OUTPUT AND INFLATION RESPONSES TO DEMAND AND SUPPLY DISTURBANCES IN EURO AREA

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1. Introduction

After creating the device needed for a single European currency and its adoption on January 1999, the European Central Bank has been addressed a lot of criticism regarding the implementation of the monetary policy in the euro area. Even before that date Aglietta and Boissieu (1998) already highlighted the institutional shortcomings in the procedural responsibilities of the new institutions. These deficiencies have resulted in the first years of operation in numerous complaints that have targeted poor communication of the ECB or its lack of transparency. Therefore, the monetary policy has been accused as the economic situation deteriorated in the euro area among the participating countries. Indeed the ECB's task is more complex than that of United States Federal Reserve, for example. Table 1 shows the share that variable rates have in the total interest rate on mortgage loans in certain euro area countries. Variable rates have a share in the total rate of between 15% and 98%, so the ECB's change directory interest rate has different effects in each country. There is a great heterogeneity, which implies a large uncertainty on monetary policy transmission channels.

Various studies do not provide any information on how to act when there is uncertainty regarding the monetary policy transmission. Therefore, there are many uncertainties about how a single monetary policy can work effectively for different macroeconomic entities. The same uncertainty exists regarding price dynamics in the euro area. Given that inflation is different for the euro area, a modification of the directory interest rate has different effects on price dynamics. Thus, the ECB may find the situation where a country would require an expansionary monetary policy, while other a more restrictive monetary policy. Therefore, in order that the ECB's monetary policy effects on inflation and other macroeconomic variables be similar in the euro area is needed accurate correlation of business cycles in each country (i.e. the response of the price index to an increase in the rate guidelines of the ECB to be similar in all countries.).

Table 1 - Share of floating rates in the total interest rate on mortgage loans

Germany	15%
Austria	58%
Belgium	52%
Spain	95%
Finland	97%
France	35%
Greece	88%
Italy	85%
Ireland	92%
Luxembourg	81%
Netherlands	44%
Portugal	98%

Source: www.ecb.int

Therefore we intend that through *vector autoregressive* methodology to

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provide an overview of how on long run, the main macroeconomic variables (gross domestic product and inflation) in the euro zone respond to the demand and supply shocks. Thus, we can know more precisely the interconnections between economic variables and the functioning of the economic mechanism in the euro area.

Three types of models are currently used to find the answers to two major questions: what are the estimated effects of monetary policy inflection on prices and production? How these effects do they spread?

a) Models of general equilibrium of dynamic stochastic type. One of the objectives of modern macroeconomic theory is to combine the mechanisms of the transmission of monetary policy through the interest rate channel and the decisions of central banks in models of general equilibrium of dynamic stochastic type (DGSE: dynamic general stochastic equilibrium models) that are characterized by: (i) a certain short-term rigidity of prices and wages, (ii) rational expectations of economic agents and population, (iii) equations derived from optimization behavior of firms and households. The interactions between the three key variables of monetary policy - interest rates, inflation and output - are represented by three equations: (1) an IS curve where the expectations are represented: thus the current output depends on its expected future value and the real interest rate, equal with the difference between nominal interest rate and expected inflation: $y_t = E_t y_{t+1} - \sigma(i_t - E_t\pi_{t+1})$ with $\sigma > 0$; 2) a new-Keynesian Phillips curve in which the inflation depends on expected inflation and current levels of production: $\pi_t = \beta E_t \pi_{t+1} + \gamma y_t$; 3) the third equation is represented by a Taylor rule: $i_t = \alpha\pi_t - \beta y_t$.

b) Traditional econometric models. Based on a detailed representation of the behavior of the economy, explaining from the macroeconomic point of view every form of equations, they are the modern version of Keynesian econometric models, improved during the 1990s by taking into account the expectations and by examining their long term properties.

c) *Vector autoregressive* (VAR). Assuming that the knowledge of how the economy work is limited in these models no structure is imposed, or they are minimized.

2. Methodology and data used

Econometric methodology used in this article is the *vector autoregressive* (VAR). The choice of this methodology is justified by the nature of the investigation of this study. Macroeconomic phenomena manifest as complex dynamic systems with feedback and mutual causality. Therefore, type analysis system (simultaneous equations) is able to capture the interconnections between macro-economic variables. In addition, we must consider the heterogeneity present in the macroeconomic entities from the Euro area. *Vector autoregressive* methodology (VAR) is a very common method in time series analysis, mainly due to its flexibility and ease of use. It can be considered a generalization of both the univariate autoregressive model because dependent variables are the sites of explanatory variables but also the simultaneous equations, because it is estimated a system of equations simultaneously. In addition, each equation also includes lagged endogenous variables of the other variables. In general, the model does not include exogenous variables, as it is done in modeling.

One of the features of VAR models is the fact that they capture the dynamic structure of several variables simultaneously, and the impulse functions capture a variable response to a shock of another variable. VAR models focus on the "shock" analysis on the

variables studied. Shock or "innovation" is that part of the variable which cannot be explained by history (the past values of that variable) or by other variables in the system. An innovation appears thus as error term (residual) in the stochastic equation of the system. The main purpose of the VAR type analysis is to assess the effects of various shocks on the variables in the system. Each variable is affected by its own innovations and also by innovations in other variables. Thus, crucial questions may receive answers in terms of macroeconomic policy formulation: How prices react to an exchange rate shock? For example, the impulse response function can describe in relative terms (the unit normally used is the standard deviation), the price response to a shock after a certain period. The main information provided by the impulse response function refers to the response sign (positive or negative) and to the continued effects of various shocks.

The main purpose of this study is to investigate the dynamics of prices and output in the euro area using an econometric approach based on demand and aggregate supply shocks. Thus, we will analyze data on output and prices for the euro area economy to extract information on unanticipated disturbances of supply and aggregate demand. To this end, we will use the approach based on *vector autoregresive* to isolate the supply and demand shocks, methodology developed by Blanchard and Quah (1989) and extended by Bayoumi (1991) and Bayoumi and Eichengreen (1992). Unlike Blanchard and Quah (1989) who used the gross national product and unemployment in their analysis, we will use the gross domestic product and the consumer price index, because so we can analyze the results using the model of supply and aggregate demand. To identify unanticipated developments in demand and aggregate supply and their effects on output and price dynamics, we impose in the same manner as Blanchard and Quah (1989) and Bayoumi and Eichengreen (1992) the following restriction: aggregate demand shocks have only a temporary impact on the level of output, but a permanent effect on prices, while aggregate supply shocks affect permanently both prices and production.

3. The Blanchard-Quah model

The BQ methodology allows the identification of permanent and temporary structural shocks to a variable. This is achieved by imposing long-run restrictions on a VAR system while leaving short-run dynamics to be determined by the data. Assume the VAR model can be represented by an infinite moving average representation of a vector of variables X_t, with an equivalent number of structural shocks ε_t:

$$\Delta X_t = A_0\varepsilon_t + A_1\varepsilon_{t-1} + \ldots = \sum_{i=0}^{\infty} A_i\varepsilon_{t-i}$$

In this setup, the A_i matrices represent the impulse reponse functions of the shocks to the elements of X, while the ε vector contains the supply and demand shocks. When X_t represents the changes of the logarithms of real output and prices, a more specific version of the model can be write as follows:

$$\begin{bmatrix}\Delta y_t \\ \Delta X_t\end{bmatrix} = \sum_{i=0}^{\infty} L^i \begin{bmatrix}a_{11} & a_{12} \\ a_{21} & a_{22}\end{bmatrix}\begin{bmatrix}\varepsilon_{st} \\ \varepsilon_{dt}\end{bmatrix}$$

where

$$Var(\varepsilon_t) = \sum$$

The fundamental shocks ε_{st} and ε_{dt} are assumend to be orthogonal and therefore, the variance-covariance matrix $\sum$ is diagonal. The BQ framework contains the restriction that supply shocks have permanent effects on the level of output while demand shocks

have only temporary effects – implying that the cumulative effect of demand shocks on the change in output must be zero. Both shocks are allowed to have permanent effects on the level of prices. This restriction means that the matrix of long-run moving average coefficients, C(1) must be lower triangular:

$$\sum_{i=0}^{\infty} a_{11} = 0$$

The structural VAR model defined by the second and the fourth equations can be estimated in its reduced form version by ordinary least squares. In typical VAR format, this means that each element of X_t is regressed on lagged values of all the elements of X, with the estimated coefficients represented by B. That is:

$$X_t = B_1 x_{t-1} + B_2 X_{t-2} + \ldots + B_n X_{t-n} + e_t$$

where e_t represents residuals from the estimation of the reduced form VAR. Next, the following algebraic manipulation is used to find the matrix of long-run moving average coefficients:

$$X_t = (I - B(L))^{-1} e_t = (I + B(L) + B(L)^2 + \ldots) e_t$$

$$X_t = e_t + D_1 e_{t-1} + D_2 e_{t-2} + D_3 e_{t-3} + \ldots$$

To move back to the structural model given by the second and the fourth equations, the residuals from the reduced form VAR, e_t, must be transformed into supply and demand shocks ε_t. This is accomplished by the restricted factor matrix C, such that $e_t = C\varepsilon_t$. Given the two variable output growth and inflation case under consideration, four restrictions are required to define the four elements of C. Two of these restrictions are simple normalizations, which define the variance of the shocks ε_{st} and ε_{dt}. A third restriction comes from assuming that the supply and demand shocks are orthogonal. The final restriction comes from assuming that the supply and demand shocks are orthogonal. The final restriction regarding the temporary nature of demand shocks, uniquely defines the C matrix and implies equation (4) in the structural model. For the reduced form VAR, this means:

$$\begin{bmatrix} \Delta y_t \\ \Delta X_t \end{bmatrix} = \sum_{i=0}^{\infty} \begin{bmatrix} d_{11} & d_{12} \\ d_{21} & d_{22} \end{bmatrix} \begin{bmatrix} c_{11} & c_{12} \\ c_{21} & c_{22} \end{bmatrix} = \begin{bmatrix} .. & 0 \\ .. & .. \end{bmatrix}$$

Although this restriction affects the response of output to the two shocks, it does not affect the impact of these shocks on prices. However, a basic aggregate supply (AS) and aggregate demand (AD) model (with a vertical long-run AS curve) implies that demand shocks should raise prices in both the short and long-run, while supply shocks should lower prices. In this model, a positive demand shock will result in a shift of the AD curve to the right, and in the short-run, to higher output and prices (Figure 1). In the long-run, the output increase is short –lived as the prices level increases to generate a new equilibrium output at potential along the new AD curve. A positive supply shock shifts short and long-run AS curves to the right by the same amount (Figure 2). Thus, in the short as well as in the long run, prices decline as output expands.

Since these responses are not imposed, authors who have used the BQ model to identify supply and demand shocks, have also examined the impulse response functions for these patterns as a form of over-identifying restriction. Researchers have found these useful in interpreting the results and ensuring that output and prices respond in a theoretically correct way to supply and demand shocks.

Quarterly data on real GDP and consumer prices index were used for the euro area. The time sample is from 1995Q1 to 2009Q4 and the data are from Eurostat. These series were de-seasonalized by using the TRAMO SEATS methodology. I will difference the variables and introduce the first

difference in longs in the VAR analysis. From an economic point of view the use of first differences of variables instead of their levels is intuitive as we want to establish correlations between economic growth (and not the level of GDP) and inflation (and not the level of GDP deflator). Thus, it makes even more sense to work with the first difference of the logged variables. The optimal lag length utilized is three.

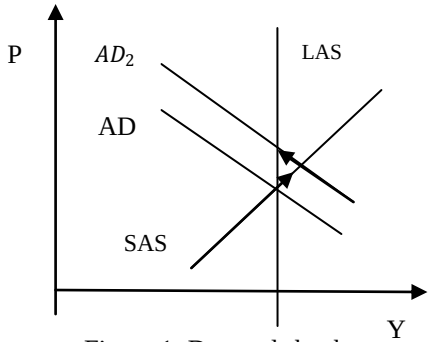


Figure 1: Demand shock

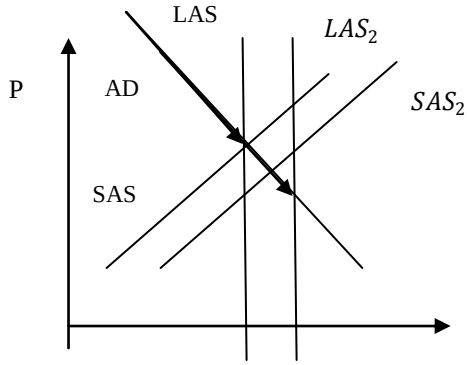
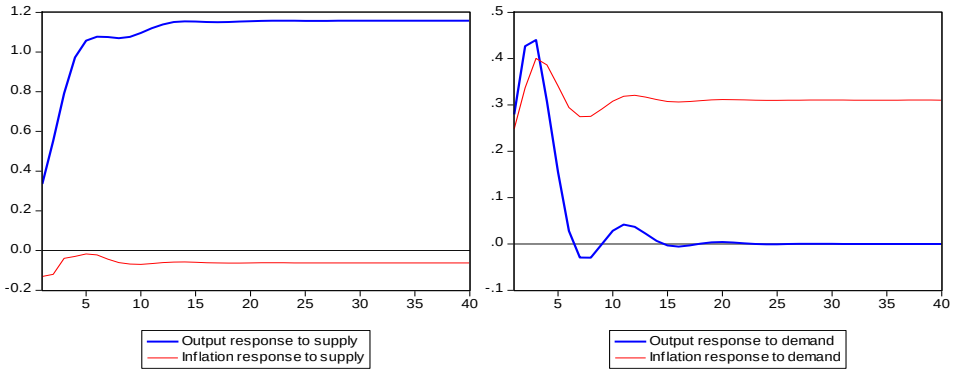


Figure 2: Supply shock

4. Empirical results of the estimations

Figure 3 present the impulse response results (the results were obtained using the Eviews program) of the output and inflation to supply and demand shocks. To note is that our results are similar to those obtained by Bayoumi and Eichengreen (1992) or Ross (2003). As we see the estimated results of the simulated model are consistent with the AS-AD methodology. Thus, a positive aggregate demand shock is associated with an increase in prices, inflation reaching a peak at the end of the first quarter, followed by a period of stabilization, while the supply shock is associated with a decrease in inflation. A positive supply shock should determine a decline in prices as these shocks are usually associated with gains in productivity or improved technique that favorably influences the level of prices. As it can be observed from the below graphs, possibly most important of all, at least for the beginning of the analysis, the result that an aggregate demand shock has only temporary and positive influence on output is confirmed.

Figure 3 - impulse response results of the output and inflation to supply and demand shocks



5. Conclusions

The results of empirical research give us an insight into factors influencing the evolution of gross domestic product and inflation in the euro area. A number of important conclusions can be drawn from the representation of these impulse response functions. First, demand shocks are almost as important on short run for gross domestic product as those of supply (on the long run the supply shocks are more important given the temporary effect of the demand shock on the gross domestic product). Secondly, the effects of a demand shock on the level of output will disappear after about two quarters, being absorbed by the economy. Thirdly, it should be noted the important impact of the demand shocks on the inflation dynamic.

Moreover, the adoption of the euro would have a positive impact only if in the countries that wish to adopt the single currency gross domestic product and inflation responses to supply and demand shocks are as close as possible to those of the euro area. A different response of inflation, for example, at an aggregate demand shock might have adverse effects on the country that adopted the euro as its adjustment through monetary policy will no longer be possible. For the ECB's monetary policy effects on output and inflation to be similar in the euro area countries it is needed accurate correlation of business cycles in each country, so that output and inflation response to supply shocks and aggregate demand to be as similar as possible.

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