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A description of the HERMES II model for Belgium

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I Introduction

The HERMES II model[1] for Belgium is the second official version of a macroeconometric model developed by the Belgian Federal Planning Bureau (FPB). The first version was built during the period 1982-1986[2]. In the meantime, the model has been maintained and developed on a regular basis. The model is suitable for the FPB's medium term forecasts and simulations of economic policy alternatives.

The purpose of the original project was to construct an instrument for economic analysis of the Economies of the Member States of the European Community. To this end, a standardized version of the HERMES model was designed and implemented in six Member States (simplified models were developed for the other countries). The individual HERMES models permit a detailed macroeconomic and sectoral analysis of a Member State's economy. In addition, the standardization of the model structure allows each individual model to be linked up with other HERMES models in the European economy, thereby enabling the analysis of cross-multiplier effects between the countries. Simplified macromodels for the USA, Japan and five other regions of the world have been constructed. The integration of all these models permits an international analysis of economic effects. The integration of the whole system is performed by means of a separate bilateral trade flows model, called HERMES-LINK (Macrosectoral Link)[3].

The current version of HERMES-Belgium has been called HERMES II, because the model underwent several adjustments in the recent years. Two major improvements are in the field of the environment and the structure of the branches. Regarding the environment, the model has been adapted in order to analyze the evolution of CO_2 emissions per branch and per agent and to test the effect of the introduction of fiscal and other measures aimed at reducing the level of CO_2 emissions[4]. Regarding the branches, a further disaggregation of the market services has been achieved last year in order to better take into account the evolution of the Belgian economy. Other properties of the original model, such as the allocation of private consumption and the energy block, have also been thoroughly revised last year. At the same time, the new input-output table (for 1990)[5] allowed for a complete reestimation of the production block. Due to the conversion of the model into 1990 prices, all existing regression estimates have been actualised systematically.

1. Harmonised Econometric Research for Modelling Economic Systems.
2. For a presentation of the first version of HERMES, see Bossier et al (1989).
3. HERMES-LINK is presented in Commission of the European Communities (1993).
4. One of the key characteristics of HERMES I is the systematic treatment of energy. The objective of the authors was to develop a tool which would permit the study of the interaction between energy and the rest of the economy and provide quantitative answers to questions about the impact of the fall in oil prices in 1986 on the real part of the economy, the evolution of Belgium's energy dependance after the first two oil shocks, the possible effects of a third shock, etc.
5. For a description of the 1990 input-output table, see Federal Planning Bureau (1999).

Finally, HERMES II exists in two versions of the national accounts, i.e. in ESA79 as well as in the new ESA95 (see chapter II). The former version of HERMES II was finalized in 1999, whereas the current version was completed this year. As ESA95 implies important changes, notably for the evaluation of GDP and its components, HERMES II had to be completely reestimated.

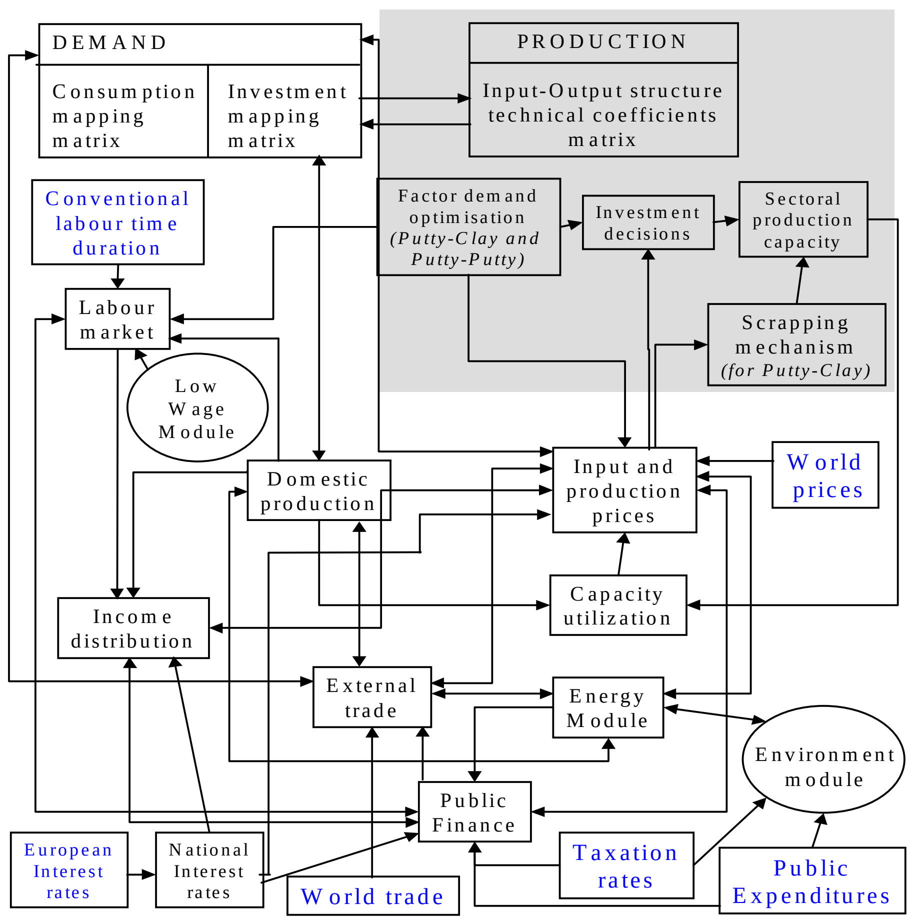
This working paper does not intend to give a complete, encyclopedic description of HERMES II. The purpose is to remain selective and survey the main blocks. The text is organised as follows: in chapter II we start with a description of the general characteristics of the model. Chapter III deals with the main blocks of the model. We focus on production, employment, prices and wages, households' demand, external trade, energy and emissions and, finally, the public sector. Chapter IV summarizes and offers some concluding remarks.

Simulation exercises will be presented in a next working paper.

II General characteristics of the model

Figure 1 gives a general simplified flowchart of the complete model. HERMES is a medium-term demand oriented model in which supply elements play an important role. The activity of the branches is determined mainly through the demand side. Production capacity is also demand determined in the long run, although supply effects are present. Adjustment of production to existing capacity plays a role in the explanation of prices, investments and imports. HERMES incorporates fundamental neoclassical mechanisms for the determination of the marginal technical coefficients, the explanation of investment and the computation of capacities. Supply side effects are also incorporated in export equations.

FIGURE 1 - A flowchart of HERMES



Starting from internal and external demand, the model computes the marginal profitability of production capacity. For this purpose, it calculates the optimal allocation of the branches' resources between the different production factors (capital, labour, energy and other intermediary inputs) on the basis of anticipated factor prices. Production costs constitute the main determinant of prices in HERMES. Other determinants in the short run are capacity utilization rates in each branch. Once demand on the various markets and prices have been computed the model allocates total resources between the different agents and computes their disposable income, taking into account taxes and social contributions paid to the State and social transfers received by each of them.

HERMES II contains about 3100 equations (of which 450 behavioural equations) and more than 380 exogenous variables. The model's size is mainly a consequence of breaking down the economy into 13 **branches**, which are groups of homogeneous units of production. Another way to break down the economy is to use the concept of **sectors**: institutional units are grouped into sectors for which a complete set of current, capital and financial accounts is available. HERMES II distinguishes five different sectors: households, non-profit institutions serving households, corporate enterprises (regrouping non-financial and financial corporate enterprises), public administrations (split themselves into four entities) and the rest of the world.

The model's size is also the consequence of the development of specific parts:

- Household consumption: the total consumption budget is allocated to 15 main categories of consumption, some of these categories being themselves disaggregated. This gives at the highest level of disaggregation 22 consumption categories (see table 1). The complete consumption module contains about 300 equations;
- The energy module is also very detailed. Aggregate energy demand of each economic agent (firms, government, households) is computed and allocated between 8 energy products; energy production is also modelled. The energy module contains about 450 equations;
- Public finances constitutes one of the main blocks of HERMES, with not less than 650 equations. This block distinguishes the different public authorities (federal government, regions and communities, local authorities and social security) and, for each of them, computes the financial capacities.

Table 1 summarizes the main characteristics and subdivisions of HERMES II.

TABLE 1 - Main characteristics and subdivisions of HERMES II

General characteristics

- 3106 equations
- 387 exogenous variables
- 4 production factors: labour, capital, energy, other intermediary goods and services
- 13 branches
- 15 main consumption categories, 22 in total
- 8 energy products

Branches	**Consumption categories**[a]
Agriculture	Food
Energy	Non alcoholic beverages
Intermediate goods	Alcoholic beverages
Equipment goods	Tobacco
Consumption goods	Clothing and footwear
Construction	Rent
Transports and communications	Fuel for heating: Coal
Trade and horeca[b]	Fuel for heating: Petroleum products
Credit and insurance	Fuel for heating: Gas
Health care	Power
Other market services to households and firms	Domestic services
General government services	Furniture and household equipment
Other non-market services	Personal transport equipment
	Operation of personal transport equipment: Petrol
	Operation of personal transport equipment: Diesel
	Operation of personal transport equipment: Other
	Transport services
	Communication services
	Medical care and health service
	Recreation, education, culture
	Other goods and services
	Tourism abroad

Energy products and environment	**Institutional sectors**
Coal	Households
Coke	Non-profit institutions serving households (NPISH)
Crude oil	Corporate enterprises
Petroleum products	- Non financial corporate enterprises
Natural gas	- Credit institutions and insurance enterprises
Derived gases	General Government
Electricity	- Federal government
Renewables	- Regions and Communities
CO_2 emissions	- Local authorities
	- Social security fund
	Rest of the world

a. At the highest level of disaggregation (22 categories).

b. Hotels, restaurants and cafés.

The change over to the ESA95 and its impact on the databasis

Since 1999, the Belgian national accounts are computed in a totally new framework: the European System of Accounts 1995 (ESA95). This system replaces the ESA79 which was used until 1998 (the national accounts of 1997 were still published in the old framework). Although this change is supposed to give a better and more complete picture of the economy, it implies important changes, notably for the evaluation of GDP and its components:[1]

- Private consumption: the adoption of the new methodology implies a large reduction of households final consumption. Indeed, the health expenditures which are assumed by public authorities are not included in the private consumption expenditures any more[2]. Differences with the preceding figures are also due to the use of new data sources and of new computation methods. Consequently, the new estimation of private consumption is about 14% less than the old estimation (for 1995);

- Public consumption: with the new ESA95, all health expenditures which are taken over by public authorites are transferred into the final expenditures of public administrations (as social allowances in kind). Moreover, the notion of consumption of fixed capital is considerably extended[3]. Therefore the new public consumption is about 48 % higher than the old estimation (for 1995);

- Gross fixed capital formation: the estimation of gross fixed capital formation is also largely increased w.r.t. its estimation in the old system (+15.5 % compared to the old estimation- year 1995). This increase is explained by the inclusion (in the estimation) of a few factors, not taken into account before: the purchase and development of softwares (as well as data basis); literary and artistic original works should also be included in the gross fixed capital formation; the same goes for the puchase of durable military goods (previously registered as intermediary goods). Moreover, the ESA95 also uses completely different data sources (than before) for the estimation of GFCF;

- Exports and imports are also largely increased in the new system (but the balance is left almost unchanged). This is explained by the fact that transaction on goods are registered in “gross terms” for temporary imports and exports;

- GDP is, itself, slightly increased: the introduction of the new methodology increases GDP with about 0.8% (year 1995).

Other differences appear when computing GDP from the revenue’s angle. In this case, one can observe a large increase of net taxes paid on production and imports. This difference is explained by the inclusion of the withholding tax on real estate (included before in the taxes on income). In the same way, the gross operating surplus is decreased by the same amount. The estimation of the compensation of employees is also revised; the new estimation is 1.2% higher than the old figure. This difference is explained by the use of more detailed and more precise accounts than before.

Another important difference between the two systems concerns the use of basic prices in ESA95. Basic prices are used to evaluate production and acquiring prices are used to evaluate intermediary and final consumption. Basic prices do not include any tax on products and include all subsidies on products. Acquiring prices include net taxes on products as well as commercial and transport margins. Therefore, GDP at market prices is defined as the sum of value added of different activity branches plus the balance of taxes and subsidies paid on products. In the old system, production prices include all taxes (except VAT) less subsidies and, consequently, value added also includes such taxes. This modification makes difficult to compare value added of different branches computed in the two systems, particularly when taxes and subsidies on products are important.

Finally, the ESA95 uses a new classification of branches. Activities are generally classified into 31 categories, but other classifications exist, notably the disaggregation into 60 products or activities. It is never easy to compare branches computed in the old and in the new system. Differences can occur for many reasons: use of a new price system, use of new data sources[4] and/or new classifications. Comparisons of figures coming from the ESA79 version of HERMES with figures published in the framework of the new HERMES, must then be taken with caution.

1. For a more complete presentation of the ESA95, see e.g. Commission des Communautés Européennes (1996).
2. However, the ESA95 considers a new notion: the “effective final consumption of households”, which is equal to the sum of their final consumption expenditures and of the social allowances in kind received from public administrations and from NPISH.
3. In the old ESA79, the consumption of fixed capital did not include assets like roads, bridges and other civil engineering works.
4. For instance, the use of new data surveys has improved to a large extent the estimation of production and value added of services. This implies sometimes a complete and large revision of the old figures.

III The main blocks of HERMES II

A. The production block

In this section we describe the determination of factor demand. For each branch four kinds of production factors are distinguished, i.e. labour, capital, energy and other intermediary inputs. However, a distinction has to be made between the approach implemented on the manufacturing and energy branches and the modelling of the other branches (i.e. agriculture, construction and market services). In the first case, a putty-clay technique has been applied, whereas for the other branches a more empirical approach of the putty-putty type has been adopted.

1. Factor demand in the manufacturing and energy branches

a. Framework: a putty-clay approach

The point of departure for the derivation of factor demand is an ex ante two-level SATO production function[1] with four factors of production: labour, investment, energy and other intermediary consumption. It is assumed that this production function is a twice differentiable, strictly quasi-concave and positive function. It is further assumed that it is separable with respect to the partition of inputs proposed. This implies that the marginal rate of substitution between two inputs which are part of one of the aggregated inputs is independant of the other aggregated inputs.

Two groups of inputs are considered: investment and energy, from one hand, and labour and other intermediary input, from the other hand. The two inner functions are CES functions for each of the groups of factors considered, whereas the outer function (which links the two groups together) is of the Cobb-Douglas type. Technical progress is assumed to be Hicks-neutral. This gives the following linear homogeneous production function:

$$Q''_t = Ae^{gt}(\alpha I_t^{-\rho} + (1-\alpha)E''^{-\rho}_t)^{-\gamma/\rho}(\beta L''^{-\delta}_t + (1-\beta)M''^{-\delta}_t)^{\frac{-(1-\gamma)}{\delta}} \qquad [1]$$

1. See Sato (1967).

where

I_t, L''_t, E''_t and M''_t denote the marginal inputs (resp. gross capital formation, labour, energy and other intermediary inputs) corresponding to the new production capacity;

Q''_t denotes the new production capacity;

$X''_{i,t}$ denotes the marginal input (i=labour, energy, intermediary input) corresponding to the new production capacity;

g is the rate of technical progress;

α is the distribution parameter for the class I-E;

β is the distribution parameter for the class L-M;

γ is the share parameter between the two inner classes;

ρ and δ are the CES parameters from which the substitution elasticities can be derived.

This function is of the putty-clay type, i.e. there are substitution possibilities *ex ante*, but not *ex post*[1]. Once a certain amount of capital has been put into production, it will continue to operate during its lifespan in cooperation with constant amounts of the other inputs. The chosen input combination to obtain a gross increment of the production capacity remains unchanged for the whole life time of that particular investment (i.e. the marginal technical coefficients are variable *ex ante*, but fixed *ex post*), so that substitution decisions are only possible at the margin. Input variations are only due to the introduction of new vintages (gross investments) and to the scrapping of unprofitable old vintages. The factor proportions can be derived on the basis of the duality principle: the producer choses a production technology on the basis of the anticipated factor prices in order to minimize the anticipated cost of the newly installed equipment.

Using a classical cost minimisation procedure starting from equation [1], one can obtain a demand function for each of the four marginal technical coefficients $K''_{i,t}=X''_{i,t}/Q''_t$ (for i= labour, energy and intermediary input) and $K''_t= I_t/Q''_t$ (for investment).

Table 2 gives the estimations of the main parameters, obtained from the derived demand functions. Note that ρ and δ are not directly estimated. We estimated, instead, $\sigma = 1/(1+\rho)$ and $\theta = 1/(1+\delta)$.

TABLE 2 - Estimation results of the demand systems

	Intermediate goods	Equipment goods	Consumption goods	Energy
α	0.99	0.98	0.98	0.98
β	0.51	0.17	0.19	0.23
σ	0.11	0.30	0.13	0.47
θ	0.70	1.00	0.86	0.60
γ	0.18	0.07	0.60	0.11

1. On putty-clay and putty-putty models, see e.g. Bliss (1968) and d'Alcantara (1981).

Note, for each branch, the high level of α, suggesting a low energy share in the total cost of industries.

On the basis of these parameter estimates, it is possible to calculate direct and cross-price elasticities of factor demand (marginal, not total). Table 3 presents the elasticities computed for the manufacturing and energy branches. The figure at the intersection of line i and column j gives the demand elasticity of factor i to the price of j. Note that these factor substitutions are only possible *ex ante*, because of the putty-clay context.

TABLE 3 - Direct and cross-price elasticities *at the margin*

Intermediate goods					Equipment goods				
	I	E	L	M		I	E	L	M
I	-0.30	-0.19	0.05	0.05	I	-0.59	-0.29	0.03	0.03
E	-0.52	-0.63	0.13	0.13	E	-0.34	-0.64	0.04	0.04
L	0.43	0.43	-0.42	0.27	L	0.15	0.15	-0.87	0.16
M	0.39	0.39	0.25	-0.45	M	0.78	0.78	0.80	-0.23
Consumption goods					**Energy**				
	I	E	L	M		I	E	L	M
I	-0.28	-0.15	0.05	0.05	I	-0.77	-0.31	0.08	0.08
E	-0.50	-0.63	0.17	0.17	E	-0.12	-0.59	0.03	0.03
L	0.18	0.18	-0.71	0.15	L	0.38	0.38	-0.39	0.21
M	0.59	0.59	0.48	-0.37	M	0.51	0.51	0.28	-0.32

Direct price elasticities are obviously negative. On the basis of the cross prices elasticities it can be seen that investments and energy demand are complements: an energy price increase leads, *ceteris paribus*, to a decrease in investments. Labour appears to be a substitute for the other production factors: increasing labour costs leads to a higher demand for the other input categories and *vice versa*.

When the optimal factor inputs have been determined, they provide the point of departure to compute effective demand for each production factor. The model first derives investments which enable the computation of the marginal production capacity Q''_t:

$$Q''_t = I_t \times K''_t \qquad [2]$$

where I_t is actual investment and K''_t is the technical coefficient for capital. On the basis of Q''_t, marginal full capacity demand for the other production factors can be derived:

$$X''_{it} = K''_{it} \times Q''_t \qquad [3]$$

The desired factor demand depends on full capacity demand as well as the capacity utilization rate QR:

$$X^*_{it} = f(QR_t, K''_{it} \times Q''_t) \qquad [4]$$

where

$$QR_t = Q_t / QP_t \qquad [5]$$

with Q_t representing the effective production in time t and QP_t the production capacity

$$QP_t = QP_{t-1} + Q''_t - Q'_t \qquad [6]$$

where Q'_t is the scrapped capacity in time t (in this version of HERMES, Q'_t is equal to Q''_{t-i}, where i is the average scrapping age).

Finally, the link between desired demand and actual demand is specified according to an error correction mechanism (ECM). The final equation form, specifying the relation between the effective factor demand (X_i), the marginal production capacity (Q"), the marginal technical coefficient of factor i (K''_i), the optimal level (full capacity level) of X ($\overline{X}_i$) and the utilization rate (QR) can be written:

$$\begin{aligned}\Delta \ln X_{i,t} = {} & \kappa_1(\Delta \ln(K''_{i,t}Q''_t + (1-\delta_i)\overline{X}_{i,t})) \\ & + \kappa_2(\ln(K''_{i,t-1}Q''_{t-1} + (1-\delta_i)\overline{X}_{i,t-2}) - \ln X_t) \\ & + \kappa_1 \psi \ln QR_t + (\kappa_2 - \kappa_1)\psi \ln QR_{t-1} + \alpha \end{aligned} \qquad [7]$$

where ($\psi > 0, 0 < \kappa_2 < 2$), or ($0 \le \kappa_1 \le 1$ and $0 < \kappa_2 \le 1$).

b. The computation of energy demand and employment by branch

Energy demand

Table 4 gives the estimation results of equation [7] in the case of energy demand[1]. The results are given for the three manufacturing branches.

TABLE 4 - The demand for energy: estimation results

	Intermediate goods	Equipment goods	Consumption goods
κ_1	0.797	0.906	0.452
κ_2	0.753	0.737	0.482
ψ	0.936	1.039	0.808
mean lag	0.270	0.128	1.137

Note that the mean lag (which only makes sense if *a priori* conditions on coefficients are verified) is low for intermediate and equipment goods and is longer for consumption goods.

For the energy branch, the energy consumption is a simple sum of the consumption of the different energy products, themselves explained by the transformation activity of the branch (refineries, electricity plants, blast furnace and coke-oven plants,...)[2].

1. Note that the same kind of equation is estimated for labour and other intermediary goods and services.
2. See the presentation of the energy module (section F).

The same kind of relation was estimated for labour demand (expressed in number of hours worked).

Labour demand

The model computes, first, the total number of hours effectively worked for each branch. The number of jobs per head is then calculated, knowing an average labour time duration per branch.

Table 5 gives the estimation of equation [7] for labour demand in the case of industrial branches.

Compared to older results, productivity cycles (measured by the mean lag) seem to be much shorter than before, indicating a more rapid adaptation of employment levels to the optimal target of the firms.

TABLE 5 - The demand for labour: estimation result

	Intermediate goods	Equipment goods	Consumption goods	Energy
κ_1	0.750	0.502	0.900	0.210
κ_2	0.990	0.588	0.953	0.500
ψ	0.890	1.142	1.056	1.656
mean lag	0.253	0.847	0.105	1.580

c. The computation of investment demand

Investment demand by branch

Gross investment is related to an accelerator mechanism and on a marginal profit condition. Both are medium term determinants, weighted by technical coefficients:

$$I^*_t = \alpha_0 (K''_{t-1} \Delta Q_{t-1})^{\alpha_1} \times \left(PQ_t \pi_t - \sum_i K''_{it} PX_{it} \pi_{it} \right)^{\alpha_2} \quad [8]$$

where I^*_t denotes the equilibrium level of investment, Q_t the effective production, π_t the anticipated growth rate of the output price (PQ_t) and π_{it} the anticipated growth rate of the ith input price (PX_{it}). The link between optimal and actual investment (I_t) is specified by means of a partial adjustment mechanism.

$$I_t / I_{t-1} = (I^*_t / I_{t-1})^{\lambda} + \mu_t \quad [9]$$

The investment functions also include the degree of capacity utilization as a short term cyclical indicator. The main estimation results for the investment functions are given in table 6.

Investment demand by product

Investments are also disaggregated by product. In HERMES I use was made of a transition matrix with coefficients derived from the input-output table of a specific year. As a consequence these coefficients (indicating for each branch the proportion of each kind of product required to realize its investment project) were fixed.

Investments are disaggregated into 3 kinds of goods, i.e. buildings (B), equipment (M) and vehicles (V), so that for each branch s:

$$I_{st} = I_sB_t + I_sM_t + I_sV_t \quad [10]$$

It is assumed that B, M and V have a complementary relationship. In order to impose this condition the investment function specification has been applied to the most important product category (I_sM for the manufacturing branches and I_sB for the energy branch). The other categories are modeled as components, by estimating them in function of the most important product category ($I_sB = f(I_sM)$ and $I_sV = f(I_sM)$ for the manufacturing branches) by means of an ECM.

Deliveries to investment

Investments can also be considered from the supply side's point of view (deliveries). This will be presented briefly *infra.*

Labour demand

Labour demand will be discussed in section B, where the model's possibilities to simulate employment policies will be described.

2. Factor demand in the other branches

Framework: a more empirical approach

For non-industrial branches it is generally less obvious to apply a putty-clay approach, both for theoretical reasons as for the measurement problems of the variables required for estimation (e.g. in manufacturing it is relatively easy to gauge output, whereas for services this is less obvious). It was thus preferred to adopt a simpler approach for the service branches, as well as for agriculture and construction.

Factor demand in the other branches is straightforwardly determined by production and relative factor prices. Although less underpinned than the putty-clay approach, this method remains consistent with the optimizing behaviour of the producer, who wants to minimize costs to realize his output. Factor demand can directly be determined by means of a cost function (obtained via the duality principle), as it only requires to take the derivative of the cost function to the factor price (Shephard's Lemma).

The approach is putty-putty, which means that there is no *ex post* rigidity of the input combinations. Factor substitution remains possible at any time for all inputs.

Investment demand by branch

For the putty-putty branches a more traditional specification has been adopted:

$$I_t / K_t = \lambda(I_{t-1} / K_{t-1}) + \alpha + \gamma\Delta \ln Q_t + \delta(GOS_t / (K_t \times PK_t)) \quad [11]$$

with K denoting the capital stock at constant prices, GOS the gross operating surplus and PK the cost of capital.

Table 6 summarizes the main parameter results of the investment functions.

TABLE 6 - Investment functions: main estimation results

	α_1	α_2	γ	δ	λ
Agriculture			0.03	0.002	0.32
Energy			0.05	0.005	0.57
Intermediate goods	0.89	0.18			0.51
Equipment goods	0.98	0.16			0.58
Consumption goods	0.98	0.10			0.38
Construction			0.20	0.010	0.41
Transport and communication			0.10	0.042	0.78
Horeca			0.05	0.026	0.76
Credit and insurance			0.04	0.005	0.85
Health care			0.00	0.000	1.00
Other market services to housholds and firms			0.05	0.003	0.78

Investment demand by product

Investment by product is modelled in a similar way as for the manufacturing branches (see *supra*). For each branch the chosen investment specification is applied to the most important product category (i.e. buildings, or I_sB, for each of these branches) and the other components are modelled as being complementary.

Deliveries to investment

The bulk of ΣI_sB (with s representing all branches) is delivered by the construction branch, whereas $\Sigma I_sM + \Sigma I_sV$ is mostly delivered by the branch of equipment goods. Minor deliveries are also made by the branches of Consumption goods, Transport and communication and Other market services. With QI_i being the delivery by branch i to the investments of all branches s, including the public sector (IG) and the households (IR), it must hold that:

$$\sum_s I_sB + \sum_s I_sM + \sum_s I_sV + IR + IG = \sum_s I_s + IR + IG = \sum_i QI_i \qquad [12]$$

with s denoting all branches and i denoting the delivering branches.

B. The modelling and simulation of employment policies

1. The impact of employment policies in the model

Employment policy can be passive (with the main purpose of preserving the standard of living of the unemployed) or can be active (with the main purpose of encouraging the unemployed to find a job). Active policy comes in three types: reducing the relative cost of labour in order to get a favourable substitution effect on labour, direct job creation and redistribution of labour time. All these policies - which may be financed in various ways - may either consist of general measures or may be aimed at specific sectors or at specific categories of producers or workers.

Employment policy today basically means to raise the labour intensity of economic growth, either by moving along the labour demand curve or by shifting the labour demand curve to the right. Employment policy has been mainly active, aimed at either specific branches, or specific workers, or both. For a model to evaluate the net impact of these policies on employment and to calculate the induced effects properly, it needs to take into account both aggregate behaviour and sector-specific behaviour in micromarkets.

The impact of a change in labour costs

A macrosectoral model like HERMES, which identifies 11 private market branches and one private non-market sector and therefore takes into account the specific behaviour in each production sector, is well equiped to analyse the effects on employment and public finances because it captures the structural changes in economic activity and the induced change in labour intensity of growth.

The effects of a change in labour cost will be illustrated in a next working paper, which will contain a series of simulations, such as the reduction of the employers' social security contributions.

The pure substitution effect[1] of a change in labour cost is obtained from a partial simulation, involving the labour price and labour demand equations. This simulation procedure also allows for the calculation of the *ex ante* price elasticity of labour demand[2]. The results are presented in table 7: the own-price elasticity of labour demand (in absolute value) is the highest in construction and the service sectors, which happen to be more labour intensive than other branches.

1. i.e. the impact on employment of the relative factor price change only (without the induced effects due to the impact on economic activity).
2. These elasticities are not to be confused with the labour price elasticities of the manufacturing and energy sectors presented in table 3, as the latter only hold for the production factor decisions 'at the margin'.

TABLE 7 - ***Ex ante*[a] price elasticity of labour demand**

	t	t+4
Agriculture	-0.07	-0.12
Energy	-0.02	-0.29
Intermediate goods	-0.02	-0.29
Equipment goods	-0.02	-0.24
Consumption goods	-0.02	-0.23
Construction	-0.42	-0.41
Transport and communication	-0.45	-0.48
Trade and horeca	-0.27	-0.52
Credit and insurance	-0.18	-0.40
Health care	-0.29	-0.46
Other market services to households and firms	-0.20	-0.50

a. before induced effects.

2. Modelling "low wage" workers and special jobs

The labour cost of specific segments of the labour force, such as the low skilled (*i.e.* low wage earners if wages are assumed to reflect qualifications) can be targetted as well. In order to evaluate the effects of measures focused on specific segments of the labour market, the model should distinguish at least two types of labour, each with a distinct set of cost and substitution elasticities. HERMES does not yet allow for this kind of labour market segmentation in a direct way.

Measures aimed at the cost of "low wage" workers: the MILOU module

As a substitute for introducing non-homogeneous labour in HERMES, a separate module (the MILOU[1] module) has been developped. MILOU is mainly based on the assumption that demand for low wage employment is more cost sensitive than for high wage employment. Linked with HERMES, it is a useful tool of analysis for the impact of lowering low wage social security contributions, be it that the results have to be interpreted with some caution[2].

The HERMES-MILOU model operates in two stages. Firstly, the MILOU module calculates the *ex ante* effects on the employment and average gross wages in each sector. The magnitude of the *ex ante* effects relies on the labour demand equations borrowed from HERMES, the weight of low wage employment in total sectoral employment, sectoral productivity cycles, parameters - fixed by assumption - that measure the sectoral cost elasticities of demand for low wage earners relative to the cost elasticities for other wage earners, and the sectoral decrease in the low wage labour cost, induced by the decrease in social contributions. By definition, the *ex ante* effects do not take into account the feedback generated by HERMES. Finally, the results of the *ex ante* evaluations are fed into HERMES for an evaluation of the induced effects.

1. Model for the Investigation of LOw wage Unemployment.
2. See Bréchet et al (1995).

Future modelling regarding "low wage" labour

A project in progress is the modelling of substituting "low wage" labour for "high wage" labour within the structure of HERMES. The model would be "top-down" in the sense that the average wage cost determines total employment and that CES-substitution determines the allocation between "low wage" labour and "high wage" labour. The proportions at which low wage and high wage are used and the wage rates feed into the average wage cost.

In spite of regulatory barriers, it is likely that various special job schemes such as "service jobs" and to some extent "start jobs" as well (see *infra*) will be partly substituted for normal low wage jobs. Hence, the issue is whether "service jobs" and "start jobs" had better be integrated in the low wage labour / high wage labour substitution model.

Ad hoc treatments of the direct creation of "special jobs"

Some of the direct job creation measures - for instance, public sector employment - are easy to incorporate into a macroeconomic model. This is not always the case for policies which mean to create jobs by developing new, labour intensive activities by targetting specific activities or specific producers or workers. Prime candidates for such policies are the so-called "proximity services", which can be produced by households for auto-consumption without resorting to paid labour but which can also be produced by workers outside the private sphere. The impact of this kind of measures is especially delicate to evaluate as no econometric estimation of these marginal or not yet existing activities is available yet.

Therefore, one has to rely on exogenous calibration if such measures are to be taken into account in the HERMES model. The calibration has to be based on assumptions about the potential demand, the weight of the different factors of production in output, the wage rates of the jobs targetted by the measure, production prices, subsidies or other means of financing, and even the substitution or opportunity effects. Each measure aimed at the creation of "new jobs" needs an *ad hoc* treatment, which, by all means, must respect the coherence between the 3 ways of calculating GDP (the demand, production, revenue approaches). The present version of HERMES distinguishes 3 kinds of special employment schemes: "service jobs" (nicknamed "Smet jobs" after the minister who introduced them, situated in Trade and Horeca and Other Market Services), "social maribel jobs" (situated in Health Care and Other Market Services) and "local employment agency jobs" (as part of Other Non-Market Services).

Future modelling regarding "special jobs"

Some important changes are considered or are about to be implemented. Firstly, three submodels are being developed to deal more adequately with service jobs and social maribel jobs. Both special employment schemes are introduced formally in all branches. Secondly, after the federal government's revamping of an existing employment requirement scheme for young unemployed ("start jobs", nicknamed "Rosetta jobs") in 2000, there is a clear need to model this employment scheme as well. Importantly, the short time span of the time series makes estimation of separate behavioural equations for special jobs impossible. Therefore, we have to rely on other methods such as calibration.

Special employment schemes: the current state of modelling

i. Service jobs

The “service jobs” scheme provides an incentive for private sector firms to employ elderly unemployed during a limited space of time, long enough to encapacitate them with the skills that enhance their employability. These jobs are not meant to be part of the normal work tasks and hence should not crowd out employees on normal labour contracts. They are essentially low paid jobs are on a part time basis (1/2 of 4/5), are exempt from employer social security contributions and additionally subsidized to the tune of 17,500 BEF resp. 22,000 BEF a month per worker by the Employment Office.

From 1998 till 1999 the subsidy was paid out directly to the employees while the employers only paid the remainder of the contractual wage. As from 2000, the employees receive the entire wage from the employers while the employers are now the nominal beneficiaries of the subsidy. This change in procedure only changed the accounting but did not matter economically.

Employment and wages are treated exogenous and serve as corrections in the behavioural equations of Trade And Horeca and Other Market Services. The nominal wage rate is far lower than the average wage rate.

ii. Social maribel jobs

The social maribel job scheme is a conditional wage cost reduction scheme, mainly in the health care sector. The institutions that are accredited under the scheme are entitled to a social security contribution rebate under the following conditions. Firstly, there should be a net increase in employment relative to a benchmark. Secondly, the rebate is solely to finance the wage cost - including normal social security contributions - of additional employment. Thirdly, there is a budgetary limit , determined by the number of employees already employed in a benchmark year and a nominal subsidy per head. The subsidy per employee has been steadily increased from 3,250 BEF per quarter in 1997 to 12,000 BEF per quarter per fulltime equivalent in 2000. Individual budgets can be pooled among several institutions to maximize the use of the scheme. The scheme has seen some changes, mostly accounting in nature: from 1997 to 1999, the social maribel rebate was booked as a reduction of employer social security contributions but is now registered as a wage subsidy.

In the context of HERMES, “social maribel jobs” are only that part of employment that is financed with the transfer. Apart from that, social maribel jobs are very much like other jobs, i.e. they enjoy the same wage rate typical of that sector, are subject to the same social security contribution rates and are entitled to equal future pension rights.

Though social maribel jobs are prominent in both Other Market Services and Health Care, they are differently modelled. The social maribel jobs that are part of Other Market Services are treated exogenous. In contrast, the social maribel jobs that are part of Health Care are lumped together with normal jobs and are considered endogenous.

iii. Local employment agency jobs

These services, booked as Other Non Market Services, are treated as exogenous. Up to a limit (44 hours a month), the unemployed are allowed to top up their unemployment allowances with income earned from supplying low-skilled maintenance services to households, while keeping the status of “unemployed”. Local employment agencies act as intermediaries between the service providers and the purchasers of the services. Anno 2000, it looks as if the system of local employment agencies will be phazed out and will be replaced by a newly introduced “local service” programme, which subsidizes the demand for services that are now provided by the local employment agencies and will be provided by regular employees employed by regular firms.

Service jobs and social maribel jobs

The first model is developed to calculate *ex ante* forecasts for the number of employed in the service and social maribel job schemes, which are subsequently to be used as input in the two other models. De *ex ante* forecasts are obtained from partial simulations, mainly involving sectoral employment equations. The solutions are rescaled by means of observations dated prior to the forecast horizon. The assumption is that demand elasticities are alike for service jobs, social maribel jobs and normal jobs.

The second submodel and the present model are similar in that service jobs and social maribel jobs are treated exogenously and serve as corrections in the employment equations. However, the second submodel is more precise in measuring the relative labour prices and the input of labour in real terms.

The third submodel is far more ambitious because it endogenizes service jobs and social maribel jobs. Endogeneity relies on trippling sectoral equations, imposing the same elasticities on each category of employment. The approach is bottom-up and precludes substitution between normal jobs and special jobs.

Start jobs

Firms employing 50 people or more are obliged to top up the number of workers hired in a benchmark year with "start jobs" by at least 3%. This measure is aimed at the young unemployed, but may encompass other categories of unemployed as well. Compliance is fostered by financial incentives. On the one hand, sanctions for non compliance are financially punitive. On the other hand, employers can have their social security contributions reduced if low skilled unemployed are hired to fulfill the "start job" quota.

3. The redistribution of working time: the 2RT procedure

Another type of employment policy concerns the working time redistribution between the employed and the unemployed. Although labour demand in the HERMES model is defined in terms of number of hours and then converted in number of jobs, some methodological problems remain. Indeed, the net effects on employment of reducing (or re-organising) working time depend highly on the impact on hourly productivity, the degree of wage compensation and the intensity of the use of equipment. HERMES as such does not deal with this kind of feedback.

To circumvent this problem, a procedure called 2RT has been developped. When linked to the HERMES model, the redistribution of employement can be analysed, be it that some interpretational caution is warranted[1]. This procedure is based on 5 parameters, determined by either policy or by assumption: the average yearly rate by which individual working time is reduced; the wage compensation rate; the variation measured in percentage points of the utilisation rate of the equipment after a one percent lowering of working time; the gain in hourly productivity following the reduction of individual working time and, finally, a smoothing parameter for the productivity cycle so that the adjustment of effective employment to its desired level is faster than estimated.

1. See Lebrun (1996) and Lebrun and Masure (1997).

C. Prices and wages

1. Prices

Prices are determined at different levels. Each level determines the next, either through a behavioural equation or through an identity.

a. Production prices

In each productive branch, the equilibrium production price is determined as a mark-up to the average production costs PB_s. The mark-up is assumed to be constant. The import price is also considered in order to capture the effects of price-takership. The production price equation also includes demand influences, proxied by the deviations of capacity utilisation (QR_s) from its sample average (QR^*). A change in this variable level may affect the mark-up, contributing to speed up or slow down the dynamic process towards equilibrium over the long term.

The short term equation for PQF_s can be written as follows:

$$\Delta \ln PQF_{s,t} = \gamma_1 (\alpha\, \Delta \ln PB_s + (1-\alpha)\, \Delta \ln PQM_s)_t + \gamma_2 (\beta + \alpha \ln PB_s + (1-\alpha) \ln PQM_s)_{t-1} + \gamma_3 \ln (QR_{s,t} / QR^*_s) \qquad [13]$$

If the long term specification implies an elasticity of prices to costs equal to unity, this is not the case in the short term. The speed of adjustment will then depend on the value of γ_1 and γ_2.

TABLE 8 - Elasticities in the production price equations

	Mark-up coefficient β	Share of production costs α	Adjustment coefficient γ_1	Adjustment coefficient γ_2	Capacity utilization elasticity γ_3
- Agriculture	0.00	0.85	0.56	0.58	0.05
- Energy	0.02	0.90	0.71	0.29	0.01
- Intermediate goods	0.01	0.69	0.82	0.44	0.20
- Equipment goods	0.01	0.95	0.78	0.85	0.25
- Consumption goods	0.01	0.80	0.95	0.18	0.10
- Construction	0.03	0.90	0.89	0.40	0.05
- Transport and communication	0.02	0.90	0.72	0.40	0.02
- Trade and horeca	0.15	0.27	0.20	0.20	0.05
- Credit and insurance	0.02	0.60	0.80	0.19	0.07
- Health care	0.05	0.82	0.63	0.55	0.02
- Other market services to households and firms	0.05	0.70	0.45	0.68	0.18

b. Production costs

The production costs PB_s are, themselves, a function of the prices of the different production factors which enter the production process. This identity is written as follows:

$$\begin{aligned} PB_{s,t} = {} & (QEO_{s,t-1} \times PQE_{s,t} + QOO_{s,t-1} \times PQO_{s,t} + \\ & H_{s,t-1} \times ((WR_{s0})/H_{s0}) \times PH_{s,t} + \\ & (DPU_{s,t-1}/PI_{s,t-1}) \times PK_{s,t})/QFO_{s,t-1} \end{aligned} \quad [14]$$

where:

QEO_s is the demand for energy of branch s, in constant prices;

PQE_s is the price of energy demand of branch s;

QOO_s is the demand for other intermediary inputs of branch s, in constant prices;

PQO_s is the price of other intermediary inputs;

H_{s0} is the number of hours worked per man-year (effective number for industrial branches, conventional-corrected for the other branches), for base year 1990;

WR_s is the wage cost per employee, for branch s; WR_{s0} is the wage cost per employee for branch s, for base year 1990;

PH_s is the cost price index per hour worked of branch s;

DPU_s is the consumption of fixed capital of branch s, in current prices;

PI_s is the price of investments of branch s;

PK_s is the cost of capital of branch s.

c. Capital cost

The definition of capital user cost is given hereafter. It classically combines investment price, the marginal capital-output coefficient (for industrial branches), a real interest rate, a depreciation rate (fixed to 0.1) and the implicit rate of taxation of corporate enterprises (less subsidies).

$$PK_{s,t} = PI_{s,t} \times KK_{s,t} \times \left((RLBE_t - \Delta \ln PI_{s,t}) + 0,1 + \sum_{i=0}^{1} 0,5(\tau_{t-i} - subr_{t-i}) \right) \quad [15]$$

where:

PI_s is the investment price for branch i;

KK_s is the marginal capita-output ratio (only for industrial branches);

RLBE is the long term interest rate;

τ is the implicit rate of taxation for corporate enterprises;

subr is the implicit rate of subsidies for corporate enterprises.

d. Absorption prices

The link between the production prices and the - final and intermediate - demand prices is made by the so-called absorption prices PA_s. The absorption price is the deflator of the domestic production plus net imports. This equation can be written as follows:

$$PA_s = (QFU_S + QMU_s + ITQ_s + ITM_s - QXU_s) / (QFO_s + QMO_s + (ITM_{s0}/QMO_{s0}) \times QMO_{s0} + (ITQ_{s0}/QFO_{s0}) \times QFO_{s0} - QXO_s) \quad [16]$$

where:

- QFU_s is the effective production of branch s, in current basic prices;
- QMU_s is the import of branch s, in current prices;
- ITQ_s is the net taxation on production, for branch s; ITQ_{s0} is the net taxation on production of base year 1990;
- ITM_s is import taxation, for branch s; ITM_{s0} is the import taxation of base year 1990;
- QXU_s is the export of branch s, in current prices;
- QMO_s is the import of branch s, in constant prices; QMO_{s0} is the import of branch s, for base year 1990;
- QXO_s is the export of branch s, in constant prices;
- QFO_s is the effective production of branch s, in constant basic prices; QFO_{s0} is the effective production of branch s, for base year 1990.

The absorption prices determine the different final demand prices (private consumption and corporate and households' investments) and the intermediary consumption prices of the branches.

e. Export and import prices

Export and import prices are presented in section E.

f. Other delivery prices

The prices of the consumption categories follow a weighted sum of the absorption prices of the delivering branches, with constant transition coefficients and the indirect taxes (VAT).

$$\Delta \ln PC_{c,t} = \alpha_0 + \Delta \ln\left(\sum_s cc_{sc} PA_{s,t}\right) + \Delta ITCR_{c,t} \quad [17]$$

where cc_{sc} is the transition matrix for consumption and $ITCR_c$ the VAT rate for consumption category c.

The consumption block is presented in more details in section D.

The price of intermediary inputs is equal to a input-output weighted sum of the prices of deliveries to intermediary branches of all non-energy branches.

$$\ln PQO_{s,\,t} \;=\; \alpha + \beta \ln\left(\sum_{s'} cq_{s's} PQQ_{s'}\right) \qquad [18]$$

where PQQ_s is the price of deliveries to intermediary branches of branch s and $cq_{s's}$ the technical coefficients of the input-output matrix.

The price of deliveries to intermediary consumption follows the corresponding absorption price

$$\Delta \ln PQQ_{s,\,t} \;=\; \alpha_0 + \Delta \ln PA_{s,\,t} \qquad [19]$$

with an ECM applied to this relation to compute the short run prices.

Finally, the investment price per branch (and product) follows a weighted sum of the absorption prices of the delivering branches, with constant transition coefficients for investments and VAT.

$$\Delta \ln PI_{s,\,t} \;=\; \alpha_0 + \Delta \ln \sum_{s'} ci_{s's} PA_{s'} + \Delta ITIQR_s \qquad [20]$$

where ITIQR is the VAT rate for investment products (if relevant).

2. Wages

In determining wages, we have tried to incorporate both the influence of structural factors (the path of labour productivity, not only within the branch, but also in relation to productivity trends in the economic system as a whole) and that of factors reflecting tensions in the labour market or of an institutional nature. Equilibrium wage setting can be specified as follows

$$\Delta \ln WBFR_{s,\,t} \;=\; \alpha_0 + \alpha_1 \Delta \ln PCH_{s,\,t} + \alpha_2 UR_t + \alpha_3 WST_{s,\,t} \qquad [21]$$

where

WBFR is equal to $WR_s / (1+SSFR_s)$; WBFR represents the total wage net of the social security contributions paid by employers, WR the wage cost per employee and SSFR the implicit rate of the employers' social security contributions.

UR is the unemployment rate;

WST represents the structural variable, defined as:

$$WST_{s,\,t} \;=\; \ln(WBFR_{s,\,t} / PQV_{s,\,t})^* - \ln(WBFR_{s,\,t-1} / PQV_{s,\,t-1}{}^*) \qquad [22]$$

in which

$$\ln(WBFR_{s,t}/PQV_{s,t})^* = \eta \ln(QVO_{s,t}/N_{s,t}) + (1-\eta)\ln(QVOT_t/N_t) \qquad [23]$$

is a linear combination between productivity per branch and average national productivity and permits to capture the effect of the so-called ‘contamination effect’ between the branches. A value η that is lower than unity allows the effects of interdependence between the labour markets in the different branches to be taken into account. Values of η equal to one indicate situations of market isolation.

$$\ln PQV_{s,t}^* = \eta \ln PQV_{s,t} + (1-\eta)\ln PQVT_t \qquad [24]$$

is a similar combination between the value added deflator per branch and the average national value added deflator.

The dynamic adjustment of the wages is described by a partial adjustment mechanism:

$$\Delta^2 \ln WBFR_{s,t} = \lambda(\alpha_0 + \alpha_1 \ln PCH_t + \alpha_2 UR_t + \alpha_3 WST_{s,t} - \Delta \ln WBFR_{s,t-1}) \qquad [25]$$

α_1 is constrained to 1 and PCH is replaced by the health index. Table 9 gives the contamination and Phillips effects obtained with this equation.

TABLE 9 - The contamination and Phillips effects in sectoral wages

Agric.	Energy	Interm. goods	Equip. goods	Cons. goods	Construction	Transp. and comm.	Trade and horeca	Credit and insurance	Health care	Other market services
					partial adjustment parameter λ					
0.95	1.00	0.95	0.95	0.83	0.93	0.70	0.64	0.85	0.55	0.95
					Phillips effect α_2					
-0.98	0.00	-0.31	-1.46	-0.78	-1.30	-0.62	-0.60	-0.13	-0.60	-0.82
					structural parameter α_3					
0.05	0.93	0.33	0.15	0.25	0.37	0.37	0.07	0.05	0.20	0.20
					contamination parameter η					
0.50	0.62	0.15	0.75	0.31	0.20	0.20	0.20	0.32	0.10	0.10

The contamination effect seems to be generally important, except for equipment goods, energy and agriculture. Also note that the Phillips effect is rather high for agriculture, equipment goods and construction. This effect seems to be, on the contrary, limited for credit and insurance and intermediate goods. No Phillips effect could be obtained for energy.

Note that in the version of HERMES used for projections (and for main variants), nominal wages are exogenised in order to take into account the wage norm. This norm stipulates that the nominal wage cost increase can not exceed the weighted average wage growth of Belgium's three main trade partners (i.e. Germany, France and The Netherlands). It is assumed that this norm holds when building a projection[1]. Imposing this norm affects the simulation results, as the wage evolution is kept under control (competitiveness is safeguarded).

The gross wage rate is then used to compute the wage cost per employee

$$WR_s = WBFR_s \times (1 + SSFR_s) \qquad [26]$$

where $SSFR_s$ is the implicit rate of employers' social security contributions for branch s ($SSFR_s = SSF_s / (WB_s - SSF_s)$) and PH_s is the wage cost per hour of branch s (PH_s is normalized).

$$PH_s = (WR_s / H_s) / WR_{s0} \qquad [27]$$

Finally, the wage bill per branch (WB_s) is the product of the wage cost per hour and the total number of hours worked by employees:

$$WB_s = WBO_s \times PH_s \qquad [28]$$

where WBO_s is the total quantity of hours worked by employees of branch s during year t.

1. Medium term calculations are based on projections of the European Commission.

D. The demand of households: consumption and investment

1. The macroeconomic consumption function

Private consumption is first determined at its macroeconomic level (this point). The obtained global amount is then allocated to the different consumption categories (see point 2 *infra*)[1].

Consumer behaviour in the new model is based on the life cycle hypothesis of consumption. According to this hypothesis rational consumers attempt to maximise their intertemporal utility and find it optimal to smooth their consumption over time. Their consumption decision is based on a discounted stream of current and future expected net income (PI) and on their current stock of financial wealth (FW). Private consumption (C) can be represented as follows:

$$C = \rho(PI + FW) \qquad [29]$$

If, as assumed by the life cycle hypothesis, all consumers were foreward looking with perfectly functioning financial markets they would be able to smooth their lifetime consumption. In reality a substantial proportion of consumers does not behave in this way for a variety of reasons e.g. market imperfections, uncertainty, myopia and backward looking behaviour. Thus over the long run consumption is a positive function of lifetime (human and non-human) wealth while in the short run it appears also to be constrained by current disposable income.

This long term equilibrium relationship between consumption, income and wealth is incorporated in the dynamic short term specification as an ECM, with λ the error correction coefficient (cfr. equation [30]).

In the short run we added the inflation and the unemployment rate. The inflation rate appears to induce households to consume less in order to maintain their real wealth. The unemployment rate can be considered as a consumer confidence indicator that negatively affects private consumption. We found different propensities to consume for the different components of income in the short run: the propensity to consume out of labour income and transfer income is fairly high, whereas the propensity to consume out of financial income is much lower.

We approximated the permanent labour income by current labour income and the financial wealth by the financial assets held by households[2].

The macroeconomic consumption function used in the model is the following (all variables are observations from year t unless otherwise indicated):

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1. For an overview of the aggregate private consumption, see e.g. Bayar and Mc Morrow (1999). Different aspects of private consumption in Belgium have also been analysed in Bossier et al (1995).
2. The financial assets held by households include time and savings deposits, foreign assets, term deposits, savings certificates and insurance certificates subject to previous deduction, Collective Investment Undertaking, bonds and tax-exempt insurance certificates.

$$\Delta \ln C = \lambda(\alpha \ln LIH + (1-\alpha)\ln AH - \ln C)_{t-1} + \gamma_1 \Delta \ln LIH + \gamma_2 \Delta \ln FIH + \gamma_3 \Delta \ln PCH + \gamma_4 \Delta UR(\Delta UR > 0) + \gamma_5 \Delta UR(\Delta UR < 0) \quad [30]$$

with:

C = private consumption in constant prices per capita;

LIH = labour and transfer income in constant prices per capita;

AH = financial assets held by households in constant prices per capita;

FIH = property income in constant prices per capita;

PCH = consumer price index;

UR = unemployment rate (definition FPB).

The estimation results for equation [30] are the following:

TABLE 10 - Coefficients for the macroeconomic consumption function

λ	α	γ_1	γ_2	γ_3	γ_4	γ_5
0.30	0.99	0.75	0.05	-0.10	-0.55	-0.15

Currently we revise the aggregate consumption function and continue to focus our attention on wealth considerations (human and non-human wealth), dynamics, the impact of expectations and questions such as liquidity constraints, uncertainty and the role of current income. This work is still in progress. Results can not be presented yet.

2. The consumption allocation module[1]

This section describes how total aggregate consumption is allocated over its different components as a function of relative prices and total income. The starting point of our modelling strategy is the assumption that there exists a long run equilibrium, but that rigidities prevent immediate adjustment to this long run equilibrium.

In paragraph *a* a specification of the long run equilibrium is presented. Here we introduce the CBS version of an econometric allocation system, which explains quantities in terms of a scale effect and relative prices, and which allows us to impose the various restrictions derived from the theory of rational consumer behaviour in a rather flexible way. In paragraph *b* an ECM for our allocation problem is derived, while in paragraphs *c* and *d* some econometric issues estimating this ECM are discussed, i.e., the Two-Step Engle-Granger estimator and groupwise separability. Finally, the analytical framework is applied to a dataset consisting of disaggregated household consumption. The estimation results, in the form of overall short and long run income elasticities and overall compensated and uncompensated own price elasticities are presented in paragraph *e*.

1. The content of point 2 is based on Bracke and Meyermans (1997).

a. Long run equilibrium

Consider a representative economic agent who allocates his total available means between n commodities, and assume that the preference ordering of this agent satisfies the regular assumptions so that a set of differentiable demand functions exists[1].

The CBS version in levels[2] of an econometric allocation system reads as follows

$$\ln y_{it} = \chi_i + \beta_i \ln Q_t + \sum_{j=1}^{n} \sigma_{ij} \ln p_{jt} + v_{it}, \quad \text{for } i = 1, ..., n \qquad [31]$$

where $\ln y_{it}$ is defined as

$$\ln y_{it} = w_{it}(\ln q_{it} - \ln Q_t) \qquad [32]$$

with

q_i : quantity of commodity i,
Q : real income,
p_j : price of commodity j,
n : number of commodities,
w_i: the budget share of commodity i.

Note that a subscript t has been added to indicate the observation unit, and that in order to capture randomness in human behaviour a random component v_{it} has been added to each equation. It is assumed that the covariance matrix of this random component is independent of t and that there is no intertemporal correlation of the disturbance terms.

1. The set of axioms of choice includes reflexivity, completeness, transitivity, continuity, nonsatiation, and convexity. See for example Barten and Böhm (1982) or Deaton and Muellbauer (1987).
2. The original CBS parametrization was derived in the context of a system in first differences, see Keller and Van Driel (1985). The levels version has been proposed by Barten (1989).

The following set of restrictions can be imposed on the parameters of system [31]

$$\sum_{i=1}^{n} \chi_i = 0, \sum_{i=1}^{n} \beta_i = 0, \sum_{i=1}^{n} \sigma_{ij} = 0 \qquad [33.a]$$

$$\sum_{j=1}^{n} \sigma_{ij} = 0 \qquad [33.b]$$

$$\sigma_{ij} = \sigma_{ji} \quad \forall i,j \qquad [33.c]$$

$$\sum_{i=1}^{n} \sum_{j=1}^{n} \alpha_i \sigma_{ij} \alpha_j < 0 \quad \text{with not all } \alpha_i \text{ having the same value.} \qquad [33.d]$$

The adding-up and homogeneity condition are a direct consequence of the linear budget constraint. The adding-up conditions indicate that the aggregate is divided into its different components, while the homogeneity condition states that it is relative prices which matter. The symmetry and negativity conditions reflect the properties of the underlying preference ordering. Symmetry is a guarantee for consumer's consistency of choice, while the negativity condition emphasizes, for example, that the own compensated price effect should be negative.

Note that the random components satisfy the condition:

$$\sum_{i=1}^{n} v_{it} = 0 \qquad [34]$$

The CBS parametrization was selected because it provided the best fit.

b. An error correction mechanism

In the previous section a long run equilibrium between quantities, prices and income has been specified. However, such equilibrium is not attained immediately. Therefore we specified an ECM which explains contemporaneous changes in the quantities by changes in the scale and prices and by past deviations of the quantities from their long run equilibrium value[1]:

1. Note that the following adding-up conditions hold:

$$\sum_{i=1}^{n} \beta_{1i} = 0, \sum_{i=1}^{n} \sigma_{1ij} = 0, \sum_{i=1}^{n} (\alpha_{ij} - \delta_{ij}) = 0$$

$$\ln y_{it} - \ln y_{it-1} = \beta_{1i}(\ln Q_t - \ln Q_{t-1}) + \sum_{j=1}^{n} \sigma_{1ij}(\ln p_{jt} - \ln p_{jt-1}) \qquad [35]$$

$$+ \sum_{j=1}^{n} (\alpha_{ij} - \delta_{ij})\left(\ln y_{jt-1} - \chi_j - \beta_j \ln Q_{t-1} - \sum_{k=1}^{n} \sigma_{jk} \ln p_{kt-1}\right)$$

$$+ u_{it}$$

for i=1,..., n;

and with:

$$\delta_{ij} = 0 \text{ for } i \neq j$$
$$= 1 \text{ for } i=j.$$

Two features estimating the ECM will be highlighted, i.e., the Two-Step Engle-Granger estimation procedure and groupwise separability.

c. The Engle-Granger Two-Step estimator

The econometric technique used to estimate the ECM [35] is the Two-Step Engle-Granger estimator[1]. In a first step the cointegration vector between the quantities, the scale effect and the relative prices, i.e. equation [31], is estimated with ordinary least squares, and the error correction term v_i is calculated. At this stage it should either be tested whether the variables are cointegrated, i.e. whether the residuals of the levels equation are stationary, or a priori be assumed that cointegration holds. In a second step, the short run adjustment scheme - including the error correction term - is estimated. Applied to our model the Two-Step Engle-Granger estimator runs as follows.

i. The first step: estimating the long run equilibrium

In the first step, we estimate the long run equilibrium, i.e. system [31], and calculate the error correction terms

$$v_{it} = \ln y_{it} - \left(\hat{\chi}_i + \hat{\beta}_i \ln Q_t + \sum_{j=1}^{n} \hat{\sigma}_{ij} \ln p_{jt}\right) \quad \text{for } i = 1,..., n \qquad [36]$$

with ^ indicating the point estimate of the corresponding parameter.

1. See Engle and Granger (1987).

ii. The second step: estimating the short run adjustment mechanism

In the second step, we insert the error correction term [36] into equation [35] yielding:

$$\ln y_{it} - \ln y_{it-1} = \beta_{1i}(\ln Q_t - \ln Q_{t-1}) + \sum_{j=1}^{n} \sigma_{1ij}(\ln p_{jt} - \ln p_{jt-1}) + \sum_{j=1}^{n} (\alpha_{ij} - \delta_{ij}) v_{jt-1} + u_{it} \qquad [37]$$

for i=1,...,n,

and we proceed by estimating system [37]. However, note that in view of condition [34], the second last term in [37] is collinear. Therefore, we proceed by noting that:

$$v_{nt} = -\sum_{j=1}^{n-1} v_{jt}. \qquad [38]$$

Inserting [38] into [37] yields

$$\ln y_{it} - \ln y_{it-1} = \beta_{1i}(\ln Q_t - \ln Q_{t-1}) + \sum_{j=1}^{n} \sigma_{1ij}(\ln p_{jt} - \ln p_{jt-1}) + \sum_{j=1}^{n-1} \phi_{ij} v_{jt-1} + u_{it} \qquad [39]$$

with $\phi_{ij} = \alpha_{ij} - \delta_{ij} - \alpha_{in} + \delta_{in}$.

Hence, equation [39] will be estimated in the second step.

d. Groupwise separability

It is clear that without further restrictions on the parameters the degrees of freedom will be small. Therefore we will make the additional assumption of weak separability of the underlying preference ordering[1].

1. Consider the continuous, differentiable direct utility function $U(q_1, q_2, ..., q_n)$. Under the assumption of (weak) separability of the underlying preference ordering the utility function can be written as $U(U_1(q_1, ..., q_j), ..., U_I(q_k, ..., q_m), ..., U_J(q_{m+1}, ..., q_n))$, i.e. the sub-utility of a convex combination of commodities of group I does not depend on the consumed amount of commodities of group J.

Under groupwise separability the consumer faces a decision problem in two stages. In a first stage the consumer decides how much to spend on "durable and complementary non-durable goods" on the one hand, and "other non-durable goods" on the other hand. In a second stage he decides how much of the amount to be spent on durable goods will be allocated to clothing, household utilities, and transportation. Transportation includes public transportation, equipment, such as cars, and energy, which includes petrol, heavy fuel and oil. The group of non-durable goods has been modified and an additional decision stage has been added. It now consists of "group 1" and "group 2". "Group 1" includes domestic services, communication, and tourism, while "group 2" includes food, beverages, tobacco, rent, heating, power, recreation, education, and culture and other expenditure items. See also figures 2 and 3. The consumption category “medical care and health service” is not represented in the allocation structure. This category is explained not only by relative prices and income but also by demographic variables. The consumption category “rent” is also not represented in the allocation structure. This category is explained by disposable income only.

FIGURE 2 - The allocation structure of the durable and complementary non-durable goods

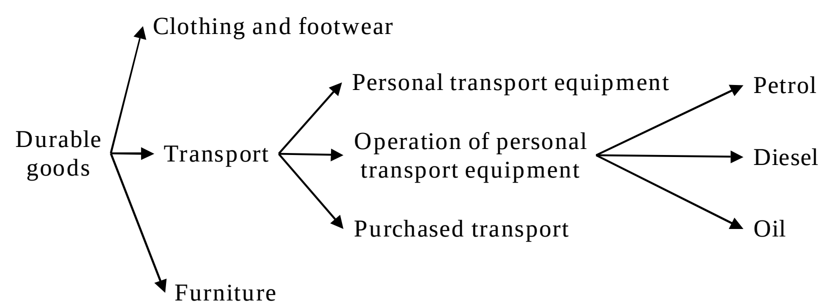
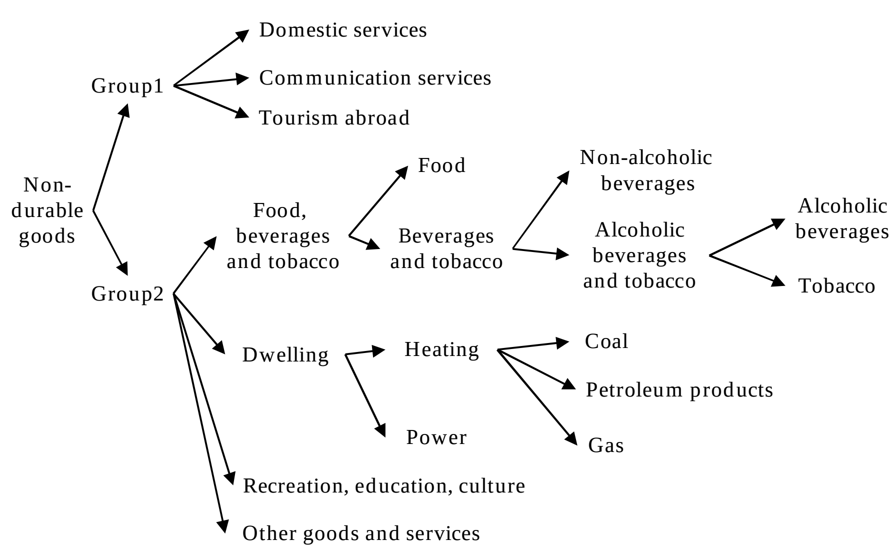


FIGURE 3 - The allocation structure of the non-durable goods



e. Estimation Results

We summarize the major results in the form of the long and short run overall income elasticities, and the compensated and uncompensated overall own price elasticities.

The overall long run elasticities are defined as

- income elasticity: $\eta_{it} = \frac{\beta_i}{w_{it}} + 1$
- compensated price elasticities: $\varepsilon_{ijt} = \frac{\sigma_{ij}}{w_{it}}$
- uncompensated price elasticities: $\theta_{ijt} = \varepsilon_{ijt} - w_{jt}\eta_{it}$

The overall short run elasticities are defined as

- income elasticity: $\eta_{1it} = \frac{\beta_{1i}}{w_{it}} + 1$
- compensated price elasticity: $\varepsilon_{1ijt} = \frac{\sigma_{1ij}}{w_{it}}$
- uncompensated price elasticities: $\theta_{1ijt} = \varepsilon_{1ijt} - w_{jt}\eta_{1it}$

The previous equations show that the elasticities of the CBS version change together with the budget shares. It should then be noted that the value of the elasticity may change significantly during the course of time, if the budget share changes significantly during the course of time.

The compensated price elasticities describe the responses of the quantities to changes in the predetermined prices as we move along the indifference curve, while the uncompensated price elasticities also take into account the budgetary effects of a change in the predetermined prices.

Because the consumption category “food” is a necessary good we found weak income and price elasticities. The consumption category “clothing and footwear” has also relatively weak elasticities for the same reason. For the energy products we found rather high income elasticities, low short term price elasticities and rather high medium term price elasticities. For the “services” categories we found rather high income elasticities and high price elasticities.

TABLE 11 - Estimation results: elasticities for the different consumption categories of the allocation structure

Consumption category	income elasticity		uncompensated price elasticty		compensated price elasticity	
	t	t+4	t	t+4	t	t+4
Food	0.43	0.46	-0.44	-0.66	-0.37	-0.59
Non alcoholic beverages	0.75	0.38	-0.41	-0.48	-0.39	-0.48
Alcoholic beverages	0.77	0.46	-0.45	-0.47	-0.43	-0.46
Tobacco	0.74	0.46	-0.44	-0.46	-0.42	-0.45
Clothing and footwear	0.47	0.81	-0.25	-0.79	-0.22	-0.74
Coal	-0.09	0.44	-0.50	-0.97	-0.50	-0.97
Petroleum products	0.61	0.93	-0.21	-0.70	-0.20	-0.69
Gas	0.99	0.81	-0.36	-0.54	-0.35	-0.53
Power	0.58	0.61	-0.23	-0.42	-0.21	-0.40
Domestic services	0.83	0.72	-0.46	-0.63	-0.45	-0.62
Furniture	0.57	0.76	-0.31	-0.28	-0.27	-0.24
Personal transport equipment	1.42	1.01	-0.51	-0.57	-0.41	-0.50
Petrol	0.54	0.30	-0.41	-0.29	-0.40	-0.28
Diesel	0.43	0.49	-0.24	-0.43	-0.24	-0.43
Oil	0.19	0.13	-0.75	-0.80	-0.74	-0.80
Transport services	2.19	1.36	-1.45	-1.61	-1.41	-1.58
Communication	1.05	1.03	-0.63	-0.55	-0.61	-0.53
Recreation, education and culture	1.36	0.93	-0.87	-1.11	-0.63	-0.95
Other goods and services	1.24	1.86	-0.47	-0.75	-0.21	-0.37
Tourism abroad	1.65	1.27	-1.23	-0.84	-1.14	-0.77

3. Housing investment

Residential investment at constant prices (IRO) is also modelled by means of an ECM, assuming a long term relationship with real disposable income (YDH / PCH) and a real mortgage rate indicator (RMR). It is assumed that residential investment has a lagged response to the evolution of its explanatory variables.

$$\ln IRO_t = \alpha \ln (YDH / PCH)_{t-1} + \beta \ln RMR_{t-1} \qquad [40]$$

Both determinants also appear in the short term relationship, together with the evolution of the unemployment rate UR (a confidence indicator) and the price level of housing investment PIR with respect to the consumption price level PCH (a decreasing relative price makes housing investment more attractive). All short term determinants are lagged. This gives the following relationship:

$$\Delta\ln IRO_t = \lambda_1 [\alpha \ln (YDH / PCH)_{t-2} + \beta \ln RMR_{t-2} - \ln IRO_{t-1}] + \lambda_2 [\alpha \Delta\ln (YDH / PCH)_{t-1} + \beta \Delta\ln RMR_{t-1}] + \phi \ln(PIR / PCH)_{t-1} + \eta \Delta UR_{t-1} \qquad [41]$$

TABLE 12 - Estimated coefficients of the households' investment function

α	β	λ_1	λ_2	ϕ	η
0.90	-4.0	0.03	0.56	-0.50	-0.15

4. The computation of the households' disposable income

We have seen that households' disposable income (YDH) is one of the main determinants of private consumption and housing investment. This point briefly describes how YDH is computed in HERMES.

a. Total disposable income

The following relation gives the aggregated disposable income of households

$$YDH_t = REMI_t + WBU_t + YN_t + GOSH_t + OCUH_t + IDH_t + SBH_t - (DTOTH_t + YSSH_t + THI_t) \quad [42]$$

where:

REMI is the mixed income (income of non wage workers);

WBU is the total compensation of employees;

YN is the compensation of border workers;

GOSH is the gross operating surplus;

OCUH are the net transfers to the households (other than from the social security);

IDH is the property income;

SBH are the transfers from the social security;

DTOTH is the income tax;

YSSH are the social contributions;

THI are the transfers to the non profit associations.

b. components of the disposable income

REMI, the mixed income is, itself, dependant on the evolution of households value added:

$$\mathrm{dln}\,REMI_t = \alpha\,\mathrm{dln}(QVUFH - (WDOM + DPUH + ITPDH - SUBDGH)) \quad [43]$$

where:

- QVUFH is the value added of households (a fraction of total firms value added);
- WDOM are the wages paid to other non-market services;
- DPUH is the households consumption of fixed capital;
- ITPDH are taxes on production paid by households;
- SUBDGH are subsidies on production paid by public administrations to households.

WBU, which represents the total wage bill, is a sum of wages paid by every market and non market branch:

$$WBU_t = \sum_s WB_{s,\,t} \quad [44]$$

where WB_s is the compensation of employees paid by branch s ($WB_{s,t} = WBO_{s,t} \cdot PH_{s,t}$).

GOSH is computed as

$$GOSH_t = QVUFH_t - (REMI_t + WBFH_t + ITPDH_t - SUBDGH_t) \quad [45]$$

where WBFH is the compensation of employees paid by the households ($WBFH = \sum_s \alpha_s WB_s$, where s=branches).

IDH is the sum of three components:

$$IDH_t = IDHI_t + IDHD_t + IDHR_t \quad [46]$$

where IDHI represents the net interest payments; IDHD the dividends distributed by enterprises and IDHR the other incomes (notably insurance incomes).

SBH is the sum of all transfers paid by the different institutional sectors to the households:

$$SBH = SBG + SBF + SBH\_B + SBI + SBB\_B - SBB\_M \qquad [47]$$

where:

SBG represents the total allowances paid to the households by the public administrations ($SBG = \sum_i SBG_i$, where i= the different levels of general government);

SBF represents the allowances paid to the households by the enterprises;

SBH_B represents imputed social allowances;

SBI represents the social allowances paid to households by the non profit institutions;

SBB_B represents social allowances paid by other countries;

SBB_M represents social allowances paid to other countries.

DTOTH, the income tax, is computed in the public finances block. DTOTH is equal to:

$$DTOTH = DTH + TCP + DTO4 + DTPAT2 + DTDIV2 \qquad [48]$$

where:

DTH is the personal income tax paid by the households;

TCP is the horsepower tax paid by the households;

DTO4 is the domestic waste tax;

DTPAT2 is the tax on capital;

DTDIV2 represents other taxes on income.

YSSH represents the total social contributions paid by households. YSSH is the sum of the following variables:

$$YSSH = SSF + SSH + SSB\_M - SSB\_B \qquad [49]$$

where:

SSF represents the employers' social security contributions ($SSF = \sum_s SSF_s$, where s=branches);

SSH represents the employees' social security contributions;

SSB_M represents the social security contributions paid by Belgian workers working for European institutions or abroad;

SSB_B represents the social security contributions paid by foreigners.

Finally, THI is the transfers of households to the non-profit institutions.

E. The external trade block

The external trade block contains equations for import and export volumes per branch, as well as corresponding export and import prices. This block is of crucial importance for the model, given the openness of the Belgian economy.

The basic specification of all export and import equations is based on two traditional determinants: the demand volume (the internal demand for imports and the world demand for Belgian goods and services for exports) and the price competitiveness of producers. This general specification is enriched (for the manufacturing branches) by the introduction of supply effects.

1. Imports

The long run import equation of branch s includes the total demand for its products and an index of price competitiveness, measured by the ratio between import price by branch s and the corresponding production price. Furthermore, the residual and cyclical component of imports (possibly due to supply bottlenecks) is explained by the introduction of the capacity utilization rate (for manufacturing goods).

This gives the following relation at the equilibrium:

$$\ln QMO_s = \alpha_0 + \alpha_1 \ln D_s + \alpha_2 \ln \frac{PQM_s}{PQF_s} \qquad [50]$$

Where QMO_s represents the equilibrium level of imported quantity of goods (or services) produced by branch s, D_s the (total) demand for products of branch s, PQM_s the import price of product s and PQF_s the domestic production price of product s.

In the short run equation, utilization rates are introduced, for the manufacturing industries, to take into account supply effects. The short run relation is obtained by applying an ECM to the long run relationship.

Table 13 gives the long run elasticities obtained for all branches, except energy[1]. Most demand elasticities are higher than 1, probably reflecting an increase of import contents of all branches. Also note the relatively low level of long run price elasticities except for the consumption goods branch.

1. The treatment of energy imports is explained in section F.

TABLE 13 - Parameters of import equations

	Demand elasticity	Relative price elasticity
Agriculture	1.32	-0.05
Intermediate goods	1.21	-0.19
Equipment goods	1.20	-0.30
Consumption goods	1.63	-0.81
Construction	1.02	-0.15
Transports- communications	0.87	-0.15
Other services[a]	1.38	-0.50

a. Trade and horeca, Credit and insurance and Other market services.

2. Import prices

Import prices are supposed to depend on world prices and on internal prices, with a unitary elasticity constraint. The target can be written:

$$\ln PQM_s = \alpha_1 \ln PQF_s + (1 - \alpha_1) \ln PWMD \qquad [51]$$

where PWMD is the external price (computed as a weighted sum of export prices of Belgian commercial partners).

The value of α_1 permits to measure the respective influence of internal and external prices on the determination of import prices. If α_1 is equal to one, the import price only depends on internal prices, when α_1 is equal to zero, the import price is completely indexed on the external prices.

The short run relation is obtained by applying an ECM to the long run equation. Table 14 gives the values of α_1 obtained for the manufacturing branches. In all cases, α_1 is small, indicating that manufacturing import prices are mainly explained by external prices.

TABLE 14 - Import prices- value of α_1 for manufacturing sectors

	α_1
Intermediate goods	0.18
Equipment goods	0.12
Consumption goods	0.15

3. Exports

The model used for the manufacturing branches starts from an *ex ante* demand and an *ex ante* supply equation. The final equation is derived as a transaction curve between planned demand and supply. Exports of services are restricted to the demand model.

Ex ante demand

Demand factors which are retained represent the world demand and the competitiveness position. It is obvious that there exists a close relationship between the increase in world demand for one country's goods (QWXD) and the growth of the actual volume of exports of this country. The relative price term (the export price PQX_s divided by the world price PWXD) is used as a competitiveness indicator. Domestic producers will lose market shares on their foreign markets when their own export price exceeds the main competitors' price.

The equation can be written as:

$$\Delta \ln QXOD_s = \alpha_0 + \alpha_1 \Delta \ln QWXD + \alpha_2 \Delta \ln\left(\frac{PQX_s}{PWXD}\right) \qquad [52]$$

with $\alpha_1 \sim 1, \alpha_2 < 0$,

Ex ante supply

The planned supply of exports is supposed to be determined by capacity growth and the profitability of exports. A growth of production capacities as well as an increase in exports profitability tend to increase Belgian manufacturing exports.

This gives the following relationship

$$\Delta \ln QXOS_s = \beta_O + \beta_1 \Delta \ln QP_s + \beta_2 \Delta \ln\left(\frac{PQX_s}{PB_s}\right) \qquad [53]$$

with β_1 and $\beta_2 > 0$.

where $QXOS_s$ is the planned supply of export, QP_s is the output capacity and PB_s is the production cost.

The actual export volume equation is obtained as follows. We suppose that each producer minimizes his cost relative to his export activity

$$\min C_s = \gamma_1(\Delta \ln QXO_s - \Delta \ln QXOD_s)^2 + \gamma_2(\Delta \ln QXO_s - \Delta \ln QXOS_s)^2 \qquad [54]$$

where QXO_s is the actual export volume of the manufacturing branch.

The first term of the right hand side of the last equation captures the idea that each producer will balance the marginal costs of a loss of additional exports versus the marginal costs of additional production in the case of excess *ex ante* demand. Following the second term, each producer will balance the trade-off between the costs of (for example) additional marketing efforts and the costs of unsold production, in the case of excess *ex ante* supply.

Differentiating this equation w.r.t. QXO_s and rearranging it permits to obtain the final form of the equation determining the volume of exports for manufacturing industries.

$$\Delta \ln QXO_s = \theta_1\left(\alpha_0 + \alpha_1 \Delta \ln QWXD + \alpha_2 \Delta \ln\left(\frac{PQX_s}{PWXD}\right)\right) + \theta_2(\beta_0 + \beta_1 \Delta \ln QP_s + \beta_2 \Delta \ln(PQX_s/PB_s)) \quad [55]$$

4. Export prices

Export prices are determined simultaneously with export volumes, as a weighted average of world price and of domestic costs. Moreover a capacity utilization rate is included in the equation as a proxy for the profit margin.

The equation is the following:

$$\Delta \ln PQX_s = \psi_1 \Delta \ln PWXD + \psi_2(\Delta \ln PB_s + \psi_3 \Delta \ln QR_s) + \psi_0 \quad [56]$$

with $0 < \psi_1$, $\psi_2 < 1$, $\psi_2 = 1 - \psi_1$ and $\psi_3 \geq 0$

where QR_s is the utilization rate.

When ψ_1 is large, the domestic export price follows strongly the competitors' export price; the exporter behaves as a price-taker and is constrained by supply (θ_2 is large in export volume equation). When ψ_2 is large, the exporter behaves as a price-setter, fixing the export price in function of production costs. In this case, exports are determined by the demand side of the market (θ_1 is large in export volume equation).

By assumption, ψ_1 is set equal to θ_2 and ψ_2 to θ_1 (and, consequently, $\theta_1 = 1 - \theta_2$). This means that the extent to which a producer is price-taker or price-setter also determines the extent to which he is constrained by supply or demand on the export market. Note that, in order to reduce the ridigity inherent to this kind of two regimes model, we have replaced θ_1 by $\theta_1 + \delta t$, with t a trend variable.

The estimation results of exports module are given hereafter. Table 15 gives the results obtained for industrial sectors, except energy[1].

Note that for all three branches, ψ_3 is not significant. For all branches, a demand regime seems to be predominant. However, for intermediate goods, a supply regime is gradually gaining in importance. Demand factors display relatively high elasticities: the world demand elasticity is always larger than one, mainly in the intermediate goods branch (but, for this branch, the demand regime gradually looses in importance- see above). On the contrary, the contribution of supply factors seems to be more limited, mainly in equipment and consumption goods.

1. The modelling of energy exports, which is made at a disaggregated level, is explained in section F.

TABLE 15 - Estimation results for the export sub-model - goods

	θ_1	δ	α_1	α_2	β_1	β_2	ψ_3
Intermediate goods	0.75	-0.009	3.33	-0.90	0.30	0.59	0
Equipment goods	0.98	0	1.10	-0.25	0.45	0.50	0
Consumption goods	0.98	0	1.20	-0.26	2.50	1.75	0

Estimation results for the services are given in the table 16.

TABLE 16 - Estimation results for the export sub-model - services

	α_1	α_2
Transports, communications	0.92	-0.67
Other services[a]	0.62	-0.54

a. Trade and horeca, Credit and insurance and Other market services.

As we mentioned before, the export model for services is restricted to a demand regime. Note that the world demand elasticity is surprisingly low, when price elasticities display a more standard value (in the range of -0.5, -0.6).

Condition of Marshall-Lerner

The condition of Marshall-Lerner tells us whether the foreign exchange market is stable or unstable. From price and volume equations, il can be verified if a devaluation gives, *ceteris paribus*, an improvement of trade balance (or if positive effects coming from competitiveness gains prevail on negative effects associated with the terms of trade deterioration). This condition can be written[1]:

$$S = \varepsilon_{px} + (1 - \varepsilon_{px})\varepsilon_x - \varepsilon_{pm}(1 - \varepsilon_m) > 0 \qquad [57]$$

where:

ε_{px} is the elasticity of exports prices to world price;

ε_{pm} is the elasticity of import prices to world price;

ε_x is the price elasticity of exports;

ε_m is the price elasticity of imports.

This condition seems to be verified with HERMES (S is positive for all branches). If the external block is simulated separately, a depreciation of 10 % gives an improvement of the trade balance equivalent to 2 % in the medium term. This relatively weak result is explained by the fact that price elasticities are generally small.

1. See e.g. Assouline et al (1998) or Salvatore (1987).

F. Energy and greenhouse gases (GHG) emissions

Energy products play a dual role in the HERMES model as production factors in the production function for each branch and as a production branch itself. For each of the eight energy products (see table 1), demand, prices and an input-output equilibrium, in quantity and in value terms are calculated. The latter leads to a central application of the energy module in the model: the compilation of annual physical energy balance sheets according to the EC format (from which, in turn, can be derived CO_2 emission sheets).

This section is organized as follows: we first present the main relationships of the energy module; then, we describe more precisely the energy allocation model which was selected and estimated for HERMES; finally, we present and discuss the environmental module.

1. Main relations of the energy module

a. Computation of total energy needs

The computation of total needs per energy product represents one of the key relations in the energy module.

$$FDE_i=EO_sE_i.\alpha_{i,s}+ECOE_i.\beta_i+EOJE_i+EELE_i+EO_jE_i+ESOE_i+EBUE_i+EPTE_i+EMPE_i+EXOE_i.\gamma_i \quad [58]$$

where:

FDE_i is the total demand of product i (in terajoules (TJ));

EO_sE_i is the consumption of product i by branch s (in constant prices);

$ECOE_i$ is the consumption of product i by private consumption (in constant prices);

$EOJE_i$ is the consumption of product i by the energy branch (in TJ);

$EELE_i$ is the transformation of product i into electricity (in TJ);

EO_jE_i is the transformation of product i into product j (other than electricity);

$ESOE_i$ is the stock change (in TJ);

$EBUE_i$ is the consumption of bunkers (only for petroleum products; in TJ);

$EPTE_i$ is the distribution losses (only for electricity; in TJ);

$EMPE_i$ is the consumption of product i for non energy needs (in TJ);

$EXOE_i$ is the export of product i (in constant prices);

α_i, β_i and γ_i are conversion coefficients (from constant prices to TJ).

Note that EO_jE_i, $ECOE_i$ and $EXOE_i$ are expressed in billions of constant BEF and must be converted into TJ (by means of conversion coefficients) to compute FDE_i.

b. Energy demand by branches and households

i. Branches[1]

Demand per product i of branch s is computed from total energy demand of branch s (which is computed in the production block, together with the other production factors) and from an allocation model (presented in point 2 below).

$$EO_sE_i = ME_{i,s} \cdot QEU_s / PE_{i,s} \qquad [59]$$

where $ME_{i,s}$ is the share of product i into total energy cost of branch s (for s= 1,...,12); $PE_{i,s}$ the price of product i for branch s and QEU_s the total energy demand (or energy cost) of branch s in current prices.

QEU_s is equal to $QEO_s \cdot PE_s$, where QEO_s, the total energy demand in constant prices is computed in the production block and PE_s, the average price of energy for branch s is presented below.

ii. Households

The energy demand per product of households is computed from the households' allocation module (see section D, point 2). This module calculates the volumes of energy consumed for heating purposes (CO_4), power (CO_5) and personal transportation (CO_9).

Energy consumed for heating

The energy module allocates the total energy consumed for heating between the different forms of energy products distinguished by the model. The model also translates the quantities consumed from BEF to TJ:

$$ECOE_i = f(CO_4), \text{ for i= coal, petroleum products and gas} \qquad [60]$$

where CO_4 is fuel for heating (in constant prices).

Electricity (power)

$$ECOE_i = f(CO_5), \text{ for i = electricity} \qquad [61]$$

where CO_5 is electricity consumption (in constant prices).

Energy consumed for personal transportation

The households allocation module divides the energy consumed for personal transportation into three categories: motor spirit (cat. 1), gasoil (cat. 2) and other products (cat. 3):

$$CO_9 = CO_{9,1}+CO_{9,2}+CO_{9,3} \qquad [62]$$

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1. Except energy branch.

The energy module translates the quantities consumed (in constant prices) into physical terms (litres).

iii.Energy branch

Energy consumption by the energy branch only contains the consumption of the branch for its own use (the transformation process is treated afterwards).

$$EOJE_i = f(EPSE_j), \text{ for } i = \text{coke, petroleum products, natural gas, derived gas and electricity} \quad [63]$$

where $EPSE_j$ is the (derived) production of product j (in TJ); j= 1,...,8.

c. Transformation activity

i. Transformation inputs

The energy module computes the inputs used to produce electricity, but also the inputs going to other transformers.

$$EELE_i = EQDJ_i \ / REND_i \quad [64]$$

where $EELE_i$ is the transformation of product i into electricity; $EQDJ_i$ the production of electricity (in TJ) coming from product i and $REND_i$ an efficiency coefficient for the conversion of product i into electricity.

Following energy products can be used for the electricity production: hard coal, petroleum products, natural gas, derived gas, nuclear heat and renewable energy (biomass).

Other transformation activities concern in Belgium: coke-oven plants, blast-furnace plants, patent fuel and briquetting plants[1] and refineries. The inputs necessary to these transformers are computed from output transformer (derived production) weighted by an efficiency coefficient.

$$EO_jE_i = f(EPSE_j \ . \ REND_j) \quad [65]$$

for i and j different from electricity.

1. The activity of patent fuel and briquetting plants in Belgium is negligible.

d. Derived production

i. Electricity

Total electricity production is explained by the evolution of total electricity needs and by a relative price comparing the production costs of electricity in Belgium to the price of total electricity resources (including imports).

$$EPSE_i = f(FDE_i, PEFE_i / PFME_i) \qquad [66]$$

where i= electricity; $PEFE_i$ the production cost of electricity in Belgium and $PFME_i$ the price of total electricity resources.

Note that $EPSE_i$ has still to be allocated between the different forms of electricity $EQDJ_i$. This allocation is exogenous in the present version of HERMES.

ii. Other products

Like in the case of electricity, the production of other products is explained by a relation including the volume of energy needs (for the product concerned) and a relative price. This is especially the case for refineries and coke-oven plants. The computation of derived gas production is a bit different. The production of coke-oven gas depends on coke production, when blast-furnace gas production depends on iron and steel activity in the country (and on the use of coke by this industry).

e. External trade

i. Exports

Exports are explained by the level of national production and by the export price divided by the absorption price (as a proxy for the profitability of foreign markets relative to the domestic market).

$$EXOE_i = f\,(EPSE_i, PEXE_i / PAE_i) \qquad [67]$$

where $PEXE_i$ is the export price of product i (computed as a weighted average between the internal costs and the world price of product i); PAE_i is the absorption price.

Note that $EXOE_i$ is expressed in billions (in constant prices).

ii. Imports

Imports make sure that, for each energy product, uses and resources are equal to each other. They are obtained as the difference between the uses and the domestic resources to cover those uses. For products which are not imported, such as manufactured gas, imports will simply be zero as domestic production covers the uses by definition, while all uses will be imported if there is no domestic production at all (e.g. for crude oil).

f. Prices and taxes

Prices are determined for each energy product and each consuming branch. Prices of product i consumed by branch s are a function of absorption price computed for product i. Absorption price is, itself, a weighted average of internal product price and net import price.

$$\ln PE_{i,\,s} = \alpha + \beta \cdot \ln PAE_i \qquad [68]$$

where $PE_{i,s}$ and PAE_i are the long run values of energy price per product and absorption price. An aggregated energy price (PE_s) can then be computed as a simple weighted average of the individual energy prices ($PE_{i,s}$).

The computation of energy prices for households is a bit more complex, because they include VAT and excises, as well as energy taxes. A price for each energy product, excluding all taxes is first computed. This price depends on the absorption price. Taxes are added to give the final price paid by the consumer. This gives the following (long run) relationship:

$$\ln PCOE_i = \alpha + \beta \cdot \ln PAE_i \qquad [69]$$

where $PCOE_i$ is the equilibrium price of product i, all taxes excluded and PAE_i the equilibrium value of absorption price.

$$PECOE_i = (PCOE_i + ENTAX_i + EXC_i).(1+ITCR_i) \qquad [70]$$

where:

$PECOE_i$ is the price for households of product i, all taxes included;

$ENTAX_i$ is the energy tax on product i (if relevant);

EXC_i is the excise on product i;

$ITCR_i$ is the VAT rate on product i.

g. Other variables

i. Consumption of bunkers[1] (in TJ)

The consumption of bunkers (only petroleum products) is explained by a long term relation including the evolution of world trade and a relative price term, measuring the competitiveness degree of Belgian petroleum market.

$$\ln EBUE_i = \alpha + \beta \cdot \ln QWXD + \gamma \cdot \ln\left(\frac{PEFE_i}{PWXD}\right) \qquad [71]$$

where QWXD is the world trade volume; $PEFE_i$ the production cost of petroleum products and PWXD the world price.

1. Energy consumption for navigation.

ii. Distribution losses (in TJ)

The distribution losses only concern electricity. The evolution of distribution losses is explained by the evolution of the electricity production level. The long term relation can be written:

$$\ln EPTE_i = \alpha + \beta \cdot \ln EPSE_i \qquad [72]$$

for i = electricity

iii.Non energy consumption (in TJ)

The final non-energy consumption is composed of two products: petroleum products and natural gas. Non-energy uses are mainly concentrated in the chemical branch. Their evolution will therefore depend on the activity in the intermediate goods branch.

iv.Stock change (in TJ)

For each energy product (except electricity), a stock change can be observed. The stock change is exogenous in the present version of the model.

2. An allocation model for the energy products

The analysis of the substitution behaviour between energy products takes a central place in the model. We have seen (section A) that the total energy demand of each industrial branch is computed with demand functions derived from two-level CD-CES production functions, in which energy is supposed to be weakly separable from the other inputs. At a second stage, expenditure on energy is broken down into expenditures in the different energy products. To this end, we use a unit energy cost function, without imposing *a priori* restrictions on the structure of demand. The chosen function is the translog specification, which is written

$$\ln PE = \alpha_0 + \sum_i \alpha_i \ln PE_i + \frac{1}{2}\sum_i \sum_j \beta_{ij} \ln PE_i \ln PE_j + \gamma t + \sum_i \gamma_i \ln PE_i t \qquad [73]$$

where PE is the price per unit of energy and PE_i is the price of energy product i.

We assume that the cost function is homogeneous of degree one in prices, that implies the following restrictions on the parameters:

$$\sum_i \alpha_i = 1$$

$$\sum_i \beta_{ij} = 0$$

If we assume cost minimising behaviour, we may obtain the demand functions for each energy product, expressed as their share in the total energy cost

$$M_i = \alpha_i + \sum_j \beta_{ij} \ln PE_j \qquad [74]$$

in which $\beta_{ij} = \beta_{ji}$.

The possible deviation of short term demand from the long term target suggests to introduce a partial adjustment process of the form:

$$\Delta M_i = \lambda(M^*_{i,t} - M_{i,t-1}) \qquad [75]$$

where M^*_i is the optimal level of the ith product share.

Note that the adjustment parameter is the same for each product in order to verify the adding-up constraint $\sum_i M_i = 1$.

Price elasticities can be computed from the estimated parameters. The elasticities vary by way of expenditures shares.

$$\eta_{ij} = M_j + \frac{\beta_{ij}}{M_i}$$

and

$$\eta_{ii} = M_i + \frac{\beta_{ii}}{M_i} - 1$$

where η_{ij} represents the elasticity of the demand of fuel i with respect to the price of fuel j.

Sample mean price elasticities obtained for all branches (with the exception of agriculture-only one fuel identified-, transports and construction) are given in the following table. Note that the size of elasticities obtained for coal can be largely influenced by the low share of this product in the total energy demand. Generally speaking, (long term) price elasticities are low in absolute terms and much lower than in the preceding version of the model. With one exception (consumption goods), the mean own price elasticity for coal does not exceed 0.60, while other fuels display in general less sensitiveness: electricity demand is never very sensitive to its own price and practically inelastic for two branches. The own price elasticity of gas is also low while the own price elasticity of oil is hardly higher. Fuels are often (not always) substitutes, but the magnitude of substitution can be very limited: for instance, gas demand is little sensitive to the oil price; this is also the case for electricity w.r.t. price of other fuels. Complementarity seems to prevail, for the majority of the branches, in the case of the couple electricity-coal, but the magnitude of this complementarity is rather limited.

TABLE 17 - Sample mean price elasticities

	Intermediate goods	Equipment goods	Consump-tion goods	Trade and horeca	Credit and insurance	Health care	Other market services	Non-market services
coal-coal	-0.47	-0.52	-3.26	-0.52	-0.64	-0.56	-0.60	-0.60
coke-coke	-0.28	-	-	-	-	-	-	-
oil-oil	-0.25	-0.31	-0.26	-0.13	-0.12	-0.25	-0.20	-0.24
gas-gas	-0.24	-0.36	-0.99	-0.13	-0.12	-0.16	-0.13	-0.07
electricity-electricity	-0.09	-0.26	-0.12	-0.30	-0.22	-0.30	-0.17	-0.09
coal-coke	-0.55	-	-	-	-	-	-	-
coal-oil	0.97	0.92	-1.87	1.31	0.58	0.66	0.89	1.22
coal-gas	-0.75	-0.59	0.63	0.52	0.24	0.35	0.28	0.36
coal-electricity	0.80	0.20	4.50	-1.32	-0.18	-0.45	-0.57	-0.98
coke-coal	-0.05	-	-	-	-	-	-	-
coke-oil	0.19	-	-	-	-	-	-	-
coke-gas	0.03	-	-	-	-	-	-	-
coke-electricity	0.11	-	-	-	-	-	-	-
oil-coal	0.18	0.06	-0.01	0.03	0.02	0.02	0.03	0.12
oil-coke	0.33	-	-	-	-	-	-	-
oil-gas	0.20	0.01	0.13	0.02	0.02	0.05	0.03	0
oil-electricity	-0.46	0.23	0.13	0.23	0.09	0.18	0.08	0.12
gas-coal	-0.05	-0.07	0.02	0.06	0.11	0.05	0.17	0.26
gas-coke	0.03	-	-	-	-	-	-	-
gas-oil	0.09	0.01	0.87	0.01	0.24	0.23	0.81	-0.12
gas-electricity	0.17	0.43	0.08	0.05	-0.22	-0.13	-0.84	-0.07
electricity-coal	0.05	0.01	0.02	-0.11	-0.01	-0.01	-0.05	-0.13
electricity-coke	0.06	-	-	-	-	-	-	0
electricity-oil	-0.13	0.13	0.10	1.03	0.26	0.33	0.36	0.23
electricity-gas	0.11	0.12	0.02	0.09	-0.03	-0.02	-0.14	0

3. The environmental module

The environmental module is designed to model the interactions between the economic activities, modelled in the other part of the model, the emission of pollutants which come from these activities and the environmental policies which should be introduced.

a. Measuring the state of the environment

In this point, we specify the technical relations between the various forms of energy consumption and the emission of air pollutants.

i. CO_2 emissions from energy use

The carbon dioxide (CO_2) emission factor for a fuel depends on:

- the carbon content of the fuel;
- the fraction of carbon (C) oxidized in the combustion process;
- the fraction of carbon sequestered in non-energy use of fuels.

The carbon content of fuels is generally issued from figures proposed by the IPCC[1]. For the evaluation of CO_2 emissions from fuel combustion, the carbon content has to be adjusted for the fraction of carbon which is not oxidized in the combustion process. IPCC adopted an average of 1 % for the different fuels, based on different studies.

Under these assumptions, average emission factors for the fuels can be derived from the carbon content figures (1 tonne of C gives 44 / 12 tonnes of CO_2), with correction of 1% for carbon which is not oxidized in the combustion process.

We formalize hereafter the relation between fuel consumption and CO_2 emissions, as it is introduced in the model. CO_2 emissions of fuel i is given by the following relation:

$$CO_{2,\,i} = \gamma C_i = \gamma\beta_i E_i = \gamma\beta_i\alpha_i Q_i \qquad [76]$$

where:

γ is the factor to convert carbon into carbon dioxide;

C_i is the carbon emission of fuel i in tonnes ($C = \beta_i E_i$);

β_i is the carbon emission factor for fuel i;

E_i is the consumption of fuel i, in TJ ($E_i = \alpha_i Q_i$);

α_i is the conversion coefficient for fuel i from constant prices to TJ;

Q_i is the consumption of fuel i, in constant prices.

The next figure shows the total emissions which are computed by the model for the period 1970-1998 (in millions of tonnes of CO_2). As can be seen, CO_2 emissions have considerably decreased between 1979 and 1985. This reduction can be explained by high relative energy prices, which have induced a reduction of energy consumptions per unit of output, but also by the transformation of the electricity branch (penetration of nuclear energy to the detriment of classical thermal power stations) and by the restructuration of heavy - and energy consuming- industries. From 1986 onwards, CO_2 emissions seem to be increasing again. This rise should be explained by low energy prices (which do not encourage energy efficiency efforts any more) and by an increase of the classical thermal power stations' share in the production of electricity.

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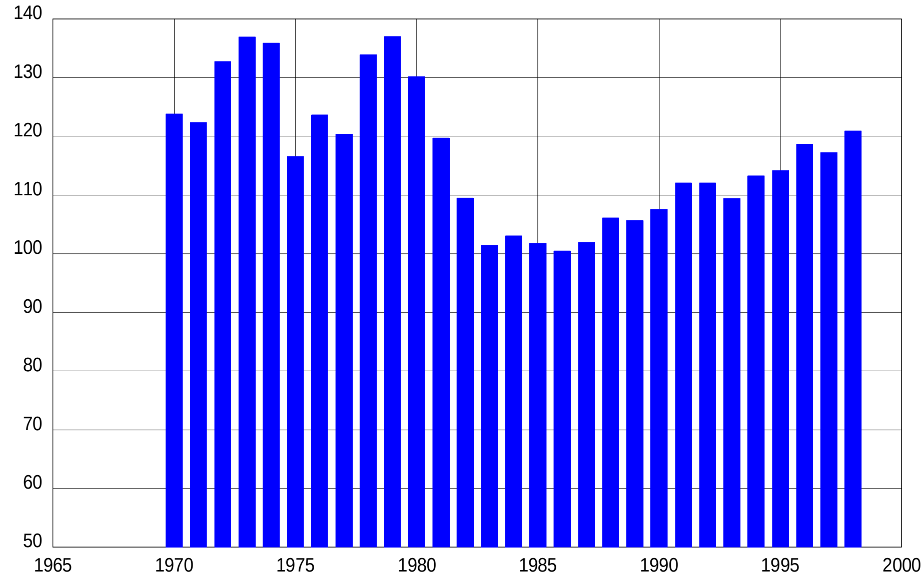
1. See Intergovernmental Panel on Climate Change (1995).

FIGURE 4 - CO_2 emissions *(millions of tonnes)*



ii. Other GHG emissions

We know that CO_2 is responsible for a high percentage of the radiative forcing but other energy-related emissions can be considered and included in the model (like sulphur dioxide SO_2 and nitrogen oxides NO_X).

Other greenhouse gases, related to the activity of specific branches can also be added, such as methane CH_4 and nitrous oxide N_2O. These different gases are not yet completely introduced in the present version of HERMES.

b. Modelling emission reduction scenarios

Different instruments can be considered in the framework of policies aimed at reducing GHG emissions. The use of market-based instruments for the control of carbon emissions is now widely accepted and, among them, environmental taxes (the so-called pigouvian tax) have been widely studied. Other market-based instruments concern for instance tradable permits.

Energy-related taxes and charges considered as environmental include:

- excise duties on energy and taxes based on the energy content of the energy source (as well as specified production taxes on hydro and nuclear power): *the energy tax*;
- taxes based on carbon content of the fuel or CO_2 emitted in the fuel combustion process: *CO_2 tax or carbon tax*;
- taxes and charges based on sulphur content of the fuel or sulphur oxides emitted in the fuel combustion process: *sulphur tax*;

- taxes and charges based on nitrous oxide (NO_X) emitted in fuel combustion process: *nitrogen charge*;
- excise duties on electricity production and taxes on electricity consumption: *electricity tax*.

The mixed carbon / energy tax was proposed by the EU Commission in 1992[1]. In this proposal, the tax was based on a 50 % revenue from both tax components. The tax level was 3$ per oil barrel in the beginning and would raise up to 10$ until the year 2000. The proposal included also taxes on electricity generated by nuclear and hydro power and a possibility to grant exceptions for industry. No agreement was found and the proposal was finally rejected by the Council of Ministers. More recently, the Commission proposed to enlarge the existing directive on harmonisation of minimum excise duty rates of mineral oils to natural gas, solid fuels and energy products such as heat and electricity. The proposed taxes were very low and were not based on either the carbon content or the energy content of the fuel.

c. Formalizing the introduction of energy or carbon tax in HERMES

The introduction of energy or carbon taxation can be written as follows

$$PE_{i,s} = (PEHT_{i,s} + EXC_{i,s} + \langle ENTAX_{i,s} \cdot \alpha_i + CO2TAX_{i,s} \cdot \beta_i \rangle) \times (1 + ITCR_i) \qquad [77]$$

where:

$PE_{i,s}$ is the price of energy product i for branch s;

$PEHT_{i,s}$ is the price of energy product i for branch s, all taxes excluded;

$EXC_{i,s}$ is the existing excise, paid on product i by branch s;

$ENTAX_{i,s} \cdot \alpha_i$ is the energy tax for product i, weighted by the energy content of i;

α_i is the energy content of i;

$CO2TAX_{i,s} \cdot \beta_i$ is the CO_2 tax of product i, weighted by β_i, the carbon content of i;

$ITCR_i$ is the VAT rate for product i (if relevant).

For instance, the EU proposal of 1992 was equivalent to the introduction of an energy tax equal to 0.21 ecu per GJ, while the carbon tax attained 2.81 ecus per tonne of CO_2.

1. See Commission des Communautés Européennes (1992).

G. The public sector

Public finance is an essential part of the HERMES model. The State intervenes at nearly all stages of the modelling process, such as price formation (VAT, excises, taxes on energy, subsidies, ...), the computation of net disposable income (via direct taxes, social security contributions or benefits), which can affect the behaviour of the different categories of economic agents, or the formation of public investment policy, which influences the different production branches directly and indirectly.

The public finance module of HERMES is characterized by a disaggregation of general government into five subsectors:

- federal government;
- communities and regions;
- local authorities;
- the social security sector;
- the EU.

For each subsector, the model computes a current transactions account and a capital account and determines respectively the operating surplus, the primary income, the disposable income, the current savings and the net financing or requirement capacity. The indebtedness is also computed (for the public administrations as a whole and for each subsector). Note that the public finance section is also built according to the ESA95 national accounts classification.

The current transactions of the general government can be divided into resources and expenditures.

1. Resources

The HERMES model is divided into eleven branches of activities. The resources of the four subsectors of the general government are modelled, as far as possible, according to the macrosectoral approach. Indirect taxes and employers' social security contributions are based on the disaggregation of the national economy into the eleven HERMES branches. Current taxes on income and wealth paid by households, corporate taxes and employees' social security contributions, however, are calculated only at the macroeconomic level.

The calculation of value added taxes is in the first place made at the level of each consumption category. The computation of excises and other indirect taxes is also made at a very detailed level. Then, the model allocates the VAT between the several branches of the HERMES model by means of a converter matrix of private consumption. Excises and other indirect taxes (such as import taxes) are also allocated, if necessary, between the different branches. This method permits the uses and resources per branch to be modelled correctly.

Current taxes on income and wealth distinguish taxes paid by households, taxes paid by non-profit institutions serving households (NPISH), corporate taxes and taxes paid by the rest of the world. Taxes paid by households are split up into taxes on movable assets, personal income tax and other taxes. The taxes on movable assets are a function of the evolution of interest receipts of households (for interest incomes) or a function of firms' gross operationg surplus (for dividends). Calculation of the other personal taxes depends upon the elasticity with respect to the disposable income of households (given the progressiveness of the income tax and taking into account different taxation rates). Corporate taxes also distinguish taxes on movable assets and other taxes. Other corporate taxes depend on the evolution of firms profits and on the corresponding taxation rate. Taxes on NPISH depend on the evolution of NPISHs' value added.

2. Expenditures

The different types of government expenditures are all modelled on a macroeconomic level, except subsidies. Expenditures are allocated between the four subsectors of the general government, in particular wages and salaries, purchase of goods and services, subsidies and interest payments.

Transfers from public authorities to other institutional sectors are also computed in detail, as well as transfers between the different levels of general government. Table 19 shows the different kinds of transfers which are modelled by HERMES.

The net financing capacity or requirement of general government is the result of the current and capital transactions of each subsector. This variable is notably used to compute the total financing capacity of the nation.

TABLE 18 - Resources of the general government: decomposition and calculation in the HERMES model

Variables in the HERMES model	Decomposition	Calculation
1. Indirect taxes		
1.1 VAT	allocated between: consumption functions per category; some kinds of investments and some categories of intermediary consumptions	application of an implicit VAT rate on a corresponding tax base
1.2 Excises	two levels: consumption functions; branches	excise duties on energy products: calculation based on taxes levied per litre of product; excise duties on non-energy products: application of an implicit tax rate on the consumed quantity
1.3 Other taxes on products	decomposition per branch and per subsector of the general government	linked to the evolution of specific branches' value added and to the evolution of GDP
1.4 Tax on income from real estate	decomposition per sector, allocation among branches afterwards	the evolution depends on consumer prices evolution
1.5 Other taxes on production	decomposition per subsector of the general government; allocation among branches afterwards	depends on GDP evolution. for some variables, exogenous
2. Current taxes on income and wealth		
2.1 Personal income tax	calculation on a macroeconomic level: distinction between tax on movable assets and other personal taxes	elasticity linked to the disposable income of housholds; depends on the progressiveness of the tax; different taxation rates are applied to different incomes
2.2 Corporate taxes	calculation on a macroeconomic level	linked to the legal corporate tax rate and to the firms' operating surplus
2.3 Taxes on NPISH	calculation on a macroeconomic level	linked to the evolution of GDP
2.4 Oher taxes on income and wealth	calculation on a macroeconomic level	linked to the evolution of GDP, or *ad hoc* explanation
3. Social security contributions		
3.1 Employers' contributions	decomposition per branch and per subsector of general government	application of an implicit rate on total wage income per branch
3.2 Employees' contributions	calculation on macroeconomic level, decomposition per subsector of general government	implicit rate on total wage income
4. Other revenues		
4.1 Interests and dividends	decomposition per subsector of general government	linked to the evolution of GDP, or exogenous
4.2 Other current transfers	decomposition per subsector of general government	linked to the evolution of consumer prices and that of public investments

TABLE 19 - Expenditures of the general government: decomposition and calculation in the HERMES model

Variables in the HERMES model	Decomposition	Calculation
1. Public consumption		
1.1 Wages and salaries	decomposition per subsector of general government	linked to the evolution of public employment and the wage rate in the public sector
1.2 Purchase of goods and services	calculation on a macroeconomic level; decomposition per subsector of general government	exogenous evolution in constant prices, generally
1.3 Consumption of fixed capital	calculation on a macroeconomic level; decomposition per subsector of general government	indexed on the evolution of prices
1.4 Social benefits in kind	calculation on a macroeconomic level; decomposition per subsector of general government	exogenous evolution at constant prices
2. Subsidies	decomposition per branch	exogenous
3. Transfers to households	decomposition per subsector of general government; calculation per type of transfer (unemployment, insurance of occupational accidents and diseases, pensions, family allowances and health insurance,...)	for the social benefits, exogenous evolution at constant prices, except unemployment which is linked to the number of unemployed (per category); for other transfers, linked to the evolution of prices and, possibly, to the evolution other indicators
4. Transfers to NPISH	decomposition per subsector of general government	linked, generally, to the evolution of prices
5. Transfers to the rest of the world	decomposition per subsector of general government	linked to the evolution of prices, of GDP and of taxes transferred to EU.

TABLE 20 - Expenditures of the general government: decomposition and calculation in the HERMES model

Variables in the HERMES model	Decomposition	Calculation
1. Resources		
1.1 Current savings	decomposition per subsector of general government	result of the current transactions account
1.2 Capital taxes	decomposition per subsector of general government	linked to the evolution of prices
1.2 Transfers from other sectors	decomposition per subsector of general government	exogenous or linked to the evolution of prices
2. Uses		
2.1 Gross capital formation	calculation on macroeconomic level; decomposition per subsector	linked to the evolution of GDP and of prices; partly exogenous
2.2 Net purchase of land and intangible assets	decomposition per subsector of general government	exogenous or linked to the evolution of prices
2.3 Transfers to other sectors	decomposition per subsector of general government	exogenous or linked to the evolution of prices

H. Interest rates

The three main interest rates used by HERMES are the three-month Treasury bill rate, the yield on government bonds with contractual maturity of over 6 years and the mortgage rate. These rates are especially important for the corporate and households' investment behaviour and - given the considerable stock of public debt - for public finance.

$$\Delta RSBE_t = \Delta RSGY_t + 0.21\ \Delta(INFL_{BEL}-INFL_{GER})_t - 0.05\ \Delta(CAC_{BEL}-CAC_{GER})_t$$

$$\Delta RLBE_t = \Delta RLGY_t + 0.15\ \Delta(INFL_{BEL}-INFL_{GER})_t - 0.04\ \Delta(CAC_{BEL}-CAC_{GER})_t$$

$$\Delta RM_t = \Delta RLBE_t$$

The Belgian short and long rates (RSBE and RLBE respectively) are supposed to vary in exactly the same way as their comparable German counterparts (RSGY and RLGY) *ceteris paribus*. Inflation (INF) and the balance-of-payments current account in terms of GDP (CAC) are also incorporated. An increase in the Belgo-German inflation differential or a decreasing current account differential are considered to widen the Belgian interest rates relative to the German yields. However, both effects - especially the current account differential - seem to remain rather limited. All foreign variables are exogenous. The Belgian mortgage rate (RM) is supposed to vary in the same way as the government bond yield.

IV Summary and concluding remarks

This working paper presented the main features of the FPB's HERMES II model for Belgium. The model is suitable for medium term forecasts and for the analysis of the effects of both economic policy adjustments and exogenous shocks on a macroeconomic level as well as by branch. HERMES became operational in the mid-1980s and has been maintained and developed on a regular basis. Recent improvements include the analysis of CO_2 emissions and the further disaggregation of the market services.

Other developments which are foreseen in the near future include the introduction of the input-output table for 1995, with a reestimation of the model in 1995 prices, and the modelling of greenhouse gases emissions other than CO_2.

An important feature of this year's version of HERMES II has been its conversion to the new European System of Accounts (ESA95), which replaces ESA79. A drawback of ESA95 - at least at this moment - is the rather short range of the time series, which made it necessary to retropolate most of the variables in order to obtain observations for the 1980s. This was done on the basis of their ESA79 profiles. Therefore, the parameter estimates of the ESA95 version of HERMES II have to be interpreted with care. However, the current parameter estimates of the ESA95 version of HERMES II do not appear to be fundamentally different from the coefficients in its ESA79 version (finalized last year), which is based on consistent time series for the period 1970-1997. Further reestimations will be undertaken as soon as longer official ESA95 time series become available.

As we mentioned in the introduction, simulation exercises will be presented in a next working paper. This permits to illustrate the dynamic properties of the model and to emphasize the impact on the Belgian economy of economic policy adjustments as well as international shocks. Eight scenarios are considered. Five of them are fiscal policy measures: an increase in public investment, a reduced VAT rate for some labour-intensive services, a reduction of the employers' social security contributions, an increase in social transfers to households and a tax shift from the fixed to the variable cost of car use. The other three scenarios focus on an international shock: an increase in world trade, an oil price increase and an USD appreciation.

V References

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