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QUEST III: An estimated open-economy DSGE model of the euro area with fiscal and monetary policy ☆

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ABSTRACT

This paper develops a DSGE model for an open economy and estimates it on euro area data using Bayesian estimation techniques. The model features nominal and real frictions, as well as financial frictions in the form of liquidity-constrained households. The model incorporates active monetary and fiscal policy rules (for government consumption, investment, transfers and wage taxes) and can be used to analyse the effectiveness of stabilisation policies. To capture the unit root character of macroeconomic time series we allow for a stochastic trend in TFP, but instead of filtering data prior to estimation, we estimate the model in growth rates and stationary nominal ratios.

1. Introduction

In this paper we develop a Dynamic Stochastic General Equilibrium (DSGE) model for an open economy. We estimate this model on quarterly data for the euro area using Bayesian estimation techniques. Following Christiano, Eichenbaum and Evans (2005) considerable progress has been made in recent years in the estimation of New-Keynesian DSGE models which feature nominal and real frictions. In these models, behavioural equations are explicitly derived from intertemporal optimisation of private sector agents under technological, budget and institutional constraints such as imperfections in factor, goods and financial markets. In this framework, macroeconomic fluctuations can be seen as the optimal response of the private sector to demand and supply shocks in various markets, given the constraints mentioned above. DSGE models are therefore well suited to analyse the extent to which fiscal and monetary policies can alleviate existing distortions by appropriately responding to macroeconomic shocks.

Following Smets and Wouters (2003) DSGE models have been used extensively to study the effects of monetary policy and the stabilising role of monetary rules. In particular it has been demonstrated that an active role for monetary policy arises from the presence of nominal rigidities in goods and factor markets. So far, not much work has been devoted towards exploring the role of fiscal policy in the New-Keynesian model. Our paper therefore extends this literature by incorporating and estimating reaction functions for government consumption, investment and transfers into a DSGE model.

There is substantial empirical evidence that prices and wages adjust sluggishly to supply and demand shocks as documented in numerous studies of wage and price behaviour, starting from early Phillips curve estimates (see, for example, Phelps, 1967) and extending to recent estimates using both backward as well as forward looking price and wage rules (see e.g. Gali et al., 2001). The recent work by Gali et al. (2007), Coenen and Straub (2005) and Forni et al. (2006) has also highlighted the presence of liquidity constraints as an additional market imperfection. The introduction of non-Ricardian behaviour in the model could give rise to a role for fiscal stabilisation, since liquidity-constrained households do not respond to interest rate signals.

Obviously, a prerequisite for such an analysis is a proper empirical representation of the data generating process. The seminal work of Smets and Wouters (2003) has shown that DSGE models can in fact provide a satisfactory representation of the main macroeconomic aggregates in the Euro area. Also, various papers by Adolfson et al. (2007) have documented a satisfactory forecasting performance when

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compared to standard VAR benchmarks. This paper extends the basic DSGE model in four directions. First, it respects the unit root character of macroeconomic time series by allowing for stochastic trends in TFP. Unlike many other estimated DGSE models, we do not detrend our data with linear time trends or the Hodrick–Prescott filter, but we estimate the model in growth rates and nominal ratios. Secondly, it treats the euro area as an open economy, which introduces additional shocks to the economy through trade and the exchange rate. Thirdly, it adds financial market imperfections in the form of liquidity-constrained households to imperfections in the form of nominal rigidities in goods and labour markets. Fourthly, it introduces a government sector with stabilising demand policies. We empirically identify government spending rules by specifying current government consumption, investment and transfers as functions of their own lags as well as current and lagged output and unemployment gaps and we allow a fraction of transfers to respond to deviations of government debt from its target. From the operation of the euro area unemployment insurance system we know that unemployment benefits provide quasi-automatic income stabilisation. Indeed we find a significant response of transfers to cyclical variations in employment. A priori government consumption is not explicitly countercyclical, though it can already provide stabilisation by keeping expenditure fixed in nominal terms over the business cycle. The empirical evidence suggests that fiscal policy is used in a countercyclical fashion in the euro area.

Our paper is structured as follows. In the following section we describe the model and characterise the shocks hitting the euro area economy. Section 3 presents the empirical fit of our DSGE model and we present priors and posterior estimates as well as the variance decomposition of the model. In Section 4 we analyse the impulse response functions of the main macroeconomic variables to structural shocks.

2. The model

We consider an open economy which faces an exogenous world interest rate, world prices and world demand. The domestic and foreign firms produce a continuum of differentiated goods. The goods produced in the home country are imperfect substitutes for goods produced abroad. The model economy is populated by households and firms and there is a monetary and fiscal authority, both following rule-based stabilisation policies. We distinguish between households which are liquidity constrained and consume their disposable income and households who have full access to financial markets. The latter make decisions on financial and real capital investments. Behavioural and technological relationships can be subject to autocorrelated shocks denoted by U_t^k, where k stands for the type of shock. The logarithm of U_t^k[1] will generally follow an AR(1) process with autocorrelation coefficient ρ^k and innovation ε_t^k.

2.1. Firms

2.1.1. Final output producers

There are n monopolistically competitive final goods producers. Each firm indexed by j produces a variety of the domestic good which is an imperfect substitute for varieties produced by other firms. Domestic firms sell to private domestic households, to investment goods producing firms, the government and to exporting firms. All demand sectors have identical nested CES preferences across domestic varieties and between domestic and foreign goods, with elasticity of substitution σ^{d} and σ^{M} respectively. The demand function for firm j is given by

$$Y_t^j = \frac{(1-s^{\mathrm{M}}-u_t^{\mathrm{M}})}{n}\left(\frac{P_t}{P_t^j}\right)^{\sigma^{\mathrm{d}}}\left(\frac{P_t^C}{P_t}\right)^{\sigma^{\mathrm{M}}}\left[\left(C_t+C_t^{\mathrm{G}}+I_t^{\mathrm{G}}+I_t^{\mathrm{inp}}+X_t\right)\right] \tag{1}$$

where C_t is total consumption of private households, C_t^{G} and I_t^{G} denote government consumption and investment, I_t^{inp} is the input of investment goods producing firms and X_t represents exports. The variables P_t, P_t^j and P_t^C represent the price index of final output, the price of an individual firm and the consumption price index. We make the assumption that individual firms are small enough such as to take P_t and P_t^C as given. Output is produced with a Cobb Douglas production function using capital K_t^j and production workers $L_t^j-\mathrm{LO}_t^j$

$$Y_t^j = \left(\mathrm{ucap}_t^j K_t^j\right)^{1-\alpha}\left(L_t^j - LO_t^j\right)^{\alpha} U_t^{Y^{\alpha}} K_t^{\mathrm{G}^{(1-\alpha_{\mathrm{G}})}}, \quad \text{with} \quad L_t^j = \left[\int_0^1 L_t^{i,j\frac{\theta-1}{\theta}}\mathrm{d}i\right]^{\frac{\theta}{\theta-1}}. \tag{2}$$

The term LO_t^j represents overhead labour. Total employment of the firm L_t^j is itself a CES aggregate of labour supplied by individual households i. The parameter $\theta>1$ determines the degree of substitutability among different types of labour. Firms also decide about the degree of capacity utilisation (ucap_t^j). There is an economy wide technology shock U_t^Y which follows a random walk with drift

$$u_t^Y = g_t^U + u_{t-1}^Y + \varepsilon_t^Y. \tag{3}$$

The share of overhead labour in total employment (lol_t^j) follows an AR(1) process around its long run value

$$\mathrm{lol}_t^j = (1-\rho^{LOL})\mathrm{lol} + \rho^{\mathrm{LOL}}\mathrm{lol}_{t-1}^j + \varepsilon_t^{\mathrm{LOL}}. \tag{4}$$

The objective of the firm is to maximise the present discounted value of profits Pr_t^j

$$\mathrm{Pr}_t^j = \frac{P_t^j}{P_t}Y_t^j - \frac{W_t}{P_t}L_t^j - i_t^K\frac{P_t^I}{P_t}K_t^j - \frac{1}{P_t}\left(adj^P\left(P_t^j\right) + adj^L\left(L_t^j\right) + adj^{UCAP}\left(ucap_t^j\right)\right), \tag{5}$$

where i^K denotes the rental rate of capital. Firms also face technological and regulatory constraints which restrict their price setting, employment and capacity utilisation decisions. Price setting rigidities can be the result of the internal organisation of the firm or specific customer–firm relationships associated with certain market structures. Costs of adjusting labour have a strong job specific component (e.g. training costs) but higher employment adjustment costs may also arise in heavily regulated labour markets with search frictions. Costs associated with the utilisation of capital can result from higher maintenance costs associated with a more intensive use of capital. Adjustment costs are given by the following convex functional forms

$$\mathrm{adj}^L\left(L_t^j\right) = W_t\left(L_t^j u_t^L + \frac{\gamma_L}{2}\Delta L_t^{j^2}\right) \tag{6a}$$

$$\mathrm{adj}^P\left(P_t^j\right) = \frac{\gamma_P}{2}\frac{\Delta P_t^{j^2}}{P_{t-1}^j} \tag{6b}$$

$$\mathrm{adj}^{\mathrm{UCAP}}\left(\mathrm{ucap}_t^j\right) = PI_tK_t\left(\gamma_{\mathrm{ucap},1}\left(\mathrm{ucap}_t^j-1\right) + \frac{\gamma_{\mathrm{ucap},2}}{2}\left(\mathrm{ucap}_t^j-1\right)^2\right). \tag{6c}$$

The firm determines labour input, capital services and prices optimally in each period given the technological and administrative constraints as well as demand conditions. The first-order conditions are given by:

$$\frac{\partial \mathrm{Pr}_t^j}{\partial L_t^j} \Rightarrow \left(\alpha\frac{Y_t^j}{L_t^j - LO_t^j}\eta_t^j - \frac{W_t}{P_t^j}u_t^L - \frac{W_t}{P_t^j}\gamma_L\Delta L_t^j + E_t\left(\frac{W_{t+1}}{P_{t+1}^j}\frac{\gamma_L}{(1+r_t)}\Delta L_{t+1}^j\right)\right) = \frac{W_t}{P_t^j} \tag{7a}$$

$$\frac{\partial \mathrm{Pr}_t^j}{\partial K_t^j} \Rightarrow \left((1-\alpha)\frac{Y_t^j}{K_t^j}\eta_t^j\right) = i_t^K\frac{P_t^{I,j}}{P_t^j} \tag{7b}$$

[1] Lower cases denote logarithms, i.e. z_t=log(Z_t). Lower cases are also used for ratios and rates.