SYSTRAL 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 trip cost of 4 €. The slopes of the volume delay functions are chosen to give the model a reasonable response when a congestion charge is imposed.

Assuming a construction cost of 2.5 billion Euro, an interest rate of 5%, a depreciation period of 100 years and that the bypass is used 250 days/year; the cost of the bypass is 400.000 €/day. A summary of the remaining model parameters are given in the Appendix.

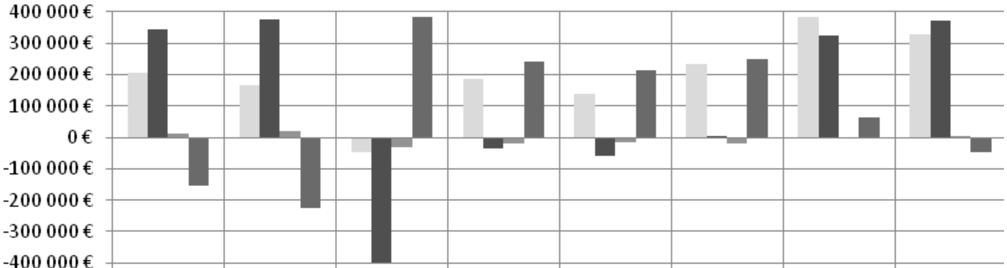
3.2 Economic efficiency

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 bypass t_B. To analyze the effect of using the policy instruments, we study the effect of a number of representative policies. The policies are summarized in
Table 4.

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 - Symmetric revenue neutral toll with bypass	Bypass	1.3 €	1.3 €
G – Welfare maximizing toll with bypass	Bypass	3.0 €	3.3 €
H – Revenue maximizing toll with bypass	Bypass	4.3 €	4.2 €

In Figure 3, a comparison of the change in total welfare, net revenue, environment external effect and traveler surplus compared to the initial situation for the eight representative policies is shown.



	Welfare maximizing toll on city road with no bypass	Revenue maximizing toll on city road with no bypass	Bypass without any toll	Welfare maximizing toll on bypass with bypass	Welfare maximizing toll on city road with bypass	Symmetric revenue neutral toll with bypass	Welfare maximizing toll with bypass	Revenue maximizing toll with bypass
Total welfare	205 000 €	167 000 €	-47 000 €	188 000 €	138 000 €	233 000 €	382 000 €	330 000 €
Net revenue	345 000 €	374 000 €	-400 000 €	-35 000 €	-59 000 €	4 000 €	323 000 €	373 000 €
Environmental effect	13 000 €	19 000 €	-30 000 €	-19 000 €	-17 000 €	-20 000 €	-5 000 €	4 000 €
Traveler surplus	-152 000 €	-226 000 €	383 000 €	242 000 €	214 000 €	249 000 €	63 000 €	-47 000 €

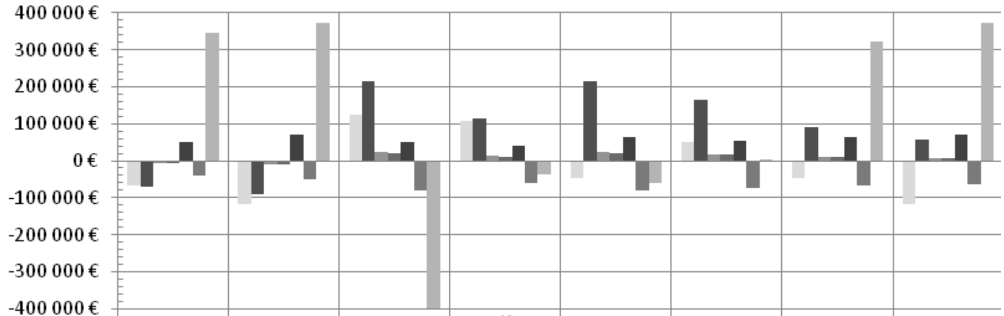
Figure 3: Comparison of change in total welfare, net revenue, environmental external effect and traveler surplus compared to initial situation for the eight representative policies.

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). In the example, total welfare can be decomposed into three parts: toll revenues, traveler surplus and environmental effect. To maximize total welfare, the decision makers must balance these interests 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 is to reduce congestion.
With a bypass, the decision makers can set tolls on both the bypass and on the main city road. Total welfare is then maximized for a bypass toll equal to 3.3 € and a matching toll on the city road equal to 3.0 € (policy G). 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.

Comparing the representative policies, we see that the bypass without tolls (policy C) has a negative effect on total welfare. The reason for this 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. By tolling the bypass, a more efficient allocation of traffic between the roads can be achieved. With efficient tolling (policy G), the bypass has the potential to nearly double total welfare compared to efficient tolling with no bypass (policy A). The effect in the example does however critically depend on both the investment cost and the travel time gains from the bypass. With a higher investment cost, the optimal policy would 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. The environmental effect is however small compared to the effect on travelers' surplus.

3.3 Decomposition of welfare effects

To analyze the distributional impact of the different policies we decompose the welfare effect into the effect on functionally specialized interests. The decomposition is shown in Figure 4.



	Welfare maximizing toll on city road with no bypass	Revenue maximizing toll on city road with no bypass	Bypass without any toll	Welfare maximizing toll on bypass with bypass	Welfare maximizing toll on city road with bypass	Symmetric revenue neutral toll with bypass	Welfare maximizing toll with bypass	Revenue maximizing toll with bypass
City trips	-66 700 €	-116 000 €	124 000 €	106 000 €	-45 300 €	50 000 €	-45 300 €	-116 000 €
Western trips	-70 700 €	-90 900 €	214 000 €	113 000 €	214 000 €	165 000 €	90 000 €	57 000 €
Transit trips	-7 700 €	-9 900 €	23 000 €	12 000 €	23 000 €	18 000 €	10 000 €	6 000 €
External trips	-7 100 €	-9 200 €	21 000 €	11 000 €	21 000 €	16 000 €	9 000 €	6 000 €
City environment	51 000 €	69 000 €	49 000 €	42 000 €	63 000 €	55 000 €	63 000 €	69 000 €
Western environment	-38 700 €	-50 000 €	-79 400 €	-61 500 €	-79 400 €	-74 800 €	-67 700 €	-64 500 €
Tax revenues	345 000 €	374 000 €	-400 000 €	-35 500 €	-58 700 €	4 000 €	323 000 €	373 000 €

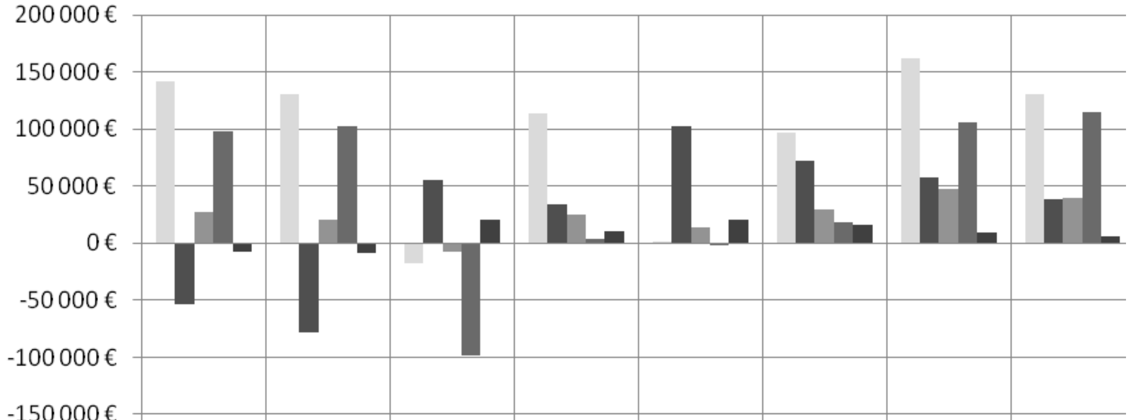
Figure 4: Decomposition of total welfare into effects on special interests for the eight representative policies.

By decomposing the total welfare effect into the effect on special interests that might be taken up by different individuals we can start to identify winners and losers from different policies. From the figure 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 Lyon since both the city toll and the bypass shifts traffic from the City to the West.

By decomposing the total effect into functionally specialized interests, we see that none of the analyzed policies make all interests better off compared to the initial situation. All of the policies therefore run the risk of being opposed by stakeholders or lobby groups representing losing interests.

3.4 Spatial equity

To analyze the effect on spatial equity we study the change in welfare for the representative policies for the five different geographical areas: City, West, North, South and an area representing External travelers from outside Lyon. The results are shown in Figure 5. Without a bypass, the toll on the city road increases welfare in the City and in the Northern and Southern parts of Lyon. Travelers in these regions benefit from the reduced congestion and receive a share of the collected toll revenues. People living in the City also benefit from the reduced local environmental externality. For the Western area the toll reduces welfare even though the western travelers are not directly affected by the city toll and receive toll revenues from the other travelers. The reason for this is that the toll on the city road shifts transit traffic from the main city road to the western back roads which increase congestion and the environmental external cost 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.



	Welfare maximizing toll on city road with no bypass	Revenue maximizing toll on city road with no bypass	Bypass without any toll	Welfare maximizing toll on bypass with bypass	Welfare maximizing toll on city road with bypass	Symmetric revenue neutral toll with bypass	Welfare maximizing toll with bypass	Revenue maximizing toll with bypass
City	142 000 €	131 000 €	-18 000 €	114 000 €	1 000 €	97 000 €	162 000 €	131 000 €
West	-53 000 €	-78 000 €	55 000 €	34 000 €	103 000 €	72 000 €	58 000 €	38 000 €
North	27 000 €	21 000 €	-7 000 €	25 000 €	14 000 €	29 000 €	48 000 €	40 000 €
South	98 000 €	102 000 €	-99 000 €	4 000 €	-2 000 €	18 000 €	106 000 €	115 000 €
External	-7 000 €	-9 000 €	21 000 €	11 000 €	21 000 €	16 000 €	9 000 €	6 000 €

Figure 5: Comparison of change in welfare for the different geographical areas for the analyzed policies.

Without tolls, the bypass only improves welfare for West and External travelers. The reason for this 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 high tolls since this result 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 suspect disadvantaged groups to oppose the policy. However, although the representatives voters differ in different areas prefer different policies, there are many policies that increase welfare for a majority of the areas and hence could be accepted compared to the initial situation.

3.5 Political Acceptability

The analysis so far revealed large conflicting interests between different special interests and representative voters. A hypothesis is therefore that some of the observed difficulties of achieving political acceptability for efficient transport pricing policies can be explained by these conflicting interests. In this and the following section, we examine this idea further by studying how these conflicting interests might 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 situation. This subset is shown in Figure 6.

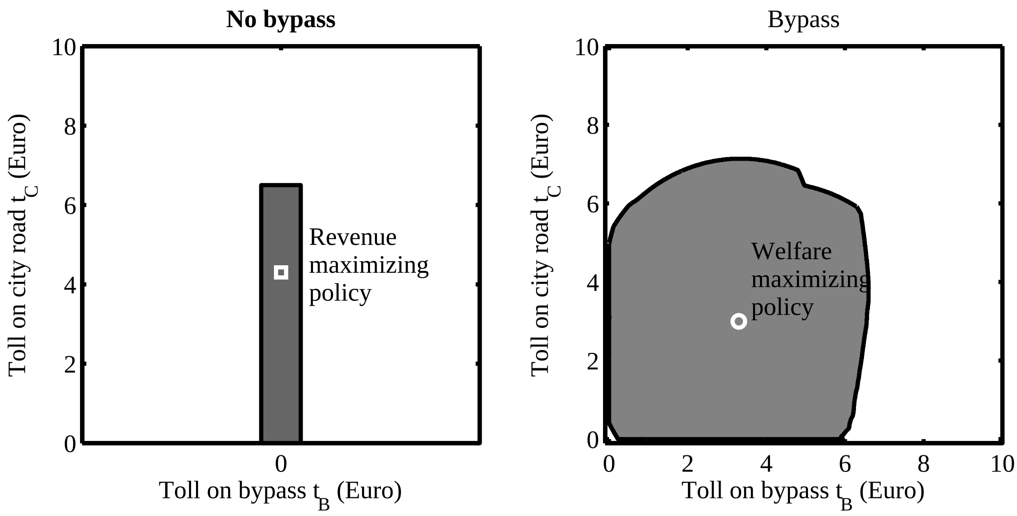


Figure 6: Political acceptability measured as the set of policies that can get majority support from the representative voters in the four geographical areas compared to the initial situation.

The figure shows all combination of policy instruments that can get majority support against the initial situation with and without a bypass. In the left figure, the gray bar shows all toll levels of the city road with no bypass that can win a pairwise election against status quo. In the right figure, the corresponding combinations of toll levels on the city road and on the bypass are shown given that the bypass is built. Without a bypass, all toll levels below 6.5 € on the main city road can get majority support from the representatives for the four different geographical areas. With a bypass, many different combinations of road tolls improve welfare for a majority of the voters compared to the initial situation. Observe that the un-tolled bypass is not included in the set of supported policies because the bypass has to be paid by the inhabitants of the city.

Given that the net revenues are distributed back to the voters in Lyon, the analysis indicates that a relatively large set of policies can win a pairwise election against the initial situation. Since the optimal policy from an efficiency point of view is included in the set of policies with majority support compared to status quo, an efficient tolling policy would be political acceptable if the revenues are properly accounted for.

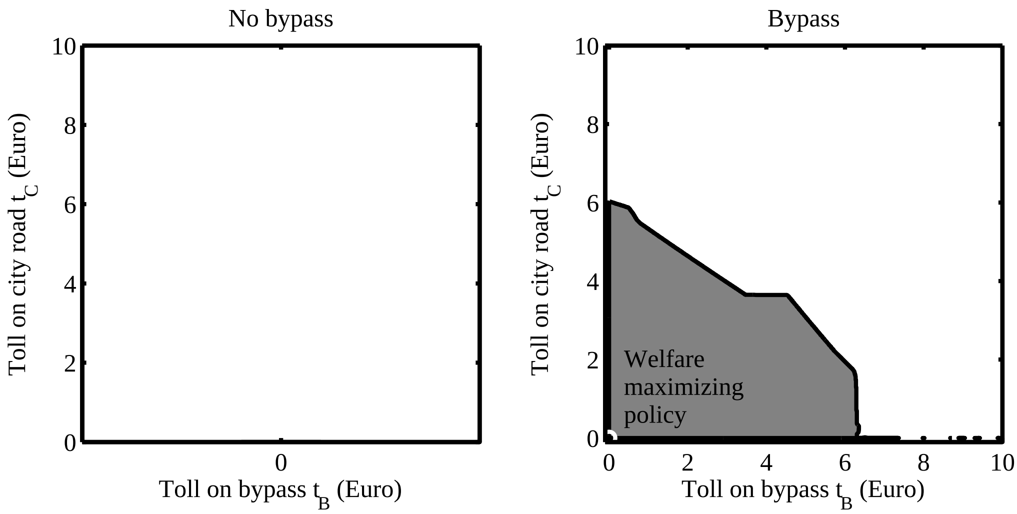


Figure 7: Political acceptability measured as the set of policies that can get majority support from the representative voters in the four geographical areas compared to the initial situation with exogenous net revenues.

An important assumption in the analysis is that all net revenues are distributed back to the population. Since the benefit of efficient road tolls to a large extent comes in the form of toll revenues, the perceived revenue use can have a large effect on the political acceptability of the project. If the decision makers do not receive the toll revenues, tolling will only be accepted in combination with a bypass. The set of policies that can be accepted by a majority of the representative voters compared to status quo with exogenous net revenues is shown in Figure 7. The preferred policy by all representative voters is in this situation not to use any tolls. This result can be compared 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 think that they will not be allowed to keep the collected toll revenues, either directly or indirectly through withdrawal of other national transfers, they will be reluctant to road tolls as a way of financing new infrastructures.

3.6 Political feasibility

In previous section we saw that many different policies could get support from a majority of the representatives when compared against the initial no-toll no-bypass situation given that the toll revenues and construction cost was shared among the constituency in Lyon. In this section we will analyze the political economy of urban road pricing by identifying the most likely policies that can receive majority support in the political equilibrium.
We first examine two cases: in the first, the agenda setters are chosen among the representative voters; in the second, we consider the outcome of allowing lobby groups representing special interests to set the agenda.

3.6.1 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. In the model, the representative voters vote on a single proposal against the 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 $P_0(y)$ that gives the probability that policy y is the outcome of the political process given the initial policy y_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 from the voters, the preference function will have a positive probability for at most four different policies. The policies that the representative voters would propose if appointed agenda setter are shown in Table 5.

Table 5: 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 €

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

The representative voter in the West will in an opposite way 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, i.e. since the purpose of the bypass is to reduce congestion and improve local environment in the city center the toll should be placed on the main city road to further enhance the effect. Placing the toll on the bypass can in a similar way be seen as counter-productive since the full effect of the bypass is not reached.

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 travelers on both the main city road and on the bypass. They have therefore 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 hence receives a larger share of the net revenues than the North, the representative voter in the South also prefers higher toll levels than the representative voter in the North.

Since the representative voters only consider the effects on their own constituencies, the outcome of the political process will deviate from the economically efficient policy. The more conflicting interests the representative voters have, the more the likely outcome of the political process will diverge from the economic efficient policy. For the outcome of the process to be an optimal tolling policy, the preferences of the appointed agenda setter must coincide with the preferences for the population as a whole. How the citizens are apportioned into representative voters can therefore have a large impact on the outcome of the political process (Aitd, 1998). To see this, we will expand the agenda setting model to include the influence of lobbying.

3.6.2 The influence of lobbying

We now study a modified version of agenda setting model where 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 be supported by 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 lobby group has an equal probability of being appointed. If a lobby group is appointed agenda setter, it will propose a policy that maximizes the welfare for its special interest within the set of policies with majority support.

Table 6: Proposed policies by lobby groups representing different special interests.

Interest	**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 €
Tax payer	No bypass	4.3 €	-	167 000 €

In Table 6 the policies proposed by lobby groups representing different special interests and that are accepted by a majority of the representative voters are shown.

Lobby 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, their second-best alternatives are instead to propose policies involving the lowest possible toll levels for their travel group. A lobby 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 lobby 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 election against status quo.

Lobby groups representing different environmental interests will in a similar way propose politically acceptable policies that reduce traffic in their area of concern the most. A lobby group representing tax payers will finally propose the policy that maximizes the net revenues.

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

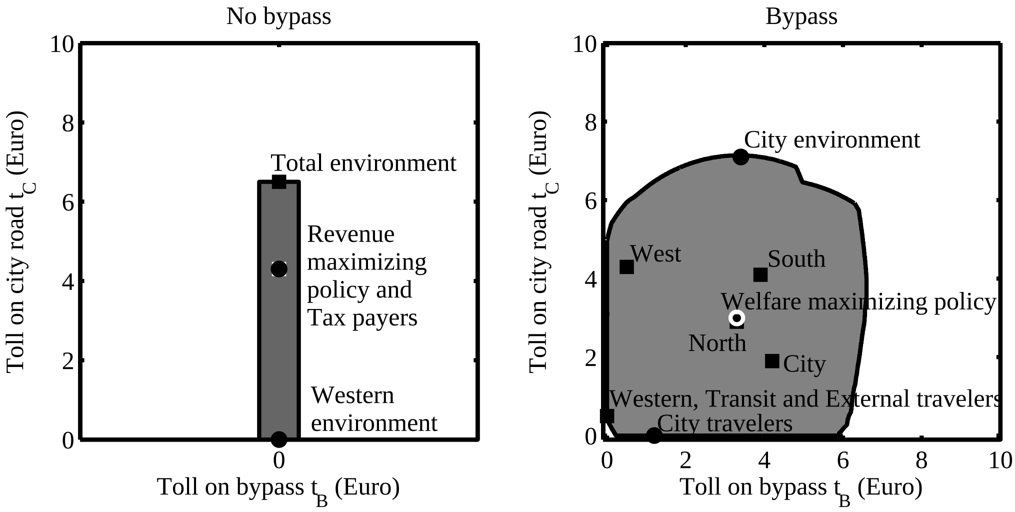


Figure 8: Preferred policies by representatives for the different geographical areas and lobby groups representing special interests.

Figure 8 shows the policies that the representative voters and lobby groups 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 lobby groups from proposing too extreme policies. Instead, the proposals are constrained to the border of the set of political acceptable policies, i.e. 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 completely 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 are therefore an important factor for the ability of the decision making process to agree upon an efficient transport policy.

To measure the effect of the political process on economic efficiency we can compare the expected welfare level in the political equilibrium with the welfare level with efficient tolling. In Table 7 the expected efficiency of the political process with and without lobbying is shown. To calculate the expected efficiency when lobby groups are allowed to set the agenda, we simply assume that all six lobby groups in Table 6 have an equal probability of being chosen as agenda setter. When the agenda setters are chosen among the representative voters, the expected welfare effect reaches 85% of the welfare maximizing level. If the agenda setters are chosen among the lobby groups, the expected welfare effect only reaches 13% of the welfare maximizing level. The model hence indicates that the influence of lobbying can reduce the welfare effect of a transport policy considerable by putting too much weight on a single interest.

Table 7: Comparison of the expected efficiency of the political process with and without lobbying.

Agenda setter	Expected total welfare	Relative welfare effect
Welfare maximum	382 000 €	100% (base)
Agenda setting model with representative voters	325 000 €	85%
Agenda setting model with lobby groups	48 000 €	13%

4 DISCUSSION

In the introduction we listed a number of potential explanations for 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 case study we studied a political process where representative voters in different geographical areas in Lyon voted on a single proposal against status quo. The analysis showed that policies involving many different toll combinations, both with and without a bypass, could be accepted by a majority of the representative voters in a pairwise comparison to the initial do-nothing situation given that the bet revenues was distributed back to the representative voters. The analysis therefore seems to suggest that although conflicting interests can have a negative effect on individual acceptability and making efficient road pricing policies unpopular; they do not necessarily have the same negative effect on political acceptability.

However, for a policy to be the outcome of the political process, someone must propose it first. Conflicting interests between possible 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 setters instead represent special interests, the outcome of the political process can be more extreme where too much weight is placed on a single interest.

From a political perspective, this is related to how the problem is framed in the political discourse and what arguments and principles that is used in the public debate. An urban road pricing can be seen as an environmental policy, a way of raising revenues for infrastructure investments or 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 bypass, the polluter-pays-principle can motivate a toll on the 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. A transport economics can in a similar way argue for economic efficiency, and fairness and equity concerns can lead to other outcomes depending on the type of equity or fairness in focus.

To reach an efficient outcome the political decision making process must balance 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, perceived revenue use and compensation schemes between different stakeholders and geographical areas can be crucial for the ability of the political process to reach a decision supporting an efficient pricing policy.

5 CONCLUSIONS

In a case study of a proposed bypass in Lyon, France, we compared a set of potential policies in terms of efficiency, equity and political acceptability. In the analysis, a relatively large number of policies, including the efficient one, could get majority support compared to the initial no-toll situation. The analysis therefore suggests that the difficulty of achieving political support for efficient road pricing policies is not necessarily due to a lack of political acceptability; instead the difficulty arises because of low political feasibility for efficient transport pricing. Optimal tolling could get majority support but the political process may not lead to it since non-efficient transport policies are more attractive to the decision makers.

Instead of focusing on political acceptability for explaining why efficient transport pricing is so seldom used, the analysis in the paper suggests that more attention should be placed on political feasibility and how the political process can resolve the inherent conflicting interests associated with efficient transport pricing.

The model framework with a political economy model combined with a transport model makes the model sensitive to variations in the underlying model assumptions. Model parameters such as the initial congestion level, bypass construction cost and capacity can therefore have a large effect on both the optimal toll levels and the set of policies that is political 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 since it allows travelers to avoid the direct cost of the road toll by changing to an un-tolled alternative road. Public transport can also be important to consider since it can have a similar role in providing travelers with an alternative to car travel.

Other results, such as the existence of conflicting interest and the difference between political acceptability and political feasibility, are more robust since they are more related to the model structure than to specific model parameters.
The case study therefore more serve as an illustration of the role of conflicting interests for explaining the difficulty of reaching political support for efficient transport polices pricing rather than being an analysis of efficient transport policies in Lyon.

This is a first attempt to analyze acceptability and political feasibility 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 representative voters that for instance include public transport user 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 polices through interpolation in order to identify optimal policies and generate preference functions for the political economy model. The political economy model can also be extended by incorporating negotiation between the agenda setters by allowing agenda setter to make counterproposals. The negotiations can also be modeled using concepts from cooperative game theory as in Westin et al. (2012).

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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 given by $t_i = t_i^0 + \Delta t_i \cdot (D_i^0 - D_i)$ 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.

Table 8: Parameter values in the volume delay function.

	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

Travel demand

The model use 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 9.

Table 9: Initial travel demand measured as the average number of daily trips in the initial situation for different travel groups divided by geographical area.

	City	**West**	**North**	**South**	**External**
City travelers High VoT	131 040	-	16 200	5 070	-
City travelers Low VoT	76 960	-	19 800	7 930	-
Western travelers High VoT	-	125 970	9 900	3 510	-
Western travelers Low VoT	-	121 030	12 100	5 490	-
North-south transit travelers High VoT	-	-	6 750	6 240	-
North-south transit travelers Low VoT	-	-	8 250	9 760	-
External travelers High VoT	-	-	-	-	14 000
External travelers Low VoT	-	-	-	-	14 000