



BANK OF GREECE

THE GREEK MODEL
OF THE EUROPEAN SYSTEM
OF CENTRAL BANKS
MULTI-COUNTRY MODEL

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ABSTRACT

The present paper presents a quarterly econometric model for the Greek economy, the GR-MCM model. The model has been developed as part of a larger project within the European System of Central Banks (ESCB), the Multi-Country Model (MCM). The model combines short-run Keynesian dynamics determined by demand with a neo-classical steady state driven by supply factors. A well-specified long-run supply side is fully and simultaneously estimated. As far as the econometric methodology is concerned, the equilibrium relationships are estimated using cointegration analysis, whereas the dynamic equations are specified as error correction models. Standard simulations result in plausible short to long-run responses to exogenous shocks, thus indicating that the model can be useful for policy analysis experiments.

Keywords: Econometric Modelling; Cointegration Techniques; Simulation Results.

JEL classification: C50; E17.

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1. Introduction

The present paper presents a quarterly econometric model of the Greek economy, the GR-MCM model. It has been developed as part of a larger project within the European System of Central Banks, the Multi-Country Model (MCM); the GR-MCM model, which is described here, is the Greek block of the MCM model of the euro area. The purposes of the Greek model are the following:

- It aims to derive useful insights into the functioning of the Greek economy during the post -1980 period. This period encompasses significant changes in economic performance. Following a prolonged period of sluggish economic growth, low productivity and high inflation, which lasted until the mid 1990s, Greece has been transformed during the last few years into a relatively high growth economy, accompanied by low inflation rates¹.
- It provides a coherent framework that can produce reliable forecasts of future developments in the Greek economy.
- It can be used as a tool for assessing the impact of alternative policy scenarios on the economy. Indeed, as part of the MCM of the European Central Bank (ECB), the model has already been used by the Bank of Greece in a number of policy applications. In these applications, the Greek economy has been treated as both an individual small open economy and as a member-country of the euro area.

The construction of an assumed constant parameter model for the Greek economy for the years 1980-2000 is a challenging task, given that the period analysed covers different monetary, fiscal and income policy regimes as well as significant structural changes and social transformation. The challenge is to estimate the model's parameters on the basis of historical data which have undergone structural changes. A model estimated with such data can reveal the underlying forces and mechanisms that led Greece to entry into EMU. By doing so, the model could provide useful insights for new and prospective EU members.

The model is built by making use of quarterly series for the Greek economy, revised according to the ESA 95 system. As no econometric model for Greece has been

¹ For an analysis of the recent macroeconomic performance of the Greek economy, see *inter alia* Garganas and Tavlas, 2001.

previously estimated with quarterly data, the building of the GR-MCM model based on a set of quarterly series turned out to be an additional challenge. The resulting model allows for a rich treatment of the short-run dynamics of the economy, has reasonable simulation properties and provides reasonable forecasts.

Another important characteristic of the model worth noting is its relatively small size, as it consists of only 80 equations. The use of a relatively small model ensures theoretical consistency across behavioural equations, facilitates (1) interpretation of the simulation results, (2) identification of possible parameter changes in certain equations, and (3) assessment and interpretation of the impact of the choice of specific parameter values on the final outcomes of model simulations². With a relatively small number of estimated and accounting equations, the GR-MCM model provides a simple and operational tool for policy analysis and forecasting.

To date, only one econometric model of the Greek economy that is operational and used for policy purposes has been reported in the literature. It is the model presented in Garganas³ (1992), which has been extensively and successfully used by the Bank of Greece for many years. The Garganas model uses annual data and covers the period 1958-88. Thus, the GR-MCM model, which is the first model of the Greek economy to use quarterly data and models the economy over the last twenty years, fills a gap in econometric model-building of the Greek economy.

The GR-MCM model is developed on the basis of common views about the functioning of an economy. It considers a one-good open economy with short-run Keynesian dynamics determined by demand and a neo-classical steady state (long-run) specification driven by supply factors. A critical feature of the GR-MCM is a well-specified consistent and simultaneously estimated long-run supply block. Output prices and factor (labour and capital) demands are derived from the profit maximisation of a representative firm, which faces an imperfectly competitive market and constant returns to scale for production derived from a Cobb-Douglas technology. The relevant theoretical restrictions concerning the long-run coefficients are imposed in the price, labour and capital equations, which are estimated jointly. The equilibrium

² In that, we follow the suggestions of *Fagan et al*, 2001.

³ To our knowledge, the other two operational Greek annual econometric models (the National Bank of Greece model and the KEPE model) have not been presented officially in public.

relationships are then used to build the dynamic equations for domestic prices, employment and capital spending. A bargaining type nominal wage equation closes the supply side of the model, while the non-accelerating inflation rate of unemployment (NAIRU) is endogenously determined by the parameters of the model.

The demand side has the standard specification with real household spending driven by real disposable income, the real interest rate and a proxy for the total wealth. Investment is determined by output demand and the real cost of capital, and trade volumes are determined by demand and relative prices. Under a fixed nominal exchange rate, the long-run price level is determined by foreign prices.

There is no monetary sector in the model. The specification of the public sector is rather limited with only a few behavioural equations. Public expenses are left exogenous while revenues are linked to nominal aggregates by implicit tax rates. The nominal exchange rate and short-term interest rate are assumed to be exogenous. Therefore, they can be used as policy instruments.

The model is backward looking, with expectations treated implicitly by the inclusion of lagged variables. As far as the econometric methodology is concerned, we specify the dynamic equations of the model using an error-correction formulation, following in particular the two-step Engle and Granger cointegration procedure. Even though some of the estimated equations are not entirely satisfactory, they provide plausible results in terms of the overall response of the model.

The equations, especially the long-run supply relations, are specified following the recommendations provided in ECB documents. Nevertheless, in some cases it was considered necessary to depart from those recommendations in order to take into account special characteristics of the recent performance of the Greek economy.

The rest of the paper is organised as follows. Section 2 provides a brief historical overview of economic developments in Greece over the period 1980-2000. Section 3 provides a brief presentation of the model and of the data series used. Sections 4-8 present the main estimated behavioural long-run and short-run equations, which model the different sectors of the Greek economy. More specifically, sections 4, 5, 6, 7 and 8 analyse the estimated equations which model the supply side, the demand side, price formation, the foreign trade sector and the public sector, respectively. Each of these five sections first analyses the underlying theory - focusing on the long-run

relationships of the variables - and then presents the estimated equilibrium and dynamic equations. Section 9 analyses the dynamic properties of the model by presenting various simulation results. The final section summarises and concludes.

2. A brief historical overview of the period 1980 -2000

The Greek economy during the 1980s and 1990s made a great leap forward, moving from an unstable period of relatively weak economic performance characterised by persistent imbalances and strong inflationary pressures, to one characterised by sustainable nominal convergence and ultimately macroeconomic stability which enabled Greece's entry to the EMU. Real GDP in the period 1980-1993 grew at an annual rate of 0.75 %, below that of the rest of the EU members. Average growth of real business investment was essentially zero, and unemployment, which stood at about 4 % in 1981, rose more steeply than in the other EU economies over the next ten years or so, reaching 8 % by the early 1990s.

The wage-price system was highly unstable (due to the establishment of full wage indexation in the early 1980s which was abolished in 1985) with real wage growth exceeding productivity in most years. The expansionary incomes policies pursued during this period, resulted in high and volatile inflation.

Fiscal policy was highly accommodative and the fiscal deficit moved upwards throughout the 1980s reaching some 16 % of GDP by 1990; it remained persistently high through the early 1990s. Public debt soared and reached levels above 110% of GDP. The persistent fiscal imbalances and ensuing borrowing requirements of the public sector, which had preferential access to credit markets, dominated the conduct of monetary policy, contributing to a highly accommodative policy stance. Money growth increased at a strong pace during the 1980s, while real interest rates were negative for long periods of time.

The highly accommodative nature of the pursued policies during 1980s took its toll on the current account deficit, which, despite a large depreciation of the nominal exchange rate, reached unsustainable levels (as a percentage of GDP) in 1985 and 1989.

The stabilization programs implemented in 1985-87 and 1991-92, helped to contain inflation, reduce the PSBR and narrow the current account deficit. However, the programs were applied only for short periods of time. In the aftermath of the termination of both programs, inflation bounced back, the fiscal situation deteriorated again and growth remained tepid.

Beginning in 1994, the policy framework aimed at addressing the long-standing macroeconomic imbalances. This framework transformed the economy into a growth regime, which can be called a “credible disinflation”. Greece experienced an acceleration of growth, while inflation declined to the low single digits, fiscal deficits fell dramatically, and long rates converged rapidly to the corresponding European rates. The tight policy stance as well as some important institutional changes (the Bank of Greece’s independence and the Drachma’s ERM participation)⁴ contributed to the successful achievement of the policy objectives set by the Government.

As indicated from the above brief exposition, during the course of the last twenty years Greece experienced a succession of policy regimes and stabilisation efforts, all coming on top of a period characterised by structural changes as well as social transformation. From an econometric point of view, this creates substantial estimation problems, requiring a judicious examination of the data as well as a thorough and historically-oriented investigation of the respective policy interventions so that reliable identification of the prevailing regimes can be achieved. Chart 1 contains a graphical exposition of some key macroeconomic aggregates (GDP growth, inflation, the PSBR and the log of real wages), highlighting the bumpy nature of the data corresponding to the turbulent economic developments just described.

3. A brief overview of the model - the data set

The GR-MCM contains a total of 80 equations, of which 14 are estimated dynamic equations. The remaining equations are technical relations, identities and reporting identities. The specification of the behavioural equations is based on the following two theoretical assumptions: (i) equilibrium relationships are formed on the basis of the micro-founded behaviour of agents who maximise their welfare, and (ii)

⁴ See Garganas and Tavlas (2001) for a more thorough description of the regimes prevailing in Greece over the last twenty-five years.

adjustment to equilibrium is not instantaneous due to the presence of inefficiencies and frictions in markets. The model is consistent with the neoclassical framework, which assumes that the long-run equilibrium is determined by supply factors while demand factors affect output in the short run due to sluggish prices and quantities.

Most long-run equilibrium relations are estimated following the Engle-Granger cointegration methodology. The dynamic equations are then estimated under the assumption of an autoregressive structure of the variables of interest, in line with the statistical properties of the analysed variables, while plausible theoretical assumptions concerning the dynamic adjustment to equilibrium are made. A number of equations include impulse and step dummies to account for exogenous effects related to the observed structural changes in the Greek economy on the formation of the modeled variables. These dummies also generally improve the statistical properties of the equations.

The model is built around national income and product accounts using the ESA-95 system and has been fitted to quarterly observations covering the period 1980q1 to 2000q4. To accommodate the lag structure of the estimated models, effective estimation periods are shorter in some cases. The monetary series (exchange rates, interest rates, etc) are taken from the Bank of Greece (BoG) database (BoG, Research Department, Statistics Department), while national account series are provided by the National Statistical Service of Greece (NSSG). The NSSG provides quarterly observations for GDP and its basic demand components (real, nominal and deflators), but only annual observations are available for the remaining series. Construction of the missing quarterly series, especially from the income appropriation account, is undertaken in the Research Department of the Bank of Greece (see Appendix A for details).

The computer implementation of the model is given in portable TROLL. The supply side long-run relations are estimated using RATS. Estimation of the model in the initial exploratory stages is carried out using the EVIEWS package. The final estimation of the model and the simulation exercises are all carried out in the TROLL system.

Needless to say, the model is continuously simulated and tested in order to analyse its properties. In this respect, the model should be viewed as work in progress and a platform for empirical research within the Bank, rather than as a finished product.

4. The supply side

The supply block comprises decisions from firms over the aggregate output prices, labour demand and the optimal capital stock. We first estimate the equilibrium behavioural equations in a system context, and we then embody these long-run equations within a set of dynamic price, employment and fixed investment equations.

4.1 The long-run theoretical structure

The formulation of the supply (production) side relates output to capital and labour inputs. The economy produces a single good. The representative firm in the economy functions in an imperfectly competitive market environment and faces a constant-elasticity, elastic demand. The firm operates with the typical Cobb-Douglas production function with constant returns to scale and exogenous technological progress, which we approximate by a time trend:

$$YIR = \alpha . KSR^{\beta} . LNN^{(1-\beta)} . e^{\gamma TIME}$$

which in logs becomes:

$$\log(YIR) = \log(\alpha) + (1-\beta)\log(LNN) + \beta(KSR) + \gamma TIME$$

where YIR is real GDP at factor costs, LNN is total employment, KSR is the total capital stock and $TIME$ is a deterministic time trend. The parameter β is the exponent on the capital stock (the capital share parameter), α is the scale factor for the production function and γ is the technology parameter, the average growth of labour neutral technological progress.

In the short run, the representative firm sets prices by applying a constant mark-up η over variable marginal cost and determines employment, but keeps the capital stock constant. These assumptions allow us to invert the production function and to obtain an expression for labour demand. From labour demand, we derive the variable cost function and the corresponding marginal cost. By applying a constant mark-up over

the variable marginal cost, we derive the price equation. Finally, using the envelope theorem we derive the optimal stock equation (see Allen and Mestre, 1997).

The three equations for output price, labour demand and the capital stock take the form:

$$\log(YID) = \log(\eta) - \log(1-\beta) - \log(\alpha)/(1-\beta) + \log(WUN) + \beta/(1-\beta) * \log(YIR/KSR) - \gamma * TIME$$

$$\log(LNN) = -\log(\alpha) + \log(YIR) - \beta * \log(KSR/LNN) - \gamma * TIME$$

$$\log(KSR) = -\log(\alpha) + (1-\beta) * \log(\beta/(1-\beta)) + (1-\beta) * \log(WUN) - (1-\beta) * \log(CC) + \log(YIR) - \gamma * TIME$$

where YID is the GDP deflator (factor costs), WUN is compensation per head (WIN/LNN), η is the mark-up over marginal costs and CC is the cost of capital. The mark-up η is assumed to be related to the degree of competition in the market for output and, in the extreme case that the market were perfectly competitive, it would take a value of unity (that is, price would be set equal to the marginal cost). The rental cost of capital is defined by the formula:

$$CC = ITD (r/4 + \delta/4 - (\Delta ITD / ITD))$$

where ITD is the investment goods deflator, r the nominal cost of borrowing funds (the bank lending rate to enterprises), δ is the depreciation factor and the final component is the rate of expected inflation measured by the rate of growth of the investment deflator ITD. The depreciation rate δ is assumed to take the value of 0.05. The same value is also used for the calculation of the capital stock series.

All three supply-side equations are derived from a single coherent theoretical model. They imply that in the long run: i) the output (value added) deflator depends on the nominal wage and the ratio of output to capital, or, equivalently, on unit labour costs; ii) employment demand is given by the inverse of the production function; and iii) the capital stock evolves with the relative costs of the productive factors and the level of output. The system of estimated equations implies cross-equation restrictions, endogeneity of prices, labour demand and the capital stock and exogeneity of aggregate demand, wages and the cost of capital. The cross-equation restrictions improve the efficiency of the estimation, the interpretability of the estimated coefficients and -- more importantly -- the system simulation properties of the model.

Thus, the specification of a fully consistent supply side allows simulation of supply side policies.

4.2 Empirical estimates

The system equations are estimated over the period 1981q2-2000q4 using non-linear multivariate least squares⁵. Where necessary, additional structural change indicators were added to the model on the basis of their significance to improve the cointegration properties of the system. The DVSHIFT dummy turned out to be significant for all three equations of the supply bloc and is included in the specification. It is a step dummy, which takes the value 1 from 1995q2. Several factors underlie the use of this variable: 1995 was the first year in which the Bank of Greece gave a prominent role to the exchange rate as a nominal anchor; 1995 also marked the first year during which Greek financial markets operated free of controls, even though the process of the gradual financial liberalisation had been underway since the mid-1980s (see also Garganas and Tavlas, 2001, for similar arguments). Other empirical studies also identify a policy regime shift in the mid-1990s (Zonzilos, 2000; Garganas and Tavlas, 2001).

The final set of estimated parameters are the following (with standard errors in brackets):

$$\alpha = 0.0054586 (0.00014)$$

$$\gamma = 0.001611 (0.00023)$$

$$\beta = 0.3344092 (0.00655)$$

$$\eta = 1.817188 (0.018862).$$

These values are broadly in line with prior expectations. The output elasticity of capital (equivalent to the capital share), β , is estimated to be 0.33, a reasonable parameter for the production function in Greece and close to the observed share of the gross operating surplus in value added. The scale parameter α equals 0.005, whereas the relatively high value of 1.817 for η indicates a lack of perfect competition.

⁵ In addition, the triangular error correction mechanism, or TECM approach, suggested by Phillips, was used. The results, however, were slightly less satisfactory in terms of the stationarity of the residuals. Thus, they are not used in simulation, but are available upon request.

The technological progress parameter, γ , indicates exogenous productivity growth of only 0.16 per cent per quarter, which, although low, is nonetheless a reasonable average value for the economy of Greece during the period 1980-2000.

Our next step was to test the residuals of the estimated system for the presence of unit roots (stationarity), using the Augmented Dickey-Fuller (ADF) and the Phillips-Perron (PP) tests. When applying the Dickey-Fuller tests, we used the MacKinnon (MacKinnon, 1991) critical values, which ‘adjust’ the Dickey-Fuller critical values depending on the number of the variables included in the estimated long-run relationship, the inclusion of a trend and a constant and the sample size. (The MacKinnon critical values for a 5% level of significance, are estimated and reported in all the unit root tests that are presented in the paper). In the event that the residuals turn out to be stationary, they can be used in the specification of the equations describing the short-run dynamics of output prices, employment and the capital stock. In what follows, the system-estimated values for equilibrium output prices, employment and capital are denoted as YDSTAR, LSTAR and KSTAR respectively, whereas the residuals from the respective equations are denoted as RYDSTAR, RLSTAR and RKSTAR, respectively. The test outcomes are given in Table 1:

Table 1: Unit root tests

	ADF tests		PP tests	
	Outcomes	MacKinnon 5% c.v.	Outcomes	1% c.v.
RYDSTAR	-3.188710	-3.90011	-2.750331	-3.516676
RLSTAR	-3.935669	-3.90011	-3.410993	-3.47444
RKSTAR	-5.940658	-4.27130	-5.661119	-3.516676

According to the ADF test outcomes, RLSTAR and RKSTAR are $I(0)$ at the 5% significance level and RYDSTAR is $I(0)$ at the 10% significance level, whereas using the PP test results, all three series are $I(0)$ at the 1% significance level. Therefore, RLSTAR, RKSTAR and RYDSTAR can be used as equilibrium terms in the error correction models which describe the short-run dynamics of labour demand,

investment and output prices, respectively. The dynamic labour demand model is presented in the following subsection. Investment is an important component of demand, so the investment equation is presented in the demand side section of the paper (section 5). Output prices at factor cost are the key variable for the formation of the other price deflators in GR-MCM; therefore, the short-run equation for output prices is presented in the price-wage section (section 6).

4.3 The dynamic labour demand equation

Based on the assumed production function, equilibrium employment (LSTAR) is given by:

$$\log(LNN_t) = -\log(\alpha) + \log(YIR_t) - \beta * \log(KSR_t / LNN_t) - \gamma * (1 - \beta) * TIME + (-0.0039 * TIME + 0.2315) * DVSHIFT$$

In the short run, total employment is shown to adjust towards its equilibrium level, influenced positively by the growth in final demand and negatively by rises in real wage. The demand growth coefficient 0.15, is imposed, based on the consideration that even though employment is quite independent of output for most of the estimation period, it becomes more output elastic over time⁶. The negative wage effect reflects the highly centralised bargaining process of wage formation in Greece. Given this centralised wage setting process, firms have to take wages as given and then decide on the desired level of employment. The adjustment to equilibrium is also strongly influenced by employment's past values, indicating persistence in unemployment which, in turn, reflects rigidities in the labour market. The impulse dummy DV911 accounts for the effect of the implementation of a number of measures taken by the government to liberalise the labour market (i.e. introduction of part-time jobs, a "fourth" work shift, etc) in January 1991. The dynamic equation for employment is estimated as (t-values in parenthesis).

⁶ It is implicitly assumed that the systematic implementation of active labour market policies in recent years has started to have an impact on the flexibility of the Greek labour market by increasing its responsiveness to demand changes.

$$\begin{aligned} \Delta \log(LNN_t) = & 0.001 - 0.030 * \log(LNN_{t-1}/LSTAR_{t-1}) + \\ & (-2.68) \\ & 0.875 * \Delta \log(LNN_{t-1}) - 0.452 * \Delta \log(LNN_{t-3}) \\ & (16.60) \quad (-10.48) \\ & + 0.15 * \Delta \log(YIR_t) - 0.034 * \Delta \log(WUN_{t-1}/YID_{t-1}) - 0.003 * DV911 \\ & (\text{imposed}) \quad (-1.95) \quad (-2.16.) \end{aligned}$$

$R^2: 0.853 \quad S.E.: 0.0018 \quad DW: 0.836 \quad LM_F(3): 15.712 \quad ARCH_F(4): 5.12$

5. The demand side

The specification of the demand side is fairly traditional. Expenditure on real GDP is split into the following components, which are modelled separately: (1) private consumption (PCR); (2) government consumption (GCR); (3) fixed investment (ITR); (4) exports of goods and services (XTR); and (6) imports of goods and services (MTR). In the Greek quarterly national accounts system, changes in inventories are reported together with the statistical discrepancy from the demand side: therefore it is not possible to model them at present. Public consumption is assumed exogenous in real terms. In this section we present the models for private consumption and investment; those for exports and imports are presented in the section on foreign trade (section 7).

5.1 The consumption function

The model for private consumption expenditure is based on the life-cycle hypothesis, which assumes that the equilibrium level of household consumption (PCR) is determined by permanent income and the real short-term interest rate (RSTR). In a backward looking framework, the flow of permanent income can be approximated by disposable income and the lifetime flow emanating from total wealth. Assuming permanent income consists of real disposable income (PYR) and real financial wealth (FWR), the long-run equation for private consumption takes the form.

$$\log(PCR_t/PYR_t) = \delta_1 + \delta_2 * \log(FWR_t/PYR_t) + \delta_3 * RSTR_t$$

According to this formulation, consumption is homogenous of degree one in income and wealth⁷. The estimated cointegrating relationship for the equilibrium private consumption (*CSTAR*) takes the form.

$$\log(PCR_t/PYR_t) = -1.248 + 0.348 * \log(FWR_t/PYR_t) - 0.304 * (RSTR_t) * (DVSHIFTC) + \\ 0.004 * TREND * DVSHIFTC - 0.149 * DVSHIFTC - 0.061 * DV8512$$

ADF -4.8215 *MacKinnon critical value at 5%*: -4.5838

where *DVSHIFTC* is a step dummy taking the value one from 1990q1 and onwards, implying that the negative effect coming from the interest rate is present from 1990, *i.e.* after the start of liberalisation of the financial system. Reform of the financial system is also dealt with by the inclusion of a time trend starting from 1990q1. In November 1984 overdrafts on current consumer accounts are permitted, to facilitate the supply of consumer credit; this measure has strong positive effects on consumption (observed in 1985q1 and 1985q2), which are present in the long- and the short run. Dummies *DV8512* and *DV851* account for these effects.

As regards the other variables involved in the specification, real disposable income *PYR* is its nominal variable, *PYN*, deflated by the private consumption deflator, *PCD*. Nominal disposable income is itself broken down into three components (as defined in the National Accounts): the wage bill net of social security contributions (*WIN-EC*), other personal income (*OPN*) and the sum of the transfers to households from the government and from abroad (*TRNY*), reduced by the amount of direct taxes (*PDN*).

$$PYN = WIN + OPN + TRNY - EC - PDN$$

All the components of disposable income are endogenous. *FWN* is a proxy for nominal total wealth. It is calculated as the sum of the stock accumulation of the public sector deficits (*SGLN*), foreign sector deficits (*SCAN*) and the nominal value of the total capital stock. The respective real aggregate, *FWR*, is derived by dividing *FWN* by the private consumption deflator, *PCD*.

The dynamics of consumption growth are modelled in a fairly standard error correction type equation. Consumption growth is related positively to growth in disposable income, which turns out to be the main determinant of consumption. The

⁷ This formulation is based on Muellbauer and Lattimore (1994)

error correction term $(PCR/CSTAR)_{t-1}$ enters the dynamic equation significantly with the expected negative sign. In May 1990, the new government, as part of its attempt at fiscal consolidation, increased tax rates significantly and broadened the tax base. The measures had an immediate negative effect on consumption as captured by DV903.

$$\begin{aligned} \Delta \log(PCR) = & 0.01 + 0.418 * \Delta \log(PYR) - 0.419 * \log(PCR/CSTAR)_{t-1} - 0.04 * DV903 \\ & (3.516) \qquad \qquad \qquad (-4.282) \qquad \qquad \qquad (-3.59) \\ & -0.06 * DV851 \\ & (-4.15) \end{aligned}$$

$$R^2 : 0.457 \quad S.E: 0.013 \quad DW: 1.942 \quad LM_F(4) : 1.27 \quad ARCH_F(4): 2.087$$

The estimated consumption function suggests that while our proxy for permanent income is the main determinant for private consumption in the long run, real disposable income exerts an important direct impact (with a coefficient of 0.4) on the short-run dynamic consumption behaviour.

5.2 Investment

The optimal capital stock ($KSTAR$) has been estimated in the supply side block as:

$$\begin{aligned} \log(KSR_t) = & -\log(\alpha) + (1-\beta) * \log(\beta/(1-\beta)) + (1-\beta) * \log(WUN_t) - (1-\beta) * \log(CC_t) + \\ & + \log(YIR_t) - \gamma * (1-\beta) * TIME + (1.899 - 0.181 * TIME) * DVSHIFT + \\ & + (0.024 * TIME - 0.412) * DUM8 + 0.189 * DUM3 \end{aligned}$$

An interesting implication of the above equation is that it entails a long-run effect from the interest rate on the optimal capital stock *via* the user cost of capital. The investment equation, together with the consumption function, thus represents a main transmission channel of monetary policy in the model.

In the short run, investment is influenced positively by output demand and negatively by its own past history and, to a lesser extent, by real cost of capital growth. The growth of real output demand influences investment with a coefficient larger than unity, reflecting probably accelerator effects. DV841 accounts for the effects of a number of tax reforms decided by the government in January 1984, whereas DV903 accounts for the effects of tax increases and the broadening of the tax base in May 1990 (as already noted). The error correction term ensures adjustment to equilibrium, with some hysteresis (as it is included in its 3rd lag):

$$\begin{aligned} \Delta \log(ITR_t) = & 0.006 - 0.062 * \log(KSR/KSTAR)_{t-3} - 0.145 * \Delta \log(ITR_{t-1}) + \\ & (-1.79) \qquad \qquad \qquad (-1.79) \\ & 1.348 * \Delta \log(YIR_t) - 0.042 * \Delta \log(CC/YID)_t - \\ & (2.89) \qquad \qquad \qquad (-2.14) \\ & - 0.199 * DV841 - 0.086 * DV941 - 0.108 * DV903 \\ & (-7.31) \qquad \qquad (-3.13) \qquad \qquad (-3.95) \end{aligned}$$

$$R^2 : 0.575 \quad DW : 2.107 \quad S.E. : 0.026 \quad LM_F(4) : 0.305 \quad ARCH_F(4) : 0.419$$

6. Prices and wages

The price indicators modelled in the price block of the model are: the GDP deflator at factor costs (YID), compensation per head (WUN), the private consumption deflator (PCD), the consumer price index (CPI), the investment deflator (ITD) and the import and export deflators (MTD and XTD, respectively). The equations for MTD and XTD are presented in the foreign sector section of the paper.

The key price variable in GR-MCM is the GDP deflator at factor cost. Its equilibrium level is determined by the long-run specification of the supply side. Modelling the GDP deflator reflects our interest in the domestic origins of inflation. The remaining domestic price deflators are related to the GDP deflator with specific additional context-dependent adjustments (i.e. for the case of the import prices equation, exchange rate effects are taken into account). When necessary in the modelling of the price deflators, external price developments are captured by the import price deflator. In all the price equations, long-run homogeneity is imposed and accepted by the data at reasonable levels of significance.

6.1 Output prices

The long-run specification of the supply side determines the equilibrium level of the GDP deflator (*YDSTAR*) conditional, however, on factor (labour) prices.

$$\begin{aligned} \log(YID_t) = & \log(\eta) - \log(1-\beta) - \log(\alpha)/(1-\beta) + \log(WUN_t) + \beta/(1-\beta) * \log(YIR_t/KSR_t) - \\ & \gamma * TIME + (0.63 - 0.01 * TIME) * DVSHIFT \end{aligned}$$

The corresponding error correction model for the output deflator takes the form.

$$\begin{aligned} \Delta \log(YID_t) = & 0.843 * \Delta \log(YID_{t-3}) - 0.047 * \log(YID/YDSTAR)_{t-1} + (1-0.843) * \Delta \log(MTD_t) \\ & (18.83) \qquad \qquad \qquad (-1.95) \\ & -0.016 * DV823 - 0.004 * DV911 \\ & (-3.08) \qquad \qquad \qquad (-1.28) \end{aligned}$$

$$R^2 : 0.843 \quad DW : 0.789 \quad S.E. : 0.007 \quad LM_F(4) : 28.342 \quad ARCH_F(4) : 2.035$$

The short-run dynamics of output price inflation are strongly affected by the past history of the process, indicating high inflation persistence⁸. Domestic inflation is also influenced by inflation in import prices, which reflects the short-run effect of the real exchange rate on the mark-up. In the long run, output prices are assumed to adjust to equilibrium through the effect of the error correction term, but this adjustment turns out to be quite slow as indicated by the low value of the loading coefficient (-0.047), probably indicating the sluggishness of the Greek price system. Short-run dynamic homogeneity⁹ is imposed and accepted by the data.

6.2 Wages

Nominal wages are approximated by average compensation per head ($WUN = WIN/LNN$) (the problem being that WUN includes also social security contributions from employers). The modelling of wages is based on the assumption that, in the long run, real wages move in line with labour productivity. In the short run, however, wages may deviate from their equilibrium level, due to adjustment costs and as a result of the bargaining process, which may cause Phillips curve type effects. For example, a reduction in the unemployment rate reduces the probability of being unemployed, so wages tend to increase. The preferred dynamic specification of wage inflation is in line with the above arguments.

⁸ These findings are consistent with the results obtained by Hondroyiannis and Lazaretou (2004).

⁹ The implication of dynamic homogeneity is that the equilibrium levels equation is independent of the short-run dynamics. This restriction together with static homogeneity ensures the independence of long-run real equilibrium from prices.

$$\begin{aligned}
\Delta \log(WUN_t) = & -0.208 * (\log(WUN/YID) - \log(PROD))_{t-1} - 0.001 * URX_{t-3} + \\
& (-2.96) \qquad \qquad \qquad (-0.978) \\
& 0.378 * \Delta \log(PCD_{t-1}) + (1-0.378) * \Delta \log(WUN_{t-1}) \\
& (5.93) \\
& + 0.175 * \Delta \log(PROD_t) + 0.204 * TT_{t-1} - 0.48 * DV861 \\
& (3.10) \qquad \qquad (2.95) \qquad (-5.17) \\
& -0.39 * DV871 \\
& (-4.48)
\end{aligned}$$

R2: 0.577 S.E: 0.008 DW: 1.844 LM_F(4) : 1.21 ARCH_F(4) : 0.27

Wage inflation is strongly and positively affected by past wage and price inflation as well as productivity growth. The unemployment rate exerts a negative but small effect on wages, which indicates the existence of some Phillips curve type dynamics in the Greek economy. The long-run relation between real wages and productivity enters with the expected negative sign but it is small. This low value implies a low speed of adjustment which reflects prevailing rigidities in Greek labour market. The variable TT is a policy regime variable. It combines the alternative regimes that governed the wage setting process in Greece, during different sub-periods of the period 1980-2000, in a single parsimonious way. The variable comprises five segmented trends corresponding to the five identified regimes in real wage policy: the 1980q1-1984q3 rapid real wage growth regime (caused by the expansionary policies pursued); the 1984q4-1988q1 strict policy regime corresponding to the application of the first stabilisation programme; the rebound period 1988q2-1990q3; the 1990q4-1994q2 period of moderate stability; and, finally the period of increased stability 1994q3-2000q4. DV861 accounts for the effects of the drachma devaluation in October 1985. Dynamic homogeneity is imposed and accepted by the data; in other words, the model specification implies that the Phillips curve is vertical in the long run. This is a necessary condition for the long-run independence of the real part of the system from the rate of growth of the nominal aggregates.

6.3 Consumer prices

Two consumer price indicators are modelled, the private consumption deflator (PCD) and the consumer price index (CPI). The private consumption deflator plays a key role in the model, given that it has feedback effects *via* real wages and real wealth. In

the long run, both deflators are modelled to move in line with the GDP deflator at factor costs: PCD is modelled to be proportional to YED, whereas the equilibrium CPISTAR cointegrates with YED in a relationship of the form.

$$\log(CPI) = 4.408 + \log(YED),$$

(ADF: -3.88, MacKinnon critical value at 5%: -2.8955).

In the short run, consumer price deflators are determined by domestic and foreign prices. Both PCD inflation and CPI inflation turn out to be functions of the GDP deflator (YED) inflation and import price (MTD) inflation¹⁰. Short-run dynamic homogeneity is accepted by the data in both equations. The inclusion of impulse dummies accounts for exogenous effects to the price formation process (i.e. DV861 accounts for the drachma devaluation in October 1985, whereas DV871 accounts for the introduction of VAT in January 1987).

$$\begin{aligned} \Delta \log(PCD_t) = & -0.065 * \Delta \log(PCD_{t-1}) + 0.097 * \Delta \log(MTD_{t-1}) \\ & (-1.59) \qquad \qquad \qquad (4.41) \\ & + (1 - 0.065 - 0.097) * \Delta \log(YED_t) - 0.058 * \log(PCD/YED)_{t-1} \\ & \qquad \qquad \qquad \qquad \qquad \qquad \qquad \qquad \qquad \qquad \qquad (-3.17) \\ & + 0.029 * DV861 + 0.030 * DV871 - 0.02 * DV821 \\ & (7.96) \qquad \qquad (9.02) \qquad \qquad (-6.49) \end{aligned}$$

R^2 : 0.852 S.R.: 0.003 DW: 1.87 $LM_F(4)$: 1.76 $ARCH_F(4)$: 1.04

$$\begin{aligned} \Delta \log(CPI_t) = & 0.258 * \Delta \log(CPI_{t-1}) + 0.142 * \Delta \log(MTD_{t-1}) \\ & (4.36) \qquad \qquad \qquad (3.54) \\ & + (1 - 0.258 - 0.142) * \Delta \log(YED_t) \\ & - 0.132 * \log(CPI/CPISTAR)_{t-1} \\ & (-3.35) \end{aligned}$$

R^2 : 0.476 S.R.: 0.006 DW: 1.997 $LM_F(4)$: 3.63 $ARCH_F(4)$: 3.53

6.4 Investment deflator

In the long run, private investment prices cointegrate with output prices and import prices (albeit at only the 10% significance level). The finding reflects the fact that

¹⁰ In the PCD and CPI equations, the constant does not appear in the specification, as it did not turn out to be significant under the conventional significance level.

investment goods include both domestic and imported products. Unit long-run elasticity is accepted by the data. The equilibrium value for the investment deflator ITDSTAR is given by.

$$\log(ITD) = 0.016 + 0.764*\log(YED) + (1-0.764)*\log(MTD)$$

$$ADF = -2.45, \text{ MacKinnon critical value at 5\%: } -3.4059$$

whereas investment price dynamics are given by:

$$\begin{aligned} \Delta\log(ITD_t) = & -0.001 + 0.114*\Delta\log(ITD_{t-1}) + 0.706*\Delta\log(YED_t) + \\ & (-1.19) \quad (1.63) \quad \quad \quad (9.43) \\ & (1-0.114-0.706)* \Delta\log(MTD_{t-1}) \\ & - 0.05*\log(ITD/ITDSTAR)_{t-1} - 0.038*DV821 + 0.039*DV891 \\ & (-2.05) \quad \quad \quad (-4.06) \quad \quad \quad (4.58) \end{aligned}$$

$$R^2:0.757 \quad S.E.: 0.008 \quad DW:2.215 \quad LM_F(4) : 1.97 \quad ARCH_F(4):0.143.$$

ITD inflation is modelled in an error correction model formulation. It is determined by its own past history, GDP deflator inflation and import prices inflation, with short-run homogeneity accepted by the data.

7. The foreign trade sector

The underlying theoretical assumption of the equations modelling real imports (MTR) and real exports (XTR) is that neither imports nor exports are perfect substitutes for the domestic goods of the importing country. Therefore, export and import demands are functions of the income level of the importing country and relative prices. Time trends are also included in the specifications of the two variables, to account for growing import penetration and non-price competitiveness effects.

7.1 Exports

Greek exports are modelled with a unitary elasticity with respect to foreign demand (WDR) in the long run (the unitary elasticity is accepted by the data set). They are also sensitive to relative prices. The foreign demand index (WDR) is computed as a weighted average of import volumes of the main trading partners of Greece, whereas the relative prices measure (which is also a measure of competitiveness due to price differences) is given by the ratio (XTD/CXD). CXD stands for the competitor's export

prices in euros. The equilibrium relationship also allows for a logistic trend to account for the deterioration of Greek export performance - most likely due to non-price competitiveness effects - over the estimation period and for two impulse dummies to capture observed data irregularities.

$$\log(XTR/WDR) = 5.18 - 0.447 * \log(XTD/CXD) - 0.526 * (1 / (1 + \exp(-0.0525 * TIME))) - 0.141 * DV903 - 0.196 * DV851$$

ADF : -4.901 , *MacKinnon critical value at 5%*: -4.2376

The value of the long-run price elasticity of exports seems reasonable.

The short-run dynamics of exports are modelled as a function of world demand and relative prices in a typical error correction formulation.

$$\begin{aligned} \Delta \log(XTR) = & 0.005 - 0.400 * \Delta \log(XTR(-1)) - 0.094 * \Delta \log(XTD/CXD) + 0.999 * \Delta \log(WDR) \\ & (-0.71) \quad (-3.72) \quad \quad \quad (-0.44) \quad \quad \quad (2.33) \\ & -0.357 * \log(XTR/XTRSTAR)_{t-2} - 0.092 * DV903 \\ & (-3.46) \quad \quad \quad (-3.01) \end{aligned}$$

R^2 : 0.299 SE : 0.050 DW : 1.88 $LM_F(4)$: 0.746 $ARCH_F(4)$: 0.33

7.2 Imports

Greek imports move in line with the domestic demand indicator with a unitary elasticity (which ensures the long-run simulation properties of the model) and are elastic to relative prices (MTD/YED). The imports demand indicator, TFER, is computed as a weighted sum of the import contents of the domestic demand components, private consumption (PCR), gross fixed capital formation (ITR) and exports (XTR).

$$TFER = 0.25 * PCR + 0.5 * ITR + 0.4 * XTR.$$

The long-run relationship also accounts for a number of structural changes that affected Greek imports. From 1994 onwards the share of Greek imports to GDP started to increase gradually. It is difficult to attribute this effect only to losses in competitiveness. Conceivably it could be reflecting more general trends in the world economy, such as globalisation and the gradual completion of the EU internal market. These more general effects are taken on board by adding to the equation a segmented trend, denoted by T1 and T2, with the blip point in 1994q1.

$$\log(MTR/TFER) = -0.496*\log(MTD/YED)+0.003*T1- 0.482*DVI+0.006*T2- \\ 0.725*DV2 -0.095*DV851$$

ADF: -4.69 MacKinnon critical value at 5%: -4.6042

The dynamic equation for imports takes the standard error correction specification with the demand indicator and relative prices being the explanatory variables. The impact elasticity of imports with respect to the domestic demand (activity variable) is noticeably high (1.922) and is reflected in the simulations below.

$$\Delta\log(MTR) = -0.002+1.922*\Delta\log(TFER)-0.323*\Delta\log(TFER)_{t-1} \\ (22.10) \quad (-3.585) \\ -0.182*\log(MTR/MTRSTAR)_{t-2} -0.313*\Delta\log(MTD/YED)_t \\ (-2.62) \quad (-1.98)$$

$R^2:0.895$ $S.E.:0.018$ $DW: 2.14$ $LM_F(4) : 2.98$ $ARCH_F(4):0.881$

7.3 Trade deflators

The main explanatory variables for the formation of export and import prices are domestic and foreign prices -expressed in domestic currency- and in the case of import prices, the price of oil. The export deflator (XTD) is modelled in the long run as a function of domestic unit labour costs (ULC) and competitors' export prices expressed in national currency (CXD). A segmented trend is added to the equation with the blip point in 1997q1.

$$\log(XTDSTAR) = -0.245+(1-0.275)*\log(ULC) + 0.275*\log(CXD) - 0.009*TIME + \\ 0.004*TIME*DVSHIFT-0.093*DVSHIFT+0.026*DVSHIFT2000$$

ADF : -5.802, MacKinnon critical value at 5%: -4.9304

In the long run, the import deflator (MTD) is modelled as a function of partner countries export prices (CMD) (expressed initially in dollars and converted into euros through the dollar/euro rate) and the price of oil expressed in euros (POILU*EXR) (POILU denotes the price of oil expressed in US dollars and EXR the euro/dollar exchange rate, period average). Long-run static homogeneity is supported by the data at a reasonable level of significance; it is therefore imposed.

$$\log(MTDSTAR) = -5.984+0.812*\log(CMD)+(1-0.812)*\log(POILU*EXR) - \\ 0.148*DV99 - 0.038*DV86$$

ADF: -5.412. MacKinnon critical value at 5%: -4.237

The resulting short-run equation specifications for the export and import deflators are:

$$\begin{aligned} \Delta \log(XTD) = & -0.007 + 0.229 * \Delta \log(CXD) + 0.435 * \Delta \log(ULC)_t \\ & (-4.63) \quad (5.13) \quad (7.82) \\ & -0.326 * \log(XTD/XTDSTAR)_{t-1} + (1-0.229-0.435) * \Delta \log(ULC)_{t-1} \\ & (-2.92) \\ & + 0.028 * DV2000 \\ & (2.19) \end{aligned}$$

R^2 : 0.667 S.E.:0.0127 D.W: 1.713 $LM_F(4)$: 2.37 $ARCH_F(4)$: 2.24

$$\begin{aligned} \Delta \log(MTD) = & 0.009 + 0.276 * \Delta \log(MTD)_{t-1} + 0.195 * \Delta \log(CMD)_{t-3} \\ & (3.31) \quad (2.94) \quad (3.11) \\ & + 0.042 * \Delta \log(POILU * EXR)_t - 0.111 * \log(MTD/MTDSTAR)_{t-1} \\ & (3.19) \quad (-1.98) \\ & + 0.077 * DV841 + 0.026 * DV20001 \\ & (5.08) \quad (1.70) \end{aligned}$$

R^2 :0.469 S.E: 0.014 DW:2.115 $LM_F(4)$: 0.89 $ARCH_F(4)$: 3.42

7.4 Identities and definitions in the trade block

Once we have real exports and imports and their corresponding deflators, it is straightforward to obtain their nominal counterparts, XTN and MTN, respectively. The trade balance of goods and services is defined as the difference XTN - MTN, and the current account (CAN) can be obtained from the following identity.

$$CAN = (XTN - MTN) + NFN + TWN$$

where NFN denotes net foreign income from the rest of the world and TWN transfers from the rest of the world. Both TWN and NFN are assumed exogenous. Additional identities, which express these variables as GDP ratios, are included in the model.

8. The government sector and interest rates

8.1 The Government

The general government block is mainly made up of identities and most of the variables on the expenditure side are considered exogenous.

Public debt (GDN) is defined as the cumulative sum of past public deficits (GLN).

$$GDN = GDN(-1) + GLN + ZGDN$$

where ZGDN reflects the stock and flow adjustment process.

General government net lending (GLN) is defined as the difference between the revenue (TCR) and the expenditure (TCU) of the public sector.

$$GLN = (TCR) - (TCU) = (PDN + TXI + EC) - (GCN + INN + TRN + SUBN + OCN)$$

On the revenue side, PDN, TXI and EC are direct taxes, indirect taxes and social security contributions, respectively. On the expenditure side, GCN, INN, TRN, SUBN and OCN are public consumption, interest payments on public debt, transfers to households (mainly pensions), subsidies and other current expenditure, respectively.

Our approach to modelling the revenue side variables is rather standard within the MCM-framework: an implicit tax rate is calculated over a tax base, which is an endogenous variable, whereas the tax rate is left exogenous. The calculation of nominal direct taxes assumes that the tax base consists of the taxable components of personal income, in other words the nominal income from labour (WIN), nominal transfers to households (TRN) and other personal income (OPN). Thus, nominal taxes (PDN) are given by.

$$PDN = PDX * (WIN + OPN + TRN)$$

The implicit direct tax rate TDX is not exogenous, given that the fiscal rule is defined on this tax rate. The fiscal rule adjusts the implicit tax rate when the ratio of nominal public debt to nominal GDP ($GDN/4*YEN$) exceeds a certain predetermined value defined by the baseline ratio (GDN/YEN).

$$TDX = TDX_{baseline} + b * (GDN/4*YEN - GDN/4*YEN') * DVFIRULE$$

In addition, other personal income, OPN, is estimated to be given by.

$$OPN_t = -236.6 + 0.09 * (GON - (1 - DEPR) * ITD * KSR_{t-1})$$

where GON stands for the gross operating surplus and DEPR is the depreciation rate (defined also as δ) of the capital stock. For the calculation of indirect taxes, TXI, the tax rate, TIX, is assumed exogenous and common for the taxable components of demand, nominal private consumption (PCN) and nominal government consumption (GCN): $TXI = TIX*(PCN+GCN)$.

Finally, social security contributions (EC) are estimated to be a function of domestic labour income: $EC_t = -60.24 + 0.42*WIND$.

Concerning the expenditure side, transfers to households, TRN, are endogenous. It is assumed that current transfers to household are proportional to nominal GDP *via* an implicit transfer rate depending on the unemployment rate. The following equations describe the behaviour of transfers to households.

$$TRN = TRX*YEN$$

$$\text{Log}(TRX) = -0.390 + 0.823*\text{log}(TRX)_{t-1} + 0.006*URX_{t-1} + 0.063*DV9034$$

However, unemployment benefits in Greece are essentially limited and transfers consist mainly of payments to retired workers.

In the model, interest payments on public debt INN and subsidies SUBN are considered to be exogenous, whereas government consumption GCN is given by.

$$GCN = GCR*GCD,$$

with GCR and GCD also left exogenous. Other current expenditure, OCN, is also exogenous.

8.2 Interest rates

Nominal long-term lending rates, LTR, are modelled using a backward-looking scheme. The long-term lending rate is a function of the short-term interest rate, STR, which is exogenous in the model. A unit coefficient is imposed in the long run equilibrium relationship. The estimated equation for the long-term rate is defined as:

$$\Delta LTR_t = 0.29 + 0.24*\Delta STR_t + 0.17*\Delta STR_{t-1} - 0.06(LTR_{t-1} - STR_{t-1})$$

9. Simulation properties of the model

This section reports the results of selected simulations using the current version of the model. All simulations assume a shock in an exogenous variable which thereafter remains constant throughout the simulation period. Although a number of experiments have been conducted in order to assess the dynamic properties of the model, in this section we present the simulations that we consider to be the most illustrative of the properties of the model. All simulations were run without imposing the fiscal closure rule and tax rates are at their baseline values. Nominal interest rates and exchange rates were assumed to remain constant at their baseline values (e.g. there is no link between nominal interest rates and inflation rates and thus, the exogenous nominal interest rates imply endogeneity of real interest rates via the inflation effect). The baseline was constructed by maintaining the observations for all variables constant at their 2000q4 level throughout the simulation period. Against this background the simulations results should be viewed more as a reflection of the basic properties of the model rather than a precise depiction of the behaviour of the Greek economy to specific exogenous shocks. However, in order to highlight the importance of the policy rules for the properties of the model, we have carried out some alternative simulations which are implemented by imposing the fiscal rule as well as a Taylor rule for the short-term interest rate. These policy simulations portray a more realistic depiction of the responses of the Greek economy to exogenous shocks as they incorporate the reaction of the authorities in an endogenous manner. We stress that the results depend strongly on the assumptions accompanying the simulations.

In the simulations, the user cost of capital is smoothed according to the following.

$$CC_t = 0.7*CC_{t-1} + (1-0.7)*ITD_t (r/4 + \delta/4 - (\Delta ITD_t / ITD_{t-1})) + RES,$$

where ITD denotes the investment goods deflator, r denotes nominal cost of borrowing funds (the bank lending rate to enterprises), δ is the depreciation factor, and the final component expresses the rate of expected inflation in the investment goods deflator. This specification prevents an excess response of investment during the simulation exercises.

The simulations are carried out over a fifteen-year period. Numerical results are presented for five years on a quarterly basis as well as annual averages.

We consider the following shocks:

- 1) A permanent increase in government consumption by one percent in baseline GDP.
- 2) A permanent increase of one percent in world demand for Greek exports.
- 3) A permanent increase of one percent in foreign prices.
- 4) A permanent appreciation of the euro by 1 percent.
- 5) A permanent 10 percent increase in the price of oil.

1) A permanent increase in government consumption by one percent of baseline GDP.

The increase in government spending is assumed to be of the form of an increase in goods and services purchased from the private sector and of an increase in government employment. The increase in government consumption spurs an immediate increase in domestic demand and output, stimulating further all elements of demand in the short run. Household consumption is boosted by higher revenues and investment *via* the accelerator effect. Increased output leads to a considerable rise in employment, especially in the light of the sluggishness of the labour market. Demand-side pressures, as well as lower unemployment, eventually drive up wages and prices. As a result, investment and private consumption are further boosted because higher inflation rates imply lower real interest rates and user costs of capital. (Table 2 summarises the numerical results and a graphical exposition is presented in Charts 2 and 3).

On the fiscal front, the rise in government consumption initially leads to an anticipated rise in nominal public expenditure and a consequent widening of the government debt – to - GDP ratio. In the medium run, price inflation exceeds real GDP growth and this leads to a gradual decline in government expenditure in nominal terms as a percentage of nominal GDP. The rise in employment leads to a decrease in public expenditure because of the falls in unemployment benefits and transfers. From the third to the fifth year of the simulation, public expenditure as a percent of GDP is on a path below that of the baseline.

As the simulation horizon lengthens, the domestic price rise leads to a loss of competitiveness, which, in turn, reduces exports, given the fixed exchange rate. This effect, accompanied by the higher domestic demand for imports (due to the demand increase), leads to widening of the trade deficit and slows down the deviation of the

level of output from the baseline. Nevertheless, without the imposition of any policy rule (fiscal or monetary), output and prices remain above the baseline until the end of the simulation period.

Moreover, in an attempt to better illustrate the properties of the model, especially the short-run dynamics of the responses, the same fiscal shock was implemented by setting in operation the government reaction function for the implicit direct tax rate (described in section 8.1). In this case output and prices converge on their base values following a rather smooth path by the end of the 15-year simulation horizon (see Chart 4). The same experiment (a permanent increase of Government consumption by 1% of GDP) was conducted over an extended simulation period of 150 years on a quarterly basis under two alternative policy assumptions:

- i. Active fiscal policy aiming to maintain the debt to GDP ratio close to base, technically implemented by switching-on the benchmark fiscal rule from the 8th quarter onwards till the end of the simulation period; and
- ii. by assuming that the monetary policy stance is described by a standard Taylor rule for short-term nominal interest rates¹¹.

Charts 5 and 6 illustrate the responses of output and prices, highlighting the stabilisation power of both rules. However, it should be stressed that the model is designed to be simulated in linked mode as a part of the eurosystem multi-country model. In such a linked framework, euro exchange rates and interest rates would be determined by the appropriate parity conditions and monetary policy rules defined at the euro-area level.

2) An increase of one percent in world demand for Greek exports.

The increase in external demand boosts exports and all other GDP components. The positive effect of rising demand and the consequent fall in unemployment lead to increased prices. The rise in prices implies lower real interest rates and user costs of capital, which, combined with the standard multiplier effect (due to increased demand) leads to a significant rise in investment, observed for the entire simulation period. Exports increase considerably in the medium run; the imposition of unit

¹¹ The Taylor rule is defined in terms of deviations of output from its base run values and not to potential output.

elasticity of exports with respect to foreign demand forces exports to deviate by up to almost 1% from baseline in the medium run.

The demand-induced inflation leads to competitiveness losses and reduces the initial positive effect on the trade balance. Net exports are reduced as a result of the change in competitiveness whereas imports are further increased due to the rise in demand. Still, the effect on the trade balance, GDP and employment remains positive till the final year of the simulation. The simulation is carried out under a constant external environment apart from the assumed increase in demand for Greek exports. Table 3 reports the numerical results of the simulation (in terms of percentage deviations from baseline), while Charts 7 and 8 show graphically the dynamic responses to the shock by real GDP, real exports and real imports as well as their implicit price deflators.

3) A permanent increase of one percent in foreign prices.

The rise in foreign prices has the expected effect on price deflators (see Table 4 and Chart 9 and 10). The trade deflators adjust almost immediately to the rise in foreign prices (reflecting the assumption of price taking behavior), whereas the consumption and GDP deflators rise only gradually. Due to the long-run homogeneity of the model, at the end of the simulation period all deflators are raised by almost the same amount. The rise in foreign prices implies an improvement in domestic competitiveness, which leads to gains in market shares and a considerable increase in exports and investment.

Because domestic price inflation, under the assumed constancy of the nominal interest rate throughout the simulation horizon¹², induce lower cost of capital, investment rises but the growth of real disposable income moderates. The slower increase in real income causes a very low growth in consumption and also impacts on imports. At the end of the simulation period, the rise in domestic prices weakens the initial positive effect in competitiveness and the deficit practically returns to base. Still, the overall effect on GDP and employment remains positive until the end of the period.

4) A permanent appreciation of the euro by 1%.

This simulation is implemented by assuming: a) an immediate rise in the euro/dollar rate by 1 percent; b) a decrease in competitor prices on the export side by 0.6 percent in euro (60 per cent of Greece's total exports are directed outside the euro area); and

¹² These results are strongly conditional on the constant nominal interest rate assumption. If the simulation was implemented under an area wide monetary rule, the results would be different

c) a decrease in competitors' prices on the import side by around 0.5 percent in euro, (Greece's extra euro area imports cover around 50 percent of total imports). All other variables remain at their baseline values.

The appreciation has a dampening effect on all price deflators. The negative impact is immediate on the import and export deflators, but the effect is also transmitted gradually to all other deflators. Exports and investment are negatively affected by the appreciation and the consequent loss of competitiveness, as expected. Consumption remains close to its baseline value throughout the simulation period. In addition, the fall in domestic prices gradually leads to a partial restoration of competitiveness, which positively affects net exports. Output remains below baseline for the full five-year simulation horizon, while unemployment and employment are only marginally affected by the appreciation. The numerical results of this simulation are reported in Table 5 while Charts 11 and 12 show graphically the responses for several real variables and implicit price deflators.

5) A permanent 10 percent increase in the price of oil.

As the model treats imports as a homogenous aggregate, the implementation of the oil price shock requires some further adjustments and judgemental interventions in order to increase the realism of the results and to overcome this particular limitation of the model.

Following Warmendinger (2003), we down-weight the elasticity of real imports demand with respect to relative prices. The adjustment is made taking into account the long-run elasticity of oil prices in the import deflator equation. Moreover the simulation is carried out by maintaining the wage variable at the baseline path in the first two years of the simulation period. This assumption, is in our view, a realistic one, given that contractual wages are normally agreed for a two-year period. From the third year onwards wages are determined endogenously by the model. In addition and throughout the simulation period, real interest rates are maintained at baseline values in order to avoid the demand-boosting impact of inflation through its effect on nominal interest rates¹³.

¹³ The maintenance of the real interest rate at baseline values in the oil price simulation is standard practice in order to avoid a strong positive and counterintuitive reaction of investment.

The increase in the price of oil has the expected positive effect on all price deflators. The import deflator is immediately affected, whereas the impact on the GDP, consumption and export deflators is more gradual. The rise in prices causes an immediate reduction in the demand for domestic and foreign goods and a consequent fall in household consumption, imports and exports. As a result, GDP and real disposable income are below baseline throughout the period under consideration. The numerical results of this simulation are reported in Table 6, while Charts 13 and 14 illustrate graphically the responses for a collection of real variables and implicit price deflators.

10. Conclusions

The Greek economy has undergone a number of structural changes during the years for which the model presented in this study was estimated. As noted, the construction of a theory- consistent model with constant parameters turned out to be challenging. Nevertheless, we believe that the model has realistic economic and statistical properties. In the present version of the model, the estimated long-run relationships are consistent with the economic theory, whereas the short-run dynamics are specified on the basis of the statistical properties of the data series. The model provides reasonable and interesting implications for the functioning of the Greek economy and was shown to be very useful for the construction of simulation exercises. As we also noted in the introduction, this particular version of the model is by-no-means the end of the story, especially given the rapid pace of developments in the field of econometric modelling. Possible extensions of the model could include a different and more sophisticated treatment of the expectations formation mechanism, which at present are treated as backward looking, the introduction of learning mechanisms, and the disaggregation of some equations, especially in the public and foreign sectors.

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APPENDIX A: The Quarterly National Account Data

By P. Tzamourani

The source of all national accounts data is the National Statistical Service of Greece (NSSG). All data are on an ESA 95 basis. The NSSG published quarterly series of GDP and its basic components for 1980-2000¹⁴. The rest of the series were on an annual basis which necessitated the construction of quarterly observations. To construct the quarterly series two methods were used: a) a cubic spline function¹⁵ and b) state space modelling¹⁶. All series were subsequently seasonally-adjusted with the X11 method. The methods used to construct the quarterly series for each group of data are given below.

GDP and components

YEN, YER, PCN, PCR, GCN, GCR, ITN, ITR,GIN,GIR, XTN, XTR, MTN, MTR are the official series of the NSSG. The deflators have been calculated by dividing the relevant seasonally-adjusted series in current prices with the corresponding ones in constant prices.

Gross Value Added

YIN and WIND were obtained by applying a cubic spline. WIN (national definition) was estimated as part of the national income equation (described below). TIN was obtained from $YEN - YIN$ and $GON = WIND - WIN$.

Income Appropriation Account

PYN, WIN, OPN, TRN, TXD and EC were estimated simultaneously using state space modelling. The state space model was formulated by defining the state variables as the estimates of the balanced quarterly series and the measured variables as the observed annual series. Restrictions were imposed on the errors so that the unobserved balanced quarterly estimates match the official annual series. PSN was the difference of private consumption from disposable income ($PYN - PCN$) whereas real

¹⁴ Press Report June 2002 and Press Report July 2002.

¹⁵ TROLL's 'spatq' function. The average of the growth rates of each quarter w.r.t.the corresponding quarter of previous year is equal to the annual growth rate (of the original data).

¹⁶ Liu H. and S.G.Hall, 2000, Creating High Frequency National Accounts with State Space Modelling: A Monte Carlo Experiment. mimeo

income was calculated by dividing the nominal disposable income by the private consumption deflator (PYN/PCD).

Labour market data

LF, LNN, LED and UN have been estimated using a cubic spline. The unemployment rate was defined as UN/LF

Income and Expenditure of General Government

The series TCR, TCRT, INN, SUBN,TCU, TCUT, GCFP, TXI were obtained by applying the cubic spline method. The rest of the variables were derived from the following identities:

$$\text{CATR} = \text{TRCT} - \text{TCR}$$

$$\text{OCN} = \text{TCU} - (\text{GCN} + \text{TRC} + \text{INN} + \text{SUBN})$$

$$\text{OCE} = \text{TCUT} - (\text{TCU} + \text{GCFP})$$

$$\text{GLN} = \text{TCRT} - \text{TCUT}$$

$$\text{RCO} = \text{TCR} - (\text{TXI} + \text{TXD} + \text{EC})$$

$$\text{GPS} = \text{TCR} - \text{TCU}$$

Current Foreign Transactions

NFN and TRON have been estimated with the cubic spline method.

$$\text{CAN} = \text{XTN} - \text{MTN} + \text{NFN} + \text{TRON}.$$

APPENDIX B: LIST OF SYMBOLS

ENDOGENOUS

CAN :	current account balance, nominal
CC0 :	user cost of capital
CPI :	consumer price index
CXD :	competitors prices on the export side in Euros
CMD :	competitors prices on the import side in Euros
EC:	social security contributions
FWN:	nominal wealth
FWR:	real wealth
GCN :	public consumption, nominal
GCR:	public consumption, real
GDN :	public debt
GLN :	public deficit
GON :	gross operating surplus of companies
ITD:	gross fixed capital formation deflator
ITN :	gross fixed capital formation, value
ITR:	gross fixed capital formation in real terms
KSR:	capital stock
LNN :	total employment
LTR:	long-term interest rate
MTD :	imports deflator
MTN :	imports, value
MTR :	imports, volume
OPN :	other personal income
PCD :	private consumption deflator
PCN :	private consumption, value
PCR :	private consumption, volume
PROD:	labour productivity
PSN:	Personal sector saving
PYN:	Personal disposable income
PYR:	Real personal disposable income
RCAN:	current account as % of GDP
REALWUN:	real wage
RGDN:	Public debt as % of GDP
RSTI:	real short-term interest rate
SGLN:	debt accumulation
TCR:	current resources
TCRT:	total current resources
TCU:	current expenditure
TCUT:	Total current expenditure
PDN:	direct taxes of households
TFER:	waited demand indicator
TDX:	effective direct tax rate on households
TIN:	indirect taxes
TRNY:	transfers to households
TRX:	Ratio of transfers to households over GDP

TXI:	indirect taxes
ULC:	unit labour cost
UN:	unemployment, number
URX:	unemployment, rate
WER:	weighted sum of demand components
WIN:	compensation of employees
WIND:	compensation of employees (domestic component)
WUN:	wage rate
XTD:	exports deflator
XTN:	exports, value
XTR:	exports, volume
YED:	GDP deflator
YEN:	nominal GDP
YER:	real GDP
YID:	GDP at factor costs deflator
YIR:	real GDP at factor costs

EXOGENOUS

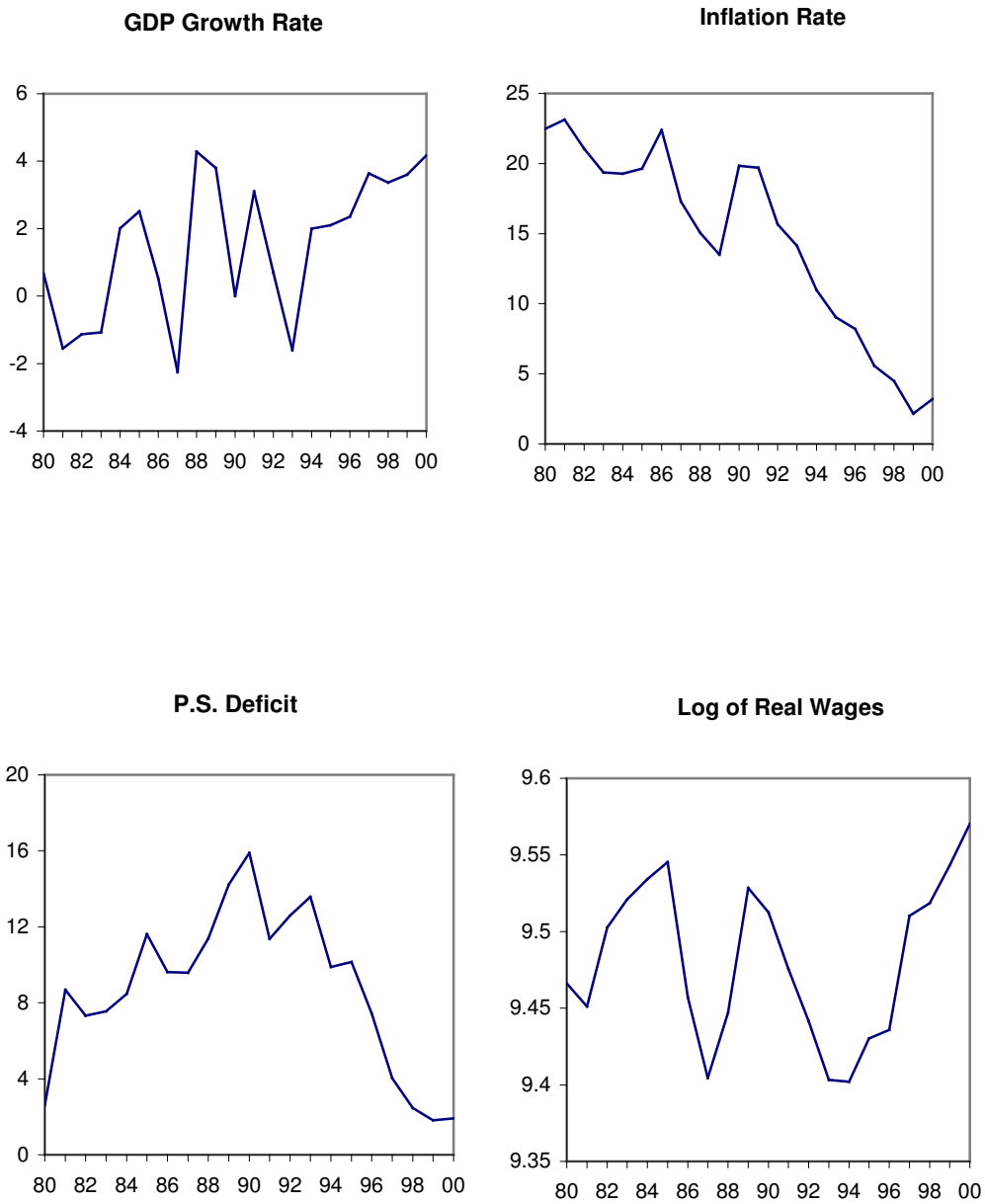
CATR:	capital transfers
CXUD:	competitor prices on the export side in USD
DEPR:	depreciation rate
EER:	effective exchange rate
EXR:	Euro/ US dollar nominal exchange rate
CMUD:	competitors prices on the import side USD
GCD:	government consumption deflator
GCFP:	gross fixed capital formation (public)
INN:	interest payments
LF :	labour force
NFN:	net factor income
OCN:	other current uses
POILU:	oil prices in US dollars
OPN:	other personal income
STI:	short term interest rate
SUBN :	subsidies
TDXBL:	Baseline tdx
TIR:	adjustment to factor cost
TIX :	effective indirect tax rate
TIME:	time trend
TRN:	transfers to households from the government
TWN:	transfers from abroad
WDR :	indicator of world demand

DVSHIFT:	DV 1995q2 - 2000q4 = 1
DUM3:	DV 1986q4 - 1987q3 = 1
DUM8:	DV 1987q1 - 1994q4 = 1
DVSHIFTC:	DV 1990q1 - 2000q4 = 1
TT:	policy regime variable
T1:	time trend 1980q1 - 1993q4

T2: time trend 1994q1 - 2000q4
DVyyq: Impulse Dummies yy stands for years and q for quarters
Z: prefix for statistical adjustment

Chart 1

The Greek Economy



Sources: NSSG and Bank of Greece

Chart 2

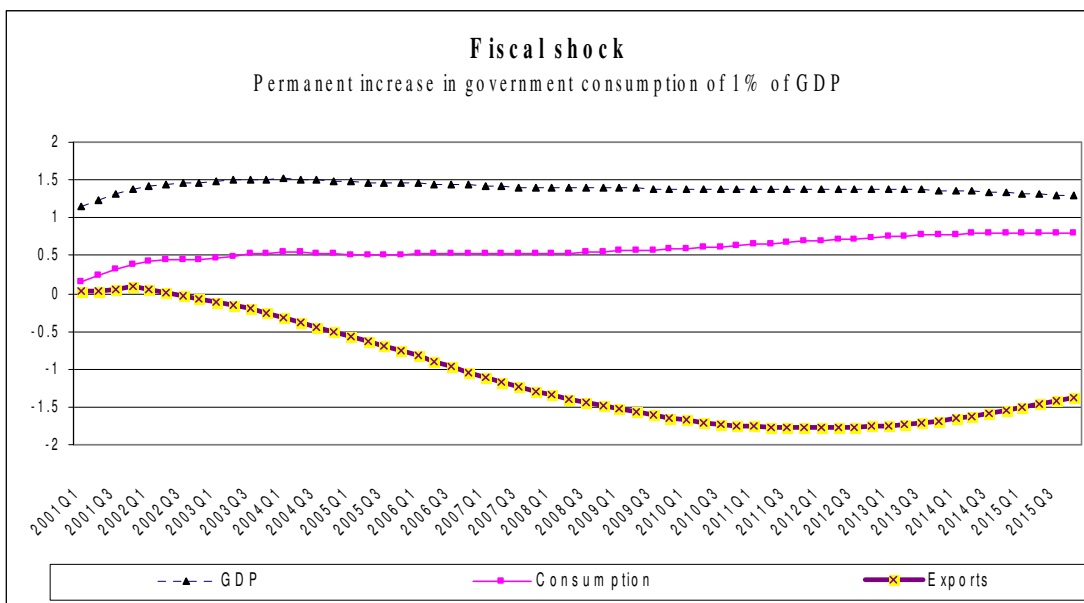


Chart 3

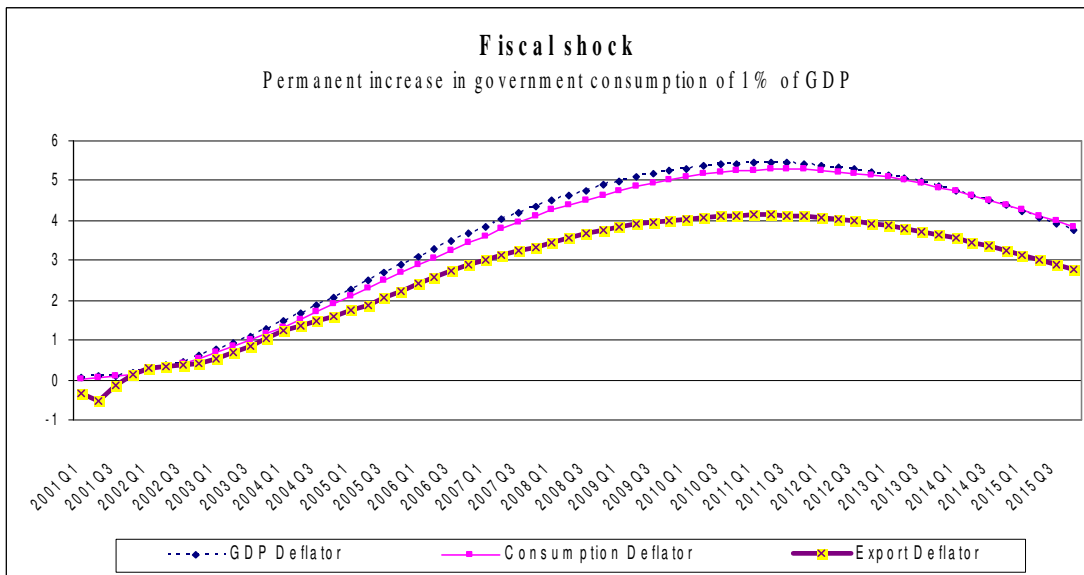


Chart 4

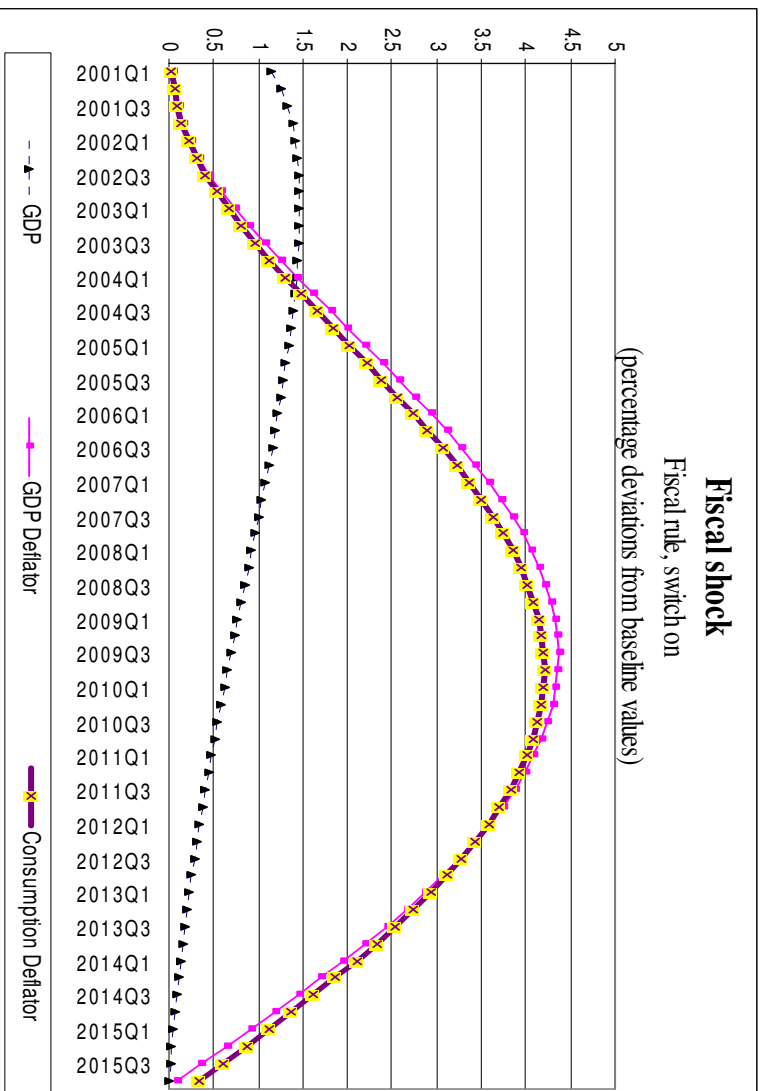


Chart 5

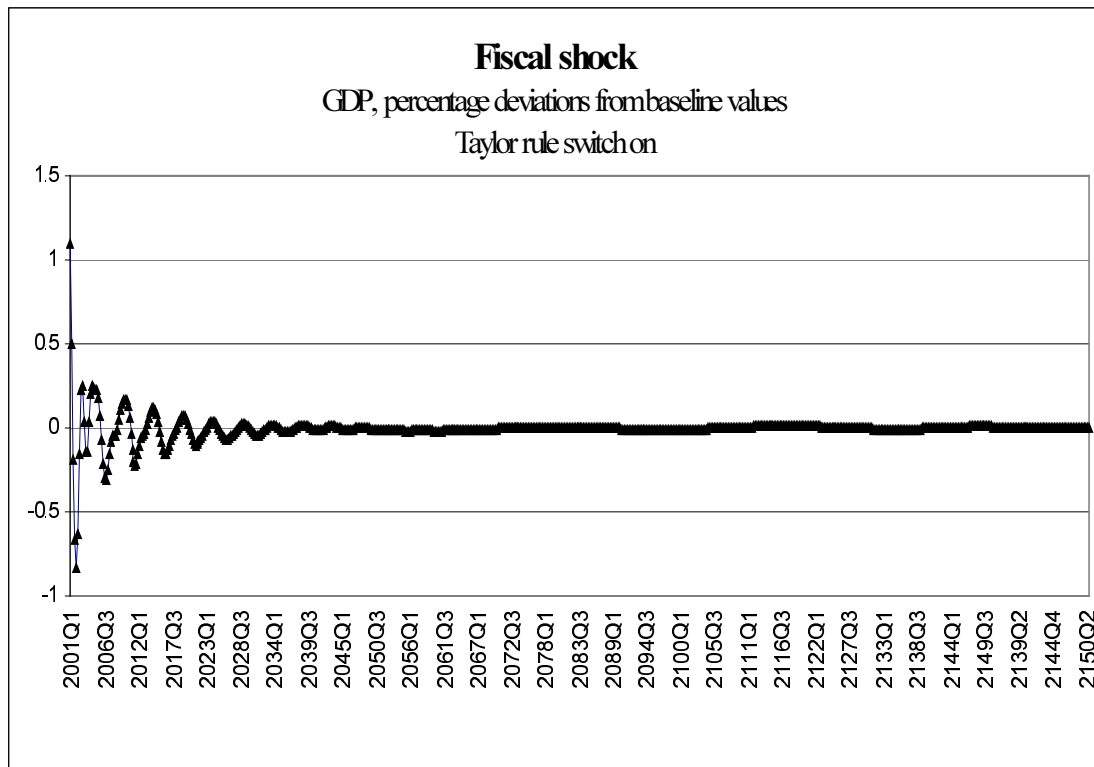


Chart 6

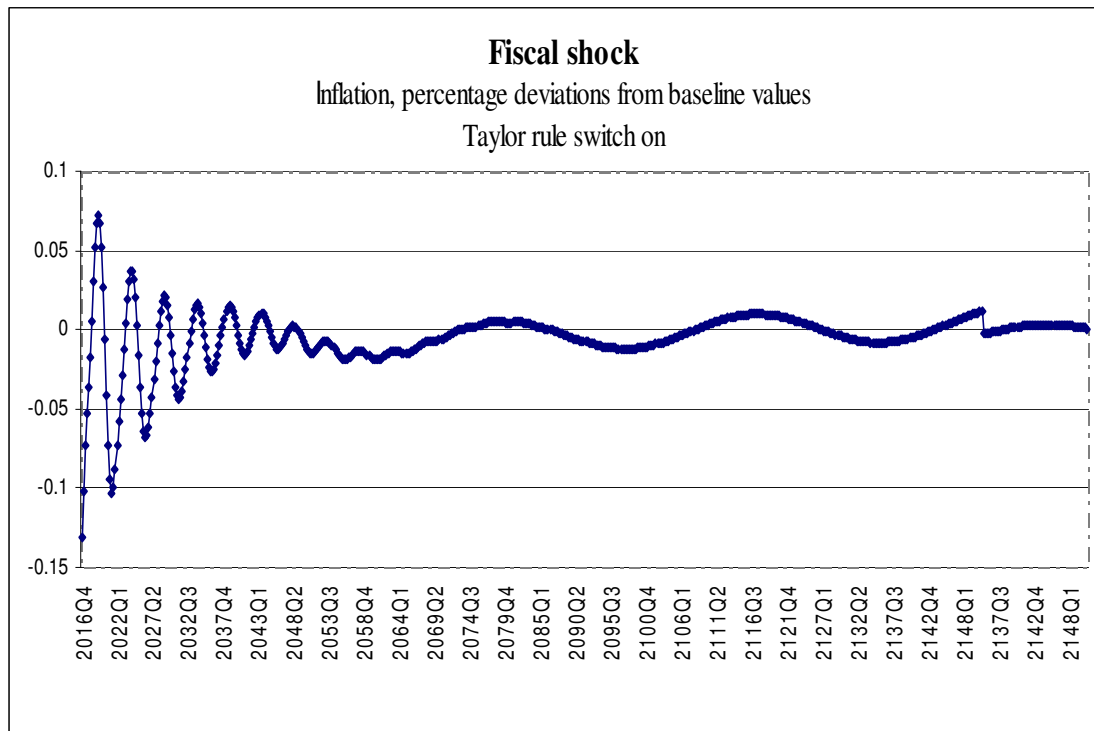


Chart 7

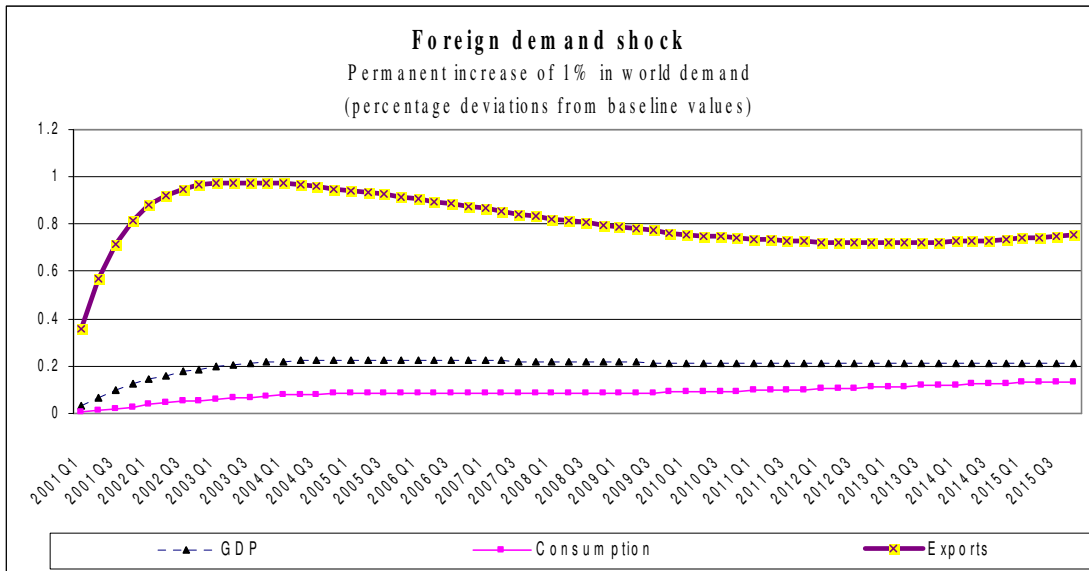


Chart 8

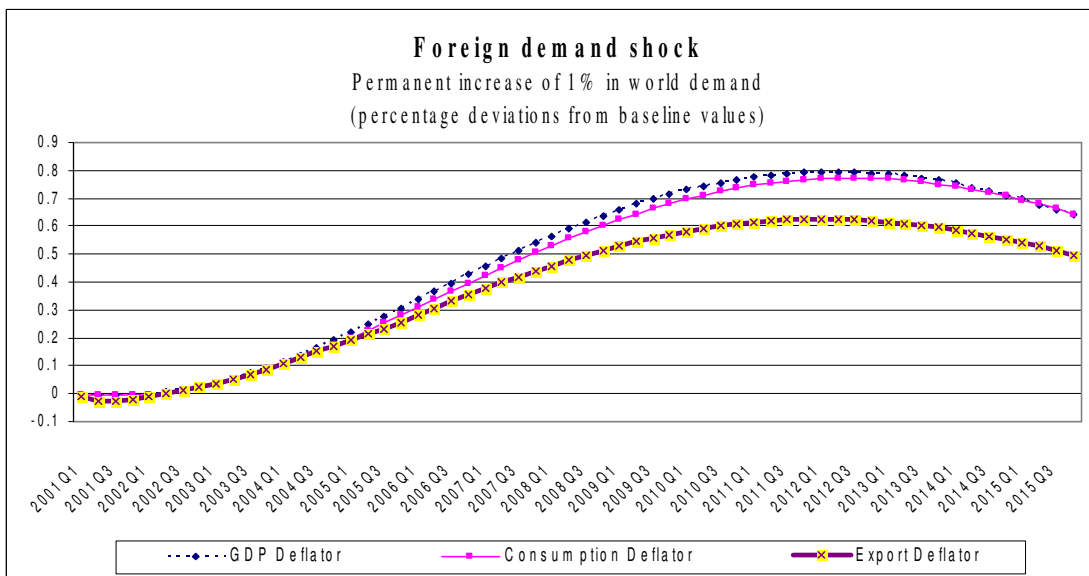


Chart 9

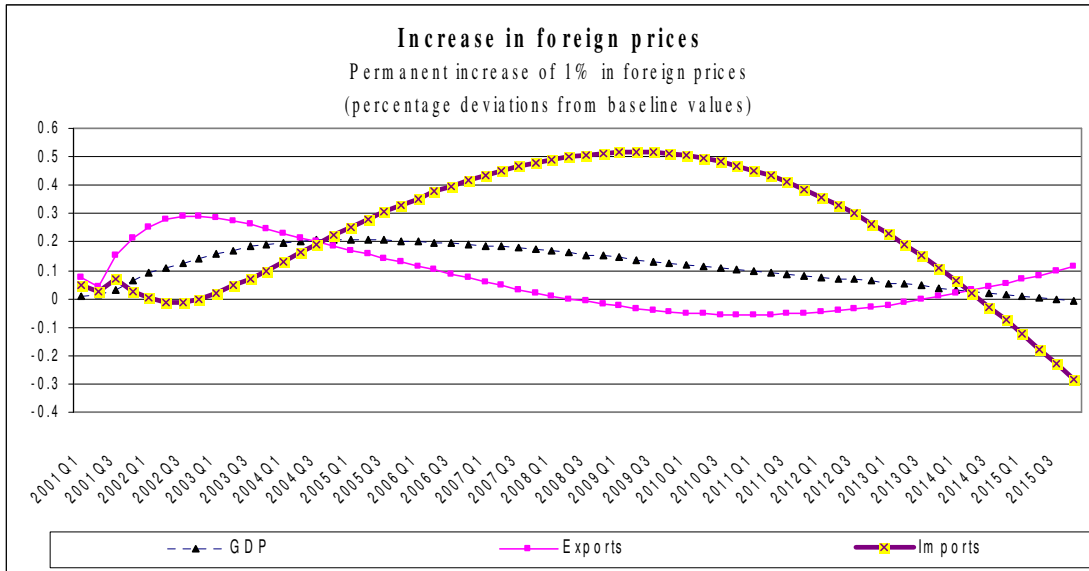


Chart 10

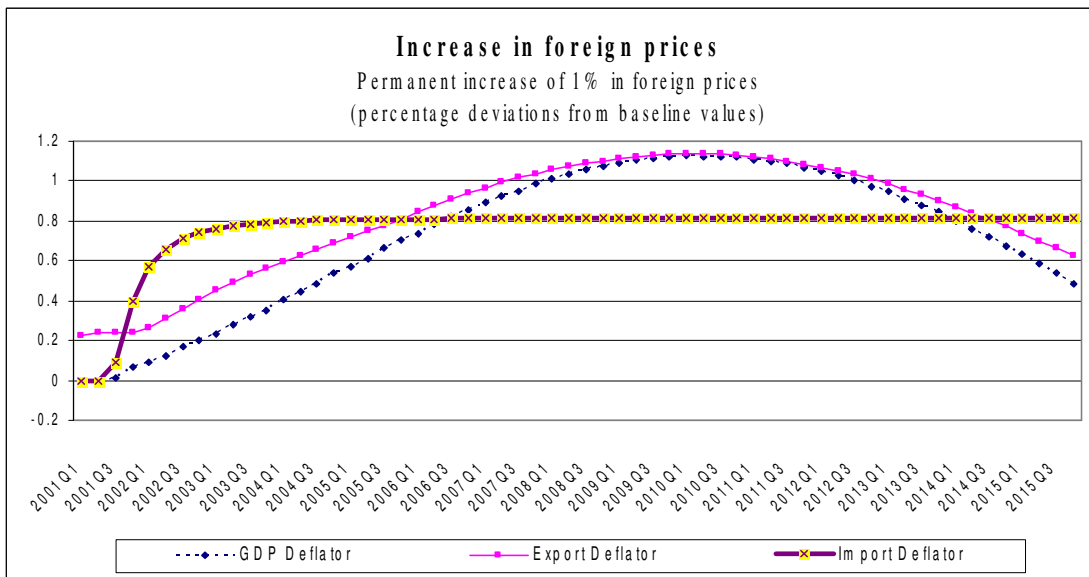


Chart 11

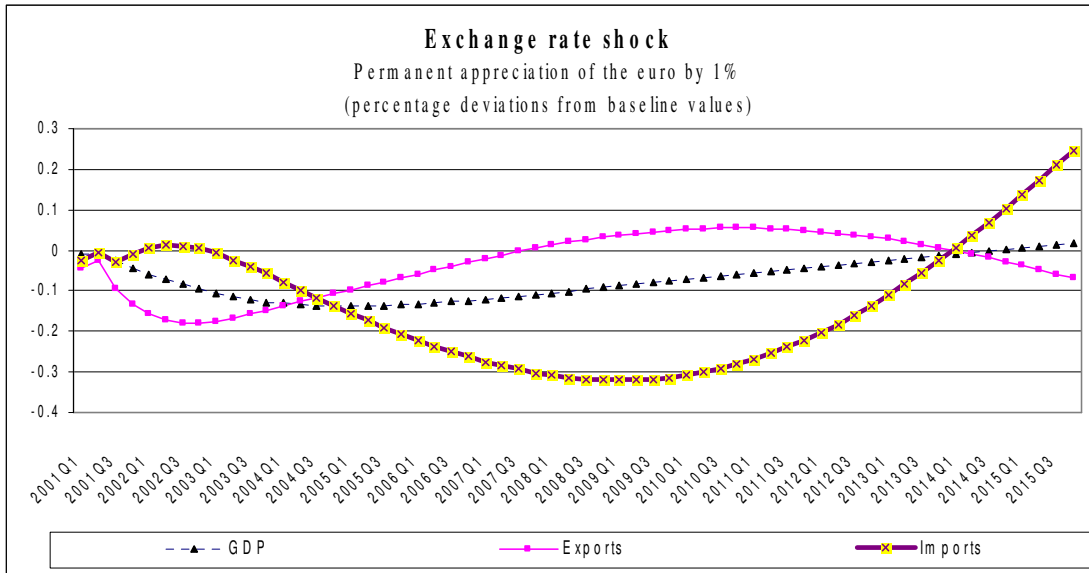


Chart 12

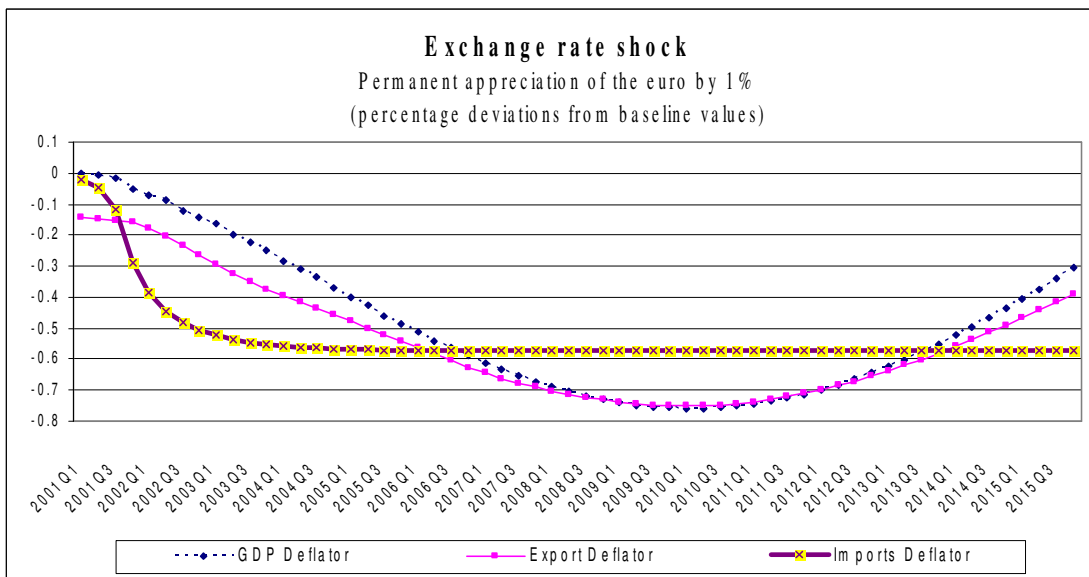


Chart 13

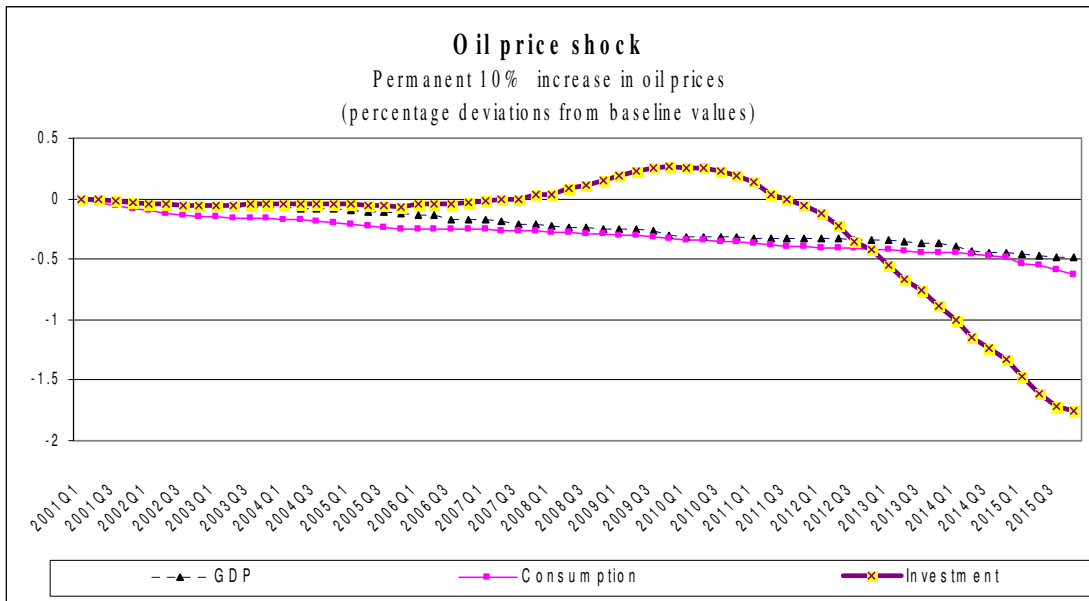


Chart 14

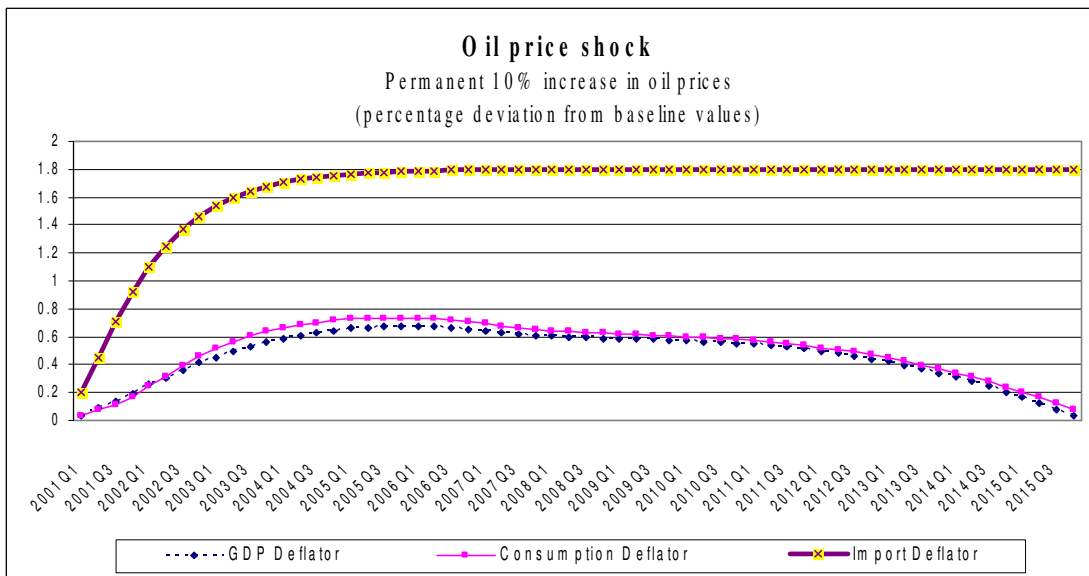


Table 2: Fiscal shock

	Annual profile (averages)					Quarterly profile							
						First year				Fifth year			
	+1	+2	+3	+4	+5	+1Q1	+1Q2	+1Q3	+1Q4	+5Q1	+5Q2	+5Q3	+5Q4
Prices													
HICP													
Consumption Deflator	0.09	0.38	0.92	1.62	2.39	0.04	0.07	0.11	0.15	2.10	2.30	2.49	2.68
GDP Deflator	0.10	0.43	1.01	1.77	2.59	0.04	0.08	0.12	0.17	2.28	2.49	2.68	2.89
Unit Labour Costs	-0.25	0.46	1.08	1.93	2.71	-0.79	-0.41	0.0	0.23	2.37	2.58	2.82	3.07
Compensation to Employees	0.53	1.15	1.76	2.32	3.06	0.17	0.43	0.68	0.86	2.73	2.95	3.17	3.39
Labour Productivity	0.78	0.69	0.67	0.39	0.34	0.96	0.85	0.70	0.63	0.36	0.36	0.34	0.31
Export Deflator	-0.22	0.36	0.78	1.42	1.98	-0.3	-0.52	-0.15	0.13	1.74	1.88	2.05	2.23
Import Deflator	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Real GDP and Components													
GDP	1.27	1.44	1.50	1.50	1.47	1.15	1.24	1.31	1.38	1.48	1.47	1.46	1.46
Consumption	0.28	0.44	0.51	0.54	0.51	0.16	0.24	0.32	0.39	0.52	0.51	0.51	0.52
Investment	1.72	2.25	2.97	3.85	4.80	1.71	1.59	1.70	1.87	4.43	4.68	4.92	5.17
Of which: Residential Inv.													
Gov. Consumption	7.21	7.21	7.21	7.21	7.21	7.21	7.21	7.21	7.21	7.21	7.21	7.21	7.21
Exports	0.05	-0.01	-0.18	-0.41	-0.67	0.03	0.04	0.04	0.08	-0.57	-0.6	-0.70	-0.76
Imports	1.11	1.30	1.72	2.28	2.89	1.20	1.01	1.07	1.17	2.64	2.81	2.97	3.14
Contributions to Impact													
Domestic Demand	1.62	1.87	2.09	2.33	2.55	1.53	1.56	1.65	1.74	2.46	2.52	2.58	2.64
Inventories													
Trade Balance	-0.35	-0.4	-0.6	-0.8	-1.1	-0.4	-0.3	-0.3	-0.4	-1.0	-1.05	-1.12	-1.19
Labour Market													
Total Employment	0.48	0.75	0.82	1.11	1.12	0.19	0.39	0.61	0.74	1.12	1.11	1.12	1.14
Employees in Employment													
Unemployment Rate	-0.4	-0.7	-0.73	-1.0	-1.00	-0.17	-0.35	-0.54	-0.7	-1.0	-1.0	-1.0	-1.01
Household Accounts													
Real Disposable Income	0.49	0.54	0.55	0.56	0.57	0.38	0.46	0.55	0.59	0.54	0.55	0.58	0.61
Savings Rate	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Fiscal Ratios													
Total Receipts	-0.21	-0.25	-0.3	-0.4	-0.5	-0.3	-0.2	-0.2	-0.2	-0.5	-0.5	-0.5	-0.51
Total Expenditure	0.60	0.25	-0.05	-0.41	-0.74	0.70	0.66	0.57	0.47	-0.6	-0.71	-0.78	-0.9
Budget Deficit	-0.81	-0.50	-0.27	0.01	0.26	-0.97	-0.9	-0.8	-0.7	0.17	0.23	0.29	0.35
Government debt	-0.9	-0.87	-1.16	-1.86	-2.81	-1.00	-0.87	-0.87	-0.87	-2.41	-2.7	-2.9	-3.2
Financial Variables													
Short-term Int. Rates	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Long-term Int. Rates	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Foreign Demand													
Total	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Foreign Competitor's Prices													
Effective Exchange Rate	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Foreign Prices (euro)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Commodity Prices (euro)													

Table 3: Foreign demand shock

	Annual profile (averages)					Quarterly profile							
						First year				Fifth year			
	+1	+2	+3	+4	+5	+1Q1	+1Q2	+1Q3	+1Q4	+5Q1	+5Q2	+5Q3	+5Q4
Prices													
HICP													
Consumption Deflator	0.00	0.01	0.06	0.14	0.24	0.00	-0.01	-0.01	0.00	0.20	0.23	0.25	0.28
GDP Deflator	-0.01	0.01	0.06	0.15	0.26	0.00	-0.01	-0.01	-0.01	0.22	0.25	0.28	0.31
Unit Labour Costs	0.0	0.01	0.08	0.19	0.30	0.0	0.0	0.0	0.0	0.26	0.29	0.32	0.35
Compensation to Employees	0.03	0.10	0.19	0.27	0.37	0.01	0.02	0.03	0.05	0.33	0.35	0.38	0.41
Labour Productivity	0.05	0.09	0.10	0.08	0.07	0.03	0.05	0.06	0.07	0.07	0.07	0.06	0.06
Export Deflator	0.0	0.01	0.06	0.14	0.22	-0.01	0.0	0.0	0.0	0.19	0.21	0.23	0.26
Import Deflator	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Real GDP and Components													
GDP	0.08	0.17	0.21	0.22	0.23	0.03	0.07	0.10	0.12	0.23	0.23	0.23	0.23
Consumption	0.02	0.05	0.07	0.08	0.08	0.00	0.01	0.02	0.03	0.08	0.08	0.08	0.08
Investment	0.11	0.23	0.34	0.46	0.59	0.05	0.09	0.13	0.16	0.54	0.57	0.61	0.64
Of which: Residential Inv.													
Gov. Consumption	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Exports	0.62	0.93	0.98	0.96	0.93	0.36	0.57	0.72	0.82	0.94	0.93	0.92	0.92
Imports	0.30	0.41	0.44	0.50	0.58	0.19	0.28	0.34	0.37	0.54	0.56	0.59	0.61
Contributions to Impact													
Domestic Demand	0.04	0.09	0.13	0.17	0.21	0.02	0.03	0.05	0.06	0.19	0.20	0.21	0.22
Inventories													
Trade Balance	0.04	0.08	0.08	0.05	0.02	0.02	0.04	0.05	0.06	0.04	0.03	0.02	0.01
Labour Market													
Total Employment	0.03	0.08	0.10	0.14	0.16	0.01	0.02	0.03	0.05	0.16	0.16	0.16	0.17
Employees in Employment													
Unemployment Rate	0.0	-0.07	-0.1	-0.12	-0.14	-0.01	-0.01	0.0	0.0	-0.14	-0.14	-0.15	-0.15
Household Accounts													
Real Disposable Income	0.03	0.07	0.08	0.09	0.09	0.01	0.02	0.04	0.05	0.09	0.09	0.09	0.09
Savings Rate	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Fiscal Ratios													
Total Receipts	0.0	0.0	-0.1	-0.1	-0.1	0.0	0.0	0.0	0.0	-0.1	-0.1	-0.1	-0.1
Total Expenditure	0.0	-0.1	-0.1	-0.2	-0.2	0.0	0.0	0.0	0.0	-0.2	-0.2	-0.2	-0.2
Budget Deficit	0.00	0.03	0.07	0.10	0.14	0.00	0.00	0.00	0.01	0.13	0.14	0.15	0.16
Government debt	-0.07	-0.2	-0.35	-0.55	-0.79	0.0	-0.1	-0.1	-0.12	-0.7	-0.8	-0.8	-0.9
Financial Variables													
Short-term Int. Rates	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Long-term Int. Rates	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Foreign Demand													
Total	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Foreign Competitor's Prices													
Effective Exchange Rate	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Foreign Prices (euro)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Commodity Prices (euro)													

Table 4: Increase in foreign prices

	Annual profile (averages)					Quarterly profile							
						First year				Fifth year			
	+1	+2	+3	+4	+5	+1Q1	+1Q2	+1Q3	+1Q4	+5Q1	+5Q2	+5Q3	+5Q4
Prices													
HICP													
Consumption Deflator	0.01	0.14	0.33	0.49	0.64	-0.01	-0.01	0.01	0.05	0.58	0.62	0.66	0.70
GDP Deflator	0.01	0.15	0.29	0.47	0.64	-0.01	-0.01	0.01	0.06	0.57	0.61	0.67	0.70
Unit Labour Costs	-0.01	0.10	0.32	0.50	0.67	-0.01	-0.01	0.0	0.0	0.60	0.64	0.69	0.73
Compensation to Employees	0.01	0.16	0.41	0.59	0.73	0.00	0.00	0.01	0.02	0.68	0.71	0.75	0.79
Labour Productivity	0.02	0.06	0.09	0.09	0.07	0.01	0.01	0.02	0.05	0.07	0.07	0.06	0.06
Export Deflator	0.24	0.33	0.51	0.64	0.76	0.23	0.24	0.24	0.24	0.72	0.75	0.78	0.81
Import Deflator	0.12	0.67	0.78	0.80	0.81	0.00	0.00	0.09	0.40	0.81	0.81	0.81	0.81
Real GDP and Components													
GDP	0.03	0.12	0.18	0.20	0.21	0.01	0.01	0.03	0.07	0.21	0.21	0.21	0.20
Consumption	0.01	0.01	0.05	0.06	0.04	0.01	0.01	0.01	0.00	0.05	0.05	0.04	0.04
Investment	0.04	0.19	0.41	0.71	0.96	0.01	0.01	0.04	0.10	0.88	0.94	0.99	1.04
Of which: Residential Inv.													
Gov. Consumption	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Exports	0.12	0.28	0.27	0.21	0.15	0.07	0.04	0.15	0.21	0.17	0.16	0.14	0.13
Imports	0.04	-0.01	0.06	0.18	0.29	0.05	0.03	0.07	0.03	0.25	0.28	0.31	0.33
Contributions to Impact													
Domestic Demand	0.02	0.05	0.14	0.21	0.27	0.01	0.01	0.02	0.03	0.25	0.26	0.27	0.28
Inventories													
Trade Balance	0.01	0.06	0.04	-0.01	-0.1	0.00	0.00	0.01	0.04	0.0	-0.1	-0.1	-0.1
Labour Market													
Total Employment	0.01	0.06	0.08	0.11	0.14	0.00	0.00	0.01	0.02	0.13	0.14	0.14	0.14
Employees in Employment													
Unemployment Rate	-0.01	0.0	-0.1	-0.10	-0.13	0.00	0.00	-0.01	0.0	-0.12	-0.12	-0.13	-0.13
Household Accounts													
Real Disposable Income	0.01	0.01	0.07	0.10	0.12	0.02	0.02	0.02	-0.01	0.11	0.12	0.12	0.13
Savings Rate	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Fiscal Ratios													
Total Receipts	0.0	0.0	0.0	0.0	-0.1	0.0	0.0	0.0	0.00	-0.1	-0.1	-0.1	-0.1
Total Expenditure	0.0	0.0	-0.1	-0.2	-0.3	0.0	0.0	0.0	-0.01	-0.3	-0.3	-0.3	-0.31
Budget Deficit	0.00	0.06	0.13	0.18	0.23	-0.01	-0.01	0.00	0.01	0.21	0.22	0.23	0.25
Government debt	-0.1	-0.1	-0.5	-0.9	-1.3	-0.1	-0.1	-0.1	0.0	-1.11	-1.21	-1.31	-1.41
Financial Variables													
Short-term Int. Rates	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Long-term Int. Rates	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Foreign Demand													
Total	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Foreign Competitor's Prices													
Effective Exchange Rate	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Foreign Prices (euro)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Commodity Prices (euro)													

Table 5: Exchange Rate shock

	Annual profile (averages)					Quarterly profile							
						First year				Fifth year			
	+1	+2	+3	+4	+5	+1Q1	+1Q2	+1Q3	+1Q4	+5Q1	+5Q2	+5Q3	+5Q4
Prices													
HICP													
Consumption Deflator	-0.01	-0.11	-0.2	-0.3	-0.4	0.00	0.00	-0.01	0.0	-0.41	-0.4	-0.5	-0.5
GDP Deflator	0.0	-0.1	-0.2	-0.3	-0.4	0.00	0.00	0.0	-0.05	-0.4	-0.4	-0.5	-0.5
Unit Labour Costs	0.0	-0.1	-0.2	-0.3	-0.5	0.01	0.00	0.01	0.00	-0.4	-0.45	-0.47	-0.50
Compensation to Employees	0.0	-0.1	-0.3	-0.4	-0.5	0.00	0.00	-0.01	0.0	-0.47	-0.5	-0.52	-0.54
Labour Productivity	0.0	0.0	-0.1	-0.1	0.0	-0.01	-0.01	0.0	0.0	-0.05	0.0	0.0	0.0
Export Deflator	-0.2	-0.2	-0.3	-0.4	-0.5	-0.14	-0.15	-0.16	-0.16	-0.5	-0.50	-0.52	-0.54
Import Deflator	-0.1	-0.5	-0.5	-0.6	-0.6	0.0	-0.05	-0.12	-0.3	-0.57	-0.57	-0.57	-0.57
Real GDP and Components													
GDP	0.0	-0.1	-0.12	-0.13	-0.14	-0.01	-0.01	0.0	0.0	-0.14	-0.14	-0.14	-0.13
Consumption	0.00	0.00	0.0	0.0	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0
Investment	0.0	-0.13	-0.3	-0.5	-0.65	-0.01	-0.01	0.0	-0.07	-0.6	-0.6	-0.7	-0.7
Of which: Residential Inv.													
Gov. Consumption	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Exports	-0.1	-0.17	-0.16	-0.12	-0.1	-0.05	0.0	-0.10	-0.13	-0.10	-0.1	-0.1	-0.07
Imports	0.0	0.01	0.0	-0.11	-0.18	0.0	-0.01	0.0	-0.01	-0.16	-0.17	-0.19	-0.21
Contributions to Impact													
Domestic Demand	-0.01	0.0	-0.1	-0.14	-0.18	-0.01	-0.01	-0.01	0.0	-0.17	-0.17	-0.18	-0.19
Inventories													
Trade Balance	-0.01	0.0	0.0	0.01	0.04	0.00	0.00	-0.01	0.0	0.03	0.04	0.04	0.05
Labour Market													
Total Employment	-0.01	0.0	-0.1	-0.1	-0.1	0.00	0.00	-0.01	-0.01	-0.1	-0.1	-0.1	-0.1
Employees in Employment													
Unemployment Rate	0.01	0.03	0.05	0.07	0.08	0.00	0.00	0.01	0.01	0.08	0.08	0.08	0.08
Household Accounts													
Real Disposable Income	0.00	-0.01	-0.05	-0.07	-0.1	-0.01	-0.01	-0.01	0.01	-0.07	-0.1	-0.1	-0.1
Savings Rate	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Fiscal Ratios													
Total Receipts	0.01	-0.01	0.01	0.02	0.04	0.01	0.01	0.01	0.00	0.03	0.03	0.04	0.04
Total Expenditure	0.01	0.03	0.10	0.15	0.19	0.01	0.01	0.01	0.01	0.18	0.19	0.20	0.21
Budget Deficit	0.00	0.0	-0.1	-0.12	-0.16	0.00	0.00	0.00	-0.01	-0.15	-0.15	-0.16	-0.17
Government debt	0.03	0.11	0.35	0.61	0.87	0.03	0.03	0.03	0.03	0.77	0.83	0.91	0.98
Financial Variables													
Short-term Int. Rates	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Long-term Int. Rates	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Foreign Demand													
Total	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Foreign Competitor's Prices													
Euro/\$ Exchange rate	-1.00	-1.00	-1.00	-1.00	-1.00	-1.00	-1.00	-1.00	-1.00	-1.00	-1.00	-1.00	-1.00
Foreign Prices (euro)	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5
Commodity Prices (euro)													

Table 6: Oil price shock

	Annual profile (averages)					Quarterly profile							
						First year				Fifth year			
	+1	+2	+3	+4	+5	+1Q1	+1Q2	+1Q3	+1Q4	+5Q1	+5Q2	+5Q3	+5Q4
Prices													
HICP													
Consumption Deflator	0.10	0.35	0.55	0.62	0.61	0.03	0.07	0.12	0.17	0.62	0.61	0.60	0.58
GDP Deflator	0.11	0.33	0.47	0.54	0.53	0.04	0.09	0.13	0.19	0.54	0.53	0.53	0.51
Unit Labour Costs	0.02	0.07	0.17	0.28	0.26	0.00	0.01	0.03	0.04	0.28	0.27	0.26	0.24
Compensation to Employees	0.01	0.01	0.11	0.23	0.20	0.00	0.00	0.01	0.01	0.23	0.21	0.19	0.17
Labour Productivity	-0.02	-0.06	-0.06	-0.05	-0.06	0.00	-0.01	-0.02	-0.04	-0.05	-0.06	-0.07	-0.07
Export Deflator	0.01	0.05	0.12	0.21	0.20	0.00	0.01	0.02	0.03	0.21	0.20	0.19	0.18
Import Deflator	0.57	1.30	1.61	1.73	1.78	0.20	0.45	0.70	0.92	1.76	1.77	1.78	1.78
Real GDP and Components													
GDP	-0.02	-0.06	-0.07	-0.08	-0.11	0.00	-0.01	-0.02	-0.04	-0.09	-0.10	-0.11	-0.12
Consumption	-0.04	-0.12	-0.16	-0.18	-0.23	-0.01	-0.03	-0.05	-0.08	-0.21	-0.22	-0.23	-0.25
Investment	-0.01	-0.05	-0.05	-0.05	-0.06	0.00	0.00	-0.02	-0.03	-0.05	-0.06	-0.06	-0.07
Of which: Residential Inv.													
Gov. Consumption	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Exports	0.00	-0.01	-0.03	-0.06	-0.09	0.00	0.00	0.00	0.00	-0.08	-0.09	-0.09	-0.09
Imports	-0.05	-0.12	-0.18	-0.24	-0.27	-0.02	-0.05	-0.06	-0.08	-0.27	-0.27	-0.27	-0.28
Contributions to Impact													
Domestic Demand	-0.03	-0.10	-0.12	-0.14	-0.18	-0.01	-0.02	-0.04	-0.06	-0.16	-0.17	-0.18	-0.19
Inventories	NA	NA											
Trade Balance	0.02	0.04	0.05	0.06	0.07	0.01	0.01	0.02	0.03	0.07	0.07	0.07	0.07
Labour Market													
Total Employment	0.00	-0.01	-0.01	-0.03	-0.04	0.00	0.00	0.00	0.00	-0.04	-0.04	-0.05	-0.05
Employees in Employment													
Unemployment Rate	0.00	0.01	0.01	0.02	0.04	0.00	0.00	0.00	0.00	0.04	0.04	0.04	0.04
Household Accounts													
Real Disposable Income	-0.07	-0.15	-0.14	-0.11	-0.10	-0.03	-0.06	-0.09	-0.12	-0.10	-0.10	-0.10	-0.10
Savings Rate	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Fiscal Ratios													
Total Receipts	0.06	0.10	0.10	0.10	0.11	0.02	0.04	0.07	0.09	0.10	0.11	0.11	0.11
Total Expenditure	0.03	0.03	0.00	-0.02	0.01	0.01	0.02	0.04	0.05	-0.01	0.00	0.01	0.02
Budget Deficit	0.03	0.06	0.10	0.12	0.10	0.01	0.02	0.03	0.04	0.11	0.11	0.10	0.09
Government debt	0.09	0.04	-0.17	-0.34	-0.39	0.03	0.07	0.11	0.13	-0.39	-0.39	-0.40	-0.39
Financial Variables													
Short-term Int. Rates	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Long-term Int. Rates	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Foreign Demand													
Total	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Foreign Competitor's Prices													
Effective Exchange Rate	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Foreign Prices (euro)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Commodity Prices (euro)													

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