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EURO AREA AND GLOBAL OIL SHOCKS: AN EMPIRICAL MODEL-BASED ANALYSIS

by Lorenzo Forni*, Andrea Gerali†, Alessandro Notarpietro† and Massimiliano Pisani†

Abstract

We assess the impact of oil shocks on euro-area macroeconomic variables by estimating a new-Keynesian small open economy model with Bayesian methods. Oil price is determined according to supply and demand conditions in the world oil market. We find that the impact of an increase in the price of oil depends upon the underlying sources of variation: when the driver of higher oil prices is an increase in the rest of the world's aggregate demand, both euro-area GDP and CPI inflation increase, whereas negative oil supply shocks and positive worldwide oil-specific demand shocks have stagflationary effects on the euro-area economy. Moreover, the increase in oil prices during the 2004-2008 period did not induce stagflationary effects on the euro-area economy because it was associated with positive aggregate demand shocks in the rest of the world. Similarly, a drop in world aggregate demand helps to explain the recent (2008) simultaneous drop in oil prices, euro-area GDP and inflation - particularly its fuel component.

JEL Classification: C11, C51, E32, F41.
Keywords: oil shocks, DSGE modelling, open-economy macroeconomics, Bayesian inference, euro area.

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1 Introduction[1]

The wide swing in the oil prices in the recent years has solicited new attempts to assess the macroeconomic effects of oil shocks. Even if oil represents a relatively small share of the overall consumption basket and production costs in industrialized countries, it crucially affects households and firms' decisions for several reasons. First, the oil price is rather volatile and hence its fluctuations have a relative large impact on domestic and international relative prices and inflation rates. Second, oil and non-oil goods are hardly substitutable. This feature is itself an amplifying factor of the relative price of oil, as wide changes in the latter are needed for a given change in the allocation of aggregate demand between oil and non-oil goods. Third, industrialized countries are net importers of oil, so they are affected by the wealth effect associated with the changes in the international relative price of oil.

Several theoretical and empirical contributions have analyzed the implications of oil shocks and their propagation mechanism to consumption and investment decisions by households and firms. In particular, recent contributions have emphasized the need of identifying the underlying (demand and supply) fundamental sources of changes in oil prices, as the implied macroeconomic effects can be rather different.[2] However, studies have mainly focused on the effects on the U.S. economy, while the analysis of the euro area has remained relatively underdeveloped.

In this paper we try to fill the gap by assessing the macroeconomic effects of oil shocks on the euro area economy. Our contribution consists in developing and estimating a small open economy DSGE model of the euro area that explicitly differentiates between oil and non-oil goods. Consistently with empirical evidence on the euro area, we assume that crude oil is imported from the rest of the world and sold to domestic households (for consumption purposes) and firms (as an intermediate good in the production function). Moreover, we assume there is an (exogenous) time-varying wedge between the price of crude oil (paid at the border) and the price of fuel (paid by consumers and firms). The wedge is a shortcut for the presence of (value added and excise) taxes, refining and distribution margins in the fuel price.[3]

For the price of crude oil, we assume that it is determined in the world oil market (the international law of one price holds). We formalize the oil market in a rather stylized way but,

[1] We thank R. Alquist, V. Di Nino, A. Locarno, P. Pagano, A. Pescatori, F. Venditti, two anonymous referees and participants at Bank of Canada Workshop "Understanding Economic Outcomes in Uncertain Times" and International Conference on Computing in Economics and Finance for useful suggestions. We thank F. Coluzzi for excellent research assistance. All errors are ours. Usual disclaimers hold.

[2] See Barsky and Kilian (2004), Kilian (2008a, 2009).

[3] For an analysis of the role of the refining and distribution margins, see Kilian (2008a, 2010).

at the same time, we try to disentangle and estimate the different sources of changes in oil prices that are relevant from a euro area perspective. Specifically, we assume that oil supply follows an exogenous process, while oil demand depends upon the degree of economic activities in the euro area and in the rest of the world and upon an exogenous residual variable. The latter captures shocks that do not directly affect aggregate demand in the euro area or abroad, such as oil-specific demand shocks due to speculative or precautionary reasons.[4]

Under this approach, aggregate demand shocks in the rest of the world would affect the euro area economy through two channels: a traditional direct trade channel and an "oil price" channel. Instead, shocks to the residual component of oil demand (called "oil-specific demand shocks" in the rest of the paper) would affect the euro area only through changes in the international relative price of oil.

Other features of the model are standard. Households in the small economy consume and invest in physical capital and in two riskless bonds, denominated in domestic and rest of the world's currency, respectively. Nominal wages and prices are sticky and subject to indexation; as a consequence, there is a nontrivial role for monetary policy, that is set according to a standard Taylor rule. For international trade variables, it is assumed that there is a (possibly different) home bias in consumption and investment and firms are specialized in the production of a tradable intermediate good and set prices in the currency of the destination market (local currency pricing assumption). A similar assumption holds for firms in the rest of the world producing non-oil goods. As said above, a riskless bond is internationally traded. So international financial markets are incomplete, implying the existence of a cross-country wealth effect associated with changes in international relative prices, in particular in the price of oil. An uncovered interest parity links the (domestic and rest of the world) interest rate differential to the expected bilateral nominal exchange rate. The assumption of small open economy simplifies the analysis and implies that rest of the world's inflation, aggregate demand and interest rate are taken as exogenous. It is supported by empirical evidence provided by Adolfson et al. (2007) for the euro area. Finally, as also stressed by Christoffel et al. (2008), it is motivated by the fact that Eurosystem staff projections are made conditional on assumptions regarding external developments. We deviate from the small open economy framework along one dimension by assuming that the euro area is

[4]This is consistent with Lutz Kilian's claim on the need to distinguish across the various (demand and supply) sources of oil and energy price changes for properly assessing the macroeconomic effects of the changes themselves. See Kilian (2008b).

able to affect the global demand of oil, jointly with the rest of the world.[5] Consistently with the focus of the paper, this allows us to disentangle the different sources of oil price movements.

We estimate the model on euro area and rest of the world data and obtain the following results. First, the impact of an increase in the price of oil depends upon the underlying source of variation. When the driver of higher oil prices is an increase in the aggregate demand in the rest of the world, both euro area GDP and CPI inflation increase. To the opposite, negative oil supply shocks and positive worldwide oil-specific demand shocks have stagflationary effects on the euro area economy.[6] In particular, an increase in the international price of oil equal to 10 percent of its steady state level generates an impact increase of about 0.2 annualized percentage points in the euro area CPI inflation rate. The effect on euro area GDP depends on the source of the shock: in response to a negative oil supply shock and a positive oil-specific demand shock, the decrease in output lies between -0.4 and -0.7 percent. A positive foreign aggregate demand shock generates instead an impact increase of 0.3 percent in the euro area GDP. Second, a positive aggregate demand shock in the rest of the world tends to generate a trade surplus in the euro area and an oil trade deficit. To the opposite, unanticipated increases in the oil-specific demand, and unanticipated oil supply disruptions, cause a trade deficit, as the oil trade deficit more than compensates for the non-oil trade surplus driven by the drop in euro area demand.[7] Third, the increase in the price of oil during the 2004-2008 period has not induced stagflationary effects on the euro area economy because it was associated with positive aggregate demand shocks in the rest of the world. A similar reason (the drop in world aggregate demand) contributes to explain the recent (2008) simultaneous drop in oil prices, euro area GDP and inflation (in particular its fuel component).

Our paper is related to other contributions that exploit DSGE models to assess the impact of oil on macroeconomic variables.

For the US, Bodenstein et al. (2011) use a large scale two-country open economy DSGE

[5]The weight of the euro area in world aggregate demand is relatively small and set to around 20% of world GDP.

[6]Lippi and Nobili (2009) estimate a structural VAR using US data and find that, consistently with our results, a negative oil supply shock reduces US output, whereas a positive oil demand shock has a positive effect on GDP. Hamilton (2009) evaluates the role of oil shocks in the 2007-2008 US recession.

[7]Kilian et al. (2009) provide estimates of the effects of demand and supply shocks in the global crude oil market on several measures of oil exporters' and oil importers' external balances. They show that the effect of oil demand and supply shocks on the merchandize trade balance and the current account depend on the source of the shock and critically on the response of the non-oil trade balance. They also find that valuation effects associated with capital gains or capital losses on asset holdings abroad also have an important role in shaping the effect of oil shocks on trade balance. Our contribution abstracts from valuations effects, but not from wealth effects associated with market incompleteness, as we assume that only a riskless bond is internationally traded.

model to assess the impact of different oil shocks on the US trade balance under alternative assumptions on the strength of the wealth effect associated with changes in the relative prices of oil. Nakov and Pescatori (2009) estimate a DSGE model using US data to assess the contribution of oil shocks to the Great Moderation. They find that oil related effects explain around a third of the decrease in the inflation volatility.[8] Blanchard and Riggi (2011), building on Blanchard and Galí (2009), find for the US that the vanishing correlation between oil prices and the business cycle is the result of important structural changes (such as the weakening of unions and the anchoring of medium-run inflation expectations) modifying the transmission mechanism of oil shocks of similar sources and magnitude.

For the euro area, Christoffel et al. (2008) estimate with Bayesian methods a small open economy of the euro area. They extend the model by introducing bridge equations for HICP excluding energy and HICP energy, the latter measuring the direct impact of changes in oil prices on the HICP, as well as a number of other macroeconomic variables. Differently from them, we make oil and fuel prices fully endogenous and determined in general equilibrium by the interaction of demand and supply curves in the various markets. Jacquinot et al. (2009) use a calibrated large scale open economy DSGE model to assess the impact of oil price shocks on euro area inflation. Consistently with their approach, we distinguish across the various sources of oil price changes but, differently from them, we estimate the model with Bayesian methods. Our results are in line with theirs, in particular for euro area macroeconomic variables (output and inflation). Sanchez (2008) analyze oil price shocks by appropriately modifying the model by Smets and Wouters (2003). Differently from that contribution, we consider the open economy dimension of the euro area and distinguish between oil demand and supply shocks. Finally, given the available sample period (1995-2007) we do not consider issues related to the impact of structural changes in the economy on the relationship between oil and macroeconomic variables.[9]

The rest of the paper is organized as follows. Next section reports the model setup. Section three describes the estimation procedure. Section four reports the results, consisting in the estimates, the impulse response analysis, the forecast error variance decomposition, the historical decomposition and the sensitivity analysis. Section five concludes.

[8]See also Nakov and Pescatori (2010) for a welfare analysis of alternative oil shocks.

[9]See Venditti (2010) and Hamilton (2011) for a discussion of nonlinearities in the responses of macroeconomic variables to oil price shocks.

2 The Model

We develop a standard small open economy model, similar to recent contributions by Adolfson et al. (2007) and Christoffel et al. (2008).[10] Differently from them, we include the world market for crude oil and a fuel sector in the small open economy. In what follows, we refer to the small economy as "Home", to the rest of the world as "Foreign".

Home households maximize an intertemporal utility function by choosing consumption and leisure. Consumption and investment are final nontradable goods. The consumption good, produced by domestic firms under perfect competition, is a basket of two bundles, fuel and non-fuel. The non-fuel bundle is composed by domestic and imported bundles of intermediate non-fuel goods. The investment basket includes domestic and imported non-fuel intermediate goods only. Home non-fuel intermediate goods are produced by firms under monopolistic competition according to a constant elasticity of substitution (CES) technology in labor, capital and fuel. They are sold domestically and abroad. Firms in the intermediate sector are price-setter. We assume that the local currency pricing assumption holds for non-oil goods, as firms set prices in the currency of the destination market (Home or Foreign). As such, pass-through of exchange rate into import and export prices is incomplete in the short-run.

The fuel bundle is a homogeneous good produced by Home firms using crude oil as the only input of a linear production function. Firms producing fuel act under perfect competition. They buy crude oil in the world market and then sell fuel domestically to households and to firms producing non-fuel intermediate goods.

The price of crude oil is set in the world market. World demand is composed by Home and Foreign demand. The latter depends on the relative price of oil and aggregate demand, which is assumed to be exogenous. The oil price is set in currency of rest of the world (we assume it is the US dollar) and is the same in both the euro area and the rest of the world, once corrected for nominal exchange rate fluctuations. So the law of one price holds for the crude oil price (there is no international price discrimination). The fuel price in the Home country is equal to the sum of the crude oil price, refining margins, distribution margins and (value added and excise) taxes. The margins and taxes are captured in a rather stylized but tractable way by a time-varying term (wedge) between the crude oil price paid at the border and the fuel price paid by households and firms in the Home country.

[10] Adolfson et al. (2007) build on the work of Christiano, Eichenbaum and Evans (2005) and extend their DSGE model using an open economy framework. See also Justiniano and Preston (2010).

Financial markets are incomplete, as there is a riskless bond denominated in domestic currency which is traded in the small economy and a riskless bond denominated in the Foreign currency that is traded internationally. As such, an uncovered interest parity holds for Home households, that links the differential between Home and Foreign interest rates to the expected nominal exchange rate depreciation. The model includes nominal and real frictions useful to fit the data. Specifically, habit in consumption, sticky prices and wages, price and wage indexation, adjustment costs on investment, imports, fuel consumption. Finally, the Home monetary policy is set according to a standard Taylor rule.

2.1 Firms

In this section we initially illustrate the Home fuel sector. Subsequently, we describe the sectors producing non-fuel final and intermediate goods.

The Fuel sector

We assume that firms in the Home fuel sector act under perfect competition. They import crude oil O_t and transform it into liquid fuel FU_t according to a simple linear technology ($FU_t = O_t$). Firms then make fuel available to domestic firms in the final consumption goods sector and to firms producing the Home (non-fuel) intermediate good.[11] The (US dollar) price of crude oil, $P_t^{O,*}$, is determined in the world market (see section below). We assume that the law of one price holds at the border.[12] The implied crude oil price in Home currency is:

$$P_t^O = S_t P_t^{O,*}$$

where S is the nominal exchange rate (number of Home currency units per unit of Foreign currency). We assume there is a time-varying wedge η_t between the border price of crude oil and the consumer price of fuel P_t^{FU}. As such, the fuel price can be written as:

$$P_t^{FU} = P_t^O + \eta_t^{FU}$$

The wedge η_t^{FU} is a proxy that implicitly captures the presence of taxes, refinement and distribution margins in the (consumer) price of fuel. The adopted framework is consistent with

[11] So firms sell fuel only domestically.

[12] As we use data about a given quality of oil (Brent), we do not consider that price levels can differ across qualities at least temporarily, as it has been the case for the WTI and other oil qualities since 2010.

the empirical evidence on oil price pass-through in fuel price for European countries, which is complete and quick. Moreover, it is consistent with the fact that in European countries taxes and margins constitute a large share, around 80 percent, of fuel prices.[13] We assume that the time-varying component of the wedge η_t^{FU} follows an exogenous (log-linear) autoregressive process:

$$\hat{\eta}_t^{FU} = \rho_{\eta^{FU}} \hat{\eta}_{t-1}^{FU} + \hat{\varepsilon}_{\eta^{FU},t}, \quad \hat{\varepsilon}_{\eta^{FU},t} \overset{iid}{\sim} N(0, \sigma^2_{\eta^{FU}}) \tag{1}$$

where a hat denotes log-deviation from the corresponding steady-state level: $\hat{X}_t = \ln X_t - \ln \bar{X}$. Our choice of assuming a simple exogenous process for the margins and taxes guarantees the tractability of the model.

Sectors producing the final goods

Firms in the final goods sector produce three different types of goods under perfect competition. One type is used for private consumption, the other for investment and the other one for public sector's consumption.

The private consumption bundle is produced according to a CES function of non-fuel basket C_{Vt} and fuel $FU_{C,t}$:

$$C_t = \left[(1 - a_{FU_C})^{\frac{1}{\rho}} C_{V,t}^{\frac{\rho-1}{\rho}} + a_{FU_C}^{\frac{1}{\rho}} \left(\left(1 - \Gamma_{FU_C} \left(FU_{C,t}/C_t; \epsilon_t^{FU_C} \right) \right) FU_{C,t} \right)^{\frac{\rho-1}{\rho}} \right]^{\frac{\rho}{\rho-1}} \tag{2}$$

where a_{FU_C} $(0 < a_{FU_C} < 1)$ is the share of fuel in the bundle and $\rho > 0$ measures the long-run elasticity of substitution between fuel, $FU_{C,t}$, and non-fuel consumption, $C_{V,t}$. As said, we assume that fuel $FU_{C,t}$ is a homogeneous good. The final good firm pays the cost $\Gamma_{FU^C} \left(FU_{C,t}/C_t; \epsilon_t^{FU_C} \right)$ when changing the amount of fuel in producing the consumption bundle:

$$\Gamma_{FU_C} \left(FU_{C,t}/C_t; \epsilon_t^{FU_C} \right) \equiv \frac{\gamma_{FU_C}}{2} \left(\left(\epsilon_t^{FU_C} \right)^{-\frac{1}{\gamma_{FU_C}}} \frac{FU_{C,t}/C_t}{FU_{C,t-1}/C_{t-1}} - 1 \right)^2 \tag{3}$$

where $\gamma_{FU_C} > 0$. As such, we distinguish between short and long run fuel consumption elasticity to changes in the relative prices, as existing evidence suggests that in the short run the fuel share is rather unresponsive to changes in the relative prices. The term $\epsilon_t^{FU_C}$ represents a fuel demand shock. We assume that it follows a (log-linear) AR(1) process:

[13] See European Central Bank (2010).

$$\hat{\epsilon}_t^{FU_C} = \rho_{\epsilon^{FU_C}} \hat{\epsilon}_{t-1}^{FU_C} + \hat{\varepsilon}_{\epsilon^{FU_C},t}, \quad \hat{\varepsilon}_{\epsilon^{FU_C},t} \overset{iid}{\sim} N(0, \sigma^2_{\epsilon^{FU_C}}) \tag{4}$$

The bundle $C_{V,t}$ consists of non-fuel domestically produced goods (C_H) and imported goods (C_F):

$$C_{V,t} = \left[a_{HC}^{\frac{1}{\eta}} C_{H,t}^{\frac{\eta-1}{\eta}} + (1 - a_{HC})^{\frac{1}{\eta}} \left(\left(1 - \Gamma_{C_F} \left(C_{F,t}/C_t; \epsilon_t^F\right)\right) C_{F,t} \right)^{\frac{\eta-1}{\eta}} \right]^{\frac{\eta}{\eta-1}} \tag{5}$$

where the parameter a_{HC} ($0 < a_{HC} < 1$) is the share of domestic goods in the bundle and $\eta > 0$ is the elasticity of substitution between domestic and imported goods. Consumption goods C_H and C_F are composite baskets of a continuum of, respectively, differentiated non-fuel domestic (h) and non-fuel imported (f) intermediate goods, each supplied by a different firm. The term $\Gamma_{C_F} \left(C_{F,t}/C_t; \epsilon_t^F\right)$ is a non-oil import adjustment cost similar to (3).[14] The term ϵ_t^F represents a non-oil import demand shock. We assume that it follows a (log-linear) AR(1) process:

$$\hat{\epsilon}_t^F = \rho_{\epsilon^F} \hat{\epsilon}_{t-1}^F + \hat{\varepsilon}_{\epsilon^F,t}, \quad \hat{\varepsilon}_{\epsilon^F,t} \overset{iid}{\sim} N(0, \sigma^2_{\epsilon^F}) \tag{6}$$

Consumption baskets C_H and C_F are produced according to the following functions, respectively:

$$C_{H,t} = \left[\int_0^n C_{H,t}(h)^{\frac{\theta_{H,t}-1}{\theta_{H,t}}} dh \right]^{\frac{\theta_{H,t}}{\theta_{H,t}-1}}, \; C_{F,t} = \left[\int_n^1 C_{F,t}(f)^{\frac{\theta_{F,t}-1}{\theta_{F,t}}} df \right]^{\frac{\theta_{F,t}}{\theta_{F,t}-1}} \tag{7}$$

where $1 < \theta_{H,t}, \theta_{F,t} < \infty$ are the time-varying elasticity of substitution among non-oil domestic and non-oil imported brands, respectively. The parameter n is the size of the Home economy (the size of the rest of the world is $1 - n$).[15] Each of the elasticities $\theta_{H,t}$, $\theta_{F,t}$ evolves according to the following log-linear stationary autoregressive stochastic process:

$$\hat{\theta}_{i,t} = \rho_{\theta_i} \hat{\theta}_{i,t-1} + \hat{\varepsilon}_{\theta_{i,t}}, \quad \hat{\varepsilon}_{\theta_{i,t}} \overset{iid}{\sim} N(0, \sigma^2_{\theta_i}), i = H, F \tag{8}$$

The production of investment goods I is isomorphic to that of non-fuel consumption (5).[16]

[14] The same applies to all the adjustment cost functions introduced henceforth.

[15] We assume that the size of the country is equal to the number of domestic firms in each sector and domestic households.

[16] Specifically:

$$I_t = \left[a_{HI}^{\frac{1}{\eta}} I_{H,t}^{\frac{\eta-1}{\eta}} + (1 - a_{HI})^{\frac{1}{\eta}} \left(\left(1 - \Gamma_{I_F} \left(I_{F,t}/I_t; \epsilon_t^F\right)\right) I_{F,t} \right)^{\frac{\eta-1}{\eta}} \right]^{\frac{\eta}{\eta-1}}$$

and:

$$I_{H,t} = \left[\int_0^n I_{H,t}(h)^{\frac{\theta_{H,t}-1}{\theta_{H,t}}} dh \right]^{\frac{\theta_{H,t}}{\theta_{H,t}-1}}, \; I_{F,t} = \left[\int_n^1 I_{F,t}(f)^{\frac{\theta_{F,t}-1}{\theta_{F,t}}} df \right]^{\frac{\theta_{F,t}}{\theta_{F,t}-1}}$$

We allow for (possibly) different import intensities (so for investment we have shares a_{HI} and $1-a_{HI}$, with $0 < a_{HI} < 1$), adjustment cost on non-oil imports, $\Gamma_{I_F}\left(I_{F,t}/I_t\right)$, while the elasticity of substitution between domestic and imported bundles (η) and across varieties in each bundle ($\theta_{H,t}$, $\theta_{F,t}$) are the same as those in the corresponding consumption bundles.

For the public expenditure, we assume it is fully biased towards domestic non-fuel varieties. The implied basket is:

$$G_t = \left[\int_0^n G_{H,t}\left(h\right)^{\frac{\theta_{H,t}-1}{\theta_{H,t}}} dh\right]^{\frac{\theta_{H,t}}{\theta_{H,t}-1}} \tag{9}$$

Sectors producing non-fuel intermediate goods

The production function for the generic intermediate good h is:

$$Y_{H,t}\left(h\right) = \left[\begin{array}{c} \left(1-a_{FU_Y}\right)^{\frac{1}{\xi_Y}} V_t\left(h\right)^{\frac{\xi_Y-1}{\xi_Y}} \\ +a_{FU_Y}^{\frac{1}{\xi_Y}}\left(\left(1-\Gamma_{FU_Y}\left(\frac{FU_{Y,t}(h)}{Y_{H,t}(h)};\epsilon_t^{FU_{Y,t}}\right)\right)FU_{Y,t}\left(h\right)\right)^{\frac{\xi_Y-1}{\xi_Y}} \end{array}\right]^{\frac{\xi_Y}{\xi_Y-1}} \tag{10}$$

where the variable $FU_{Y,t}\left(h\right)$ represents fuel, bought from the domestic fuel sector, the variable $V_t\left(h\right)$ is the value added input and a_{FU_Y} $(0 < a_{FU_Y} < 1)$ is the weight of fuel in the production. The parameter $\xi_Y > 0$ measures the long run elasticity of substitution between value added and fuel. The term $\Gamma_{FU_Y}\left(FU_{Y,t}\left(h\right)/Y_{H,t}\left(h\right);\epsilon_t^{FU_{Y,t}}\right)$ represents a fuel demand adjustment cost similar to equation (3) The term $\epsilon_t^{FU_{Y,t}}$ is a shock to the fuel demand. We assume that it follows a process similar to equation (6). The value added input is defined as:

$$V_t\left(h\right) = \epsilon_{H,t}\left[\left(1-a_L\right)^{\frac{1}{\xi_V}} K_{t-1}\left(h\right)^{\frac{\xi_V-1}{\xi_V}} + a_L^{\frac{1}{\xi_V}}\left(z_t L_t\left(h\right)\right)^{\frac{\xi_V-1}{\xi_V}}\right]^{\frac{\xi_V}{\xi_V-1}} \tag{11}$$

where the variable $K_{t-1}\left(h\right)$ is the physical capital, rented from domestic households in a competitive market, and $L_t\left(h\right)$ is labor, supplied by domestic households under monopolistic competition (see below and next section). The parameter $\xi_V > 0$ measures the elasticity of substitution between capital and labor. The parameter a_L $(0 < a_L < 1)$ is the weight of labor in the production of the value added. The variable z_t is a unit-root labor-augmenting technology shock capturing world productivity. It is common to all firms in the Home and rest of the world. The variable $\epsilon_{H,t}$ is a domestic stationary technology shock, common to all Home firms. The growth rate of the unit-root technology follows a log-linear stationary autoregressive process:

$$\hat{\mu}_{z,t} = \rho_z\hat{\mu}_{z,t-1} + \hat{\varepsilon}_{\mu_Z,t}, \quad \hat{\varepsilon}_{\mu_Z,t} \overset{iid}{\sim} N(0,\sigma_{\mu_Z}^2) \tag{12}$$

where:

$$\hat{\mu}_{z,t} \equiv \frac{z_t}{z_{t-1}} - 1 \tag{13}$$

Similarly, the stationary technology process is:

$$\hat{\epsilon}_{H,t} = \rho_\epsilon \hat{\epsilon}_{H,t-1} + \hat{\varepsilon}_{\epsilon,t}, \quad \hat{\varepsilon}_{\epsilon,t} \overset{iid}{\sim} N(0, \sigma_\epsilon^2) \tag{14}$$

The variable $L(h)$ is a composite of a continuum of differentiated labor inputs, each supplied by a different domestic household j under monopolistic competition:

$$L_t(h) = \left[\int_0^n L_t(j)^{\frac{\theta_{L,t}-1}{\theta_{L,t}}} dj \right]^{\frac{\theta_{L,t}}{\theta_{L,t}-1}} \tag{15}$$

where $1 < \theta_{L,t} < \infty$ is the time-varying elasticity of substitution between labor varieties, which is distributed according to the following log-linear autoregressive process:

$$\hat{\theta}_{L,t} = \rho_{\theta_L} \hat{\theta}_{L,t-1} + \hat{\varepsilon}_{\theta_{L,t}}, \quad \hat{\varepsilon}_{\theta_{L,t}} \overset{iid}{\sim} N(0, \sigma_{\theta_L}^2)$$

Each firm h in the intermediate sector minimizes its production costs by optimally choosing the amount of inputs given the above technology constraints and the corresponding prices (the gross nominal rental rate of capital R_t^K,the nominal wage rate W_t and the price P_t^{FU} of fuel).

We introduce nominal price rigidities by assuming that each non-fuel intermediate good is sold domestically and abroad subject to market-specific cost of adjusting prices à la Rotemberg (1982). Appendix A provides further details on the price-setting problem.

2.2 Rest of the world economy

The setup of the Foreign economy is stylized to keep the model parsimonious. For the oil market, we assume that oil supply $Y_{O,t}^S$ is exogenous. It follows a log-linear AR(1) process:

$$\hat{y}_{O,t}^S = \rho_{y_O^S} \hat{y}_{O,t-1}^S + \hat{\varepsilon}_{O,t}^S, \quad \hat{\varepsilon}_{O,t}^S \overset{iid}{\sim} N(0, \sigma_{y_O^S}^2) \tag{16}$$

The rest of the world demand for oil $Y_{O,t}^{D,*}$ is a function of the relative price of crude oil, aggregate demand and a "residual" shock:[17]

$$Y_{O,t}^{D,*} = \gamma_{OIL,t}^{*} a_{OIL}^{*} \left(\frac{P_{OIL}^{*}}{P_t^{*}} \right)^{-\rho} AD_t^{*} \tag{17}$$

where the parameter a_{OIL}^{*} $(0 \leq a_{OIL}^{*} \leq 1)$ is the share of oil in euro area trade partners' aggregate demand bundle, $\rho > 0$ is the elasticity of substitution between oil and other goods (we assume it is the same as in the Home economy), P_t^{*} is the price deflator and AD_t^{*} is the aggregate demand. The shock $\gamma_{OIL,t}^{*}$ captures oil demand shocks that are not related to aggregate demand in main euro area trade partners. We define these shocks as "oil-specific" , i.e. specific to the crude oil market (as such, they are not related to changes in aggregate demand neither in the euro area nor in its main trade partners), consistently with Kilian (2009). Oil-market-specific demand shocks can be thought as shocks to the precautionary demand for crude oil, to speculative demand or to aggregate demand shocks in countries that are not main trade partners of the euro area. We assume that $\gamma_{OIL,t}^{*}$ and the aggregate demand AD_t^{*} are exogenous. They follow standard AR(1) log-linear processes, respectively:

$$\widehat{AD_t^{*}} = \rho_{AD^{*}} \widehat{AD_{t-1}^{*}} + \hat{\varepsilon}_{ad^{*},t}, \quad \hat{\varepsilon}_{ad^{*},t} \overset{iid}{\sim} N(0, \sigma_{ad^{*}}^{2}) \tag{18}$$

$$\hat{\gamma}_{OIL,t}^{*} = \rho_{\gamma_{OIL}^{*}} \hat{\gamma}_{OIL,t}^{*} + \hat{\varepsilon}_{\gamma_{OIL}^{*},t}, \quad \hat{\varepsilon}_{\gamma_{OIL}^{*},t} \overset{iid}{\sim} N(0, \sigma_{\gamma_{OIL}^{*}}^{2}) \tag{19}$$

World oil demand ($Y_{O,t}^{D,W}$) is the sum of Home ($Y_{O,t}^{D,H}$) and rest of the world demand ($Y_{O,t}^{D,*}$):

$$Y_{O,t}^{D,W} = Y_{O,t}^{D,H} + Y_{O,t}^{D,*} \tag{20}$$

where $Y_{O,t}^{D,H}$ is:

$$Y_{O,t}^{D,H} = nFU_{C,t} + nFU_{Y,t} \tag{21}$$

Euro area exports depend on their relative price (P_H^{*}/P_t^{*}) and rest of the world aggregate demand AD_t^{*}:

$$Y_{H,t}^{*} = a_H^{*} \left(\frac{P_H^{*}}{P_t^{*}} \right)^{-\eta} AD_t^{*} \tag{22}$$

where a_H^{*} $(0 \leq a_H^{*} \leq 1)$ is the share of Home exports in the Foreign aggregate demand bundle and $\eta > 0$ is the elasticity of substitution between Home exports and other goods.

[17] In the rest of the world we do not formalize the distribution sector for fuel. Hence, there is no distinction between the price of oil and the price of fuel.

For the supply of non-oil goods produced in the Foreign country and imported by the Home economy, we assume that the local currency pricing assumption holds. We provide further details in the Appendix.

2.3 The trade balance of the Home economy

The Home trade balance is obtained by consolidating the private sector (households and firms) aggregate budget constraint and the government budget constraint. Assuming that a symmetric equilibrium holds (so that there is a representative household and a representative firm in each production sector), the resulting trade balance is:

$$\begin{aligned} TB_t &= nS_t B_{F,t} - nS_t B_{F,t-1} R^*_{t-1} \Phi \left(a_{t-1}, \tilde{\phi}_{t-1} \right) \\ &= nP_{H,t} Y_{H,t} + nS_t P^*_{H,t} Y^*_{H,t} - nP_t C_t - nP_{I,t} I_t - P_H G_t \\ &\quad - nP^O_t FU_{Y,t} \\ &= nS_t P^*_{H,t} Y^*_{H,t} - (1-n) P_{F,t} Y_{F,t} - P^O_t Y^{D,H}_{O,t} \end{aligned}$$

The first equality expresses the trade balance as the sum of the change in and the interest payment on the net foreign asset position (R^* is the gross nominal interest rate). The second equality is the difference between total aggregate revenues from production and total aggregate expenditures. The term $nP^O_t FU_{Y,t}$ represents expenditure for fuel as input in the production of Home non-fuel goods. It is evaluated at the border price of crude oil, expressed in Home currency. Finally, the third equality is net exports, expressed in domestic currency. The term $P^O_t Y^{D,H}_{O,t}$ is the value of the total amount of oil imports, used as intermediate good in the production of the final consumption good and as input in the production function of Home non-fuel tradable goods.

The overall trade balance can be split in non-oil and oil trade balance. The first is equal to the difference between Home export and non-oil imports:

$$TB^{NO}_t = nS_t P^*_{H,t} Y^*_{H,t} - (1-n) P_{F,t} Y_{F,t} \tag{23}$$

The oil trade balance simply corresponds to the value of oil imports, as the Home country does not export oil products:

$$TB^O_t = -P^O_t Y^{D,H}_{O,t} \tag{24}$$

Finally, we define the Home non-oil terms of trade as the ratio of non-oil import-to-export prices, both expressed in Home currency:

$$TOT_t \equiv \frac{P_{F,t}}{S_t P^*_{H,t}} \tag{25}$$

where $P_{F,t}$ and $P^*_{H,t}$ are respectively the prices of Home non-oil imports and Home exports expressed in the currency of the correspondent destination market.[18]

3 Estimation

In what follows we describe the data, the calibrated parameters and the prior distributions of estimated parameters. We solve the model by log-linearizing the equations around the model's steady state. We estimate the model with Bayesian methods using euro area quarterly data. The Bayesian approach implies that the posterior distributions of the estimated parameters are obtained by updating the information in the prior distributions with the information in the data.[19]

3.1 Data

We use quarterly euro area data for the period 1995:1–2007:4 to estimate the model. We are forced to start from 1995 as data for fuel are not available before that date. We do not include the years 2008 and 2009 to avoid breaks in the structural relationships related to the global financial crisis. We match twenty variables. For the euro area (the Home country): employment, government consumption, real exchange rate, GDP, consumption, investment, the HICP deflator, the GDP deflator, the investment deflator, wage, exports, imports, the deflator of fuel-liquid fuel-lubricants (fuel from now on), the deflator of the ex-fuel component of HICP, the short term interest rate. For the rest of the world (Foreign) economy: the aggregate demand, the consumption deflator, the short term interest rate. For the international oil market: the crude oil price and oil supply.

All data are from the Area Wide Model (AWM) data set, except for the Foreign interest rate, the fuel price, the HICP deflator net of fuel, oil supply and hours worked.[20] For the Foreign interest rate, we use the effective Fed funds rate as a proxy. Data of fuel and HICP net of fuel

[18] An increase (decrease) in the value of TOT represents a deterioration (improvement) of Home terms of trade.

[19] For a comprehensive discussion on the Bayesian estimation of DSGE models, see Lubik and Schorfheide (2005). For a discussion of the implementation of Bayesian methods, see Geweke (1999) and Gelman et al. (2004).

[20] For details on the AWM dataset see Fagan et al. (2005).

are from Eurostat. Data of global oil supply are from OECD-International Energy Agency. For hours worked we use employment from AWM data set. We model the link between hours and employment using a Calvo-rigidity equation:[21]

$$\hat{E}_t = \frac{\beta}{1+\beta} E_t \left[\hat{E}_{t+1} \right] + \frac{1}{1+\beta} \hat{E}_{t-1} + \frac{(1-\beta\xi_E)(1-\xi_E)}{(1+\beta)\xi_E} \left(\hat{L}_t - \hat{E}_t \right) \tag{26}$$

where $1 - \xi_E$ is the fraction of firms that can adjust the (log-linear) level of employment $\hat{E}$ to the preferred amount of total labor input $\hat{L}$.

In the AWM data set export and import series include both intra- and extra-area trade and there is no series on aggregate hours worked. The exchange rate is the ECB's official effective exchange rate for the 12 main trading partners of the Euro area.[22]

The assumption of non stationary technology shock implies a common stochastic trend in the real variables. We make them stationary by using first log-differences. Similarly, we take first difference of GDP deflator, consumer prices, ex-fuel consumer prices, nominal wage, foreign prices.

We remove a linear trend from the employment, the public consumption expenditure, the oil supply, the rest of the world demand. We also remove an excessive trend of import and export (with respect to output) series, to make the correspondent shares stationary.[23]

Employment, public expenditure, the real exchange rate, the real price of oil and the real price of fuel are measured as percentage deviations around the mean. The real price of oil is the US dollar price of oil deflated by the Foreign price index. The real price of fuel is the euro price deflated by the euro consumer price index.

3.2 Calibrated parameters

We calibrate parameters to match the sample mean of observed variables and those that are weakly identified. Values are in line with Adolfson et al. (2007), Christoffel et al. (2008), Jacquinot et al. (2009) and ECB (2010).

In Table 1 we report the calibrated parameters. In Table 2 the implied steady state values of main variables.

We calibrate the weight of labor, a_L, in the production function of the value added to 0.48 (so

[21] See Smets and Wouters (2003).
[22] See Adolfson et al. (2007).
[23] The data treatment is similar to Adolfson et al. (2007) and Christoffel et al. (2008).

the weight of capital is 0.52). We set the weight of fuel in the production function of intermediate goods, a_{FU_Y}, to 0.03 (consistently with a share of fuel in the production cost equal to 4 percent), the long-run elasticity of substitution between fuel and non-fuel inputs to 0.5, the elasticity of substitution between capital and labor to 0.75. As such, oil and other inputs are hardly substitutable.

For the consumption basket, we set the weight of fuel to 0.03, so that the share of fuel in the consumption basket is equal to 4.0 percent. Moreover, we set the steady state value of η^{FU}/P^{FU} (the share of the fuel price absorbed by distribution margin, refinement margin and oil taxes) equal to 0.8. This value is consistent with existing evidence on the shares of refining margin, distribution margin and (value added and excise) taxes in the euro area consumer price of fuel. The long-run elasticity of substitution between non-fuel and fuel is equal to 0.2. As in the case of the production of intermediate goods, oil and other goods are hardly substitutable. We calibrate the weight of imported non oil good to 0.2. The long-run elasticity of substitution between domestic and imported non oil goods is 1.1.

For the investment basket, we calibrate the weight of imported good to 0.3. The long-run elasticity of substitution between domestic and imported goods is the same as that of the consumption basket (1.1).

We set the (steady-state) elasticity of substitution across brands ($\theta_H, \theta_F, \theta_H^\star, \theta_F^\star$) to 6, the elasticity of substitution across labor varieties, θ_L, to 4.33. They imply steady state markup values equal to 1.2 and 1.3, respectively.

For households' preferences, we calibrate the discount factor β to 0.9996, consistently with an annualized equilibrium nominal interest rate of 4.0 percent (the sample mean). The inverse of the labor supply elasticity, σ^L, is set to 2. The depreciation rate δ of physical capital to 0.025.

The calibration allows us to match all the ratios reported in Table 2. Home consumption, investment and government consumption as a ratio to Home GDP are respectively equal to 58, 20 and 22 percent. The non-oil import content of consumption and investment spending is respectively 10 and 6 percent as a ratio to GDP. The oil imports amount to 0.01 percent of Home GDP. We set the steady state net foreign asset position to zero, implying that both trade balance and current account are equal to zero. We assume that the steady state growth rate of the world economy is 2.00 percent per annum. For the monetary authority, we assume its long-run annualized gross inflation objective $\bar{\pi}$ is 1.9 percent.

3.3 Prior distributions of the estimated parameters

We report in Table 3 the prior distribution of the estimated parameters (first fourth columns from the left hand side). The location of the prior distribution corresponds to a large extent to that in Adolfson et al. (2007). Parameters bounded between 0 and 1 are distributed according to a beta (B in the table) distribution (habit persistence b, indexation parameters α and coefficients of shock autocorrelation ρ). Positive parameters have an inverse gamma (G) distribution (wage and price stickiness parameters κ, adjustment costs γ, standard deviations of the shocks σ). Finally, unbounded parameters are distributed according to the normal (N) distribution (the interest rate response to output growth in the Taylor rule $\rho_{\Delta y}$).

For the monetary policy rule, the prior mean on the the lagged interest rate coefficient is set to 0.8, those on inflation and inflation growth coefficients respectively to 1.7 and 0.3. Finally, the coefficient responding to output (deviation from steady state) is calibrated to zero, while the prior mean of the coefficient responding to output growth is set to 0.0625. For nominal rigidities, we set the prior mean of wages and prices of Home as well Foreign intermediate goods to 250 (if converted in Calvo (1983) terms, it implies an average contract duration equal to about 4 quarters). The standard deviation is set to 60, implying that the prior distributions are rather loose. For imports and exports, we set the prior mean to 10 (in Calvo terms, it corresponds to a contract duration of 2 quarters), so that the exchange rate pass-through into import and export prices is rather quick. We set the standard deviation to 2.5. The implicit assumption of relatively flexible import and export prices is consistent with estimates by Adolfson et al. (2007), that suggest 2–3 quarters stickiness in these sectors. Finally, we set the mean values of the indexation parameters to 0.5 (standard deviation equal to 0.1) and that of the adjustment costs on oil imports, non-oil imports and exports to 2.0. All the autocorrelated shocks have an autoregressive coefficient set to 0.75. Innovations to all shocks are assumed to be white noise with standard deviation mean set to 0.1 percent.

4 Results

In what follows we report the estimated values of the parameters, and some results from analysis performed on the basis of those estimates. In particular, we show the responses of the main euro area variables to shocks that directly hit the oil market and report the contribution of these shocks to the variance and historical path of euro area variables.

4.1 Posterior distributions of the estimated parameters

We estimate the posterior distributions of the parameters using the Metropolis–Hastings algorithm with 1200000 iterations. The joint posterior distribution of all estimated parameters is obtained in two steps. First, the posterior mode and an approximate covariance matrix, based on the inverse Hessian matrix evaluated at the mode, is obtained by numerical optimization on the log posterior density. Second, the posterior distribution is explored by generating draws using the Metropolis–Hastings algorithm. The proposal distribution is taken to be the multivariate normal density centered at the previous draw with a covariance matrix proportional to the inverse Hessian at the posterior mode.[24] The results are reported in Table 3, where we show the posterior mode of all the parameters, along with the approximate posterior standard deviation, as well as the mean and median of the posterior distribution, along with the 5th and 95th percentiles.

The degree of habit formation in consumption and the investment adjustment cost parameter are in line with the corresponding values reported in Adolfson et al. (2007). The posterior mean of habit parameter is 0.65, that of investment adjustment cost is 5.37. For nominal price rigidities, we find that the degree of domestic price stickiness is equal to be 0.85 in Calvo (1983) terms, slightly lower than the findings by Smets and Wouters (2003, 2005), Christoffel et al. (2008) and Adolfson et al. (2007). The implied average contract duration is 6 quarters. We estimate a higher value (corresponding to 7 quarters of average price duration) for the degree of price stickiness in the rest of the world. High price stickiness allows, to some extent, to simultaneously fit the volatile real exchange rate and the relatively stable price indices, a result that is well known in the international business cycle literature. Nominal wages are sticky as well. The implied duration in Calvo terms is equal to 7 quarters. The estimated value is higher than those reported by Adolfson et al. (2007) and Christoffel et al. (2008). The likely reason is that high sticky wages contribute to stabilize marginal costs and prices in correspondence of volatile oil prices. For indexation parameters, we find that they are rather low. This is a finding common to the other contributions (e.g. Adolfson et al. 2007). The posterior mode of the persistence parameters are generally lower than those reported Smets and Wouters (2003, 2005) and in line with Adolfson et al. (2007), that explain the result in terms of the inclusion of the unit-root technology shock and of the open economy aspects of the model.[25]

[24] See Schorfheide (2000) and Smets and Wouters (2003) for further details.

[25] Adolfson et al. (2007) finds lower numbers than those reported by Smets and Wouters (2003, 2005) for the autocorrelation of shocks. They attribute the result to the inclusion of the unit-root technology shock and to the open economy aspects of the models, two features that characterize our framework as well.

Figure 1 shows the data and the benchmark model's Kalman filtered one-sided estimates of the observed variables, computed at the posterior mode of the estimated parameters. The in-sample fit of the model is satisfactory, as we fit all the observables rather well.

4.2 Impulse response functions

In this section we perform the impulse response analysis to assess how the main Home macroeconomic variables react to shocks affecting the oil market, i.e. the global oil supply shock, the rest of the world aggregate demand shock, and demand shocks that are specific to the crude oil market.

Oil supply shock

We assess the impact of an exogenous reduction in the global oil production that induces on impact an increase in the international real (expressed in foreign consumption terms) price of oil equal to 10 percent of its steady state level.

We report in Figure 2 the results.[26] The CPI inflation increases on impact, up to almost 0.2 annualized percentage points, and then quickly falls. The initial increase is mainly driven by its fuel component, as the pass-through of the price of oil into the price of fuel is quick and complete. The non-fuel component increases as well, albeit to a much lower extent. The increase in the production costs is transmitted only gradually to final goods prices due to the high estimated nominal price rigidities of Home goods (whose share in the consumption bundle is relatively high). Given the increase in the consumer price inflation, the monetary authority rises the policy rate, albeit slightly. The relatively small size of the interest rate increase reflects the short-lived variation in consumer price inflation and is in line with results reported in ECB (2010) and Jacquinot et al. (2009). Households' consumption suffers a negative wealth effect associated with higher oil price (more below). Investment decreases as well, in the usual hump-shaped and persistent manner. Overall, there is a rather small reduction in the euro area output, to -0.04 percent.

Looking at the trade balance, the overall impact deterioration amounts to about 0.1 percentage points of GDP. The real exchange rate depreciation, necessary to guarantee the equilibrium in the goods and bonds' markets, generates a negative wealth effect whose size depends, among

[26] All figures in this section report the mean (solid line) and the 95 percent equal-tail uncertainty bands. The results are based on 5,000 draws from the posterior distribution of the model's parameters.

other things, on the price elasticity of oil demand (see Bodenstein et al. 2011). As a result, household consumption and hence aggregate demand fall. The related decrease in non-oil import partially offsets the increase in the value of oil imports. The non-oil component of the trade balance benefits from the depreciation of the Home real exchange rate, which makes Home exports cheaper than foreign non-oil goods. After 10 quarters, the trade deficit shifts into a small surplus, as the price of oil decreases and the amount of exports increases. Results are qualitatively in line with those reported by Kilian et al. (2009).

Rest of the world oil-specific demand shock

We now show the effects of an oil price rise generated by a demand shock that is specific to the oil market (as, such it does not affect the aggregate demand in the main trade partners of the euro area). We calibrate the shock to generate an increase in the international relative price of oil equal to 10 percent on impact. We report the results in Figure 3. Qualitatively, the effects are similar to those of a negative oil supply shock. The shock induces higher CPI inflation through the increase in the price of fuel. The negative wealth effect induces households to reduce consumption and investment. As such aggregate demand and GDP decrease as well. The monetary authority raises the nominal interest rate, given the relatively high weight of the CPI inflation in the monetary policy rule. Quantitatively, the effects of the shocks on real variables are slightly more persistent than those induced by a negative supply shock of the same size. The reason is that the oil-specific demand shock is estimated to be more persistent. As such, the related negative wealth effect is stronger. The Home GDP decreases by almost 0.1 percent, and stays below the baseline for a longer time than in the case of an oil supply shock. The same is true for consumption and investment. For the trade balance, the initial deterioration (-0.06 percent of GDP) is roughly equivalent to the one experienced under the oil supply shock, but in this case the balance shifts to surplus later (15 vs 10 quarters). The reductions in non-oil imports and in the volume of oil imports partially compensate for the increase in the value of oil imports.

Foreign aggregate demand shock

We report in Figure 4 the effects of a positive shock to the foreign aggregate demand (RW demand shock, in the following) that increases the international oil price by 10 percent on impact. The Home CPI inflation increases up to the peak of 0.15 annualized percentage points on impact.

The increase is mainly driven by its fuel component. The change in the non-fuel component is much less pronounced, as nominal rigidities are relatively high and firms end up absorbing almost entirely the increase in production costs driven by higher fuel prices. Results are in line with those reported by ECB (2010) and Jacquinot et al. (2009). Differently from the oil supply and oil-specific demand shocks, the positive RW demand shock has a positive effect on euro area exports and GDP. The latter increases up to 0.3 percent on impact. Home consumption gradually increases, albeit to a lower extent than Home GDP as households smooth consumption by lending abroad. Investment in physical capital increases, so as to sustain the increase in the level of production. The trade balance improves (up to 0.2 percent, as a ratio to domestic output), driven by higher export that more than counterbalances the increase in non-oil import (due to higher aggregate demand). As such, the non-oil trade balance surplus more than compensates for the increase in the value of oil imports, driven by the higher price of oil. The euro area real exchange rate appreciates, as demand for euro area goods increases. As a result, the initial increase in (US dollar) oil prices is partially offset and the associated increase in fuel prices (that are set in euro currency) is of limited amount. Consistently with the increase in inflation and economic activity, the monetary authority rises the policy rate.

The RW demand shock affects euro area dynamics in two ways: directly, as it increases the export of the area, and indirectly, via its impact on oil demand and hence oil price. To isolate this latter indirect effect, in Figure 5 we show responses from an economy in which oil demand is not affected by RW demand. Comparing results from Figure 4 and Figure 5, we can evaluate the quantitative importance of the oil channel in transmitting external demand shocks to the euro area. Looking at Figure 5, inflation is now barely affected by the shock, as the fuel price decreases instead of increasing, pushed down by the real exchange rate appreciation (that reduces the price of oil in euro). The increase in consumption is slightly larger and more front-loaded, as households are not affected by the negative wealth effect associated with the higher oil price. As such, euro area output increases slightly more, up to more than 0.35 percent. Higher consumption drives up oil and non-oil imports. For oil imports, now quantities increase. The related value (expressed in terms of euro) does not greatly change, because of the real exchange rate appreciation. As such, the overall trade balance improves to a larger extent (more than 0.2 percent, as a ratio to domestic output). Overall, the two sets of results suggest that the "oil price channel" of the RW demand shock mainly affects euro area inflation. To the opposite, oil prices changes driven by this shock do not greatly change real variables other than oil imports.

4.3 Forecast error variance decomposition

Table 4, 5 and 6 decompose the forecast error variances of the main euro area variables into components attributable to the shocks perturbing the model over short (1 and 4-quarter) and medium-term (40-quarter) horizons, respectively. We report values obtained using the posterior mode. We group the shocks as follows: technology (Tech), monetary policy (Mon Pol), euro area demand (Dem), markup (Mkps), rest of the world (RW), fuel margin (Fuel Mkp), oil supply (Oil sup), oil-specific demand (Oil dem), foreign aggregate demand (RW dem).[27] Moreover, we do not include the contribution of measurement errors (ME) used in the estimation process, which is usually rather low (below 2 percent at most).

The impact of oil supply shocks and oil-specific demand shocks on the Home GDP, consumption, investment and (real) amount of exports and imports is rather low. The impact on consumption fluctuations is higher than that on other GDP components. The reason is that oil shocks directly affect consumption through its oil component, while they affect investment only indirectly, through changes in the relative prices and, as a consequence, allocations of the available resources (the oil component of the investment basket is zero). The GDP and its components are mainly explained by a combination of preference and technology shocks, in line with evidence provided by Christoffel et al. (2008).

For Home inflation rates, oil shocks explain close to 3 percent of the CPI in the short run and 2 percent in the long run. If we also take into account shocks to fuel margins, oil-related shocks explain around 16 percent of CPI inflation in the short run. In particular, the shocks to oil supply, oil specific demand and to the Home margin on fuel explain almost completely the fuel component of the CPI. Oil specific demand provides the largest contribution, while oil supply and euro area foreign demand shocks provide small contributions. The decomposition is similar to that of the international relative price of oil, as the pass-through into fuel prices of changes in the crude oil price is quick and complete. The oil-related shocks' contribution to the non-fuel component fluctuations of CPI is muted. The component is mainly explained by a combination

[27]Following Christoffel et al.(2008), the technology group includes the permanent technology shock, the transitory technology shock and the investment-specific technology shock. The monetary group is represented by the innovation to interest rate and the inflation target shock. The euro area demand group includes the preference shock, shocks to the external risk premium, domestic risk premium, government consumption and import demand. The markup group consists of the wage markup, the domestic price markup and the import price markup shocks. The foreign group consists of shocks to euro area export markup, foreign markup, inflation and interest rate. The fuel group includes the shock to the fuel distribution margin and the fuel demand shocks related to consumption and production. The oil supply group is the shock to the international supply of oil. The oil demand group is the oil-specific demand shock. Finally, the foreign aggregate demand group comprises the shock to foreign aggregate demand and to preferences for euro area exported goods.

of shocks to markup, external risk premium and inflation target.

Overall, our results suggest that oil shocks affect mainly the CPI inflation rate and the consumption component of GDP. The main impact is through the fuel component of the two variables. The impact is immediate and rather similar across all horizons, as the short-run pass-through of changes in crude oil prices into fuel prices is complete. Oil shocks also indirectly affect, to some extent, the investment component of GDP.

4.4 Historical decomposition

We next show the contribution of shocks to the historical fluctuations in real output growth, CPI inflation, fuel component of CPI inflation and oil price over the period 1996-2009. We group the shocks in the same way as for the forecast error variance decomposition.[28]

According to Figure 6, the impact on GDP of oil supply and oil-specific demand shocks has been rather muted. As reported also by Christoffel et al. (2008), the stronger real GDP growth in 1999 and 2000 is mainly due to favorable markup and demand shocks, which offset the overall negative contribution of technology shocks. For the 2001-2008 period, the oil contributions are overall tiny and negative, as the oil price spikes in correspondence of positive oil-specific demand shocks and tight oil supply. The prolonged growth of real GDP between 2005 and 2008 can be mainly attributed to domestic and rest of the world demand. Going to the more recent period, oil supply and demand-specific shocks continue to play a limited role in the decline of GDP growth from the second half of 2008. Foreign aggregate demand, instead, plays a much more crucial role. In fact, lower Foreign activity has a direct negative effect on GDP, via the contraction of exports, but a partially offsetting positive effect via the decrease in oil prices. In correspondence of the trough of GDP growth in 2009:1, oil-specific demand shocks give a positive contribution, as the oil price reached its minimum value around that period.

We report the CPI historical decomposition in Figure 7. Oil-specific demand shocks contribute negatively to inflation during the 1997-2000 and 2001-2002 periods, when the oil price

[28] We newly report them here for the convenience of the reader. The technology group includes the permanent technology shock, the transitory technology shock and the investment-specific technology shock. The monetary group is represented by the innovation to interest rate and the inflation target shock. The euro area demand group includes the preference shock, shocks to the external risk premium, domestic risk premium, government consumption and import demand. The markup group consists of the wage markup, the domestic price markup and the import price markup shocks. The foreign group consists of shocks to euro area export markup, foreign markup, inflation and interest rate. The fuel group includes the shock to the fuel distribution margin and the fuel demand shocks related to consumption and production. The oil supply group is the shock to the international supply of oil. The oil demand group is the oil-specific demand shock. Finally, the foreign aggregate demand group comprises the shock to foreign aggregate demand and to preferences for euro area exported goods.

decreases. The same shocks turned to positive contributions during the 2004-2008 period. Foreign demand shocks follows a similar path, consistently with their positive contribution to real activity. The decline in inflation from the second half of 2008 is due to the negative contribution of domestic demand and the decreasing contribution of Foreign aggregate demand. As in the case of GDP, Foreign aggregate demand has a direct and an indirect impact on inflation. The former is due to low demand for euro area tradables (that affect the ex fuel component of CPI, not reported), the latter to low demand for crude oil and more favorable supply conditions, that induce a decline in the fuel prices.

We show in Figure 9 the path of (the level of) oil international relative price. The increase over time of the international relative price of oil is mainly explained by the increase in oil-specific demand contribution (which goes from negative to positive) and, to a less extent, by the increase in the contribution of higher Foreign aggregate demand. These contributions are only partially offset by favorable, albeit decreasing, oil supply shocks during the 2001-2007 period. From 2008, the drop in the relative price of oil is due to the negative contribution of Foreign aggregate demand shocks and oil-specific demand.

4.5 Sensitivity Analysis

In what follows we show the role of some key parameters in the transmission of oil supply shocks. We initially consider higher fuel share in the consumption basket. Subsequently, we assume a rather high value (close to one) for the persistence of the oil supply shock. Finally, we assume a higher value of the elasticity of substitution between non-fuel and fuel goods.

Higher fuel share in the consumption basket

Figure 9 shows the responses to a 10 percent oil price hike induced by a negative oil supply shock under two alternative calibrations of the fuel share in the consumption bundle. In the benchmark case it is calibrated to 4 percent, in the alternative calibration to 10 percent. Under the new calibration, the euro area GDP decreases more than in the benchmark scenario (to 0.08 percent instead of 0.03 percent). Similarly, annualized CPI inflation increases up to 0.7 percent (0.2 percent in the benchmark). As the share of fuel is higher, households income and, hence, demand are more strongly affected by the increase in the price of oil. Non-oil imports decrease to a larger extent, following the larger drop in consumption and investment, while the value of oil imports is hardly affected, as it is mainly driven by the wide change in the international price of oil.

Higher persistence of the oil supply shock

Figure 10 shows responses of the euro area to a 10 percent permanent rise in the relative price of oil driven by a negative oil supply shock.[29] The bigger negative wealth effect associated with the higher persistence implies a stronger decrease in Home real variables and is mirrored in the sustained real exchange rate depreciation. Home GDP now decreases to a bigger extent than in the benchmark case (-0.12 against -0.04). Similarly, consumption and investment decrease to a bigger extent. Moreover, real variables persistence increase. After 20 periods, GDP deviation from baseline is equal to -0.1 percent. The Home CPI inflation increase is the same as in the benchmark case, as the spike in the fuel component of CPI more than compensates for the negative response of the non-fuel part. For the trade balance, its deterioration is lower. The reason is the stronger exchange rate depreciation, that contributes to shift world's demand towards Home tradables (the high pass-through into export and import prices is relatively quick, as the corresponding nominal rigidities are estimated to be rather low). For the same reason, the non-oil trade balance quickly shifts towards surplus.

Higher elasticity of substitution

Figure 11 shows the responses to a 10 percent oil price hike induced by a negative oil supply shock under two alternative calibrations of the elasticity of substitution between fuel and non fuel goods. In the benchmark case it is calibrated to 0.2. In the alternative scenario, to 5. Moreover, we set to zero the short-run adjustment costs of fuel in the consumption basket. As such, there is not anymore a difference between short-run and long-run elasticity.[30] Increasing the elasticity of substitution does not greatly affect the responses of GDP, consumption and investment. Oil imports are affected relatively more, as households substitute more easily non-fuel goods to fuel. As such, the core component of inflation increases relatively more, inducing a slightly larger increase in the overall CPI index. For the same reason, oil imports and non-oil imports respectively decrease and increase relatively more, driving initially the non-oil trade balance towards deficit. The extra-impact on the overall trade balance (compared to the case of

[29] The autoregressive coefficient of the shock is set to 0.999.

[30] To get the same fuel share in consumption (3 per cent) across the two calibrations, we opportunely change the weight of fuel in the consumption basket. Moreover, we modify the elasticity of substitution between fuel and non-fuel goods only in the Home country, while in the rest of the world we continue to set it equal to 0.15.

low elasticity) is however nil.

5 Conclusions

In this paper we have empirically analyzed the macroeconomic effects of oil price shocks in the euro area by estimating a small open economy DSGE model. We have assumed that the oil price is endogenously determined by oil demand and supply shocks in the global oil market. According to our results, the euro area GDP and CPI inflation increase when the higher oil price is due to an increase in world aggregate demand. Global oil supply shocks, instead, induce stagflationary effects on the euro area economy. Overall, results point out the need of identifying the (demand and supply) shocks that drive the changes in oil prices, to fully and correctly assess the impact of these changes on macroeconomic variables.

Our contribution can be improved along several dimensions. First, by inserting microfoundations of the supply of oil. One possibility is to follow Nakov and Pescatori (2009, 2010), that endogenize OPEC decisions. On a different but complementary route, taking into account the role of oil inventories could be relevant for clearly distinguishing between precautionary demand and supply. Also, we have not fully specified the refining and distribution margins. As such, we cannot fully capture the role of refining and distribution sector for the propagation of oil supply and demand shocks. Moreover, we do not explicitly formalize value added and excise taxes, that could have relevant implications for relative prices and, hence, welfare and optimal policy. Finally, it may be worth relaxing the assumption of equal elasticity of substitution between fuel and non-fuel goods across countries in order to assess differences in the country-specific transmission mechanism of a given worldwide oil price shock. We leave these issues for future research.

References

[1] Adolfson, M., Laséen, S., Lindé, J., Villani, M., 2007. Bayesian estimation of an open economy DSGE model with incomplete pass-through. Journal of International Economics, 72, 481–511.

[2] Barsky, R.B., Kilian L., 2004. Oil and the Macroeconomy Since the 1970s. Journal of Economic Perspectives, 18(4), 115–134.

[3] Benigno, P., 2009. Price Stability with Imperfect Financial Integration, Journal of Money, Credit and Banking. Volume 41 Issue s1, Pages 121–149.

[4] Blanchard, O. J., Galí J., 2009. The Macroeconomic Effects of Oil Shocks: Why are the 2000s so Different from the 1970s? in J. Gali and M. Gertler (eds.), International Dimensions of Monetary Policy, University of Chicago Press (Chicago, IL), 373–428.

[5] Blanchard, O. J., Riggi M., 2011. Why are the 2000s so different from the 1970s? A structural interpretation of changes in the macroeconomic effects of oil prices in the US. Bank of Italy Working Papers (Temi di discussione), No. 835.

[6] Bodenstein, M., Erceg C. J., Guerrieri L., 2011. Oil Shocks and External Adjustment. Journal of International Economics 83 (2), 168–184.

[7] Calvo, G., 1983. Staggered prices in a utility maximizing framework. Journal of Monetary Economics 12, 383–398.

[8] Christiano, L.J., Eichenbaum, M., Evans, C., 2005. Nominal rigidities and the dynamic effects of a shock to monetary policy. Journal of Political Economy 113 (1), 1–45.

[9] Christoffel K., Coenen G., Warne A., 2008. The New Area-Wide Model of the euro area a micro-founded open-economy model for forecasting and policy analysis. ECB Working Paper no. 944.

[10] European Central Bank 2010. 2010 Structural Issues Report on Euro Area Energy Markets and the Macroeconomy.

[11] Fagan, G., Henry, J., Mestre, R., 2005. An area-wide model for the Euro area. Economic Modelling 22 (1), 39–59.

[12] Gelman, A., Carlin, J., Stern, H., Rubin, D., 2004. Bayesian Data Analysis, 2nd edition. Chapman and Hall, New York.

[13] Geweke, J., 1999. Using simulation methods for Bayesian econometrics models: inference, development and communication. Econometric Reviews 18 (1), 1–73.

[14] Hamilton J., 2009. Causes and consequences of the oil shocks of 2007-08. Brookings Papers on Economic Activity, Spring, 215–278.

[15] Hamilton J., 2011. Nonlinearities and the macroeconomic effects of oil prices. Macroeconomic dynamics, 364-378.

[16] Jacquinot P., Kuismanen M., Mestre R., Spitzer M., (2009). An Assessment of the Inflationary Impact of Oil Shocks in the Euro Area. The Energy Journal, International Association for Energy Economics, vol. 30(1), pages 49-84.

[17] Justiniano, B., Preston A, 2010. Can structural small open-economy models account for the influence of foreign disturbances? Journal of International Economics 81 61-74.

[18] Kilian, L., 2008a. The Economic Effects of Energy Price Shocks. Journal of Economic Literature, 46(4), December, 871–909.

[19] Kilian, L., 2008b. Exogenous Oil Supply Shocks: How Big Are They and How Much Do They Matter for the U.S. Economy? Review of Economics and Statistics, 90(2), 216–240, May.

[20] Kilian, L., 2009. Not All Oil Price Shocks Are Alike: Disentangling Demand and Supply Shocks in the Crude Oil Market. American Economic Review, 99(3), June, 1053–1069.

[21] Kilian, L., 2010. Explaining Fluctuations in Gasoline Prices: A Joint Model of the Global Crude Oil Market and the U.S. Retail Gasoline Market. The Energy Journal, 31(2), April, 105–130.

[22] Kilian, L., Rebucci A., Spatafora N. (2009). Oil shocks and external balances. Journal of International Economics 77 2009b 181–194.

[23] Lippi, F., Nobili A., 2009. Oil and the macroeconomy: a quantitative structural analysis. Bank of Italy Working Papers (Temi di discussione), No. 751.

[24] Lubik, T., Schorfheide F., 2005. A Bayesian look at new open economy macroeconomics. In: Gertler, M., Rogoff, K. (Eds.), NBER Macroeconomics Annual. MIT Press.

[25] Nakov, A. Pescatori A., 2009. Oil and the Great Moderation. The Economic Journal, Volume 120 Issue 543, 131–156, March.

[26] Nakov, A. Pescatori A., 2010. Monetary Policy Trade-Offs with a Dominant Oil Producer. Journal of Money, Credit and Banking, Vol. 42, No. 1 February.

[27] Rotemberg, J.J., 1982. Monopolistic price adjustment and aggregate output. Review of Economic Studies 49, 517–531.

[28] Sanchez, M., 2008. Oil Shocks and Endogenous Markups. Results from an Estimated Euro Area DSGE Model. ECB Working Paper no. 860.

[29] Smets, F., Wouters, R., 2003. An estimated dynamic stochastic general equilibrium model of the Euro area. Journal of the European Economic Association 1 (5), 1123–1175.

[30] Smets, F., Wouters, R., 2005. Comparing shocks and frictions in US and Euro area Business cycles: a Bayesian DSGE approach. Journal of Applied Econometrics 20 (2), 161–183.

[31] Schmitt-Grohé, S., Uribe M., 2003. Closing Small Open Economy Models, Journal of International Economics. 61, October , Pages 163–185.

[32] Venditti F., 2010. Down the non-linear road from oil to consumer energy prices: no much asymmetry along the way. Bank of Italy Working Papers (Temi di discussione), No. 751.

Appendix

In this Appendix we report a detailed description of the model, excluding the parts concerning oil production that are reported in the main text.

Households

There is a continuum ($0 \leq j \leq n$) of households that maximize expected utility subject to a standard flow budget constraint. The preferences of household j are given by:

$$E_t \left[\sum_{k=0}^{\infty} \beta^k \left(\xi_{t+k}^C \log \left(C_{t+k}(j) - bC_{t+k-1} \right) - \frac{\xi_{t+k}^L}{1+\sigma_L} L_{t+k}(j)^{1+\sigma_L} \right) \right] \tag{27}$$

where β denotes the discount factor, $C_t(j)$ and $L_t(j)$ are respectively the j-th household's levels of consumption and labor supply, each of them subject to a preference shock, ξ_t^C and ξ_t^L respectively. The parameter b ($0 \leq b \leq 1$) measures the degree of external habit formation in consumption (C is the consumption level of the Home representative household), while $1/\sigma_L$ is the labor Frisch elasticity. Each of the two shocks is distributed according to the following autoregressive process:

$$\hat{\xi}_t^i = \rho_{\xi^i} \hat{\xi}_t^i + \hat{\varepsilon}_{\xi^i,t}, \quad \hat{\varepsilon}_{\xi^i,t} \overset{iid}{\sim} N(0, \sigma_{\xi^i}^2), i = C, L$$

Home households can save in Home and Foreign riskless bonds, respectively $B_{H,t}$ and $B_{F,t}$ as well as in physical capital K_t. Home bonds are denominated in Home currency and are traded only domestically, while Foreign bonds are denominated in Foreign currency and are traded between Home households and the rest of the world. The resulting budget constraint is:

$$\begin{aligned}
& B_{H,t}(j) + S_t B_{F,t}(j) - B_{H,t-1}(j) R_{t-1} \epsilon_{t-1}^{RP} - S_t B_{F,t-1}(j) R_{t-1}^* \Phi \left(a_{t-1}, \tilde{\phi}_{t-1} \right) \\
= \; & W_t(j) N_t(j) + \left(R_{K,t} K_{i,t-1}(j) + \frac{\Pi_t}{n} \right) \\
& + T_t(j) - P_{C,t} C_t(j) - P_{I,t} I_t(j) - \Gamma_W(j)
\end{aligned}$$

where R_t and R_t^* are respectively the gross nominal interest rates on Home and Foreign bonds. The term ϵ_{t-1}^{RP} represents a risk premium shock on the Home bond, distributed according to a standard log-linear AR(1) process:

$$\hat{\epsilon}_t^{RP} = \rho_{\epsilon^{RP}} \hat{\epsilon}_{t-1}^{RP} + \hat{\varepsilon}_t^{RP}, \quad \hat{\varepsilon}_t^{RP} \overset{iid}{\sim} N(0, \sigma_{\epsilon^{RP}}^2) \tag{28}$$

The term $\Phi\left(a_{t-1}, \tilde{\phi}_{t-1}\right)$ is a premium that depends on the net foreign asset position of the home economy (a, see below). It ensures a well-defined steady-state. The variable Π_t represents total profits from ownership of domestic firms. We assume they are equally distributed across households. The variable $T_t(j)$ represents net lump-sum taxes. The households can invest (I_t) in additional physical capital (K_t) undertaking a quadratic adjustment cost. The implied capital accumulation equation is:

$$K_t(j) = (1-\delta) K_{t-1}(j) + \left(1 - \frac{\gamma_I}{2}\left(\frac{\Upsilon_t I_t(j)}{I_{t-1}(j)} - 1\right)^2\right) I_t(j) \tag{29}$$

where $\gamma_I > 0$ is a parameter, $0 < \delta < 1$ is the depreciation rate and the term Υ_t is an investment-specific technology shock that follows a stationary autoregressive log-linear process:

$$\widehat{\Upsilon}_t = \rho_\Upsilon \widehat{\Upsilon}_{t-1} + \hat{\varepsilon}_{\Upsilon,t}, \quad \hat{\varepsilon}_{\Upsilon,t} \overset{iid}{\sim} N(0, \sigma_\Upsilon^2) \tag{30}$$

Finally, each household is a monopolistic supplier of a differentiated labor service. She chooses her wage given labor demand by domestic firms and subject to Rotemberg-type wage adjustment costs Γ_W, whose functional form is:

$$\Gamma_W(j) \equiv \frac{\kappa_W}{2}\left(\frac{W_t(j)/W_{t-1}(j)}{\pi_{W,t-1}^{\alpha_W} \bar{\pi}_t^{1-\alpha_W}} - 1\right)^2 L_t \tag{31}$$

where $\kappa_W \geq 0$ is the wage adjustment cost parameter , α_W $(0 \leq \alpha_W \leq 1)$ is a parameter that measures indexation to the gross wage inflation rate in the previous period ($\pi_{W,t} \equiv W_t/W_{t-1}$) and to the current inflation target of the central bank, while L is the bundle of labor varieties (15).

From the two first order conditions with respect to the two bond positions, $B_{H,t}(j)$ and $B_{F,t}(j)$, we obtain a modified uncovered interest parity condition. The latter links the interest rate differential, comprehensive of the domestic premium ϵ_{t-1}^{RP} and the premium $\Phi\left(a_{t-1}, \tilde{\phi}_{t-1}\right)$ on the holdings of Foreign bond, to next period expected exchange rate change. The premium $\Phi\left(a_t, \tilde{\phi}_t\right)$ is given by:

$$\Phi\left(a_t, \tilde{\phi}_t\right) = \exp\left(-\tilde{\phi}_a\left(a_t - \bar{a}\right) + \tilde{\phi}_t\right) \tag{32}$$

where $a_t \equiv S_t B_{F,t} / (P_t z_t)$ is the net foreign asset position (divided by the Home consumption deflator and the stochastic technology trend) and $\tilde{\phi}_t$ is a shock to the external risk premium.[31] The (log-linearized) shock is distributed as follows:

$$\widehat{\tilde{\phi}}_t = \rho_{\tilde{\phi}} \widehat{\tilde{\phi}}_{t-1} + \hat{\varepsilon}_{\xi^{\tilde{\phi}},t}, \quad \hat{\varepsilon}_{\xi^{\tilde{\phi}},t} \overset{iid}{\sim} N(0, \sigma^2_{\xi^{\tilde{\phi}}}) \tag{33}$$

Central bank

The monetary policy specification is in line with Smets and Wouters (2003). We assume that the central bank follows an augmented Taylor interest rate feedback rule characterized by the response of the nominal rate R_t to its lagged value, to the gap between lagged gross consumer price inflation inflation π_{t-1} ($\pi_t \equiv P_t/P_{t-1}$) and targeted inflation $\bar{\pi}_t$, to the gap between contemporaneous (detrended) output Y_t and its steady state value, to changes in inflation $\Delta\pi_t \equiv \pi_t/\pi_{t-1}$ and to output growth $\Delta Y_t \equiv Y_t/Y_{t-1}$. In log-linearized terms we have:

$$\begin{aligned} \hat{R}_t &= \rho_R \hat{R}_{t-1} + (1-\rho_R)\left(\widehat{\bar{\pi}}_t + r_\pi \left(\hat{\pi}_{t-1} - \widehat{\bar{\pi}}_t\right) + r_y \hat{y}_t\right) \\ &\quad + r_{\Delta\pi} \Delta\hat{\pi}_t + r_{\Delta y} \Delta\hat{y}_t + \hat{\varepsilon}_{R,t} \end{aligned} \tag{34}$$

where $\varepsilon_{R,t}$ is an uncorrelated monetary policy shock and $\widehat{\bar{\pi}}_t$ is a shock to the monetary authority inflation target. They are respectively distributed as:

$$\hat{\varepsilon}_{R,t} \overset{iid}{\sim} N(0, \sigma^2_R) \tag{35}$$

$$\widehat{\bar{\pi}}_t = \rho_{\bar{\pi}} \widehat{\bar{\pi}}_t + \hat{\varepsilon}_{\bar{\pi},t}, \quad \hat{\varepsilon}_{\bar{\pi},t} \overset{iid}{\sim} N(0, \sigma^2_{\bar{\pi}}) \tag{36}$$

Fiscal Policy

We assume that the Home fiscal authority simply buys domestic intermediate non-fuel goods. Purchases (G_t) are financed by lump-sum taxes (T_t) paid by domestic households. The implied budget constraint is:

$$P_{H,t} G_t = T_t \tag{37}$$

[31] See Benigno (2009) and Schmitt-Grohé and Uribe (2003). The cost implies that domestic households are charged a premium over the foreign interest rate R^*_t if the net foreign asset position of the country is negative, and receive a lower remuneration if the net foreign asset position is positive.

We assume that the stationary components of government purchases expressed in real terms (deflated by domestic consumer prices), g, follows the log-linear AR(1) process:

$$\hat{g}_t = \rho_g \hat{g}_{t-1} + \varepsilon_{g,t}, \quad \hat{\varepsilon}_{g,t} \overset{iid}{\sim} N(0, \sigma_g^2) \tag{38}$$

Rest of the world economy

As for the Home intermediate goods, we assume that in any period, each intermediate Foreign firm can re-optimize its prices in the Home and Foreign country, $P_{F,t}(f)$ and $P^*_{F,t}(f)$ respectively, subject to quadratic adjustment costs in the form of a CES basket of all goods produced in the same sector of the economy ($Y_{F,t}$ and $Y^*_{F,t}$, respectively):

$$AC_{F,t}(f) \equiv \frac{\kappa_F}{2} \left(\frac{P_{F,t}(f)/P_{F,t-1}(f)}{\pi_{F,t-1}^{\alpha_F} \bar{\pi}_t^{1-\alpha_F}} - 1 \right)^2 Y_{F,t} \tag{39}$$

$$AC^*_{F,t}(f) \equiv \frac{\kappa^*_F}{2} \left(\frac{P^*_{F,t}(f)/P^*_{F,t-1}(f)}{\left(\pi^*_{F,t-1}\right)^{\alpha^*_F} (\bar{\pi}^*_t)^{1-\alpha^*_F}} - 1 \right)^2 Y^*_{F,t} \tag{40}$$

where $\kappa_F, \kappa^*_F \geq 0$ are adjustment cost parameters, α_F $(0 \leq \alpha_F \leq 1)$ and $(1-\alpha_F)$ measure the indexation to previous period's sector-specific inflation and current period Home inflation target, respectively. Similar interpretations hold for α^*_F and $(1-\alpha^*_F)$. As such, there is a Phillips curve, holding in the Home market. Its log-linearized form is:[32]

$$\begin{aligned}
\kappa_F \hat{\pi}_{F,t} - \alpha_F \kappa_F \hat{\pi}_{F,t-1} - (1-\alpha_F)\kappa_F \hat{\bar{\pi}}_t \;=\;& \kappa_F \beta \pi_{ss} \hat{\pi}_{F,t+1} - \alpha_F \kappa_F \beta \pi_{ss} \hat{\pi}_{F,t} \\
& - (1-\alpha_F)\kappa_F \beta \pi_{ss} \hat{\bar{\pi}}_{t+1} \\
& - \frac{\theta_F - 1}{p_{F,ss}} \hat{p}_{F,t} \\
& - (\theta_F - 1)\widehat{rer}_t \\
& + \hat{\theta}_{F,t}
\end{aligned}$$

The markup shock $\hat{\theta}_{F,t}$ follows an AR(1) log-linear process:

$$\hat{\theta}_{F,t} = \rho_{\theta_F} \hat{\theta}_{F,t-1} + \hat{\varepsilon}_{\theta_F,t}, \quad \hat{\varepsilon}_{\theta_F,t} \overset{iid}{\sim} N(0, \sigma^2_{\theta_F}) \tag{41}$$

[32] As we do not explicitly consider the production process in the rest of the world, the foreign Phillips curves do not include real marginal costs. The latter are catched by the markup shocks.

Similarly, the Phillips curve in the rest of the world is:

$$
\begin{aligned}
\kappa_F^* \hat{\pi}_t^* - \alpha_F^* \kappa_F^* \hat{\pi}_{t-1}^* - (1-\alpha_F^*) \kappa_F^* \hat{\bar{\pi}}_t^* &= \kappa_F^* \beta \pi_{ss} \hat{\pi}_{t+1}^* - \alpha_F^* \kappa_F \beta \pi_{ss} \hat{\pi}_t^* \\
&\quad - (1-\alpha_F^*) \kappa_F^* \beta \pi_{ss} \hat{\bar{\pi}}_{t+1}^* \\
&\quad + \hat{\theta}_{F,t}^*
\end{aligned}
$$

where $\hat{\bar{\pi}}_t^*$ is a shock aiming at capturing long-run trend in inflation rate and is $\hat{\theta}_{F,t}^*$ a markup shock. Each shock follows an AR(1) process, respectively:

$$
\hat{\bar{\pi}}_t^* = \rho_{\bar{\pi}^*} \hat{\bar{\pi}}_{t-1}^* + \hat{\varepsilon}_{\bar{\pi}^*,t}, \quad \hat{\varepsilon}_{\bar{\pi}^*,t} \overset{iid}{\sim} N(0, \sigma_{\bar{\pi}^*}^2) \tag{42}
$$

$$
\hat{\theta}_{F,t}^* = \rho_{\theta_F^*} \hat{\theta}_{F,t-1}^* + \hat{\varepsilon}_{\theta_F^*,t}, \quad \hat{\varepsilon}_{\bar{\pi}^*,t} \overset{iid}{\sim} N(0, \sigma_{\theta_F^*}^2) \tag{43}
$$

For the rest of the world nominal interest rate R_t^*, we assume it is exogenous and follows an AR(1) process:

$$
\hat{R}_t^* = \rho_{R^*} \hat{R}_{t-1}^* + \hat{\varepsilon}_{R^*,t}, \quad \hat{\varepsilon}_{R^*,t} \overset{iid}{\sim} N(0, \sigma_{R^*}^2) \tag{44}
$$

The above assumptions contribute to fit the real exchange rate dynamics.

Intermediate goods market clearing condition

The market clearing condition for the generic intermediate good h reads:

$$
V_t(h) = C_t(h) + I_t(h) + G_t(h) + Y_{H,t}^*(h) \tag{45}
$$

Table 1. Calibrated parameters

Parameter	Description	Value
Preferences		
β	Discount factor	0.9996
σ^L	Labor supply elasticity	2.00
Final consumption		
a_{FU_C}	Fuel weight	0.03
a_{HC}	Home trad. share	0.8
ρ	Fuel Non-fuel substitution	0.2
η^C	Home trad. non-fuel import substitution	1.1
δ	Capital depreciation	0.025
Final investment		
a_{HI}	Non-fuel-import share	0.7
η^I	Home trad. non-fuel import substitution	1.1
Intermediate goods		
θ_H	Home trad. brands substitution	6
θ_F	Non-fuel import brands substitution	6
θ_L	Labor varieties substitution	4.33
a_{FU_Y}	Fuel weight	0.03
a_L	Labor weight	0.48
ξ_Y	Fuel-value added substitution	0.5
ξ_V	Labor-capital substitution	0.75
Other parameters		
n	Home size	0.2
η^{FU}/P^{FU}	distribution margin and taxes in fuel price	0.8

Table 2. Steady state relationships

Variable	Description	Value
$\bar{\pi}$	Inflation rate (annualized)	1.9
gr	Growth rate (annualized)	2.0
R	Nominal interest rate (annualized)	4.0
C/Y	Consumption-to-output ratio	0.58
I/Y	Investment-to-output ratio	0.20
$P_H G/Y$	Public expenditure-to-output ratio	0.22
$M(X)/Y$	Imports (Exports)-to-output ratio	0.17
$P_F C_F/Y$	Cons. Imp.-to-output ratio	0.10
$P_F I_F/Y$	Inv. Imp.-to-output ratio	0.06
$P^O Y_O^{D,H}/Y$	Oil imports-to-output ratio	0.01
B^F/Y	Net foreign asset	0.00
FU/C	Fuel-to-consumption ratio	0.04
P_{FU}/MC	Fuel price-to-marginal cost ratio	0.04

Table 3. Prior and Posterior Moments of the Parameters

		type	mean	std.dev.	mode	mean	median	5%	95%
Preferences									
Habit formation	h	B	0.6	0.05	0.640	0.664	0.669	0.577	0.731
Employment									
Calvo-style parameter	ξ_E	B	0.5	0.15	0.797	0.774	0.776	0.733	0.808
Adjustment costs									
Investment	ψ	G	3	1.5	5.506	9.290	9.230	6.795	12.011
Ex-oil Import content: cons.	γ_{C_F}	G	2	0.75	1.127	0.918	0.859	0.548	1.491
EX-oil Import content: inv.	γ_{I_F}	G	2	0.75	3.372	2.928	2.741	1.992	4.715
Oil content: prod. func.	γ_{FU_Y}	G	2	0.75	2.067	2.196	2.111	1.370	3.299
Oil Import content: cons.	γ_{FU_C}	G	2	0.75	1.798	1.698	1.631	0.841	2.784
Export	$\gamma^*_{Y_H}$	G	2	1	1.680	1.980	1.969	1.539	2.447
Monetary policy									
Interest rate smoothing	ρ_R	B	0.8	0.05	0.820	0.828	0.828	0.788	0.869
Resp. to inflation	ρ_π	G	1.7	0.25	2.001	1.920	1.910	1.664	2.213
Resp. to change in inflation	$\rho_{\Delta\pi}$	G	0.3	0.15	0.225	0.203	0.199	0.155	0.263
Resp. to output growth	$\rho_{\Delta y}$	G	0.0625	0.1	0.084	0.094	0.087	0.059	0.166
Wage and price setting									
Dom. prices	κ_H	G	250	60	186.187	208.853	202.562	137.792	296.179
Imp. prices	κ_F	G	10	2.5	14.250	15.314	15.171	12.782	18.439
Foreign prices	κ^*_F	G	250	60	249.947	262.315	261.946	186.711	336.907
Exp. Prices	κ^*_H	G	10	2.5	7.532	8.359	7.877	5.133	12.754
Wages	κ_W	G	250	60	259.456	267.277	268.876	201.579	331.595
Indexation: prices	α_H	B	0.5	0.1	0.333	0.379	0.368	0.289	0.492
Indexation: exports	α^*	B	0.5	0.1	0.282	0.275	0.275	0.151	0.408
Indexation: wages	α_W	B	0.5	0.1	0.335	0.371	0.367	0.284	0.467
Shock: autoregr. coeff.									
Transitory techn.	ρ_ϵ	B	0.75	0.15	0.701	0.754	0.746	0.585	0.897
Inv.-spec. tech	ρ_Υ	B	0.75	0.15	0.605	0.496	0.504	0.383	0.591
Permanent tech.	ρ_μ	B	0.75	0.15	0.789	0.626	0.637	0.375	0.765
Preferences	ρ_{ζ^C}	B	0.75	0.15	0.741	0.697	0.703	0.610	0.777
Public exp.	ρ_g	B	0.75	0.15	0.769	0.729	0.727	0.639	0.815
Dom. risk premium	ρ_{RP}	B	0.75	0.15	0.718	0.604	0.620	0.393	0.766
External risk premium	$\rho_{\tilde{\phi}}$	B	0.75	0.15	0.972	0.968	0.968	0.951	0.982
Price markup: domestic	ρ_{θ_H}	B	0.75	0.15	0.384	0.317	0.307	0.225	0.434
Price markup: export	$\rho_{\theta^*_H}$	B	0.75	0.15	0.790	0.808	0.815	0.722	0.874

Table 3. Prior and Posterior Moments of the Parameters (continued)

		type	mean	std.dev.	mode	mean	median	5%	95%
Price markup: import	ρ_{θ_F}	B	0.75	0.15	0.952	0.945	0.947	0.915	0.968
Wage markup	ρ_{θ_L}	B	0.75	0.15	0.316	0.418	0.394	0.283	0.602
Inflation target	$\rho_{\bar{\pi}}$	B	0.75	0.15	0.751	0.887	0.893	0.830	0.919
Ex-oil Import	ρ	B	0.75	0.15	0.552	0.327	0.325	0.141	0.576
Fuel import: firms	$\rho_{\eta^{FU_Y}}$	B	0.75	0.15	0.754	0.745	0.785	0.530	0.897
Fuel import: cons.	$\rho_{\eta^{FU_C}}$	B	1.75	0.15	0.974	0.988	0.990	0.978	0.995
Fuel margin	$\rho_{\eta^{FU}}$	B	2.75	0.15	0.850	0.872	0.895	0.725	0.938
Export preference	$\rho_{a_H^*}$	B	0.75	0.15	0.951	0.929	0.929	0.900	0.960
Aggregate demand: foreign	ρ_{ad^*}	B	0.75	0.15	0.948	0.965	0.963	0.951	0.980
Oil-spec. dem	$\rho_{\gamma_{OIL}^*}$	B	0.75	0.15	0.950	0.949	0.949	0.907	0.978
Oil supply	$\rho_{y_O^S}$	B	0.75	0.15	0.783	0.744	0.746	0.657	0.839
Price markup: foreign	$\rho_{\theta_F^*}$	B	0.75	0.15	0.743	0.644	0.652	0.545	0.724
Interest rate: foreign	ρ_R^*	B	0.75	0.15	0.902	0.900	0.903	0.865	0.930
Inflation: foreign	ρ_{π^*}	B	0.75	0.15	0.304	0.388	0.379	0.308	0.494
Standard deviations									
Transitory techn.	σ_ϵ	G	0.001	0.1	0.001	0.001	0.001	0.001	0.001
Inv.-spec. tech	σ_Υ	G	0.001	0.1	0.040	0.074	0.073	0.055	0.095
Permanent tech.	σ_μ	G	0.001	0.1	0.002	0.001	0.001	0.001	0.002
Monetary policy	σ_R	G	0.001	0.1	0.000	0.001	0.001	0.000	0.001
Preferences	σ_{ϵ^C}	G	0.001	0.1	0.010	0.011	0.011	0.008	0.014
Public exp.	σ_g	G	0.001	0.1	0.003	0.003	0.003	0.003	0.004
Dom. risk premium	σ_{RP}	G	0.001	0.1	0.001	0.001	0.001	0.000	0.001
External risk premium	$\sigma_{\tilde{\phi}}$	G	0.001	0.1	0.001	0.001	0.001	0.001	0.002
Price markup: domestic	σ_{θ_H}	G	0.001	0.1	0.564	0.704	0.677	0.455	1.042
Price markup: export	$\sigma_{\theta_H^*}$	G	0.001	0.1	0.545	0.587	0.577	0.442	0.772
Price markup: import	σ_{θ_F}	G	0.001	0.1	0.163	0.173	0.171	0.146	0.206
Wage markup	σ_{θ_L}	G	0.001	0.1	0.097	0.097	0.097	0.070	0.129
Inflation target	$\sigma_{\bar{\pi}}$	G	0.001	0.1	0.002	0.001	0.001	0.001	0.002
Ex-oil Import	$\sigma_{\epsilon^{C_F}}$	G	0.001	0.1	0.024	0.020	0.019	0.015	0.026
Fuel import: firms	$\sigma_{\eta^{FU}}$	G	0.001	0.1	0.087	0.091	0.090	0.071	0.115
Fuel import: cons.	$\sigma_{\eta^{FU}}$	G	0.001	0.1	0.001	0.001	0.001	0.000	0.001
Fuel margin	$\sigma_{\eta^{FU}}$	G	0.001	0.1	0.022	0.022	0.022	0.019	0.026
Export preference	$\sigma_{a_H^*}$	G	0.001	0.1	0.028	0.032	0.032	0.026	0.038
Aggregate demand: foreign	σ_{ad^*}	G	0.001	0.1	0.003	0.003	0.003	0.003	0.003
Oil-spec. dem	$\sigma_{\gamma_{OIL}^*}$	G	0.001	0.1	0.027	0.027	0.027	0.022	0.032
Oil supply	$\sigma_{y_O^S}$	G	0.001	0.1	0.010	0.010	0.010	0.009	0.012
Price markup: foreign	$\sigma_{\theta_F^*}$	G	0.001	0.1	0.001	0.001	0.001	0.001	0.003
Interest rate: foreign	σ_{R^*}	G	0.001	0.1	0.001	0.001	0.001	0.001	0.001
Inflation: foreign	σ_{π^*}	G	0.001	0.1	0.003	0.003	0.003	0.002	0.004

Table 4. Forecast Error Variance Decomposition (1-quarter horizon)

	Tech	Mon. Pol.	Dem.	Mkp	Foreign	Fuel	Oil Sup.	Oil dem.	RW dem.
GDP	31.9	1.2	13.7	23.8	8.3	4.5	0.0	1.1	15.5
Consumption	10.1	2.1	36.7	32.9	1.7	12.5	0.1	2.4	1.4
Investment	67.7	0.2	6.6	20.3	0.9	1.9	0.0	0.5	1.9
Export	3.5	0.0	0.9	0.4	51.6	0.7	0.0	0.0	42.8
Import	4.4	0.0	17.8	58.2	3.3	5.9	0.0	0.5	9.7
Interest rate	4.4	14.5	33.4	29.5	2.6	12.5	0.3	1.1	1.8
GDP deflator	8.1	5.1	6.5	24.7	53.1	1.3	0.0	0.1	1.1
CPI	4.1	6.1	24.0	43.4	0.7	19.3	0.3	2.0	0.1
CPI ex. fuel	4.8	6.9	27.6	51.1	0.7	8.7	0.0	0.0	0.0
CPI fuel rel. price	0.0	0.0	0.5	0.6	0.2	27.9	9.0	61.0	0.9
Oil international rel. price	0.0	0.0	0.0	0.0	0.0	0.0	12.8	86.1	1.0
Real eff. exchange rate	1.1	1.2	35.8	33.5	10.6	0.9	0.0	0.0	16.8

Table 5. Forecast Error Variance Decomposition (4-quarter horizon)

	Tech	Mon. Pol.	Dem.	Mkp	Foreign	Fuel	Oil Sup.	Oil dem.	RW dem.
GDP	32.1	1.6	13.1	25.3	9.3	4.2	0.0	1.0	13.5
Consumption	9.9	2.2	36.7	34.6	1.8	11.1	0.1	2.2	1.5
Investment	61.2	0.2	7.6	25.0	0.9	1.6	0.0	0.5	3.1
Export	4.2	0.0	0.9	0.5	55.0	0.8	0.0	0.0	38.6
Import	5.2	0.0	17.5	57.3	3.4	5.7	0.0	0.6	10.4
Interest rate	8.0	6.1	26.9	42.2	10.4	4.9	0.1	1.0	0.4
GDP deflator	7.7	5.8	5.9	23.7	53.6	1.2	0.0	0.0	2.1
CPI	4.2	7.5	23.6	43.7	1.1	17.5	0.3	1.8	0.2
CPI ex. fuel	4.8	8.5	26.8	50.7	1.2	7.8	0.0	0.0	0.2
CPI fuel rel. price	0.0	0.0	0.3	1.1	0.1	18.0	4.6	74.7	1.1
Oil international rel. price	0.0	0.0	0.0	0.0	0.0	0.0	5.8	93.0	1.1
Real eff. exchange rate	1.4	0.5	21.6	49.6	4.9	0.3	0.0	0.1	21.5

Table 6. Forecast Error Variance Decomposition (infinite horizon)

	Tech	Mon. Pol.	Dem.	Mkp	Foreign	Fuel	Oil Sup.	Oil dem.	RW dem.
GDP	33.9	1.5	10.4	26.7	10.8	4.3	0.0	1.1	11.3
Consumption	10.4	1.7	31.3	39.9	2.3	10.2	0.1	2.2	2.0
Investment	46.7	0.3	11.7	33.5	1.7	1.5	0.0	0.6	4.0
Export	4.1	0.0	1.6	0.7	61.2	0.6	0.0	0.0	31.8
Import	3.8	0.0	17.9	59.6	3.2	3.5	0.0	0.6	11.4
Interest rate	8.8	3.5	25.6	43.6	7.4	6.5	0.1	1.4	3.0
GDP deflator	8.0	7.7	6.1	27.1	45.9	1.5	0.0	0.1	3.7
CPI	5.2	12.3	21.1	44.1	1.9	13.0	0.2	1.4	0.7
CPI ex. fuel	5.7	13.3	23.0	48.8	2.1	6.2	0.0	0.1	0.7
CPI fuel rel. price	0.0	0.0	0.3	1.6	0.1	12.3	3.0	81.4	1.3
Oil international rel. price	0.0	0.0	0.0	0.0	0.0	0.1	3.6	95.2	1.1
Real eff. exchange rate	1.3	0.2	13.9	54.0	2.7	0.6	0.0	0.2	27.1

Figure 1: Data (thick) and one-sided predicted values from the model (thin).

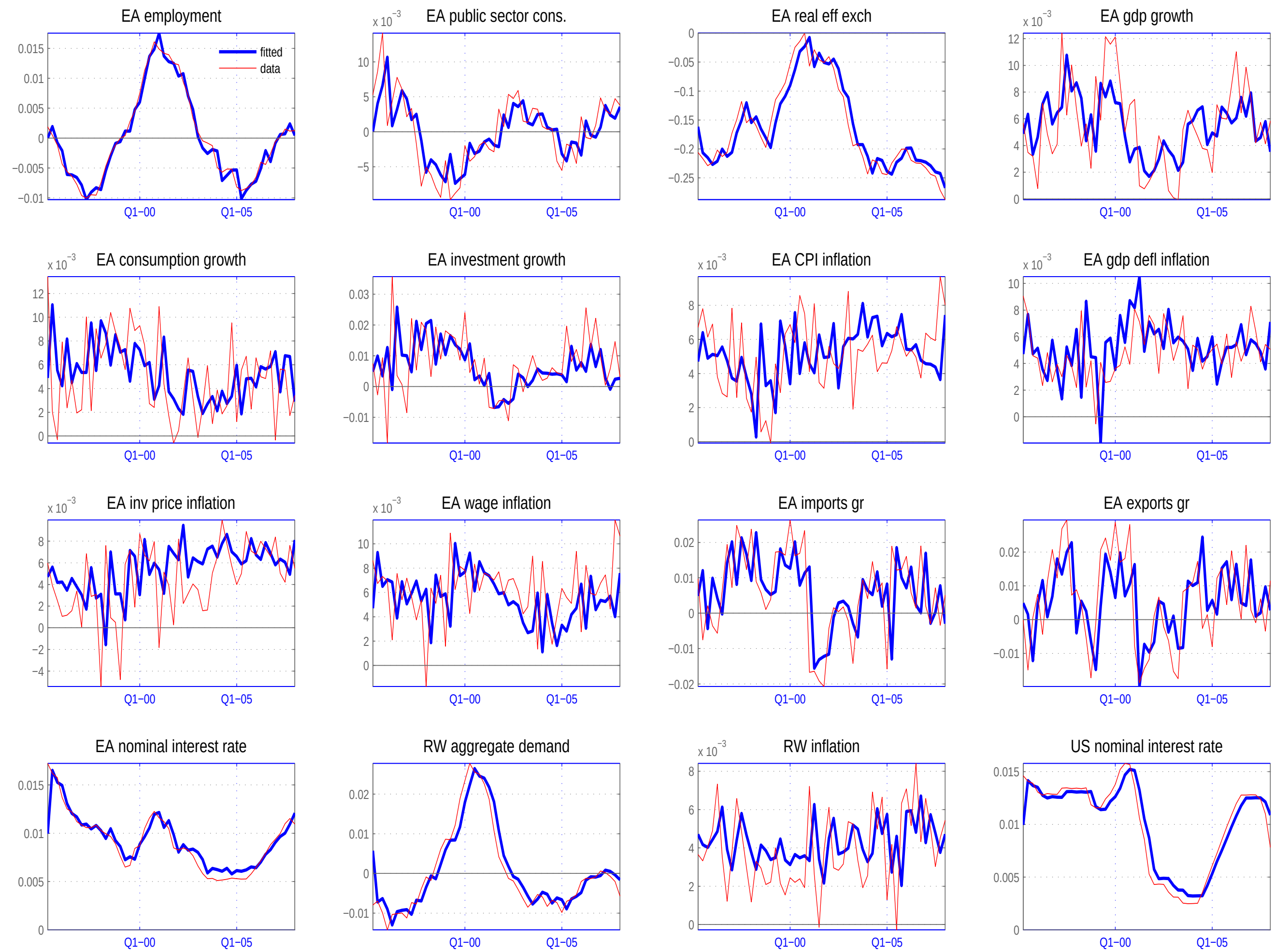
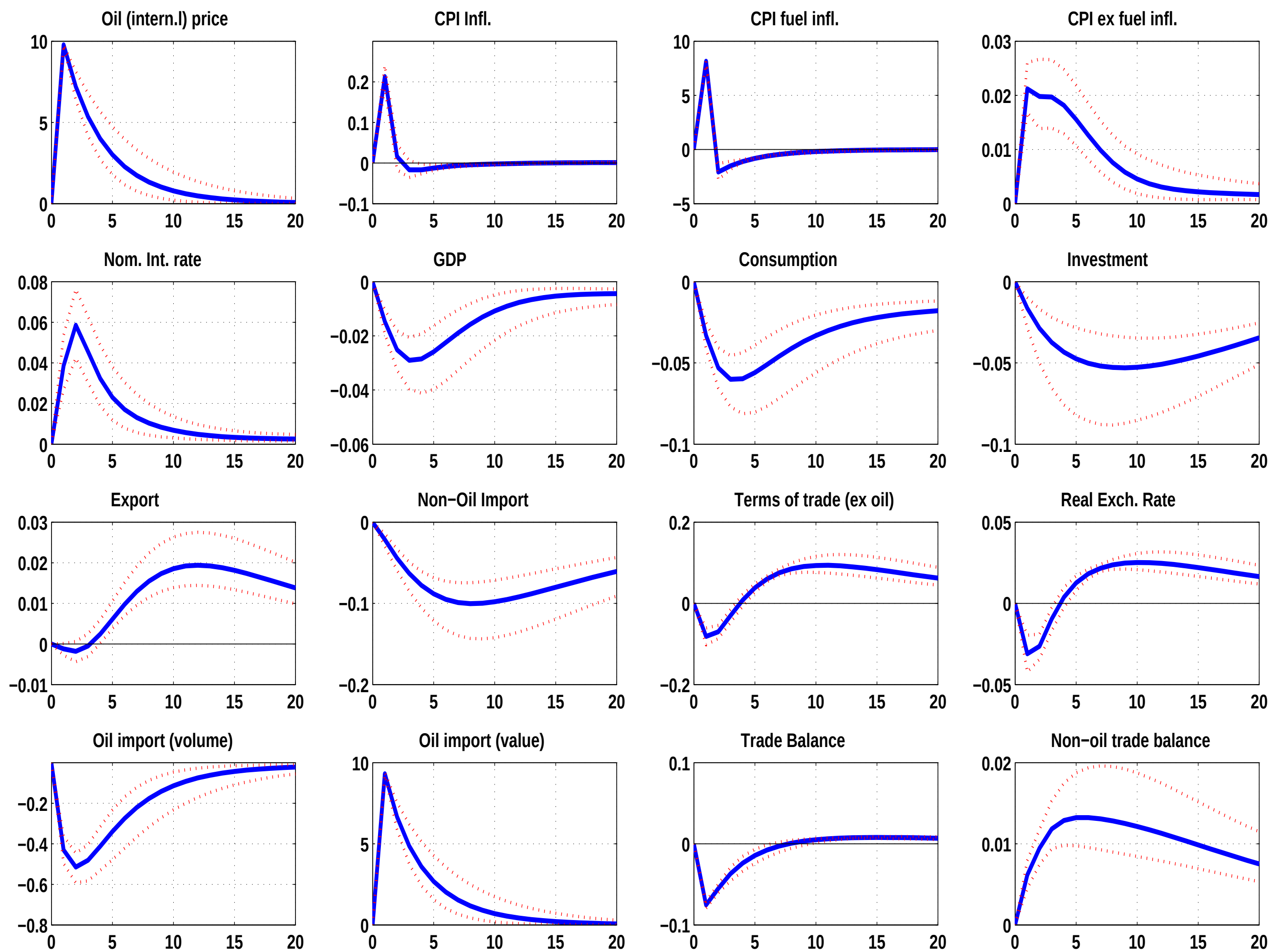
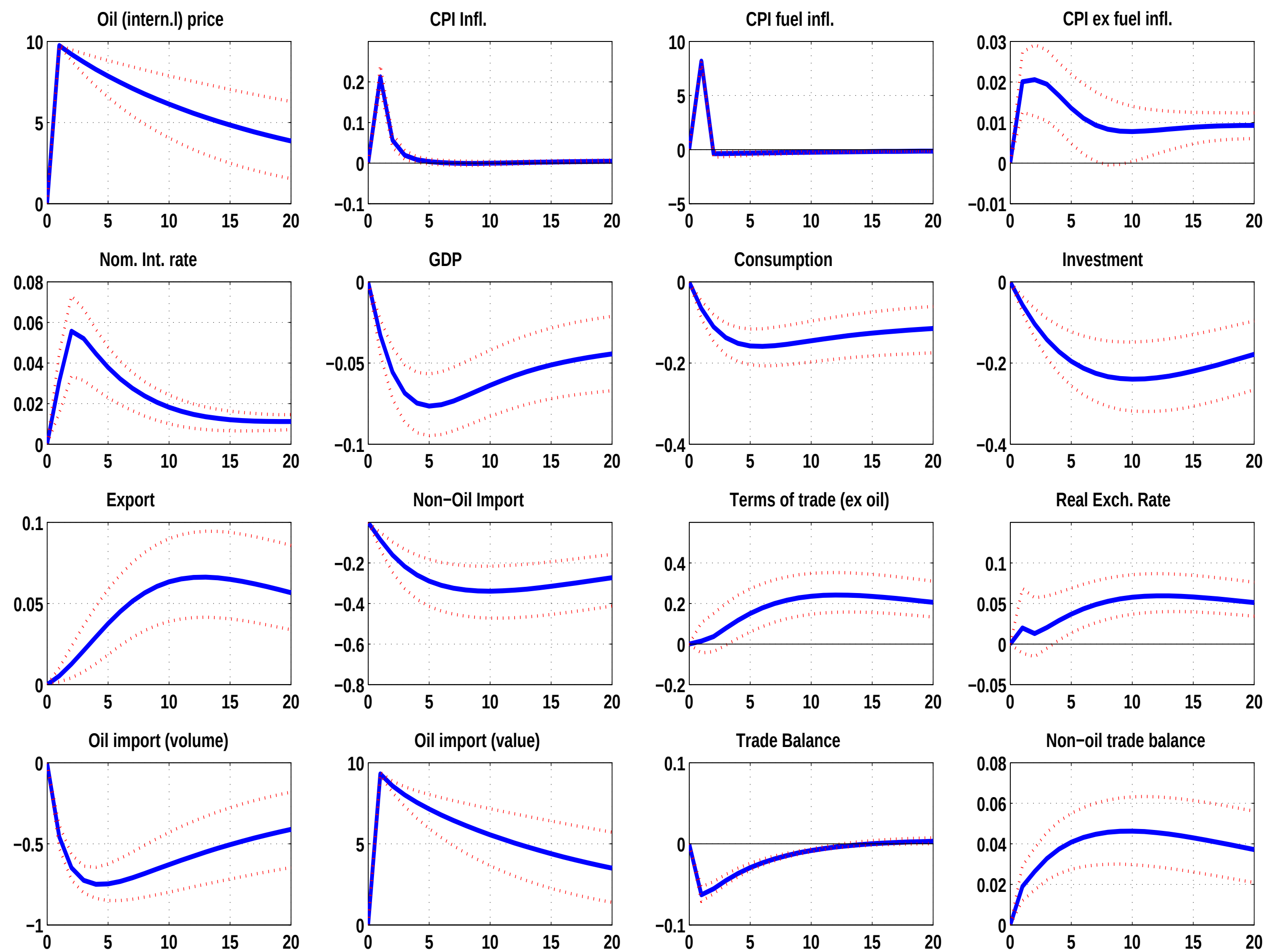


Figure 2: Responses to a negative oil supply shock



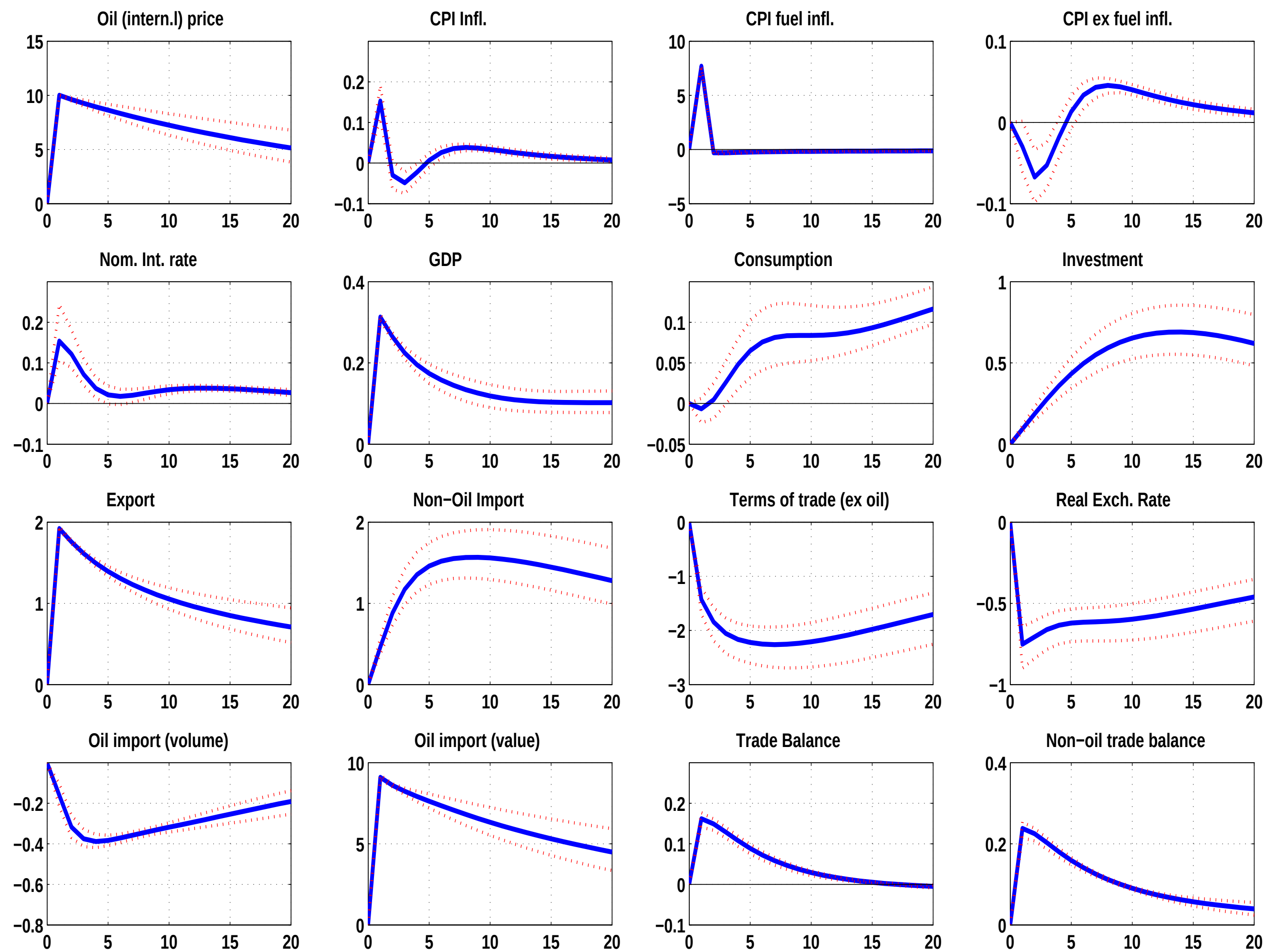
Horizontal axis: quarters. Vertical axis: percentage deviations from the baseline, except for inflation and interest rates (annualized percentage-point deviations), and the trade balance (as a ratio to GDP, percentage-point deviations). GDP and its components are reported in real terms.

Figure 3: Responses to a positive oil-specific demand shock



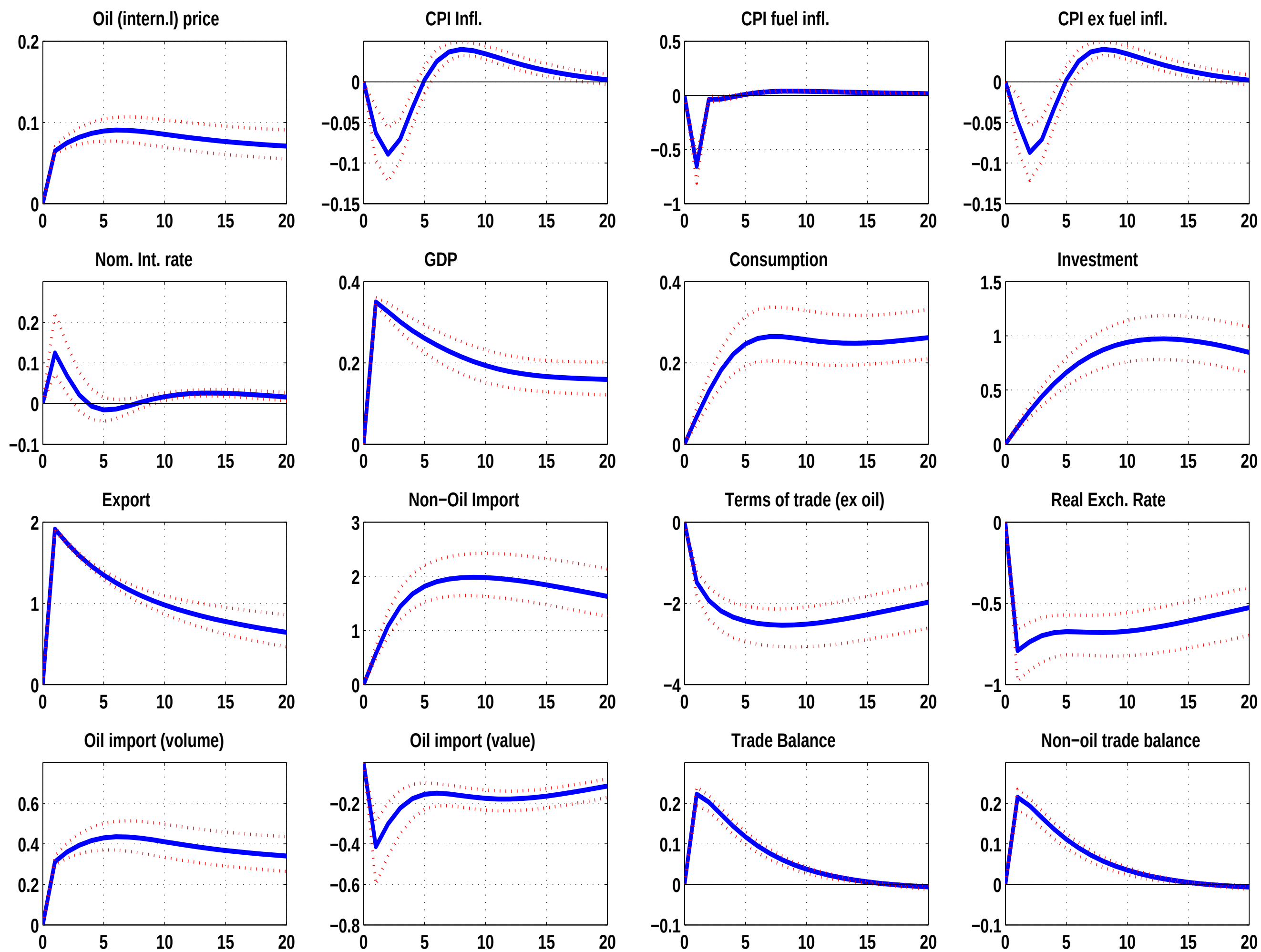
Horizontal axis: quarters. Vertical axis: percentage deviations from the baseline, except for inflation and interest rates (annualized percentage-point deviations), and the trade balance (as a ratio to GDP, percentage-point deviations). GDP and its components are reported in real terms.

Figure 4: Responses to a positive foreign aggregate demand shock



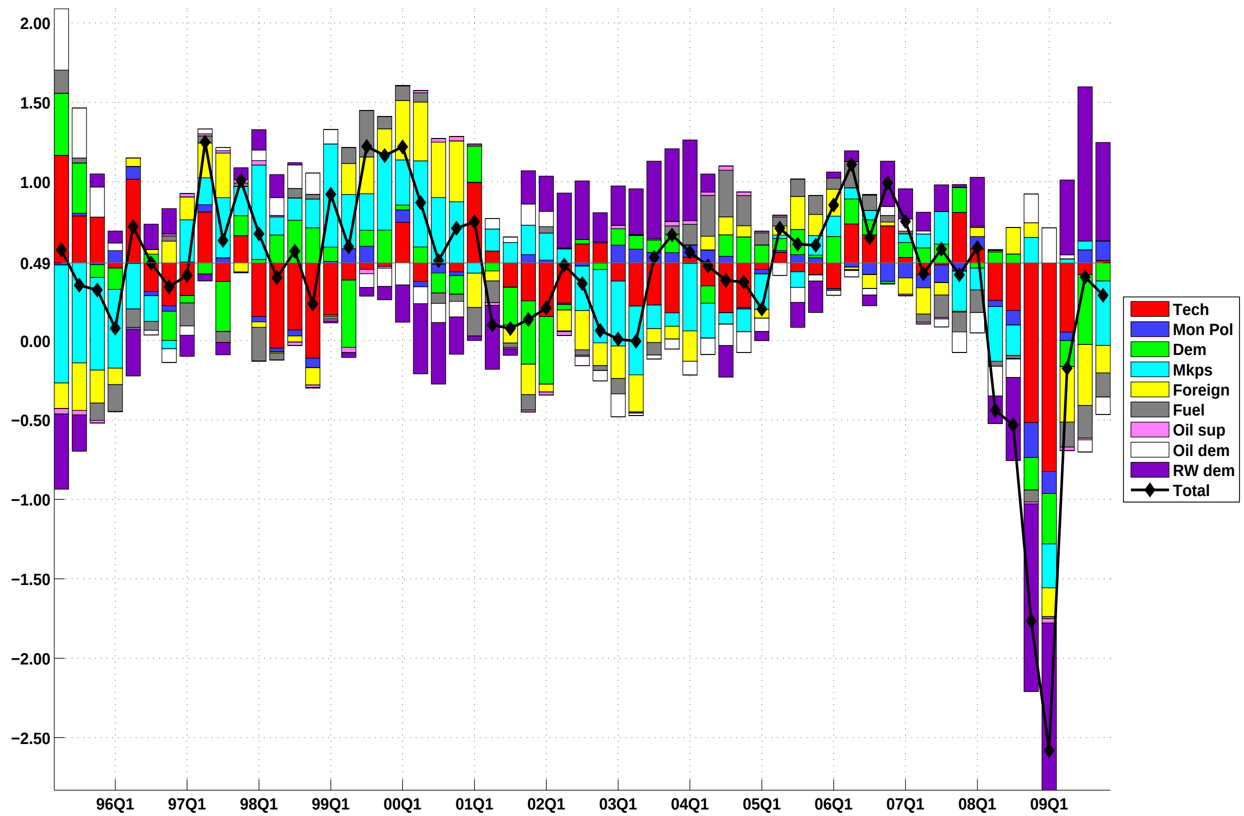
Horizontal axis: quarters. Vertical axis: percentage deviations from the baseline, except for inflation and interest rates (annualized percentage-point deviations), and the trade balance (as a ratio to GDP, percentage-point deviations). GDP and its components are reported in real terms.

Figure 5: Responses to a positive foreign aggregate demand shock that does not affect the price of oil



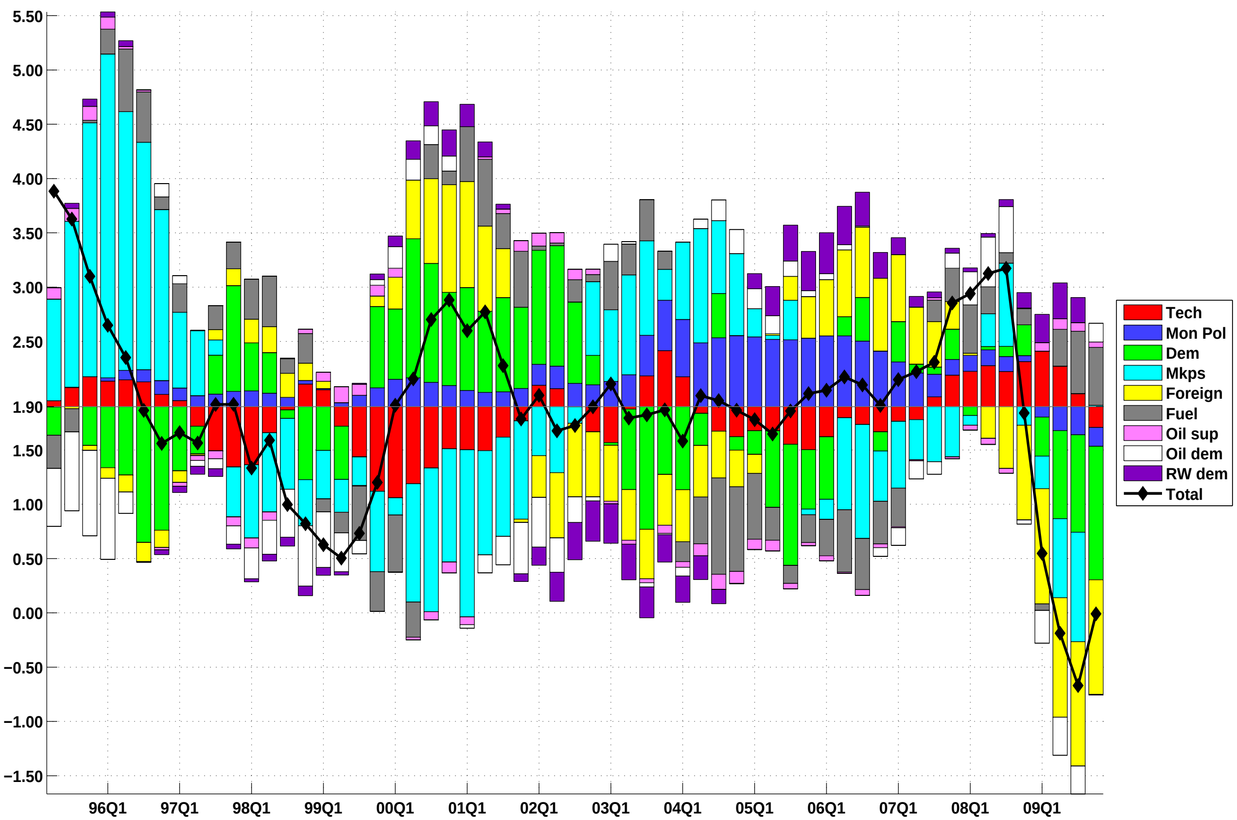
Horizontal axis: quarters. Vertical axis: percentage deviations from the baseline, except for inflation and interest rates (annualized percentage-point deviations), and the trade balance (as a ratio to GDP, percentage-point deviations). GDP and its components are reported in real terms.

Figure 6: Historical decomposition of GDP growth rate (q/q)



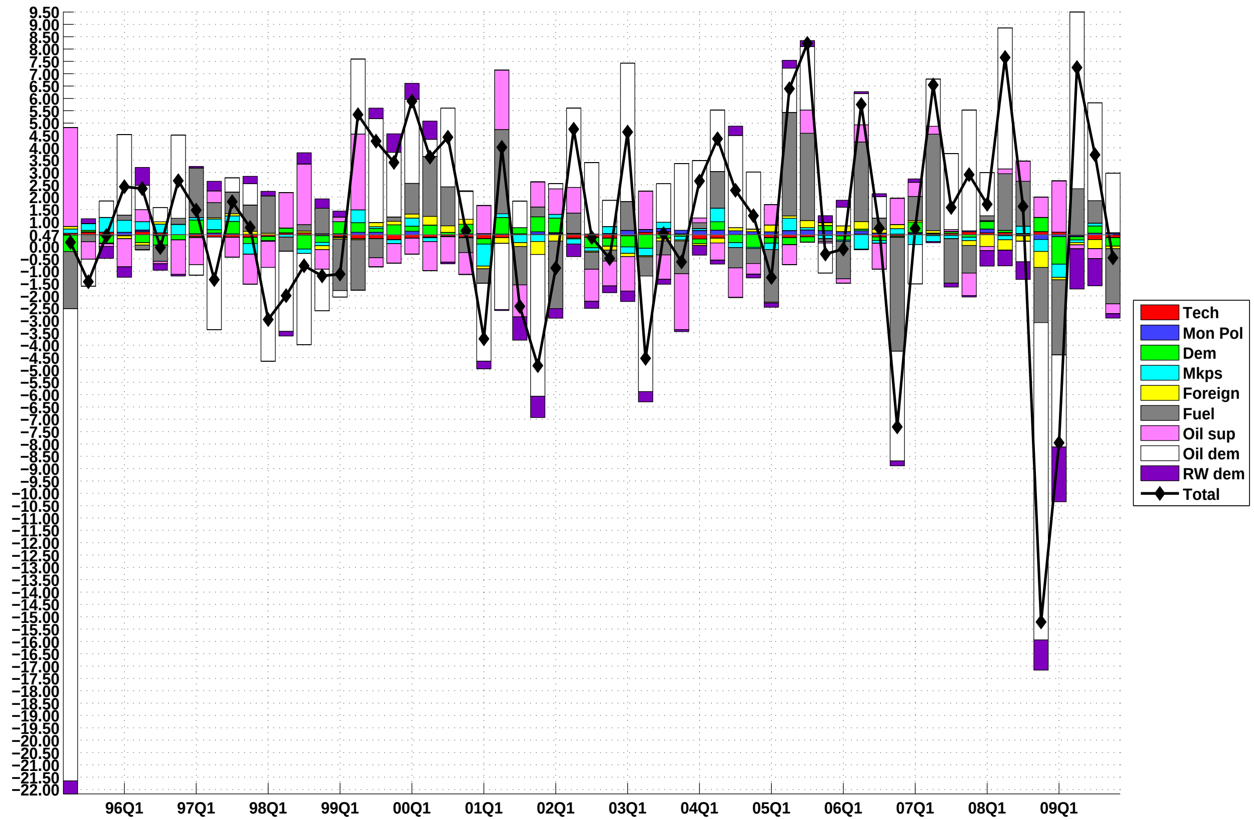
Each colored bar shows how that group of shocks contributes to the absolute deviation from steady-state (expressed in percentage points) of the GDP growth rate in a given quarter.

Figure 7: Historical decomposition of yearly inflation rate



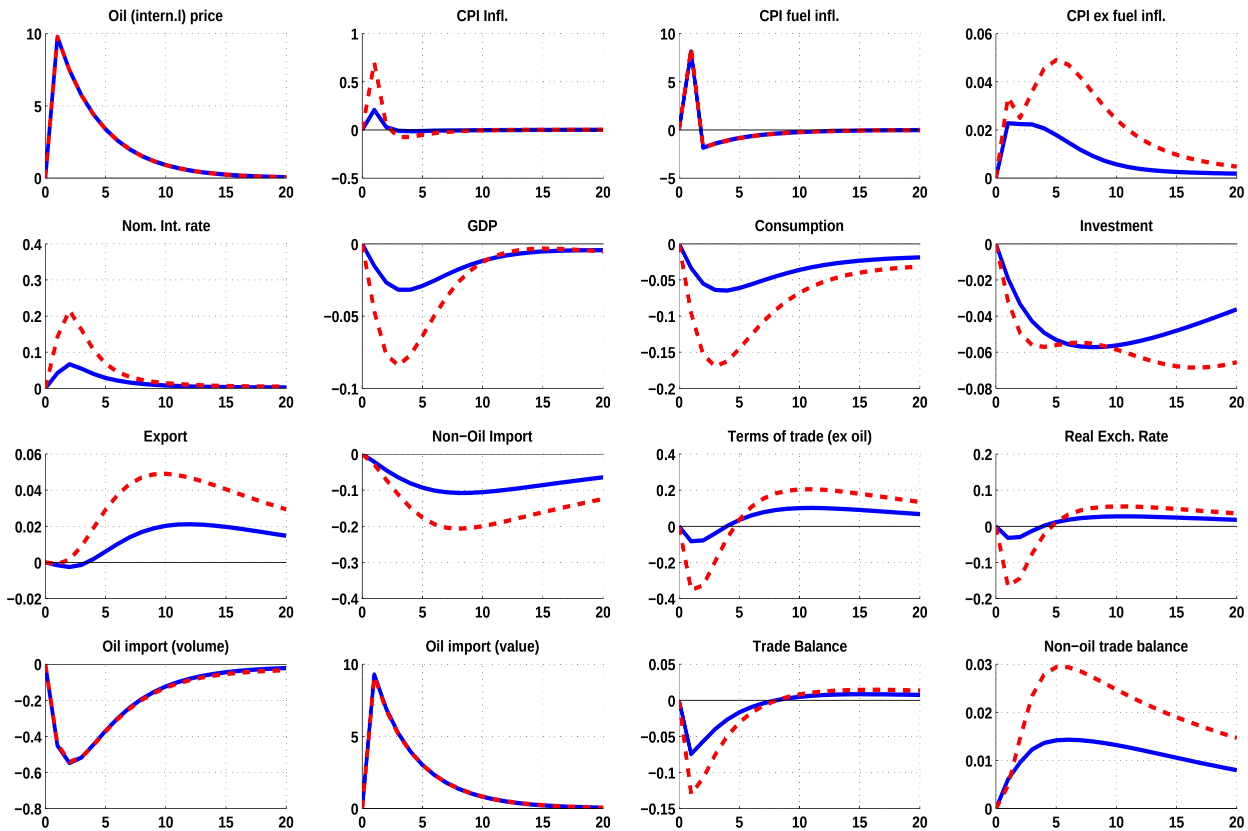
Each colored bar shows how that group of shocks contributes to the absolute deviation from steady-state (expressed in percentage points) of the yearly inflation rate in a given quarter.

Figure 8: Historical decomposition of international relative price of oil



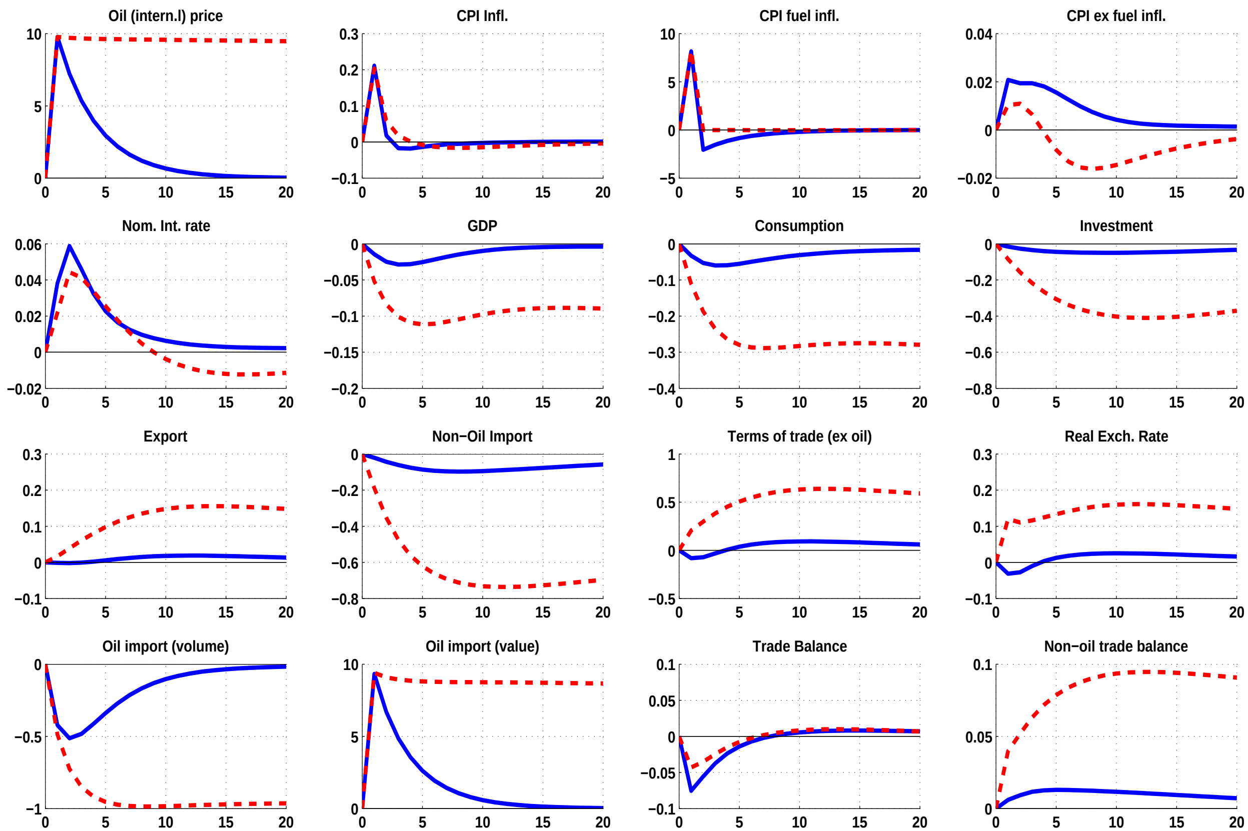
Each colored bar shows how that group of shocks contributes to the absolute deviation from steady-state (expressed in percentage points) of the oil price in a given quarter.

Figure 9: Responses to a negative oil supply shock. High fuel weight in consumption



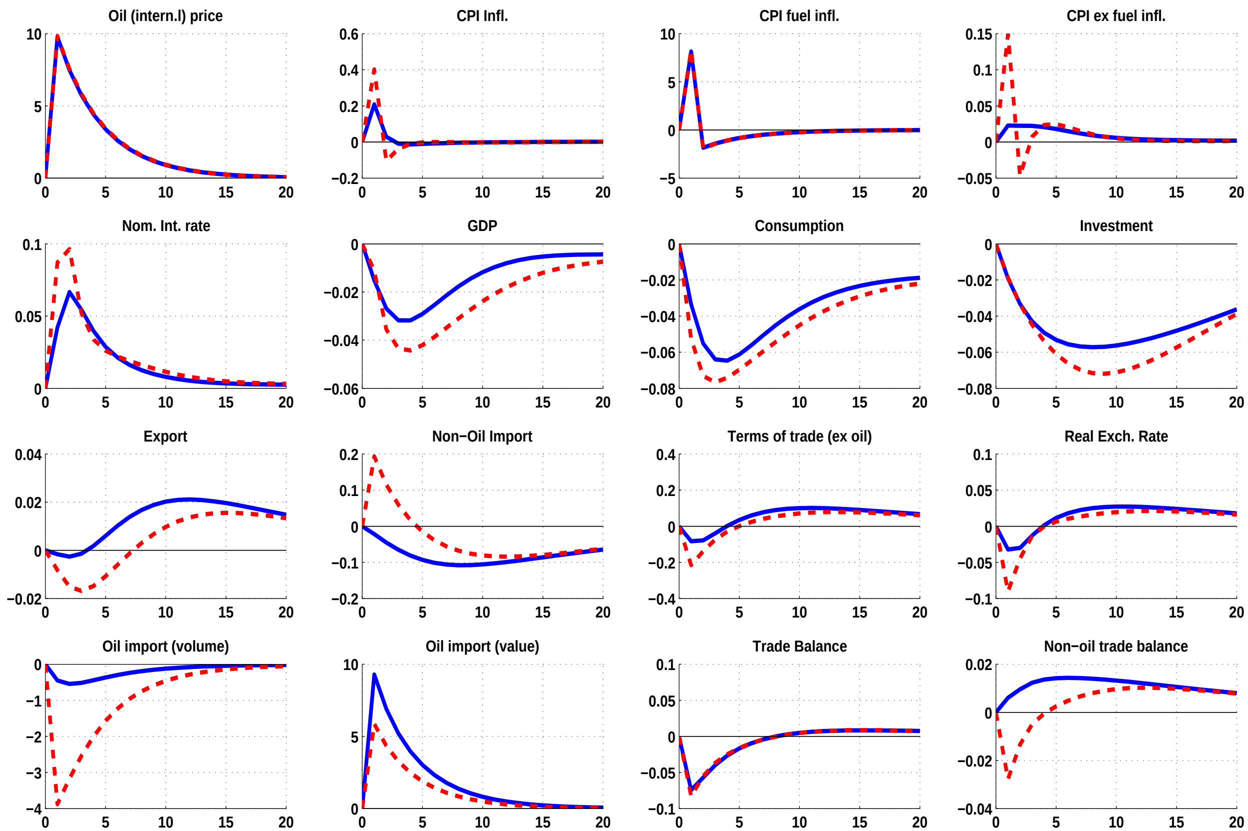
Horizontal axis: quarters. Vertical axis: percentage deviations from the baseline, except for inflation and interest rates (annualized percentage-point deviations), and the trade balance (as a ratio to GDP, percentage-point deviations). GDP and its components are reported in real terms. Blue line: baseline calibration. Red dotted line: high fuel weight.

Figure 10: Responses to a negative oil supply shock. Permanent oil supply shock



Horizontal axis: quarters. Vertical axis: percentage deviations from the baseline, except for inflation and interest rates (annualized percentage-point deviations), and the trade balance (as a ratio to GDP, percentage-point deviations). GDP and its components are reported in real terms. Blue line: baseline calibration. Red dotted line: permanent shock.

Figure 11: Responses to a negative oil supply shock. High fuel elasticity



Horizontal axis: quarters. Vertical axis: percentage deviations from the baseline, except for inflation and interest rates (annualized percentage-point deviations), and the trade balance (as a ratio to GDP, percentage-point deviations). GDP and its components are reported in real terms. Blue line: baseline calibration. Red dotted line: high elasticity.

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G. DE BLASIO and G. NUZZO, *Historical traditions of civicness and local economic development*, Journal of Regional Science, v. 50, 4, pp. 833-857, **TD No. 591 (May 2006).**

E. IOSSA and G. PALUMBO, *Over-optimism and lender liability in the consumer credit market*, Oxford Economic Papers, v. 62, 2, pp. 374-394, **TD No. 598 (September 2006).**

S. NERI and A. NOBILI, *The transmission of US monetary policy to the euro area*, International Finance, v. 13, 1, pp. 55-78, **TD No. 606 (December 2006).**

F. ALTISSIMO, R. CRISTADORO, M. FORNI, M. LIPPI and G. VERONESE, *New Eurocoin: Tracking Economic Growth in Real Time*, Review of Economics and Statistics, v. 92, 4, pp. 1024-1034, **TD No. 631 (June 2007).**

U. ALBERTAZZI and L. GAMBACORTA, *Bank profitability and taxation*, Journal of Banking and Finance, v. 34, 11, pp. 2801-2810, **TD No. 649 (November 2007).**

M. IACOVIELLO and S. NERI, *Housing market spillovers: evidence from an estimated DSGE model*, American Economic Journal: Macroeconomics, v. 2, 2, pp. 125-164, **TD No. 659 (January 2008).**

F. BALASSONE, F. MAURA and S. ZOTTERI, *Cyclical asymmetry in fiscal variables in the EU*, Empirica, **TD No. 671**, v. 37, 4, pp. 381-402 **(June 2008).**

F. D'AMURI, O. GIANMARCO I.P. and P. GIOVANNI, *The labor market impact of immigration on the western german labor market in the 1990s*, European Economic Review, v. 54, 4, pp. 550-570, **TD No. 687 (August 2008).**

A. ACCETTURO, *Agglomeration and growth: the effects of commuting costs*, Papers in Regional Science, v. 89, 1, pp. 173-190, **TD No. 688 (September 2008).**

S. NOBILI and G. PALAZZO, *Explaining and forecasting bond risk premiums*, Financial Analysts Journal, v. 66, 4, pp. 67-82, **TD No. 689 (September 2008).**

A. B. ATKINSON and A. BRANDOLINI, *On analysing the world distribution of income*, World Bank Economic Review , v. 24, 1 , pp. 1-37, **TD No. 701 (January 2009).**

R. CAPPARIELLO and R. ZIZZA, *Dropping the Books and Working Off the Books*, Labour, v. 24, 2, pp. 139-162 ,**TD No. 702 (January 2009).**

C. NICOLETTI and C. RONDINELLI, *The (mis)specification of discrete duration models with unobserved heterogeneity: a Monte Carlo study*, Journal of Econometrics, v. 159, 1, pp. 1-13, **TD No. 705 (March 2009).**

L. FORNI, A. GERALI and M. PISANI, *Macroeconomic effects of greater competition in the service sector: the case of Italy*, Macroeconomic Dynamics, v. 14, 5, pp. 677-708, **TD No. 706 (March 2009).**

V. DI GIACINTO, G. MICUCCI and P. MONTANARO, *Dynamic macroeconomic effects of public capital: evidence from regional Italian data*, Giornale degli economisti e annali di economia, v. 69, 1, pp. 29-66, **TD No. 733 (November 2009).**

F. COLUMBA, L. GAMBACORTA and P. E. MISTRULLI, *Mutual Guarantee institutions and small business finance*, Journal of Financial Stability, v. 6, 1, pp. 45-54, **TD No. 735 (November 2009).**

A. GERALI, S. NERI, L. SESSA and F. M. SIGNORETTI, *Credit and banking in a DSGE model of the Euro Area*, Journal of Money, Credit and Banking, v. 42, 6, pp. 107-141, **TD No. 740 (January 2010).**

M. AFFINITO and E. TAGLIAFERRI, *Why do (or did?) banks securitize their loans? Evidence from Italy*, Journal of Financial Stability, v. 6, 4, pp. 189-202, **TD No. 741 (January 2010).**

S. FEDERICO, *Outsourcing versus integration at home or abroad and firm heterogeneity*, Empirica, v. 37, 1, pp. 47-63, **TD No. 742 (February 2010).**

V. DI GIACINTO, *On vector autoregressive modeling in space and time,* Journal of Geographical Systems, v. 12, 2, pp. 125-154, **TD No. 746 (February 2010).**

L. FORNI, A. GERALI and M. PISANI, *The macroeconomics of fiscal consolidations in euro area countries,* Journal of Economic Dynamics and Control, v. 34, 9, pp. 1791-1812, **TD No. 747 (March 2010).**

S. MOCETTI and C. PORELLO, *How does immigration affect native internal mobility? new evidence from Italy,* Regional Science and Urban Economics, v. 40, 6, pp. 427-439, **TD No. 748 (March 2010).**

A. DI CESARE and G. GUAZZAROTTI, *An analysis of the determinants of credit default swap spread changes before and during the subprime financial turmoil,* Journal of Current Issues in Finance, Business and Economics, v. 3, 4, pp., **TD No. 749 (March 2010).**

P. CIPOLLONE, P. MONTANARO and P. SESTITO, *Value-added measures in Italian high schools: problems and findings*, Giornale degli economisti e annali di economia, v. 69, 2, pp. 81-114, **TD No. 754 (March 2010).**

A. BRANDOLINI, S. MAGRI and T. M SMEEDING, *Asset-based measurement of poverty,* Journal of Policy Analysis and Management, v. 29, 2 , pp. 267-284, **TD No. 755 (March 2010).**

G. CAPPELLETTI, *A Note on rationalizability and restrictions on beliefs,* The B.E. Journal of Theoretical Economics, v. 10, 1, pp. 1-11,**TD No. 757 (April 2010).**

S. DI ADDARIO and D. VURI, *Entrepreneurship and market size. the case of young college graduates in Italy,* Labour Economics, v. 17, 5, pp. 848-858, **TD No. 775 (September 2010).**

A. CALZA and A. ZAGHINI, *Sectoral money demand and the great disinflation in the US*, Journal of Money, Credit, and Banking, v. 42, 8, pp. 1663-1678, **TD No. 785 (January 2011).**

2011

S. DI ADDARIO, *Job search in thick markets*, Journal of Urban Economics, v. 69, 3, pp. 303-318, **TD No. 605 (December 2006).**

F. SCHIVARDI and E. VIVIANO, *Entry barriers in retail trade,* Economic Journal, v. 121, 551, pp. 145-170, **TD No. 616 (February 2007).**

G. FERRERO, A. NOBILI and P. PASSIGLIA, *Assessing excess liquidity in the Euro Area: the role of sectoral distribution of money,* Applied Economics, v. 43, 23, pp. 3213-3230, **TD No. 627 (April 2007).**

P. E. MISTRULLI, *Assessing financial contagion in the interbank market: maximun entropy versus observed interbank lending patterns*, Journal of Banking & Finance, v. 35, 5, pp. 1114-1127, **TD No. 641 (September 2007).**

E. CIAPANNA, *Directed matching with endogenous markov probability: clients or competitors?*, The RAND Journal of Economics, v. 42, 1, pp. 92-120, **TD No. 665 (April 2008).**

M. BUGAMELLI and F. PATERNÒ, *Output growth volatility and remittances*, Economica, v. 78, 311, pp. 480-500, **TD No. 673 (June 2008).**

V. DI GIACINTO e M. PAGNINI, *Local and global agglomeration patterns: two econometrics-based indicators,* Regional Science and Urban Economics, v. 41, 3, pp. 266-280, **TD No. 674 (June 2008).**

G. BARONE and F. CINGANO, *Service regulation and growth: evidence from OECD countries,* Economic Journal, v. 121, 555, pp. 931-957, **TD No. 675 (June 2008).**

R. GIORDANO and P. TOMMASINO, *What determines debt intolerance? The role of political and monetary institutions*, European Journal of Political Economy, v. 27, 3, pp. 471-484, **TD No. 700 (January 2009).**

P. ANGELINI, A. NOBILI e C. PICILLO, *The interbank market after August 2007: What has changed, and why?*, Journal of Money, Credit and Banking, v. 43, 5, pp. 923-958, **TD No. 731 (October 2009).**

L. FORNI, A. GERALI and M. PISANI, *The Macroeconomics of Fiscal Consolidation in a Monetary Union: the Case of Italy,* in Luigi Paganetto (ed.), Recovery after the crisis. Perspectives and policies, VDM Verlag Dr. Muller, **TD No. 747 (March 2010).**

A. DI CESARE and G. GUAZZAROTTI, *An analysis of the determinants of credit default swap changes before and during the subprime financial turmoil,* in Barbara L. Campos and Janet P. Wilkins (eds.), The Financial Crisis: Issues in Business, Finance and Global Economics, New York, Nova Science Publishers, Inc., **TD No. 749 (March 2010).**

A. LEVY and A. ZAGHINI, *The pricing of government guaranteed bank bonds,* Banks and Bank Systems, v. 6, 3, pp. 16-24, **TD No. 753 (March 2010).**

G. BARBIERI, C. ROSSETTI and P. SESTITO, *The determinants of teacher mobility: evidence using Italian teachers' transfer applications,* Economics of Education Review, v. 30, 6, pp. 1430-1444, **TD No. 761 (June 2010).**

G. GRANDE and I. VISCO, *A public guarantee of a minimum return to defined contribution pension scheme members*, The Journal of Risk, v. 13, 3, pp. 3-43, **TD No. 762 (June 2010).**

P. DEL GIOVANE, G. ERAMO and A. NOBILI, *Disentangling demand and supply in credit developments: a survey-based analysis for Italy*, Journal of Banking and Finance, v. 35, 10, pp. 2719-2732, **TD No. 764 (June 2010).**

G. BARONE and S. MOCETTI, *With a little help from abroad: the effect of low-skilled immigration on the female labour supply,* Labour Economics, v. 18, 5, pp. 664-675, **TD No. 766 (July 2010).**

A. FELETTIGH and S. FEDERICO, *Measuring the price elasticity of import demand in the destination markets of italian exports,* Economia e Politica Industriale, v. 38, 1, pp. 127-162, **TD No. 776 (October 2010).**

S. MAGRI and R. PICO, *The rise of risk-based pricing of mortgage interest rates in Italy*, Journal of Banking and Finance, v. 35, 5, pp. 1277-1290, **TD No. 778 (October 2010).**

M. TABOGA, *Under/over-valuation of the stock market and cyclically adjusted earnings*, International Finance, v. 14, 1, pp. 135-164, **TD No. 780 (December 2010).**

S. NERI, *Housing, consumption and monetary policy: how different are the U.S. and the Euro area?*, Journal of Banking and Finance, v.35, 11, pp. 3019-3041, **TD No. 807 (April 2011).**

V. CUCINIELLO, *The welfare effect of foreign monetary conservatism with non-atomistic wage setters*, Journal of Money, Credit and Banking, v. 43, 8, pp. 1719-1734, **TD No. 810 (June 2011).**

A. CALZA and A. ZAGHINI, *welfare costs of inflation and the circulation of US currency abroad,* The B.E. Journal of Macroeconomics, v. 11, 1, Art. 12, **TD No. 812 (June 2011).**

I. FAIELLA, *La spesa energetica delle famiglie italiane*, Energia, v. 32, 4, pp. 40-46, **TD No. 822 (September 2011).**

R. DE BONIS and A. SILVESTRINI, *The effects of financial and real wealth on consumption: new evidence from OECD countries,* Applied Financial Economics, v. 21, 5, pp. 409–425, **TD No. 837 (November 2011).**

F. CAPRIOLI, P. RIZZA and P. TOMMASINO, *Optimal fiscal policy when agents fear government default,* Revue Economique, v. 62, 6, pp. 1031-1043, **TD No. 859 (March 2012).**

2012

M. PERICOLI and M. TABOGA, *Bond risk premia, macroeconomic fundamentals and the exchange rate,* International Review of Economics and Finance, v. 22, 1, pp. 42-65, **TD No. 699 (January 2009).**

G. ASCARI and T. ROPELE, *Disinflation in a DSGE perspective: sacrifice ratio or welfare gain ratio?*, Journal of Economic Dynamics and Control, v. 36, 2, pp. 169-182, **TD No. 736 (January 2010).**

A. ACCETTURO and G. DE BLASIO, *Policies for local development: an evaluation of Italy's "Patti Territoriali",* Regional Science and Urban Economics, v. 42, 1-2, pp. 15-26, **TD No. 789 (January 2011).**

FORTHCOMING

M. BUGAMELLI and A. ROSOLIA, *Produttività e concorrenza estera,* Rivista di politica economica, **TD No. 578 (February 2006).**

F. CINGANO and A. ROSOLIA, *People I know: job search and social networks*, Journal of Labor Economics, **TD No. 600 (September 2006).**

M. BRATTI, D. CHECCHI and G. DE BLASIO, *Does the expansion of higher education increase the equality of educational opportunities? evidence from Italy,* Labour, **TD No. 679 (June 2008).**

S. MOCETTI, *Educational choices and the selection process before and after compulsory school*, Education Economics, **TD No. 691 (September 2008).**

P. SESTITO and E. VIVIANO, *Reservation wages: explaining some puzzling regional patterns*, Labour, **TD No. 696 (December 2008).**

P. PINOTTI, M. BIANCHI and P. BUONANNO, *Do immigrants cause crime?*, Journal of the European Economic Association, **TD No. 698 (December 2008).**

F. LIPPI and A. NOBILI, *Oil and the macroeconomy: a quantitative structural analysis,* Journal of European Economic Association, **TD No. 704 (March 2009).**

F. CINGANO and P. PINOTTI, *Politicians at work. The private returns and social costs of political connections*, Journal of the European Economic Association, **TD No. 709 (May 2009).**

Y. ALTUNBAS, L. GAMBACORTA, and D. MARQUÉS-IBÁÑEZ, *Bank risk and monetary policy*, Journal of Financial Stability, **TD No. 712 (May 2009).**

A. FINICELLI, P. PAGANO and M. SBRACIA, *Ricardian selection*, Journal of International Economics, **TD No. 728 (October 2009).**

G. BARONE and S. MOCETTI, *Tax morale and public spending inefficiency*, International Tax and Public Finance, **TD No. 732 (November 2009).**

I. BUONO and G. LALANNE, *The effect of the Uruguay Round on the intensive and extensive margins of trade*, Journal of International Economics, **TD No. 835 (February 2011).**

G. BARONE, R. FELICI and M. PAGNINI, *Switching costs in local credit markets*, International Journal of Industrial Organization, **TD No. 760 (June 2010).**

L. MONTEFORTE and G. MORETTI, *Real-Time forecasts of inflation: the role of financial variables*, Journal of Forecasting, **TD No. 767 (July 2010).**

E. COCOZZA and P. PISELLI, *Testing for east-west contagion in the European banking sector during the financial crisis*, in R. Matoušek; D. Stavárek (eds.), Financial Integration in the European Union, Taylor & Francis, **TD No. 790 (February 2011).**

S. NERI and T. ROPELE, *Imperfect information, real-time data and monetary policy in the Euro area*, The Economic Journal, **TD No. 802 (March 2011).**

M. AFFINITO, *Do interbank customer relationships exist? And how did they function in the crisis? Learning from Italy*, Journal of Banking and Finance, **TD No. 826 (October 2011).**

O. BLANCHARD and M. RIGGI, Why are the 2000s so different from the 1970s? A structural interpretation of changes in the macroeconomic effects of oil prices, Journal of the European Economic Association, **TD No. 835 (November 2011).**

R. CRISTADORO and D. MARCONI, *Households Savings in China*, Chinese Economic and Business Studies, **TD No. 838 (November 2011).**