Testing alternative transport pricing strategies: A CGE analysis for Belgium[1]

Paper to be presented at the Conference on
"Input-Output and General Equilibrium: Data, Modeling and Policy Analysis",
Brussels, 2-4 September 2004

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Abstract

The objective of the paper is to compare the effects of two alternative transport pricing rules: average cost and marginal social cost pricing. For both pricing scenarios, two alternative ways of using surpluses or financing deficits of the transport sector are used. The first is to change the marginal labour tax rate, the second way is to vary the level of social transfers. The effects of the scenarios are tested using a computable general equilibrium model for Belgium. The model is also used to analyse whether the changes in the transport accounts caused by a pricing reform are good welfare indicators.

1. Introduction

The aim of the paper is to explore the effects of alternative transport pricing rules on prices, traffic levels, revenues, welfare and income distribution. We also test whether the changes in the transport accounts that are recorded after a pricing reform are good welfare indicators. We compare two basic pricing rules: average cost (AC) and short run marginal social cost (MSC) pricing.

With AC pricing prices of each mode are set equal to the sum of financial costs of that mode divided by the total volume of that mode. The main goal of the tax reform is cost recovery.

Short run MSC pricing means that prices are set equal to the sum of the short run marginal resource cost (fuel, vehicle, maintenance cost of the infrastructure, etc.) and the marginal external cost (including congestion, air pollution, noise and accident cost), all this for a given infrastructure. The term "marginal" means that we consider the additional costs associated

[1] The research reported in this paper was funded by the UNITE project of the 5th Framework RTD Programme of the European Commission and by a postdoctoral grant of the Fund for Scientific Research - Flanders. The paper is based on Mayeres, I., S. Proost and K. Van Dender (2003), "The Impacts of Marginal Social Cost Pricing", in: C. Nash and B. Matthews (eds.), Measuring the Marginal Social Cost of Transport, Elsevier, forthcoming. The conclusions presented here do not necessarily reflect the official views of the Belgian Federal Planning Office.

with a vehicle kilometre (vkm), passenger kilometre (pkm) or tonne kilometre (tkm). In this pricing principle there is no consideration whatsoever for the financial impact per mode. In the economic literature MSC pricing is the benchmark for an efficient transport pricing policy. This principle holds when there are no other price distortions in the economy and no income distribution concerns. The short run MSC principle ensures that the existing infrastructure is used as efficiently as possible. Whether the infrastructure is at an efficient level or not has an impact on the level of the MSC but not on the MSC pricing principle.

To determine an efficient investment level requires a cost-benefit analysis that trades off the benefits of infrastructure extension (discounted sum of saved user costs, including time, saved external accident and environmental costs, reduced maintenance costs) and the costs of an infrastructure extension (investment costs). This rule only holds if there is short run MSC pricing and if there are no other distortions in the economy[2].

We test the effects of the two pricing rules using a computable general equilibrium (CGE) model for Belgium. While general equilibrium models cannot offer the same degree of modelling detail of the transport sector as partial equilibrium models, they offer two important advantages. Firstly, they allow to model the economic costs of financing a larger deficit in the transport sector. Any increase in the deficit in the transport sector will require an increase of labour or other taxes and this may be more or less costly. The second advantage of general equilibrium models is that they allow to track better the full incidence of a tax reform on the utility of different individuals. They are therefore better suited for an analysis of the equity effects. The next section describes the main characteristics of the CGE model for Belgium.

2. A brief description of the CGE model

The CGE model for Belgium builds upon Mayeres (2000)[3]. It is a static model for a small open economy, with a medium term time horizon. Four types of economic agents are considered: five consumer groups, fourteen main production sectors, the government and the foreign sector. The model is an extension of Mayeres (2000) in that it includes five consumer groups, corresponding with the quintiles of the Belgian household budget survey, instead of one representative consumer group. Two individuals belonging to a different consumer group are assumed to differ in terms of their productivity, their tastes and their share in the total endowment of capital goods and the government transfers. Individuals belonging to the same consumer group are however identical in terms of their needs. The second difference w.r.t. Mayeres (2000) concerns the production technology of the public transport sectors: the model takes into account the existence of fixed costs, rather than assuming constant returns to scale technology. For the other production sectors the assumption of constant returns to scale technology is made, with freight transport as one of the inputs in the production process, together with labour, capital, energy and other commodities.

[2] The pricing and investment rules get more complicated in the presence of budget constraints or when there are restrictions on the available policy instruments (e.g., when prices cannot be tailored to each transport market separately). In those cases short run MSC pricing is no longer optimal. However, the resulting “constrained” pricing rules are based on carefully balanced deviations from the short run MSC. This implies that MSC information remains crucial. This also implies that average cost pricing is an inefficient way of achieving balanced budgets.

[3] For a detailed discussion of the CGE model the reader is referred to Mayeres (1999, 2000).

The CGE model includes several transport commodities, summarized in Table 1. A distinction is made between passenger and freight transport, between various transport modes, between vehicle types and for some transport modes between peak and off-peak transport.

Table 1: Transport in the CGE model for Belgium

Passenger transport[a]			Freight transport[b]		
	Private	Business		Domestic	Export or import related, transit
Car			Road		
Gasoline	X	X	Gasoline van	X	
Diesel	X	X	Diesel van	X	
LPG	X	X	Truck	X	X
Bus, tram, metro	X		Rail	X	X
Rail	X	X	Inland navigation	X	X
Non-motorized	X				

[a] For all passenger transport modes a distinction is made between peak and off-peak transport
[b] The split between peak and off-peak transport is made only for road transport

The following externalities are taken into account: congestion, air pollution (including global warming) and accidents. Air pollution and accidents are assumed to have an impact on the consumers' welfare, but not on the behaviour of the economic agents[4]. This assumption is relaxed for congestion, which does not only affect the consumers' welfare negatively, but also influences their transport choices. Moreover, the modelling approach implies that the value of a marginal time saving is determined endogenously in the model. Congestion also reduces the productivity of transport labour in the production sectors.

The starting point of the exercises is the situation in Belgium in 1990[5], which represents the benchmark equilibrium. Table 2 presents the marginal external costs of the various transport modes in the initial equilibrium. The table compares the marginal external costs with the taxes paid in order to give an idea of the distortions in the benchmark. For heavy road vehicles the taxes paid are net of the road damage costs caused by these vehicles. The incorporation of the road damage costs is a third extension w.r.t. Mayeres (2000). For peak road transport congestion accounts for the largest share in the external costs. In the off-peak period air pollution is the most important external cost category for diesel vehicles, while accident costs form the largest category for gasoline vehicles. In general it is found that congestion is the dominant marginal external cost of transport. This implies that transport instruments that tackle this problem efficiently will have an advantage over the others.

For all transport modes there is a large divergence between the tax and the sum of the marginal external costs and the road damage costs. Therefore MSC pricing can be expected to

[4] In reality air pollution and accident risks also affect the consumption and production choices. Such feedback effects are not yet included in the model. The importance of the feedback effect of the health related benefits of environmental policies is studied by Mayeres and Van Regemorter (2003).

[5] There are two exceptions, however. First, the emission characteristics of cars and trucks are those observed in 2000. Secondly, the data by income class are based on the Belgian expenditure survey for 1995.

lead to substantial price changes. In the case of public transport the subsidies related to the provision of the transport services are high, which results in a negative tax[6].

Table 2: The marginal external costs and taxes in the benchmark equilibrium (Belgium, 1990)

		Marginal external cost (euro/vkm)	Share in marginal external costs			Tax[a] (euro/vkm)
			Congestion	Air pollution	Accidents	
Passenger transport						
Peak	Gasoline car	0.28	83%	6%	10%	0.10 [0.04]
	Diesel car	0.33	73%	18%	9%	0.06 [0.02]
	Tram	0.47	100%			-1.83
	Bus	1.03	46%	44%	12%	-1.83
	Rail (diesel)	0.19	0%	100%	0%	-8.99 [-9.66]
Off-peak	Gasoline car	0.09	49%	20%	31%	0.10 [0.04]
	Diesel car	0.13	34%	44%	22%	0.06 [0.02]
	Tram	0.09	100%			-1.47
	Bus	0.66	14%	68%	18%	-1.47
	Rail (diesel)	0.19	0%	100%	0%	-1.61 [-1.73]
Freight transport						
Truck – peak		0.80	59%	39%	2%	0.07
Truck – off-peak		0.42	22%	75%	3%	0.07
Inland navigation		0.01	0%	100%	0%	n.a.
Rail (diesel)		0.52	0%	100%	0%	-0.84

[a] The figures between brackets refer to transport for business purposes

In the initial equilibrium the financial cost coverage rate, defined as the ratio of revenue over financial costs, equals 2.5 for road transport, 0.28 for rail and 0.37 for other public transport. Revenue from the road transport modes is much higher than financial costs. For public transport the rate of financial cost coverage is quite low. This will have implications for the welfare effects of the alternative pricing instruments.

Before turning to the description of the policy scenarios and the simulation results, attention should be drawn to a number of limitations of the CGE model. First, the location decisions of the households and firms are not modelled. Therefore, the equity impacts of a change in land use are not captured by the analysis. Secondly, the number of consumer groups considered is limited to five. This entails that only a general idea can be formed of the equity impacts. A further disaggregation of the consumer groups would generate additional insights. Thirdly, in modelling transport decisions, no distinction is made between different trip purposes. Since different trip purposes have a different relationship with labour supply, this will affect optimal taxation (see Parry and Bento, 2001; Calthrop, 2001; Van Dender, 2002). These issues are not considered here. Fourthly, the shift towards vehicle types with a higher fuel efficiency or new emission technology is not modelled. Nor is the choice between trucks with different road damage effects. This means that not all effects of the pricing reforms on the externalities are included.

[6] Table 2 only includes the public transport subsidies related to variable operating costs.

3. The policy scenarios

The CGE model is used to calculate the welfare effects of two transport pricing policies: AC pricing for each mode independently and MSC pricing. Since these policies have an impact on the government budget, their full welfare impact can be assessed only if one considers the accompanying measures by which the government achieves budget balance. This is necessary for evaluating both the efficiency and the equity impacts. Here we consider two such instruments, namely the labour income tax and the social security transfers[7]. Table 3 summarizes the four scenarios for which the welfare effects are calculated. In the four scenarios no account is taken yet of the implementation costs.

Table 3: Overview of the policy scenarios

		Budget neutrality ensured by	
		Labour income tax	Social security transfers
Transport pricing principle	Average cost pricing	Scenario 1	Scenario 2
	Marginal social cost pricing	Scenario 3	Scenario 4

Average cost pricing

Scenarios 1 and 2 introduce AC pricing for three transport sectors: road, rail and other public transport. Due to the lack of reliable data for inland navigation, this sector is not included in the exercise. AC pricing is defined as balancing the financial budget for each of the three transport sectors. Prices are set equal to the sum of the financial costs of each mode divided by the total volume of that mode. This implies that there is no attention for the structure of the resource costs (fixed or not, sunk or not, etc.), no consideration of the external costs and identical treatment of all transport services (freight, passengers, etc.). For road transport the financial costs equal the infrastructure costs (excl. taxes). For public transport they equal the sum of infrastructure and supplier operating costs (excl. taxes). The financial costs and revenues are calculated as much as possible according to the methodology described in Link et al. (2000, 2002).

In the AC scenarios all existing transport taxes (except the VAT) and subsidies are set equal to zero. The VAT rate is set at the standard rate[8]. In the case of road transport AC pricing is introduced by means of an undifferentiated tax per vkm for car, truck and bus. No distinction is made between heavy and light road vehicles. Transit transport is assumed to be subject also to the tax reform. For rail transport an undifferentiated tax is imposed on pkm and tkm. For the other public transport modes an undifferentiated tax per pkm is used.

[7] Various alternatives, such as infrastructure investment, a change in the supply or quality of public transport, etc., could be considered. The efficiency and equity effects will in general depend on the instrument that is chosen.

[8] The treatment of VAT in these scenarios is in line with the definition of revenues in the UNITE transport accounts (Link et al., 2000).

Marginal social cost pricing

Scenarios 3 and 4 concern MSC pricing for all transport sectors except inland navigation. All existing taxes (including VAT) and the subsidies related to the variable operating costs of public transport are abolished. An externality tax is introduced ensuring that each transport user pays his marginal social cost. Both domestic and transit transport are subject to the tax reform.

Budget neutrality

In all four scenarios budget neutrality is assumed. We consider two alternative instruments to achieve this. In Scenarios 1 and 3 budget neutrality is obtained by means of the labour income tax. In Scenarios 2 and 4 the social security transfers are changed. In all cases an equal percentage change in the revenue-recycling instrument is assumed for all quintiles. It is evident that this assumption affects the distributional impacts of the scenarios and that different assumptions may lead to different conclusions.

4. Results

4.1. Transport prices, transport demand and marginal external costs

Tables 4 to 6 summarise the impact of the policy scenarios on prices, demand and marginal external costs.

Average cost pricing

Given the financial cost coverage rates observed in the initial equilibrium, the two AC pricing scenarios imply a reduction in the taxes on road transport and a substantial increase in the taxes on public transport. As a result, the money price of car and truck transport falls, while that of public transport increases considerably (Table 4). Table 5 gives the resulting impacts on transport demand[9]. For passenger transport there is a shift from the peak to the off-peak and from public transport to private transport. The share of public transport becomes much smaller. Similar impacts are observed for freight transport. Total demand rises by appr. 0.8% for passenger transport and falls by appr. 3.1% for freight transport.

Table 6 shows how the AC policies affect the marginal external costs of transport. Given the shift towards road transport, average road speed falls both in the peak and the off-peak period, which leads to an increase in the marginal external costs of road transport, especially during the peak.

[9] The average cost scenarios are quite extreme scenarios. The resulting demand changes should be regarded with caution. They should be considered as very rough estimates for the cases with large price changes.

Table 4: The effect of the policy reforms on transport prices (Belgium, 1990)

	Benchmark	Scenario 1	Scenario 2	Scenario 3	Scenario 4
		AC + higher labour income tax	AC + lower social security transfer	MSC + lower labour income tax	MSC + higher social security transfer
Price passenger transport	(euro/pkm)	Percentage change w.r.t. benchmark			
Peak					
Gasoline car – committed[a]	0.29	-16%	-16%	21%	20%
Gasoline car – suppl.[a]	0.13	-19%	-19%	84%	82%
Diesel car – committed	0.19	-12%	-12%	69%	67%
Diesel car – suppl.	0.08	-8%	-8%	209%	204%
Bus, tram, metro	0.06	154%	154%	89%	91%
Rail	0.06	764%	763%	73%	75%
Off-peak					
Gasoline car – committed	0.29	-16%	-16%	-8%	-9%
Gasoline car – suppl.	0.13	-19%	-19%	16%	15%
Diesel car – committed	0.19	-12%	-12%	23%	23%
Diesel car – suppl.	0.08	-8%	-8%	98%	96%
Bus, tram, metro	0.06	193%	193%	146%	149%
Rail	0.06	769%	768%	72%	75%
Price freight transport	(euro/tkm)	Percentage change w.r.t. benchmark			
Truck					
Peak – committed	0.17	-10%	-10%	40%	40%
Peak – suppl.	0.17	-9%	-9%	111%	110%
Off-peak – committed	0.16	-11%	-11%	27%	27%
Off-peak – suppl.	0.16	-12%	-12%	89%	88%
Rail	0.05	349%	348%	7%	9%

[a] The distinction between committed and supplementary mileage allows us to model the link between car ownership and car use. The CGE model assumes that owning a car implies a certain minimum mileage. This is reflected in the committed mileage, which is proportional to the vehicle stock. The costs of committed mileage include the ownership and running costs per km. The consumers can choose to drive more than the minimum mileage per car. This is captured in the supplementary mileage, whose cost includes only running costs.

Table 5: The effect of the policy reforms on transport demand (Belgium, 1990)

	Benchmark	Scenario 1	Scenario 2	Scenario 3	Scenario 4
		AC + higher labour income tax	AC + lower social security transfer	MSC + lower labour income tax	MSC + higher social security transfer
Passenger transport	mio pkm/year	Percentage change w.r.t. benchmark			
Peak	36532	-2.38%	-2.39%	-12.89%	-12.76%
car	29308	4.68%	4.66%	-14.28%	-14.14%
bus, tram, metro	4239	-18.82%	-18.83%	-3.98%	-3.64%
rail	2985	-48.33%	-48.32%	-11.93%	-12.21%
Off-peak	59684	+2.73%	+2.73%	-5.42%	-5.37%
car	51813	8.75%	8.76%	-3.36%	-3.27%
bus, tram, metro	4317	-26.19%	-26.19%	-20.38%	-20.41%
rail	3554	-50.04%	-50.02%	-17.30%	-17.69%
Freight transport	mio tkm/year	Percentage change w.r.t. benchmark			
Road – peak	7485	10.34%	10.38%	-15.04%	-15.12%
Road – off-peak	32715	11.07%	11.11%	-11.12%	-11.30%
Rail	8354	-81.28%	-81.27%	6.51%	4.05%

Table 6: The effect of the policy reforms on the marginal external costs (Belgium, 1990)

	Benchmark	Scenario 1	Scenario 2	Scenario 3	Scenario 4
		AC + higher labour income tax	AC + lower social security transfer	MSC + lower labour income tax	MSC + higher social security transfer
Marginal external cost (euro/vkm)					
Peak					
Gasoline car	0.28	0.32	0.32	0.19	0.19
Diesel car	0.33	0.36	0.36	0.23	0.23
Tram	0.47	0.54	0.54	0.29	0.29
Bus	1.03	1.09	1.09	0.85	0.85
Truck	0.80	0.87	0.87	0.62	0.62
Off-peak					
Gasoline car	0.09	0.10	0.10	0.09	0.09
Diesel car	0.13	0.14	0.14	0.13	0.13
Tram	0.09	0.11	0.11	0.08	0.08
Bus	0.66	0.67	0.67	0.65	0.65
Truck	0.42	0.44	0.44	0.41	0.41
Rail					
Passenger –electricity	0.00	0.00	0.00	0.00	0.00
Passenger – diesel	0.19	0.19	0.19	0.19	0.19
Freight – electricity	0.00	0.00	0.00	0.00	0.00
Freight – diesel	0.52	0.51	0.51	0.52	0.52

Marginal social cost pricing

With MSC pricing all existing transport taxes and the subsidies related to variable operating costs are abolished, and replaced by a tax per vkm such that each transport users pays for his marginal social costs. It should be noted that the CGE model is a model for a second-best economy in which the government needs to use distortionary taxes to finance its budget. Therefore, the MSC pricing that is considered here is in general not the optimal[10] pricing policy. Note also that all other taxes (except the revenue recycling instruments) are assumed to remain constant.

For road transport MSC pricing entails a substantial increase in the tax per vkm in the peak period, reflecting the high congestion costs. In the off-peak the tax is also raised for most road transport modes, but less so. The tax is differentiated according to vehicle type. For example, diesel cars are now subject to a higher tax than gasoline cars, since they are associated with higher air pollution costs. The MSC scenarios also imply a tax increase for the input of vkm by the public transport companies.

Table 4 presents the resulting effect on transport prices. In most cases transport prices increase. The increases are higher in the peak than in the off-peak. The increase in the price of public transport reflects not only the internalisation of the external costs, but also the abolishment of the variable subsidies. Total transport demand falls both for passenger (-8.2%)

[10] For the optimal tax and investment rules in a second-best economy in the presence of externalities, see Mayeres and Proost (1997).

and freight transport (-9.5%). The reduction in transport demand means that people respond to this type of pricing by reconsidering their transport decisions, for example, by abolishing some trips, by choosing destinations that are closer by, or by rethinking the organisation of production. As is shown in Table 5, MSC pricing also leads to a shift from peak to off-peak transport both for passenger and freight transport, and from private to public transport (except for off-peak passenger transport).

The impact on the marginal external costs is summarised in Table 6. MSC pricing raises average road speed during the peak, which is the main explanation of the fall in the marginal external costs in this period. The impact in the off-peak period is much smaller.

4.2. The transport accounts

Tables 7 and 8 present the impact of the policy scenarios on the transport accounts, which are constructed using the UNITE methodology. The benchmark equilibrium corresponds with the situation in Belgium in 1990. The impact of the AC and MSC cost scenarios on the accounts is computed by means of the CGE model for Belgium[11].

Table 7: Road transport account (Belgium, 1990)

	Benchmark	Scenario 1	Scenario 2	Scenario 3	Scenario 4
		AC + higher labour income tax	AC + lower social security transfer	MSC + lower labour income tax	MSC + higher social security transfer
COSTS (mio euro)					
Infrastructure costs (excl. taxes)	1797	1815	1818	1812	1771
Capital costs	1198	1196	1198	1241	1207
Running costs	599	619	620	571	565
Fixed	300	300	300	300	300
Variable	299	319	320	271	265
External accident costs	2198	2341	2342	2057	2041
Environmental costs (change w.r.t. benchmark)		255	258	-537	-572
COSTS (additional information)					
User costs (time)	1531	1770	1772	758	740
Internal accident costs	5006	5331	5333	4683	4648
REVENUES (mio euro)	4562	1833	1833	10382	10146
Kilometre charge	0	1833	1833	11912	11685
Circulation tax	868				
Fuel duty	2535				
VAT	1158			-1530	-1539
REVENUES / FINANCIAL COSTS	2.54	1.01	1.01	5.73	5.73

[11] For the environmental costs Tables 7 and 8 present the change with respect to the reference equilibrium, rather than the total environmental costs. For the valuation of emissions we have information only about the marginal willingness-to-pay for emission reductions. These values can be used only to evaluate relatively small changes in emissions. It would therefore be incorrect to use them to calculate the total environmental costs.

The AC pricing scenarios ensure a financial cost coverage rate of 1 for the three transport sectors. For the road sector, the uniform levy leads to an increase in revenues. There is also a small increase in infrastructure costs, due to higher demand for road transport. The higher transport demand, accompanied by a shift to private transport, also increases the accident and environmental costs of the road sector. For public transport, the higher prices lead to more revenue, but also to lower costs due to the reduction in demand for public transport.

MSC pricing raises the financial cost coverage rate for the three transport sectors. For road and public transport other than rail it more than doubles. On the cost side, the change in financial, accident and environmental costs is a consequence of the change in transport demand, as described in Table 5.

Note that the financial cost coverage rate for the MSC scenarios can to some extent be used as guidance for determining the optimal surplus/deficit by mode. However, this information is not sufficient for determining optimal policies, since there is no guarantee that the associated tax structure is optimal.

Note also that the transport accounts are almost not affected by the choice of the revenue recycling instruments considered here. Therefore Table 8 presents the public transport accounts for one revenue recycling strategy only.

Table 8: Public transport accounts (Belgium, 1990)

	Public transport other than rail			Rail		
	Benchmark	Scenario 1 AC + higher labour income tax	Scenario 3 MSC + lower labour income tax	Benchmark	Scenario 1 AC + higher labour income tax	Scenario 3 MSC + lower labour income tax
COSTS (mio euro)						
Total financial costs	1149	951	966	2608	1923	2486
Infrastructure costs (excl. taxes)	30	30	31	872	871	891
Supplier operating costs (excl. taxes)	1118	921	934	1736	1052	1595
Vehicle related	741	589	581	700	276	634
Other	378	332	353	1035	776	962
External accident costs	32	25	27	0	0	0
Environmental costs (change w.r.t. benchmark)		-29	-19		-8	0
COSTS (additional information)						
User costs (time)	226	216	110	0	0	0
Internal accident costs	61	47	52	0	0	0
REVENUES (mio euro)	430	948	799	723	1927	925
Tax on pkm or tkm	0	191	0			
Excises paid by operators	4	4	4	1	1	1
Tariff revenue	479	754	958	759	424	1012
Taxes on tariffs	-53	0	-163	-37	1502	-89
REVENUES (additional information)						
Subsidies related to variable operating costs	506	0	0	350	0	0
REVENUES / FINANCIAL COSTS	0.37	1.00	0.83	0.28	1.00	0.37

While summarising some of the effects of the policy scenarios, the transport accounts are not sufficient for policy making. They give no indication of whether AC pricing and/or MSC pricing constitute an improvement with respect to the benchmark equilibrium. Nor do they allow to make a choice between revenue recycling instruments. This is because they do not contain all elements necessary for a social cost benefit analysis. The transport accounts do not take into account the benefits that people derive from transport or their user costs, nor do they allow to assess the effects on the different income groups. Moreover, they do not take into account how a higher deficit in the transport sector is financed or how additional revenue is used. All these elements are crucial for an evaluation of transport policies. Therefore, transport accounts are not sufficient to monitor whether policy is improving, nor to assess whether revenues reasonably reflect relevant costs. For this additional analysis is required. Here we use the CGE model to calculate the social welfare impacts of the policy reforms.

4.3. The impacts on welfare

Table 9 summarises the welfare effects of the policy reforms for the household income quintiles. Quintile 1 presents the poorest households, while quintile 5 represents the richest households. The welfare impact on the quintiles is measured by means of the equivalent gain: the increase in the initial equivalent income of an individual that is equivalent to implementing the policy reform. In the table it is presented as the percentage increase in the initial equivalent income of the individual. The effect on social welfare is described by the social equivalent gain. This is defined as the change in each individual's original equivalent income that would produce a level of social welfare equal to that obtained in the post-reform equilibrium. The social desirability of a policy depends not only on its efficiency, but also on its equity impact. Hence we present the social equivalent gain for two degrees of inequality aversion, denoted by ε. With ε equal to zero, only efficiency matters. We also present the social welfare change for ε equal to 0.5. This corresponds with a medium degree of inequality aversion. In this case the marginal social welfare weight of people belonging to the richest quintile is approximately 70% of those belonging to the poorest quintile.

Table 9: The welfare effects of the policy reforms (Belgium, 1990)

	Benchmark	Scenario 1	Scenario 2	Scenario 3	Scenario 4
		AC + higher labour income tax	AC + lower social security transfers	MSC + lower labour income tax	MSC + higher social security transfers
Equivalent income (euro/person/year)		percentage change w.r.t. benchmark			
Quintile 1	18586	-0.78%	-0.97%	0.47%	3.88%
Quintile 2	22260	-0.04%	-0.16%	0.03%	2.21%
Quintile 3	25027	-0.24%	-0.29%	-0.16%	0.75%
Quintile 4	28330	-0.20%	-0.19%	0.22%	0.00%
Quintile 5	35579	-0.49%	-0.38%	1.45%	-0.51%
Social equivalent gain (euro/person/year)					
$\varepsilon = 0$		-92.71	-92.08	160.66	148.89
$\varepsilon = 0.5$		-89.56	-91.74	142.50	179.17

Average cost pricing

AC pricing leads to a reduction in government revenue. In Scenario 1 this is financed by an increase in the labour income tax by 0.5% for all quintiles. In Scenario 2, the social security transfers are reduced by 1% for all quintiles. Both AC scenarios reduce welfare for all quintiles. Consequently they both lead to a social welfare loss. This shows clearly that balancing the financial part of the transport accounts is not an objective that one should aim at. Table 9 also shows that AC pricing cannot be defended because of equity reasons, since all income groups become worse off. These findings are a confirmation of the theoretical discussion in Mayeres et al. (2001).

Within each AC scenario the differential impact on the quintiles can be explained, inter alia, by their share in the consumption of the transport goods, their share in the total social security transfers or labour income, the level of initial taxation and the quintiles' valuation of the reduction in the externalities. For example the relatively high welfare loss of quintile 1 in Scenario 1 is due to its large share in the consumption of public transport that becomes considerably more expensive. The high welfare loss of quintile 5 is due to the high share of labour income in its income and the high labour income tax of this quintile in the benchmark equilibrium.

The difference in welfare impact between Scenario 1 and 2 is due to choice of budget neutralising instrument. When the social security transfers are reduced, the welfare losses for Quintiles 1 to 3 are higher than when the labour income tax is increased. This is because the social security transfer accounts for a larger share of their income. The share of labour income is relatively smaller for these quintiles, as is the labour income tax rate.

Social welfare is reduced in both AC scenarios, as is reflected in the negative social equivalent gain. The social equivalent loss does not differ a lot between the two revenue-recycling strategies. This is because the required changes in the labour income tax and the social security transfers are relatively small. With AC pricing the impact on welfare is dominated by the change in the transport taxes.

Marginal social cost pricing

Since the MSC scenarios raise the revenue collected by the government, the full welfare assessment needs to take into account how this revenue is used. In Scenario 3 the labour income tax is reduced by 10% for all quintiles. In Scenario 4 the extra revenue is used to increase the social security transfers by 11%.

In both MSC scenarios the impact on social welfare is positive. However, not all quintiles benefit to the same extent from the policy reforms. Moreover, the welfare impacts on the quintiles are quite different in the two MSC scenarios. The difference is more pronounced than with AC pricing. When the extra revenue is returned through higher transfers (Scenario 4), the welfare gains become lower as the income of the quintiles rises. The poorer quintiles benefit most from the higher transfers, since they make up a higher share of their income. In this scenario the two richest quintiles do not benefit from the policy reform: they pay higher transport taxes, but benefit only to a small extent from the redistribution of the extra government revenues.

In Scenario 3 all quintiles gain, except quintile 3. This quintile consumes a lot of car transport and does not benefit as much as the higher quintiles from the reduction in the labour income tax. The highest welfare gain is observed for quintile 5. While consuming relatively a lot of transport, this quintile benefits most from the lower labour income tax and from the reduction in the externalities.

While the transport account is similar in Scenarios 3 and 4, the impact on social welfare is not. It depends on the revenue-recycling instrument that is used, and on the inequality aversion of society. When only efficiency considerations are important (ε = 0), the labour income tax is preferred as revenue recycling instrument. When a higher weight is given to the poorer quintiles (as is the case with ε = 0.5) it is better to recycle the revenue through higher transfers.

5. Conclusions

The general equilibrium analysis shows that the requirement of modal budget balance reduces welfare when this requirement is met through AC pricing. The welfare cost of AC pricing relative to MSC pricing may be substantial. The analysis also shows that AC pricing leads to welfare losses for all income groups considered in the study. This indicates that AC pricing cannot be justified on equity grounds.

Of course, there are other ways of defining AC pricing schemes than the one analysed here, and alternative definitions may produce better results. These alternative schemes will however become more complex, and they will still perform worse than marginal-cost-based pricing approaches. From related economic literature we know that when the budget is met through Ramsey pricing, rather than AC pricing, this is most often welfare improving (see, for example, Proost and Van Dender, 2003), though the imposition of a budget constraint still involves an important welfare cost in comparison with pricing schemes that do not impose such a constraint. Another option may be to use two-part tariffs (see, for example, De Borger, 2001). The welfare effect therefore depends not only on the presence of a budget constraint but also on the flexibility with which that constraint can be met.

MSC pricing generally increases social welfare. The CGE model for Belgium shows that in general not all groups are affected equally by MSC pricing. The equity impacts depend on how budget neutrality is ensured[12]. The Belgian CGE model, which considers several income groups, shows that when society becomes more inequality averse, the revenue recycling instrument that is more beneficial to the poorer income groups will be preferred. One can conclude that the revenue recycling instruments have an important role to play in enhancing the political acceptability of transport pricing.

It should be noted that the relative welfare effects of MSC and AC pricing depend on the transport situation in the country or region under study. In countries where congestion is the dominant marginal external cost of transport, transport instruments that tackle this problem efficiently have an advantage over the others. Therefore, instruments that do not make a distinction between congested and uncongested situations get a large penalty. A second determining factor is the ratio of transport revenue to financial costs in the reference

[12] This would also hold when equity is considered in terms of other dimensions than income, e.g. when a distinction is made according to urban and non-urban households as in Wickart et al. (2002).

equilibrium. A different ratio means that the alternative pricing instruments will have a different implication for the transport accounts and government budget[13].

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[13] Simulations with a CGE model for Switzerland show that in Switzerland AC pricing leads to a lower welfare loss in comparison with MSC pricing than in Belgium (Wickart et al., 2002). This can be explained by the lower congestion levels in Switzerland and by the fact that the ratio of transport revenue to financial costs is different in the two countries. In the reference equilibrium in Belgium revenue from the road transport modes is much higher than financial costs. In Switzerland revenue is approximately equal to financial costs. For public transport the rate of financial cost coverage is lower in Belgium.

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