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Abstract

This paper presents the update of the macroeconometric model used at the Bank of Spain for medium term macroeconomic forecasting of the Spanish economy, as well as for performing policy simulations. The many changes that the Spanish economy has experimented in the last years, and the new system of national accounts published by the national statistical office, suggested that a reestimation of the model was due. This paper presents such reestimation with newer data (up to the end of 2005), and includes some modifications that were deemed necessary in certain equations.

The quarterly model of the Bank of Spain keeps a similar structure to its previous version; it is basically a demand-driven model. The Spanish economy is found, in general, more sensitive than in previous periods to changes in exogenous variables, especially to the financial conditions. The new model also shows changes in demographic trends, and presents an external sector less sensitive to changes in price-competitiveness.

JEL classification: E10, E17, E20, E60.

Keywords: Spanish economy, macroeconometric model.

1 Introduction

This paper presents the update of the macroeconometric model used at the Bank of Spain for medium term macroeconomic forecasting of the Spanish economy, as well as for performing policy simulations. The quarterly model of the Banco de España (MTBE hereafter) fulfills the need every central bank faces of having a tool able to describe the national economy as a whole in such a way that, on the one hand, reflects its recent evolution faithfully enough to forecast its future developments, and, on the other hand, covers the transmission mechanism of changes in policy or other shocks adequately enough to guarantee a sound analysis of which factors are behind the evolution of the main economic aggregates.

A macroeconometric model able to satisfy this double function —forecast and policy simulation— must be a framework where the relationships between macro aggregates and their determinants are adequately characterised, consistently with the national accounts definitions and with the rest of the tools available for the analysis and forecast of the Spanish economy. Therefore, such model has to lay in the intersection between the conditionings imposed by the data, national accounts identities and definitions, economic theory, available estimation methods, macroeconometric models used for forecasting the rest of the euro area economies[1] and the rest of the forecasting and analysis tools used by the experts on the Spanish economy at the Bank of Spain.

The previous version of the MTBE [see Estrada et al. (2004)] fulfilled this complex and necessary function, but was estimated with data up to 1998. The Spanish economy has experienced many changes since then, which granted the convenience of updating the model. Also, the national statistical office —INE— produced recently the new system of national accounts with base year 2000 (CNE 2000).

The main objective of this update is, therefore, to have a macroeconometric model of the Spanish economy similar to the previous one but with better simulation and forecasting properties, using the new national accounts dataset. Hence, the model was not only reestimated with the most recent data but it was also modified and improved in several aspects, which will be highlighted throughout the paper. It is important to note that, for such a model to be really useful, a continuous effort of improvement of the model has to be granted. In that sense, it is to be expected that some features of some equations may be revised in the future.

Given the importance of an adequate characterisation of the dynamics and relationships between the main variables of the Spanish economy, the estimation must cover a sufficiently long period as updated as possible. For that reason, the period 1986Q1-2005Q4 was chosen. Data prior to the entry of Spain in the European Communities was discarded, since it showed an economy with structural characteristics quite different to the current ones. Also, although data for 2006 is available, it may still be subject to revision and therefore it was decided not to include it.

1. The volume edited by G. Fagan and J. Morgan (2005) describes the MultiCountry Model, developed by the European Central Bank, as well as other similar models developed by the national central banks of the Eurosystem.

The structure of the MTBE is, like in the previous version, that of a small open economy within a monetary union. In the long run the model is determined by the supply side of the economy, but its short run behaviour is demand driven, with a slow adjustment to the long run due to the high degree of inertia throughout the model. The MTBE describes mainly the behaviour of the private sector of the economy, and derives the main components of the institutional sectors accounts accordingly. Hence, the Spanish balance of payments is the sum of the public sector surplus or deficit and the net financial savings of households and firms. Households are the owners of the public debt as well as of the net foreign assets of the economy. Exogenous variables to the model are the population, nominal interest rate, nominal exchange rate, rest of the world activity and prices, energy prices, tax and social security contribution rates, and government spending in real terms.

The updated MTBE, compared to the previous version estimated for the period 1980Q1-1998Q4, describes a Spanish economy where:

1. Financial variables are more relevant, especially for private consumption and residential investment. Households spending is more sensitive than before to the rates of interest and to the value of wealth, both financial and non-financial (mainly real estate), and less sensitive than before to real disposable income and other measures of the business cycle, such as the rate of unemployment.

2. Investment has an important accelerator role.

3. The external sector is less sensitive to price-competitiveness when the more recent years are taken into account in the estimation. Exports have been diversified and seem to compete more in quality rather than in price. Moreover, they are less sensitive to rest of the world developments, including world demand. On the contrary, imports react more than before to changes in final demand.

4. The most significant change related to the labour market variables is the higher sensitivity of labour supply to demographic changes. Also, probably due to the high rate of temporality in the more recent period, employment adjusts more rapidly to wage developments. Wages, in turn, react somewhat faster to productivity developments.

5. All prices are highly intertwined and show somehow less inertia than before. Also, the dependency of domestic prices with respect to foreign prices is lower.

Section 2 describes the theoretical foundations of the model and the main features of the estimated relationships. Section 3 characterises the transmission mechanisms of shocks by means of a series of simulation exercises. The use of the MTBE in the forecasting exercises is discussed in section 4 and section 5 concludes.

2 Model description

As mentioned in the introduction, the theoretical foundations of the updated MTBE are very similar to its previous version[2]. It is essentially a model for a small open economy within a monetary union, i.e. where interest and exchange rates are given, and whose production is an imperfect substitute of that of the rest of the world. Long run output is determined by technology and production inputs (capital and labour), but short run output is demand driven. The adjustment of prices and quantities towards the long run equilibrium has a large inertial component.

The Appendix displays all the estimated behavioural equations, both their long run relationships (in levels and marked with an asterisk) and their short run dynamics (expressed in quarterly growth rates). The latter include, in general, the same determinants than the long run relationships, in as long as they are significant, as well as an error correction mechanism, lags of the dependent variable, and other additional variables which are found important to explain the short run dynamics.

The estimation method is similar to that of the previous model: two stages maximum likelihood with complete information[3]. In the first stage cointegration relationships are estimated in levels, while the second stage estimates relationships between quarterly rates of growth of the series, including the relationships of the first stage as error correction mechanisms. The dimension of the model (28 behavioural equations, within a total of over 150 equations which include definitions and identities) forced us to split the estimation of the model in several blocks, which were designed so as to maximize the interdependencies between variables. Theoretical restrictions have been imposed on some equations so as to maintain the medium and long run coherency of the model, but apart from these necessary restrictions, we chose the specification for each equation which displayed better estimation properties.

The database used is, as explained before, the new CNE 2000 for the period 1986Q1-2005Q4. Quarterly national accounts data are available in base 2000 only since 1995; they have been backtracked using the quarterly growth rates of the corresponding series in base 1995. Annual national accounts data for institutional sectors are available in the new base only since 1999 and have been backtracked in a similar way. These series have been made quarterly using indicators and finally have been seasonally adjusted using the TRAMO-SEATS program. Estimations are performed, in general, on the logs of the series.

In order to allow for a better assessment of the estimated relationships and their comparison to the previous model, two additional pieces of information are included. On the one hand, Table 1 shows the impact (one quarter) and 3-year[4] elasticities of the main determinants of each variable for both the updated and the previous version of the model. On the other hand, Figures 1 to 3 show the contributions of the determinants to the growth of

2. A summary of the latter can be found in Estrada, Á. and J. Vallés (2005).

3. Estimations have been performed with version 9.1 of the PC-GIVE program, by Jurgen Doornik and David Hendry.

4. 3-year elasticities are chosen because that is the usual time horizon of the macroeconomic projections made with the MTBE, but also because it is the typical timeframe where all the effects of an aggregate shock are observed. At longer time horizons the elasticities coincide with the estimated coefficients for the long run relationships.

each of the main variables according to the new estimated model. The estimation update allows for a much better fit of the observed growth of the different series to that of their determinants. The unexplained component of that observed growth (the residual) is smaller in most cases[5].

2.1 The supply side

Private sector production (PYER[6]) is assumed to be conducted by a representative firm that maximizes profits selling goods and services in an imperfect competition framework. Production technology is a Cobb-Douglas function, with constant returns to scale in capital (PKR) and labour (PLN), and with an exogenous rate of growth (γ) of total factor productivity (TFP); the coefficient of employment in the production function, typically associated to the labour income share in total income, is α. Using lowcase letters to represent the logs of the variables, the production function is expressed as:

$$pyer = a + \alpha\gamma TFP + \alpha\ pln + (1-\alpha)\ pkr$$

For a given demand of goods and services, profit optimization yields the long run equilibrium conditions (represented with asterisk) for factor demands and price setting. The equation for capital demand (pkr*) is obtained from the equalization of the ratio of marginal products of capital and labour to the ratio of their nominal costs (user cost of capital PUC[7] and wage PWUN), while labour demand (pln*) equation is obtained from the previous production function. Hence,

$$pkr^* = [\alpha\ \ln(1-1/\alpha)-a] + pyer + \alpha(pwun-puc) - \alpha\gamma TFP$$

$$pln^* = -(1/\alpha)\ a + (1/\alpha)\ pyer - (1-1/\alpha)\ pkr - \gamma TFP$$

Parameter estimates show a fall in the labour share coefficient α with respect to the previous version of the model (which was estimated for the period 1980Q1-1998Q4), going from 64% to 58%. Similarly to the results in several other papers, it is also found a fall in the estimated average rate of growth of TFP, γ, to an annual rate of 0,04% in the current estimation period as opposed to an annual rate of 0,8% in the previous one. These changes in the aggregate production function contribute, together with the higher labour elasticity to wages in the short run (see Table 1), to better explain the evolution of employment in the private sector (the residuals in Figure 1 are smaller than in the previous version of the model).

The productive capital stock PKR is obtained by accumulating productive private investment (PIR) net of depreciation, which in turn is explained in the short run by the same

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5. In some variables large residuals are still found, which shows the need of a further revision of the determinants included or of their definition and/or measurement. The growth contributions for the earlier version of the model are available from the authors upon request.

6. We keep the notation of the previous version of the model, which coincides with that of the rest of the macroeconometric models of the same kind used in the Eurosystem coordinated projection exercises.

7. In real and quarterly terms, the user cost of capital is $PUC/PID = RR - \delta - ¼\ (PID/PID_{-4})$, where PID is the private productive investment deflator, RR is the nominal interest rate on credits to firms (a combination of short and long run rates), and δ is the depreciation rate of the private non residential capital. As can be seen, this real user cost of private productive investment depends negatively on the inflation rate of its own deflator, which in turn reacts to shocks affecting the prices and wages of the model. In some of the simulation exercises performed later, the fluctuations observed on that inflation rate will be such that it will be advisable to keep the real user cost of investment exogenous.

determinants than the demand for capital, plus the ratio of firms' disposable income to capital and, similarly to all the short run equations, an error correction term. This error correction term changes private productive investment towards the long run level of the capital stock (pkr*). In this equation it is worth noting the high sensitivity of investment to activity, through an accelerating effect which is even stronger than in previous versions of the model, also reflected in the higher elasticity with respect to GDP. This strong accelerating effect may be due to the fact that the demand of productive investment equation does not include any variable measuring confidence or expectations of future profits, which are important determinants of investment projects lasting several years (this could also explain the large residuals observed in the graph of growth contributions).

Under imperfect competition, profit maximization sets long run equilibrium prices (private value added deflator net of indirect taxes, PYED) as a mark-up over marginal labor costs. In this small open economy, markups depend on competitor export prices in domestic currency (CXGEED). In addition, we have included a time trend starting in 1999[8] related to the increase in the importance of the construction and services sectors in Spain, which have larger markups than the rest of the economy. This trend explains the larger part of the residual observed in the previous version of the model. Therefore,

$$pyed^* = (1-\eta-\nu)\ [\ \ln\eta_0 - \ln\alpha - a/\alpha + pwun - (1-1/\alpha)\ (pyer - pkr) - \gamma TFP] + \eta\ cxgeed + \nu T99$$

The wage is determined as the result of a bargaining process between unions, who maximize the welfare of its members, and firms, who, once the wage is set, decide their labor demand. Real wages, deflated by the private consumption deflator (PCD), are a function of labor productivity, the gap between production and consumption prices, the unemployment rate (URX), plus other variables measuring the structure of the labor market (like the replacement rate or ratio between unemployment benefits and wages, RRU, which in this version of the model, is only significant in the short run). Finally, labor taxes (TWED) affect real wages negatively. In this update of the model we have included the difference between the wage growth estimated by the Quarterly National Accounts and the one included in the collective agreements (also called wage drift), which has been systematically negative since the end of the nineties. This exogenous variable improves substantially the explanatory power of the equation (the systematic residual previously observed disappears). The long run equation for private sector wages becomes

$$pwun^* = \beta pyed + (1-\beta)pcd + (pyer-pln) - \lambda URX + \theta \text{ drift accumulated since 1999} - TWED$$

This long run wage equation, together with the value added deflator equation, determine the level of unemployment compatible with price stability, or NAIRU, while the short run equation for wages is one of the main mechanisms relating prices and quantities in the short run. Real wages adjust to labour productivity, unemployment and the rest of prices in the economy slightly quicker than in previous versions of the model (see Table 1).

8. Necessary to obtain a cointegration relationship.

Finally, it is assumed that the decision of the working age population (POPWA) to make part of the labour force (LFN) depends negatively on unemployment, as well as other cultural and demographic variables, measured through dummies.

$$lfn^* = dummies + popwa - \upsilon\ URX$$

The estimation results for the short and long run show a larger and quicker response of labour force to working age population, and slightly less to unemployment, compared to the previous version of the model. This greater adjustment to demographic changes helps to explain better the evolution of this variable, as shown by the small residuals in the growth contributions of Figure 2.

In addition to the wages and value added deflator, a group of equations is estimated to explain the behavior of the consumption deflator, the private productive investment deflator, net of indirect taxes, and for the energy and non-energy components of HICP. Each of these equations is specified as a weighted average of domestic prices and the three components of the imports deflator (imports of goods from the euro area, MGED, of goods from the rest of the world, MGND, and of services, MSD)[9], where the estimated weights give greater importance to domestic prices. Both, in the long and short run equations, it is imposed that the sum of coefficients on prices equals one, to ensure that in the long run relative prices do not change (nominal homogeneity) and that all prices grow at the same rate (dynamic homogeneity). This way the long run value of real variables is independent of nominal variables.

This makes all prices in MTBE highly interlinked, like it was the case in previous versions of the model, so that any change in one price affects the whole price and wage system, although with a smaller inertia than before. In addition, the degree of dependency on foreign prices has been generally reduced.

2.2 Household demand

While the Supply block sets investment demand by firms and employment, the Demand block concentrates on the behavior of households. This section explains the estimated equations modelling the spending decisions of households, about consumption goods and residential investment, as well as the concepts and identities needed to derive household income and wealth.

Together with productive investment and the relationship between prices and wages, this block of equations describes some of the most important mechanisms in the model to stabilize the economy after a shock. Although the long run equilibrium is mainly determined by the supply side, the adjustment of the economy towards that equilibrium falls on demand variables, wages and prices. In particular, household demand has a central role in the adjustment after a shock. For instance, any change in fiscal variables affects household's disposable income and their spending. Similarly, since households own all the assets in the model, any external imbalance, like a fall in net foreign assets, reduces household wealth, decreasing their spending, and helping correct the imbalance.

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9. The price of energy is excluded from the imports deflator when explaining the investment deflator because energy is not considered an investment good. Similarly, in the consumption price equation, the residential investment deflator (weighted by the share of construction in value added, around 10% for the sample period 1986Q1-2005Q4) is excluded from the value added deflator.

The long run equations of consumption and residential investment are based on the first order conditions of the maximization problem of a representative household who derives utility from consumption and household services. Therefore, both of them depend on permanent income and the real interest rate (RRC), which determines the choice between current and future spending, while the decision to invest in housing depends also on the user cost of housing (RRI). In the model, interest rates and real user costs are defined ex-post[10]. It is assumed that total household spending responds in the long run with unit elasticity to permanent income [defined as the weighted average of real disposable income, HDYR, and total wealth, (FW+NFW)/PCD]. However, unit elasticity is not imposed on each one of the components of household spending[11]. The long run equations for private consumption (PCR) and residential investment (RIR) are

$$pcr^* = const + \varepsilon^{y,\,PCR}\, hdyr + \varepsilon^{W,\,PCR} \ln[(FW+NFW)/PCD] - \varphi\, RRC$$

$$rir^* = const + \varepsilon^{y,\,RIR}\, hdyr + \varepsilon^{W,\,RIR} \ln[(FW+NFW)/PCD] - \varphi\, RRC - \psi\, RRI$$

Disposable income includes wages of employees and labor income of non-employees, imputed rents for house owners who live in them, transfers from the government to households, other income (mainly capital income from the assets owned by the private sector, since in the model domestic firms are owned by households), minus social contributions and direct taxes. Wealth is equal to financial wealth (FW) and non-financial wealth (NFW) in nominal terms, deflated by the consumption deflator (PCD). Financial wealth is obtained from the net financial assets of households and ISFLSH in the Quarterly Financial Accounts. The model updates this variable (either when there is no data available in the forecast horizon or for simulation exercises) according to the capital gains of financial assets in this period (which depends on the evolution of the Stock market index) to maintain the long run consistency between the financial assets of households, the public sector and the rest of the world. Non-financial wealth is equal to the stock of residential capital (obtained by accumulating the residential investment), valued using house prices. The evolution of these prices is linked to the residential investment deflator through a transfer function.

The estimated long run equations and their short-term dynamics show that the financial variables have gained importance as explanatory factors of household spending. Consumption demand and residential investment of Spanish households are more sensitive than before to interest rates and wealth, both financial and non-financial, and less sensitive to disposable income and other measures of the cycle, which are, however, significant in the short term dynamics, like unemployment in the case of residential investment. In this sense, wealth and real interest rates have a large weight in the contributions to the growth of consumption and residential investment (see Figure 2) and the elasticities with respect to them are significantly larger than in the previous version of the model (see Table 1).

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10. In particular, we use a nominal rate of interest of mortgages (HTI), modeled as a weighted average of current and past short term interest rates (STI, 3-month rate), and it is converted into real terms using the inflation of the private consumption deflator, for the case of consumption real interest rate (RRC), and the inflation of the residential investment deflator, in the case of the user cost of this investment (RRI), which also includes the depreciation rate of the residential capital stock δ^{RKR}.

11. This ensures the stationarity of net financial savings of households as a percentage of their income (HDYR-PCR-RIR)/HDYR, although not necessarily in levels (HDYR-PCR).

The long-run equation for the residential investment deflator is derived from the equilibrium of the residential investment demand and the supply of residential services. This is done under the assumption that new residential investment every period represents a small percentage of the total stock of residential capital, so that the supply of housing services is determined by the previous year stock of houses. The residential investment deflator depends positively on demand pressure (measured by the consumption over residential capital stock ratio, PCR/RKR) and housing prices, and negatively on the user cost of housing. In the estimation of this equation a trend from 2000 was included to capture the acceleration of housing prices above the determinants included in the equation.

In the model, real public consumption and investment are exogenous, and the same is true for the variation of stocks. Therefore, to cover aggregate demand we need to describe the foreign sector.

2.3 Foreign Sector

The MTBE disaggregates the foreign sector, distinguishing, on the one hand, between exports and imports of goods with the rest of the euro area and the rest of the world, and, on the other hand, the trade in services. The equations for real imports and exports are fairly standard: they depend on a scale variable which refers to the level of demand and on relative prices, which measure the competition effect.

In the case of real exports (X**R[12]), the scale variable (WD**R) captures the growth of the markets of Spanish products, through the correct weighting of imports from other countries, while price-competitiveness is measured by the ratio of the exports deflator (X**D) to the price of competitors in that market (CX**D)[13]. In the case of real imports (M**R), the scale variable (FD**R) is the weighted sum of the different components of final demand, where the weights take into account their import content. The price-competitiveness of imports is measured by the ratio of import prices (M**D) to the private sector value added deflator (PYED).

$$xr^* = \text{constant} + wdr - \mu\,(xd - cxd)$$

$$mr^* = \text{constant} + fdr - \omega\,(md - pyed)$$

To allow all real variables to grow in the long run at the same rate, we have imposed in the estimation unit elasticity in the long run to the scale variable, which ensures that the trade balance does not explode after a shock which affects differently the domestic economy and the rest of the world. In the previous version of the MTBE, this hypothesis was rejected by the data, especially until the year 2000, which required the inclusion of trends in these equations. Current estimation results suggest that these trends are no longer needed, except for the equation for imports of goods from the rest of the world (MGNR), thus the equations include a truncated trend. Finally, the short run demand elasticity is estimated unrestricted,

12. The notation of the model substitutes ** by GE for real exports and imports of goods and the corresponding deflators to/from the euro area, GN for goods to/from the rest of the world and S for services.

13. The competitors' price is a weighted average of export prices from other countries. We follow the method of double weighting, in which we take into account not only the importance of Spanish exports in one particular country, but also that country's weight in world trade. Moreover, it also takes into account the competition for Spanish exports in other markets represented by that country's exports.

and imports show a very high short run elasticity with respect to internal demand, even higher than in previous versions.

The most relevant estimation result of the exports and imports equations is the smaller sensitivity to price competitiveness, especially in the short and medium run (see Table 1 and the estimated long run equations in the appendix). A possible reason for this change could be, in the case of exports, the higher degree of differentiation, which allows exporters to compete increasingly through mechanisms other than prices. The explanatory power of the real imports equations has improved in this new version of the modelled, but the ones for real exports have not improved so much.

Export prices for the three categories (goods to the euro area, goods to the rest of the world and services) are modeled as a markup over domestic marginal costs, where the markup is variable and depends on competitors' relative prices. Therefore, the equations explaining these prices include a combination of domestic and competitors prices (CX**D). In the short run, the corresponding nominal effective exchange rates (EFX**) are also significant. Similarly, import deflators are also modeled as a combination of domestic and foreign prices[14]. The domestic price captures the effects of pricing-to-market, that is, it takes into account the conditions of the local market where they are selling their products, while foreign prices (CM**D) are a weighted average of the export prices of Spain's trade partners based on their weight on total imports. The estimation results show a smaller sensitivity to changes in foreign prices (lower competitiveness effect) and quite a larger one to domestic prices, especially in the case of import deflators (see Table 1). In addition, the static and dynamic homogeneity conditions are accepted.

Finally, the MTBE obtains a forecast for the current account balance and the balance of payments by adding to the trade balance, described above, the compensation to employees and net transfers from the rest of the world, as well as the net interest payments (net foreign assets[15] are valued using the long term U.S. interest rate) and the payments of direct and indirect taxes.

The model includes different items from the income accounts of households, firms[16] and public administrations. Using the forecasts of the model about the several institutional sectors it is obtained to which extent the balance of payments of the country corresponds to each of them. Thus, the net lending/borrowing of the households yields from subtracting the expenditure on consumption and residential investment to the gross disposable income. The pool of firms conducts productive investment, and its income and saving reverts to households.

2.4 Public sector

The main section of the MTBE is the private sector of the economy. The public sector is composed by some accounting definitions and a few estimated equations for some prices. Although in its most part the public sector is exogenous, its evolution is not independent from the rest of the economy. Several fiscal variables are introduced in the determination of the long run equilibrium of the economy, and the behaviour of some private sector's variables

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14. The import deflator from the rest of the world includes the evolution of the price of energy imports (PEI) and that of raw materials (PRM). However, real imports from the rest of the world are defined excluding energy imports. That is why the deflator is corrected accordingly.

15. Net foreign assets are defined as the accumulation of the current account balance.

16. The model assumes that firms, public debt and net foreign assets are owned by households.

determines government revenues and expenditures. This way, total public revenues and transfers are computed applying exogenous rates —for the different categories of direct taxation, indirect taxation, social security contributions and social benefits— to base values related to value added, income or unemployment, which depend on the evolution of the private sector in the model.

Equations have been estimated for the deflators of the public sector value added (GYED), public consumption (GCD) and public investment (GID), and for wages of public employees (GWUN). From these deflators and the corresponding values on real terms —exogenous to the model—, nominal value added, consumption, investment and public employment compensations are computed. Adding all of them plus the net interests' payments, which depend on the long run interest rates and the accumulated stock of public debt, the model computes the budget balance and the debt of public administrations.

In the cases where the model is used for simulation exercises with extended horizons, a fiscal rule is added to the model. This rule modifies the effective tax rate for households in order to keep unchanged the long run GDP share of public debt or of the budget balance.

3 The transmission mechanisms of shocks in the MTBE

As mentioned in the introduction, the two main uses of the MTBE are the participation in the macroeconomic projections and carrying simulation exercises out. For the first one, a central projection scenario is obtained conditioned to the assumptions made for the evolution of the exogenous variables of the model in the forecast horizon (obtained from specific models or taken from other sources or institutions). This central scenario is considered the most likely.

In order to assess possible different future evolutions, which are known as "risks", simulation exercises are conducted with the MTBE, by changing the path of a subgroup of exogenous variables. Simulation exercises are also conducted with the model outside the context of the macroeconomic projections, with the purpose of examining the effects of a measure of economic policy or of the change in a variable whose evolution or whose effect on the set of the economy is perceived with uncertainty.

In this section a series of simulation exercises illustrates how the main macroeconomic variables react in the MTBE when faced with different shocks. The horizon analyzed is up to 6 years, period in which probably the economic policies have already unfolded all their effects and most of the adjustments to a shock have occurred. As mentioned before, although the evolution of the economy in the long term is essentially driven by supply variables, the adjustment mechanisms of the model, in the short and medium term, rely basically on prices and demand variables. Thus, in the bulk of these simulations, the reaction of the demand side after a shock is essential.

A relevant aspect of the simulations generated with this model is that they are relatively linear: changing the sign of the shock causes practically identical effects but in opposite direction, while rescaling the size of the shock causes approximately proportional reactions of the variables adjustments. In a similar way, combining some shocks in a unique simulation results similar to adding the corresponding individual simulations.

3.1 Public spending

This shock consists of a permanent increase of the demand, caused by an increase of real public consumption of one percent[17]. The effects of this shock appear in Figure 4, and in the first columns of Table 2.

In this model, given a demand level, and given the technology available (i.e. the implicitly estimated production function in the supply section), firms set their desired levels of capital and labour. Thus, in this case, the greater demand caused by the increased public spending causes higher investment and employment. Smaller unemployment fosters the rise of wages and, with them, of prices, while the greater income of households (due to the increase of both employment and real wages) translates to greater consumption. This triggers a feedback process in the expansion of demand, which continues increasing although at a slower rate during approximately four years. A second feedback

17. This corresponds to about 0.2% of GDP.

process takes place through the higher observed inflation, which reduces the real user cost, stimulating again investment and consumption[18].

The final impact on GDP is relatively big, with a maximum multiplier close to 2, which is reached in the fourth year. This is due, at least in part, to the absence of crowding-out effects, since in this model interest rates are exogenous and do not rise after this shock.

On the other hand, the contribution of the foreign sector to growth diminishes, since the higher domestic demand causes an increase in imports. In this the reaction of investment is especially relevant, given that its import component is substantially greater than that of other demand components. Also, price increases harm both competitiveness and exports, but effects are small, mainly because the estimated elasticity of the export deflators to domestic prices is small (it is zero in the short run, and approximately 0.3 in the long run, as showed in Table 1), but also because the sensitivity of the exports to the competitiveness is relatively low (compared to the previous version of the MTBE, and, in particular for the exports of goods to the euro area).

3.2 Interest rates

This shock consists on an increase of a percentage point in the short term interest rate during 6 years, accompanied by the corresponding increase in the long term interest rates, which are the ten-year rates[19].

This increase of the cost of financing causes the reduction of productive investment by firms and the reduction of residential investment and consumption by households[20] (see Figure 5 and Table 2). A demand adjustment process as the one described for the previous shock starts, but in the opposite sense: lower aggregated demand triggers a reduction of capital and labour demand by firms, and greater unemployment reduces wages and, with them, prices. The second round effects on consumption[21] and investment, through lower income and through higher real user cost caused by lower inflation, reinforce the initial impact of the demand reduction. The improvement in the growth contribution of the foreign sector mitigates the recessionary effect of this shock.

3.3 Housing prices

This shock consists in a lower growth rate of housing prices, such that the accumulated growth rate after six years is five percentage points lower than the baseline scenario.

The direct impact of this shock is twofold: first, as a result of lower housing prices, households have less wealth and they reduce consumption and residential investment. Second, as a result of lower house prices growth rate, its real user cost increases, affecting negatively the residential investment.

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18. This process explains up to a third of the effect on private productive investment, a third of that on residential investment, and a quarter of the effect on households' consumption.

19. In the simulation exercises, long term interest rates are calculated at every period, according to the term structure of interest rates, as the average short term interest rates of the next ten years. In the forecast exercises they are exogenous and its value is taken from market expectations.

20. Most of this reaction occurs through the long term equations of productive and residential investments, where the most statistically significant reactions to the user cost are found (both for the short term equations for investment and the short and long term consumption equations, and as usually happens in similar models, it is hard to find a measurement of the interest rates which appears highly significant in the estimated equations).

21. In some years a reduction in the savings rate of households is observed, relatively small (the reaction of consumption is quite similar to that of the disposable income), which takes place because most of the response of households' spending to harder financing conditions happens through the residential investment: the household's capacity of financing, affected by the residential investment increases considerably in this simulation.

Here also, like in the previous shock, an aggregate demand reduction takes place which triggers a process analogous to the one described in the case of the public spending shock: firms reduce their capital and labour demands, higher unemployment brings down wages and prices, etc. (See Figure 6 and Table 2).

3.4 World demand

In this case a permanent decrease, of one percent, is simulated in the demand of imports of all the trade partners of the Spanish economy.

Given the unit elasticity of exports to world demand imposed in the long run, and the high estimated values for the error correction mechanism coefficients in these equations in the short run, the reaction of the exports to this shock is a rather fast fall, of approximately one percentage point (see Figure 7 and Table 2). This export fall implies, as in previous cases, an aggregate demand reduction, which makes firms reduce their investment and labour demand, which ends up provoking the decrease of wages and prices.

It is worth to note that the GDP growth contribution of the external sector starts with a negative behaviour as a result of lower exports, but recovers later on as the reduced activity (especially investment) lowers import demand. Also, although quantitatively less relevant, the reduction of domestic prices fosters exports, which mitigates the long run fall they would have experienced according to the imposed unitary elasticity with respect to world demand.

3.5 World prices

This shock consists on a permanent reduction of world prices (including those of all the countries of the area of euro, except Spain) of a percentage point relative to the baseline scenario.

The initial loss of price-competitiveness of this alternative scenario causes a reduction of exports in the first quarters (see Figure 8 and Table 2), which in the case of the exports of goods, is reverted when the export deflators react to lower world prices. This occurs rapidly, due to the high elasticities of export deflators of goods shown in Table 1, especially in the short term. However, the deflator of the exports of services depends mainly on domestic prices, so that the recovery of exports is smaller and slower for services.

The fall of the exports triggers again a demand contraction process whereby investment, employment, wages and prices are reduced. In a specially significant way for this shock, the lower demand (and in particular the lower investment) reduces imports[22], causing —together with the recovery of price-competitiveness as export deflators adjust (because of their direct reaction to international prices, and because the smaller activity also reduces domestic prices)— that the contribution of the foreign sector to the growth of GDP, whose rate initially had been reduced, returns to its original level in three years.

3.6 Total factor productivity

In this simulation, the rate of growth of total factor productivity is increased in one percentage point with respect to the base scenario, throughout the whole simulation period. The results of the simulation are presented first (they are in Figure 9 and the last columns of Table 2),

---

22. The fall of the world prices makes imports increase in the first years, but this effect is relatively small because the import prices only react partially and slowly to the international prices, and because imports sensitivity to competitiveness has declined in the updated model; the later reduction of the demand ends up dominating, in the three import categories considered, over the effects of the lower competitiveness.

followed by a discussion on the different ways in which this simulation can be complemented in order to obtain reactions that are closer to what is to be expected.

The direct effects of the faster growth of TFP, in this model, are two: on the one hand, the marginal cost is reduced, and this allows for lower prices; on the other hand, this improvement in technology enables firms to satisfy a given demand level using a lower quantity of productive factors, which reduces employment and investment[23]. The first channel has an expansive effect on demand, mainly through exports, which increase thanks to the improvement in price competitiveness (even though the transmission of the reduction in domestic prices to export prices is limited), while the second channel has a contractive effect, more through the reduction in investment than in consumption. This last variable remains stable because the possible reduction of households' disposable income that could be provoked by the increase in unemployment is offset by the increase of the real wages (which respond to labour productivity, which has increased given that the same output is achieved with a lower amount of labour).

In the first years, these effects compensate each other: the fall in investment offsets the increase of net exports, and as a result GDP doesn't change much. From the third year on, however, households' real disposable income starts rising, and drags consumption and residential investment, so that starting on the fourth year the positive effects dominate and GDP accelerates.

The reason why in this model an increase in TFP growth does not directly and from the first quarter affect consumption or investment is that agents are not completely rational: if, for example, consumers realized that in the future their income is going to increase, they could raise their consumption from the start, trying to smooth it. Other models with non-rational expectations, like the Area Wide Model of the ECB, try to mitigate this problem by introducing exogenous measures of potential output directly in the equations for some variables, like investment or employment, so that an increase in the rate of growth of TFP can directly accelerate economic activity. In the case of MTBE, in order to achieve these effects it is necessary to complement the original shock on TFP with additional movements that mimic the channels not included in the model. This way, the shock to TFP could be paired with a shock to consumption —calibrated so as to simulate households desire to smooth their consumption— or with a smaller increase of the real user cost of investment which would increase the desired level of capital of firms[24].

23. Additionally, the reduction in inflation increases the real user cost of private productive investment, reinforcing the reduction of investment. However, in the simulation presented here this channel has been disabled, as the contraction in demand thus generated could overturn the expansive effect that this shock should generate. Such negative impact wouldn't exist if the equation for private productive investment included elements linked to the expected future evolution of activity or profits.

24. A downwards correction on interest rates could also be included, so as to simulate the response of monetary authorities to a less inflationary scenario, but in the case of Spain this would not be adequate, unless the increase of TFP growth is generalized to the whole euro area.

4 Forecasting

As previously explained, the MTBE model can generate a full scenario of macroeconomic forecasts, given a set of hypothesis for all the exogenous variables –mainly external and fiscal conditions, and interest rates. Besides, any forecast scenario can be contrasted with the model: it can be quantified how the evolution of the main variables and their determinants in that scenario fit the relationships described by the model equations. An additional use of the MTBE model in the context of the forecast exercises of the Bank of Spain is to generate alternative forecasts that quantify the risks around the central projection.

For any of the possible uses of the model in the context of the macroeconomic projections of the Spanish economy, it is necessary to evaluate de predicting power of MTBE, and, in particular, to assess to which extent this new version of the model performs better than the previous one. For that purpose, several projections have been generated with each model, using a set of relatively simple and objective common criteria; these projections have been used to compare the errors made, at different time horizons, when forecasting the evolution of the main macroeconomic variables.

Using the latest version of the model's database, with observed information running up until the fourth quarter of 2006, a full forecasting exercise has been created starting in every quarter since 1988, with both the updated and the previous versions of the model. Each time, the exogenous variables of the model were set using their last observed values[25], while for the endogenous variables model generated forecasts are used from the first quarter of the projection[26]. It is also imposed that the residuals of all the equations reach, in one quarter, a reference value that is considered neutral, which is defined as their average value for the period up to the start of the projection[27].

Forecast errors are then computed for one-quarter-ahead annual growth rate, the average growth rate of the first year, and the average growth rate of the second year, for each of the main twelve variables. Given that a full projection exercise is made starting each quarter since 1988, the output from this process is a series of forecasting errors for each variable and each forecasting horizon. These series are summarized by the root mean square error (RMSE) for four different time periods. Table 3 shows the ratios of the RMSE obtained with the updated MTBE and that obtained with the previous version of the model: ratios lower than one show an improvement, while values bigger than one point to worsening forecasting properties.

In general, improvements are reckoned in most variables, especially in the most recent period of 2003-2006 (which lies partially in sample for the new version of the model, but completely out of sample for the previous version). These improvements are more

25. This constitutes a considerable advantage relative to the actual projection exercises, where exogenous variables are set as a function of market expectations, forecasts from other models, and assumptions imposed by the framework in which the forecast is made. Besides, final data is used for all the variables in the model, whereas in the real projection exercises the most recent data is expected to be revised at a later point in time.

26. In fact, as is common practice in the projection exercises, some endogenous variables of the model are set as exogenous when building forecasts. These are: active population, housing prices, financial wealth, and public sector deflators and wages.

27. In practical terms, this treatment of the residuals is equivalent to re-estimating the constants of all the short-run equations, keeping fixed all the other coefficients and using as sample period the one from the first quarter of 1986 to the beginning of the forecast, and then make the projections using zero residuals.

generalized at short forecasting horizons than at long ones, showing that problems may still exist in the equations for some relevant variables, which could affect the forecasts for the rest of the economy. In general, and confirming the impression from the analysis of the estimated equations as well as that of the growth contribution figures, private productive investment and the external sector seem to be the areas in which the forecasting capabilities of the MTBE still need additional enhancement, especially for long forecasting horizons. The first efforts of partial revision and improvement of the model will have to be directed towards those areas. On the other hand, the variables relating to the job market seem to be the ones most benefited from the general overhaul presented in this paper.

5 Conclusions

This paper presents a revision of the quarterly model of the Bank of Spain (MTBE), which is used both in the elaboration of macroeconomic projections and in the generation of simulations that quantify the effects of economic policies, as well as of risks around the central forecast, on the evolution of the Spanish economy.

The structure of the model is similar to the prior version [Estrada et al. (2004)], which was estimated for the period 1980Q1-1998Q4. The updated model has been estimated for the period 1986Q1-2005Q4, so it includes the numerous changes that the Spanish economy has gone through in the last years, apart from the new national accounts in base 2000. Besides this, the specification of certain equations has been modified, wherever it was necessary.

The model is still basically demand-driven, as is shown by the simulation exercises presented in this paper. The mechanisms for the transmission of shocks that can be traced through these simulations, as well as the estimated values of the parameters of the equations, show a Spanish economy that looks more dynamic than in previous periods —in particular, one that responds with more intensity to changes in financial conditions and in the wealth of the households.

It can be noted, also, that the reestimated model incorporates the impact of demographical changes and displays an external sector that is less sensitive to changes in price competitiveness. Finally, some exercises have been carried in order to assess the predictive capabilities of this revised MTBE. These find generalized improvements with respect to the previous version, especially in the most recent periods and for short forecasting horizons.

For a macroeconometric model of this kind to be really useful, it must be subject to continual improvement efforts. In this respect, as the experience in the use of the model evidences such a need, some equations may change with respect to what is described in this paper. In general, the analysis of the estimations, the growth contributions and the forecasts of the model reveal that private productive investment and the external sector seem to be the areas to which the first efforts of partial revision and improvement of the model will have to be directed. On the other hand, the variables relating to the job market seem to be the ones most benefited from the general overhaul that is presented here.

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Table 1. Elasticities of main variables

	Updated MTBE		Previous version MTBE	
	On impact	**After 3 years**	**On impact**	**After 3 years**
Private Consumption:				
Real financial wealth	0.06	0.07	0.02	0.02
Real non fin. wealth	0.15	0.14	0.14	0.07
Real disposable income	0.13	0.62	0.38	0.96
Real interest rate	-1.12 (srt.term)	-0.24 (srt.term)	-0.28 (lng.term)	-0.16 (lng.term)
Residential investment:				
Real financial wealth	0.10	0.08	0.07	-0.002
Real non fin. wealth	0.36	0.16	-	0.02
Real disposable income	0.13	1.31	0.46	0.65
Real interest rate	-0.95	-0.92	-0.27	-0.39
Unemployment	-1.56	-0.31	-2.64	-0.46
Productive investment:				
Real user cost	-0.01	-0.34	-0.05	-0.46
Real GDP	1.38	1.85	1.06	1.06
Imports:				
Final demand (euro)	2.98	1.03	2.40	1.02
Final demand (non-euro)	2.66	1.00	2.18	1.08
Competitiveness (euro)	-0.58	-0.38	-0.74	-0.54
Competitiveness (non-euro)	-0.20	-0.21	-0.18	-0.47
Exports:				
World demand (euro)	0.63	0.99	0.87	1.00
World demand (non-euro)	-	1.00	0.64	1.00
Competitiveness (euro)	-0.37	-0.43	-0.48	-0.86
Competitiveness (non-euro)	-0.50	-0.91	-0.50	-1.08
Wages:				
Productivity	0.44	1.02	0.47	0.88
Unemployment	-0.32	-0.25	-0.19	-0.39
Domestic prices	0.55	0.58	0.24	0.81
Private Employment:				
Real wages	-0.21	-0.11	-0.13	-0.11
Real GDP	0.49	1.40	0.83	1.12
Labour force:				
Working age population	0.69	0.98	-	1.00
Unemployment	-0.28	-0.44	-0.32	-0.46

	Updated MTBE		Previous version MTBE	
	On impact	**After 3 years**	**On impact**	**After 3 years**
Value added deflator:				
Real wage	0.23	0.78	0.43	0.73
Productivity	-	0.52	-	0.26
Foreign prices	0.05	0.12	0.07	0.11
Prod. Investment deflator:				
Domestic prices	0.95	0.77	0.71	0.70
Foreign prices	0.04	0.24	0.18	0.26
Res. Investment deflator:				
User cost	-	-1.09	-0.18	-0.51
Demand pressure	-	1.03	-	0.94
Consumption deflator:				
Domestic prices	0.37	1.05	0.71	0.95
Foreign prices	0.14	0.08	0.09	0.06
Exports deflator:				
Domestic prices (euro)	-	0.33	-	0.28
Domestic prices (non-euro)	-	0.29	-	0.40
Foreign prices (euro)	0.56	0.66	0.72	0.72
Foreign prices (non-euro)	0.51	0.69	0.44	0.62
Imports deflator:				
Domestic prices (euro)	0.45	0.005	-	-
Domestic prices (non-euro)	0.37	0.08	-	-
Foreign prices (euro)	0.42	1.00	0.42	1.05
Foreign prices (non-euro)	0.29	0.53	0.50	0.52
Energy price (non-euro)	0.26	0.17	0.23	0.23

FIGURE 1

Growth Contributions

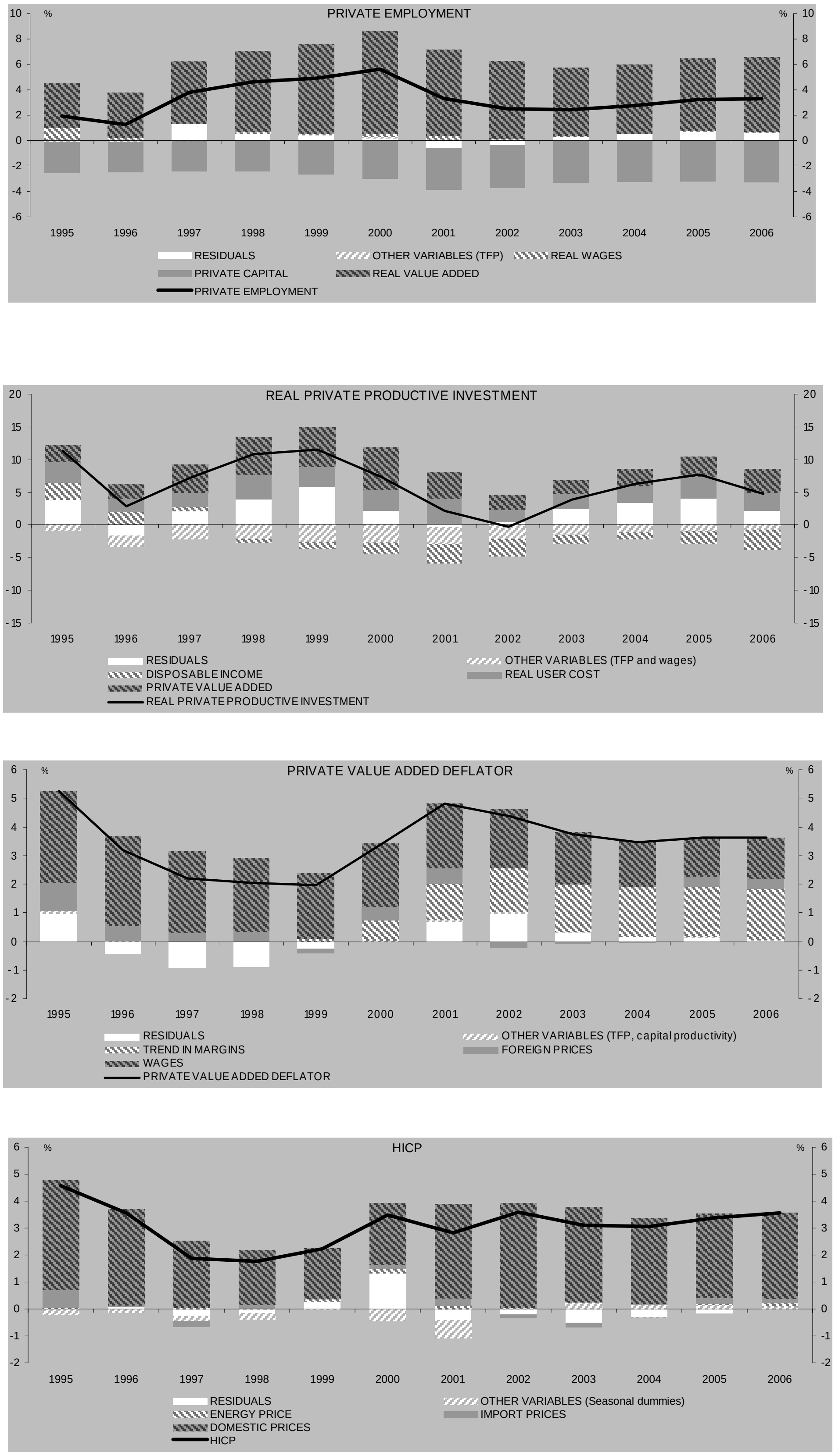
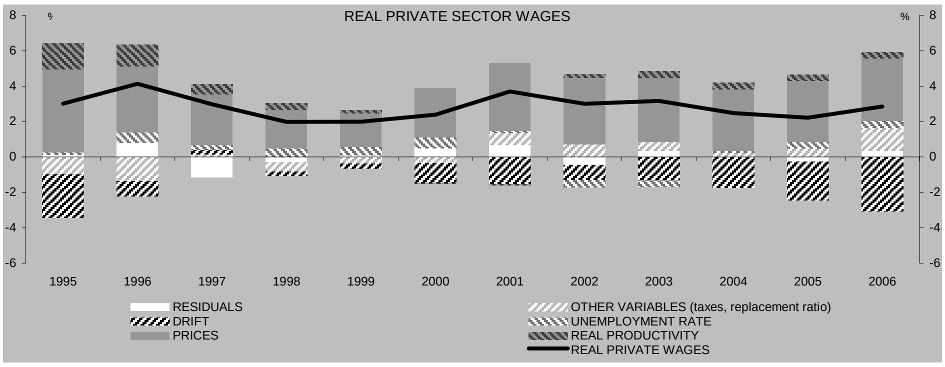
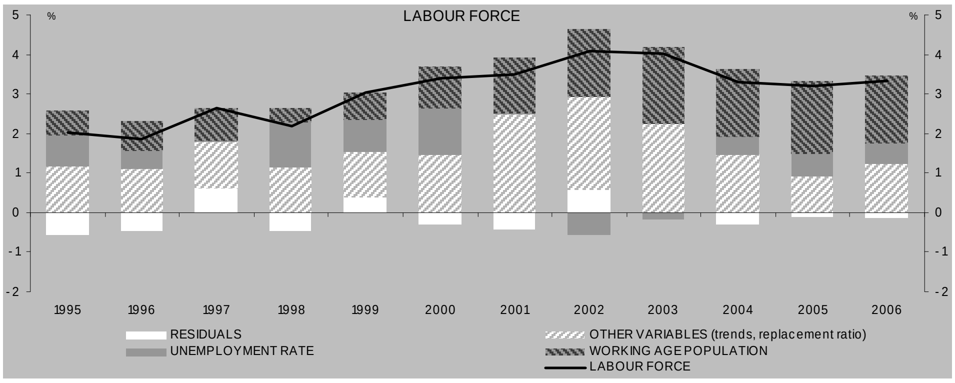
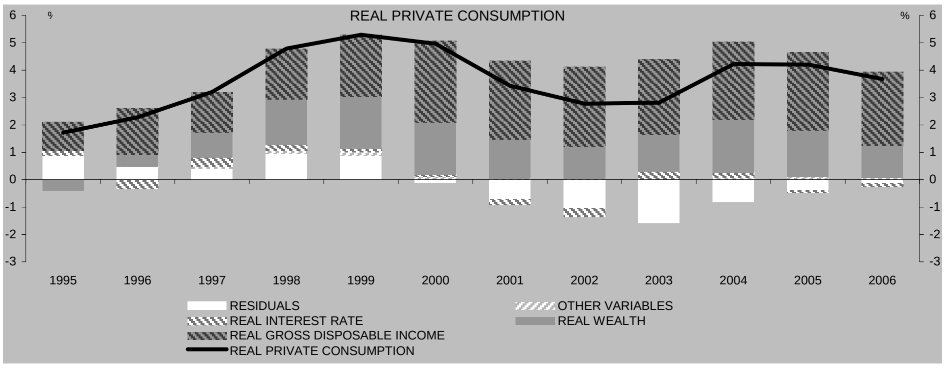


FIGURE 2

Growth Contributions







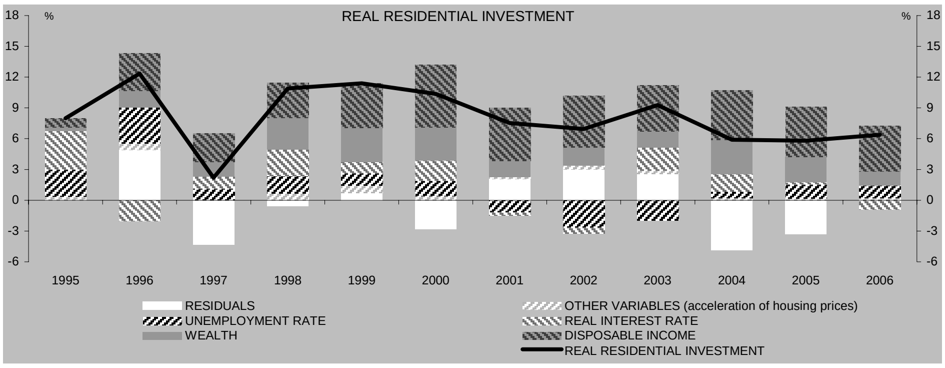
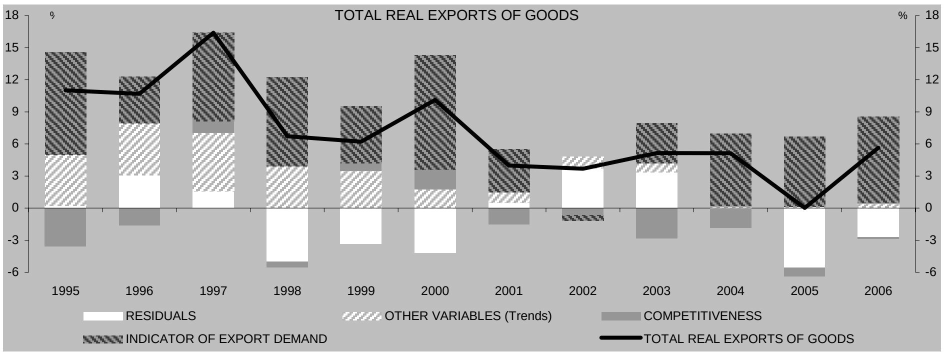
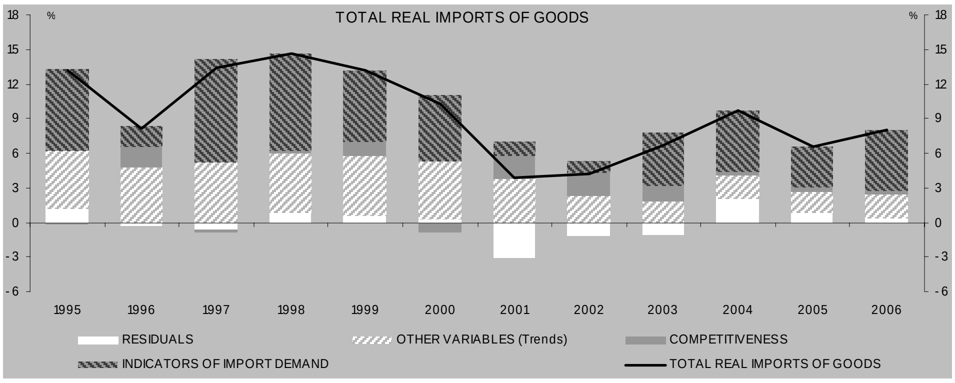
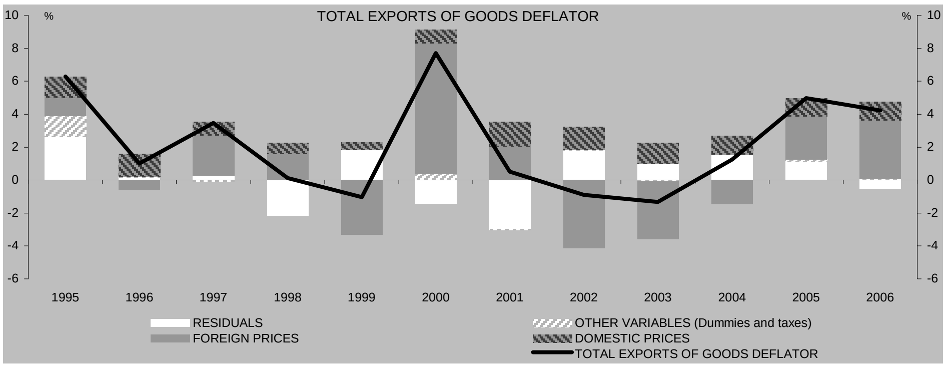


FIGURE 3

Growth Contributions







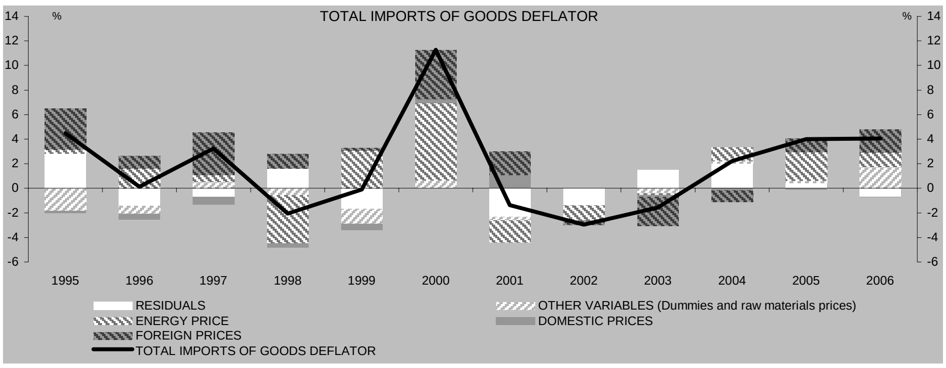


Table 2. Summary of shock simulation exercises

	Public expenditure			Interest rates			Housing prices			World demand			World prices			TFP		
	Year 1	Year 3	Year 6	Year 1	Year 3	Year 6	Year 1	Year 3	Year 6	Year 1	Year 3	Year 6	Year 1	Year 3	Year 6	Year 1	Year 3	Year 6
1. PRICES AND COSTS																		
1.1. HICP	0,02	0,20	0,29	0,00	-0,23	-0,40	0,00	-0,12	-0,37	-0,01	-0,18	-0,32	-0,06	-0,39	-0,57	-0,03	-0,80	-2,96
1.2. GDP deflator	0,04	0,24	0,31	-0,02	-0,37	-0,43	-0,04	-0,30	-0,69	-0,02	-0,22	-0,34	-0,05	-0,37	-0,54	-0,04	-0,89	-2,93
1.3. Nominal wages	0,09	0,24	0,30	-0,04	-0,43	-0,66	-0,02	-0,24	-0,53	-0,06	-0,24	-0,33	-0,06	-0,36	-0,57	0,01	0,00	0,07
1.4. Exports deflator (a)	0,00	0,07	0,11	0,00	-0,08	-0,15	0,00	-0,08	-0,22	0,00	-0,06	-0,12	-0,74	-0,74	-0,85	0,00	-0,23	-0,96
2. ACTIVITY																		
2.1. GDP	0,19	0,33	0,33	-0,11	-0,76	-0,80	-0,04	-0,35	-0,65	-0,14	-0,35	-0,38	-0,10	-0,25	-0,19	0,00	0,01	0,59
2.2. Private consumption	0,03	0,17	0,20	-0,15	-0,62	-0,58	-0,06	-0,45	-0,94	-0,02	-0,16	-0,23	-0,01	-0,10	-0,06	0,00	-0,02	0,70
2.3. Fixed capital formation	0,19	0,66	0,55	-0,32	-2,87	-2,96	-0,11	-0,99	-1,64	-0,12	-0,66	-0,66	-0,13	-0,65	-0,42	-0,01	-0,46	-0,48
2.3.1. Private productive investment	*0,31*	*0,85*	*0,78*	*-0,47*	*-3,49*	*-4,35*	*-0,07*	*-0,85*	*-1,68*	*-0,21*	*-0,84*	*-0,91*	*-0,22*	*-0,94*	*-0,69*	*-0,02*	*-0,46*	*-0,94*
2.3.2. Residential investment	*0,10*	*0,64*	*0,41*	*-0,23*	*-3,01*	*-1,97*	*-0,19*	*-1,54*	*-2,34*	*-0,05*	*-0,63*	*-0,53*	*-0,05*	*-0,48*	*-0,15*	*-0,01*	*-0,62*	*0,06*
2.4. Exports of goods and services	0,00	-0,05	-0,09	0,00	0,06	0,13	0,00	0,06	0,18	-0,90	-1,00	-0,90	-0,21	-0,24	-0,13	0,00	0,16	0,77
2.5. Imports of goods and services	0,18	0,39	0,31	-0,23	-1,39	-1,14	-0,08	-0,59	-0,96	-0,45	-0,66	-0,63	0,00	-0,23	-0,03	-0,02	-0,35	-0,34
2.6. Contribution to GDP: external sector	-0,06	-0,15	-0,14	0,08	0,49	0,44	0,03	0,22	0,39	-0,09	-0,05	-0,03	-0,05	0,01	-0,03	0,01	0,16	0,34
2.7. Net lending or net borrowing (b)	-0,04	-0,10	-0,08	0,07	0,41	0,39	0,02	0,16	0,28	-0,11	-0,12	-0,15	-0,07	0,04	-0,03	0,00	0,07	-0,02
3. HOUSEHOLDS																		
3.1. Real disposable income	0,17	0,26	0,20	-0,11	-0,67	-0,47	-0,07	-0,40	-0,61	-0,12	-0,28	-0,24	-0,09	-0,12	-0,07	0,00	0,14	1,52
3.2. Savings rate (% of disposable income)	0,12	0,08	0,00	0,04	-0,04	0,10	0,00	0,04	0,30	-0,09	-0,11	0,00	-0,06	-0,02	0,00	0,00	0,15	0,72
4. JOB MARKET																		
4.1. Unemployment rate	-0,07	-0,23	-0,26	0,03	0,41	0,43	0,02	0,20	0,48	0,05	0,23	0,30	0,04	0,16	0,13	0,03	0,59	1,73
4.2. Employment	0,11	0,36	0,40	-0,04	-0,67	-0,67	-0,02	-0,32	-0,74	-0,07	-0,36	-0,46	-0,06	-0,25	-0,20	-0,05	-0,93	-2,70
4.3. Labour productivity (c)	0,09	-0,03	-0,07	-0,07	-0,11	-0,17	-0,02	-0,04	0,09	-0,08	0,02	0,09	-0,05	0,00	0,00	0,06	1,07	3,80

(a) Goods, euro area.
(b) Difference in percentages of GDP.
(c) Apparent labour productivity in the private sector.

Figure 4. Demand shock: increase in public expenditure

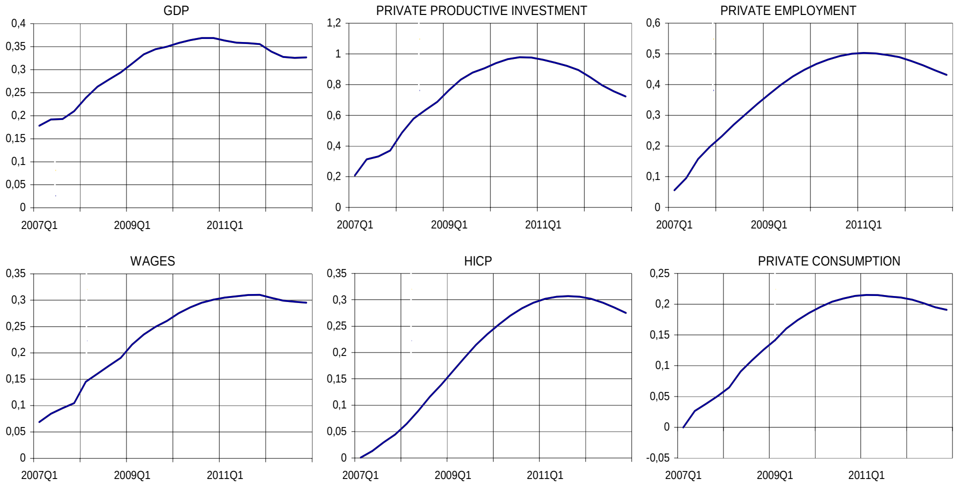


Figure 5. Increase in interest rates

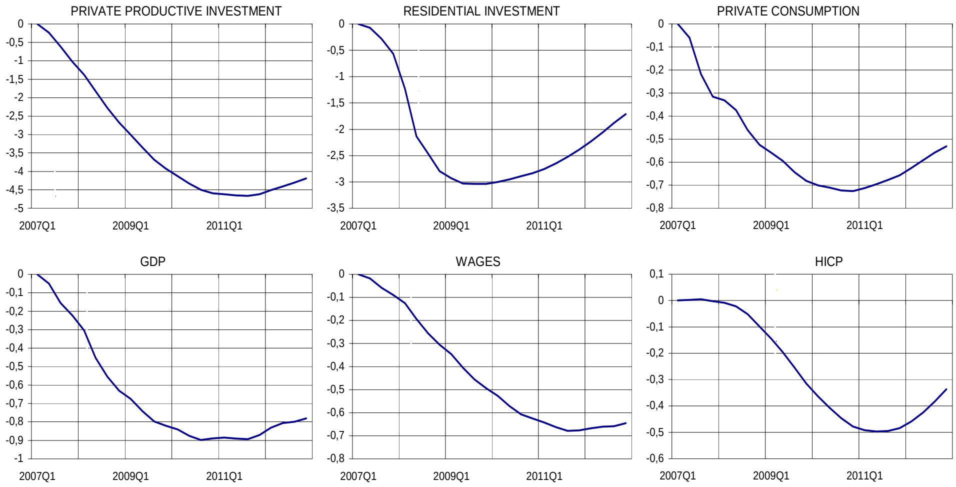


Figure 6. Slower increase of housing prices

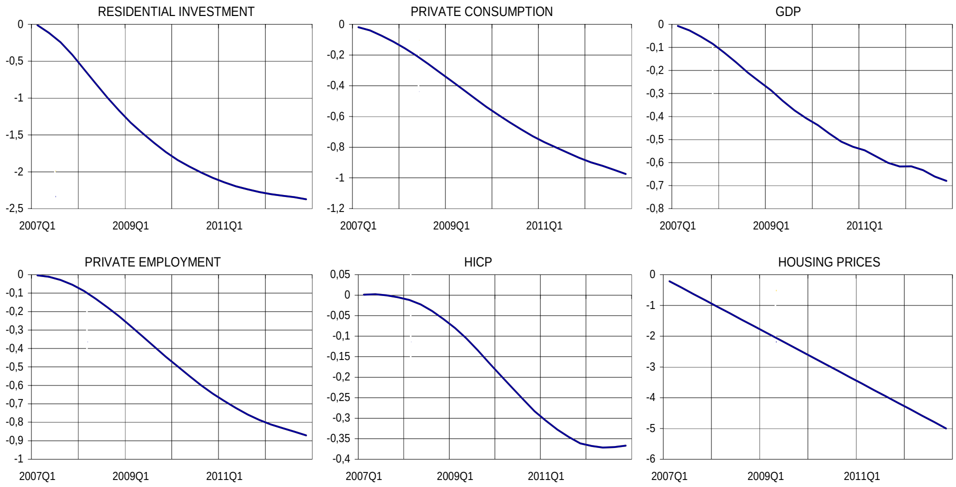


Figure 7. Lower world demand

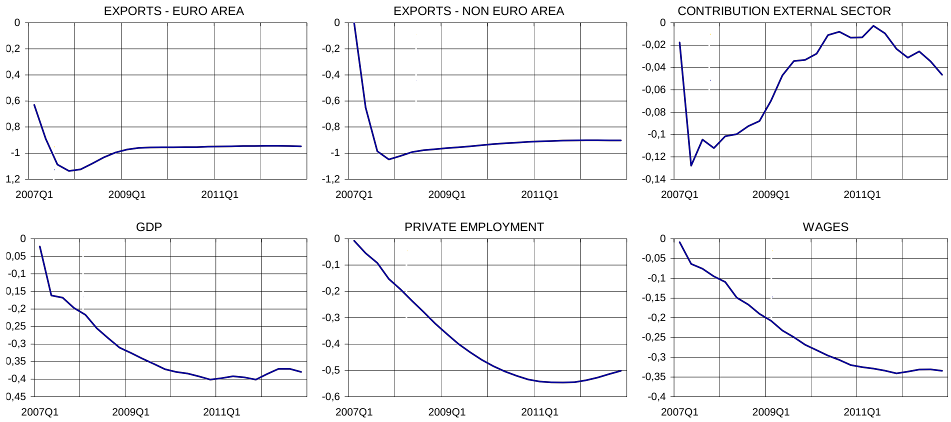


Figure 8. Lower world prices

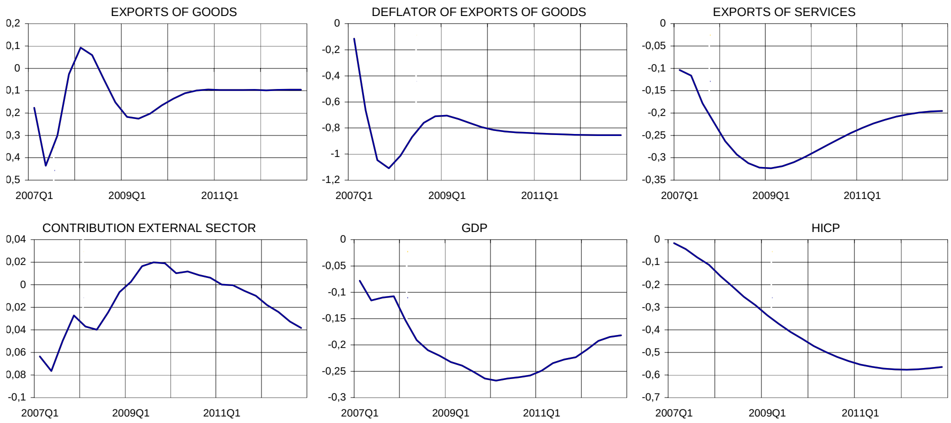


Figure 9. Faster growth of total factor productivity

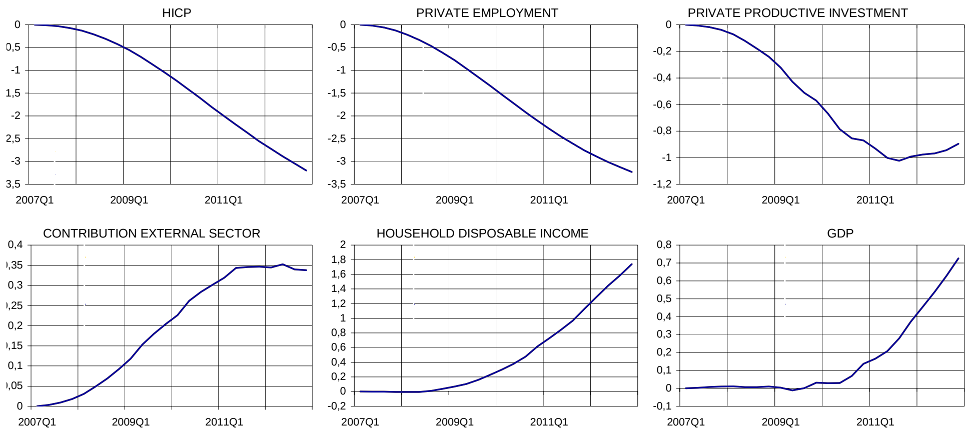


Table 3: Evaluation of the predictive ability of the model.

Improvement in the ratio of the root mean square error (RMSE) of the updated model to that the previous version of the MTBE (a).

	2003-2006			1998-2002			1993-1997			1988-1992		
	Quar 1	Year 1	Year 2	Quar 1	Year 1	Year 2	Quar 1	Year 1	Year 2	Quar 1	Year 1	Year 2
1. ACTIVITY												
1.1. Real GDP	0,45	0,40	1,94	0,96	0,77	1,09	1,06	0,88	0,51	1,11	1,29	0,96
1.2. Real private value added	0,45	0,40	1,94	0,96	0,77	1,08	1,06	0,89	0,51	1,11	1,29	0,96
1.3. Real private consumption	0,99	1,40	0,99	0,68	0,69	1,16	0,78	0,81	0,69	0,60	0,82	1,20
1.4. Real private productive investment	1,28	1,42	2,75	1,06	1,39	1,28	0,98	0,85	0,48	0,89	0,96	1,00
1.5. Real residential investment	0,31	0,15	0,19	0,57	0,33	0,30	0,67	0,72	0,53	0,95	1,26	1,49
2. JOB MARKET												
2.1. Total employment	0,32	0,32	0,51	0,43	0,38	0,46	0,68	0,68	0,60	0,58	0,89	1,02
2.2. Unemployment rate	0,68	0,58	0,62	1,03	1,07	1,04	0,79	0,77	0,68	0,82	1,01	1,30
2.3. Private wages	0,25	0,11	0,10	0,45	0,30	0,27	0,73	0,46	0,36	1,13	0,83	0,56
3. PRICES												
3.1. GDP deflator	1,35	1,14	0,70	1,00	0,74	0,69	1,00	0,72	0,49	1,39	0,92	0,51
3.2. HICP	0,19	0,17	0,51	0,43	0,35	0,44	0,68	0,60	0,48	0,78	0,80	0,57
4. EXTERNAL SECTOR												
4.1. Real imports of goods	0,92	1,17	1,22	0,95	1,09	1,34	1,13	0,77	0,77	0,85	0,76	1,00
4.2. Real exports of goods	1,05	1,46	1,88	1,17	1,40	0,90	1,00	1,19	1,48	1,00	1,19	1,04
5. SUMMARY: GEOMETRIC MEAN	0,57	0,51	0,78	0,76	0,68	0,74	0,86	0,76	0,59	0,91	0,98	0,92

(a) Values lower than 1 denote an improvement on the previous version of the MTBE; values higher than 1 denote a worsening.

APPENDIX. ESTIMATED EQUATIONS OF THE MODEL

TABLE A1. SUPPLY SIDE EQUATIONS FOR THE PRIVATE SECTOR: EMPLOYMENT (PLN), PRODUCTIVE INVESTMENT (PIR), VALUE ADDED DEFLATOR (PYED), WAGES (PWUN) AND LABOUR FORCE (LFN)

Long-run relations:

$$\underset{}{\text{pln}^{*}} = \underset{(-36.99)}{-1.17} \quad \underset{(-0.78)}{-0.0001\ \text{TFP}} \underset{(-)}{+1.71\,\text{pyer}} \underset{(-)}{-0.71\,\text{pkr}}$$

σ(%) = 2.02 ADF = -1.93 AR(5).LM=387.4 NORM.χ^2=12.16 ARCH.F=24.45

$$\text{pkr}^{*} = \underset{(-34.27)}{-1.26} \quad \underset{(-)}{-0.0001\ \text{TFP}} \underset{(-)}{+1.00\,\text{pyer}} \underset{(76.96)}{-0.58\,(\text{puc - pwun})} \underset{(-15.06)}{-0.26\,\text{J93.99}}$$

σ(%) = 6.78 ADF = -4.70 NORM.χ^2=5.51 ARCH.F=10.85

$$\text{pyed}^{*} = \underset{(-21.54)}{-0.65} \underset{(-)}{+0.63\,(\text{pyer - pkr})} \underset{(-)}{-0.0001\ \text{TFP}} \underset{(-)}{-0.89\,\text{pwun}} \underset{(9.75)}{-0.12\,\text{cxgeed}} \underset{(25.18)}{-0.005\text{T99}} \underset{(5.15)}{-0.04\,\text{D90}}$$

σ(%) = 1.20 ADF = -2.77 NORM.χ^2=11.99 ARCH.F=18.20

$$\text{pwun}^{*} = \underset{(-44.16)}{-0.91} + \underset{(2.77)}{\left(0.57\text{pyed} + 0.43\,\text{pcd} + \text{pyer} - \text{pln}\right)} \underset{(-)}{-\text{twed}} \underset{(-2.38)}{-0.20\,\text{URX}} \underset{(11.03)}{+0.005\ \text{Accumulated Drift}}$$

σ(%) = 1.59 ADF = -3.46 AR(5).LM=72.36 NORM.χ^2=20.5 ARCH.F=4.73

$$\text{lfn}^{*} = \underset{(-99.11)}{-0.51} \underset{(-)}{+\text{popwa}} \underset{(-13.74)}{-0.47\,\text{URX}} \underset{(9.43)}{+0.001\,\text{T86}} \underset{(8.49)}{+0.002\ \text{T93}} \underset{(8.74)}{+0.003\,\text{T00}} \underset{(-4.47)}{-0.003\,\text{T03}}$$

σ(%) = 0.64 ADF = -5.28 AR(5).LM=157.1 NORM.χ^2=4.97 ARCH.F=24.48

Vectorial Tests (equations of pln*, pkr* and pyed* jointly): AR(5).LM=3.65 NORM.χ^2=40.53

Vectorial Tests (equations of pwun* and lfn* jointly): AR(5).LM=5.92 NORM.χ^2=24.33

T-ratio in brackets. (-) if estimation is restricted by theory or by definition of the variable.

ADF Test: null hypothesis is non-stationarity of cointegration vector.
LM Test: null hypothesis is non-residual autocorrelation.
χ^2 Test: null hypothesis is normality of residuals.
F Test: null hypothesis is non-autoregressive conditional heteroskedasticity in the residuals.

J93.99: gradual shift in the level linearly distributed between 1993Q1-1999Q4. D90: dummy from 1990Q3 to 1990Q4.
T86, T93, T99, T00, T03: linear trend starting in 1986Q1, 1993Q1, 1999Q1, 2000Q1 and 2003Q1.

Dynamic specifications:

$$\Delta pln = \underset{(1.26)}{0.01} + \underset{(-)}{0.25}\Delta pln_{-1} + \underset{(6.32)}{0.30}\Delta pyer + \underset{(3.80)}{0.19}\Delta pyer_{-2} - \underset{(-2.58)}{0.08}\Delta pwunr - \underset{(-4.29)}{0.14}\Delta pwunr_{-2} - \underset{(-3.48)}{0.07}(pln - pln^{*})_{-1}$$

σ(%) = 0.33 NORM.χ^2=3.00 ARCH.F=0.05

$$\Delta pir = \underset{(2.82)}{-0.25} + \underset{(2.86)}{0.25}\Delta pir_{-4} + \underset{(-)}{\Delta pyer} + \underset{(-)}{0.38}\Delta pyer_{-1} + \underset{(1.41)}{0.50}\,D86.94\Delta pyer_{-2} - \underset{(-0.63)}{0.01}\Delta pucr_{-3} + \underset{(1.58)}{1.52}\frac{FDYN}{PKN_{-1}} - \underset{(-2.19)}{0.06}(pir - pkr^{*})_{-1}$$

σ(%) = 2.62 NORM.χ^2=9.18 ARCH.F=0.50

$$\Delta pyed = \underset{(2.59)}{0.005} + \underset{(2.37)}{0.27}\Delta pyed_{-2} + \underset{(1.07)}{0.05}\Delta mgd_{-2} + \underset{(1.84)}{0.23}\Delta pwun - \underset{(-)}{0.10}(pyed - pyed^{*})_{-1}$$

σ(%) = 1.13 NORM.χ^2=62.61 ARCH.F=0.59

$$\Delta pwun = \underset{(1.62)}{0.003} - \underset{(2.44)}{0.20}\Delta pwun_{-4} + \underset{(4.81)}{0.44}\left(0.49\Delta pyed + 0.51\Delta pcd + \Delta pyer - \Delta pln\right) - \underset{(-1.48)}{0.32}\Delta URX_{-2} + \underset{(1.95)}{0.10}\Delta RRU_{-4}$$

$$+ \underset{(3.617)}{0.003}\,Deriva - \underset{(-3.64)}{0.20}(pwun - pwun^{*})_{-1}$$

σ(%) = 0.72 AR(5).LM=18.38 NORM.χ^2=13.83 ARCH.F=0.21

$$\Delta lfn = \underset{(0.046)}{0.00} + \underset{(4.62)}{0.45}\Delta lfn_{-1} + \underset{(2.02)}{0.20}\Delta lfn_{-2} + \underset{(2.06)}{0.69}\Delta popwa - \underset{(-2.87)}{0.28}\Delta URX_{-1} - 0.4(lfn - lfn^{*})_{-1}$$

σ(%) = 0,35 AR(5).LM=27.42 NORM.χ^2=29.57 ARCH.F=0.56

Vectorial tests (equations of Δpln, Δpkr and Δpyed jointly): AR(5).LM=1.91 NORM.χ^2=82.59

Vectorial tests (equations of Δpwun and Δlfn jointly): AR(5).LM=1.30 NORM.χ^2=42.57

D86.94Δpyer: this variable appears only from 1986Q1 to 1994Q4

pucr = ln[(PID/PYED)1/4 [(RCC+LTI)/2 +0.085 –log(1/2 PID/PID$_{-8}$)]] , where RCC= 0.024 + 0.50 STI + (1-0.50) STI$_{-1}$

TABLE A2. EQUATIONS FOR REAL PRIVATE CONSUMPTION (PCR), PRIVATE RESIDENTIAL INVESTMENT (RIR) AND ITS DEFLATOR (RID)

Long-run relations:

$$pcr^{*} = \underset{(8.86)}{0.56} + \underset{(48.31)}{0.82}\ hdyr + \underset{(7.03)}{0.10}\ \ln(FWR_{-1} + NFWR_{-1}) - \underset{(-0.90)}{0.26}\ RRC$$

σ(%) = 1.40   ADF = -3.07   AR(5).LM=25.65   NORM.χ^2=0.13   ARCH.F=0.46

$$rir^{*} = -\underset{(-19.86)}{9.11} + \underset{(-)}{1.39}\ hdyr + \underset{(-)}{0.17}\ \ln(FWR_{-1} + NFWR_{-1}) - \underset{(-5.46)}{3.36}\ RRI - \underset{(-)}{0.26}\ RRC$$

σ(%) = 6.42   ADF = -2.49   AR(5).LM=25.33   NORM.χ^2=2.09   ARCH.F=9.33

$$Ln\left(\frac{RID^{*}}{1 + TIXRI}\right) = \underset{(11.84)}{2.19} + \underset{(31.17)}{0.01}\ T00 + \underset{(-)}{\ln}\left(\frac{PCD}{1 + TIXPC}\right) + \underset{(11.93)}{1.03}\ (pcr - rkr_{-1}) - \underset{(5.08)}{1.09}\ RRI$$

σ(%) = 2.03   ADF = -5.38   AR(5).LM=23.05   NORM.χ^2=0.74   ARCH.F=0.45

Vectorial tests (equations of pcr*, rir* and rid* jointly):   AR(5).LM=5.17   NORM.χ^2=1.81

RRC= ¼ [HTI – log(PCD/PCD_{-4})] y RRI= (RID/PCD) ¼ [HTI + 0.02– log(RID/RID_{-4})], where HTI = 0.015 + 0.35 STI + (1-0.35) STI_{-1}

Dynamic specifications:

$$\underset{}{\Delta pcr} = \underset{(0.36)}{0.00} + \underset{(3.04)}{0.31}\,\Delta pcr_{-4} + \underset{(2.04)}{0.13}\,\Delta hdyr_{-1} + \underset{(1.38)}{0.03}\,\Delta fwr + \underset{(1.65)}{0.03}\,\Delta fwr_{-2} + \underset{(2.22)}{0.09}\,\Delta nfwr +$$

$$\underset{(1.40)}{0.06}\,\Delta nfwr_{-2} - \underset{(-1.74)}{0.62}\,\Delta RRC_{-1} - \underset{(-1.61)}{0.50}\,\Delta RRC_{-2} - \underset{(-1.03)}{0.07}\,(pcr - pcr^{*})_{-1}$$

σ(%) = 0.64 AR(5).LM=9.20 NORM.χ^2=13.06 ARCH.F=0.08

$$\Delta rir = \underset{(-0.57)}{-0.003} + \underset{(2.15)}{0.22}\,\Delta rir_{-2} + \underset{(0.63)}{0.14}\,\Delta hdyr_{-1} + \underset{(1.40)}{0.10}\,\Delta fwr_{-2} + \underset{(2.41)}{0.36}\,\Delta nfwr_{-1} - \underset{(-1.43)}{0.95}\,\Delta HTI_{-4} + \underset{(0.93)}{0.06}\,\Delta^2 RID$$

$$- \underset{(-2.24)}{1.56}\,\Delta URX_{-2} - \underset{(-2.48)}{0.15}\,(rir - rir^{*})_{-1}$$

σ(%) = 2.49 AR(5).LM=16.33 NORM.χ^2=1.07 ARCH.F=0.53

$$\Delta Ln\left(\frac{RID}{1 + TIXRI}\right) = \underset{(1.78)}{0.005} + \underset{(-)}{\Delta ln}\left(\frac{PCD}{1 + TIXPC}\right) - \underset{(-7.04)}{0.90}\,(rid - rid^{*})_{-1}$$

σ(%) = 2.29 AR(5).LM=589.21 NORM.χ^2=4.14 ARCH.F=0.30

Vectorial tests (equations of Δpcr, Δrir and Δrid jointly): AR(5).LM=1.26 NORM.χ^2=20.33

TABLE A3. EQUATIONS FOR PRIVATE CONSUMPTION (PCD) AND PRIVATE PRODUCTIVE INVESTMENT DEFLATORS (PID), AND ENERGY (HICPE) AND NON-ENERGY (HICPNE) COMPONENTS OF HICP

Long-run relations:

$$\mathrm{Ln}\left(\frac{\mathrm{PCD}^*}{1+\mathrm{TIXPC}}\right) = -\underset{(-6.99)}{0.01} + \underset{(264.4)}{0.94}\left(\frac{\mathrm{pyed}-0.1\,\mathrm{rid}}{0.9}\right) + \underset{(-)}{0.04}\,\mathrm{mged} + \underset{(-)}{0.02}\,\mathrm{mgnd} + \underset{(-)}{0.003}\,\mathrm{msd}$$

σ(%) = 1.16 ADF = -2.72 AR(5).LM=32.47 NORM.χ^2=3.32 ARCH.F=5.07

$$\mathrm{hicpne}^* = \underset{(-169.04)}{-0.16} \underset{(-3.65)}{-0.01}\,\mathrm{S1} \underset{(-0.36)}{-0.001}\,\mathrm{S2} \underset{(-5.31)}{-0.01}\,\mathrm{S3} + \underset{(219.1)}{0.91}\frac{\mathrm{pyedt}-0.1\mathrm{rid}}{0.9} + \underset{(-)}{0.06}\,\mathrm{mged} + \underset{(-)}{0.02}\frac{\mathrm{mgnd}-0.15\,\mathrm{pei}}{0.85} + \underset{(-)}{0.004}\,\mathrm{msd}$$

σ(%) = 0.61 ADF = -3.94 AR(5).LM=12.52 NORM.χ^2=9.41 ARCH.F=0.32

$$\mathrm{hicpe}^* = -\underset{(-16.14)}{0.16} + \underset{(-)}{0.93}\frac{\mathrm{pyedt}-0.1\mathrm{rid}}{0.9} + \underset{(3.49)}{0.07}\,\mathrm{pei}$$

σ(%) = 5.30 ADF = -3.73 AR(5).LM=61.47 NORM.χ^2=9.88 ARCH.F=30.57

$$\mathrm{Ln}\left(\frac{\mathrm{PID}^*}{1+\mathrm{TIXPI}}\right) = -\underset{(-0.84)}{0.003} + \underset{(85.49)}{0.76}\,\mathrm{pyed} + \underset{(-)}{0.14}\,\mathrm{mged} + \underset{(-)}{0.08}\frac{\mathrm{mgnd}-0.15\,\mathrm{pei}}{0.85} + \underset{(-)}{0.014}\,\mathrm{msd}$$

σ(%) = 2.90 ADF = -4.93 AR(5).LM=14.18 NORM.χ^2=9.44 ARCH.F=4.10

Vectorial tests (equations of **pcd*** and **pid*** jointly): AR(5).LM=9.40 NORM.χ^2=12.63

Vectorial tests (equations of **hicpne* and hicpe*** jointly): AR(5).LM=11.08 NORM.χ^2=10.30

S1, S2, S3: seasonal dummies associated to 1st, 2nd and 3rd quarters of the year.

Dynamic specifications:

$$\Delta Ln\left(\frac{PCD}{1+TIXPC}\right) = \underset{(0.47)}{0.00} + \underset{(6.40)}{0.50}\,\Delta Ln\left(\frac{PCD}{1+TIXPC}\right)_{-4} + \underset{(-)}{0.37}\Delta\left(\frac{pyed-0.1rid}{0.9}\right) + \underset{(4.14)}{0.11}\,\Delta mged_{-4} +$$

$$+ \underset{(1.05)}{0.02}\,\Delta mgnd_{-1} + \underset{(0.94)}{0.01}\,\Delta mgnd_{-4} - \underset{(-5.95)}{0.06}\,\Delta tixpc + \underset{(5.27)}{0.06}\,\Delta tixpc_{-4} - \underset{(-3.87)}{0.27}\,(pcd-pcd^{*})_{-1}$$

σ (%) = 0.65 AR(5).LM=26.49 NORM.χ^2=5.17 ARCH.F=1.40

$$\Delta hicpne = \underset{(1.01)}{0.001} - \underset{(-3.38)}{0.006}\,S1 + \underset{(3.29)}{0.005}\,S2 - \underset{(-4.56)}{0.008}\,S3 + \underset{(7.10)}{0.44}\,\Delta hicpne_{-4} + \underset{(-)}{0.49}\Delta\left(\frac{pyedt-0.1rid}{0.9}\right)$$

$$+ \underset{(2.52)}{0.05}\,\Delta mged + \underset{(1.32)}{0.03}\,\Delta mged_{-4} - \underset{(-3.97)}{0.30}\left(hicpne - hicpne^{*}\right)_{-1}$$

σ (%) = 4.16 AR(5).LM=12.52 NORM.χ^2=4.36 ARCH.F=0.13

$$\Delta hicpe = -\underset{(-2.20)}{0.004} + \underset{(1.56)}{0.12}\,\Delta hicpe_{-3} + \underset{(-)}{0.81}\Delta\left(\frac{pyedt-0.1rid}{0.9}\right) + \underset{(3.44)}{0.06}\,\Delta pei + \underset{(4.65)}{0.14}\,D99\Delta pei + \underset{(0.63)}{0.01}\,\Delta pei_{-2}$$

$$- \underset{(-2.64)}{0.10}\,(hicpe-hicpe^{*})_{-1}$$

σ (%) = 1.56 AR(5).LM=19.76 NORM.χ^2=0.97 ARCH.F=0.01

$$\Delta Ln\left(\frac{PID}{1+TIXPI}\right) = -\underset{(-0.87)}{0.002} + \underset{(11.78)}{0.97}\,\Delta pyed_{-3} + \underset{(-)}{0.03}\,\Delta mged_{-1} - \underset{(-4.36)}{0.44}\,(pid-pid^{*})_{-1}$$

σ (%) = 2.28 AR(5).LM=31.09 NORM.χ^2=5.38 ARCH.F=0.48

Vectorial tests (equations of Δpcd, Δhicpne, Δhicpe and Δpid jointly): AR(5).LM=1.53 NORM.χ^2=15.95

D99Δpei: this variable starts in 1999Q1.

TABLE A4. EQUATIONS FOR REAL EXPORTS OF GOODS TO THE EURO AREA (XGER), TO THE REST OF THE WORLD (XGNR) AND OF SERVICES (XSR), AND THEIR RESPECTIVE DEFLATORS

Long-run relations:

$$\underset{}{xger^{*}} = \underset{(462.90)}{8.53} + \underset{(39.79)}{0.01}\, T80.98 + \underset{(-)}{wdger} - \underset{(-4.25)}{0.44}\,(xged - 0.6\,cxgeed - 0.4\,cxgend)$$

σ (%) = 4.58 ADF = -2.62 AR(5).LM=19.94 NORM.χ^2=2.36 ARCH.F=0.96

$$xgnr^{*} = \underset{(779.77)}{8.76} + \underset{(12.14)}{0{,}01}\, T92.02 + \underset{(-)}{wdgnr} - \underset{(-8.06)}{0.91}\,(xgnd - 0.6\,cxgnnd - 0.4\,cxgned)$$

σ (%) = 6.49 ADF = -2.92 AR(5).LM=18.40 NORM.χ^2=3.10 ARCH.F=0.36

$$xsr^{*} = \underset{(969.48)}{8.92} + \underset{(53.55)}{0.02}\, T94.00 + \underset{(-)}{wdsr} - \underset{(-)}{0.51}\, xsd + \underset{(8.07)}{0.51}\, cxsd$$

σ (%) = 3.53 ADF = -1.76 AR(5).LM=55.01 NORM.χ^2=1.29 ARCH.F=4.74

$$\frac{xged^{*}}{1+tixxge} = \underset{(6.95)}{0.07} - \underset{(-14.07)}{0.10}\, D93q2 + \underset{(-)}{0.67}\left(0.6\,cxgeed + 0.4\,cxgend\right) + \underset{(11.97)}{0.33}\, pyed$$

σ (%) = 2.72 ADF = -2.43 AR(5).LM=80608 NORM.χ^2=7.61 ARCH.F=4.17

$$\frac{xgnd^{*}}{1+tixxgn} = \underset{(11.47)}{0.10} - \underset{(-21.59)}{0.16}\, D93q2 + \underset{(-)}{0.70}\left(0.6\,cxgnnd + 0.4\,cxgned\right) + \underset{(12.61)}{0.30}\, pyed$$

σ (%) = 2.74 ADF = -2.66 AR(5).LM=25514 NORM.χ^2=4.05 ARCH.F=2.40

$$\frac{xsd^{*}}{1+tixxs} = \underset{(7.18)}{0.05} - \underset{(-5.95)}{0.02}\, D93q2 + \underset{(-)}{0.19}\, cxsd + \underset{(29.16)}{0.82}\, pyed$$

σ (%) = 1.73 ADF = -3.85 AR(5).LM=3061 NORM.χ^2=5.89 ARCH.F=1.26

Vectorial tests (equations of xger*, xgnr*, xsr*, xged*, xgnd* and xsd* jointly): AR(5).LM=3.28 NORM.χ^2=10.78

T80.98: linear trend from 1980Q1 to 1998Q4
T92.02: linear trend from 1992Q1 to 2002Q4
T94.00: linear trend from 1994Q1 to 2000Q4
D93q2 : dummy in 1993Q2

Dynamic specifications:

$$\Delta xger = \underset{(0.86)}{0.01} + \underset{(-)}{0.19}\Delta xger_{-1} + \underset{(-)}{0.17}\Delta xger_{-2} + \underset{(2.31)}{0.63}\Delta wdger - \underset{(-)}{0.21}\Delta(xged - cxgeed)_{-1} - \underset{(-)}{0.16}\Delta(xged - cxgeed)_{-2}$$

$$- \underset{(-4.14)}{0.38}(xger - xger^{*})_{-1}$$

σ(%) = 3.80 AR(5).LM=39.56 NORM.χ^2=2.11 ARCH.F=0.03

$$\Delta xgnr = \underset{(2.46)}{0.02} - \underset{(-)}{0.17}\Delta xgnr_{-1} - \underset{(3.06)}{0.50}(\Delta\Delta xgn - \Delta cxgnnd) - \underset{(-6.60)}{0.65}(xgnr - xgnr^{*})_{-1}$$

σ(%) = 5.81 AR(5).LM=19.73 NORM.χ^2=1.77 ARCH.F=0.08

$$\Delta xsr = - \underset{(-0.70)}{0.003} + \underset{(1.92)}{0.01} D91.00 + \underset{(-)}{0.15}\Delta xsr_{-1} + \underset{(-)}{0.22}\Delta xsr_{-2} + \underset{(1.95)}{1.10}\Delta wdsr_{-1} - \underset{(1.53)}{0.10}\Delta(xsd - cxsd)_{-1}$$

$$- \underset{(-2.57)}{0.17}(xsr - xsr^{*})_{-1}$$

σ(%) = 1.71 AR(5).LM=12.62 NORM.χ^2=15.97 ARCH.F=0.05

$$\Delta\frac{xged}{1+tixxge} = \underset{(0.92)}{0.002} + \underset{(-)}{0.45}\Delta\left(\frac{xged}{1+tixxge}\right)_{-1} + \underset{(-)}{0.56}\Delta cxgeed_{-1} - \underset{(-)}{0.56}\Delta efxgee_{-1} - \underset{(-5.06)}{0.33}(xged - xged^{*})_{-1}$$

σ(%) = 2.02 AR(5).LM=23.72 NORM.χ^2=11.52 ARCH.F=0.08

$$\Delta\frac{xgnd}{1+tixxgn} = - \underset{(-0.20)}{0.00} + \underset{(-)}{0.49}\Delta\frac{xgnd}{1+tixxgn}_{-1} + \underset{(-)}{0.25}\Delta cxgnnd + \underset{(-)}{0.26}\Delta cxgnnd_{-2} - \underset{(-)}{0.26}\Delta efxgnn_{-2}$$

$$- \underset{(-4.87)}{0.35}(xgnd - xgnd^{*})_{-1}$$

σ(%) = 2.14 AR(5).LM=13.80 NORM.χ^2=6.70* ARCH.F=0.14

$$\Delta\frac{xsd}{1+tixxs} = \underset{(1.12)}{0.002} + \underset{(-)}{0.55}\Delta cxsd_{-1} - \underset{(-)}{0.57}\Delta efxs_{-1} + \underset{(-)}{0.45}\Delta pyed - \underset{(-1.92)}{0.02} S1 + \underset{(1.23)}{0.01} S2 + \underset{(0.15)}{0.001} S3 - \underset{(-6.54)}{0.64}(xsd - xsd^{*})_{-1}$$

σ(%) = 1.60 AR(5).LM=15.55 NORM.χ^2=38.79 ARCH.F=1.52

Vectorial tests (equations of Δxger, Δxgnr and Δxsr): AR(5).LM=1.75 NORM.χ^2=20.18

Vectorial tests (equations of Δxged, Δxgnd and Δxsd): AR(5).LM=1.88 NORM.χ^2=34.26

D91.00: dummy from 1991Q1 to 2000Q4

TABLE A5. EQUATIONS FOR REAL IMPORTS OF GOODS FROM THE EURO AREA (MGER), FROM THE REST OF THE WORLD (MGNR) AND OF SERVICES (MSR), AND THEIR RESPECTIVE DEFLATORS

Long-run relations:

$$mger^{*} = -\underset{(-14.93)}{0.74} + \underset{(14.85)}{0.01}\ T86.00 + \underset{(-)}{fdger} + \underset{(-3.95)}{0.38}\ (pyed - mged)$$

σ(%) = 6.16 ADF = -4.45 NORM.χ^2=63.08 ARCH.F=8.90

$$mgnr^{*} = -\underset{(-0.20)}{0.01} + \underset{(19.99)}{0.01}\ T86 + \underset{(-)}{fdgnr} + \underset{(-5.14)}{0.22}\left(pyed - \frac{mgnd - 0.15\,pei}{0.85}\right)$$

σ(%) = 4.12 ADF = -2.73 NORM.χ^2=1.90 ARCH.F=1.16

$$msr^{*} = -\underset{(-8.35)}{0.14} + \underset{(39.83)}{0.01}\ T86.02 + \underset{(-)}{fdsr} + \underset{(4.53)}{0.63}\ (pyed - msd)$$

σ(%) = 5.50 ADF = -3.07 NORM.χ^2=1.94 ARCH.F=12.99

$$mged^{*} = \underset{(11.38)}{0.07} - \underset{(-19.82)}{0.15}\ D93q2 + \underset{(-)}{cmged}$$

σ(%) = 3.21 ADF = -4.12 NORM.χ^2=3.04 ARCH.F=3.15

$$mgnd^{*} = \underset{(12.88)}{0.10} - \underset{(-24.64)}{0.24}\ D93q2 + \underset{(-)}{0.58}\ cmgnd + \underset{(-)}{0.15}\ pei + \underset{(8.70)}{0.27}\ prm$$

σ(%) = 4.26 ADF = -3.94 NORM.χ^2=4.96 ARCH.F=3.46

$$msd^{*} = -\underset{(-4.86)}{0.07} + \underset{(6.82)}{0.07}\ D93q2 + \underset{(9.65)}{0.39}\ cmsd + \underset{(-)}{0.61}\ pyed$$

σ(%) = 3.97 ADF = -4.09 NORM.χ^2=8.26 ARCH.F=2.37

Vectorial tests (equations of mger*, mgnr*, msr*, mged*, mgnd* and msd*): AR(5).LM=3.01 NORM.χ^2=46.39

T86.00: linear trend up to 2000Q1

T86.02: linear trend up to 2002Q1

Dynamic specifications:

$$\Delta mger = -\underset{(-3.21)}{0.01} + \underset{(8.34)}{1.77}\,\Delta fdger + \underset{(5.61)}{1.21}\,\Delta fdger_{-2} - \underset{(-)}{0.58}\,\Delta mged + \underset{(4.10)}{0.58}\,\Delta pyed - \underset{(-9.11)}{0.36}\,(mger - mger^{*})_{-1}$$

σ(%) = 2.34 NORM.χ^2=6.83

$$\Delta mgnr = -\underset{(-1.56)}{0.01} + \underset{(5.74)}{1.18}\,\Delta fdgnr + \underset{(4.72)}{0.99}\,\Delta fdgnr_{-1} + \underset{(2.31)}{0.50}\,\Delta fdgnr_{-2} - \underset{(-)}{0.20}\,\Delta\left(\frac{mgnd - 0.15pei}{0.85}\right) + \underset{(2.52)}{0.20}\,\Delta pyed - \underset{(-6.58)}{0.53}\,(mgnr - mgnr^{*})_{-1}$$

σ(%) = 3.05 NORM.χ^2=4.62

$$\Delta msr = \underset{(1.72)}{0.01} + \underset{(2.12)}{0.1}\,\Delta msr_{-2} + \underset{(2.80)}{0.83}\,\Delta fdsr_{-1} - \underset{(-)}{0.36}\,\Delta msd + \underset{(3.02)}{0.36}\,\Delta pyed - \underset{(-2.70)}{0.14}\,(msr - msr^{*})_{-1}$$

σ(%) = 2.47 NORM.χ^2=0.28

$$\Delta mged = -\underset{(-2.07)}{0.01} + \underset{(1.67)}{0.13}\,\Delta mged_{-1} + \underset{(3.78)}{0.42}\,\Delta cmged + \underset{(-)}{0.45}\,\Delta pyed_{-2} - \underset{(-4.61)}{0.33}\,(mged - mged^{*})_{-1}$$

σ(%) = 2,32 NORM.χ^2=1.73

$$\Delta mgnd = -\underset{(-3.38)}{0.01} + \underset{(-)}{0.29}\,\Delta cmgnd + \underset{(15.36)}{0.26}\,\Delta pei + \underset{(1.82)}{0.09}\,\Delta prm_{-1} + \underset{(6.68)}{0.37}\,\Delta pyed_{-2} - \underset{(-3.00)}{0.15}\,(mgnd - mgnd^{*})_{-1}$$

σ(%) = 2.04 NORM.χ^2=1.63

$$\Delta msd = -\underset{(-0.14)}{0.001} + \underset{(2.43)}{0.32}\,\Delta cmsd + \underset{(-)}{0.68}\,\Delta pyed_{-2} - \underset{(-435)}{0.37}\,(msd - msd^{*})_{-1}$$

σ(%) = 3.39 NORM.χ^2=73.15

Vectorial tests (equations of Δmger, Δmgnr, Δmsr, Δmged, Δmgnd and Δmsd jointly): AR(5).LM=1.20 NORM.χ^2=69.04

TABLE A6. EQUATIONS FOR PUBLIC SECTOR INVESTMENT DEFLATOR (GID), VALUE ADDED DEFLATOR (GYED), CONSUMPTION DEFLATOR (GCD) AND WAGES (GWUN)

$$\underset{}{\frac{gid^{*}}{tixgi}} = \underset{(8.87)}{0.03} - \underset{(-10.33)}{0.04}\,D93.99 + \underset{(-)}{0.91}\,pyed + \underset{(-)}{0.07}\,mged + \underset{(7.63)}{0.02}\left(\frac{mgnd - 0.15\,pei}{0.85}\right)$$

σ(%) = 1.20 ADF = -5.40 AR(5).LM=410.1 NORM.χ^2=7.20 ARCH.F=0.90

$$\left(gwun^{*} - pcd\right) = \underset{(18.44)}{0.97} + \underset{(17.85)}{0.003}\,T98 + \underset{(20.20)}{0.64}\left(pwun - pcd\right)$$

σ(%) = 1.57 ADF = -2.86 AR(5).LM=79.36 NORM.χ^2=3.60 ARCH.F=7.78

$$gyed^{*} = -\underset{(-26.17)}{1.25} - \underset{(-15.23)}{0.05}\,D00 + \underset{(-)}{0.61}\,gwun + \underset{(16.67)}{0.39}\,gid$$

σ(%) = 0.01 ADF = -1.70 AR(5).LM=65.11 NORM.χ^2=0.80 ARCH.F=3.06

$$\frac{gcd^{*}}{tixgc} = -\underset{(-2.12)}{0.01} - \underset{(-8.77)}{0.02}\,D98 + \underset{(-)}{0.85}\,gyed + \underset{(2.97)}{0.13}\,pyed + \underset{(-)}{0.02}\,mged + \underset{(4.75)}{0.01}\left(\frac{mgnd - 0.15\,pei}{0.85}\right)$$

σ(%) = 0.61 ADF = -5.00 AR(5).LM=67.90 NORM.χ^2=1.60 ARCH.F=14.17

Vectorial tests (equations of gid* gwun*, gyed* and gcd* jointly): AR(5).LM=3.89 NORM.χ^2=19.06

Dynamic specifications:

$$\Delta\frac{gid}{tixgi} = \underset{(1.18)}{0.003} + \underset{(-)}{0.68}\Delta pyed + \underset{(1.94)}{0.09}\,\Delta\left(\frac{mgnd - 0.15pei}{0.85}\right) + \underset{(4.34)}{0.22}\,\Delta\left(\frac{mgnd - 0.15pei}{0.85}\right)_{-2} - \underset{(-8.45)}{0.93}\,(gid - gid^{*})_{-1}$$

σ(%) = 2.11 AR(5).LM=1131 NORM.χ^2=12.73 ARCH.F=0.52

$$\Delta(gwun - pcd) = \underset{(0.60)}{0.001} + \underset{(-)}{0.15}\Delta(gwun - pcd)_{-1} + \underset{(3.01)}{0.23}\,\Delta(gwun - pcd)_{-3} + \underset{(5.59)}{0.45}\,\Delta(pwun - pcd)$$

$$+ \underset{(2.46)}{0.18}\,\Delta(pwun - pcd)_{-2} - \underset{(-6.20)}{0.38}\,(gwun - gwun^{*})_{-1}$$

σ(%) = 1.01 AR(5).LM=83.47 NORM.χ^2=0.46 ARCH.F=0.38

$$\Delta gyed = -\underset{(-1.82)}{0.001} + \underset{(-)}{0.22}\Delta gyed_{-2} + \underset{(9.13)}{0.52}\,\Delta gwun + \underset{(2.49)}{0.16}\,\Delta gwun_{-1} + \underset{(5.25)}{0.11}\,\Delta gid - \underset{(-4.47)}{0.20}\,(gyed - gyed^{*})_{-1}$$

σ(%) = 0.63 AR(5).LM=25.87 NORM.χ^2=1.11 ARCH.F=0.10

$$\Delta\frac{gcd}{tixgc} = -\underset{(-0.71)}{0.00} + \underset{(-)}{0.78}\Delta gyed + \underset{(5.05)}{0.22}\,\Delta pyed - \underset{(-7.12)}{0.67}\,(gcd - gcd^{*})_{-1}$$

σ(%) = 0.55 AR(5).LM=19.39 NORM.χ^2=0.54 ARCH.F=0.43

Vectorial tests (equations of Δgid, Δgwun, Δgyed and Δgcd jointly): AR(5).LM=1.86 NORM.χ^2=17.00

APPENDIX. DEFINITION OF VARIABLES

Variable	Definition	Variable	Definition
CMGED	Export prices of the euro area weighted by their share in imports	*PIR*	Real productive investment
CMGND	Export prices of the rest of the world weighted by their share in imports	*PKN*	Stock of private productive capital in nominal terms
CMSD	Export prices of services of the rest of the world weighted by their share in imports	*PKR*	Stock of real private productive capital
CXGEED	Competitor prices of euro area exports to euro area	*PLN*	Private sector employment
CXGEND	Competitor prices of rest of the world exports to euro area	*POPWA*	Working age population
CXGNED	Competitor prices of euro area exports to the rest of the world	*PRM*	Non-energy raw materials prices in euros
CXGNND	Competitor prices of rest of the world exports to the rest of the world	*PUC*	User cost of private productive investment
CXSD	Competitor prices of exports of services	*PUCR*	Real user cost of private productive investment
Drift	Difference between the increase in negotiated wages and the observed average wage increase	*PWUN*	Private sector wages
EFXGEE	Effective exchange rate of exports to euro area	*PWUNR*	Real private sector wages
EFXGNN	Effective exchange rate of exports to the rest of the world	*PYED*	Private value added deflator without taxes
EFXS	Effective exchange rate of exports of services	*PYEDT*	Private value added deflator with taxes
FDGER	Indicator for import demand. Euro area	*PYER*	Real private value added
FDGNR	Indicator for import demand. Rest of the world	*RID*	Residential investment deflator
FDSR	Indicator for import demand. Services	*RIR*	Real residential investment
FDYN	Gross domestic income. Firms	*RKR*	Stock of residential capital
FWR	Real financial wealth of private sector	*RRC*	Real mortgage interest rate, or user cost of private consumption
GCD	Government sector consumption deflator	*RRI*	User cost of residential investment
GID	Government sector investment deflator	*RRU*	Replacement ratio
GWUN	Government sector wages	*TFP*	Total factor productivity
GYED	Government sector value added deflator	*TIXGC*	Indirect taxation rate. Public consumption
HDYR	Real gross domestic income. Households	*TIXGI*	Indirect taxation rate. Public investment
HICPE	Energy component of harmonized index of consumption prices	*TIXPC*	Indirect taxation rate. Private consumption
HICPNE	Non-energy component of harmonized index of consumption prices	*TIXPI*	Indirect taxation rate. Private investment
HTI	Mortgage interest rate	*TIXRI*	Indirect taxation rate. Residential investment
LFN	Labour force	*TIXXGE*	Indirect taxation rate. Exports to euro area
MGD	Imports of goods deflator	*TIXXGN*	Indirect taxation rate. Exports to the rest of the world
MGED	Deflator of imports of goods from euro area	*TWED*	Percentage of wage income remaining after direct taxes and social contributions
MGER	Real imports of goods from the euro area	*URX*	Unemployment rate
MGND	Deflator of imports of goods from the rest of the world	*WDGER*	Indicator for export demand. Euro area
MGNR	Real imports of goods from the rest of the world	*WDGNR*	Indicator for export demand. Rest of the world
MSD	Deflator of imports of services	*WDSR*	Indicator for export demand. Services
MSR	Real imports of services	*XGED*	Deflator of exports of goods to euro area
NFWR	Stock of real residential capital or non-financial real wealth	*XGER*	Real exports of goods to the euro area
PCD	Private consumption deflator	*XGND*	Deflator of exports of goods to the rest of the world
PCR	Real private consumption	*XGNR*	Real exports of goods to the rest of the world
PEI	Energy import prices in euros	*XSD*	Deflator of exports of services
PID	Productive investment deflator	*XSR*	Real exports of services

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