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A new version of MODTRIM II

An overview of the model for short-term forecasts

June 2014

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Abstract - This working paper describes the current version of MODTRIM II, the quarterly macroeconomic model developed at the Federal Planning Bureau (FPB) for short-term forecasting. The aim of this working paper is not to provide a complete user's guide for the model, but to focus on the specification and estimation results of the behavioural equations for the private sector. While the model has retained the same overall architecture and underlying structure since its initial construction, the main differences relative to the 2003 version described in a similar working paper, will be highlighted.

Jel Classification - C5, E17

Keywords - econometric model, macroeconomic forecasts

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1. Introduction

This working paper describes the current version of MODTRIM II, the quarterly macroeconomic model developed at the Federal Planning Bureau (FPB) for short-term forecasting. These forecasts, which are published three times a year[1], are usually referred to as the "economic budget", as they are used by the Belgian federal government to set up its budget and to perform budgetary control exercises. It is therefore important to be as transparent as possible about the tools and methods to produce these forecasts, implying the availability of a clear description of the hypotheses and of the major economic mechanisms involved.[2]

The aim of this working paper is not to provide a complete user's guide for the model, but to focus on the specification and estimation results of the behavioural equations for the private sector.[3] While the model has retained the same overall architecture and underlying structure since its initial construction, the main differences relative to the 2003 version, which was described in a similar working paper[4], will be highlighted. It should be noted that the model has been regularly re-estimated with the release of new data and modified in the course of time. It is obvious that it will continue to be developed further as potential improvements are identified. The version presented in this paper is based on the quarterly accounts published in October 2013.

MODTRIM is a structural model, which has the advantage (compared to a purely statistical approach) that the forecasts result from the interaction of economic mechanisms. This makes the forecasts of the key variables easier to explain. If possible, long-run structural relationships among the variables as well as short-term dynamics are established econometrically, so that they react in a way consistent with past experience. The econometric approach also makes the model appropriate for risk scenario and sensitivity analyses as required by the new European Directive on budgetary frameworks. As the forecasting horizon of the model is six to eight quarters, fluctuations in economic activity are assumed to be driven predominantly by changes in aggregate demand.[5]

The paper is organised as follows. The model's main characteristics and estimation results are described in Chapter 2. In Chapter 3 a few simulation results are presented in order to examine the response of the complete model to exogenous shocks or policy adjustments.

1 The FPB's short term forecasts are normally scheduled in February, June and September. Until recently, the June version was mostly a preliminary, unpublished forecast, but it became an official publication in 2013 (under the form of a press release). The forecasts of February and September are more elaborate publications.

2 A similar approach was applied recently for the FPB's medium term model HERMES, see Bassilière et al. (2013).

3 Public sector demand and employment are obviously important as well, but they largely reflect public policy decisions.

4 See Hertveldt and Lebrun (2003).

5 Other models used for similar purposes, like the Opale model at the French Treasury, exhibit comparable characteristics, see Bardaji et al. (2010).

2. Model specification and estimation results

2.1. Overall structure of the model

The model aims to produce forecasts for the main categories of expenditures in the quarterly national accounts in both prices and volumes (chain-linked) as well as for the accounts of the institutional sectors.[6] Value added for the total economy is derived from the expenditure side. The model remains strongly aggregated as it only identifies an endogenous private sector and an exogenous public sector. Employment is broken down in wage earners and self-employed, with only wage earners from the private sector (excluding specific subsidized categories) determined endogenously. The model also contains an integrated indexation module reproducing specific Belgian legislation. The hourly gross wage increase in the private sector, exclusive of indexation, is considered exogenous in forecasting as it is largely determined by biannual collective agreements between social partners.[7] Nonetheless to measure the impact of specific shocks, a wage equation can be activated. The other main exogenous variables consist of international ones like potential export markets, international prices including oil prices, interest rates and exchange rates as well as of national policy variables (e.g. taxation rates and public expenditure) and non-policy variables (e.g. demography). In all, the model contains around 20 true behavioural equations, the remaining 380 being *ad hoc* equations or identities.

In the following sections we present the main behavioural equations for the different expenditure categories (private consumption, housing investment, business investment, exports and imports), for wage-earning employment as well as for the main deflators. Compared to the 2003 version of the behavioural equations, priority has been given to empirical validation over theoretical priors. For instance, the strong assumptions on labour, capital demand and the value added deflator implied by the use of a Cobb-Douglas production function have been abandoned. Another change concerns export and import prices for which a distinction is now made between energy and non-energy products. Moreover, due to the increasing importance of financial variables in the real economy, the impact of interest rates on investment decisions has been carefully tested. Finally, in order to limit the sample to officially published national accounts and to be able to obtain coefficients over only one monetary policy regime[8], behavioural equations have been estimated on a sample starting in 1995Q1 at the earliest.

Estimation results for the long-run equations described in this chapter are obtained using static ordinary least squares. To test theoretical restrictions on coefficients rigorously, in particular regarding static homogeneity, fully modified ordinary least squares estimates have been used. Results of these tests are given in Annex 1. The assumption of static homogeneity guarantees that an equation generates a stable steady-state path, i.e. a situation in which, on the one hand, all variables in real terms grow at the same speed and in which, on the other hand, all deflators do the same.

Dynamic equations are estimated in error correction format, i.e. past discrepancies between the observed and the estimated long-term level are gradually removed. To illustrate this adjustment, a table

6 For a detailed description of these accounts see Hertveldt and Lebrun, op. cit.

7 Or implemented by the government if no agreement is reached.

8 While the euro became a currency only in 1999, stage two of the EMU was launched back in 1994.

presents the transition path, for each (semi-)elasticity, from its short-term value (given by the corresponding coefficient in the dynamic equation) to its long-term value (provided by the coefficient in the level equation).

2.2. Aggregate demand

2.2.1. Private consumption

As in the previously published version of the model, households' consumption[9] is determined in the long run by real disposable income and financial wealth accumulated up to the previous quarter. Nonetheless, some changes have been introduced. Firstly, net property income, which appeared to have no explanatory power and disturbed the cointegrating relationship, has now been excluded from disposable income. For the same reason, direct equity holdings have been left out of households' financial wealth which is approximated only by interest-bearing assets[10]. Finally, a four-quarter moving average is used to measure inflation in order to smooth the evolution of income and wealth in real terms.

As shown in Table 1, the ADF test clearly rejects the presence of a unit root in the residuals of the long-term equation. After being tested and accepted[11], static homogeneity is imposed in order to guarantee a stable steady-state path. In the dynamic equation, the change in unemployment is introduced as an additional variable to account for, among other things, temporary variations in the savings rate for precautionary reasons. Two dummies are also included to account for the abrupt changes in opposite directions in 2008Q1 and 2008Q4. We also added a constant to capture the negative consumption growth during the three last quarters of 2012. All coefficients are highly significant and the absence of first-order autocorrelation in the residuals is confirmed by the LM-statistic. The impact of interest rates and the role of consumer credit was also tested but not found to be statistically significant.

Table 1 Estimation results for private consumption

Long-term equation	ln(CCO_L) = cco_l0 + cco_l1*ln((YDH_I-IDH_I)/ma(4,PCC)) + (1-cco_l1)*ln(IAH/ma(4,PCC))[-1]			
	Estimation period:	1996Q1 – 2012Q4		
	Coefficient values:	cco_l0: -0.17	cco_l1: 0.92	
	Tests:	R² adj: 0.98	ADF: -5.53	
Dynamic equation	dln(CCO) = cco0 + cco1*dln(CCO)[-1] + cco2*dln(YDH_I/PCC) + cco3*d(U/NAT) + cco4*(t=2008Q1) - cco4*(t=2008Q4) + cco5*(t>2012Q1) *(t<2013Q1) + cco_e*(ln(CCO)-ln(CCO_L))[-1]			
	Estimation period:	1996Q2 – 2012Q4		
	Coeff. values (t-stat):	cco0: 0.002 (4.5)	cco1: 0.346 (3.7)	cco2: 0.112 (3.1)
		cco3: -0.582 (-2.6)	cco4: 0.007 (3.7)	cco5: -0.006 (-3.8)
		cco_e: -0.259 (-6.2)		
	Tests:	R² adj: 0.58	DW: 2.08	LM(1): 0.49

As shown in the left-hand panel of Graph 1, the fitted long-term values fluctuate around the observed levels indicating stationary residuals, confirming the ADF test result. Private consumption dropped

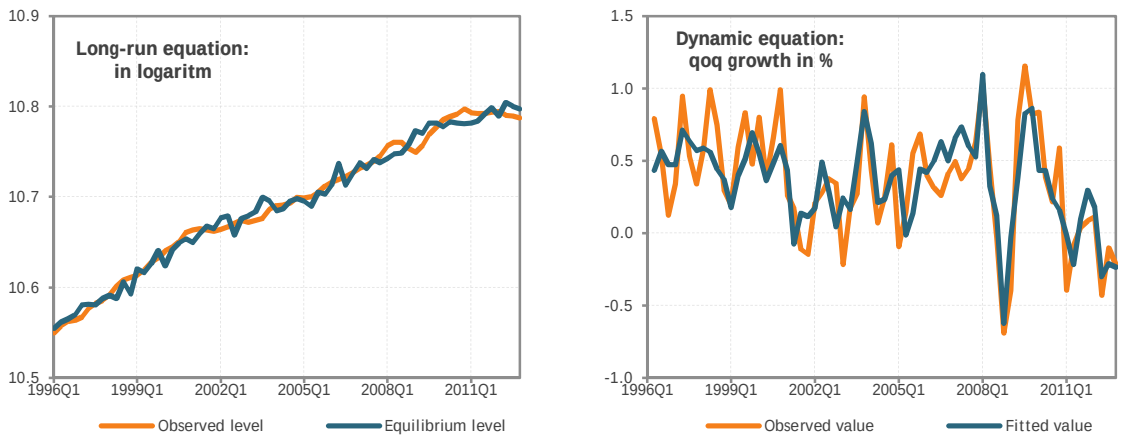
9 For simplicity of notation, "households" includes non-profit institutions serving households (S.14 + S.15)

10 Savings deposits and fixed-interest securities, while excluding sight deposit accounts.

11 See Annex 1.

below its long-run value during the financial crisis of 2008-2009, but recovered subsequently. The dynamic equation is also performing reasonably well considering the high volatility of the quarter-on-quarter evolution.

Graph 1 Private consumption: observed and fitted values



Source: NAI, FPB

The impact on private consumption of a normalized shock regarding each exogenous variable is summarized in Table 2. A permanent increase of 1% of disposable income translates progressively into a rise of private consumption of 0.92%, with a slight overshooting after two years due to the auto-regressive term in the dynamic equation. The effect of a boost in inflation is dampened by the moving average process built into the model but after two years most of the downward adjustment is completed. An increase in the value of assets (with fixed returns) of 1% stimulates private consumption by 0.08% after two years. A rise in the unemployment rate of 1 percentage point has an immediate significant impact on consumption (-0.63% after one semester) but phases out after two years as consumers get accustomed to this new level of unemployment.

Table 2 Elasticities or semi-elasticities for private consumption

	Q1	Q2	Q3	Y1	Y2	Y5	LT
Disposable income (excluding property income) (+1%)	0.11	0.36	0.59	0.76	0.93	0.92	0.92
Deflator of private consumption (+1%)	-0.11	-0.18	-0.28	-0.43	-0.96	-0.99	-0.99
Financial wealth (assets with fixed returns) (+1%)	0.00	0.00	0.02	0.04	0.08	0.08	0.08
Unemployment rate (+1 pp)	-0.58	-0.63	-0.48	-0.31	0.00	0.00	0.00
Results obtained with the 2003 version of the model							
Disposable income (+1%)	0.30	0.34	0.37	0.40	0.51	0.70	0.86
Deflator of private consumption (+1%)	-0.30	-0.38	-0.42	-0.46	-0.58	-0.81	-0.99
Financial wealth (+1%)	0.00	0.04	0.05	0.05	0.08	0.11	0.14
Unemployment rate (+1 pp)	-0.09	-0.09	-0.08	-0.08	-0.06	-0.03	0.00

In comparison with the 2003 version of the model, short-term (semi-)elasticities are, in absolute value, smaller except for unemployment, but convergence towards the steady state is significantly faster.

2.2.2. Housing investment

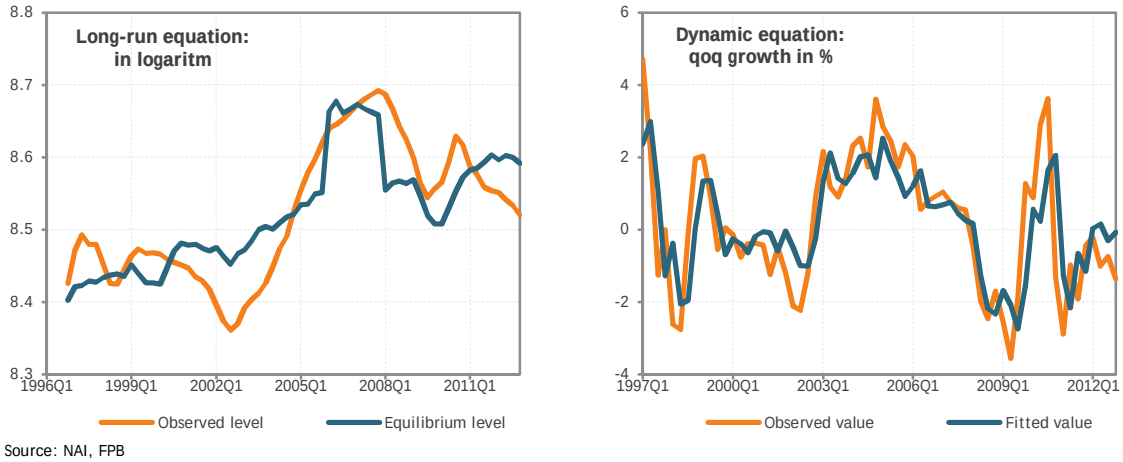
Residential investment comprises the building of new houses and the renovation of existing dwellings by households. Several relationships between residential investment and its potential determinants were tested in order to include an adjustment towards the long-term equilibrium in the dynamic representation. The coefficient of this error correction term was systematically very small because the short-term dynamics of housing investment is dominated by strong inertia modelled as a first-order autoregressive process (i.e. current housing investment growth is largely explained by its past development).

We finally retained a long-run specification in which residential investment is determined by households' disposable income net of property income and the real mortgage rate. A dummy is also included to account for the residential investment boom in 2006-2007, which could be partially due to the lagged impact of measures such as the fiscal amnesty operation in 2005. This encouraged households to repatriate funds. A part of these financial assets was probably reinvested in property. The ADF test statistic barely exceeds its critical value at the 10% significance level, so that evidence against the presence of a unit root in the residuals of the equation is only marginally significant. The short-term equation only takes into account the lagged value of residential investment and the error correction term.

Table 3 Estimation results for housing investment

Long-term equation	ln(IRO_L) =	iro_l0 + iro_l1*ln((YDH_I-IDH_I)/ma(4,PCC)) + iro_l2*(RHYP10-ma(4,grt(4,PCC))) + iro_l3*(t>2005Q4)*(t<=2007Q4)		
	Estimation period:	1996Q4 – 2012Q4		
	Coefficient values:	iro_l0: 3.91	iro_l1: 0.44	iro_l2: -0.02
		iro_l3: 0.11		
	Tests:	R² adj: 0.66	ADF: -1.68	
Dynamic equation	dln(IRO) =	iro1*dln(IRO)[-1] + iro_e*(ln(IRO)-ln(IRO_L))[-1]		
	Estimation period:	1997Q1 – 2012Q4		
	Coeff. values (t-stat):	iro1: 0.725 (8.8)	iro_e: -0.071 (-2.4)	
	Tests:	R² adj: 0.55	DW: 1.72	LM(1): 1.21

Graph 2 Housing investment: observed and fitted values



Source: NAI, FPB

The elasticities or semi-elasticities for housing investment are summarized in Table 4. A permanent increase of 1% in disposable income (net of property income) will gradually push up housing investment to 0.38% after two years. A one percentage point increase in the mortgage interest rate will contract housing investment by 1.70% over the same period. A 1% higher general consumer price level implies a *temporary* lower real mortgage interest rate[12] as well as a *permanently* lower real disposable income. The interest rate effect is dominant in the short run, so that housing investment increases by 0.77% after two years, but subsequently only the negative purchasing power effect remains.

It should be noted that the combination of a weak error correction mechanism and a strong autoregressive process implies a high degree of "stickiness" of the growth rate of housing investment. This implies not only a slow adjustment towards the long-term values denoted in the table, but also a temporary overshooting of these values in the medium term.

Table 4 Elasticities or semi-elasticities for housing investment

	Q1	Q2	Q3	Y1	Y2	Y5	LT
Disposable income (excluding property income) (+1%)	0.00	0.03	0.08	0.14	0.38	0.45	0.43
Deflator of private consumption (+1%)	0.00	0.03	0.10	0.23	0.77	-0.57	-0.43
Long-term mortgage interest rate (+1 pp)	0.00	-0.14	-0.37	-0.65	-1.70	-2.01	-1.95
Results obtained with the 2003 version of the model							
Disposable income (+1%)	0.24	0.51	0.75	0.92	1.02	0.90	0.90
Deflator of private consumption (+1%)	-0.24	-0.34	-0.34	-0.30	-0.19	-0.72	-0.76
Deflator of housing investment (+1%)	0.00	-0.03	-0.06	-0.10	-0.16	-0.13	-0.13
Long-term interest rate (+1 pp)	0.00	-0.56	-1.32	-2.05	-3.06	-2.36	-2.38

The income elasticity appears to be considerably smaller than in the 2003 version of the model. This made the old version much more sensitive to purchasing power effects and, thus, also to consumer price shocks.

2.2.3. Business investment

In the 2003 version, business investment was derived from a capital stock equation based on a Cobb-Douglas production function. As such a functional form implies strong assumptions, we decided to drop this approach and to estimate directly a behavioural equation, in levels, for business investment. This specification supposes that business investment adjusts with an elasticity equal to one to private value added, implying a stable investment to value added ratio in the long run. It also assumes a direct influence by the real long-term interest rate, neglecting the other components of the cost of capital which are difficult to measure.

This specification generates residuals that are reasonably stable as shown by the ADF-statistic. Homogeneity vis-à-vis value added is well accepted by the data as tested in Annex 1. Like in other model equations, the impact of inflation (here on the real interest rate) has been smoothed using a four-quarter moving average. Next to the error correction mechanism, only value added appears in the

[12] Such a price level shift has an impact on inflation only during 4 quarters, but in this case the real mortgage rate will be affected during 8 quarters due to the moving average specification.

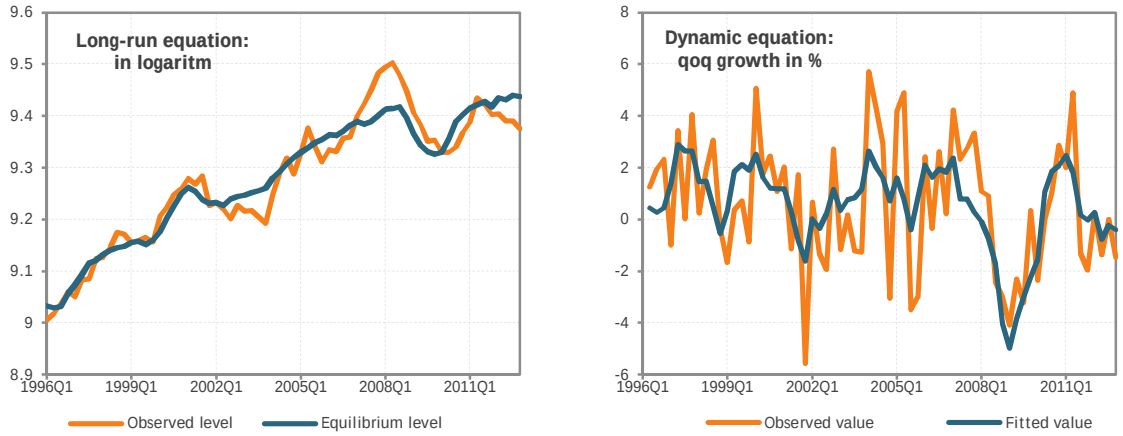
dynamic equation as an explanatory variable, both contemporaneously[13] and as a one-period lagged moving average. The latter captures the impact on investment growth of past value added growth rates. The spread between the interest rates paid by firms on bank loans and on government bond yields appeared not to be significant. The residual diagnostic tests show no sign of autocorrelation.

Table 5 Estimation results for business investment

Long-term equation	ln(IQO1_L) := iqo1_l0 + ln(QVOF) + iqo1_l1*(RLBE-ma(4, grt(4, PCC)))			
	Estimation period:	1996Q1 – 2012Q4		
	Coefficient values:	iqo1_l0 : -1.70	iqo1_l1 : -0.02	
	Tests:	R² adj: 0.92	ADF: -2.52	
Dynamic equation	dln(IQO1) := iqo10 + iqo11*dln(QVOF) + iqo12*dln(ma(4, QVOF))[-1] + iqo1_e*(ln(IQO1) -ln(IQO1_L))[-1]			
	Estimation period:	1996Q2 – 2012Q4		
	Coeff. values (t-stat):	iqo10 : -0.008 (-2.3)	iqo11 : 1.101 (3.1)	iqo12: 1.864 (3.8)
		iqo1_e: -0.223 (-3.1)		
	Tests:	R² adj: 0.40	DW: 2.14	LM(1): 0.52

The fitted values for the level equation (see the left-hand panel of Graph 3) indicate that there was an unsustainable increase in investment prior to the outburst of the financial crisis while they do not yet confirm the most recent slack. As shown in the right-hand panel, the dynamic equation is only able to pick up part of the extreme quarter-on quarter volatility displayed by the data although the recent downturns and upswing are well captured.

Graph 3 Business investment: observed and fitted values



Source: NAI, FPB

A permanent shock of 1% on value added illustrates the so-called accelerator effect by generating an increase in investment of over 2% after one year before returning progressively to its long-term impact. The effect of a long term interest rate increase of 100 basis points is activated gradually through the error correction mechanism. After two years most of the adjustment has taken place with a decrease in investment of about 1.6%.

[13] To account for a possible bias in the coefficient of value added due to endogeneity, estimation with instrumental variables was also performed but results appeared not to be significantly different from those obtained with ordinary least squares.

Table 6 Elasticities or semi-elasticities for business investment

	Q1	Q2	Q3	Y1	Y2	Y5	LT
Value added private sector (+1%)	1.10	1.55	1.90	2.17	1.64	1.03	1.00
Long-term interest rate (+100 bp)	0.00	-0.42	-0.75	-1.00	-1.56	-1.86	-1.87
Results obtained with the 2003 version of the model							
Value added private sector (+1%)	1.44	1.09	1.21	1.20	1.26	1.30	1
Cost of capital (+1%)	0.00	-0.17	-0.28	-0.40	-0.74	-1.22	-0.99
Long-term interest rate (+100 bp) (*)	0.00	-0.03	-0.06	-0.08	-0.15	-0.24	-0.19
Business investment deflator (1%)	0.00	-0.14	-0.22	-0.31	-0.59	-0.96	-0.78
Profitability (+1%)	0.00	0.02	0.03	0.05	0.09	0.14	0.11

(*) Because the interest rate appears in logarithm in the equation, the semi-elasticity will vary according to the initial level of the interest rate.

In the 2003 version of the model, the accelerator effect was instantaneous but remained below 1.5. The cost of capital had a slowly increasing effect in the medium-run before returning to its long-term impact constrained by assumption to minus one. The decomposition of the cost of capital into its main determinants[14] shows, in particular, that the latest vintage of the investment equation is more sensitive to changes in the interest rate. Profitability, which has now disappeared from the equation, only played a minor role in determining investment in the 2003 version.[15]

2.2.4. Changes in inventories

Inventories represent a stock of goods at a specific point in time, whereas GDP is a flow variable, representing economic activity over a period of time. This means that inventory changes contribute to the level of GDP (and that the change in the rate of change in inventories matters for GDP growth). The contribution of inventories to GDP growth has, on average, been close to zero during the sample period, although this average can deviate from zero over consecutive years.

We usually assume that changes in inventories are neutral to economic growth in the forecasting period, but they are determined by a behavioural equation if the model is used for scenario analyses. To deal with the difficulty to interpret changes in inventories expressed in chain-linked volumes, the left-hand side of the equation is modelled as the ratio (in logarithm) of GDP to GDP excluding changes in inventories.

This ratio exhibits strong inertia, modelled as a first-order autoregressive process, and is further explained by changes (in logarithm) in final demand (excluding changes in inventories) lagged one period to avoid purely accounting effects. Because the first difference of this ratio represents approximately the contribution of changes in inventories to GDP growth, the specification ensures that in the steady state this contribution returns to zero.

14 The impact of the depreciation rate is not shown in the table.

15 As variations in profitability are mainly business cycle related, most of the effect of profitability on business investment is likely to be captured by private sector value added.

Table 7 Estimation results for changes in inventories

Dynamic equation	ln(YO/(YO-SO)) := so1*ln(YO/(YO-SO))[-1] + so2*dln(YO + MO-SO)[-1] + so3*(t= 2001Q3) + so4*(t= 2011Q3)			
	Estimation period:	1996Q1 – 2012Q4		
	Coeff. values (t-stat):	so1: 0.804 (18.36)	so2: 0.161 (4.8)	so3: -0.010 (-3.1)
		so4: 0.009 (2.7)		
	Tests:	R^2 adj: 0.76	DW: 1.92	LM(1): 0.00

2.2.5. Exports of goods and services

The indicator of Belgian potential export markets, defined as the weighted average of its trading partners' imports[16], is the main determinant of exports both in the short and in the long-term equation. The second factor determining exports is a competitiveness indicator, here represented by Belgian export prices (excluding energy) relative to a weighted average of export prices of Belgium's competitors (both expressed in euro). A rise of this indicator, which is strongly influenced by exchange rate movements, implies a worsening of competitiveness.

We also tested two alternative competitiveness measures, i.e. the real effective exchange rate based on relative unit labour costs[17] and a double weighted price indicator[18], but neither of them improved the explanatory power of the equation.

The long-term specification finally withheld is close to the one included in the 2003 version of the model[19] except that we now have omitted the trend which accounted for the systematic loss in export market share since the end of the 1990s. Consequently, the elasticity of potential export markets (0.70) is now smaller than in the 2003 version (0.89) of the model and an elasticity equal to unity is statistically rejected.. This implies that, in contrast to the previous specification with a trend, the loss in market share has become proportional to the growth in world trade. The (absolute value of the) coefficient of competitiveness has been revised down. This is altogether not that surprising as a period of strong volatility of the exchange rate has now been left out of the estimation period.[20]

The ADF test statistic exceeds its critical value (at the 5% significance level), so that the null hypothesis that the residuals contain a unit root is rejected.

16 The weighting scheme (coming from the IMF Direction of Trade Statistics database) varies from year to year to take into account the geographical composition of Belgian exports. The import growth rates come from the AMECO database of the EC.

17 The exporting country's unit labour costs are related to a weighted average of its competitors' unit labour costs expressed in a common currency.

18 Double weights are used to account for the so-called "third-market effects", i.e. to capture the competition faced in foreign markets from both domestic producers and exporters from third countries.

19 A breakdown of the equation into a goods and services component was tested in De Ketelbutter et al. (2007), but this did not improve forecasts.

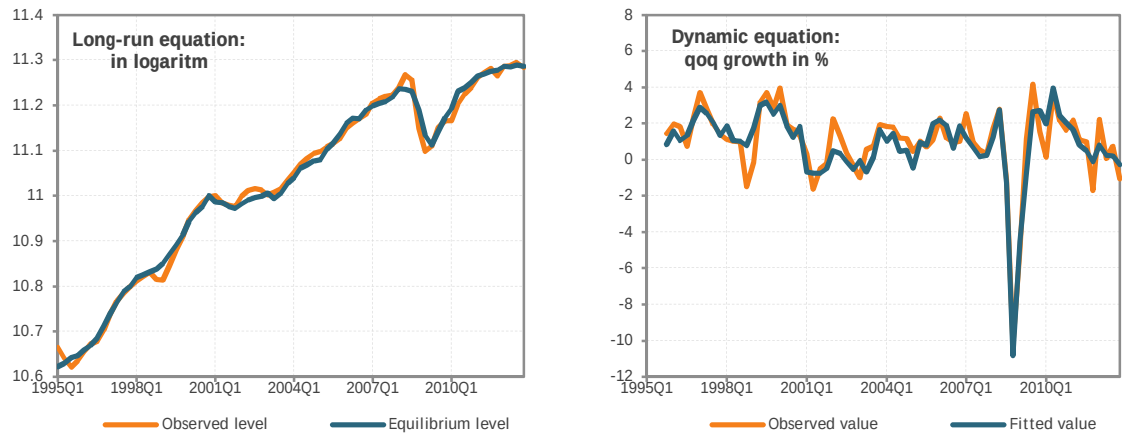
20 This encompassed the devaluation of the Belgian franc in 1982, the strong depreciation of the dollar in 1986-1987 and the depreciation of the Belgian franc in the ERM crisis of 1993.

Table 8 Estimation results for exports

Long-term equation	ln(XO_L) =	xo_l0 + xo_l1*ln(QWXSS) + xo_l2*(PX_EXE/PWXSS*EX)		
	Estimation period:	1995Q1 – 2012Q4		
	Coefficient values:	xo_l0: 9.53	xo_l1: 0.70	xo_l2: -0.32
	Tests:	R^2 adj: 0.99	ADF: -5.59	
Dynamic equation	dln(XO) =	xo1*dln(XO)[-1] + xo2*dln(QWXSS) + xo3*dln(PX_EXE/PWXSS*EX) + xo4*(t=2008Q2) + xo5*(t=2008Q4) + xo_e*(ln(XO)-ln(XO_L))[-1]		
	Estimation period:	1995Q2 – 2012Q4		
	Coeff. values (t-stat):	xo1: 0.161 (2.2)	xo2: 0.554 (7.9)	xo3: -0.155 (-2.0)
		xo4: 0.027 (3.1)	xo5: -0.065 (-7.1)	xo_e: -0.430 (-5.3)
	Tests:	R^2 adj: 0.83	DW: 1.75	LM(1): 0.36

The short-term equation takes into account lagged export growth, potential export market growth, competitiveness and the error correction term. Two dummy variables were added. The low level of the LM-test points to the absence of first order auto-correlation in the residuals.

Graph 4 Exports: observed and fitted values



Source: NAI, FPB

The impact on exports of a normalized shock regarding each explanatory variable is summarized in Table 9. A permanent increase of 1% of potential export markets translates progressively into a rise of exports of 0.70%, with the full impact being reached after two quarters. This fast adjustment towards the long-term values reflects the high value of the coefficient of the error correction mechanism which is amplified by the autoregressive term.

The effect of a deterioration of 1% in Belgian competitiveness is relatively moderate, translating into a decline of about 0.30% in exports. Most of the impact of this shock is transmitted after three quarters. In the 2003 version the adjustment was milder the first year but became stronger afterwards.

Table 9 Elasticities for exports

	Q1	Q2	Q3	Y1	Y2	Y5	LT
Potential export markets (+1%)	0.55	0.70	0.72	0.72	0.70	0.70	0.70
Price competitiveness (+1%)	-0.15	-0.25	-0.29	-0.30	-0.31	-0.31	-0.31
Results obtained with the 2003 version of the model							
Potential export markets (+1%)	0.46	0.89	0.89	0.89	0.89	0.89	0.89
Price competitiveness (+1%)	0.00	-0.14	-0.23	-0.29	-0.39	-0.42	-0.42

2.2.6. Imports of goods and services

Imports have an evolution that is very similar to re-weighted final demand, where the weights depend on the import content of the expenditure components.[21] This import content is quite high for exports and gross capital formation, less important for private consumption and low for public consumption. Hence, a dynamic equation has been estimated based on these "theoretical" imports, without an error correction mechanism.

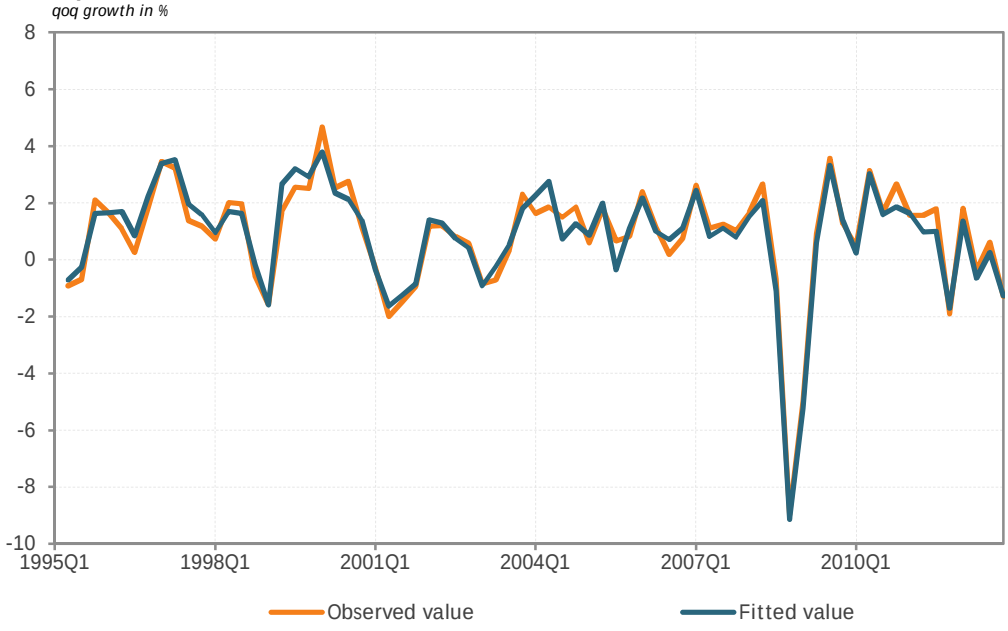
Table 10 Estimation results for imports

Dynamic equation	dln(MO) := mo0 + mo1*(t= 1999Q1) + mo2*dln(QMOAB)			
	Estimation period:	1995Q2 – 2012Q4		
	Coeff. values (t-stat):	mo0: -0.002 (-3.3)	mo1: -0.018 (-4.1)	mo2: 1.253 (37.3)
	Tests:	R^2 adj: 0.95	DW: 1.71	LM(1): 1.50

Previous versions of this equation also included relative prices and a lagged endogenous variable, but these are now found to be insignificant. Graph 6 shows that the new import equation performs well, even during the recession of 2008-2009.

Graph 5 Imports: observed and fitted values

qoq growth in %



Source: NAI, FPB

The impact on imports of a normalized shock on final demand is summarized in Table 11. The obtained elasticities are not very different from the 2003 version. A permanent increase of 1% of private consumption immediately translates in a 0.27% rise of imports. The same goes for gross fixed capital formation, albeit that the increase remains limited to 0.14%. A 1% increase in exports has the largest effect as it boosts imports by 0.80%.

[21] These import contents have been calculated on the basis of input-output information for 1995, 2000, 2005 and 2010. Linear interpolation has been used to get values in between the data points. As regards the period after 2010, import contents are kept constant at their 2010 level, so that theoretical imports (QMOAB) equal 0.336 * private consumption + 0.111 * government consumption + 0.427 * (gross fixed capital formation + inventory changes) + 0.606 * exports during the forecast period.

Table 11 Elasticities for imports

	Q1	Q2	Q3	Y1	Y2	Y5	LT
Private consumption (+1%)	0.27	0.27	0.27	0.27	0.27	0.27	0.27
GFCF and stocks (+1%)	0.14	0.14	0.14	0.14	0.14	0.14	0.14
Exports (+1%)	0.80	0.80	0.80	0.80	0.80	0.80	0.80
Results obtained with the 2003 version of the model							
Private consumption (+1%)	0.25	0.22	0.22	0.22	0.22	0.22	0.22
GFCF (excl. housing) and stocks (+1%)	0.18	0.15	0.16	0.16	0.16	0.16	0.16
Housing investment (+1%)	0.06	0.05	0.06	0.06	0.06	0.06	0.06
Exports (+1%)	0.86	0.75	0.77	0.76	0.76	0.76	0.76
Relative prices (+1%)	-0.11	-0.10	-0.10	-0.10	-0.10	-0.10	-0.10

2.3. Main deflators

2.3.1. Implicit deflator of private value added

The deflator of private value added is the domestic price anchor in the model. It serves in other equations as a measure for domestic costs. As the evolution of the production factors in the model is - in contrast to the 2003 version of the model - not determined anymore by an explicit production function (see Section 2.2.3 and 2.4.2), it is neither the case for the deflator of private value added.

In the long run, the deflator of private value added is a function of a weighted average of capital and unit labour costs in the enterprise sector, and the development of the capacity utilisation rate.[22] It may come as a surprise that the latter explanatory variable, which is business-cycle related, appears in the long-term equation. However, it takes some time before business cycle developments translate into up- or downward pressure on domestic prices, making it difficult to take these mechanisms into account in the dynamic equation. A gradual pass-through via the error correction mechanism is justifiable from that point of view. The cost of capital is a function of the real long-term interest rate, the deflator of business investment and the depreciation rate of the capital stock. Downward pressure of total factor productivity growth on prices was tested by introducing a trend in the long-term equation, but that did not improve the explanatory power of the equation.[23] Finally, the mark-up, which is captured by the constant, seems to increase over time as is indicated by the dummy that raises the constant from 2002Q4 onwards.

The results reported for the ADF test in Table 12 show that the presence of a unit root in the residuals of the long-term equation can be rejected. Static homogeneity was imposed after being well-accepted by a Wald test (see Annex 1).

[22] Note that the level of the capacity utilisation rate was adjusted by subtracting its long run average to assure that it is equal to zero in the steady state.

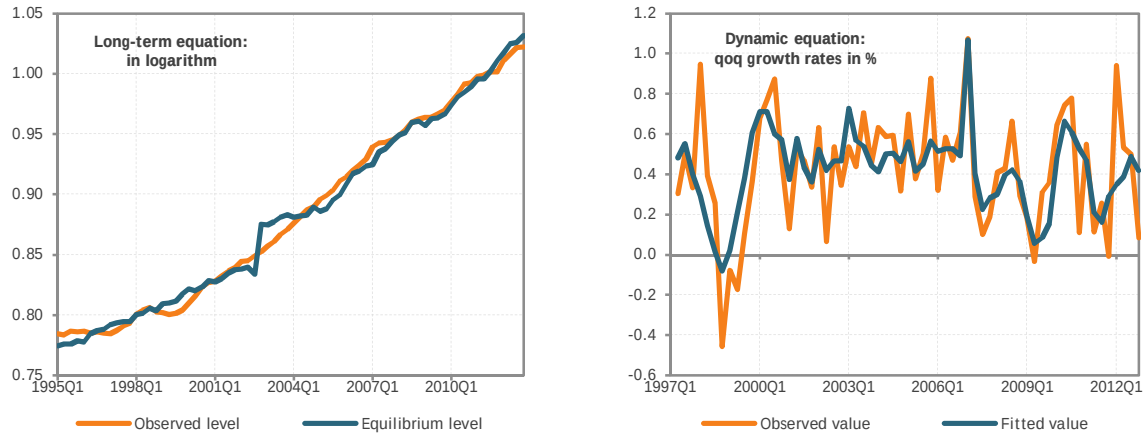
[23] This is probably due to the fact that labour productivity is already taken into account through the use of unit labour costs in the equation.

Table 12 Estimation results for the implicit deflator of private value added

Long-term equation	ln(PQVFZ_L) :=	pqvfz_l0 + pqvfz_l1*ln(WBFF/QVOFF) + (1-pqvfz_l1) *ln(CK_ HP) + pqvfz_l2*ZKF + pqvfz_l01*(t>2002Q3)		
	Estimation period:	1995Q1 – 2012Q4		
	Coefficient values:	pqvfz_l0: 0.135	pqvfz_l1: 0.410	pqvfz_l2: 0.212
		pqvfz_l01: 0.049		
	Tests:	R² adj: 0.99	ADF: -3.71	
Dynamic equation	dln(PQVFZ) :=	pqvfz0 + pqvfz1*dln(ma(6,WBFF/QVOFF))[-4] + pqvfz2*dln(ma(4,PWMSS*EX)) + pqvfz_e*(ln(PQVFZ)-ln(PQVFZ_L))[-1] + pqvfz01*(t=2007Q1) + pqvfz02*(t>2001Q1)*(t<2007Q3)		
	Estimation period:	1997Q2 – 2012Q4		
	Coeff. values (t-stat):	pqvfz0: 0.002 (3.5)	pqvfz1: 0.192 (2.6)	pqvfz2: 0.145 (5.2)
		pqvfz_e: -0.083 (-2.6)	pqvfz01: 0.006 (2.6)	pqvfz02: 0.003 (4.6)
	Tests:	R² adj: 0.42	DW: 1.87	LM(1): 0.11

Short-run fluctuations are determined by unit labour costs and international prices. Both variables appear in the dynamic equation as a (lagged) moving average, indicating that they only feed into prices very gradually. This price rigidity implies that profit margins fall in the short run in case of an increase in production factor costs, while the inverse is true when production factor costs decrease. The dynamic equation also contains a constant that captures the part of the price increases that is not explained by unit labour costs and foreign prices. These unexplained price increases were higher during the period 2001Q2-2007Q2, as is indicated by the second dummy. All coefficients in the dynamic equation are significantly different from zero at the 5%-level, while the Durbin-Watson and the LM statistic confirm the absence of serial correlation in the residuals of the equation.

Graph 6 Implicit private value added deflator: observed and fitted values



Source: NAI, FPB

The left-hand panel of Graph 6 shows that observations for the implicit deflator of value added fluctuate around the simulated values of the long-term equation, indicating stationary residuals. The shock in the simulated values in 2002Q4 is due to the dummy in the long-term equation. The right-hand panel shows that an important part of the short-term fluctuations remains unexplained, but that the main cycles in the growth rates of the deflator are well reproduced by the equation.

Table 13 Elasticities or semi-elasticities for the implicit deflator of private value added

	Q1	Q2	Q3	Y1	Y2	Y5	LT
Nominal unit labour cost (+1%)	0.00	0.03	0.06	0.09	0.30	0.40	0.41
Cost of capital (+1%)	0.00	0.05	0.09	0.13	0.27	0.48	0.59
Capacity utilisation rate (+1 pp)	0.00	0.02	0.03	0.05	0.10	0.17	0.21
World import price (+1%)	0.04	0.07	0.10	0.13	0.09	0.03	0.00
Results obtained with the 2003 version of the model							
Nominal hourly wage (+1%)	0.07	0.10	0.14	0.17	0.28	0.48	0.68
Cost of capital (+1%)	0.00	0.02	0.04	0.05	0.11	0.22	0.32
Trend total factor productivity (+1%)	0.00	-0.06	-0.11	-0.17	-0.34	-0.68	-0.99
World import price (+1%)	0.03	0.03	0.02	0.06	0.04	0.02	0.00
Output gap (+1 pp)	0.00	0.00	0.00	0.00	0.13	0.06	0.00

The reaction of the implicit deflator of value added to a normalised shock on its determinants is summarised in Table 13. The most striking feature of the equations is that the deflator of value added reacts very slowly to increases in costs (cost push inflation) or demand (demand pull inflation). After four quarters, only around 25% of the long-term effect of the determinants is visible in the deflator. These sluggish reactions of prices were also seen in the 2003 version of the model. The elasticities of capital and labour costs differ strongly from the 2003 version of the model. Back then, these elasticities were provided by the Cobb-Douglas production function, while they are now freely estimated.

2.3.2. Export and import prices

In order to distinguish different transmission mechanisms in the model for external price shocks that are caused by energy prices and those triggered by non-energy price fluctuations, Belgian exports and imports were split up in an energy and a non-energy component. As these components are not available in the quarterly national accounts, the disaggregation was done on the basis of foreign trade statistics.

As Belgian non-energy import and export prices exhibit an upward trend on the whole sample, while their international counterparts show no trend till 2007, we decided to split up the sample for non-energy prices into two sub-periods for the estimation of the long-term equation. Belgian non-energy prices evolve more in line with international prices in the second sub-period (2008Q1-2012Q4), which is more likely for a small open economy, so we shall use these coefficients' values for simulations.

a. Non-energy export prices

In the long run, Belgian exporting firms are supposed to set prices as a weighted average of international export prices excl. energy in euro and (the long-term value of) domestic value added prices. The coefficient of the latter variable reflects these firms' degree of price-makership (0.5 for the period starting from 2008Q1). It should be noted that static homogeneity has been imposed and that the ADF test statistic allows us to reject the hypothesis of non-stationary residuals.

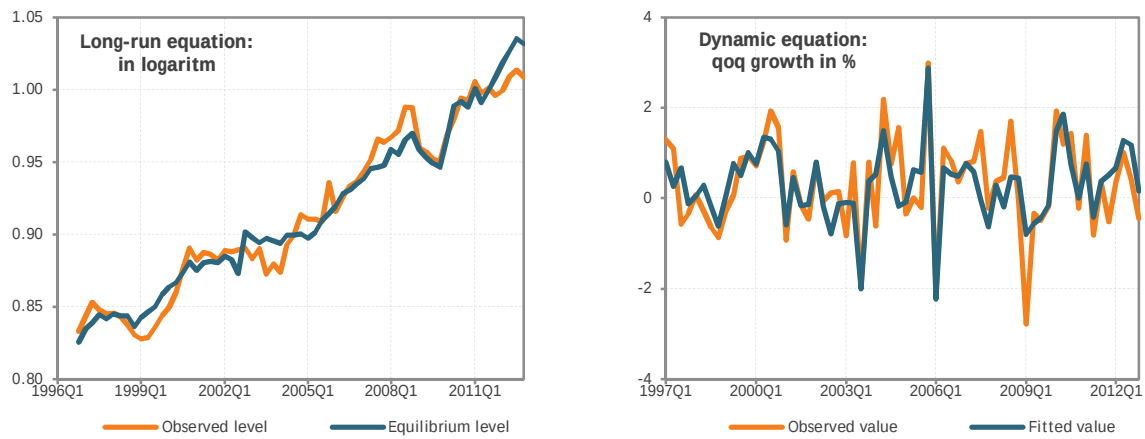
Table 14 Estimation results for the export price deflator excluding energy

Long-term equation	ln(PX_EXE_L) :=	px_exe_l0*(t<2008Q1) + px_exe_l1*ln(PWXAS*EX) *(t<2008Q1) + (1-px_exe_l1) *ln(PQVFZ_L) *(t<2008Q1) + px_exe_l0b*(t>= 2008Q1) + px_exe_l1b*ln(PWXAS*EX) *(t>= 2008Q1) + (1-px_exe_l1b) *ln(PQVFZ_L) *(t>= 2008Q1)		
	Estimation period:	1996Q4 – 2012Q4		
	Coefficient values:	px_exe_l0: -1.055	px_exe_l1: 0.299	px_exe_l0b: -1.762
		px_exe_l1b: 0.500		
	Tests:	R² adj: 0.96	ADF: -3.08	
Dynamic equation	dln(PX_EXE) :=	dln(PX_EXE) := px_exe1*dln(PWXAS*EX) + px_exe2*dln(PQVFZ)[-1] + px_exe_e*(ln(PX_EXE) -ln(PX_EXE_L))[-1] + px_exe01*(t= 2003Q3) + px_exe02*(t= 2005Q4) - px_exe02*(t= 2006Q1)		
	Estimation period:	1997Q1 – 2012Q4		
	Coeff. values (t-stat):	px_exe1: 0.380 (6.5)	px_exe2: 0.686 (4.1)	px_exe_e: -0.146 (-2.1)
		px_exe02: -0.024 (-3.6)	px_exe01: 0.023 (4.8)	
	Tests:	R² adj: 0.58	DW: 1.91	LM(1): 0.09

The dynamic equation contains the same explanatory variables as the long-term equation. All estimated coefficients in the dynamic equation are significantly different from zero at the 5%-level. The Durbin-Watson and the LM-test statistics indicate the absence of serial correlation.

The left-hand panel of Graph 7 shows that non-energy export prices can be above or below their equilibrium level for quite some time. The right-hand panel illustrates that the dynamic equation captures the development of export prices relatively well, which is confirmed by an adjusted R-squared of 58%.

Graph 7 Export price deflator excluding energy: observed and fitted values



Source: NAI, FPB

When comparing the behaviour of these equations to their 2003 version (see Table 15), it should be noted, on the one hand, that the latter were not split up into an energy and a non-energy component. Consequently, it should not come as a surprise that total export prices in the 2003 model reacted a little stronger to world export prices as the price of energy products depends on quotations on international markets, where the development of prices inside Belgium is of no importance. On the other hand, the deflator of private value added was not included in the dynamic equation of the 2003 version, whereas it has now a prominent role which even leads to an overshooting in the first years of the simulation.

Table 15 Elasticities for the export price deflator excluding energy

	Q1	Q2	Q3	Y1	Y2	Y5	LT
World export price excluding energy (+1%)	0.38	0.40	0.41	0.42	0.46	0.49	0.50
Deflator of private value added (+1%)	0.00	0.76	0.72	0.69	0.60	0.51	0.50
Results obtained with the 2003 version of the model (deflator of total exports)							
World export prices (+1%)	0.37	0.47	0.50	0.52	0.55	0.56	0.56
Deflator of private value added (+1%)	0.00	0.11	0.20	0.27	0.40	0.44	0.44

b. Non-energy import prices

Non-energy import prices are also a function of international prices (in euro) and (the long-term value of) domestic prices. The coefficient of domestic prices (0.19 for the period starting from 2008Q1) indicates that "pricing to the market" by foreign firms[24] is low when they export to Belgium. Static homogeneity has been imposed and the ADF-test statistic indicates that the residuals of the equation are stationary.

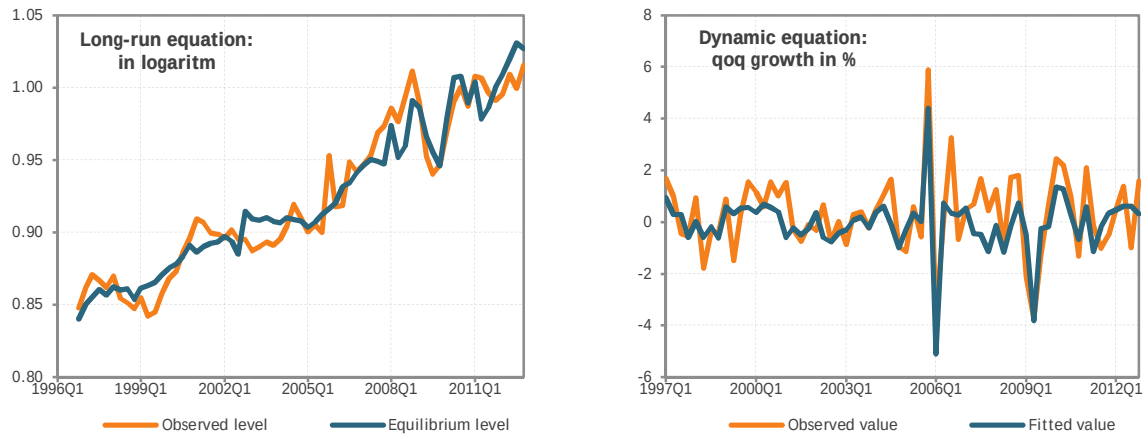
Table 16 Estimation results for the import price deflator excluding energy

Long-term equation	ln(PM_EXE_L) :=	pm_exe_l0*(t<2008Q1) + pm_exe_l1*ln(PWMAS*EX) *(t<2008Q1) + (1-pm_exe_l1) *ln(PQVFZ_L) *(t<2008Q1) + pm_exe_l0b*(t>= 2008Q1) + m_exe_l1b*ln(PWMAS*EX) *(t>= 2008Q1) + (1-pm_exe_l1b) *ln(PQVFZ_L) *(t>= 2008Q1)		
	Estimation period:	1996Q4 – 2012Q4		
	Coefficient values:	pm_exe_l0: -0.954	pm_exe_l1: 0.278	pm_exe_l0b: -2.769
		pm_exe_l1b: 0.810		
	Tests:	R² adj: 0.92	ADF: -4.23	
Dynamic equation	dln(PM_EXE) :=	pm_exe1*dln(PWMAS*EX) + pm_exe_e*(ln(PM_EXE) - ln(PM_EXE_L))[-1] + pm_exe01*(t= 2005Q4) - pm_exe01*(t= 2006Q1) + pm_exe02*(t= 2009Q2)		
	Estimation period:	1997Q1 – 2012Q4		
	Coeff. values (t-stat):	pm_exe1: 0.336 (4.1)	pm_exe_e: -0.167 (-1.8)	pm_exe01: 0.041 (5.2)
		pm_exe02: -0.029 (-2.7)		
	Tests:	R² adj: 0.51	DW: 1.88	LM(1): 0.00

The dynamic equation does not include the domestic value added price, which was found to be insignificant. The tests point out that the residuals in the dynamic equation do not exhibit serial correlation. The right hand panel in Graph 8 shows that the short-run volatility is captured quite well by the equation, resulting in a reasonable adjusted R-squared value of 51%.

[24] This strategy implies that import prices are not only a function of foreign prices (in euro) but also of (the long-term value of) domestic value added prices. In other words, it measures the extent to which domestic price changes in the destination market lead exporters to adjust their prices.

Graph 8 Import price deflator excluding energy: observed and fitted values



Source: NAI, FPB

The deviation of observations from the simulated values of the long-term equations (left hand panel of Graph 8) can be quite large. The elasticities in Table 17 show that import prices are mainly determined by international non-energy prices, as in the 2003 version of the model.

Table 17 Elasticities for the import price deflator excluding energy

	Q1	Q2	Q3	Y1	Y2	Y5	LT
World import prices excluding energy (+1%)	0.33	0.41	0.48	0.53	0.68	0.79	0.81
Deflator of private value added (+1%)	0.00	0.03	0.06	0.08	0.14	0.18	0.19
Results obtained with the 2003 version of the model (deflator of total imports)							
World import prices (+1%)	0.35	0.56	0.69	0.76	0.84	0.85	0.85
Deflator of private value added (+1%)	0.00	0.04	0.08	0.11	0.14	0.15	0.15
Oil price (+1%)	0.04	0.04	0.02	0.02	0.00	0.00	0.00

c. Import and export prices of energy products

Although the volume of energy products that is imported in Belgium is much bigger than the volume that is exported, the structure of energy imports and exports is very similar. Foreign trade statistics show that oil products account for around 75% of exports and imports, while gas represents around 20% and the remaining part consists of electricity and coal.

Import and export prices of energy products are both modelled as an error correction mechanism that is fully determined by the development of oil prices expressed in euro. All estimated equations exhibit high R-squares and satisfy all statistical tests that were performed (not reported here). Their properties are discussed on the basis of the elasticities provided in Table 18.

Table 18 Elasticities for import and export prices of energy products

	Q1	Q2	Q3	Y1	Y2	Y5	LT
Import prices of energy products							
Brent oil price in euro (+1%)	0.56	0.75	0.77	0.78	0.79	0.79	0.79
Export prices of energy products							
Brent oil price in euro (+1%)	0.44	0.65	0.67	0.68	0.70	0.70	0.70

Import prices react stronger to oil prices than export prices of energy products, implying that an increase in the oil price will lead to a worsening in Belgian terms of trade. Short run as well as long run elasticities are around 0.1 higher for the deflator of energy imports. Moreover, Belgium is a net-importer of energy products, which reinforces the effect of energy prices on terms of trade. The adjustment to an oil price shock is quite fast, with more than 90% of the long-term impact being achieved after two quarters. Long-term elasticities of both deflators are smaller than one[25], which is mainly explained by the fact that energy exports and imports do not consist of oil products only. The prices of these other products are not necessarily fully indexed on oil prices. Moreover, part of the oil products consist of refined products of which the mark-up over crude oil prices is rather a fixed amount than a fixed share of the price.

2.3.3. Consumer prices

Due to the automatic indexation of wages and social benefits in Belgium, forecasts for consumer prices are of particular interest. The indexation coefficients are calculated on the basis of the development of a modified version of the Belgian national consumer price index, i.e. the so-called "health index".[26] As the national consumer price index and the deflator of private consumption are highly correlated, yoy growth rates of the former are used to forecast the latter in the model. To model the national consumer price index, it is split up into an underlying price index and several groups of excluded products. Prices of excluded products are simulated by means of ad hoc equations in which they can be linked to oil prices, excises, underlying inflation etc.

To calculate underlying inflation, the national consumer price index is corrected for changes in VAT-rates and price developments in product groups characterised by volatile prices (fuels for vehicles, energy products for heating and lighting, fresh vegetables and fruit, meat products) and product groups of which the price depends heavily on changes in taxes or levies (alcoholic beverages, tobacco products, circulation tax on vehicles and water consumption).

In the long run, underlying inflation adjusts to the long-term value of domestic prices and to import prices. Although static homogeneity is not accepted by statistical tests (see Annex 1), it is imposed to preserve the long-term theoretical properties of the model. The long-term elasticities of domestic and import prices are not estimated, but calculated by means of the Belgian input-output tables for the year 2010. This does not jeopardise the essential properties of the equation, which still delivers stationary residuals as shown by the ADF test statistic.

[25] A Wald test clearly rejects the hypothesis that the coefficient of oil prices in the long-term equations of import and export prices of energy products is equal to one (see Annex 1).

[26] The health index is obtained by correcting the national consumer price index for the price development of motor fuels, alcoholic beverages and tobacco products.

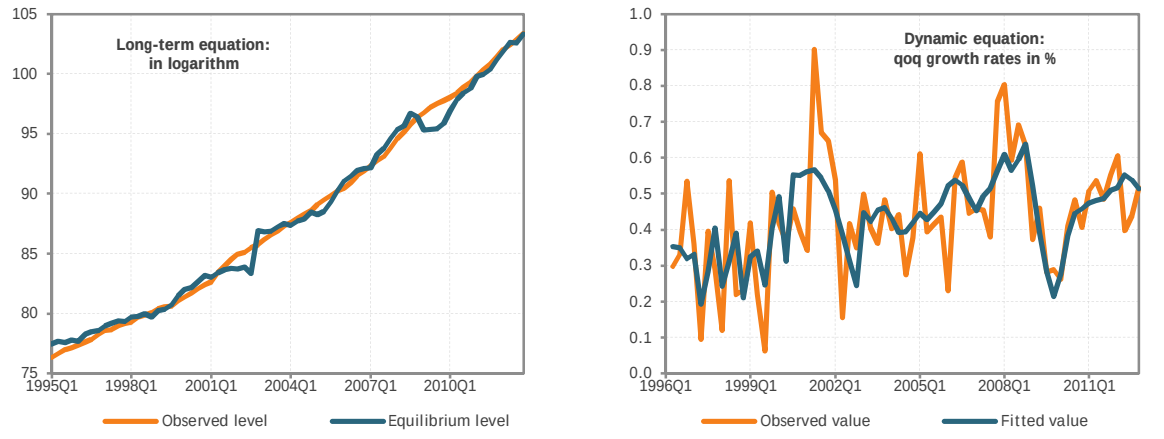
Table 19 Estimation results for underlying inflation

Long-term equation	ln(PCUI_L) := pcui_l0 + pcui_l1*ln(PQVFZ_L) + (1-pcui_l1)*ln(PM)			
	Estimation period:	1995Q1 – 2012Q4		
	Coefficient values:	pcui_l0: 4.608	pcui_l1: 0.862	
	Tests:	R² adj: 0.99	ADF: -3.75	
Dynamic equation	dln(PCUI) := pcui0 + pcui1*dln(PCUI)[-2]*(t<2000Q3) + pcui2*dln(ma(4,(WBFF/QVOFF))) + pcui3*dln(ma(4,PM)) + pcui_e*(ln(PCUI)-ln(PCUI_L))[-1]			
	Estimation period:	1996Q1 – 2012Q4		
	Coeff. values (t-stat):	pcui0: 0.004 (16.2)	pcui1: -0.473 (-4.3)	pcui2: 0.096 (3.0)
		pcui3: 0.036 (2.2)	pcui_e: -0.050 (-2.3)	
	Tests:	R² adj: 0.42	DW: 2.15	LM(1): 0.43

In the short run, underlying inflation depends on the evolution of unit labour costs and import prices. As underlying inflation is not influenced by the most volatile price components of consumer prices, it reacts very gradually to its determinants, which is captured by the use of four-quarter moving averages in the dynamic equation. The LM test statistic shows that the absence of serial correlation in the residuals cannot be rejected.

As shown in the right hand panel of Graph 9 the most important accelerations and decelerations in underlying inflation are well reproduced by the equation, although much of the short-run volatility is not explained. Changes in underlying inflation from one quarter to another are more erratic up to 2000 than later on. This is taken into account in the dynamic equation by a second-order autoregressive process.

Graph 9 Underlying inflation: observed and fitted values



Source: NAI, FPB

The long-term elasticities of underlying inflation with respect to its determinants are close to the (estimated) elasticities of the model of 2003. Underlying inflation largely depends on the deflator of private value added. Due to the small value of the error correction coefficient in the dynamic equation, this adjustment is very slow, with only around one fourth of the long-term impact being reached after two years. The impact of a change in unit labour costs is temporary as it only shows up in the dynamic equation. When using the full model, however, a change in unit labour costs will feed into the deflator of private value added.

Table 20 Elasticities for underlying inflation

	Q1	Q2	Q3	Y1	Y2	Y5	LT
Deflator of private value added (+1%)	0.00	0.04	0.08	0.12	0.26	0.53	0.86
Deflator of imports (+1%)	0.01	0.02	0.04	0.05	0.07	0.10	0.14
Nominal unit labour cost (+1%)	0.02	0.05	0.07	0.09	0.07	0.04	0.00
Results obtained with the 2003 version of the model							
Deflator value added private sector (+1%)	0.18	0.29	0.41	0.50	0.76	0.97	0.91
Deflator of imports (+1%)	0.00	0.00	0.02	0.04	0.07	0.10	0.08
Unit labour cost (+1%)	0.01	0.02	0.03	0.03	0.04	0.02	0.00

2.3.4. Investment deflators

In the long-term equation investment deflators are explained by (the long-term value of) domestic prices and import prices excluding energy. In the case of business investment static homogeneity is imposed while for housing investment coefficients are unrestricted.[27] One level shift in both equations guarantees stationary residuals. Quarterly dynamics are characterised by strong inertia, particularly in the case of housing investment, captured in the equation by an autoregressive process.[28] Furthermore, the same two explanatory variables appear to be significant in the short-term equation.

Table 21 Estimation results for investment deflators

Housing investment				
Long-term equation	ln(PIR_L) := pir_l1*ln(ma(4, PQVFZ_L)) + pir_l2*ln(ma(4, PM_EXE)) + pir_l01*(t>2005Q2) *(t<2011Q1)			
	Estimation period:	1995Q4 – 2012Q4		
	Coefficient values:	pir_l1: 1.468	pir_l2: 0.726	pir_l01: 0.041
	Tests:	R² adj: 0.99	ADF: -3.90	
Dynamic equation	dln(PIR) := pir1*dln(PIR)[-1] + pir2*dln(ma(2, PQVFZ))[-1] + pir3*dln(ma(2, PM_EXE)) + pir_e*(ln(PIR) -ln(PIR_L))[-1] + pir01*(t= 2005Q3) + pir02*(t= 2008Q1)			
	Estimation period:	1996Q1 – 2012Q4		
	Coeff. values (t-stat):	pir1: 0.509 (5.3)	pir2: 0.546 (2.5)	pir3: 0.112 (1.5)
		pir_e: -0.173 (-2.6)	pir01: 0.014 (2.3)	pir02: 0.019 (3.0)
	Tests:	R² adj: 0.41	DW: 1.51	LM(1): 5.50
Business investment				
Long-term equation	ln(PIQ_L) := piq_l0 + piq_l01*(t>2001Q4) + piq_l1*ln(PQVFZ_L) + (1-piq_l1) *ln(PM_EXE)			
	Estimation period:	1995Q1 – 2012Q4		
	Coefficient values:	piq_l0: 0.041	piq_l01: -0.051	piq_l1: 0.884
	Tests:	R² adj: 0.99	ADF: -5.38	
Dynamic equation	dln(PIQ) := piq1*dln(PIQ)[-1] + piq2*dln(ma(2, PQVFZ)) + piq3*dln(PM) + piq_e*(ln(PIQ) -ln(PIQ_L))[-1]			
	Estimation period:	1995Q3 – 2012Q4		
	Coeff. values (t-stat):	piq1: 0.292 (2.9)	piq2: 0.332 (2.5)	piq3: 0.130 (4.1)
		piq_e: -0.177 (-2.7)		
	Tests:	R² adj: 0.30	DW: 2.09	LM(1): 0.00

[27] Statistical tests (see Annex 1) clearly reject homogeneity for housing investment and accept it for public investment. In the case of business investment, although homogeneity is rejected by the Wald test, the sum of the unrestricted coefficients is still reasonably close to one and therefore the restriction is imposed nonetheless.

[28] Despite the presence of the lagged housing investment series on the right-hand-side of its equation, residuals continue to show some degree of autocorrelation according to the LM test.

2.4. Wages and wage earning employment in the private sector

2.4.1. Wages in the private sector

Because the simulation horizon is limited to six to eight quarters when the model is used in forecasting, the hourly gross wage increase in the private sector, exclusive of indexation, is considered exogenous, as it is largely determined by the biannual collective agreements between social partners. Hourly wage cost growth is then calculated by multiplying it with the indexation coefficient and by adding different categories of employers' social contributions.

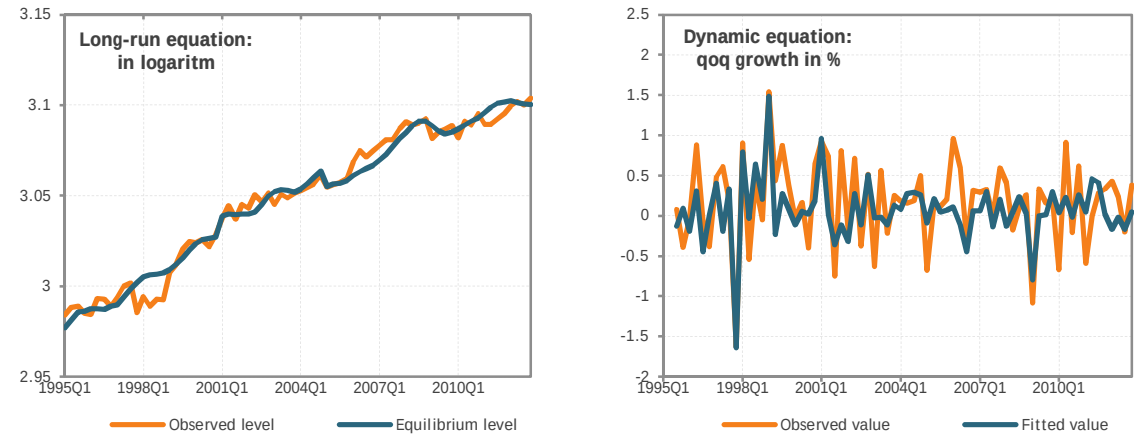
In case the model is used to measure the impact of specific exogenous shocks, an error correction type of equation determining hourly gross wage before indexation can be activated. In the long run, its logarithm depends upon the logarithm of labour productivity and level of the unemployment rate lagged with one quarter. A level shift during the period 2001-2004 allows the residuals to be stationary. Both productivity and the unemployment rate are smoothed using a four-quarter moving average. Homogeneity vis-à-vis productivity is clearly rejected, the coefficient being, surprisingly so, well below unity. In the short-term dynamics, the negative coefficient of the autoregressive process captures part of the extreme quarter-on-quarter volatility. The percentage change in productivity and the first difference in the unemployment rate appear with a one-period lag. Two dummies have been introduced to neutralise outliers.

Table 22 Estimation results for hourly gross wage before indexation

Long-term equation	ln(WRN_L) :=	wrn_l0 + wrn_l01*(t>2000Q4) *(t<2005Q1) + wrn_l1*ma(4, ln(QVOFF/NFH_ENDO)) + wrn_l2*ma(4, (U/NAT)[-1])		
	Estimation period:	1995Q1 –2012Q4		
	Coefficient values:	wrn_l0: 1.256	wrn_l01: 0.010	wrn_l1: 0.485
		wrn_l2: -0.765		
	Tests:	R² adj: 0.97	ADF: -3.88	
Dynamic equation	dln(WRN) :=	wrn1*dln(WRN)[-1] + wrn2*dln(QVOFF/NFH_ENDO)[-1] + wrn3*d(U/NAT)[-1] + wrn4*(t= 1997Q4) + wrn5*(t= 1999Q1 or t= 2001Q1) + wrn_e*(ln(WRN) -ln(WRN_L))[-1]		
	Estimation period:	1995Q3 – 2012Q4		
	Coeff. values (t-stat):	wrn1: -0.280 (-2.7)	wrn2: 0.303 (4.2)	wrn3: -0.544 (-1.8)
		wrn4: -0.018 (-4.3)	wrn5: 0.011 (3.6)	wrn_e: -0.195 (-2.1)
	Tests:	R² adj: 0.40	DW: 2.00	LM(1): 0.00

As shown in the left-hand panel of Graph 10, the long-term equation captures the trend reasonably well, while the tremendous volatility of the series (see the right-hand panel) is only partly explained by the dynamic equation.

Graph 10 Hourly gross wage before indexation: observed and fitted values



Source: NAI, FPB

A permanent shock of 1% on labour productivity translates into an increase in gross wages before indexation of 0.28% after one year and 0.48% in the long run. A one percentage point rise in the unemployment rate pushes wages downwards by 0.40% after one year and by 0.76% in the steady state.

Table 23 (Semi-)elasticities for hourly gross wage before indexation

	Q1	Q2	Q3	Y1	Y2	Y5	LT
Hourly labour productivity (+1%)	0.00	0.33	0.22	0.28	0.37	0.47	0.48
Unemployment rate (+1 pp)	0.00	-0.54	-0.32	-0.40	-0.55	-0.73	-0.76

2.4.2. Wage earning employment in the private sector

Similarly as for business investment, wage earning employment in the private sector (expressed in total hours worked and excluding specific subsidised categories) is not derived explicitly anymore from a production function. While in the 2003 version we assumed a Cobb-Douglas technology, this time we tested a more general functional form. However, breaking down productivity in its labour efficiency and real wage component proved to be empirically impossible because both components exhibit a similar decreasing trend in the sample. Therefore we decided, as an exception to the modelling strategy retained for other equations, to impose an elasticity of 0.5 for real wages[29] and of 1 for value added. The latter restriction allows the equation to be interpreted as a productivity equation.[30]

In order to take into account the observed decrease in productivity growth, a break in the linear trend was introduced in 2004. This break implies a decrease in year-on-year trend productivity growth from 1.3% to 0.8% during the most recent period. Another option would have been to estimate a quadratic trend but such a specification is inappropriate for forecasting purposes. One dummy has been added to cover the period following the burst of the dot-com bubble and another to address the Great Recession. With these empirical choices, the residuals have a stationary profile as testified by the ADF-statistic. In the dynamic equation, the growth rate of both real wages and value added are highly significant. Two

[29] This is the value for the elasticity of substitution obtained with a CES production function and used in the S3BE model, see: Lebrun (2009).

[30] The value of the unrestricted coefficient for value added reaches 0.84 (see Annex 1).

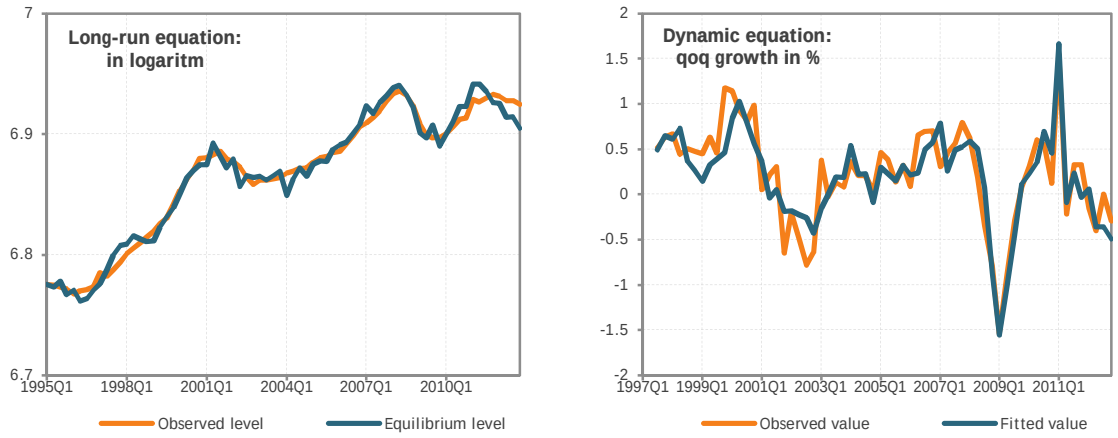
dummies have been included to neutralise outliers as well as a second-order auto-regressive process along with the error correction mechanism. The residuals are exempt of first-order autocorrelation.

Table 24 Estimation results for wage earning employment in the private sector

Long-term equation	ln(NFH_ENDO_L) := nfh_endo_l0 + nfh_endo_l01*(t>2003Q4) + nfh_endo_l02*(t>2001Q1 and t<2002Q2) + nfh_endo_l03*(t>2008Q3 and t<2009Q4) + ln(QVOFF) + nfh_endo_l1*ln((WBF_ENDO/NFH_ENDO) /PQVF) - (nfh_endo_l_t1*(t<2004Q1) *t + nfh_endo_l_t2*(t>2003Q4) *t)			
	Estimation period:	1995Q1 – 2012Q4		
	Coefficient values:	nfh_endo_l0: -2.00	nfh_endo_l01: -0.74	nfh_endo_l02: 0.023
		nfh_endo_l03: 0.026	nfh_endo_l1: -0.50	nfh_endo_l_t1: 0.002
		nfh_endo_l_t2: 0.001		
	Tests:	R² adj: 0.98	ADF: -4.84	
Dynamic equation	dln(NFH_ENDO) := nfh_endo1*dln(NFH_ENDO)[-1] + nfh_endo2*dln(NFH_ENDO)[-2] + nfh_endo3*dln(QVOFF) + nfh_endo4*dln((WBF_ENDO/NFH_ENDO) /PQVF) + nfh_endo5*(t= 2009Q1) + nfh_endo6*(t= 2011Q1) -nfh_endo6*(t= 2011Q2) + nfh_endo_e*(ln(NFH_ENDO) -ln(NFH_ENDO_L))[-1]			
	Estimation period:	1997Q3 – 2012Q4		
	Coeff. values (t-stat):	nfh_endo1: 0.407 (4.6)	nfh_endo2: 0.173 (2.2)	nfh_endo3: 0.197 (4.5)
		nfh_endo4: -0.185 (-4.0)	nfh_endo5: -0.008 (-2.9)	
		nfh_endo6: 0.009 (4.5)	nfh_endo_e: -0.162 (-3.4)	
	Tests:	R² adj: 0.76	DW: 1.76	LM(1): 0.03

The fit for the equation in levels is satisfactory as testified by the left-hand panel in Graph 11. The dynamics along the cycle is also very well captured as can be seen in the right-hand panel.

Graph 11 Private sector employment: observed and fitted values



Source: NAI, FPB

According to the estimated equation, employment increases with 0.20% during the first quarter following a 1% shock on value added. After six quarters the long-run impact is reached but there is a slight overshooting afterwards due to employment growth inertia. A shock on real hourly wages exhibits a similar pattern but the medium-term impact is limited to 0.58 before returning to its long-term value.

Table 25 Elasticities for private sector employment

	Q1	Q2	Q3	Y1	Y2	Y5	LT
Value added private sector (+1%)	0.20	0.41	0.62	0.81	1.13	0.99	1.00
Real hourly wage (+1%)	-0.18	-0.31	-0.42	-0.50	-0.58	-0.49	-0.50
Results obtained with the 2003 version of the model							
Value added private sector (+1%)	0.24	0.35	0.41	0.46	0.62	0.86	1.00
Real hourly wage (+1%)	-0.11	-0.19	-0.26	-0.32	-0.52	-0.82	-0.99

The response to an increase in value added was rather similar in the short run in the 2003 version, but further adjustment to the long-run target was much slower. The short-term elasticity of real hourly wages is also comparable in both versions, but then it converged very gradually to minus one following the assumption of a Cobb Douglas technology, implying a one-to-one reaction of productivity to a wage increase.

3. Model simulations

In this chapter the properties of the complete model are analysed by means of four simulation exercises. Our aim is to illustrate the endogenous transmission mechanisms of the model in response to the modification of one or more exogenous variables. These simulations do not necessarily imply realistic scenarios, as this could require the incorporation of additional exogenous assumptions or even policy reactions to the initial shock. They should therefore be considered as purely technical exercises.

All simulation results are expressed relative to a baseline reference.[31] This baseline is generated by an out-of-sample model simulation in which exogenous variables have been mechanically extrapolated or calculated on the basis of their historical averages (levels or, in the case of non-stationary variables, growth rates). Note that econometric equations generate the best forecasts for values of the exogenous variables close to their sample mean. Therefore it could be dangerous to use the results presented in this chapter in order to calculate the outcome of larger shocks (not experienced in the sample) with a simple arithmetic rule.

Four shocks are considered, the first two focusing on international variables and the last two on policy measures:

– an increase in world trade;

– a euro depreciation;

– a reduction in employers' social security contributions;

– an increase in the VAT rate on private consumption.

The quarterly simulation results reported here cover a period of two years, which corresponds to the model's usual forecasting horizon. Over this period, the hypothesis of unchanged hourly gross wage increases (exclusive of indexation) seems reasonable considering the prevailing institutional wage negotiation context.[32] The results are presented for the first four quarters as well as for the eighth quarter.

3.1. An increase in world trade

In this scenario we assume that potential export markets for Belgium increase by an additional 1% during the first quarter of simulation. Afterwards the growth rate is identical to that of the baseline. This is a purely technical simulation as all other international variables (international prices, exchange rates and interest rates) are assumed to remain unchanged.

The positive shock on international demand has a direct positive impact on export demand (+0.54% in the first quarter) in line with its short-term elasticity relative to world trade. Due to the high coefficient of the error correction term, amplified by the auto-regressive term, adjustment towards the new

[31] Deviations from the baseline are expressed as a percentage of the baseline level. Exceptions are made for a few variables representing ratios, such as the households' savings rate or the unemployment rate, for which it is more appropriate to indicate the effect in absolute differences from the baseline level.

[32] See also Section 2.4.1.

long-term level of exports (+0.70%) is already achieved in the second quarter. This increase in external demand induces a rise in production which induces extra business investment (+0.51% at the end of the first year).

The increase in production stimulates private sector employment with a time lag (only 0.17% above baseline after four quarters), leading to temporary productivity gains. This rise in employment implies a higher disposable income, resulting in a modest rise in private consumption spending (+0.09% in the fourth quarter). A substantial part of the increase in final demand is met by imports from abroad (+0.68% in the fourth quarter), as the elasticity of imports relative to the re-weighted indicator for final demand exceeds one. As a result, the rise in GDP is relatively modest and stabilises at about 0.2% above baseline. The current account balance improves only slightly.

As hourly gross wages are considered exogenous, temporary productivity gains are reflected entirely in decreasing unit labour costs, which in turn have a slightly negative impact on prices during the first year. Unit labour costs return to their baseline level at the end of the second year as employment has fully adjusted to the increase in value added.

Table 26 An increase in world trade

	Q1	Q2	Q3	Q4	Q8
% difference from the baseline					
GDP and its components (volumes)					
Private consumption	0.01	0.03	0.06	0.09	0.12
Government consumption	0.00	0.00	0.00	0.00	0.00
Gross fixed capital formation, of which:	0.09	0.19	0.27	0.33	0.31
Business investment	0.15	0.30	0.41	0.51	0.46
Housing investment	0.00	0.00	0.00	0.01	0.02
Total national expenditure	0.02	0.10	0.14	0.16	0.15
Exports of goods and services	0.54	0.70	0.73	0.72	0.70
Imports of goods and services	0.45	0.63	0.67	0.68	0.65
Gross domestic product	0.11	0.17	0.20	0.21	0.20
Prices					
Consumer price index	0.00	-0.01	-0.01	-0.01	0.00
Health index	0.00	-0.01	-0.01	-0.01	0.00
Export prices	0.00	0.00	0.00	0.00	0.00
Export price competitiveness[a]	0.00	0.00	0.00	0.00	0.00
Import prices	0.00	0.00	0.00	0.00	0.00
Terms of trade	0.00	0.00	0.00	0.00	0.00
GDP deflator	-0.01	-0.01	-0.01	-0.01	0.00
Employment and wages (enterprises)					
Hourly wage cost	0.00	0.00	0.00	0.00	0.00
Real hourly wage cost	0.00	0.00	0.00	0.00	0.01
Unit labour cost	-0.11	-0.15	-0.13	-0.09	0.03
Employment (wage earners, in hours)	0.03	0.07	0.12	0.17	0.28
Value added (volume)	0.13	0.22	0.25	0.26	0.26
Hourly labour productivity	0.11	0.15	0.13	0.09	-0.02
Income					
Real disposable income households	0.03	0.06	0.08	0.10	0.10
p.m. Real disposable income households excl. property income	0.03	0.06	0.07	0.08	0.10
Absolute difference from the baseline					
Household savings as % of disposable income	0.02	0.03	0.02	0.01	-0.02
Unemployment rate as % of labour force	0.00	-0.02	-0.05	-0.07	-0.14
Wage share as % of value added of enterprises	-0.05	-0.08	-0.06	-0.04	0.02
Current account balance as % of GDP	0.08	0.07	0.05	0.04	0.05

a. World export prices relative to Belgian export prices. An increase implies an improvement in competitiveness.

3.2. A euro depreciation

In this scenario a sustained 10% nominal effective depreciation of the euro against all other currencies is imposed.[33] International import and export prices are adjusted as well. Moreover, we suppose an increase of Belgium's export market indicator (relative to its baseline level) of 1.5% in the first year and of 2.3% in the second year, as Belgium's main trading partners are within the euro area and enjoy better growth prospects thanks to an improvement in price competitiveness.[34] Oil prices expressed in dollar and foreign interest rates are assumed unchanged. Belgian real long term interest rates are supposed to remain unaffected, so that nominal interest rates fully reflect the inflationary consequences of the external shock. This purely technical assumption is important for the determination of variables sensitive to interest rates such as investment and households' property income.

As Belgian exporting firms are only partly price-taker, Belgian export prices will increase less than world export prices, leading to an improvement in export price competitiveness and an increase in exports that also benefit from additional growth in Europe. On the whole, exports increase by 0.71% in the first quarter and by 2.11% after a year. This extra growth in production boosts business investment (+1.09% after a year). The rise in final demand pushes imports upwards (+1.89% after a year).

Households' disposable income is affected by counteracting factors. On the one hand, the increase in economic activity causes a rise in employment, leading to higher nominal labour income. On the other hand, the purchasing power of wages and social benefits is not entirely (and only with a time lag) protected by indexation[35] if inflation accelerates. Moreover, several components of disposable income are not price-linked. As the (negative) price effects kick in faster than the (beneficial) employment effects, real disposable income is negatively affected during the first year (-0.39% after four quarters). This decrease in income is partially compensated for by a temporary lower savings rate (thanks to the fall in the unemployment rate) so that private consumption remains close to its baseline level (+0.04% at the end of the first year). All in all, real GDP exceeds its baseline level by 0.51% in the fourth quarter.

The improvement in economic activity and the built-in indexation mechanisms of some income components bring real disposable income progressively back to its baseline level in the course of the second year. Competitiveness erodes somewhat as Belgian export prices go up, bringing exports slightly closer to their baseline level (from +2.34% in the sixth to +2.29% in the eighth quarter). Export prices themselves are driven by steadily increasing domestic prices, which are in turn the result of higher nominal hourly wage costs that are not fully compensated for by higher labour productivity.[36] The GDP deflator exceeds its baseline level by only 0.59% in the eighth quarter, which is due to terms of trade losses as import prices are influenced more by international prices than export prices. At the end of the second

[33] The nominal effective exchange rate appreciation for the Belgian economy remains limited to about 4%, given the importance of the euro area countries in Belgium's international trade.

[34] These are percentages on a yearly basis. The adjustment of Belgian export markets is partially based on the simulation results of a 10% euro depreciation on regional GDPs by means of an OECD model (see Hervé et al. (2010), p. 31). We translated this into an adjustment of Belgian export markets by means of average import elasticities per region.

[35] Various wage indexation mechanisms exist in Belgium, but most of them are discontinuous. This implies that households suffer losses of purchasing power between two points of indexation. Moreover, indexation is generally based on a moving average of the health index, which does not take into account the price evolution of alcoholic beverages, tobacco products and motor fuels.

[36] Labour productivity expands moderately during the first year, but falls back to its baseline level at the end of the second year.

year, real GDP is still 0.53% above baseline driven by business investment and net exports. The current account balance deteriorates, however, as the terms of trade losses are only partially offset by higher net exports in volume.

Table 27 A depreciation of the euro

	Q1	Q2	Q3	Q4	Q8
% differences from the baseline					
GDP and its components (volumes)					
Private consumption	-0.02	-0.01	0.02	0.04	-0.03
Government consumption	0.00	0.00	0.00	0.00	0.00
Gross fixed capital formation, of which:	0.12	0.29	0.50	0.71	0.89
Business investment	0.18	0.46	0.77	1.09	1.37
Housing investment	0.00	0.00	0.00	-0.01	-0.03
Total national expenditure	0.01	0.11	0.21	0.29	0.26
Exports of goods and services	0.71	1.31	1.76	2.11	2.29
Imports of goods and services	0.58	1.13	1.55	1.89	2.01
Gross domestic product	0.13	0.29	0.41	0.51	0.53
Prices					
Consumer price index	0.35	0.57	0.78	0.99	1.20
Health index	0.11	0.37	0.58	0.80	1.04
Export prices	1.75	2.13	2.30	2.46	2.67
Export price competitiveness[a]	2.87	2.68	2.51	2.35	2.11
Import prices	1.98	2.53	2.80	3.02	3.50
Terms of trade	-0.23	-0.39	-0.48	-0.54	-0.80
GDP deflator	0.07	0.13	0.24	0.40	0.62
Employment and wages (enterprises)					
Hourly wage cost	0.00	0.04	0.14	0.31	0.98
Real hourly wage cost	-0.17	-0.30	-0.37	-0.37	0.25
Unit labour cost	-0.10	-0.14	-0.04	0.15	0.99
Employment (wage earners, in hours)	0.06	0.18	0.33	0.49	0.69
Value added (volume)	0.16	0.35	0.51	0.65	0.69
Hourly labour productivity	0.10	0.17	0.19	0.16	0.00
Income					
Real disposable income households	-0.28	-0.40	-0.43	-0.39	-0.02
p.m. Real disposable income households excl. property income	-0.28	-0.40	-0.45	-0.44	-0.11
Absolute difference from the baseline					
Household savings as % of disposable income	-0.23	-0.33	-0.39	-0.38	-0.01
Unemployment rate as % of labour force	-0.02	-0.07	-0.14	-0.22	-0.34
Wage share as % of value added of enterprises	-0.11	-0.16	-0.16	-0.14	0.29
Current account balance as % of GDP	-0.07	-0.13	-0.18	-0.21	-0.36

a. World export prices relative to Belgian export prices. An increase implies an improvement in competitiveness.

3.3. A reduction in employers' social security contributions

Employers' social contributions are reduced by an *ex ante* amount equivalent to 0.5% of baseline GDP throughout the simulation period. No additional adjustments are made, except that Belgian real long term interest rates are assumed to remain unaffected.[37]

The decrease in wage costs induces three mechanisms. Firstly, it encourages factor substitution in favour of labour. Employment creation is strengthened by multiplier effects: more employment boosts households' disposable income which in turn stimulates private consumption, economic activity and again employment. Private sector employment exceeds its baseline level with 0.24% in the first quarter and with 0.68% at the end of the first year. Secondly, it exerts downward pressure on prices so that export price competitiveness improves and export volumes rise (which, together with private consumption, also stimulates investment demand). As prices are rather sticky, the slowdown appears only gradually (-0.11% for the consumer price index and -0.10% for export prices at the end of the first year). Thirdly, firms experience an increase in profitability (mainly in the first year), as can be seen from the declined wage share.

At the end of the second year, employment in the private sector has improved somewhat further (+0.78%). The shift towards more labour-intensive production has lowered labour productivity (-0.70%). This, together with a deterioration in the terms of trade[38], mitigates the initial loss in the wage share. All final demand categories exceed their baseline level, but GDP in volume is only 0.08% higher due to increased import demand. The deterioration in the current account balance reflects terms of trade losses and increased imports in volume.

[37] An increase in Belgian real interest rates (meaning that lower inflation is not reflected in a corresponding decrease in nominal interest rates) would mitigate the positive effect of reduced contributions on investment.

[38] Export prices have decreased further whereas import prices are barely affected by domestic prices.

Table 28 A reduction in employers' social security contributions

	Q1	Q2	Q3	Q4	Q8
% differences from the baseline					
GDP and its components (volumes)					
Private consumption	0.08	0.16	0.23	0.26	0.17
Government consumption	0.00	0.00	0.00	0.00	0.00
Gross fixed capital formation, of which:	0.02	0.06	0.10	0.13	0.13
Business investment	0.04	0.09	0.15	0.20	0.18
Housing investment	0.00	0.00	0.01	0.01	0.05
Total national expenditure	0.05	0.10	0.15	0.18	0.13
Exports of goods and services	0.00	0.00	0.01	0.03	0.08
Imports of goods and services	0.03	0.06	0.09	0.12	0.13
Gross domestic product	0.03	0.06	0.08	0.10	0.08
Prices					
Consumer price index	-0.02	-0.06	-0.09	-0.11	-0.14
Health index	-0.02	-0.06	-0.09	-0.12	-0.15
Export prices	0.00	-0.03	-0.07	-0.10	-0.25
Export price competitiveness[a]	0.00	0.03	0.08	0.12	0.27
Import prices	0.00	-0.01	-0.02	-0.02	-0.05
Terms of trade	0.00	-0.02	-0.05	-0.08	-0.20
GDP deflator	-0.01	-0.06	-0.13	-0.19	-0.42
Employment and wages (enterprises)					
Hourly wage cost	-1.26	-1.27	-1.28	-1.31	-1.39
Real hourly wage cost	-1.26	-1.24	-1.22	-1.21	-1.10
Unit labour cost	-1.04	-0.93	-0.81	-0.74	-0.70
Employment (wage earners, in hours)	0.24	0.41	0.56	0.68	0.78
Value added (volume)	0.02	0.05	0.09	0.11	0.08
Hourly labour productivity	-0.22	-0.35	-0.47	-0.57	-0.70
Income					
Real disposable income households	0.08	0.17	0.22	0.26	0.12
p.m. Real disposable income households excl. property income	0.06	0.13	0.17	0.20	0.13
Absolute difference from the baseline					
Household savings as % of disposable income	-0.01	0.00	-0.01	-0.01	-0.04
Unemployment rate as % of labour force	-0.13	-0.22	-0.30	-0.36	-0.42
Wage share as % of value added of enterprises	-0.66	-0.53	-0.41	-0.31	-0.13
Current account balance as % of GDP	-0.04	-0.07	-0.12	-0.15	-0.21

a. World export prices relative to Belgian export prices. An increase implies an improvement in competitiveness.

3.4. An increase in the VAT rate on private consumption

In this simulation the normal VAT rate of 21% is permanently increased to 23%.[39] No additional adjustments are made, except that Belgian real long term interest rates are assumed to remain unaffected.[40]

The impact of this measure on consumer price inflation is almost entirely concentrated in the first quarter (+0.86%). During the following seven quarters the qoq inflation rate is barely affected, but the price level is permanently higher. Immediately after the shock, households' real disposable income is hit strongly because it takes at least one quarter before higher prices are passed on to wages and social benefits by means of indexation mechanisms. In addition, some income components are not price-linked and employment is falling. During the first year, private consumption (-0.17% in the fourth quarter) is less affected than households' real disposable income (-0.23%), as a decline in the savings rate absorbs part of the shock.

The loss in households' total purchasing power is more limited in the second year (-0.10% in the last quarter) due to a recovery of real property income.[41] However, private consumption remains significantly below its baseline (-0.35%) as it is largely determined by real disposable income excluding property income[42] (-0.21% in the eighth quarter) and also because it is negatively affected by an increasing unemployment rate. As a result, the savings rate increases above its baseline level in the second year.

The initial impact on employment is rather limited, as employment reacts with a certain delay to value added (productivity cycle). Afterwards, employment deteriorates continuously (0.55% below baseline in the eighth quarter) as a consequence of the fall in value added and the rise in real[43] hourly wage costs.

The decrease in domestic demand leads to lower imports, which implies, given nearly unchanged exports and slightly improved terms of trade, an improvement in the current account balance. GDP in volume is 0.06% below its baseline level in the fourth quarter. This loss is more than doubled at the end of the second year (-0.13%).

39 This simulation takes into account the fact that not all goods and services are subject to the normal rate.

40 A decrease in Belgian real interest rates (which would happen if the inflationary effect of the VAT measure is not reflected in an increase in nominal interest rates) would positively affect the simulation results for business and housing investment.

41 This recovery is largely due to increased savings in the second year and the (purely technical) assumption of nominal long term interest rates fully reflecting the increase in inflation.

42 Property income does not play a role in the long-term equation of private consumption.

43 Deflated by the deflator of private value added, which is affected less by a change in the VAT rate than the health index that is used to adjust wages to the higher cost of living.

Table 29 An increase in the VAT rate on private consumption

	Q1	Q2	Q3	Q4	Q8
% differences from the baseline					
GDP and its components (volumes)					
Private consumption	-0.08	-0.10	-0.13	-0.17	-0.35
Government consumption	0.00	0.00	0.00	0.00	0.00
Gross fixed capital formation, of which:	0.00	-0.02	-0.04	-0.06	-0.19
Business investment	-0.01	-0.03	-0.06	-0.09	-0.26
Housing investment	0.00	0.00	-0.01	-0.02	-0.07
Total national expenditure	-0.04	-0.06	-0.08	-0.11	-0.24
Exports of goods and services	0.00	0.00	0.00	0.00	-0.03
Imports of goods and services	-0.02	-0.03	-0.04	-0.06	-0.15
Gross domestic product	-0.02	-0.03	-0.04	-0.06	-0.13
Prices					
Consumer price index	0.86	0.86	0.88	0.89	0.95
Health index	0.81	0.81	0.83	0.85	0.90
Export prices	0.00	0.00	0.00	0.01	0.10
Export price competitiveness[a]	0.00	0.00	0.00	-0.02	-0.11
Import prices	0.00	0.00	0.00	0.00	0.02
Terms of trade	0.00	0.00	0.00	0.01	0.08
GDP deflator	0.45	0.47	0.54	0.60	0.79
Employment and wages (enterprises)					
Hourly wage cost	0.00	0.21	0.43	0.65	0.91
Real hourly wage cost	0.00	0.21	0.42	0.63	0.79
Unit labour cost	0.00	0.19	0.34	0.48	0.49
Employment (wage earners, in hours)	0.00	-0.05	-0.12	-0.22	-0.55
Value added (volume)	-0.01	-0.02	-0.03	-0.05	-0.13
Hourly labour productivity	0.00	0.02	0.08	0.17	0.42
Income					
Real disposable income households	-0.70	-0.59	-0.35	-0.23	-0.10
p.m. Real disposable income households excl. property income	-0.71	-0.61	-0.38	-0.31	-0.21
Absolute difference from the baseline					
Household savings as % of disposable income	-0.53	-0.41	-0.19	-0.06	0.20
Unemployment rate as % of labour force	0.00	0.02	0.06	0.11	0.29
Wage share as % of value added of enterprises	-0.36	-0.23	-0.16	-0.09	-0.17
Current account balance as % of GDP	0.01	0.02	0.03	0.05	0.15

a. World export prices relative to Belgian export prices. An increase implies an improvement in competitiveness.

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Annex 1: Coefficient restriction tests for level equations

Estimation results for the level equations presented in the main text are obtained using static ordinary least squares (SOLS) estimation. If the series are cointegrated, SOLS estimation of the cointegrating vector is consistent, converging at a faster rate than is standard. One important shortcoming of SOLS is the fact that it is not recommended if one wishes to conduct inference on the cointegrating vector. To test restrictions on coefficients in the level equations, in particular homogeneity, we used the Fully Modified OLS (FMOLS) estimator which allows for standard Wald tests using asymptotic Chi-square statistical inference. The test results are presented in the table below.

Table 30 Testing restriction with FMOLS estimators

Equation	Unrestricted value of coefficients for	Null hypothesis	Wald test (Probability in brackets)
Private consumption	c1: 0.92 c2: 0.07	c1+c2=1	X^2: 0.03 (0.85)
Housing investment	c1: 0.42	c1=1	X^2: 8.46 (0.00)
Business investment	c1: 1.07	c1=1	X^2: 0.34 (0.56)
Exports	c1: 0.70	c1=1	X^2: 1349 (0.00)
Implicit deflator of value added	c1: 0.48 c2: 0.49	c1+c2=1	X^2: 0.46 (0.50)
Underlying inflation	c1: 0.99 c2: 0.05	c1+c2=1	X^2: 7.47 (0.01)
Deflator of business investment	c1: 0.97 c2: 0.11	c1+c2=1	X^2: 6.92 (0.01)
Deflator of housing investment	c1: 1.44 c2: 0.82	c1+c2=1	X^2: 307 (0.00)
Deflator of energy imports	c1: 0.80	c1=1	X^2: 281 (0.00)
Deflator of energy exports	c1: 0.71	c1=1	X^2: 447 (0.00)
Hourly gross wage before indexation	c2: 0.48	c2=1	X^2: 548 (0.00)
Wage earning employment	c1: 0.84	c1=1	X^2: 4.55 (0.03)

Notes: Coefficient numbers follow the order of the explanatory variables (excluding constants and dummies) as presented in the equations in Chapter 2.

Homogeneity is clearly accepted for private consumption and business investment. It is also unambiguously rejected for disposable income in the housing investment equation, for world trade in the export equation and productivity in the wage equation. Concerning prices, homogeneity is validated empirically for the deflator of private value added. It is rejected in all other cases.

Annex 2: Glossary

This glossary contains all variables used in Chapter 2. Please note that the "private sector" equals total economy minus general government (S.1 - S.13 in the ESA95 national accounts), whereas the "business sector" is defined as the sum of financial and non-financial corporations (S.11 + S.12). For simplicity of notation, "households" includes non-profit institutions serving households (S.14 + S.15).

Glossary of variable names

CCO	Private consumption (in volume)
CK_HP	Business sector capital costs (Hodrick-Prescott filtered)
EX	EUR/USD exchange rate
IAH	Interest-bearing assets of households (savings deposits and fixed-interest securities)
IDH_I	Net property income of households
IQO1	Business investment (in volume)
IRO	Housing investment (in volume)
MO	Imports of goods and services (in volume)
NAT	Labour force
NFH_ENDO	Private sector wage earning employment (number of hours, excluding specific subsidised categories)
PCC	Private consumption deflator
PCUI	Underlying inflation
PIQ	Business investment deflator
PIR	Housing investment deflator
PM	Import prices
PM_EXE	Import prices excluding energy
PQVF	Deflator of private sector value added
PQVFZ	Private value added deflator
PQVFZ_L	Implicit deflator of private value added
PWMAS	International import prices excluding energy
PWMSS	International import prices
PWXAS	International export prices excluding energy
PWXSS	International export prices
PX_EXE	Export prices excluding energy
QMOAB	Re-weighted final demand (in volume, based on import contents)
QVOF	Private sector value added (in volume)
QVOFF/NFH	Business sector hourly labour productivity
QWXSS	Potential export markets for Belgium (in volume)
RHYP10	Mortgage rate
RLBE	Long-term interest rate (10Y government bond yield)
SO	Changes in inventories (in volume)
U	Unemployment
WBF_ENDO	Compensation of employees in the private sector (excluding specific subsidised categories)
WBFF/QVOFF	Business sector unit labour costs
WRN	Hourly gross wages before indexation
XO	Exports of goods and services (in volume)
YDH_I	Disposable income of households
YO	Gross domestic product (in volume)
ZKF	Industrial capacity utilisation rate

Glossary of mathematical and logical functions

ln(X)	Natural logarithm of X
dln(X)	First difference of natural logarithm of X
grt(Y,X)	Growth rate of X in %, yoy growth rate if Y=4, qoq growth rate if Y=1 or absent
d(Y,X)	Difference of X, yoy difference if Y=4, qoq difference if Y=1 or absent
ma(Y,X)	Y-quarter moving average of X
(X or Y)	Equals 1 if condition X *or* Y are satisfied and 0 otherwise
(X and Y)	Equals 1 if condition X *and* Y are satisfied and 0 otherwise