

LES IMPACTS DE LA TARIFICATION DU TRANSPORT SUR LA MOBILITE ET L'OCCUPATION DU TERRITOIRE, DANS LA REGION DE BRUXELLES ET SA PROCHE PERIPHERIE

IMPACTS OF TRANSPORT PRICE ON MOBILITY AND LAND USE IN THE BRUSSELS AREA

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Présenté lors du symposium international sur le Financement de la route les 4, 5 et 6 novembre 1998 à Paris - Publié aux presses de l'Ecole Nationale des Ponts et Chaussées.

RESUME

L'objectif de l'étude est d'examiner les effets de politiques de transport qui consistent à modifier les coûts de transport supportés par les utilisateurs de la route et des transports publics. Les scénarios envisagés visent à examiner l'impact du financement de services de RER par une tarification routière sur les principaux accès à la Région de Bruxelles-Capitale.

Les scénarios envisagés ont été testés à l'aide d'un logiciel inter-modal qui permet de modéliser le passage d'un mode privé à un mode public. D'autre part, il s'agit d'un logiciel intégré "land-use transport" capable d'évaluer toutes les interactions entre aménagement du territoire et transport, et ce dans les deux sens.

ABSTRACT

The objective of the study consists in analysing the effects of transport policies consisting of changes in the transport cost supported by the users, for public transport and/or private car. Scenarios investigated examine the impact of cross-subsidiation of RER services with road pricing on the main access to the Brussels-Capital Region.

The tool used to analyse the consequences of implementing scenarios is a fully intermodal transport model of passengers' transport system. Moreover, it is an integrated land-use/transport model able to simulate the impacts of land-use policies on transport and the impacts of transport policies on land-use.

1 INTRODUCTION

1.1 General Context

It is now generally accepted that transport policies alone will not achieve a sustainable level of fuel consumption and emissions. A consensus is also emerging that it is necessary to co-ordinate land use changes with transport measures in order to achieve an environmentally and economically sustainable transport system.

It is intended that transport and land-use have to be considered as an integrated and mutually dependant system. Unfortunately, in many urban areas this system is not presently operating in a positive fashion. On the contrary, the system resembles a spiral of urban decline, a vicious circle. Figure 1, below, provides a description of the potentially vicious interactions of this system at an urban level.

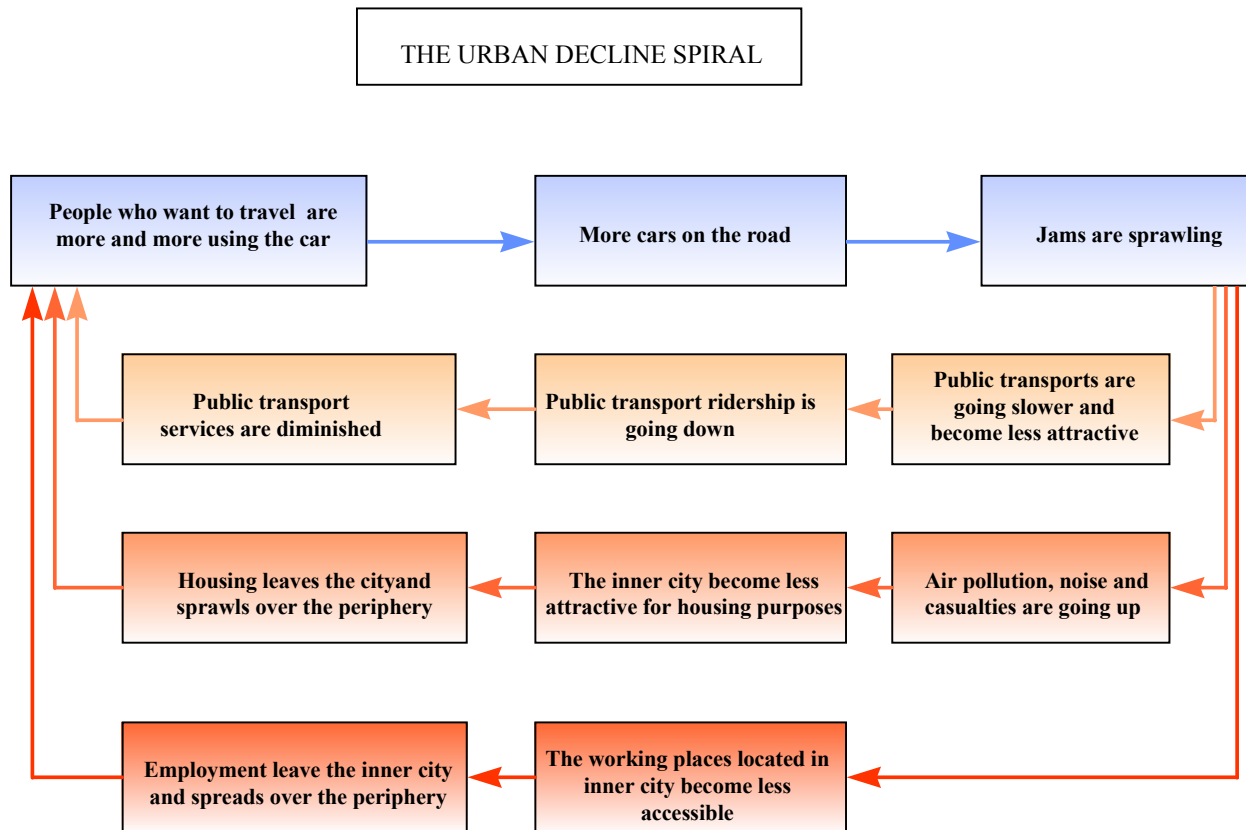


Figure 1 : The spiral of urban decline

This process illustrates the

- short term effects of land-use on transport
- short term effects of the system land-use transport system on the environment
- medium term effects of the environment on housing location
- medium term effects of transport on employment location
- long term effects of transport on housing location.

As can be seen from Figure 1, this process has no beginning and no end. It resembles a closed loop in which each element is in perpetual interaction with the other elements. Any direct action involving an element of the system has repercussions on all the other elements which, in turn, cause another wave of impacts on the system as a whole. An additional dimension is added by the fact that these impacts can occur in the short, medium or long term.

1.2 The Brussels case

The population of the Brussels metropolitan area has been slowly but regularly decreasing and the evolution in the Brussels-Capital Region has been much faster, with an important consequence: as the main part of the Region's financial resources comes from the taxes levied on its inhabitants income, these resources are quickly diminishing as a result of the decrease of the population and average household income. Households migrating to the close periphery are mainly middle and upper class families, with a high car ownership level. Evolution in these suburbs cannot be controlled by the Government of the Brussels Region because it is located outside of its borders, nor by the Federal Government, because the land use planning jurisdiction has been fully decentralised.

In the same time, for the last twenty years the economy of the Region has undergone a significant mutation. Initially an industrial centre, it progressively became an important administrative centre and has recently been designated as the European Union Capital. Industrial activities and wholesale have also been, and are migrating towards the periphery, seeking both better accessibility by road and cheaper land.

It is difficult to identify the actual cause of such an evolution but it seems that it was accelerated by the dramatic improvement of the accessibility to the city by road which resulted from the building, during the seventies, of a high standard motorway network.

1.3 RER project

Presently, the lack of accessibility of the Brussels region generate a handicap for the economic growing of the Brussels region. Simulations had shown that the introduction of RER¹ services generates an accessibility improvement which generates retail and services increases in the centre; however it intensifies population diffusion to the periphery.

On the other hand, it has also already been revealed that the attraction of more commuters on the public transport network induced by RER services benefits the most to the remaining road users².

Figure 2.1 hereafter shows travel time gains of different types of private car users in term of average gains of car users travel time at morning peak hours : the highest values observed (8 to 10 minutes) concern users going from more than 30 km of Brussels to the Brussels region and others ones going from the Brussels periphery (less than 30 km from Brussels) to the Brussels region ; it also shows a decreasing of the average congestion inside of the Brussels region.

Figure 2.2 hereafter provides annual private car travel time gains thanks to RER services on the main origin-destination relationships. It gives an idea about the split in term of benefits due to the introduction of RER between users. It could be used to determine the investment split between local authorities.

¹ ESTEEM (European Scenarios on Transport-Energy-Environment for Metropolitan areas is a research project financed by the THERMIE R&D Programme of the European Commission (DG XII). The development of the Brussels model is co-financed by the Federal Government of Belgium, the Government of the Brussels-Capital Region and the Regional Public Transport Operator of Brussels (STIB).

² IRIS (Brussels Transport Plan commissioned by the Brussels regional Government)

Figure 2.1 Private car travel time gains at morning peak hours, thanks to RER services

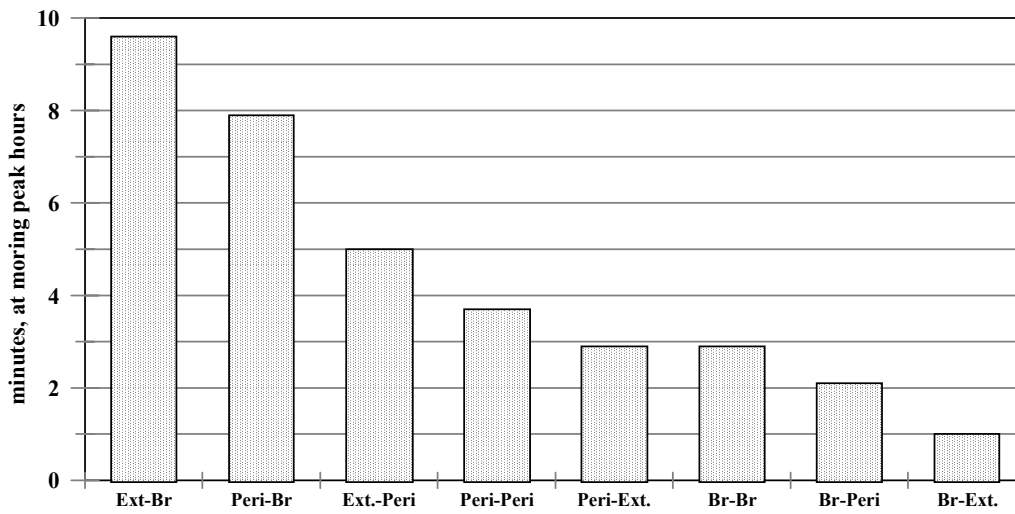
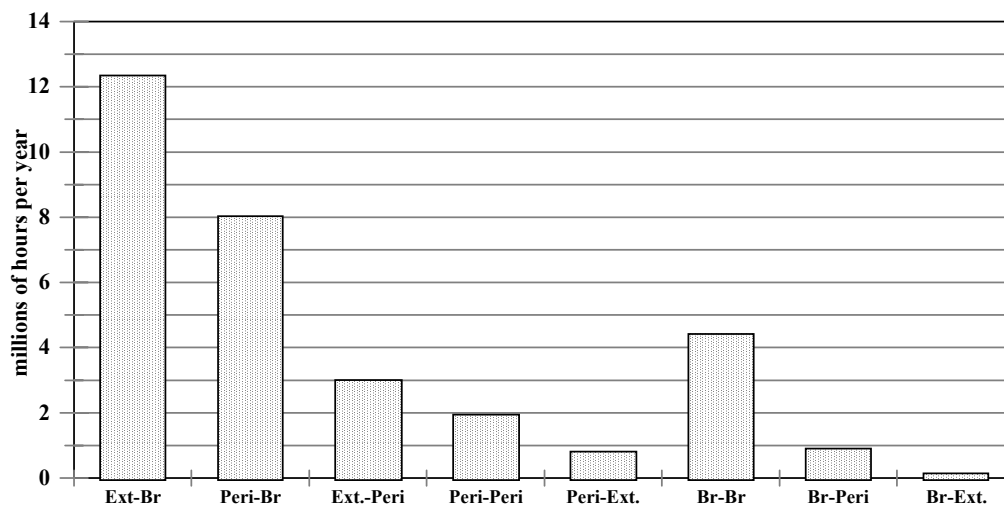


Figure 2.2 Annual private car travel time gains thanks to RER services



1.4 Road pricing project

The combination of RER services and road pricing³ at the entrance of the Brussels region could mitigate the impact of the introduction of RER services.

Hence came the idea that the cross-subsidisation of public transport with the road tolling revenues could multiply the positive impact of the road tolling on the modal split and contributes in that way to improve the transport accessibility.

The primary aim of these policies is to encourage a modal transfer of the commuters entering the city centre towards public transport (multi-modality) or park & ride (inter-modality), in order to reduce congestion on the ring and improve through traffic conditions on the TERN. But, the implementation of tolling policies will also affect the spatial distribution of households and activities.

1.5 Objective of the study

The primary aim of the study is to assess the efficiency of this set of tolling scenarios, in terms of impacts on the modal split and of alleviation of the road congestion. As a second aim, the study is also investigating spatial impacts due to tolling implementation.

From the point of view of the public authorities of the Brussels-Capital Region, this aim is the most important one and a lot of efforts has been devoted to the modelling of the area development impacts of the pricing scenarios.

1.6 The model

The tool used to analyse the consequences of implementing the hereafter scenarios is a land use-transport model of the Brussels metropolitan area that has been developed and calibrated within the framework of the ESTEEM research project. The model is based on the TRANUS software developed by T. de la Barra and B. Perez and marketed by the Modelistica Company of Caracas (Venezuela).

The TRANUS modelling tool is :

- a fully intermodal transport model of passengers' transport system
- an integrated land-use/transport able to simulate the impacts of land-use policies on transport and the impacts of transport policies on land-use

Its structure comprises two main components : a land use sub-model and a transport sub-model, which interact dynamically.

The land use model estimates the location of activities in the different zones in which the study area has been divided, and equilibrates a property market. The activity allocation process results in a set of matrices representing the flows of peoples and goods from each zone to each other .

In the transport model, these matrices of flows are transformed into trip matrices. The transport model, in turn, calculates the generalised composite cost of transport, which is one of the components of the utility function of the activities allocation model. These transport costs are fed into the land use sub-model.

³ EUROSIL (European Strategic Intermodal Links is a research project financed by the TRANSPORT R&D Programme of the European Commission (DG VII).

Models founded on the equilibrium theory, like TRANUS, do not simulate the different response times of different subsystems (travel subsystem, land-use subsystem) to any change. To represent the superposition of slow and fast processes and take into account time lags or delays, they make use of lagged relationships and incremental allocation.

In TRANUS, economic activities interact with each other, generating flows: these flows determine the transport demand and are assigned to the transport supply in the transport sub-model. Thus, changes in land-use will result in changes in the travel demand within the same time period. On the other hand, changes in the transport system (a new road, a mass transit system, changes in tariff) will also have an immediate effect on travel demand.

In turn, the supply-demand equilibrium in the transport sub-model determines accessibility, which is fed back into the land-use system, influencing the location and, hence, flows between activities. This feedback however does not occur instantly in the same time period, but is lagged: transport accessibilities in period t_1 affect the spatial distribution of activities and the distribution of flows in the following period t_2 . Since there are also elements of inertia in land-use from one period to the next one, the effects of changes in the transport system might well take several periods to consolidate.

At the end of the modelling process, an evaluation procedure can be used to compare the results of the base case and of alternative scenarios: this procedure estimates several socio-economic and financial indicators and, optionally, energy consumption indicators.

2 DESCRIPTION OF THE SCENARIOS

All the simulated scenarios include the introduction of RER services, as recommended in the IRIS plan. It consist of new regional train services over distances from 10 to 40 km from the centre of Brussels on the existing star shaped

rail network. Its characteristics are similar to the ones of the Brussels metro which is appreciated by the population. RER services advantages are mainly linked on the RER speed (acceleration and deceleration, door opening, quicker boarding and alighting), RER frequency, higher stops number, higher capacity.

Figure 3 hereafter provides RER services characteristics.

Characteristics of scenarios which have been simulated and assessed are the following:

- **reference scenario** : no pricing at all

The public transport fare considered in the reference scenarios is the current one.

- Train (and RER) fare is composed of :
 - a fixed component :16.5 FB
 - an component dependant on the travelled distance :1.59FB/km
- Metro is charged at the flat fare of 30 FB / one way trip
- **Scenarios 1 and 2** investigate tolling performed during peak hours on all road accessing the Brussels-Capital Region (see figure 4.1). Table 1 hereafter provides the levels of fare by road users' category examined in scenarios 1 and 2. The public transport fare considered in scenarios 1 and

2 is the current one. It has been already described for the reference scenario

- **Scenarios 3 and 4** investigate tolling performed during peak hours at all the interchanges giving access to the ring (see figure 4.2). Table 1 hereafter provides the levels of fare by road users' category examined in scenarios 3 and 4. The public transport fare considered in scenarios 3 and 4 is the current one. It has been already described for the reference scenario.
- In **scenario 5**, tolling is applied during the congestion periods on all the road accessing or exiting Brussels and at all the interchanges giving access to the ring (see figure 4.1 and 4.2) and, moreover, trips made by public transport between origin and destination within the Brussels region and its peripheries are charged at a flat fare. Table 1 hereafter provides the levels of fare by users' category examined in scenarios 5 :

Table 1 provide the summary of the characteristics of the simulated scenarios

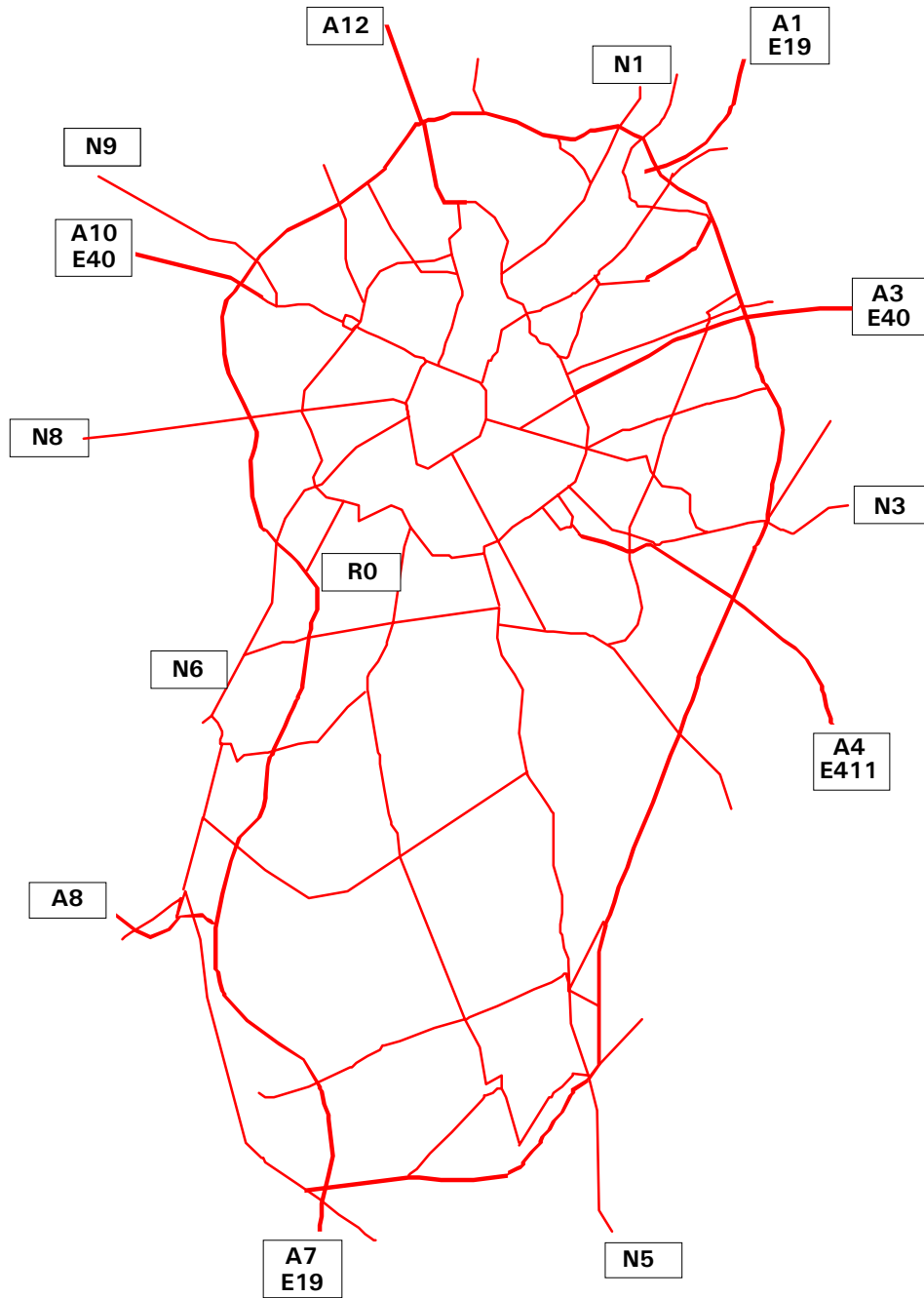
TABLE 1 SUMMARY OF THE CHARACTERISTICS OF THE SIMULATED SCENARIOS

SCENARIO	REFERENCE	SCENARIO 1	SCENARIO 2	SCENARIO 3	SCENARIO 4	SCENARIO 5
Tolling location						
no tolling	X					
tolling at the entrances of the Brussels region		X	X			X
tolling on the accesses to the orbital motorway				X	X	X
Tolling fares						
regular trips: 100 BEF; non regular trips: 150 BEF		X		X		X
regular trips: 200 BEF; non regular trips: 300 BEF			X		X	
Public transport fares						
current fare	X	X	X	X	X	
flat fare (30 BEF/trip) in Brussels and its periphery						X

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Figure 4.1 LOCALISATION OF THE TOLL PLAZAS

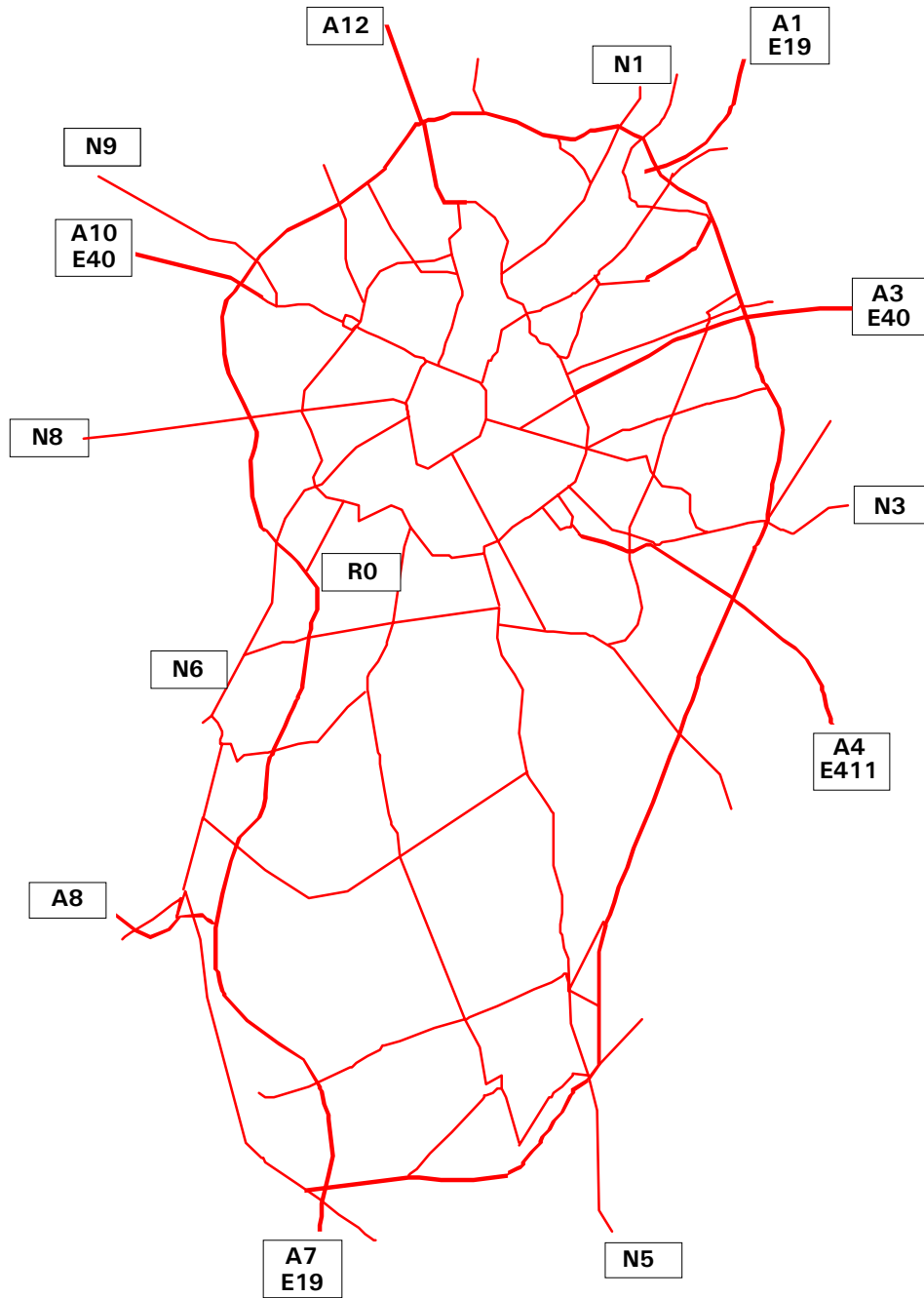
*Scenario 1, 2 & 5 :
pricing the access to Brussels by car during the morning peak hours*



Toll plazas

Figure 4.2 LOCALISATION OF THE TOLL PLAZAS

*Scenario 3, 4 & 5
pricing the access to Brussels by car during the morning peak hours
(orbital motorway and other roads)*



Toll plazas

3 RESULTS

3.1 Land use

The key results of the simulations performed with the Brussels TRANUS model are shown in table 2 hereafter

TABLE 2 IMPACTS OF TRANSPORT PRICING POLICIES ON LAND USE INDICATORS

INDICATORS	REFERENCE	SCENARIO 1	SCENARIO 2	SCENARIO 3	SCENARIO 4	SCENARIO 5
Population living in the Brussels Region, in values	952768	962513	987225	949256	954397	936136
in % related to the reference	100%	101%	104%	100%	100%	98%
Nr of households living in the Brussels Region, in values	453372	457722	465591	454654	453119	450546
in % related to the reference	100%	101%	103%	100%	100%	99%
Employment in the Brussels Region (retail and services only), in values	238579	225202	220286	240211	240501	237400
in % related to the reference	100%	94%	92%	101%	101%	100%

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Tolling at the gates of the Brussels Region (as in scenarios 1 and 2) has a significant positive impact on the region's population: an increasing number of households is inclined to choose living in Brussels instead of the periphery, but the services and retail sectors of Brussels are losing customers and jobs.

Tolling the trips travelled on the ring (scenarios 3 and 4) induces less successful results in terms of population.

In scenario 5, the compensation of the higher cost of travelling by car through a reduction of the public transport fares produces negative but smoother impacts on both the population and the employment figures for Brussels.

should leave Brussels, according to scenario 5 is composed of families and would be partly replaced by smaller sized households.

3.2 Modal split and traffic

The key results of the simulations performed with the Brussels TRANUS model are shown in table 3 hereafter.

It is to mention that the population which

TABLE 3 IMPACTS OF TRANSPORT PRICING POLICIES ON TRANSPORT INDICATORS (working days 7-9 a.m.)

INDICATORS	REFERENCE	SCENARIO 1	SCENARIO 2	SCENARIO 3	SCENARIO 4	SCENARIO 5
whole study area						
Percentage of trips made by public transport (%) in % related to the reference	31 100%	35 113%	38 123%	34 110%	36 116%	40 129%
Persons*km by private car (*1000), in values in % related to the reference	11353 100%	10637 94%	10096 89%	10632 94%	10245 90%	9987 88%
Persons*km by train (* 1000), in values in % related to the reference	3984 100%	4249 107%	4461 112%	4236 106%	4320 108%	5503 138%
Persons*km by metro (* 1000), in values in % related to the reference	218 100%	242 111%	317 145%	233 107%	242 111%	230 106%
Persons*km by RER (* 1000), in values in % related to the reference	1798 100%	2014 112%	2118 118%	2070 115%	2125 118%	3127 174%
Persons *km by all mechanised modes (* 1000), in values in % related to the reference	17388 100%	17181 99%	17035 98%	17209 99%	16972 98%	18892 109%
Persons using P&R facilities, in values in % related to the reference	2220 100%	5454 246%	21000 946%	3048 137%	3571 161%	5075 229%
Average speed by private car (km/hr), in values in % related to the reference	46.2 100%	48.5 105%	49.7 108%	43.5 94%	42.0 91%	48.6 105%
orbital motorway						
Persons*km by private car (* 1000), in values in % related to the reference	1227.6 100%	1154.4 94%	1090.8 89%	574.8 47%	222.6 18%	1036.8 84%
Average speed by private car (km/hr), in values in % related to the reference	82 100%	86 105%	89 109%	106 129%	114 139%	89 109%

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Tolling at the gates to Brussels (scenario 1 and 2) or on the ring (scenario 3 and 4) induces a shift from private car to public transport. It also induces a slight decrease of the total length travelled by all mechanised modes : households and services are locating closer to each others in order to reduce their travelling and accessibility costs.

Tolling at the gates of Brussels also enables to increase the average speed on the whole road network of the study area. To attract more commuters on the public transport network benefits the remaining road users.

Tolling the trips travelled on the ring (scenario 3 and 4) causes car travellers to look for alternative routes which do not include ring sections. It induces a strong decrease of the

traffic flows on the ring and, consequently, an increase of the average speed on this infrastructure. However, at the same time, the traffic conditions on the other parts of the network are deteriorating and the average speed is decreasing in the whole study area. The benefits to the remaining users of the ring are too low as compared to the deterioration of the level of service caused to the other road users.

A combined strategy, as simulated in scenario 5, leads to much better results because it gives a more balancing distribution of the traffic. It is however important that this scenario has been build on a more attractive public transport fare than the other, which contributes to the general improvement of the road network conditions.

3.3 Financial impacts

TABLE 4 IMPACTS OF TRANSPORT PRICING POLICIES ON FINANCIAL INDICATORS (working days7-9 a.m.)

INDICATORS	REFERENCE	SCENARIO 1	SCENARIO 2	SCENARIO 3	SCENARIO 4	SCENARIO 5
Persons going through the tolling gates, in values in % related to scenario 1		103829 100%	62000 60%	39397 38%	15029 14%	109994 106%
Total tolling revenue, in values in % related to scenario 1		6118300 100%	7462000 122%	2750000 45%	1927000 31%	6780148 111%
Persons using the public transport system, in values in % related to the reference	210516 100%	233127 111%	258155 123%	231923 110%	238585 113%	273841 130%
Total public transport revenue, in values in % related to the reference	13065108 100%	14346210 110%	16178044 124%	14338640 110%	14797030 113%	8198793 63%
Average public transport revenue per trip, in values in % related to the reference	62 100%	62 100%	63 102%	62 100%	62 100%	30 48%
Average public transport revenue per pers*km, in values in % related to the reference	2.18 100%	2.2 101%	2.34 107%	2.19 100%	2.21 101%	0.93 43%

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Table 4 shows the estimated revenues of the tolling systems with regards to the public transport revenues.

In scenario 5, it is interesting to note that the tolling revenue has the same order of magnitude as the loss of revenue incurred by the public transport operators caused by applying the flat fare of 30 BEF per trip instead of the real fare structure (like in scenarios 1 to 4). Therefore it seems possible that the public transport loss could be cross-subsidised with the road tolling revenue.

3.4 Conclusions

First of all, the simulations have shown that a tolling that only applies to the ring, is not appropriate. The ring has to be included in a global urban road pricing strategy aiming to induce a shift in the modal split. This

conclusion should apply to most of suburban motorway project in Europe.

Then, the simulation are also demonstrating that most of the negative impacts of the urban road pricing on the number of jobs within the Brussels Region (scenarios 1 and 2) could be compensated with a lowering of the public transport fares (scenario 5). But, the lowering of the public transport fares, if applied to the commuters only (as in scenario 5), reduces the relative utility of living in Brussels and causes a migration of households to the periphery.

At last, the lowering of the public transport fares through the cross-subsidisation of public transport with the road tolling revenues multiplies the positive impact of the road tolling on the modal split and seems to be recommended in each urban transport pricing scheme.

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