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The PLANET model
Methodological Report:
Modelling of Short Sea Shipping and Bus-Tram-Metro

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Abstract - This Working Paper describes the methodological changes in the Modal and Time Choice module of the PLANET model, further to the endogenisation of short see shipping (SSS) for international transport and the splitting of the Bus-Tram-Metro (BTM) aggregate into 3 distinct transport modes. The PLANET model produces: (i) medium- and long-term projections of transport demand in Belgium, both for passenger and freight transport; (ii) simulations of the effects of transport policy measures; (iii) cost-benefit analyses of transport policy measures. The main features of the PLANET model are described in former Working Paper 10-08.

Jel Classification - R41, R48

Keywords - Freight and passenger transport model, Long-term transport projections.

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1. Introduction

The PLANET model is a model of the Belgian Federal PLANning Bureau that models the relationship between the Economy and Transport. The main features and modular structure of the PLANET model are described extensively in Working Paper 10-08. The past two years, the model was used to produce medium- and long-term projections of transport demand in Belgium, both for passenger and freight transport (e.g. Working Paper 12-08, Planning Paper 107) and to simulate the effects and perform cost-benefit analyses of transport policy measures (e.g. Working Paper 14-09).

The PLANET model is not aimed to remain a 'static' policy tool; quite on the contrary, the goal is to make it evolve in time so as to enlarge its analytical capabilities. In this context, a Car Stock module has been recently integrated in PLANET that calculates the size and composition of the car stock. This module will allow to better capture the impact of changes in fixed and variable taxes levied on cars. This new module is described in Working Paper 02-10.

This Working Paper deals with another extension of PLANET, that is to say the explicit modelling of short sea shipping as an alternative transport mode to road, rail and inland waterways for the international transport of goods, on the one hand, and of bus, tram and metro as independent passenger transport modes, on the other hand.

In the previous version of the model, the evolution of maritime (short and deep sea shipping), air and pipeline transport was defined exogenously. It was therefore assumed that maritime, air and pipeline transport activities were not affected by policy measures on the other modes and vice versa. However, as short sea shipping is a possible substitute for international road, rail and inland navigation, it was decided to model it endogenously. On the other hand, the development of deep sea shipping, air and pipeline transport remains exogenous.

As to bus, tram and metro, the previous version of PLANET considered these three modes as one single aggregated transport mode, referred to as BTM. By doing so, tram and metro were penalised in the same way as buses by an increase in road traffic flows even though they are not or only partly affected by congestion on the roads. The splitting of BTM into three distinct modes allows preventing bias against tram and metro.

Both new extensions of the PLANET model have only an impact on the Modal and Time Choice Module. This module determines the modal and time choice while the number of passenger trips or tonnes transported between zone pairs is taken as given.

The number of passenger-kilometers (pkm) and tonne-kilometers (tkm) driven by the different modes and in the different time periods is chosen such as to minimise the generalised costs of realising the exogenously given passenger trips or tonnes transported. The "technology of production" for passenger and freight transport is represented by a nested MCES function. "MCES" stands for modified constant elasticity of substitution. The general properties of nested MCES functions are discussed in chapter 5.2 of Working Paper 10-08. The calibration of the modal and time choice module involves (i) the definition of the nesting structure of the model and (ii) the choice of the elasticities of substitution, the weighting parameters and the scaling parameters such as to obtain realistic generalised cost elasticities for the base year. Chapter 2 discusses the calibration for freight transport and Chapter 3 for passenger transport.

For the resulting transport flows, the Modal and Time Choice module also calculates the environmental impacts. The environmental impacts concern the emissions of carbon monoxide (CO), nitrogen oxides (NO_x), particulate matter (PM), non-methane volatile organic compounds (NMVOC) and sulphur dioxide (SO_2). Furthermore, we consider three greenhouse gases: carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O). The explicit modelling of short sea shipping has no impact on the calculation of emissions because PLANET focuses on emissions on the Belgian territory. As far as bus, tram and metro are concerned, the model calculates now explicitly the direct and indirect[1] emissions of buses and the indirect emissions of tram and metro related to the production of electricity.

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[1] Indirect emissions are related to the production and transport of fuel.

2. Freight transport

The scope of the modal and time choice module for freight transport in the previous version of the PLANET model was road, rail and inland navigation. With the extension proposed, there is a new freight transport mode in PLANET: short sea shipping (SSS). The evolution of deep sea shipping (DSS), air and pipeline transport is still imposed exogenously.

Short sea shipping refers to maritime transport services which do not involve an ocean crossing. It includes the movement of freight along the coasts and between the mainland coasts and islands of the European Union, as well as sea-river transport by coastal vessels to and from ports in the hinterland. In Belgium, SSS transport exists from and to the ports of Antwerp, Brussels, Ghent, Liege, Ostend and Zeebrugge. By contrast, inland waterways transport refers to freight transport by barges, i.e. by not seagoing vessels.

2.1. Nesting structure

For freight transport the general nesting structure of Figure 1 is used[2]. It is defined for all zone pairs and NST/R10 goods categories. The tonnes transported of a certain goods type between a given zone pair are produced with the input of tkm. A distinction is made between:

- tkm in Belgium and abroad;
- tkm by the following modes: road HDV[3], road LDV[4], rail, inland waterways (IWW), SSS;
- tkm by Belgian and foreign suppliers;
- tkm in the peak and off-peak period (in the case of road transport).

The σ values refer to the elasticities of substitution, which will be discussed in more detail later.

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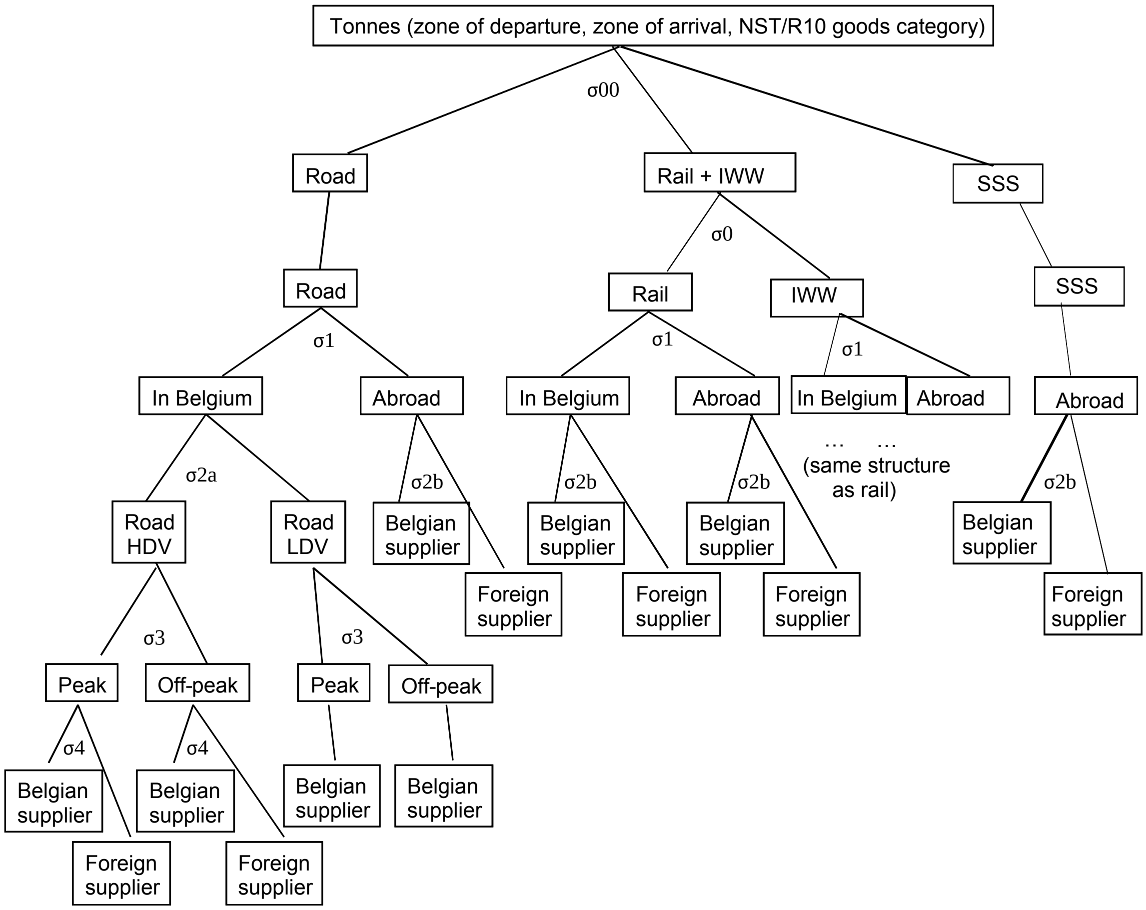
[2] To simplify the graphical representation of the nesting structure, we dropped the subscripts for the elasticities of substitution. It should be noted that these elasticities may differ according to the zone pair, goods type and branch of the nesting tree that is considered.

[3] Heavy Duty Vehicles.

[4] Light Duty Vehicle.

Figure 1: Nesting structure for freight transport



It should be noted that not all elements are relevant for all zone-pairs. More particularly:

- In the case of national transport no transport takes place abroad;
- LDVs are assumed to be used only for national transport;
- SSS is used only for international transport and takes place only abroad[5];
- National rail transport is assumed to be supplied by Belgian firms only.

Finally, for some goods types, some components are not chosen in the base year. The modelling approach implies that they will not be chosen in future years either. The nesting structure imposes a number of limitations on the transport choices. More particularly, elements on a given branch of the tree will react identically to changes in the generalised costs of all elements on the other branches of the tree. For example, a change in the unit costs of rail transport abroad is assumed to have the same impact on all tkm performed by road, IWW or SSS abroad, and for transport in Belgium a change in the unit cost of peak transport by road LDV affects road HDV in the peak and off-peak in an identical way.

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[5] This scope results from the definition of SSS and related statistics. This means that the journeys from and to the ports of Brussels and Liege are assimilated to transport abroad although part of them take place on the Belgian territory.

2.2. Inputs for the calibration

In the calibration we start from the observed tonnes, tkm and generalised costs per tkm in the base year. The parameters of the nested MCES function are chosen in order to obtain realistic generalised cost elasticities in this base year. The next paragraphs describe the data used for the calibration. In some cases the data were not available and assumptions needed to be made.

a. Tonnes transported in base year

For each NST/R10 goods category the tonnes transported between the zone pairs are taken from the OD matrices for 2000 (for more details see WP 10-08, chapter 4).

The number of tkm in the base year is derived by multiplying the tonnes transported with the average distance travelled. The endogenous modelling of short sea shipping has only an impact on the km/tonne for transport abroad. Table 1 presents the new figures calculated for 2000. A distinction is made between transport from Belgium to the rest of the world (ROW) and from ROW to Belgium. Table 1 presents averages over the four transport modes.

For international rail and IWW transport only the average km/tonne in Belgium is known per goods type. No information is available on the distance travelled abroad. We approximate this distance by looking at the distribution of the foreign origins/destinations of rail and IWW transport and by applying the average distance of road HDV transport per foreign origin/destination. For SSS, the distances between the main European seaports are based on data from ADSEI/DGSIE. For smaller and non-European ports, data comes from http://www.dataloy.com and complemented where necessary by data from http://www.portworld.com.

Table 1: Km per tonne in 2000 for transport abroad

From Belgium to ROW		From ROW to Belgium	
Brussels	477	Brussels	463
Flanders	687	Flanders	750
Wallonia	181	Wallonia	169
Belgium	575	Belgium	654

Source: FPB on the basis of Gusbin and Hoornaert (2006), unpublished data by ADSEI/DGSIE, NMBS/SNCB (2000), ADSEI/DGSIE (2003), http://www.dataloy.com, http://www.portworld.com.

As SSS applies above all to transport from and to harbours located in Flanders (i.e. Antwerp, Zeebrugge, Ghent and Ostend), the endogenisation of SSS in PLANET has a significant impact on the km/tonne from Flanders to ROW and from ROW to Flanders: it is about three times higher than the km/tonne calculated in the previous version of PLANET.

SSS also exists from and to Brussels and from and to Wallonia (Liege) but to a far lesser extent: the km/tonne from Brussels (Wallonia) to ROW and from ROW to Brussels (Wallonia) is about 40% (2%) above figures calculated in the previous version of PLANET. It is worth noting that SSS transport from and to Brussels is characterised by higher transport flows (in terms of tonnes lifted) and by longer distances to the destination and from the origin of the transport flows, than Wallonia.

b. Monetary costs per tkm

The monetary costs of road, rail and IWW freight transport are described in Chapter 5 of WP10-08. In particular, the average monetary cost per tkm for rail (resp. IWW) transport is calculated as the ratio of the value of domestic production of good "rail" (resp. "IWW") including transport margin and the tkm transported by NMBS/SNCB (resp. Belgian shippers on inland waterways).

For SSS, it is not possible to follow the same approach because there is no matching possible between the value of domestic production (numerator) and the tkm transported by SSS (denominator). Transport activity is allocated according to the flag and not according to the nationality of the shipper. Therefore, another approach is followed for SSS where the monetary cost per tkm in 2000 is calculated on the basis of the supply and use table for that year and the average fuel[6] consumption of SSS in kg per 1000 tkm. It is determined as follows:

> (Fuel consumption in kg/1000tkm*fuel price in euro/kg)/share of intermediate fuel consumption in domestic production of branch 61A1

Good 61A01 refers to freight maritime transport performed by Belgian shippers. Fuel consumption of SSS is taken to be 5.6 kg/1000 tkm. This figure is based on ADSEI/DGSIE data on in- and outgoing ships in Belgian seaports, on parts of the methodology described in EX-TREMIS (2008) and assumes a load factor of 0.89[7]. The tax per tkm is assumed to be zero. The share of intermediate fuel consumption in domestic production of branch 61A1 is equal to 5% in 2000. We assume that this percentage does not differ significantly according to the nationality of the shipper. The resulting monetary cost is 19 euro/1000 tkm.

It is assumed that this cost is the same for Belgian and foreign suppliers and for all goods types.

c. Time costs per tkm

Koopmans and de Jong (2004) provide information on the value of time for all freight transport modes. The values of time of Koopmans and de Jong (2004) are expressed in €/transport/hour. To transform them in €/tonne/hour, information about the number of tonnes per transport is required. For SSS, the information comes from De Sadeleer (2005). The different steps that are taken and the resulting value of time in €/tonne/hour for international rail, IWW and SSS freight transport, are presented in Table 2.

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[6] i.e. heavy fuel oil.

[7] The load factor refers here to the ratio of load and dead weight tonnes (DWT). Calculations based on a lower load factor (e.g. 0.65) lead to a higher figure for fuel consumption (i.e. 8.3 kg/1000 tkm). We took the lower figure for fuel consumption because it is closer to values quoted by the shippers (around 5.2 kg/1000tkm).

Table 2: The value of time for international freight transport by SSS, IWW and rail

Value of time (€/transport/h)		
SSS	71	
Inland waterways	74	
Rail	918	
Tonne/transport	**From Belgium to ROW**	**From ROW to Belgium**
SSS	1674	2672
Inland waterways	557	691
Rail	419	419
Value of time (€/tonne/h)	**From Belgium to ROW**	**From ROW to Belgium**
SSS	0.04	0.03
Inland waterways	0.13	0.11
Rail	2.19	2.19

Source: NMBS/SNCB (2000), ADSEI/DGSIE, Koopmans and de Jong (2004).

Speed of road transport abroad is determined endogenously in the model, whereas it is imposed exogenously for the other freight transport modes. For rail transport abroad we assume a speed of 55 km/h. The average speed of IWW is taken to be 10 km/h, on the basis of De Borger and Proost (2001). For SSS, there is a difference in speed between container and bulk transport, therefore an average speed is calculated on the basis of the share of both types of transport in 2000 and speeds provided in ENTEC (2002). The result of the calculation gives 27 km/h. The speed of non-road freight transport abroad is assumed to remain constant over the time horizon.

The time cost per tkm is obtained by multiplying the time needed per tkm by the value of time.

d. Generalised cost elasticities

Table 3 presents an overview of the elasticities of substitution in the nested MCES functions for freight transport. The table uses the same symbols as Figure 1.

σ_{00}, the elasticity of substitution between road, the rail&IWW composite and SSS is taken to be larger for international than for national transport. It is taken to be the largest for goods categories that are transported in bulk and for NST/R9[8] that is transported relatively more in containers.

σ_0, the elasticity of substitution between rail and IWW is assumed to be larger for international transport than for national transport.

σ_1, the elasticity of substitution between transport in Belgium and transport abroad, is relevant only for international transport (excl. transit without transhipment[9]). It is taken to be very low given the limited possibilities to switch between transport in Belgium and abroad when the origin or destination of the freight flows is located in Belgium.

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[8] The description of the different goods categories classifies according to the NST/R chapters is provided in annex.

[9] Note that the elasticity of total transit without transhipment in Belgium w.r.t. generalised costs in Belgium is taken into account in the transport generation module (see Part 3 of the PLANET report).

σ_{2a}, the elasticity of substitution between road HDV and LDV, is relevant only for national road transport, since LDVs are assumed to be used for national transport only. The substitution possibilities are taken to be the largest for the goods categories for which LDVs have a relatively large share in the base year (NST/R1 and NST/R9).

σ_3 is the elasticity of substitution between peak and off-peak road transport in Belgium. It is taken to be larger for international than for national transport. Furthermore, it is assumed that the delivery constraints are less flexible for some goods than for others, resulting in a lower value for the elasticity.

Finally, σ_{2b} and σ_4 give the substitution possibilities between Belgian and foreign transporters. This is assumed to be quite high in all cases, implying that transport users do not give a lot of importance to the nationality of the supplier (at a given level of generalised costs).

Table 4 and Table 5 present the calibrated generalised cost elasticities used in PLANET for international transport abroad.

Table 4 refers to transport from Belgium to ROW while Table 5 refers to transport from ROW to Belgium.

Table 3: Overview of the elasticities of substitution in the nested MCES functions for freight transport

	Elasticity of substitution between	Type of transport	NST/R goods category	Value
σ_{00}	Road, Rail+IWW, SSS*	National	0, 1	1.4
			Others	2.2
		International - BEROW	0, 1	2.2
			Others	3.2
		International - ROWBE	0, 1	2
			Others	3
		Transit	All	3
σ_0	Rail and IWW	National	All	2
		International	0, 1	2
			Others	3
σ_1	Transport in Belgium and transport abroad	Belgium to ROW &	All	0.11
		ROW to Belgium	All	0.11
σ_{2a}	Road HDV and road LDV	National road transport in Belgium	2, 6	0.2
			0, 7_8	1.1
			1, 9	2
σ_{2b}	Belgian and foreign transport suppliers	Road abroad	All	5
		Rail	All	5
		IWW	All	5
σ_3	Peak and off-peak	Road LDV and HDV in Belgium (National)	0, 1, 5, 9	0.7
			2, 3, 4, 6, 7_8	1.2
		Road HDV in Belgium (Belgium to ROW and ROW to Belgium)	0, 1, 5, 9	1.4
			2, 3, 4, 6, 7_8	2.4
		Road HDV in Belgium (transit)	All	2
σ_4	Belgian and foreign transport suppliers	Road HDV in Belgium	All	5

*: for SSS, only international transport is relevant.

Table 4: Calibrated generalised cost elasticities of freight transport from Belgium to ROW

NST/R	Road in Belgium		Road abroad	Rail		IWW		SSS
	Peak	Off-peak		in Belgium	Abroad	In Belgium	Abroad	Abroad
0	-0.95	-0.55	-0.15	-0.60	-0.59	-0.48	-1.31	-0.24
1	-0.95	-0.54	-0.13	-0.54	-0.58	-0.33	-1.46	-0.11
2	-1.70	-1.03	-0.60	-0.54	-0.85	-0.18	-0.72	-0.08
3	-1.84	-1.31	-1.18	-0.62	-0.37	-0.17	-1.10	-0.31
4	-1.64	-0.91	-0.36	-0.36	-0.46	-0.28	-0.80	-0.04
5	-1.05	-0.73	-0.69	-0.58	-0.71	-0.61	-1.52	-0.47
6	-1.68	-1.01	-0.21	-0.80	-1.06	-0.76	-0.80	-0.32
7_8	-1.02	-0.69	-0.63	-1.02	-1.08	-0.35	-1.85	-0.52
9	-1.00	-0.63	-0.43	-0.60	-0.60	-0.27	-1.93	-0.25
Average	-1.15	-0.72	-0.43	-0.64	-0.68	-0.52	-1.38	-0.28

Table 5: Calibrated generalised cost elasticities of freight transport, from ROW to Belgium

NST/R	Road in Belgium		Road abroad	Rail		IWW		SSS
	Peak	Off-peak		in Belgium	Abroad	In Belgium	Abroad	Abroad
0	-0.96	-0.58	-0.24	-0.44	-0.71	-0.32	-0.86	-0.35
1	-0.98	-0.59	-0.19	-0.58	-0.73	-0.44	-1.29	-0.54
2	-1.62	-0.89	-0.14	-0.11	-0.12	-0.07	-0.11	-0.01
3	-1.90	-1.44	-0.50	-0.57	-0.82	-0.22	-0.25	-0.01
4	-1.65	-0.94	-0.20	-0.22	-0.15	-0.13	-0.25	-0.02
5	-1.03	-0.71	-0.53	-0.44	-0.52	-0.38	-2.05	-0.17
6	-1.72	-1.08	-0.37	-1.38	-0.55	-0.34	-0.72	-0.28
7_8	-1.04	-0.72	-0.40	-1.57	-1.44	-0.60	-1.53	-0.30
9	-1.03	-0.68	-0.46	-0.80	-0.64	-0.29	-1.98	-0.25
Average	-1.12	-0.73	-0.38	-0.70	-0.63	-0.30	-1.16	-0.14

3. Passenger transport

3.1. Nesting structure

For passenger transport the general nesting structure of Figure 2 is used. It is defined for all zone pairs and motives. For motives other than commuting and school, no distinction is made according to zone pair, due to a lack of data. The trips for a given zone pair are produced with the input of passenger kilometres (pkm). A distinction is made between:

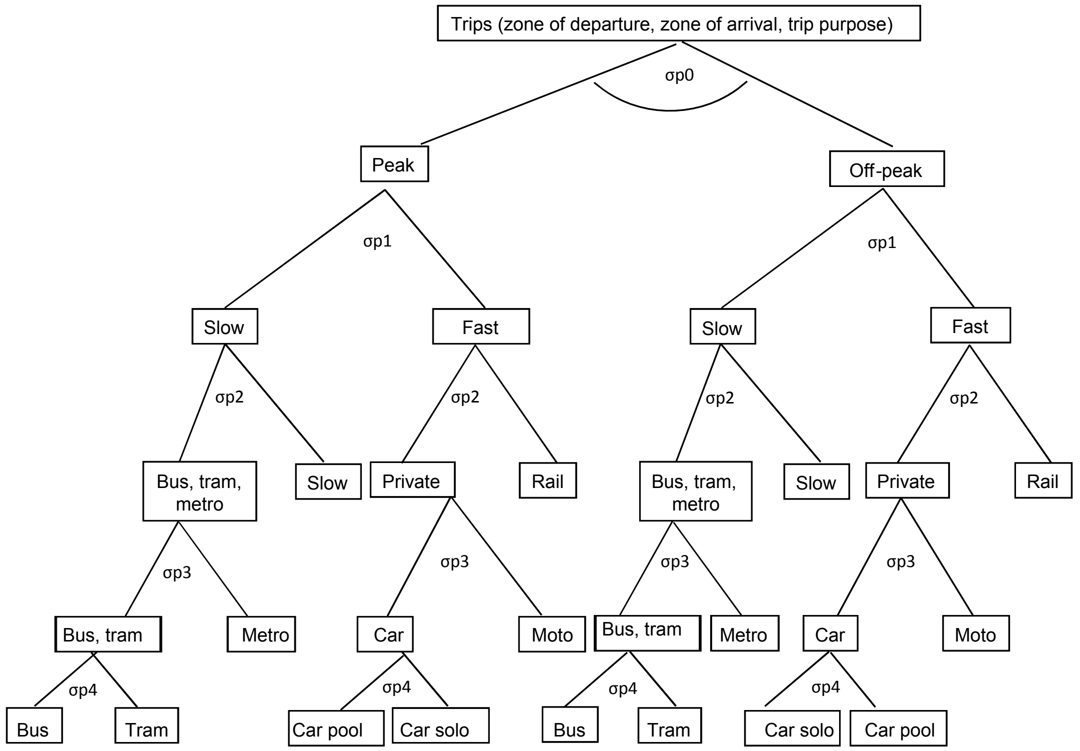
- pkm by the following modes: car solo, car pool, slow, rail, motorcycle, bus, tram and metro;
- pkm in the peak and off-peak period.

For some zone pairs, some modes are not chosen in the base year. The modelling approach implies that they will not be chosen in future years either. The σp symbols refer to the elasticities of substitution which will be discussed in more detail in section 3.2.d.

The nested MCES function is represented by a tree with 5 levels. The top level of the tree represents the total number of trips, per motive and zone pair as a MCES function of components at the next level (peak or off-peak). These components are each in turn a function of a separate group of components, "slow" or "fast". The "slow" component refers to pkm travelled by bicycle or on foot, on the one hand, and by bus, tram and metro, on the other hand. The bus, tram, metro component is a function of bus/tram and metro pkm. The bus/tram component is then further split into bus and tram. The "fast" component is a function of private and rail transport. The private component is a function of car and motorcycle pkm. For car pkm a distinction is made between car solo and car pool.

As in the case of freight transport, the nesting structure imposes a number of limitations on the transport choices. For example, a change in the unit cost of peak transport affects all transport modes in the off-peak period in an identical way.

Figure 2: Nesting structure for passenger transport



3.2. Inputs for the calibration

In the calibration we start from the observed trips, pkm and generalised costs per pkm in the base year. The parameters of the nested MCES function are chosen such as to obtain realistic generalised cost elasticities in this base year. The next paragraphs describe the new data used for the calibration given the splitting of the composite BTM mode into three distinct modes, namely bus, tram and metro. In some cases the required data are not available and assumptions needed to be made.

a. Passenger kilometres in base year

For commuting and school the trips between the zone pairs are taken from the OD matrices for 2001, based on the socio-economic survey of 2001. For the other motives the number of trips is based on MOBEL. In this case however, no information exists on the trip distribution. Consequently, we do not make a distinction between zone pairs in Belgium for these trips.

b. Monetary costs per pkm

The resource costs and taxes per vkm are taken from Hertveldt et al. (2006). To compute the costs per pkm we use the occupancy rates presented in Table 6. For bus, tram and metro they are based on MOBEL data, data from public transport operators and own assumptions. The occupancy rates for car pool are own calculations based on the average car occupancy rates for school and commuter traffic.

Table 6: Occupancy rates for passenger transport in the base year (for the peak period)

	Car solo	Car pool	Bus	Tram	Metro	Moto
Commuting	1	2.30	33.5	37.4	246.6	1
School	1	2.86	33.5	37.4	246.6	1
Other	1	2.80	33.5	37.4	246.6	1

c. Time costs per pkm

The value of time, VOT, denotes the exchange rate at which a traveller is indifferent between marginal changes in the time and monetary cost involved in travel. Monetary values for travel time have been applied as an input in many forecasting studies, allowing time and cost to be expressed in common units of "generalised cost". The literature contains many VOT studies. We make use of a survey conducted in the HEATCO project (Bickel et al., 2006).

The VOT used in PLANET is shown in Table 7. The values of time are expressed in €/passenger/hour. They are the same as in the previous version of PLANET. For bus, tram and metro, we assume that the VOT of each individual mode is equal to that of the BTM composite mode. For the other passenger transport modes, the assumptions are the following: for car pool 80% of the VOT for car solo was recommended; the VOT for slow is an average of the VOT of car solo, car pool, train and BTM; the VOT of a motorcyclist is the same as for car solo.

Table 7: VOT in €/passenger/hour in base year

Mode	Commuting	School and other motives
Car solo	7.40	6.20
Car pool	5.92	4.96
Train	7.40	6.20
Bus, tram, metro	5.32	4.46
Slow	6.51	5.46
Motorcycle	7.40	6.20

Source: Bickel et al. (2006) and own calculations.

The values presented in Table 7 are for expected in-vehicle travel time. Evidence suggests that the changes in walk and wait time are valued more highly than changes in in-vehicle time. Based on Nellthorp et al. (2001) in-vehicle time values should be multiplied by a factor of 1.6 to obtain the value of walking and waiting time.

For trips done by more than one transport mode we had to make an assumption on the distance and speed of the second transport mode. We keep the same assumptions as before. We assume a speed of 4 km/h for transport on foot, 12.5 km/h for transport by bicycle and 35 km/h for trips on a longer distance. We assume a distance for the second mode of 750 metres if the second mode is a bicycle, 500 metres when it is bus, tram or metro (BTM in the previous version of PLANET) and 4 km when the car is the second mode. For trips by car pool we assume that the average distance to the place of departure equals 100 metres.

d. Generalised cost elasticities

The production functions are nested MCES functions – hence, we assume constant elasticity of substitution at each level of the tree. This implies that at each branch of the tree an elasticity of substitution must be specified. These elasticities of substitution are explicitly present in the production functions and are determined outside the model (exogenously fixed parameters).

The parameters of the MCES are calibrated such that realistic generalised cost elasticities are obtained. Table 8 presents the elasticities of substitution that are used in the new version of PLANET. The same symbols are used as in Figure 2.

Table 8: Overview of the elasticities of substitution for passenger transport

	Elasticity of substitution between	**Commuting**	**School**	**Other purposes**
σp_0	Peak and off-peak	0.55	0.2	1.5
σp_1	Fast and slow modes	0.55	0.25	1.5
σp_2	Private and rail transport	5	3	5
	Slow and BTM transport	7	7 (peak); 6 (off-peak)	5
σp_3	Car and moto	2.5	1.5	3
	Bus/tram and metro	3.0	3.5	4
σp_4	Car solo and car pool	4.5 (peak); 4 (off-peak)	1.5	4 (peak); 5 (off-peak)
	Bus and tram	4.5	4	4.5

The resulting calibrated fuel price elasticities are presented in Table 9. They are in line with the literature review made in the European TRACE project (de Jong et al., 1999), as reported in Table 10. The calibrated fare elasticities of public transport are given in Table 11.

Table 9: Calibrated fuel price elasticities

		Car solo	**Car pool**	**Motorcycle**
Commuting	Peak	-0.12	-0.44	-0.22
	Off-peak	-0.13	-0.40	-0.21
School	Peak	-0.20	-0.05	-0.12
	Off-peak	-0.20	-0.05	-0.13
Other purposes	Peak	-0.38	-0.26	-0.25
	Off-peak	-0.35	-0.33	-0.27

Table 10: Survey of transport elasticities

	Commuting	School
Train	-0.50 to -0.69	-0.50 to -0.69
BTM	-0.20	-0.30
Car solo	-0.20	-0.32

N.B. fare elasticities for public transport and fuel price elasticities for car.
Source: TRL and own calculations based on TRACE.

Table 11: Calibrated fare elasticities

		Bus	Tram	Metro	Rail
Commuting	Peak	-0.08	-0.19	-0.12	-0.42
	Off-peak	-0.12	-0.24	-0.14	-0.52
School	Peak	-0.21	-0.34	-0.16	-0.42
	Off-peak	-0.34	-0.45	-0.24	-0.52
Other purposes	Peak	-0.62	-0.46	-0.53	-1.44
	Off-peak	-0.87	-0.59	-0.61	-1.51

3.3. Speed-flow relationship

As in the previous version of the model, we assume one speed-flow relationship for all road transport in Belgium. In this context, the splitting of the BTM composite mode into three distinct modes does imply some changes in PLANET.

The speed-flow relationship gives the relationship between car speed (in km/h) and the number of vehicle-km (vkm) of passenger car units per hour per day. In other words, it describes how the speed on the road network decreases as a function of congestion (i.e. number of vkm on the roads). In the previous version of PLANET, BTM was considered to be a road transport mode and to contribute to congestion. In the new version, the modelling of the relationship between speed and congestion is improved: buses contribute 100% to road congestion, 70% of tram traffic is assumed to contribute to road congestion (reflecting the fact that some trams drive on separate lines), and metro vkm do not contribute to congestion at all. In order to translate the bus and tram traffic into vkm of passenger car units, a bus and a tram are assumed to be equivalent to 2.5 cars.

The speed-flow relationship is calibrated from data in the base year (2000). The new calibrated speed-flow relationship is very close to the one presented in WP 10-08 (Figure 29). This is explained by the fact that buses and trams represent a negligible fraction (less than 1%) of total vkm in Belgium. However, for the projection of passenger transport, the evolution of pkm by tram (resp. metro) is now partly (resp. fully) independent from the evolution of passenger and freight transport activity on the road network.

4. Annex: The NST/R chapters

Table A1: The NST/R chapters

NST/R chapter	Description
0	Agricultural Products and Live Animals
1	Foodstuffs and animal fodder
2	Solid mineral fuels
3	Petroleum products
4	Ore and metal waste
5	Metal products
6	Crude and manufactured minerals, building materials
7	Fertilizers
8	Chemicals
9	Machinery, transport equipment, manufactures articles and miscellaneous articles

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