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THE BANK OF ITALY ECONOMETRIC MODEL: AN UPDATE OF THE MAIN EQUATIONS AND MODEL ELASTICITIES

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Davide Fantino, Andrea Locarno and Lisa Rodano*

Abstract

The Bank of Italy quarterly econometric model (BIQM) is a large-scale 'semi structural' macro-econometric model. It tries to strike the right balance between theoretical rigour and statistical fit to the data. This paper provides an update of the features and the properties of the model, focussing on the empirical estimates of its main equations and on the system responses to various shocks; interactions and feedback mechanisms between the financial and the real side of the economy are also illustrated. The BIQM is primarily used to produce macroeconomic forecasts, but it is also employed – in conjunction with other tools – for evaluating the impact of monetary and fiscal policy options and for counterfactual analyses. Examples of the types of macro-economic analyses carried out with the model are provided.

JEL Classification: C30, E10, E17.
Keywords: Macro-econometric models, Italy, forecasting, policy simulation.

Contents

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1. Introduction[1]

Econometric models are routinely employed by central banks in a variety of contexts. For example, macroeconomic forecasts are mostly, although not exclusively, based on economic scenarios derived from models simulations; models are also a valuable tool for assessing the impact of alternative policy options; a measure of uncertainty around predicted economic developments can be derived from their probabilistic structure; they can further be used to construct counterfactual scenarios, e.g. to evaluate the economic impact of past events (such as an international crisis) by artificially replacing the actual developments with alternative hypothetical assumptions. Several models are typically available for macroeconomic analyses in any given organisation, some of them being more appropriate for forecasting activities, others for policy evaluation.

The Bank of Italy, similarly to other institutions, also relies on a number of tools. The main macro-econometric models employed at the Bank of Italy, which include the quarterly econometric model for the Italian economy, dynamic general equilibrium models and models for short-term forecasting, are succinctly described at https://www.bancaditalia.it/compiti/ricerca-economica/modelli-macroeconomici/index.html. This paper presents the main features of the one used primarily to produce macroeconomic projections[2] and assess the impact of macroeconomic policies.

The Bank of Italy quarterly econometric model (BIQM) is a large-scale 'semi structural' macro-econometric model (with 750 endogenous variables, of which 95 are generated by stochastic equations, the others by identities) that tries to strike the right balance between theoretical rigour and statistical fit to the data. It is a descendant of the model developed in the eighties by a team led by Ignazio Visco, with the scientific guidance of the late Albert Ando; see Banca d'Italia (1986) and Galli et al. (1990). Since then the model has continuously evolved to take account, among else, of changed institutional frameworks, alternative expectation formation mechanisms and policy rules, several interactions and feedbacks between the financial and the real side of the economy. This paper provides an update of the features and properties of the latest version of the model, focussing on the empirical estimates of its main equations and the system responses to various shocks. It also updates and expands the description of Busetti et al. (2005).

One distinctive feature of the new version of the BIQM is the interaction between cyclical conditions, borrowing costs and solvency rates of households and firms, which introduces a (non-linear) feedback mechanism between the financial sector and the real economy. The model also contains a block of stochastic equations and identities tracking banks' profits and capital, as a function of developments in the credit market and of economic and financial strengths of the private sector. Supply and demand in the housing market are also fully modelled, yielding to significant repercussions of house prices on the real economy. Certain macroprudential issues can thus be tackled within the BIQM, allowing a comprehensive understanding of their impact on the Italian economy.

The BIQM is however primarily employed to produce the macroeconomic projections that are regularly published by the Bank of Italy, as well as the Italian projections that enter the coordinated euro area projection exercises released during the June and December meetings of the Governing Council of the European Central Bank.[3] The model is also used, in connection with other tools, for evaluating the impact of economic policy options, for counterfactual analyses and for assessing the effects of monetary and macroprudential measures on

[1] We thank Stefano Siviero and two anonymous referees for insightful comments and suggestions.

[2] The medium term macroeconomic projections produced by the econometric model described in this paper build up on 'forecast initial conditions' set on the basis of the information provided by a large number of data, which are filtered using a variety of nowcasting tools developed at the Bank of Italy; see e.g. Baffigi et al. (2004), Bencivelli et al. (2012), Marcellino et al. (2016).

[3] See European Central Bank (2016) for a description of the procedures employed to construct the Eurosystem's projection exercises based on contributions from the staff of the ECB and of the euro-area national central banks. Projections for the Italian economy released for the coordinated exercises are available at the webpage http://www.bancaditalia.it/pubblicazioni/proiezioni-macroeconomiche/index.html.

the aggregate banking sector. The results of these analyses are frequently presented in official publications and in research and policy papers of the Bank of Italy.

The paper proceeds as follow. Section 2 gives an overview of the structure of the model, distinguishing between supply and demand side features. The theoretical and empirical properties of the main equations[4] (GDP components, employment, wages and prices) are discussed in section 3. Section 4 reports the model responses to the following shocks: monetary and fiscal policy, foreign demand, exchange rate, oil price. Examples of the types of macroeconomic analyses carried out with the model are provided in section 5. An appendix contains: (i) the econometric estimates of the main stochastic equations, (ii) detailed tables of model responses to the shocks described in section 4.

2. An overview of the structure of the model

As is generally the case for semi-structural macro-econometric models, in the long run the BIQM shares the theoretical properties of a neoclassical growth model, with output growth determined by factor endowments and technical progress, while in the short run it behaves according to Keynesian principles, with output mainly driven by aggregate demand fluctuations. In equilibrium, when no shocks take place, all adjustment processes are completed and expectations are fulfilled and the model is consistent with a full-employment economy, in which all real variables grow according to (a combination of) the (exogenous) rate of increase of population and technical progress. Inflation is constant and consistent with the equilibrium level of employment.

The production side of the economy is characterized by oligopolistic markets in which firms take production costs as given and choose the appropriate level of labour and capital which will be converted into output according to a constant return-to-scale technology. The price of output is set as a mark-up over marginal cost.

Consumers formulate their spending plans according to the life-cycle hypothesis, taking into account their income and net wealth, and real interest rates. Savings finance capital accumulation, to expand the production capacity, with relative prices of labour and capital ensuring that the amount of savings is exactly equal to the capital needs and that the labour market is in equilibrium.

In the short run, a number of rigidities and adjustment processes affect equilibrium outcomes: delivery lags and other costs of changing the capital stock; sticky prices and wages; expectation errors.

The BIQM separately describes the public and the private sector; within the latter, it distinguishes among energy, agriculture and the rest. As to expectation formation mechanisms, extensive use is made of survey data. Although they can be set in a model-consistent way, inflation expectations are normally backward looking and modelled under the assumption that agents relate future inflation to the same variables affecting actual inflation in the BIQM, namely commodity and foreign goods prices, nominal exchange rates and domestic cost pressures. All equations in the model are estimated by limited-information techniques, mostly ordinary least squares.[5] A small set of parameters are calibrated. A detailed account of the basic structure of the model is Banca d'Italia (1986). Descriptions of the properties of past versions of the model are contained in Galli et al. (1990), Terlizzese (1994), Siviero (1995), Busetti et al. (2005).

2.1. The supply side

In the BIQM firms decide on: (i) future capacity output; (ii) production inputs needed for fulfilling the desired expansion in capacity output; (iii) the price of output.

[4] A list with all the equations and variables of the BIQM is available on the Bank of Italy website; cf. https://www.bancaditalia.it/compiti/ricerca-economica/modelli-macroeconomici.

[5] The software package used for estimation and simulation of the model is Speakeasy/Modeleasy+.

The desired addition to capacity depends on firms' expectations about future demand, which are assumed to be adaptive, based on past and current demand developments. Once future capacity output has been set, production factors are chosen so as to minimise costs. In the BIQM, technology has a putty-clay nature: the assumption is that there exists a continuum of capital goods, each requiring a different and unmodifiable amount of labour to be operational; after installation, i.e. when firms have irreversibly decided which specific capital good to purchase, factor proportions can no longer be changed, regardless of fluctuations in their prices: capital is no longer malleable and can only be used with the amount of labour it was designed to be combined with. This is equivalent to specify a traditional production function only for the increase in capacity output, which is obtained with the new machines and the associated labour input. Such function is assumed to be of the Cobb-Douglas type with labour-augmenting technological progress. The solution to the cost minimization problem leads to a demand for new capital goods that is proportional to the desired additional capacity output, with the factor of proportionality given by the optimal capital/output ratio; the latter is a function of the relative prices of capital and labour. In formal terms, the conditions for optimal capital-output ratio and investment demand may be written as follows:

$$I_t^P = k_t^* \Delta Y_{t+1}^E$$

$$k_t^* = \left(\frac{1-\alpha}{\alpha}\frac{W_t(1+g)^{-t}}{C_{k,t}}\right)^{\alpha} \tag{2.1.1}$$

where I_t^P is planned investment at time t, k_t^* is the optimal capital/output ratio, ΔY_{t+1}^E is the desired additional capacity output, W_t and $C_{k,t}$ are, respectively, the nominal cost of labour and capital, g is the exogenous rate of growth of technical progress and α is the labour share in the production function. Similarly, labour demand associated with the desired increase in capacity output, ΔL_t, and the optimal labour/output ratio, l_t^*, are given by:

$$\Delta L_t(1+g)^t = l_t^* \Delta Y_{t+1}^E$$

$$l_t^* = \left(\frac{\alpha}{1-\alpha}\frac{C_{k,t}}{W_t(1+g)^{-t}}\right)^{1-\alpha}. \tag{2.1.2}$$

Equations (2.1.1) and (2.1.2) define factors' demand along a balanced growth path. In the short run a number of rigidities (such as delivery lags in the installation of new machinery and discrepancies between realized and expected production) causes investment and employment dynamics to differ from those equilibrium values. In section 3 more details will be provided about the empirical specification of the investment and employment equations, where such short-run features are modelled.

Factor prices, which determine the optimal mix between capital and labour needed to increase capacity output, depend on a number of determinants. The labour cost W_t represents compensation per employee (gross wage plus social contributions) and the cost of capital is defined as $C_{k,t} \equiv \frac{p_{I,t}(r_{I,t}+\delta_k)(1-F)}{(1-\tau)}$, where $p_{I,t}$ denotes the price of one unit of capital, $r_{I,t}$ is the after-tax real interest rate and δ_k is the depreciation rate of capital, τ is the tax rate and F is the present discounted value of fiscal depreciation allowances. The nominal component of the interest rate is a weighted average of the cost of credit (net of taxes) $r_{L,t}^N$ and of the opportunity cost of self-financing $r_{SF,t}^N$.

As to supply prices, the key assumption is that firms operate in an oligopolistic market and set their price as a mark-up over average minimum cost:

$$P_{y,t} = \mu_t ULC_t \tag{2.1.3}$$

where $P_{y,t}$ is the value added deflator, ULC_t denotes average unit labour cost, which proxies for the marginal cost, and μ_t is the mark-up. The latter is in turn affected by competitive pressures from foreign producers and cyclical conditions on the domestic market (see section 3.5).

2.2. The demand side

On the demand side, it is assumed that households set their consumption plans according to a simple life-cycle model. As argued in Ando and Modigliani (1963), after aggregating across households, total consumption C_t can be written as a linearly homogeneous function of real labour income YL_t and private wealth $W_{P,t}$, $C_t = \beta_y YL_t + \beta^0_{w,t} W_{P,t-1}$, where β_y and $\beta^0_{w,t}$ denote the marginal propensity to consume income and wealth, the latter being a (generally increasing) function of the real interest rate. This relationship can be equivalently expressed in terms of aggregate disposable income $Y_t = YL_t + r_{C,t} W_{P,t-1}$, where $r_{C,t}$ denotes the rate of return of private wealth. It follows that:

$$C_t = \beta_y Y_t + \beta_{w,t} W_{P,t-1} \tag{2.2.1}$$

where $\beta_{w,t} = \beta^0_{w,t} - \beta_y r_{C,t}$. This is the long-run relationship driving consumption demand in the BIQM;[6] the short-run adjustment is modelled as an Error Correction Mechanism (see section 3). Note that consumers compute their life-time resources without anticipating the need for the government to satisfy a long-run solvency condition; hence Ricardian equivalence does not hold and the stock of public debt is perceived to be part of total wealth.

As regards equipment investment, it is determined on the basis of the firms' demand for productive capital, as described in the previous subsection; construction investment is separately modelled for commercial and residential buildings (see subsection 3.2). While the commercial component is specified according to a standard error-correction framework, with private-sector value added and the bank lending rate (in real terms) as explanatory variables, residential investment depends on: (i) a profitability measure, proxied by the ratio of market prices and construction costs, (ii) financing constraints, (iii) population developments. House prices are pinned down by the equilibrium between supply and demand for dwellings, with the latter determined on the basis of a portfolio allocation decision.

Exports are modelled in terms of standard determinants: foreign demand (with unit long-run elasticity) and competitiveness (see subsection 3.3). Imports are likewise driven by an absorption variable, which takes into account the different import content of the various aggregate demand components, and relative prices.

Government consumption in nominal terms is the sum of total compensation of public-sector employee and intermediate consumption: the former is linked to compensation per employee in the private sector and to public employment; in equilibrium, the latter grows in line with nominal GDP.[7]

Implicit price deflators for the main demand components are assumed to be homogeneous of degree 1 (in the long run) in supply prices, which include the deflator of the value added of the private sector and import prices; fiscal factors, such as indirect tax rates, excise taxes and administered prices, are explicitly taken into account in modelling demand prices.

The next section provides a detailed account of the empirical specification of the main equations of the BIQM and presents the single-equation short and long-run properties (i.e. the dynamic multipliers) of each of them.

[6] Dividing both sides by $W_{P,t-1}$, and assuming linearity of $\beta_{w,t}$, the 'equilibrium' condition can be rewritten as $\frac{C_t}{W_{P,t-1}} = \beta_y \frac{Y_t}{W_{P,t-1}} + \alpha_0 + \alpha_1 r_{C,t}$; this is the form that appears in the empirical estimates presented in section 3.

[7] In actual macroeconomic projections Government consumption is treated as exogenous, calibrated using information contained in the Budget Law.

3. Properties of the main equations and blocks

This section presents the empirical specification and the dynamic properties of the most relevant equations of the BIQM. Regarding the long-run properties, all equations are specified so as to ensure convergence to a steady-state growth path: demand components driven by domestic economic activity have unit elasticity with respect to output or variables growing in the long run at the same rate as output (e.g. disposable income); given price competitiveness, exports increase one-to-one with foreign demand; prices and wages show no-money illusion, with the latter growing, in real terms, with trend productivity; capital and labour (in efficiency units) move in line with domestic value added.

3.1. Consumption

The equation modelling households' economic consumption[8] postulates a dynamic adjustment with an error correction mechanism around the long-run equilibrium (2.2.1):

$$\Delta logC_t = \alpha_0 + \alpha_1 \Delta logC_{t-1} + \alpha_2 \Delta logY_t^d + \alpha_3 \frac{C_{t-1}}{W_{P,t-2}} + \alpha_4 \frac{Y_{t-1}^d}{W_{P,t-2}} + \alpha_5 r_{C,t-1} \tag{3.1.1}$$

where C_t is economic consumption, Y_t^d is disposable income of the private sector[9] (both variables are in real terms), $r_{C,t}$ is the real interest rate (the average yield of longer term Government bonds minus expected inflation). See <EQ1> in Appendix A for the estimates of the coefficients of the equation.

Regarding the dynamic properties of the equation, figure 1 shows the response of consumption (as a percentage deviation from the baseline levels) to a permanent increase by 1 per cent in real disposable income and in real wealth and to a permanent increase of 100 basis points in the real interest rate, over a ten-year horizon.

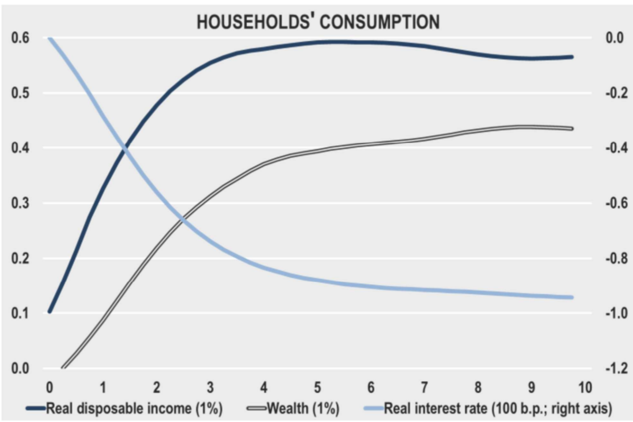

FIGURE 1. DYNAMIC RESPONSE OF THE HOUSEHOLDS' CONSUMPTION TO PERMANENT SHOCKS IN ITS DETERMINANTS.

The elasticity of consumption to income is about 0.6 in the long run, 0.4 that to wealth; they sum to unity, to ensure consistency with a steady-state growth path; see equation (2.2.1). The adjustment is gradual and subdued in the first year, due to consumption smoothing, but almost complete after three years. The savings ratio thus exhibits a pro-cyclical behaviour, in line with the historical patterns. The semi-elasticity of consumption to the

[8] Economic consumption is defined as spending on non-durables plus the fraction of durables consumed in the quarter, measured by the (real) interest rate times the stock of durables. The BIQM includes a separate equation for modelling (the share of) spending on durables as a stock adjustment process, driven by the real long-term interest rate, relative prices and demographic factors.

[9] In the BIQM the balance sheets of households and firms are consolidated, hence in the consumption equation disposable income and wealth refer to the private sector as a whole.

real interest rate is about -0.9 in the long run. The nominal disposable income includes the so-called Hicksian correction (*HC$_t$*), which captures the capital losses (or the lower capital gains) on financial wealth due to inflation:

$$HC_t = \bar{\pi}_t W_{f,t-1}^N$$

where $\bar{\pi}_t$ is the percentage change of the non-durables consumption deflator recorded on average in the latest four quarters and $W_{f,t}^N$ is the stock of financial wealth. Hence a change in inflation affects consumption through two channels: first, everything else being equal, higher (lower) inflation reduces (increases) the purchasing power of nominal income; second, it reduces (increases) nominal disposable income through the Hicksian correction. The size of the latter effect is not negligible: a sustained increase of 1 per cent in inflation, through this channel only, translates into lower households spending by about 0.3 per cent (cumulatively after two years).

3.2. Investment and the housing market

As shown in section 2, in equilibrium firms' demand for productive capital in the long run is given by the expression $I_t^P = k_t^* \Delta Y_{t+1}^E$, stating that investment is proportional to the desired addition to capacity output, with the factor of proportionality (the capital-output ratio) being a function of relative factor prices. Allowing for demand expectations and delivery and implementation lags of capital goods, the desired addition to capacity can be proxied by a distributed lag on the actual output and the optimal capital-output ratio:

$$I_t = \sum_{i=0}^{q} \beta_{1,i}\, k_{t-i-1} Y_{t-i} + \sum_{i=1}^{q+1} \beta_{2,i}\, k_{t-i} Y_{t-i}$$

where Y_t is the value added of the private sector, whose weighted lags proxy for expected demand. Typically, the coefficients $\beta_{1,i}$ are positive and the coefficients $\beta_{2,i}$ are negative; both result from the convolution of expectations and delivery lags.[10] Taken together, these coefficients imply that the response of investment to output displays the familiar accelerator shape, overshooting in the short term the long-run response, while the response to the capital-output ratio is smooth and monotone (see below).

The empirical specification of the equipment investment equation includes additional terms aimed at tracking more closely the short-run behaviour, such as business climate, firms' uncertainty and changes in real bank lending rates:[11]

$$\Delta i_{M,t} = \alpha_0 + \alpha_1 \left(i_{M,t-1} - k_{t-1} - y_{t-1} \right) + \textstyle\sum_{i=1}^{s} \alpha_{2,i} \Delta y_{t-i} + \alpha_3 \Delta bc_t + \alpha_4 unc_t + \alpha_5 \Delta r_{L,t} \qquad (3.2.1)$$

where $i_{M,t}$ is equipment investment, k_t the optimal capital-output ratio (function of the user cost of capital and compensation per employee), y_t the value added of the private sector, all in logarithmic terms, while bc_t and unc_t are indicators of business confidence and uncertainty,[12] respectively. Finally, $r_{L,t}$ is the real bank lending rate to non-financial corporations. See <EQ2> in Appendix A for the estimates of the coefficients.

Figure 2 displays the response of equipment investment to: (i) a permanent increase of 1 per cent in the value added of the private sector, (ii) a permanent decrease by 100 basis points of the user cost of capital (excluding the term $\Delta r_{L,t}$), (iii) a temporary shock to uncertainty, for two years, with magnitude similar to that observed during the Great Recession of 2008-09. The response to a value added shock is found to reach a peak at the end

[10] See Parigi and Siviero (2001) for a detailed derivation of the equipment investment equation of the Bank of Italy's model.

[11] A version of equation (3.2.1) allowing for the possibility of investment being hampered by constraints in credit supply has been employed in the assessment of the impact of financial and banking tensions during the financial crisis of 2008-09 and the sovereign debt crisis of 2011-12; see Panetta and Signoretti (2010), Caivano et al. (2011), Busetti et al. (2016).

[12] See Busetti et al. (2016) for the definition and properties of the uncertainty indicator used in the investment equation. In that paper a slightly different model was considered, including among short-run determinants also a proxy for credit supply restrictions. The dynamic response to investment to the other shocks are however broadly in line with those presented in figure 2.

of the third year, when the elasticity of investment to output is about 2.9; thereafter it moves towards the long-run value of 1. A permanent rise of 100 basis points in the real user cost of capital has a gradual and prolonged negative impact on investment, peaking at about 5 per cent after ten years (4 after five years). A worsening of uncertainty of a similar magnitude of that observed during the crisis of 2008–09 curbs investment sizeably, by about 5 per cent at the peak, which occurs after two years.

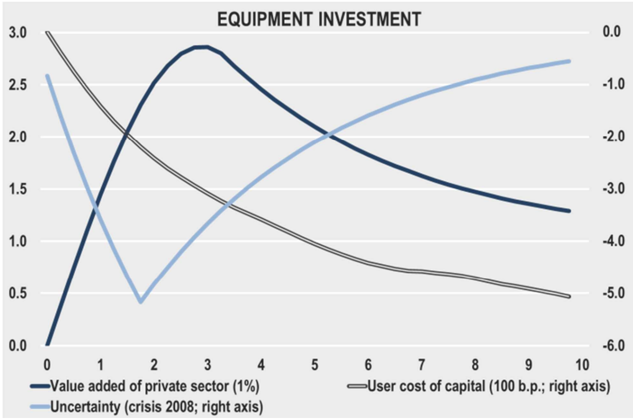

FIGURE 2. DYNAMIC RESPONSE OF EQUIPMENT INVESTMENT TO PERMANENT SHOCKS IN OUTPUT AND USER COST OF CAPITAL AND A TEMPORARY SHOCK TO UNCERTAINTY.

As regards construction investment, in the BIQM the residential and commercial components are separately modelled. Investment in commercial buildings co-moves in the long run with the value added of the private sector, with unit elasticity, with the real interest rate and business confidence as additional determinants. A standard ECM-type equation is adopted in the empirical specification.

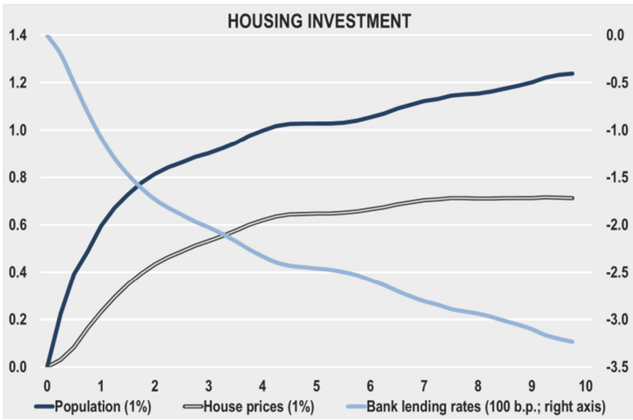

FIGURE 3. DYNAMIC RESPONSE OF HOUSING INVESTMENT TO PERMANENT SHIFTS IN ITS DETERMINANTS.

The equation for residential investment relies on a variant of Tobin's q model: housing capital depends on the present value of the future stream of profits (proxied by the ratio between market price and construction costs) generated by an additional unit of capital. Financing costs are accounted for by the real interest rate as an explanatory variable; demographic effects (population developments) and fiscal factors also play a role. Formally, the empirical specification is:

$$i_{qH,t} = \alpha_0 + \alpha_1 i_{qH,t-1} + \alpha_2 \frac{1}{1+e^{a+b\frac{K_{H,t-1}}{POP_t}}} + \alpha_3 \frac{P_{H,t-1}}{C_{H,t-1}} + \alpha_4 r_{L,t-1} + \alpha_5 \tau_{H,t} + \alpha_6 D_t$$

(3.2.2)

$$K_{H,t} = K_{H,t-1}\left(1 + i_{qH,t} - \delta_{H,t}\right)$$

where $i_{qH,t}$ is the ratio of new houses to the previous period existing stock, $\frac{K_{H,t-1}}{POP_t}$ per capita residential capital, $P_{H,t}$ house prices, $C_{H,t}$ construction costs, $r_{L,t}$ the real bank lending rate, $\tau_{H,t}$ the implicit property tax rate, D_t captures a gradual change in the constant term after the crisis, $K_{H,t}$ is total residential capital and $\delta_{H,t}$ the depreciation rate. See <EQ3> in Appendix A for the estimates of the coefficients. Figure 3 shows the response of residential investment to permanent shifts by 1 per cent in population and house prices and to a permanent increase of 100 basis points of the bank lending rate. Ceteris paribus, a 1 per cent increase in bank lending rates curbs residential investment by about 2.5 per cent after five years and 3.5 per cent in the long run.

Equations (3.2.2) define the supply side of the housing market, i.e. the addition to the stock of housing due to residential investment. House prices are obtained by the interaction of supply (modelled in real terms) and demand (modelled in nominal terms) for houses. The demand for houses is generated by the households' sector. Following a portfolio allocation approach, households decide which share of their total wealth they want to allocate to housing on the basis of the relative return they can gain from such an investment. The equation modelling household demand for housing is the following:

$$q_{H,t} = \alpha_0 + \sum_{i=1}^{p} \beta_i q_{H,t-i} + \alpha_1\left(r_{H,t-1} - r_{B,t-1}\right) + \alpha_2 \pi_t^e + \alpha_3 D_t^* \qquad (3.2.3)$$

where $q_{H,t}$ is the share of private-sector wealth $W_{P,t}$ devoted to house purchases, $r_{H,t}$ is the return on housing investment (defined as the sum of rents and the capital gain on the market price of dwellings), $r_{B,t}$ is the long-term government bond yield (which proxies for the return on alternative investment options), π_t^e is expected inflation. The equation also includes a deterministic term D_t^* that captures a gradual increase in the constant term during the nineties. See <EQ4> in Appendix A for the estimates of the coefficients. Finally house prices, $P_{H,t}$, are determined by equating housing demand and supply in nominal terms:

$$q_{H,t} W_t = P_{H,t} K_{H,t} \qquad (3.2.4)$$

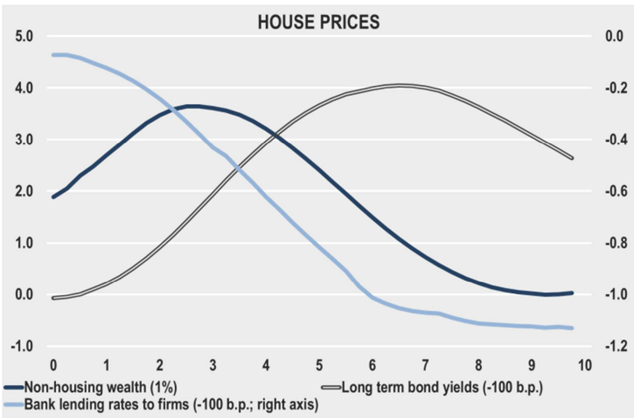

FIGURE 4. DYNAMIC RESPONSE OF HOUSE PRICES TO PERMANENT SHOCKS TO WEALTH, BOND YIELDS AND LENDING RATES.

Taking into account both demand and supply relationships, figure 4 displays the response of house prices to: (i) a permanent increase of 1 per cent in non-housing wealth; (ii) a permanent decrease of 100 basis points of long-term bond yields; (iii) a 100 basis points decrease of bank lending rates to firms. Note that a fall in government bond yields increases the relative return of investing in house purchases, which raises housing demand and prices; on the other hand, a decrease of bank lending rates determines an upward shift in the supply of housing, which reduces the equilibrium price of dwellings. In a general equilibrium perspective, however, bank lending rates, government bond yields and households' wealth tend to co-move, with the effect of the former being dominated by the others; as a result, in model-wide simulations the response of house prices to a generalized increase in interest rates is negative.

3.3. External trade

Exports and imports are modelled separately for manufactured goods, agricultural and energy products and services. Both trade variables are modelled as economy-wide aggregate and then disaggregated into intra and extra euro-area components.

Import demand for manufactured goods is derived on the basis of the assumption of imperfect substitutability between imported and domestically produced goods; assuming separability and homogeneity of the utility function, spending plans on the one hand and the split of aggregate demand between domestic and foreign goods on the other hand can be treated separately. Import demand can then be described in equilibrium by the equation $M_t = \beta_t A_t$, where A_t is an absorption variable, which is a function of aggregate demand components and β_t depends on relative prices of imports and domestically-produced goods. A_t may be regarded as a weighted average of aggregate demand components D_{it}, of the form $A_t = \sum_i \omega_i D_{it}$, where the weights ω_i are computed on the basis of input-output coefficients; exports and business investment have the largest weights.[13] The empirical specification of the import demand for manufactured goods is

$$m_t^G = \alpha_0 + \sum_{j=1}^{p} \alpha_j m_{t-j}^G + \left(1 - \sum_{j=1}^{r} \alpha_j\right) a_t + \beta log\left(\frac{P_{M,t}}{P_{D,t}}\right) \tag{3.3.1}$$

where m_t^G is real imports, a_t is absorption (both in logs), $P_{M,t}$ is the import deflator and $P_{D,t}$ is the total resource deflator. The condition that the coefficients on the lags of m_t^G and on a_t sum to 1 ensures that in the long run import demand grows at the same pace as absorption. See <EQ5> in Appendix A for the estimates of the coefficients.

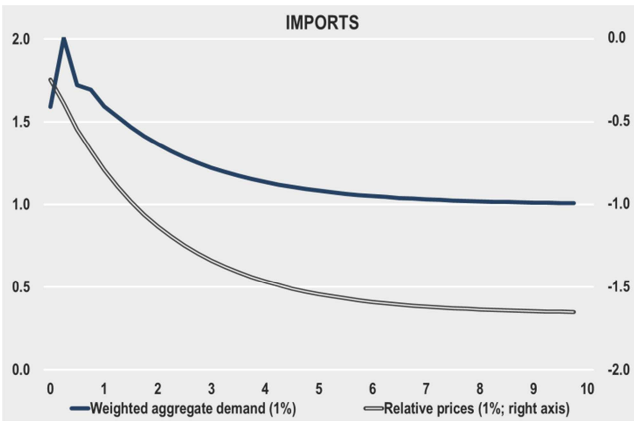

FIGURE 5. DYNAMIC RESPONSE OF IMPORTS OF NON-FARM NON-ENERGY GOODS TO PERMANENT SHOCKS IN WEIGHTED AGGREGATE DEMAND AND RELATIVE PRICES.

As concerns the other components of imports, the demand for foreign services is primarily driven by that of goods, as the purchase of products from abroad must be financed and insured and requires transportation

[13] This approach has been recently popularized by Bussiére et al. (2013), who use the acronym IAD (Import intensity-Adjusted Demand) for a demand index constructed as a weighted average of traditional aggregate demand components.

services, while agricultural and energy imports are modelled in the same way as manufactured goods, with sector-specific absorption and relative prices.

Figure 5 shows the response of merchandise imports to a 1 per cent permanent increase of the weighted aggregate demand (absorption) and a 1 per cent permanent increase in relative prices. Note that in the short run the elasticity of imports to demand is considerably higher than in the long run, as bottlenecks in domestic production make easier to satisfy (unexpected) demand increases with purchases from abroad.

Merchandise (non-farm, non-energy) exports are modelled as a function of competitiveness and foreign demand, with unit elasticity in the long run:

$$x_t^G = \alpha_0 + \alpha_1 x_{t-1}^G + (1-\alpha_1)FDR_t + \alpha_3 log\left(\frac{P_t^* EEN_t^X}{P_{X,t}}\right) + \alpha_4 Z_t \qquad (3.3.2)$$

where x_t^G is Italian exports of manufactured goods, FDR_t is foreign demand of Italian goods and services from abroad, proxied by a weighted sum of imports from our main exporting markets (both in logs), P_t^* the international price of manufactured goods,[14] $P_{X,t}$ their implicit domestic price deflator, EEN_t^X is the Italian nominal effective exchange rate[15] and Z_t includes the percentage changes of demand from intra and extra-euro area countries, which allow to account for different effects in the short term of foreign demand stemming from those markets.[16] See <EQ6> in Appendix A for the estimates of the coefficients.

Figure 6 presents the dynamic response of exports to permanent changes in foreign demand and price competitiveness. The elasticity to foreign demand quickly approaches the long-run value of 1, while the response to competitiveness is gradual but relatively high (2.1) in the long run. The other components of exports are modelled in a similar way.

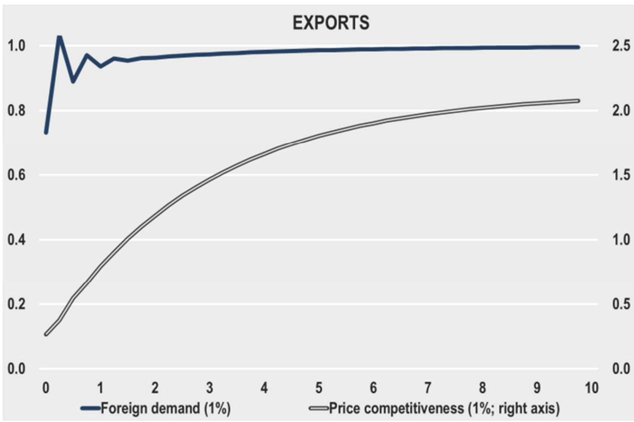

FIGURE 6. DYNAMIC RESPONSE OF EXPORTS OF NON-FARM NON-ENERGY GOODS TO PERMANENT SHIFTS IN FOREIGN DEMAND AND COMPETITIVENESS.

Nominal trade in goods and services is computed by combining the outcome of equations (3.3.1)-(3.3.2) with that of specific equations modelling price deflators; it contributes to the current account of the balance of payments. The balance on services is further disaggregated, by modelling tourism flows.

[14] P^* is a weighted average of the prices in foreign currencies of the main competitors of domestic producers; the average is computed using a double weighting scheme. See the article "Nuovi indicatori di tasso di cambio effettivo nominale e reale" in Banca d'Italia (1998) and Felettigh et al. (2015) for an update.

[15] The nominal effective exchange rate of the Italian economy is computed as a weighted average of bilateral exchange rates of the euro vis-à-vis the currencies of the main Italian competitors, including other euro area countries; the weights are computed on the basis of a double-weighting scheme, as in Banca d'Italia (1998).

[16] The assumption is that it is easier to react, in the short run, to demand shocks hitting the euro area.

Net capital income is modelled in terms of differential yields on domestic and foreign assets, while net secondary income (net unilateral transfers in the older terminology) are exogenous.

Turning to stocks, the international investment position is reconstructed by cumulating past current account balances, with adjustments to take into account valuation changes.

3.4. The labour market

The assumption that capital is putty-clay implies that firms' demand for labour and capital refers to the desired addition to capacity output; the overall demand of both factors is obtained by summing over the different vintages of capital and labour.

The demand for labour is determined in a stepwise procedure: (i) as shown in subsection 2.1, cost minimisation determines the optimal labour-to-output ratio for the planned addition to capacity; (ii) the labour requirement of the last vintage of installed rather than desired investment is derived;[17] (iii) the demand of labour associated with the overall stock of capital is computed by cumulating the labour requirement of the various vintages of capital installed in t, $t\text{-}1$, $t\text{-}2$,…. The average optimal labour-output ratio for the overall stock of capital can be approximated by an equation of the form: $\hat{l}_t = \rho\hat{l}_{t-1} + (1-\rho)l_t^*$, where l_t^* is the optimal labour-output ratio associated with the vintage of capital installed in t (determined in step (ii)). Actual private-sector employment, L_t, is then modelled through an error correction model where the equilibrium condition is expressed in terms of the logarithm of the private-sector value added (y_t), times the average labour/output ratio($\hat{l}_t$). The empirical specification is:

$$logL_t = \alpha_0 + \alpha_1 logL_{t-1} + (1-\alpha_1)\left[y_t - gt + log\,\hat{l}_t\right] + \alpha_2 \textstyle\sum_{i=0}^{q} \Delta y_{t-i} \qquad (3.4.1)$$

where g is the exogenous rate of growth of technical progress.[18] See <EQ7> in Appendix A for the estimates of the coefficients.

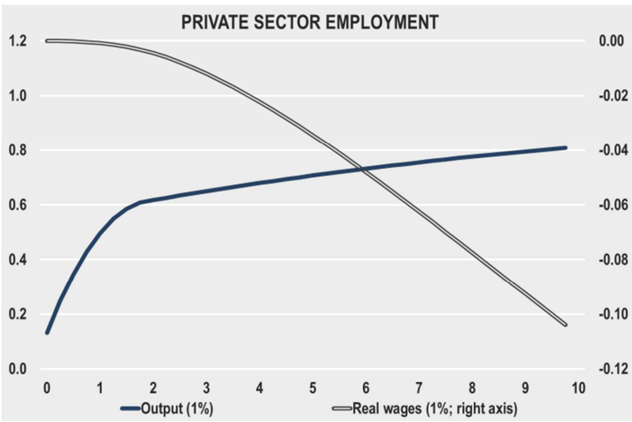

FIGURE 7. DYNAMIC RESPONSE OF EMPLOYMENT IN THE NON-FARM NON-ENERGY PRIVATE SECTOR TO PERMANENT SHOCKS IN OUTPUT AND REAL WAGES.

[17] Associated with each vintage of capital is a fixed amount of labour which is needed to operate the new machinery and an efficient quantity of output which can be produced with it.

[18] Equation (3.4.1) is equivalent to an ECM specification as follows: $\Delta logL_t = a + b\left[logL_{t-1} - y_{t-1} + g(t-1) - log\hat{l}_{t-1}\right] + c\Delta\left(y_t - gt + log\hat{l}_t\right) + d\sum_{i=1}^{q}\Delta y_t$, where the expression in square brackets is the distance of actual employment from the long-run equilibrium.

The dynamic response of employment to a permanent 1 per cent increase in output and real wages (that enter the definition of $\hat{l}_t$) is showed in figure 7. The elasticity of labour demand to output is about 0.6 after two years and then increases very slowly towards its long-run value of one. Labour supply is endogenously determined: participation rates are modelled as a function of labour demand, compensation per employee and private-sector wealth. The coefficient on employment, which is positive, allows to capture the "discouraged worker" effect. The unemployment rate is determined by an identity, with public employment exogenous.

Unit wages are determined according to an accelerationist two-regime Phillips curve, describing both the pre-1993 indexation of wages to past inflation and the subsequent regime, where labour costs are linked to expected inflation, cyclical conditions and productivity developments. The specification of the equation is as follows:

$$\Delta w_t = \alpha_0 + \pi_{t-1} d_{BF93} + \pi^e_{t|t-1}(1 - d_{BF93}) + \beta_1 u_{t-1} + \bar{a}_t \qquad (3.4.2)$$

where w_t is the logarithm of unit wages in the private sector, π_t is consumer price inflation and $\pi^e_{t|t-1}$ is expected inflation, u_t is the unemployment rate, $\bar{a}_t$ is a five-year average of labour productivity growth and d_{BF93} is a dummy variable equals to 1 in periods before and including 1993 and zero afterwards. To ensure theoretical consistency, the coefficient describing the impact of productivity developments on real wages is restricted to 1; the restriction is not rejected by the data. See <EQ8> in Appendix A for the estimates of the coefficients.

Figure 8 shows the dynamic response of wages to an exogenous (permanent) increase by 1 per cent in the level of consumer prices and a temporary decrease in the unemployment rate (by 1 per cent for two years). In simulating the effects of an increase in prices, inflation expectations are determined endogenously, according to a backwards looking equation estimated in the model. Thus higher prices are gradually transmitted to inflation expectations and hence to wages; the pass-through is nearly completed after three years.

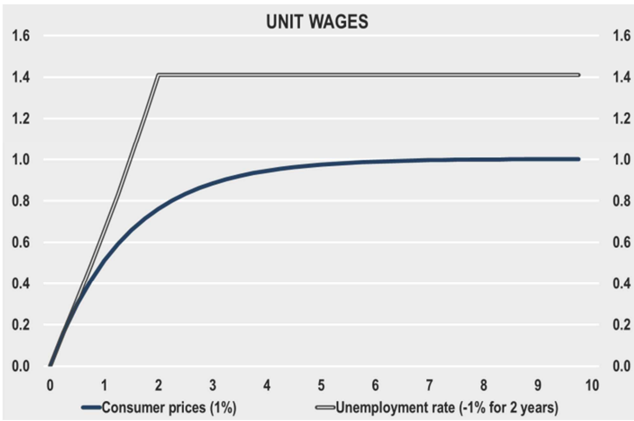

FIGURE 8. DYNAMIC RESPONSE OF UNIT WAGES TO A PERMANENT SHOCK IN CONSUMER PRICES AND A TEMPORARY SHOCK IN UNEMPLOYMENT.

3.5. Prices and deflators

The BIQM features a detailed description of a system of supply and demand prices, disaggregated for the most important production sectors and aggregate demand components, that takes into account indirect taxes and institutional mechanisms affecting price formation in the Italian economy. Supply prices include value-added and import deflators; demand prices are the deflators of the aggregate demand components (e.g. consumption, investments, exports).

Supply prices are modelled as behavioural equations, based on the assumption that, in equilibrium, monopolistically competitive firms set their output price as a mark-up over average minimum costs. For the private sector this condition can be expressed as $P_{y,t} = \mu_t ULC_t$, where $P_{y,t}$ is the value added deflator of the private sector (net of energy and agriculture), ULC_t denotes "normal" unit labour costs, which proxy for marginal costs, and μ_t is the mark-up. The latter, in turn, is assumed to depend on competitive pressures from abroad, cyclical conditions and fluctuations in commodity prices, with asymmetric effects:

$$\log\mu_t = \alpha_0 + \alpha_1 log\left(\frac{P_t^* EEN_t}{P_{y,t}}\right) + \alpha_2 x_t + \alpha_3 \pi_t^{COM} I_t(\pi_t^{COM} < 0) \tag{3.5.1}$$

where μ_t is the mark-up, P_t^* denotes foreign prices of manufactured goods, EEN_t is the nominal effective exchange rate, $P_{y,t}$ are domestic prices proxied by the value added deflator of the private sector, x_t is the output gap, π_t^{COM} is the rate of change of a weighted average of commodity import deflators and $I_t(\pi_t^{COM} < 0)$ an indicator variable equal to 1 when π_t^{COM} is negative and 0 otherwise.[19] Taken together, the equilibrium condition and the mark-up relation (3.5.1) yield the estimated equation for the (non-farm, non-energy) private-sector value-added deflator:

$$logP_{y,t} = \beta_0 + \beta_1 logP_{y,t-1} + \beta_2 logULC_t + (1 - \beta_1 - \beta_2) log(P_t^* EEN_t) +$$
$$+\beta_3 x_t + \beta_4 \pi_t^{COM} I_t(\pi_t^{COM} < 0) + \beta_5 \sum_{i=0}^{3} \Delta logULC_{t-i} \tag{3.5.2}$$

where ULC_t is defined as private-sector compensation per employee divided by a moving average of labour productivity, aimed at removing cyclical fluctuation, so as to capture "normal" unit labour costs. In the long run, supply prices are homogeneous in the unit labour cost, implying that the mark-up is constant.[20] See <EQ9> in Appendix A for the estimates of the coefficients. Figure 9 shows the dynamic response of the price of output to: (i) a permanent increase of 1 per cent in nominal wages, (ii) a permanent increase of 1 per cent in foreign prices, (iii) a temporary (two-year) shock of 1 per cent to a measure of output gap (x_t). Note that a shift in nominal wages is immediately translated into "normal" unit labour costs, as the smoothness of ULC_t is obtained by averaging productivity developments only; thus the response of the value added deflator to wages is front loaded.

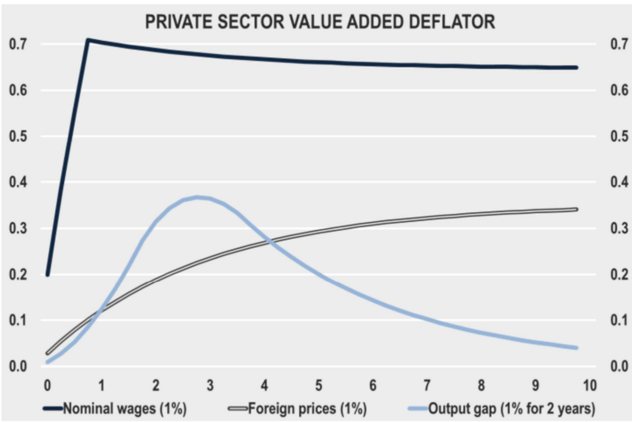

FIGURE 9. DYNAMIC RESPONSE OF THE VALUE ADDED DEFLATOR TO SHIFTS IN NOMINAL WAGES, FOREIGN PRICES AND CYCLICAL CONDITIONS.

[19] The asymmetric response of the mark-up to changes in commodity prices is based on empirical evidence and reflects the temporary increase in the mark-up that occurs when commodity prices fall (with no corresponding decline in output prices). On the contrary, profit margins do not decrease (and accordingly output prices increase) when commodity prices rise.

[20] It must be noted however that the model does not exhibit super-homogeneity, implying for instance that the mark-up is a function of the steady-state value of inflation, population growth and technical progress. Specifically, it is decreasing in the rate of inflation and increasing in the rate of productivity growth. For a detailed discussion of the consequences on the model's properties of the violation of the super-homogeneity requirement, see Cagliesi and Siviero (1994) and the appendix in Visco (1994).

Value added deflators for the energy and agricultural sectors are determined through equations similar to equation (3.5.2), once the relevant unit labour costs and foreign prices are taken into account.

Import prices for manufactured goods are determined under the assumption that foreign firms set a price for the goods they export to Italy that may differ from that charged elsewhere on the basis of exchange rate developments and cyclical conditions. The deflator of imported commodities is instead the direct outcome of international prices and exchange rate developments; however, changes in the deflator tend to smooth the fluctuations occurring in international commodity markets, reflecting an average of spot and forward/future prices.

Domestic demand prices are homogeneous of degree 1 (in the long run) in supply prices, which include the deflator of the value added of the private sector, and import prices;[21] fiscal determinants, such as indirect tax rates, excise taxes and administered prices, are also taken into account in modelling demand prices. As an example, the empirical equation for the non-durable consumption deflator (net of the energy component), $P_{C,t}$, is

$$logP_{C,t}^{\tau} = \beta_0 + \beta_1 logP_{C,t-1}^{\tau} + \beta_2 logP_{C,t-2}^{\tau} + \beta_3 logP_{y,t} + (1 - \beta_1 - \beta_2 - \beta_3) logP_{M,t} + \beta_5 \Delta log(1 + \tau_t)$$

where $P_{C,t}^{\tau} = \frac{P_{C,t}}{1+\tau_t}$ is the deflator net of indirect taxes (τ_t being the implicit tax rate), $P_{y,t}$ is the deflator of the private-sector value added, $P_{M,t}$ is the import deflator (excluding commodities). As the adjustment of final consumer prices to a change in indirect taxes is gradual, the coefficient β_5 has a negative sign. See <EQ10> in Appendix A for the estimates of the coefficients. The equations for other demand deflators are specified in a similar vein, with the stock-building deflator ensuring mutual consistency between nominal GDP constructed from the demand and supply side.

Figure 10 shows the dynamic response of the non-durables consumption price to: (i) a permanent increase of 1 per cent in domestic prices and in the import deflator; (ii) an increase of 100 basis points in the implicit tax rate.

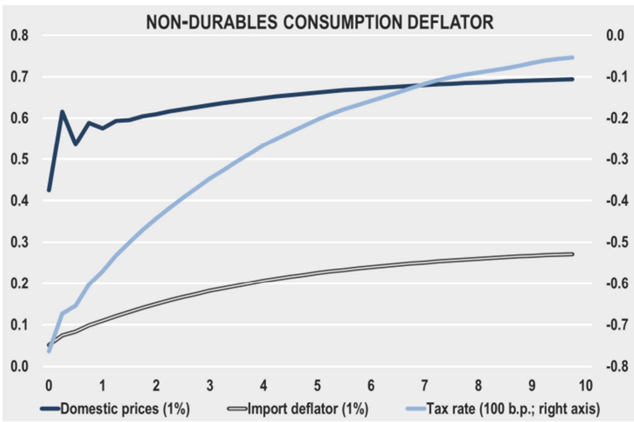

FIGURE 10. DYNAMIC RESPONSE OF NON-DURABLES CONSUMPTION DEFLATOR (NET OF INDIRECT TAXES) TO SHIFTS IN DOMESTIC PRICES, IMPORT DEFLATOR AND IMPLICIT TAX RATE.

3.6. The public sector

The BIQM features a detailed specification of the various items of the Government budget. Fiscal revenues and expenditures are not set according to a specific policy rule, but reflect the institutional design of the Italian public sector. On the revenue side the main items are direct and indirect taxes, which are disaggregated in various sub-items corresponding to the main taxes of the Italian fiscal system, and social contributions. In the typical

[21] For a theoretical justification of the links between supply and demand prices, see Klein and Welfe (1983).

simulation experiments, tax rates are normally kept exogenous, while the various tax bases evolve endogenously, following developments in the private-sector economy, thus ensuring the working of automatic stabilizers. On the expenditure side, the main items are represented by intermediate consumption of the public sector, compensation to employee, transfers (mainly pensions), interest payments and public investment. Public wages are assumed to evolve in line with those of the private sector in the long run (but they may deviate in forecasting). Pensions are determined on the basis of demographics and consumer prices. Interest payments are determined on the basis of public debt and the yields associated to government securities. Intermediate consumption and public investment evolve in line with nominal GDP in equilibrium (but they are exogenously calibrated according to the government plans in forecasting exercises). The mismatch between revenues and expenditures steers government deficit and debt, whose stability in terms of GDP is ensured in long-term counter-factual simulations by a growth of nominal aggregates which is explicitly (for intermediate consumption and investment) or implicitly (for other items) linked to that of nominal GDP.

3.7. Monetary policy and interest rates

Monetary policy shocks are transmitted to a whole set of interest rates and exchange rates. The resulting changes in financing conditions affect aggregate demand through a variety of channels: cost of capital, bank lending, substitution in consumption, exchange rate, income and wealth effects.[22] The ensuing demand pressures induce wages and prices to adjust – gradually offsetting the initial shock – bringing the economy towards a new equilibrium.

The pass-through to financing costs of the policy interest rate,[23] which is controlled by the Governing Council of the ECB, is assumed, and statistically tested, to be complete in the long run. Short-term yields on Government bonds adapts quickly to the policy instrument, while the response of the long-term rate is gradual; the equations modelling the evolution of the bond yield also account for asymmetric volatility effects that push up yields in times of market tensions. Short- and long-term bank lending rates to households and non-financial corporations are modelled in terms of a risk-free rate (with a complete pass-through in the long run) and a time-varying risk spread linked to default probabilities on these loans: indeed, the deterioration of firms' solvency conditions typically induces banks to charge higher premia, thus increasing funding costs.

In particular, the model contains stochastic equations that describe the dynamics of the *bad loans* to households and non-financial corporations, defined as the ratio between the flow of loans turned sour and the total outstanding amount of bank credit net of bad debts.[24] For non-financial corporations the equation includes as determinants: (i) cyclical conditions, (ii) lending rates, (iii) the ratio of borrowing costs to gross operating surplus. Allowance for non-linear responses (in the sense that the magnitude of the responses is a function of the underlying level of the dependent variable) is made using a logit transform for the endogenous variable:

$$Tbd_t = log\left(\frac{bd_t}{1-bd_t}\right)$$

where bd_t is the share of new bad debt. The equation is specified as

$$Tbd_t = \alpha_0 + \alpha_1 Tbd_{t-1} + \alpha_2 y_{t-1} + \alpha_3 r_t + \alpha_4 bc_t + u_t$$

[22] For a detailed description of these channels in the context of large-scale semi-structural macroeconomic models, see van Els et al. (2001).

[23] Technically, in the model the policy interest rate could be either treated as exogenous or set according to a policy rule (e.g. a standard Taylor rule).

[24] The share of bad loans to non-financial firms began to increase in the wake of the global financial crisis and rose sharply during the sovereign debt crisis (to nearly 5 per cent, from about 1.5 in the pre-crisis periods); cf. Notarpietro and Rodano (2016). The bad debt is a somewhat smaller subset of the so-called *non performing loans* (NPL); cf. the Bank of Italy Financial Stability Report for the precise definitions.

where y_t is a measure of output gap, r_t is a real bank lending rate and bc_t is the ratio of borrowing costs (function of the nominal lending rate) to the gross operating surplus. See <EQ11> in Appendix A for the estimates of the coefficients.

Figure 11 shows the dynamic response of the (percentage) level of bd_t to: (i) a permanent decrease of 1 per cent in GDP; (ii) a permanent increase of 100 basis points of the nominal bank lending rate. The figure is split in two panels: the left-hand side provides the dynamic responses in 'tranquil times' (with the threshold set at the 2001 average level), the right-hand side considers instead a crisis period (2013). There exist clear nonlinearities in the effects: all things equal, a one percent fall in GDP increases bd_t by 0.1 per cent in tranquil times and by 0.3 during a crisis period; similarly, the impact of a rise in the bank lending rate is about three times larger during the crisis (1.2 per cent vs. 0.4).

One distinctive feature of the BIQM is that this interplay between cyclical conditions, borrowing costs and firms solvency rates introduces a feedback from the financial sector to the real economy; these mechanisms are further reflected in the set of equations modelling the aggregate banking sector (cf. the next section). This feedback between the financial and the real side of the economy was basically missing in the older versions of the model.

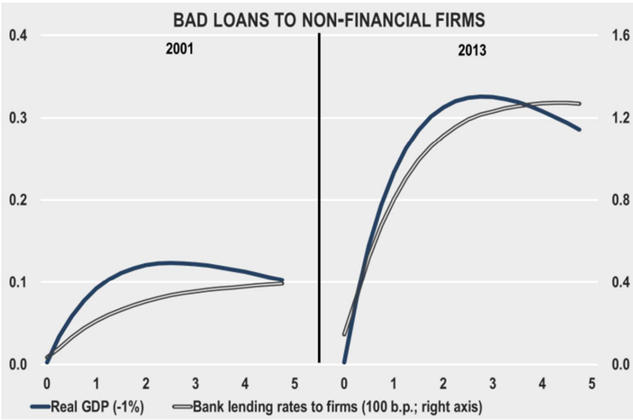

FIGURE 11. DYNAMIC RESPONSE OF THE RATE OF NEW BAD LOANS TO NON-FINANCIAL FIRMS TO SHOCKS TO GDP LEVEL AND TO BANK LENDING RATES TO FIRMS.

As regards a standard monetary policy shock, the estimates of its impact on the Italian economy are reported in section 4.1. For an assessment of non-standard monetary policy measures using the BIQM, see Casiraghi et al. (2013) and Cova and Ferrero (2015).

3.8. Credit and the banking sector

Bank credit to households and non-financial corporations follow standard demand-type equations. Loans to firms are modelled in terms of investment demand (proxying for financing needs), gross operating surplus (as a measure of non-bank, self-financing), lending rates; credit to households is disaggregated between mortgages (driven, among other things, by the return on housing investment) and consumer credit.

The equation for loans to firms has been at times modified to allow for episodes of disequilibrium in the credit market, in order to deal with issues of credit rationing and tightening of non-price conditions (that in Italy played a relevant role during both the Great Recession of 2008-2009 and the sovereign debt crisis of 2011-12). After having obtained a proxy for credit rationing through this modified equation, this proxy is included among the determinants of the BIQM investment equation, thus delivering a 'model consistent' assessment of the impact of credit restriction on Italian GDP and its component; see e.g. Caivano et al. (2011).

The BIQM contains a block of equations and identities tracking banks' profits and capital. The main components of banks' profits (net interest margins, other revenues, operating costs and provisions) are modelled in terms of macroeconomic conditions (cf. Miani et al. (2012) for details). In particular, banks provisions are affected, among other things, by firms and households' solvency rates, that are in turn modelled as described in the previous section.

Thanks to the modelling of the aggregate banking sector and to the feedback mechanisms between the financial and the real side of the economy, the BIQM can also be used for macroprudential purposes.[25] As an example, Albertazzi et al. (2016) investigate the determinants of the lower profitability of Italian credit institutions, compared with that of banks in other European countries. The counterfactual analysis of Notarpietro and Rodano (2016) on the other hand suggests that, in the absence of the double recession of 2008-09 and 2012-13, the stock of non-financial corporations' bad debts at the end of 2015 would have been lower by as much as 63 per cent (€52 billion instead of €143).

4. Model properties

This section presents the full model responses of GDP, its main components, wages and prices to a set of standard shocks to exogenous (or exogenized) variables in the model. The results are reported in terms of (cumulated) percentage deviations from a baseline scenario, for a five-year period. In all cases (except for the monetary policy shock) short-term nominal interest rates are unchanged with respect to the baseline scenario, i.e. it is assumed that the central bank does not respond to changes in macroeconomic conditions.

4.1. Monetary policy

The shock is a 100 basis points increase of the (short-term) ECB monetary policy rate sustained for two years. The euro exchange rate appreciates according to a standard uncovered interest rate parity (UIP) relation. Long-term interest rates, with an average duration of about six years, change according to the Expectation Hypothesis (i.e. they are based on the future path of short-term rates). Long-term inflation expectations are assumed not to be affected by the (conventional) monetary policy intervention.

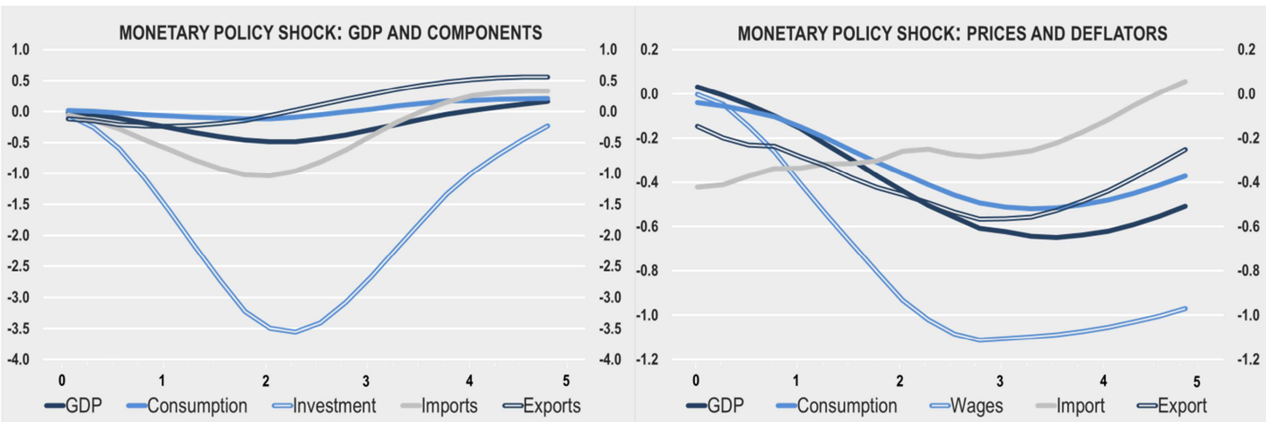

FIGURE 12. MODEL ELASTICITIES: MONETARY POLICY SHOCK (100 B.P. FOR TWO YEARS).
Percentage deviations from a baseline.

[25] A further important channel for macroprudential analyses is related to the real effects of house price shocks. In the BIQM housing market developments are fully modelled and they turn out to have significant effects on economic activity, as showed in figure 3 and 4 of this paper.

The monetary policy tightening induces a contraction in activity and a decrease in the price level (figure 12 and table B1 of Appendix B). Investment is the component of aggregate demand that is mostly affected by the shock, due to the combined impact of the rise in the cost of capital and of the output accelerator. The impact on household spending is also negative, as a result of inter-temporal substitution effects associated to the increase in interest rates which are stronger than the income effects of higher interest revenues; moreover, they are compounded by the decline in output, which adversely affects disposable income. This is partly dampened, through the Hicksian correction, by the exchange rate appreciation and the resulting lower inflation. Net exports provide a positive contribution to GDP as the contraction of activity reduces the demand for foreign goods. At the trough, after nine quarters, GDP decreases by nearly 0.5 per cent; the impact is gradually reabsorbed in the following periods as the shock vanishes.

As regards the nominal side, the decrease in the import deflator is immediately reflected in consumer prices. Wages respond very gradually partly due the delayed and smooth adjustment of labour demand. The price stickiness properties of the model translate into a muted response of output prices (GDP deflator), with the mark-up buffering shocks to unit labour costs. At the trough both consumer prices and GDP deflator fall cumulatively by about 0.4 per cent. The competitiveness gains consequent to the fall in export prices contribute to the adjustment of GDP towards the baseline levels once the shock comes to an end.

The exchange rate channel plays an important role in shaping the effects of a monetary policy shock. In an alternative simulation (not reported in the graphs) where the exchange rate is not allowed to adjust, the impact on GDP and prices after two years is about -0.4 and -0.2 per cent, respectively.

4.2. Foreign demand

The shock is a 1 per cent (sustained) increase of foreign demand for Italian goods, from both intra and extra euro area commercial partners. Exports rise in response to stronger foreign demand, but the increase in GDP is sizeably attenuated by the leakage due to the surge in imports. After five years GDP is about 0.2 per cent higher than in the baseline (figure 13 and table B2 of Appendix B). As demand pressures build up, prices rise, with a one/two-year lag, and competitiveness deteriorates, attenuating the initial boost. The current account (not reported in the graph but only in table B2 of Appendix B) improves by 0.1 percentage points of GDP.

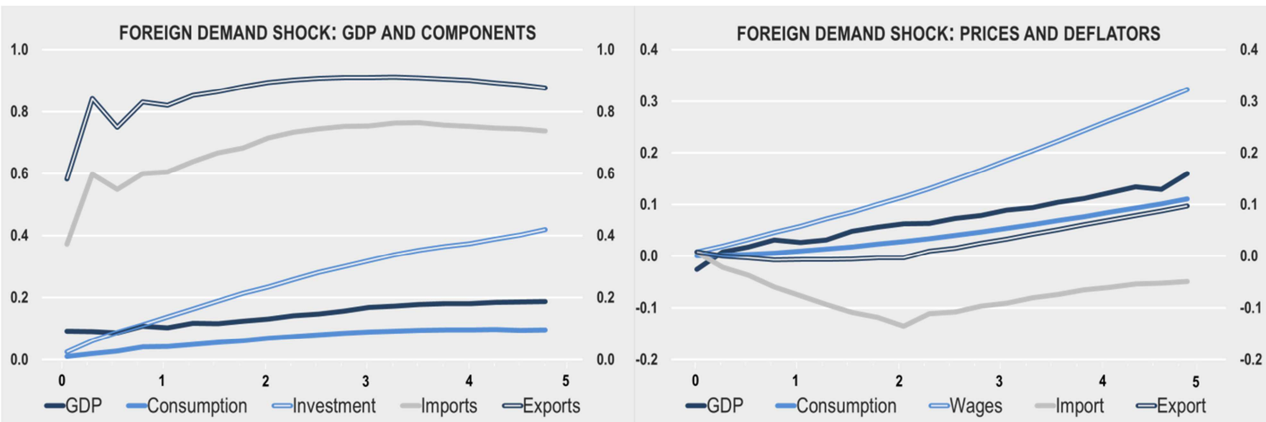

FIGURE 13. MODEL ELASTICITIES: FOREIGN DEMAND SHOCK (1%).
Percentage deviations from a baseline.

4.3. Euro exchange rate

The shock is a 5 per cent sustained appreciation of the euro exchange rate against all currencies. The appreciation engenders a contraction in exports, which persistently depresses GDP (about -0.6 per cent at the trough, after five years). Investment is, among the component of domestic demand, the one most sharply affected by the initial shock, being hit also by the increase in the real rental cost of capital associated with the reduction in inflation ensued by the appreciation (nominal short-term interest rates are assumed to remain unchanged at their baseline levels). Consumer spending, by contrast, shows a limited response, as the effect of the fall in economic activity is compensated by the favourable impact of lower inflation on disposable income (via the Hicksian correction). The current account initially improves, owing to the J-curve effect, but then deteriorates, reflecting the competitiveness loss stemming from the appreciation of the domestic currency. Prices fall on impact as the exchange rate appreciates; the initial movement is subsequently amplified by the contraction in aggregate demand. After five years the consumption deflator is nearly 2 per cent lower than in the baseline scenario (figure 14 and table B3 of Appendix B).

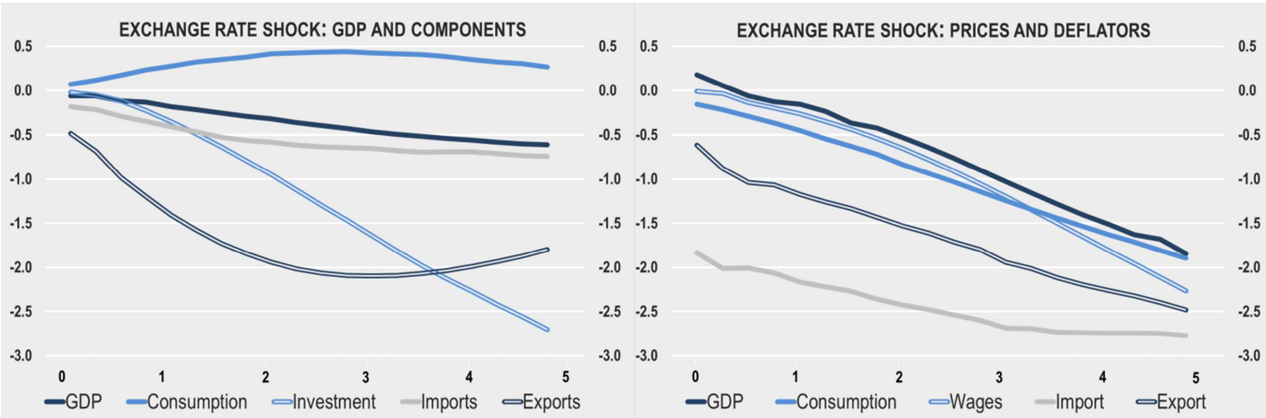

FIGURE 14. MODEL ELASTICITIES: EURO APPRECIATION (5%).
Percentage deviations from a baseline.

4.4. Oil price

The shock is a 10 per cent sustained increase of the price of oil, in dollars. Unlike the other shocks, there are non-negligible nonlinearities in the model responses, that differ according to the underlying path of the oil price, as well as on the sign of the shock. The results presented here correspond to a baseline scenario where the price is about 50 dollars per barrel; higher (lower) prices translate into stronger (milder) effects. Note also that in these simulations we do not account for different underlying drivers of the oil shock, i.e. whether it is supply or demand-driven.[26]

The increase in oil prices is rapidly transmitted to the import deflator and then, more gradually, to domestic prices (figure 15 and table B4 of Appendix B). The surge in energy prices heavily affects real disposable income and consumption; the latter fall by nearly as much as GDP (about -0.4 per cent after five years). The deterioration in competitiveness depresses exports (this effect would be lower than estimated here if one took into account the impact of the oil price hike on the price of competitors). Output decelerates, and so does investment, due to the accelerator mechanism. The current account deteriorates (by about 0.2 percentage points of GDP after five years), reflecting the worsening of the terms of trade. The slack engendered by the economic slowdown gradually offsets the inflationary impulses associated with the increase in oil prices: seven years after the initial shock, the GDP deflator is below the baseline value, which helps restoring competitiveness conditions and sustaining disposable income.

[26] See, among else, Kilian (2009) for an analysis of differential effects of supply vs demand driven shock in the oil market. To a large extent one might view our elasticities mostly connected to supply shocks, as demand driven shocks would be accompanied by related changes in global trade that would dampen the overall effect on the economy.

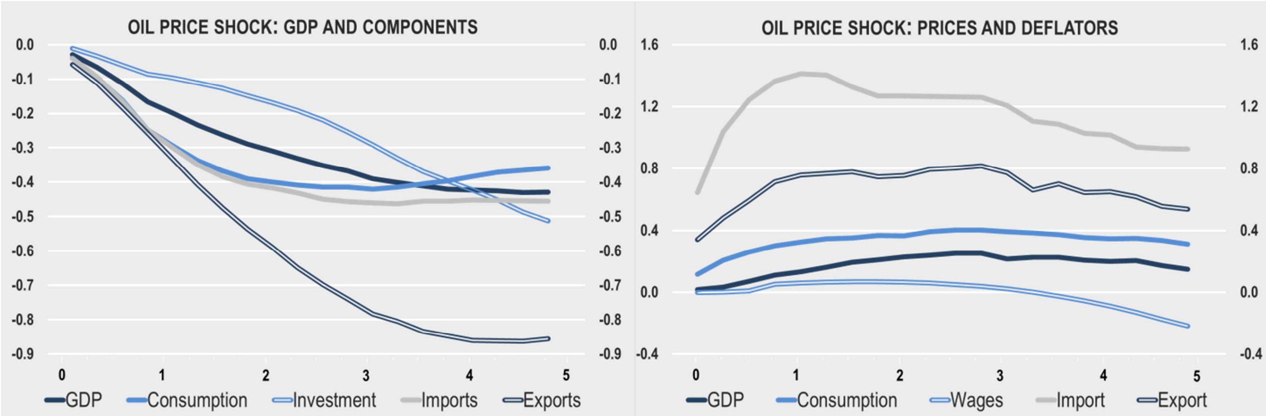

FIGURE 15. MODEL ELASTICITIES: OIL PRICE SHOCK (10%).
Percentage deviations from a baseline.

4.5. Fiscal policy shocks: public investment, transfers to households, indirect taxes and social contributions

The shock is a (sustained) fiscal expansion of 1 per cent of GDP using alternative instruments: (i) an increase of public investment; (ii) higher transfers to households; (iii) lower indirect taxes; (iv) cuts in social contributions. In all cases there is no response of monetary policy; also, government bond yields do not incorporate possible increases in risk premia induced by the fiscal expansion.

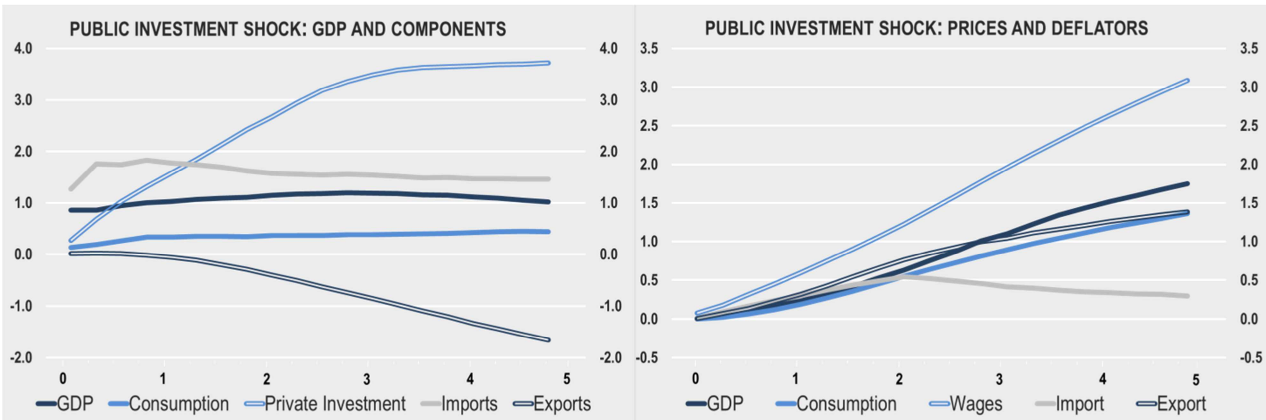

FIGURE 16. MODEL ELASTICITIES: PUBLIC INVESTMENT SHOCK (1% OF GDP).
Percentage deviations from a baseline.

Consider first the case of an increase of public investment (figure 16 and table B5 of Appendix B). In the first year of the experiment the fiscal stimulus results in a rise of GDP broadly in line with the size of the shock itself, then the effects gradually compound for a few years, before starting declining; ten years after the shock, real GDP is back to the baseline level. The Keynesian multiplier reaches its highest value of 1.2 between the third and the fourth year. While the surge in public spending boosts household consumption and private investment, net trade deteriorates sharply. Spurred by the surge in activity, consumer prices start rising gradually: after five years they are 1.4 per cent higher than in the baseline scenario. Under the assumption of fixed nominal short-term interest rates, which corresponds to a lax monetary policy stance, the rise in inflation engendered by the fiscal stimulus results in a decline of real interest rates and contributes to amplify the impact of the initial shock. The reaction of business investment follows the typical accelerator pattern; the response of (private) construction spending is more gradual and delayed. Overall, after five years private investment is 3.7 per cent higher than in the baseline, fostered also by the pick-up in real wages and the fall in real interest rates, both factors engendering a decrease in the relative cost of capital.[27] Consumer spending increases as well, but less markedly, due to its smoother response to output and to the higher inflation that attenuates the effects on disposable income (mainly via the Hicksian correction) of the policy-induced upturn. Net exports steadily decrease, reflecting first the expansion in imports driven by the delayed adjustment of production to the higher level of aggregate demand and then the deterioration in competitiveness ensued by the increase in domestic prices. Labour dishoarding and the unfavourable change in relative factor prices delay the reaction of private-sector employment to the fiscal stimulus: total employment (not shown in the graph) rises by 0.3 per cent in the first year, by 0.9 (cumulatively) after five years.

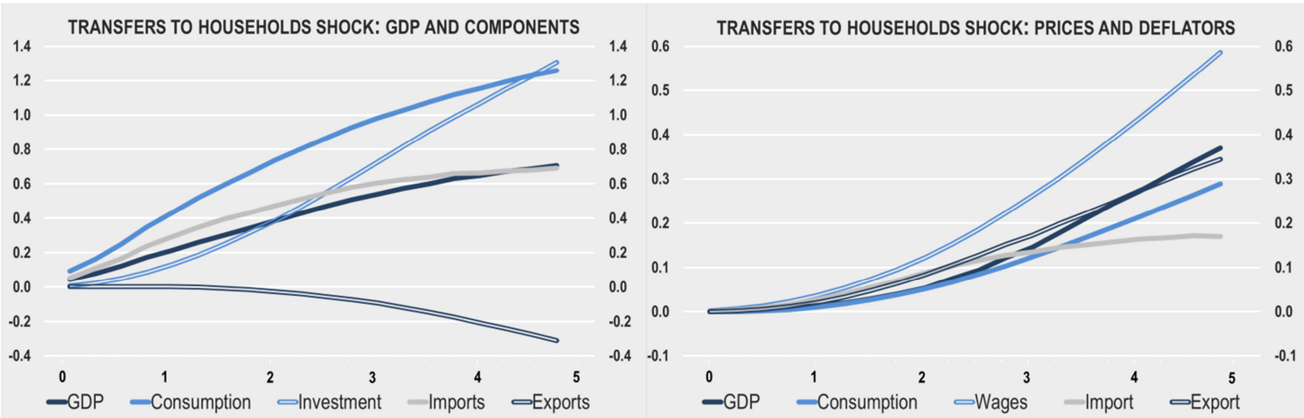

FIGURE 17. MODEL ELASTICITIES: TRANSFERS TO HOUSEHOLDS SHOCK (1% OF GDP).
Percentage deviations from a baseline.

The macroeconomic effects of higher transfers to households (including, among else, cuts in income taxes) are shown in figure 17 and table B6 of Appendix B. The GDP response is more muted compared to the case of public investment. The main channel of transmission is through the increase of disposable income that gradually boosts consumption (according to the average propensity to consume estimated from past data). After five years households spending is about 1.3 per cent higher than in the baseline, GDP increases by 0.7 per cent (against 0.2 and 0.1, respectively, in the first year); the GDP effect peaks at around 0.8 per cent after nine years and then starts declining. Price pressures are overall limited, leading to a small rise of the real interest rate. The response of capital accumulation is therefore also very moderate (1.3 per cent after five years), as that of employment (about 0.3 per cent).

A cut in indirect taxes produces broadly similar results to the previous simulation in terms of demand components but opposite in terms of domestic prices, that now decrease sharply (figure 18 and table B7 of Appendix B). Households consumption is stimulated by the direct effect of the tax cut on nominal income and the indirect effect of low inflation on real disposable income (via the Hicksian correction). After five years consumption is 1.4 per cent higher than in the baseline, GDP is nearly 0.8 percentage points higher. Investment is to a large extent unaffected, as the positive impact of stronger demand is broadly compensated by the rise of the real interest rate.

[27] The impact on business investment would be much lower if monetary policy reacts to the shock. Assuming a standard Taylor rule, the increase in policy rates would be such to largely crowd out private investment that, after an initial increase (of about 1 percentage point), would revert towards baseline levels two years after the public investment shock. The impact on GDP would also be milder, with the Keynesian multiplier reaching a maximum value of 0.9.

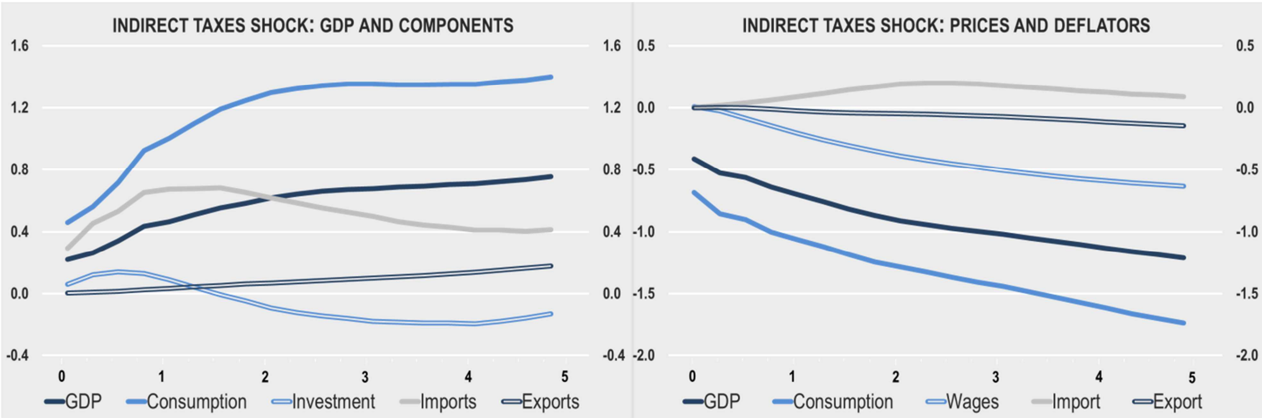

FIGURE 18. MODEL ELASTICITIES: INDIRECT TAXES SHOCK (-1% OF GDP).
Percentage deviations from a baseline.

Finally the model responses to a cut in social contributions (paid by the employers) are shown in figure 19 and table B8 of Appendix B. The reduction of the tax wedge on labour is gradually passed to output costs and hence to final prices: at the peak the GDP deflator is 2.1 per cent lower than in the baseline, while the decline of consumer prices amounts to 1.9 per cent. GDP is spurred by the lower prices through two main channels: (i) the increase in competitiveness of Italian firms translates into higher exports (2.9 per cent after five years); (ii) lower prices stimulate households' real disposable income and spending (1.9 per cent at the peak). As regards investment, the positive impact of output is to some extent offset by the increase of the cost of capital relative to labour, while the fall in real wages contributes to stimulate labour demand. Overall, after five years GDP and employment are higher than in the baseline by about 1.7 and 1.2 percentage points, respectively. The current account worsens in the first two years following the deterioration in the terms of trade and then gradually improves thank to the positive dynamics of net real exports.

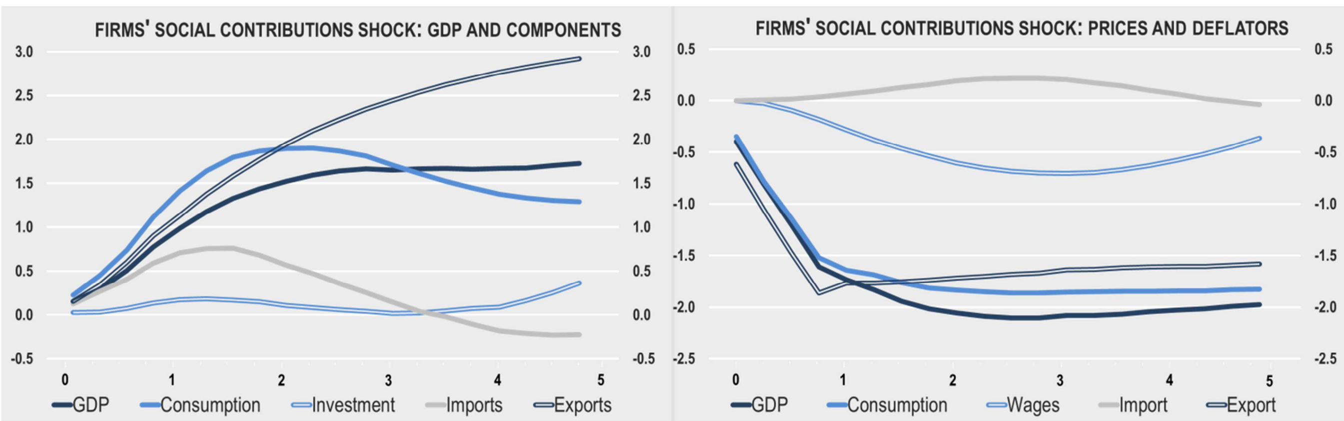

FIGURE 19. MODEL ELASTICITIES: FIRMS' SOCIAL CONTRIBUTIONS SHOCK (-1% OF GDP).
Percentage deviations from a baseline.

5. Uses of the model

The BIQM is heavily used in the context of macroeconomic forecasting. The Bank of Italy regularly publishes the macroeconomic projections for the Italian economy prepared in the context of the Eurosystem's coordinated projection exercises and updates to those projections in the January and July issues of its Economic Bulletin. These projections are mostly, although not exclusively, based on a simulated scenario constructed with the model. The forecast scenarios are conditional on a set of assumptions on the international environment, on financial market developments and on discretionary public sector variables.

The usefulness of a 'semi-structural' model such as the BIQM in producing macroeconomic forecasts is convincingly asserted in Siviero and Terlizzese (2008), where it is argued that the model allows to assemble '*a fully fledged view – one may call it a "story behind the figures" – of what could happen: a story that has to be internally consistent, whose logical plausibility can be assessed, whose structure is sufficiently articulated to allow one to make a systematic comparison with the wealth of information that accumulates as time goes by … In other words, it is essential that a logical, consistent causal chain can be traced from the assumptions to the results and that well-known economic mechanisms are evoked at each step.*' Indeed, the impulse-response functions presented in this paper are used in internal discussions at the Bank of Italy to clarify the quantitative relevance of the various economic mechanisms underlying the projections.

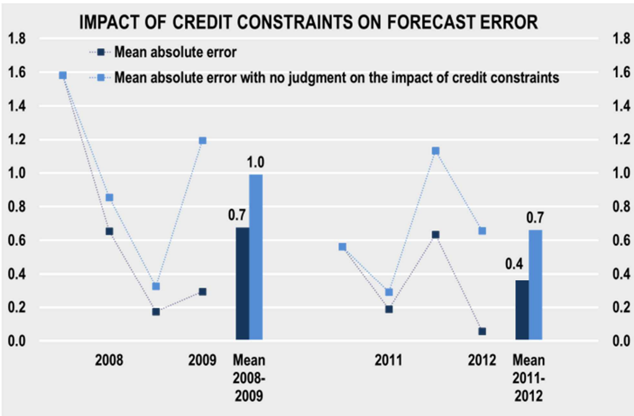

FIGURE 20. MACROECONOMIC IMPACT OF CREDIT CONSTRAINTS: MEAN ABSOLUTE PROJECTION ERRORS DURING CRISES EPISODES.

Clearly, in many cases the forecasts produced by the BIQM are supplemented by external information, e.g. in the context of 'nowcasting'. This is especially important in the presence of (suspected) structural breaks or when there are known economic developments in areas not covered by the relationships embodied in the model. Judgmental considerations and, possibly, the use of satellite models can significantly improve the accuracy of the forecasts. As an example of such adjustments, during the Great Recession of 2008-09 and the euro area Sovereign Debt Crisis of 2011-12 the model forecasts were integrated to take into account a sharp tightening of banks' credit supply. A simple disequilibrium model of the credit market, similar to Fair and Jaffee (1972), was developed and used to quantify the impact of credit supply constraints on investment; see Panetta and Signoretti (2010) and Caivano et al. (2011) for details. Figure 20, taken from Rodano et al. (2013), shows that without those adjustments the forecast error of annual GDP would be significantly higher, especially for the years 2009 and 2012 in which the tightening of credit supply was particularly strong.

Regarding the Bank of Italy's forecast performance, table 1 reports the average mean absolute error (MAE) for GDP and inflation over the period 1999-2015, in comparison with that of the International Monetary Fund (IMF), the European Commission, the OECD and the average of private analysts surveyed by Consensus Economics. Errors are computed for the current year and for one year-ahead forecasts (taking the average of June and December macroeconomic projections; for the other institutions we use the forecasts released at about the same period). Overall, Bank of Italy's projections are on average more accurate for both GDP and inflation, although in many cases the difference is not statistically significant.

The BIQM is also used to produce forecasts for the whole distribution of GDP and inflation, that are presented in the form of 'fan charts'. In detail, the probability distribution is computed as the result of model-based stochastic simulations, by bootstrapping from the historical distribution of the main 'risk factors' around the central scenarios (the sources of risk include the international environment, financing conditions, components of aggregate demand, wages and prices). The historical distribution is modified by imposing the skewness that emerges from judgmental considerations by Bank of Italy experts, on the basis of all information and analyses available at the Bank, on the prevalent direction of each individual risk factor. The technique, thoroughly described in Miani and Siviero (2010), is designed to deliver the desired degree of skewness without making any parametric assumption on the distribution of risks.

Table 1. Mean absolute error for GDP and inflation projections (1999-2015)

	GDP growth		Inflation	
	Current year	One year ahead	Current year	One year ahead
Bank of Italy	0.30	1.40	0.11	0.72
European Commission	0.42	1.53	0.16	0.74
IMF	0.39	1.54	0.29	0.85
OECD	0.35	1.45	0.17	0.78
Consensus	0.40	1.47	0.12	0.72

Sources of forecasts: Bank of Italy: Eurosystem Broad Macroeconomic Projection Exercise (BMPE); IMF: World Economic Outlook; European Commission: European Economic Forecast; OECD: OECD Economic Outlook; Consensus: Consensus Forecasts.

The model is also used, together with other tools, for evaluating the impact of macroeconomic policies. A recent example is provided in Cova and Ferrero (2015), where simulations with the BIQM are employed to quantify the macroeconomic effects on the Italian economy of the ECB Public Sector Purchase Programme (PSPP), using a two-stage approach. First, the impact of the ECB purchases on Government bond yields, financing conditions for the private sector and the exchange rate is estimated (or calibrated on the basis of other studies); second, these estimates are used as conditioning assumptions in the BIQM to derive the impact on GDP and inflation. According to simulations in Cova and Ferrero (2015), the PSPP – in the initial set-up that was announced in January 2015 – would have supported Italian GDP and consumer prices by over 1 per cent, cumulatively, in 2015-16.

As regards fiscal policy, the effects of various (restrictive or expansionary) measures planned by the government in the Budget Law are regularly assessed with the BIQM. These simulations contribute to the analyses and the opinions expressed by the Bank of Italy in official publications and Parliamentary hearings.

Finally, counterfactual scenarios are at times built with the BIQM, e.g. to evaluate the economic impact of past events (such as an international crisis) by artificially replacing the actual developments with alternative hypothetical assumptions. For instance, Busetti and Cova (2013) study the macroeconomic impact of the euro area sovereign debt crisis by estimating the contribution of its main transmission channels to the Italian economy. They find that, compared with a "no-crisis scenario", the GDP loss amounts cumulatively to around 6.5 percentage points in 2012-2013. The large fall in investment (about 20 per cent with respect to the counterfactual simulation) stems mainly from a worsening of financing costs and credit availability for firms, while the contraction in consumption expenditure (8.5 per cent) results from the heightened uncertainty and lower confidence, and also reflects the negative impact on households' disposable income of the fiscal measures enacted in response to the crisis. A similar exercise was carried out by Caivano et al. (2011) to explore the impact of the Great Recession of 2008-09. By confronting the two studies it emerges that the sovereign debt crisis affected economic activity mostly through channels related to domestic weaknesses, whereas the recession of 2008-09 was mainly a consequence of the sharp deterioration of the international environment.

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Appendix A: Estimates of the main equations

<EQ1> ECONOMIC CONSUMPTION

```
DEL(LOG(CECORD),1)  =     .029094
                        ( 2.5296 )

                      +   .46385   * MAVE(LAG(DEL(LOG(CECORD),1),1),3)
                        ( 4.3762 )

                      -   1.9587   * LAG(CECORD,1) / LAG(WNEGCK2/PCFNDUD,2)
                        (-4.0817 )

                      +   1.1218   * LAG(REDISR2,1) / LAG(WNEGCK2/PCFNDUD,2)
                        ( 5.9886 )

                      -   .062575 * LAG(RRATE/100,1)
                        (-2.7777 )

                      +   .10375   * DEL(LOG(REDISR2),1)
                        ( 1.8364 )

                      +   .014462 * (DU813+DU853)
                        ( 4.5647 )

     R-Squared                         :  .50429
     Adjusted R-Squared                :  .48523
     Durbin-Watson Statistic           :  1.691
     Sum of squares of residuals       :  .0030226
     Standard Error of Regression      :  .0044018
     Log of the Likelihood Function    :  656.69
     F-statistic (   6 , 156 )         :  26.45
     F-probability                     :  0
     Mean of Dependent Variable        :  .0047274
     Number of Observations            :  163
     Number of Degrees of Freedom      :  156
     Current Sample                    : 1972 2 2012 4
     Estimation Method                 : IV

DEPENDENT VARIABLE:
  CECORD   : ECONOMIC CONSUMPTION, PRIVATE SECT., CHAIN-LINKED VOLUMES, S.A.

INDEPENDENT VARIABLES:
  WNEGCK2 : NET WEALTH, PRIVATE SECT., EXCL. CAPITAL GAINS OVER HOUSING
  PCFNDUD : ECONOMIC CONSUMPTION DEFLATOR, NON-DURABLE GOODS & SERVICES,
            PRIVATE SECT., S.A.
  REDISR2 : REAL NET DISPOSABLE INCOME, INCLUDING INCOME ATTRIBUTABLE TO
            DURABLE GOODS
  RRATE    : AVERAGE NET REAL INTEREST RATE ON LONG-TERM GOVERNMENT BONDS
  DU813    : DUMMY VARIABLE EQUAL TO 1 IN 1981.Q3 AND ZERO OTHERWISE
  DU853    : DUMMY VARIABLE EQUAL TO 1 IN 1985.Q3 AND ZERO OTHERWISE
```

<EQ2> PRIVATE SECTOR EQUIPMENT INVESTMENT

```
DEL(LOG(IMANEAR),1)  = -  .068996
                        (-.64422 )

                       -  .067845 * LAG(LOG(IMANEAR),1)
                        (-2.0854 )

                       +  .067845 * LAG(LOG(KSTAR),1)
                         ( 2.0854 )

                       +  .067845 * LAG(LOG(VACNERD),1)
                         ( 2.0854 )

                       +  .20374  * DEL(CLIMA,1)
                         ( 3.4866 )

                       -  .037617 * MAVE(DEL(TIMPT-INFEL,1),8)
                         (-2.6329 )

                       + C07      * LAG(DEL(LOG(VACNERD),1),1)

                       -  .19861  * INCORDQ
                         (-2.2846 )

                       -  .12748  * DU031
                         (-5.2196 )

  RESTRICTIONS: C01 + C02 = 0
                C01 + C03 = 0

  ALMON:  C07  2  14  FAR
  Distributed Lag Coefficient:  C07
```

Lag	Coeff.	Std error	T-statistic
0	.30867	.1205	2.5616
1	.32845	.093495	3.5131
2	.34099	.075931	4.4907
3	.34626	.068375	5.0642
4	.34428	.068549	5.0224
5	.33505	.072191	4.6411
6	.31856	.075719	4.2071
7	.29482	.077011	3.8282
8	.26382	.074939	3.5204
9	.22556	.068898	3.2739
10	.18006	.058549	3.0753
11	.12729	.043692	2.9134
12	.067273	.024203	2.7796
13	0	RESTR.	RESTR.
SUM	3.4811	.69311	5.0224

```
   R-Squared                        :  .50579
   Adjusted R-Squared               :  .47119
   Durbin-Watson Statistic          :  1.9239
   Sum of squares of residuals      :  .056977
   Standard Error of Regression     :  .02387
   Log of the Likelihood Function   :  254.31
   F-statistic (  7 , 100 )         :  14.62
   F-probability                    :  5.4901E-13
   Mean of Dependent Variable       :  .0040576
```

```
     Number of Observations         :  108
     Number of Degrees of Freedom   :  100
     Current Sample                 : 1986 1 2012 4

 -----------  Restrictions Test  ------------

   F-VALUE        D.O.F.      F-PROB %
   1.1625         2 , 98      31.697

DEPENDENT VARIABLE:
  IMANEAR : EQUIPMENT INVESTMENT, PRIVATE SECT. EXCL. FARM & ENERGY,
            CHAIN-LINKED VOLUMES, S.A.

INDEPENDENT VARIABLES:
  KSTAR   : OPTIMAL CAPITAL OUTPUT RATIO, COBB-DOUGLAS SPECIFICATION
  VACNERD : VALUE ADDED, FACTORS COST, PRIVATE SECT. EXCL. FARM, ENERGY &
            RENTAL SERVICES, CHAIN-LINKED VOLUMES, S.A.
  CLIMA   : BUSINESS CONFIDENCE
  TIMPT   : AVERAGE INTEREST RATE ON BANK LOANS, NON-FINANCIAL CORPORATIONS
  INFEL   : EXPECTED LONG-TERM YEARLY INFLATION
  INCORDQ : UNCERTAINTY INDEX, SURVEY ABOUT ORDERS IN MANUFACTURING
  DU031   : DUMMY VARIABLE EQUAL TO 1 IN 2003.Q1 AND ZERO OTHERWISE
```

<EQ3> HOUSING INVESTMENT

```
ICORERD/LAG(KCASED,1)  =     .028476
                           ( 1.0253 )

                         +  .37666  * 1/(1+EXP(-3+.1*LAG(CASEMQ/POPM,1)))
                           ( 4.1363 )

                         +  .77182  * LAG(ICORERD,1)/LAG(KCASED,2)
                           ( 17.001 )

                         +  .059715 * LAG(MAVE(PRCASQ2/1703.15/PICORED,4),1)
                           ( 3.6052 )

                         + C04      * LAG(TIMPS-INFEY,1)

                         -  .3095   * MAVE(ALICI,16)
                           (-2.751 )

                         +  .05138  * 1/(1+EXP(-5+.65*(TREND-192)))
                           ( 5.6011 )

                         -  .045824 * (DU084-DU081)
                           (-4.1106 )

  ALMON:  C04  1  3
  Distributed Lag Coefficient:  C04
  Lag    Coeff.       Std error    T-statistic
   0     -.0020132     .0012279    -1.6395
   1     -.0016192     3.3861E-4   -4.7818
   2     -.0012252     .0012354    -.9917
  SUM    -.0048575     .0010158    -4.7818

     R-Squared                       :  .97324
     Adjusted R-Squared              :  .97138
     Durbin-Watson Statistic         :  1.9573
     Sum of squares of residuals     :  .028546
     Standard Error of Regression    :  .015755
     Log of the Likelihood Function  :  343.4
     F-statistic (  8 , 115 )        :  522.78
     F-probability                   :  0
     Mean of Dependent Variable      :  .98094
     Number of Observations          :  124
     Number of Degrees of Freedom    :  115
     Current Sample                  : 1982 1 2012 4

DEPENDENT VARIABLE:
  ICORERD : HOUSING INVESTMENT, PRIVATE SECT., CHAIN-LINKED VOLUMES, S.A.
  KCASED  : REAL WEALTH IN RESIDENTIAL BUILDINGS

INDEPENDENT VARIABLES:
  CASEMQ  : STOCK OF RESIDENTIAL BUILDINGS, IN SQUARE METERS
  POPM    : OVERALL POPULATION
  PRCASQ2 : HOUSE PRICES, BY SQUARE METER
  PICORED : HOUSING INVESTMENT DEFLATOR, PRIVATE SECT., S.A.
  TIMPS   : SHORT-TERM INTEREST RATE ON BANK LOANS, NON-FINANCIAL
            CORPORATIONS
  INFEY   : EXPECTED SHORT-TERM YEARLY INFLATION
  ALICI   : IMPLICIT TAX RATE ON HOUSING
```

TREND	:	LINEAR TREND (1 IN 1960)
DU084	:	DUMMY VARIABLE EQUAL TO 1 IN 2008.Q4 AND ZERO OTHERWISE
DU081	:	DUMMY VARIABLE EQUAL TO 1 IN 2008.Q1 AND ZERO OTHERWISE

<EQ4> HOUSE DEMAND

```
CASVAL2/WSPABP3  =     .0096603
                      ( 1.191 )

                   +  1.4629  * LAG(CASVAL2/WSPABP3,1)
                      ( 13.62 )

                   -  1.117   * LAG(CASVAL2/WSPABP3,2)
                      (-7.3655 )

                   +  .87273  * LAG(CASVAL2/WSPABP3,3)
                      ( 5.7085 )

                   -  .26518  * LAG(CASVAL2/WSPABP3,4)
                      (-2.4776 )

                   +  5.485E-4 * INFEY
                      ( 1.7562 )

                   +  3.362E-4 * LAG(MAVE(RENDAB3-TAOB,8))
                      ( 3.4123 )

                   +  .02314   * (1-1/(1+EXP(.02*(TREND-60))))
                      ( 2.2008 )

                   -  .0042529 * (DU041-DU021)
                      (-2.6439 )

     R-Squared                        :  .99271
     Adjusted R-Squared               :  .99204
     Durbin-Watson Statistic          :  2.1714
     Sum of squares of residuals      :  4.4195E-4
     Standard Error of Regression     :  .0022539
     Log of the Likelihood Function   :  453.64
     F-statistic (  8 , 87 )          :  1480.9
     F-probability                    :  0
     Mean of Dependent Variable       :  .68012
     Number of Observations           :  96
     Number of Degrees of Freedom     :  87
     Current Sample                   : 1989 1 2012 4

DEPENDENT VARIABLE:
  CASVAL2 : NOMINAL WEALTH IN RESIDENTIAL BUILDINGS
  WSPABP3 : NET WEALTH, PRIVATE SECT., INCL. CAPITAL GAINS OVER HOUSING

INDEPENDENT VARIABLES:
  INFEY   : EXPECTED SHORT-TERM YEARLY INFLATION
  RENDAB3 : RATE OF RETURN ON HOUSING INVESTMENT (RENTS & CAPITAL GAINS)
  TAOB    : AVERAGE NET NOMINAL INTEREST RATE ON LONG-TERM GOVERNMENT BONDS
  TREND   : LINEAR TREND (1 IN 1960)
  DU041   : DUMMY VARIABLE EQUAL TO 1 IN 2004.Q1 AND ZERO OTHERWISE
  DU021   : DUMMY VARIABLE EQUAL TO 1 IN 2002.Q1 AND ZERO OTHERWISE
```

<EQ5> IMPORTS OF NON-FARM NON-ENERGY GOODS

```
LOG(IMNEARD)  = -  .0027014
                  (-.98375 )

                +  .54092  * LAG(LOG(IMNEARD),1)
                  ( 8.3993 )

                +  .30268  * LAG(LOG(IMNEARD),2)
                  ( 4.6814 )

                + C03      * LOG(ATTNEA)

                -  .26549  * LOG(PIMNEAD/PRISORC)
                  (-5.8841 )

                -  .080296 * (DU914+DU923+DU932)
                  (-7.041 )

  ALMON:  C03  2  4  FAR
  Distributed Lag Coefficient:  C03
  Lag    Coeff.       Std error    T-statistic
   0      1.5883       .10499       15.127
   1     -.45122       .036585     -12.334
   2     -.98065       .070561     -13.898
   3      0           RESTR.        RESTR.
  SUM     .1564        .024309      6.4338

  RESTRICTIONS: C01 + C02 + C03 + LAG(C03,1) + LAG(C03,2) + LAG(C03,3) = 1

     R-Squared                        :  .99765
     Adjusted R-Squared               :  .99753
     Durbin-Watson Statistic          :  1.7675
     Sum of squares of residuals      :  .034235
     Standard Error of Regression     :  .018691
     Log of the Likelihood Function   :  269.41
     F-statistic (  5 , 98 )          :  8335.1
     F-probability                    :  0
     Mean of Dependent Variable       :  10.714
     Number of Observations           :  104
     Number of Degrees of Freedom     :  98
     Current Sample                   : 1987 1 2012 4

 -----------  Restrictions Test  ------------

   F-VALUE        D.O.F.      F-PROB %
   .80684         1 , 97      37.128

DEPENDENT VARIABLE:
  IMNEARD : IMPORTS, GOODS, PRIVATE SECT. EXCL. FARM & ENERGY,
            CHAIN-LINKED VOLUMES, S.A.

INDEPENDENT VARIABLES:
  ATTNEA   : ABSORPTION OF NON-FARM & NON-ENERGY IMPORTS
  PIMNEAD : IMPORT DEFLATOR, GOODS, PRIVATE SECT. EXCL. FARM & ENERGY, S.A.
  PRISORC : RESOURCES (GDP+IMPORTS) DEFLATOR
  DU914    : DUMMY VARIABLE EQUAL TO 1 IN 1991.Q4 AND ZERO OTHERWISE
  DU923    : DUMMY VARIABLE EQUAL TO 1 IN 1992.Q3 AND ZERO OTHERWISE
  DU932    : DUMMY VARIABLE EQUAL TO 1 IN 1993.Q2 AND ZERO OTHERWISE
```

<EQ6> EXPORTS OF NON-FARM NON-ENERGY GOODS

```
LOG(ESNEARD)  = -  1.6836
                  (-6.197 )

                +  .8744   * LAG(LOG(ESNEARD),1)
                  ( 38.339 )

                +  .1256   * LOG(WORLDMR)
                  ( 5.507 )

                +  .26717  * LOG(P30EIT*ITEXP30/PESNEAD)
                  ( 6.5743 )

                +  .67475  * MAVE(DEL(LOG(INITRLQ),1),2)
                  ( 3.6706 )

                +  .54324  * MAVE(DEL(LOG(EXITRLQ),1),2)
                  ( 3.5407 )

                -  .46335  * LAG(DEL(LOG(ESNEARD),1),1)
                  (-5.9036 )

                -  .058226 * (DU091+DU084)
                  (-2.8758 )

  RESTRICTIONS: C01 + C02 = 1

     R-Squared                        :  .99647
     Adjusted R-Squared               :  .99629
     Durbin-Watson Statistic          :  1.9773
     Sum of squares of residuals      :  .061259
     Standard Error of Regression     :  .023283
     Log of the Likelihood Function :  284.54
     F-statistic (  6 , 113 )         :  5322.1
     F-probability                    :  0
     Mean of Dependent Variable       :  10.881
     Number of Observations           :  120
     Number of Degrees of Freedom     :  113
     Current Sample                   : 1983 1 2012 4

-----------  Restrictions Test  ------------

   F-VALUE        D.O.F.      F-PROB %
   .19547         1 , 112     65.926

DEPENDENT VARIABLE:
  ESNEARD : EXPORTS, GOODS, PRIVATE SECT. EXCL. FARM & ENERGY,
            CHAIN-LINKED VOLUMES, S.A.

INDEPENDENT VARIABLES:
  WORLDMR : WEIGHTED FOREIGN DEMAND, GOODS, ROLLING WEIGHTS
  P30EIT  : FOREIGN PRODUCERS PRICE INDEX, 30 COUNTRIES, EXPORT WEIGHTS
  ITEXP30 : NOMINAL EFFECTIVE EXCHANGE RATE, 30 COUNTRIES, EXPORT WEIGHTS
  PESNEAD : EXPORT DEFLATOR, GOODS, PRIVATE SECT. EXCL. FARM & ENERGY, S.A.
  INITRLQ : WEIGHTED FOREIGN DEMAND, GOODS, INTRA EURO AREA, ROLLING WEIGHTS
  EXITRLQ : WEIGHTED FOREIGN DEMAND, GOODS, EXTRA EURO AREA, ROLLING WEIGHTS
  DU091   : DUMMY VARIABLE EQUAL TO 1 IN 2009.Q1 AND ZERO OTHERWISE
  DU084   : DUMMY VARIABLE EQUAL TO 1 IN 2008.Q4 AND ZERO OTHERWISE
```

<EQ7> PRIVATE SECTOR NON-FARM NON-ENERGY EMPLOYMENT

```
LOG(OCCNEAD)  = -  .039215
                  (-2.5914 )

                +  .97798  * LAG(LOG(OCCNEAD),1)
                  ( 109.11 )

                +  .022024 * LOG(VACNERD)
                  ( 2.4572 )

                +  .022024 * (1-GPROD)*TREND
                  ( 2.4572 )

                +  .022024 * LOG(LQSTARK)
                  ( 2.4572 )

                + C05      * DEL(LOG(VACNERD),1)

                +  .0048445* (1-DUBF021)
                  ( 3.3657 )

  ALMON:  C05  1  9  FAR
  Distributed Lag Coefficient:  C05
  Lag    Coeff.       Std error    T-statistic
   0      .11002       .018223      6.0374
   1      .096267      .015945      6.0374
   2      .082515      .013667      6.0374
   3      .068762      .011389      6.0374
   4      .05501       .0091115     6.0374
   5      .041257      .0068337     6.0374
   6      .027505      .0045558     6.0374
   7      .013752      .0022779     6.0374
   8      0            RESTR.       RESTR.
  SUM     .49509       .082004      6.0374

  RESTRICTIONS: C01 + C02 = 1
                C01 + C03 = 1
                C01 + C04 = 1

     R-Squared                         :  .99523
     Adjusted R-Squared                :  .9951
     Durbin-Watson Statistic           :  1.794
     Sum of squares of residuals       :  .0016106
     Standard Error of Regression      :  .0038618
     Log of the Likelihood Function    :  465.46
     F-statistic (  3 , 108 )          :  7518.1
     F-probability                     :  0
     Mean of Dependent Variable        :  9.8014
     Number of Observations            :  112
     Number of Degrees of Freedom      :  108
     Current Sample                    : 1986 1 2013 4

 -----------  Restrictions Test  ------------

   F-VALUE        D.O.F.      F-PROB %
   .76418         3 , 105     51.663
```

```
 DEPENDENT VARIABLE:
  OCCNEAD : EMPLOYMENT, F.T.E., PRIVATE SECT. EXCL. FARM & ENERGY, S.A.

INDEPENDENT VARIABLES:
  VACNERD : VALUE ADDED, FACTORS COST, PRIVATE SECT. EXCL. FARM, ENERGY &
            RENTAL SERVICES, CHAIN-LINKED VOLUMES, S.A.
  GPROD   : 1+LONG RUN REAL GDP GROWTH RATE
  TREND   : LINEAR TREND (1 IN 1960)
  LQSTARK : AVERAGE OPTIMAL CAPITAL OUTPUT RATIO, COBB-DOUGLAS SPECIFICATION
  DUBF021 : DUMMY VARIABLE EQUAL TO 1 BEFORE 2002.Q1 AND ZERO OTHERWISE
```

<EQ8> PRIVATE SECTOR UNIT WAGES

```
DEL(LOG(RTUNEAD),1)  =    .024598
                        ( 3.2449 )

                     -  .011722 * LAG(LOG(URD),1)
                        (-3.3543 )

                     +  1       * LAG(DEL(LOG(ISD),1),1)*DUBF934
                        ( INF. )

                     +  1       * LOG(1+INFEQ/100)*(1-DUBF934)
                        ( INF. )

                     +  1       * MAVE(DEL(LOG(VANFENR/OCCNEAD),1),20)
                        ( INF. )

  RESTRICTIONS: C02 = 1
                C03 = 1
                C04 = 1

     R-Squared                        :  .8065
     Adjusted R-Squared               :  .80502
     Durbin-Watson Statistic          :  2.3785
     Sum of squares of residuals      :  .0074267
     Standard Error of Regression     :  .0075583
     Log of the Likelihood Function :  458.54
     F-statistic (  1 , 130 )         :  541.85
     F-probability                    :  0
     Mean of Dependent Variable       :  .020016
     Number of Observations           :  132
     Number of Degrees of Freedom     :  130
     Current Sample                   : 1976 1 2008 4

 -----------  Restrictions Test  ------------

   F-VALUE        D.O.F.      F-PROB %
   1.4162         3 , 127     24.112

DEPENDENT VARIABLE:
  RTUNEAD : NOMINAL UNIT WAGES, PRIVATE SECT., S.A.

INDEPENDENT VARIABLES:
  URD     : UNEMPLOYMENT RATE, S.A
  ISD     : CONSUMER PRICE INDEX, TRADE UNION DEFINITION, S.A.
  INFEQ   : EXPECTED SHORT-TERM QUARTERLY INFLATION
  VANFENR : VALUE ADDED, FACTORS COST, PRIVATE SECT. EXCL. FARM, ENERGY,
            TARIFS & RENTAL SERVICES, CHAIN-LINKED VOLUMES, S.A.
  OCCNEAD : EMPLOYMENT, F.T.E., PRIVATE SECT. EXCL. FARM & ENERGY, S.A.
  DUBF934 : DUMMY VARIABLE EQUAL TO 1 BEFORE 1993.Q4 AND ZERO OTHERWISE
```

<EQ9> PRIVATE SECTOR NON-FARM NON-ENERGY VALUE ADDED DEFLATOR

```
LOG(PVNFESB)  = -  .35968
                  (-3.6796 )

                +  .91898  * LAG(LOG(PVNFESB),1)
                  ( 38.079 )

                +  .052418 * LOG(CLUPPRD)
                  ( 2.5676 )

                +  .028598 * LOG((PALTRI*ITCAMB+PIMPMFD)/2)
                  ( 3.7318 )

                -  .049139 * (DEL(LOG(.65*PIMPEND+.15*PIMPAGD+.2*PIMPMPD),1)
                   -ABS(DEL(LOG(.65*PIMPEND+.15*PIMPAGD+.20*PIMPMPD),1)))/2
                  (-4.3597 )

                +  .079932 * LOG(MAVE(CPUNFED,8))
                  ( 3.6865 )

                +  .59212  * MAVE(DEL(LOG(CLUPPRD),1),4)
                  ( 5.6781 )

                +  .0025275* DUBF991
                  ( 1.7499 )

  RESTRICTIONS: C01 + C02 + C03 = 1

     R-Squared                       :  .9994
     Adjusted R-Squared              :  .99936
     Durbin-Watson Statistic         :  2.0881
     Sum of squares of residuals     :  .0024259
     Standard Error of Regression    :  .0048769
     Log of the Likelihood Function  :  429.19
     F-statistic (  6 , 102 )        :  28109
     F-probability                   :  0
     Mean of Dependent Variable      : -.22037
     Number of Observations          :  109
     Number of Degrees of Freedom    :  102
     Current Sample                  : 1985 4 2012 4

 -----------  Restrictions Test  ------------

   F-VALUE        D.O.F.      F-PROB %
   .25238         1 , 101     61.65
```

DEPENDENT VARIABLE:
  PVNFESB : VALUE ADDED DEFLATOR, FACTORS COST, PRIVATE SECT. EXCL. FARM, ENERGY, TARIFS & RENTAL SERVICES, S.A.

INDEPENDENT VARIABLES:
  CLUPPRD : UNIT LABOR COSTS, BY VALUE ADDED, PRIVATE SECT. EXCL. FARM & ENERGY, S.A.
  PALTRI : FOREIGN PRODUCERS PRICE INDEX, 25 COUNTRIES, EXPORT WEIGHTS
  ITCAMB : NOMINAL EFFECTIVE EXCHANGE RATE, 25 COUNTRIES, EXPORT WEIGHTS
  PIMPMFD : IMPORT DEFLATOR, MANUFACTURING SECTOR, S.A.
  PIMPEND : IMPORT DEFLATOR, ENERGY SECTOR, S.A.
  PIMPAGD : IMPORT DEFLATOR, FARM SECTOR, S.A.

PIMPMPD : IMPORT DEFLATOR, COMMODITIES, S.A.
CPUNFED : USED PRODUCTIVE CAPACITY INDEX, PRIVATE SECT. EXCL. FARM & ENERGY, CHAIN-LINKED VOLUMES, S.A.
DUBF991 : DUMMY VARIABLE EQUAL TO 1 BEFORE 1999.Q1 AND ZERO OTHERWISE

<EQ10> NON DURABLE NON-ENERGY CONSUMPTION DEFLATOR

```
LOG(PCNDNN2)  =     .0018711
                   ( 1.9278 )

                +  .44517  * LAG(LOG(PCNDNN2),1)
                   ( 6.8342 )

                +  .46287  * LAG(LOG(PCNDNN2),2)
                   ( 7.3583 )

                +  .026825 * LOG(PIMPD)
                   ( 4.7221 )

                +  .065133 * LOG(PVNFES1)
                   ( 3.9678 )

                + C05      * DEL(LOG((1+AMPIVND+AMPADVA)*(1+ALIACR)),1)

                +  .72245  * MAVE(DEL(LOG(PVNFES1),1),2)
                   ( 6.0648 )

                +  .050125 * MAVE(DEL(LOG(PIMPD),1),2)
                   ( 2.0439 )

                -  .022248 * (DU902-DU931-DU911)
                   (-6.2441 )

  ALMON:  C05  2  3  FAR
  Distributed Lag Coefficient:  C05
  Lag    Coeff.       Std error    T-statistic
   0     -.78564       .045429     -17.294
   1     -.34128       .055331     -6.168
   2      0           RESTR.        RESTR.
  SUM    -1.1269       .077349     -14.569

  RESTRICTIONS: C01 + C02 + C03 + C04 = 1

     R-Squared                        :  .99982
     Adjusted R-Squared               :  .99981
     Durbin-Watson Statistic          :  1.8895
     Sum of squares of residuals      :  .0028759
     Standard Error of Regression     :  .004916
     Log of the Likelihood Function :  503.39
     F-statistic (  8 , 119 )         :  84834
     F-probability                    :  0
     Mean of Dependent Variable       : -.38184
     Number of Observations           :  128
     Number of Degrees of Freedom     :  119
     Current Sample                   : 1981 1 2012 4

-----------  Restrictions Test  ------------

   F-VALUE        D.O.F.      F-PROB %
   2.3525         1 , 118     12.776

DEPENDENT VARIABLE:
  PCNDNN2 : ECONOMIC CONSUMPTION DEFLATOR, NON DURABLE GOODS EXCL. ENERGY,
            TARIFS, RENTAL SERVICES & INDIRECT TAXES, S.A.
```

```
INDEPENDENT VARIABLES:
  PIMPD   : IMPORT DEFLATOR, GOODS & SERVICES, S.A.
  PVNFES1 : VALUE ADDED DEFLATOR, FACTORS COST, INCL. PRODUCTION TAXES,
            PRIVATE SECT. EXCL. FARM, ENERGY, TARIFS & RENTAL SERVICES, S.A.
  AMPIVND : IMPLICIT TAX RATE, VAT, NON DURABLE GOODS EXCL. ENERGY, TARIFS &
            RENTAL SERVICES
  AMPADVA : IMPLICIT TAX RATE, OTHER CONSUMPTION TAXES
  ALIACR  : IMPLICIT TAX RATE, EXCISES, EXCL. ENERGY
  DU902   : DUMMY VARIABLE EQUAL TO 1 IN 1990.Q2 AND ZERO OTHERWISE
  DU931   : DUMMY VARIABLE EQUAL TO 1 IN 1993.Q1 AND ZERO OTHERWISE
  DU911   : DUMMY VARIABLE EQUAL TO 1 IN 1991.Q1 AND ZERO OTHERWISE
```

<EQ11> BAD LOANS TO NON-FINANCIAL CORPORATIONS

```
LOG(PDEIMP/(1-PDEIMP)) =   1.0284
                          ( 3.4993 )

                         +  .80986 * LAG(LOG(PDEIMP/(1-PDEIMP)),1)
                          ( 18.883 )

                         + C02     * LAG(TIMPT-INFEY,1)

                         -  1.8539 * LAG(PILRD,1)/LAG(MAVE(PILRD,40),2)
                           (-4.8108 )

                         +  .00170 * TIMPT*CRIMPC/(VACIMP-RLDDPR-RDLAVAD
                                      +RLDCRAS)
                           ( 2.4003 )

                         -  .35455  * (DU983-DU984-DU023)
                           (-5.4023 )

  ALMON:  C02  1  2
  Distributed Lag Coefficient:  C02
  Lag    Coeff.       Std error    T-statistic
   0      .016671      .016939      .9842
   1      .0077509     .015317      .50603
  SUM     .024422      .0099261     2.4604

     R-Squared                      :  .94212
     Adjusted R-Squared             :  .93822
     Durbin-Watson Statistic        :  1.8143
     Sum of squares of residuals    :  1.1311
     Standard Error of Regression   :  .11273
     Log of the Likelihood Function :  76.957
     F-statistic (  6 , 89 )        :  241.46
     F-probability                  :  0
     Mean of Dependent Variable     : -3.7145
     Number of Observations         :  96
     Number of Degrees of Freedom   :  89
     Current Sample                 : 1991 1 2014 4

 -----------  Stability Analysis  -----------

****  Chow Test - Predictive Power  ****

 ---  Sample  ---    F-value    D.O.F.    F-prob %
 2015 1  2015 4     .853       4, 93     49.532

  DATE       ACTUAL    PREDICTED    ERROR        STD-ERR       T-STAT

   2015.1  -3.1422   -3.0795      -.062663     .11529       -.54351
   2015.2  -3.0117   -3.1684       .1567       .1152         1.3603
   2015.3  -3.1574   -3.0849      -.072474     .11563       -.62677
   2015.4  -3.1322   -3.2238       .091653     .11524        .79531
```

```
DEPENDENT VARIABLE:
  PDEIMP  : FLOW OF BAD LOANS OVER TOTAL STOCK OF OUSTANDING LOANS NET OF
            BAD DEBTS, NON-FINANCIAL CORPORATIONS

INDEPENDENT VARIABLES:
  TIMPT   : AVERAGE INTEREST RATE ON BANK LOANS, NON-FINANCIAL CORPORATIONS
  INFEY   : EXPECTED SHORT TERM YEARLY INFLATION
  PILRD   : GDP, CHAIN-LINKED VOLUMES, S.A.
  CRIMPC  : LOANS INCL. SECURITIZATIONS, OUTSTANDING AMOUNTS, NON-FINANCIAL
            CORPORATIONS, NOTIONAL STOCKS
  VACIMP  : NOMINAL VALUE ADDED, FACTORS COST, PRIVATE SECT. EXCL. CREDIT
            AND INSURANCE, S.A.
  RLDDPR  : NOMINAL INCOME FROM DEPENDENT EMPLOYMENT, PRIVATE SECT., S.A.
  RDLAVAD : NOMINAL INCOME FROM SELF-EMPLOYMENT, PRIVATE SECT., S.A.
  RLDCRAS : NOMINAL INCOME FROM DEPENDENT EMPLOYMENT, CREDIT AND INSURANCE
            SECT., S.A.
  DU983   : DUMMY VARIABLE EQUAL TO 1 IN 1998.Q3 AND ZERO OTHERWISE
  DU984   : DUMMY VARIABLE EQUAL TO 1 IN 1998.Q4 AND ZERO OTHERWISE
  DU023   : DUMMY VARIABLE EQUAL TO 1 IN 2002.Q3 AND ZERO OTHERWISE
```

Appendix B: Model responses to various shocks

Table B1. Model elasticities: monetary policy shock (100 b.p. for 2 years)

		1	2	3	4	5
GDP	(1)	-0.09	-0.37	-0.45	-0.17	0.09
Imports (goods and services)	(1)	-0.24	-0.84	-0.86	-0.11	0.30
Exports (goods and services)	(1)	-0.18	-0.20	0.07	0.38	0.55
Household consumption	(1)	-0.01	-0.10	-0.07	0.11	0.20
Gross fixed investment	(1)	-0.49	-2.43	-3.39	-2.01	-0.60
GDP deflator	(1)	-0.03	-0.26	-0.53	-0.64	-0.57
Import deflator (goods and services)	(1)	-0.39	-0.32	-0.27	-0.23	-0.03
Export deflator (goods and services)	(1)	-0.20	-0.35	-0.51	-0.53	-0.35
Private consumption deflator	(1)	-0.07	-0.23	-0.43	-0.51	-0.43
Private sector gross wage	(1)	-0.12	-0.61	-1.04	-1.09	-1.01
Private sector unit labour cost	(1)	0.00	-0.24	-0.70	-1.04	-1.11
Export competitiveness	(1)	-0.38	0.08	0.55	0.58	0.34
Current account BoP (% of GDP)	(2)	0.05	0.17	0.19	0.04	-0.03
Total employment (standard unit)	(1)	-0.03	-0.15	-0.27	-0.21	-0.01
Private sector employment (standard unit)	(1)	-0.03	-0.18	-0.32	-0.24	-0.01

(1) Percentage deviation from the baseline.
(2) Absolute deviation from the baseline.

Table B2. Model elasticities: foreign demand shock (1%)

		1	2	3	4	5
GDP	(1)	0.09	0.11	0.14	0.17	0.18
Imports (goods and services)	(1)	0.53	0.65	0.74	0.76	0.75
Exports (goods and services)	(1)	0.75	0.86	0.90	0.91	0.89
Household consumption	(1)	0.02	0.05	0.08	0.09	0.10
Gross fixed investment	(1)	0.07	0.18	0.27	0.34	0.40
GDP deflator	(1)	0.01	0.04	0.07	0.10	0.14
Import deflator (goods and services)	(1)	-0.03	-0.10	-0.11	-0.08	-0.05
Export deflator (goods and services)	(1)	0.00	-0.01	0.01	0.05	0.08
Private consumption deflator	(1)	0.00	0.02	0.04	0.07	0.10
Private sector gross wage	(1)	0.03	0.08	0.14	0.21	0.29
Private sector unit labour cost	(1)	-0.07	0.00	0.05	0.11	0.20
Export competitiveness	(1)	0.00	0.01	0.00	-0.04	-0.08
Current account BoP (% of GDP)	(2)	0.05	0.07	0.07	0.09	0.10
Total employment (standard unit)	(1)	0.03	0.07	0.09	0.11	0.12
Private sector employment (standard unit)	(1)	0.04	0.08	0.10	0.13	0.15

(1) Percentage deviation from the baseline.
(2) Absolute deviation from the baseline.

Table B3. Model elasticities: nominal effective exchange rate shock (appreciation 5%)

		1	2	3	4	5
GDP	(1)	-0.09	-0.24	-0.38	-0.50	-0.59
Imports (goods and services)	(1)	-0.26	-0.49	-0.62	-0.68	-0.72
Exports (goods and services)	(1)	-0.84	-1.64	-2.03	-2.07	-1.90
Household consumption	(1)	0.15	0.33	0.43	0.41	0.31
Gross fixed investment	(1)	-0.10	-0.57	-1.21	-1.89	-2.49
GDP deflator	(1)	0.01	-0.30	-0.71	-1.22	-1.67
Import deflator (goods and services)	(1)	-1.98	-2.25	-2.51	-2.71	-2.75
Export deflator (goods and services)	(1)	-0.90	-1.30	-1.66	-2.07	-2.36
Private consumption deflator	(1)	-0.26	-0.59	-0.99	-1.39	-1.76
Private sector gross wage	(1)	-0.09	-0.40	-0.85	-1.42	-2.04
Private sector unit labour cost	(1)	0.10	-0.03	-0.39	-0.92	-1.55
Export competitiveness	(1)	-1.95	-1.60	-1.23	-0.83	-0.51
Current account BoP (% of GDP)	(2)	0.07	-0.06	-0.18	-0.32	-0.38
Total employment (standard unit)	(1)	-0.05	-0.18	-0.33	-0.46	-0.54
Private sector employment (standard unit)	(1)	-0.06	-0.22	-0.39	-0.54	-0.64

(1) Percentage deviation from the baseline.
(2) Absolute deviation from the baseline.

Table B4. Model elasticities: oil price shock (10%)

		1	2	3	4	5
GDP	(1)	-0.09	-0.25	-0.34	-0.41	-0.43
Imports (goods and services)	(1)	-0.14	-0.36	-0.44	-0.46	-0.45
Exports (goods and services)	(1)	-0.15	-0.44	-0.67	-0.82	-0.86
Household consumption	(1)	-0.14	-0.35	-0.41	-0.41	-0.37
Gross fixed investment	(1)	-0.05	-0.12	-0.21	-0.35	-0.47
GDP deflator	(1)	0.06	0.17	0.24	0.22	0.18
Import deflator (goods and services)	(1)	1.07	1.35	1.25	1.13	0.95
Export deflator (goods and services)	(1)	0.53	0.76	0.79	0.69	0.59
Private consumption deflator	(1)	0.22	0.35	0.39	0.38	0.34
Private sector gross wage	(1)	0.02	0.06	0.05	-0.02	-0.15
Private sector unit labour cost	(1)	0.09	0.21	0.23	0.20	0.05
Export competitiveness	(1)	-0.44	-0.63	-0.64	-0.57	-0.44
Current account BoP (% of GDP)	(2)	-0.14	-0.17	-0.18	-0.23	-0.24
Total employment (standard unit)	(1)	-0.02	-0.08	-0.15	-0.21	-0.26
Private sector employment (standard unit)	(1)	-0.02	-0.09	-0.18	-0.25	-0.31

(1) Percentage deviation from the baseline.
(2) Absolute deviation from the baseline.

Table B5. Model elasticities: public investment shock (1% of GDP)

		1	2	3	4	5
GDP	(1)	0.92	1.07	1.17	1.17	1.07
Imports (goods and services)	(1)	1.65	1.71	1.56	1.51	1.46
Exports (goods and services)	(1)	0.01	-0.17	-0.57	-1.03	-1.50
Household consumption	(1)	0.23	0.34	0.37	0.40	0.44
Private gross fixed investment	(1)	0.82	2.00	3.04	3.59	3.69
GDP deflator	(1)	0.07	0.37	0.82	1.27	1.63
Import deflator (goods and services)	(1)	0.13	0.40	0.50	0.38	0.32
Export deflator (goods and services)	(1)	0.11	0.49	0.88	1.13	1.32
Private consumption deflator	(1)	0.05	0.32	0.68	1.00	1.27
Private sector gross wage	(1)	0.26	0.83	1.50	2.22	2.87
Private sector unit labour cost	(1)	-0.73	0.07	0.78	1.60	2.41
Export competitiveness	(1)	-0.13	-0.56	-0.98	-1.23	-1.39
Current account BoP (% of GDP)	(2)	-0.40	-0.53	-0.56	-0.56	-0.61
Total employment (standard unit)	(1)	0.31	0.66	0.81	0.87	0.85
Private sector employment (standard unit)	(1)	0.37	0.78	0.95	1.03	1.00

(1) Percentage deviation from the baseline.
(2) Absolute deviation from the baseline.

Table B6. Model elasticities: transfers to households shock (1% of GDP)

		1	2	3	4	5
GDP	(1)	0.11	0.28	0.45	0.59	0.68
Imports (goods and services)	(1)	0.14	0.37	0.53	0.63	0.68
Exports (goods and services)	(1)	0.00	-0.01	-0.05	-0.13	-0.26
Household consumption	(1)	0.21	0.55	0.83	1.05	1.21
Gross fixed investment	(1)	0.04	0.22	0.51	0.86	1.19
GDP deflator	(1)	0.00	0.03	0.09	0.19	0.32
Import deflator (goods and services)	(1)	0.01	0.05	0.11	0.15	0.17
Export deflator (goods and services)	(1)	0.01	0.04	0.12	0.21	0.31
Private consumption deflator	(1)	0.00	0.02	0.08	0.16	0.25
Private sector gross wage	(1)	0.01	0.06	0.17	0.33	0.51
Private sector unit labour cost	(1)	-0.05	-0.06	-0.01	0.12	0.30
Export competitiveness	(1)	-0.01	-0.05	-0.14	-0.24	-0.34
Current account BoP (% of GDP)	(2)	-0.04	-0.13	-0.20	-0.24	-0.27
Total employment (standard unit)	(1)	0.02	0.07	0.15	0.22	0.28
Private sector employment (standard unit)	(1)	0.02	0.09	0.17	0.26	0.34

(1) Percentage deviation from the baseline.
(2) Absolute deviation from the baseline.

Table B7. Model elasticities: indirect taxes shock (-1% of GDP)

		1	2	3	4	5
GDP	(1)	0.32	0.53	0.65	0.69	0.73
Imports (goods and services)	(1)	0.48	0.67	0.57	0.46	0.41
Exports (goods and services)	(1)	0.01	0.05	0.08	0.11	0.16
Household consumption	(1)	0.66	1.13	1.33	1.35	1.37
Gross fixed investment	(1)	0.11	0.02	-0.13	-0.19	-0.16
GDP deflator	(1)	-0.54	-0.79	-0.96	-1.06	-1.17
Import deflator (goods and services)	(1)	0.03	0.13	0.20	0.16	0.11
Export deflator (goods and services)	(1)	0.00	-0.04	-0.06	-0.09	-0.13
Private consumption deflator	(1)	-0.86	-1.15	-1.35	-1.51	-1.68
Private sector gross wage	(1)	-0.06	-0.28	-0.44	-0.54	-0.61
Private sector unit labour cost	(1)	-0.22	-0.46	-0.64	-0.73	-0.80
Export competitiveness	(1)	0.00	0.03	0.05	0.08	0.13
Current account BoP (% of GDP)	(2)	-0.15	-0.27	-0.27	-0.21	-0.18
Total employment (standard unit)	(1)	0.05	0.15	0.24	0.31	0.37
Private sector employment (standard unit)	(1)	0.06	0.18	0.29	0.37	0.44

(1) Percentage deviation from the baseline.
(2) Absolute deviation from the baseline.

Table B8. Model elasticities: firms' social contributions shock (-1% of GDP)

		1	2	3	4	5
GDP	(1)	0.43	1.23	1.60	1.66	1.69
Imports (goods and services)	(1)	0.35	0.73	0.41	0.02	-0.21
Exports (goods and services)	(1)	0.50	1.47	2.16	2.58	2.85
Household consumption	(1)	0.63	1.68	1.87	1.57	1.33
Gross fixed investment	(1)	0.07	0.17	0.07	0.04	0.22
GDP deflator	(1)	-1.01	-1.88	-2.09	-2.07	-2.00
Import deflator (goods and services)	(1)	0.01	0.11	0.21	0.15	0.01
Export deflator (goods and services)	(1)	-1.25	-1.76	-1.69	-1.62	-1.60
Private consumption deflator	(1)	-0.95	-1.73	-1.85	-1.85	-1.84
Private sector gross wage	(1)	-0.08	-0.42	-0.66	-0.68	-0.48
Private sector unit labour cost	(1)	-4.20	-4.99	-5.30	-5.26	-5.03
Export competitiveness	(1)	1.43	1.91	1.77	1.67	1.61
Current account BoP (% of GDP)	(2)	-0.27	-0.36	-0.13	0.16	0.37
Total employment (standard unit)	(1)	0.05	0.36	0.73	0.98	1.16
Private sector employment (standard unit)	(1)	0.06	0.43	0.86	1.16	1.38

(1) Percentage deviation from the baseline.
(2) Absolute deviation from the baseline.

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