DOES ONE MONETARY POLICY FIT ALL? THE DETERMINANTS OF INFLATION IN EMU COUNTRIES*

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Abstract

This chapter aims at assessing the long-run determinants and the short-run dynamics of inflation in each country belonging to the European Monetary Union (EMU). Our work complements the recent literature on this topic for the Euro Area as a whole. Detecting such determinants can be crucial in designing structural reforms acting as aside instruments of monetary policy in maintaining price stability. The empirical methodology consists of a re-interpretation of the structural cointegrating VAR approach, which allows for a structural long-run analysis of inflation determinants along with an accurate assessment of its short-run dynamics. The main conclusion emerging from the estimates is that not only the determinants of inflation differ in the countries belonging to the Euro Area, but also that cost-push factors have a considerable role in explaining inflation in most of the countries examined. As a policy implication, a tight monetary policy pursued in those countries whose inflation is mainly driven by costs would result in a contraction of economic activity without exerting relevant effects on price dynamics.

JEL no. C32, E00, E31, E37.
Keywords: Inflation, markup, EMU countries, long-run structural VARs, subset VEC models.

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* The views expressed do not necessarily reflect those of the Ministry of Economy and Finance and of the Institute for Economic Studies and Analyses (ISAE) of Italy.

1 Introduction

On 1 January 1999 eleven European countries entered the third stage of the European Monetary Union. A new currency – the euro – replaced the national currencies, and a new institution – the Eurosystem, consisting of the European Central Bank (ECB) and the national central banks of those countries that adopted the euro – took on the responsibility for the monetary policy within the Euro Area. The single countries' governments remained in charge of the fiscal policy under the binding constraints of the Stability and Growth Pact.

In the new European institutional architecture designed by the Treaty of Maastricht, the Eurosystem has the main objective of maintaining the price stability in the Euro Area. More precisely, the single monetary policy of the ECB is carried out targeting the price stability of the Euro Area as a whole and, as such, it is common to all countries belonging to the EMU. The price stability is quantitatively defined as an annual inflation rate, referred to the Harmonized Index of Consumer prices (HICP), close to 2% in the medium-run. The ECB's monetary policy strategy is based on two pillars related to the temporal perspectives relevant for assessing the risks to price stability: the economic analysis aims to determine the short to medium-term determinants of price dynamics, while the monetary analysis focuses on longer-term horizons. The economic analysis focuses on the shocks hitting the European economy and produces projections of the main macroeconomic variables; the monetary analysis, exploiting the long-run link between money and prices, monitors the development of several monetary indicators, including the aggregate M3, its components, and counterparts, in particular the domestic credit and the different measures of excess liquidity (ECB, 2004).

By this strategy, the ECB fits one instrument to all countries, disregarding the country-specific determinants of prices long- and short-run dynamics. Nevertheless, the assessment of such determinants can be crucial in designing structural reforms acting as aside instruments of monetary policy in maintaining price stability. In this respect, a disaggregated analysis, conducted by estimating national models, can shed light on country-specific determinants of inflation and possibly identify those countries where cost-push factors have the most relevant role.

This chapter aims at assessing the long-run determinants and the short-run dynamics of inflation in each country belonging to the European Monetary Union (EMU). Our work is a complement of the recent literature on this topic for the Euro Area as a whole (Banerjee and Russel, 2002b; Bowdler and Jansen, 2004; Boschi and Girardi, 2005). With reference to the monetary policy strategy pursued by the ECB, the present analysis may be considered as contributing to the first "pillar," aiming to uncover the economic determinants of inflation.

The empirical methodology consists of a re-interpretation of the structural cointegrating VAR approach recently proposed by Garratt *et al.* (2003). This allows for a structural long-run analysis of inflation determinants along with an accurate assessment of its short-run dynamics. To this end, the Vector Error Correction (VEC) methodology (Johansen, 1995) is applied to a four-dimensional system including the labor productivity, the real exchange rate, the domestic inflation rate and the ratio between unit labor cost and price level. We use data ranging from the first quarter of 1984 to the last quarter of 1998 for each EMU member country, namely Austria, Belgium, Finland, France, Germany, Ireland, Italy, Netherlands, Portugal, and Spain. Luxembourg and Greece are not included, the first due to its negligible economic dimension, the second because it entered EMU later than the other countries.

The investigation consists of two stages. *First*, we disentangle the long-run determinants of inflation in each of the member countries of the EMU within the theoretical framework developed by Boschi and Girardi (2005), which is based on two long-run dynamic relationships (Juselius, 2002) relating inflation to the markup and the output gap respectively. This extends the model introduced by Banerjee *et al.* (2001). These long-run structural relationships between the variables of the model are embedded in an otherwise unrestricted VAR model and finally tested formally. *Next*, the estimated models are used to analyze the short-run behavior of inflation, highlighting the factors that drive its dynamics.

The main conclusions emerging from the estimates are that: *i*) the determinants of inflation differ in the countries belonging to the Euro Area; *ii*) cost-push factors have a considerable role in explaining inflation in most of the countries examined. A tight monetary policy pursued in those countries whose inflation is mainly driven by costs would result in a contraction of economic activity without exerting relevant effects on prices dynamics. This would be the consequence of higher financing costs for firms and a lower aggregate demand determined by an increasing interest rate. These are precisely the effects observed in the most recent years, when most of the European economies have been characterized by close to zero output rates of growth.

The paper is articulated as follows: Section 2 discusses some stylized facts on the convergence process of EMU member countries and their structural characteristics. Section 3 introduces the long-run theoretical framework. Section 4 describes the econometric methodology used, illustrating the long-run structural modeling approach and the parsimonious (subset) VEC procedure to analyze short-run dynamics. Section 5 illustrates the tests performed in order to check the statistical validity of the theoretical constraints on the long-run structure and reports both long- and short-run parameters estimates. Conclusion and References follow.

2 Stylized Facts

During the second stage of the EMU a progressive homogenization of national economic policies and structural features of several European countries took place, even though the Maastricht criteria were met only partially. Despite very dissimilar conditions in terms of deficit/GDP and debt/GDP ratios across member countries at the time of their entrance in the third stage of the EMU, an almost complete convergence in terms of interest and inflation rates occurred.

Figure 1 (dashed line) shows the reduction of the standard deviation of yield differentials between ten-year government bonds issued in the EMU member countries (with the exception of Greece) and the corresponding ten-year government bond issued in Germany, regarded to as a risk-free asset (Favero *et al.*, 1997), over the EMS years. During the eighties and the nineties, indeed, Germany was a meta-economic reference point for the other European countries. Although its central role may be less evident in recent years, Germany still weights for roughly one third of the euro area GDP. Moreover, the German monetary and fiscal policy strategies have inspired, to some extent, the EMU's institutional architecture.

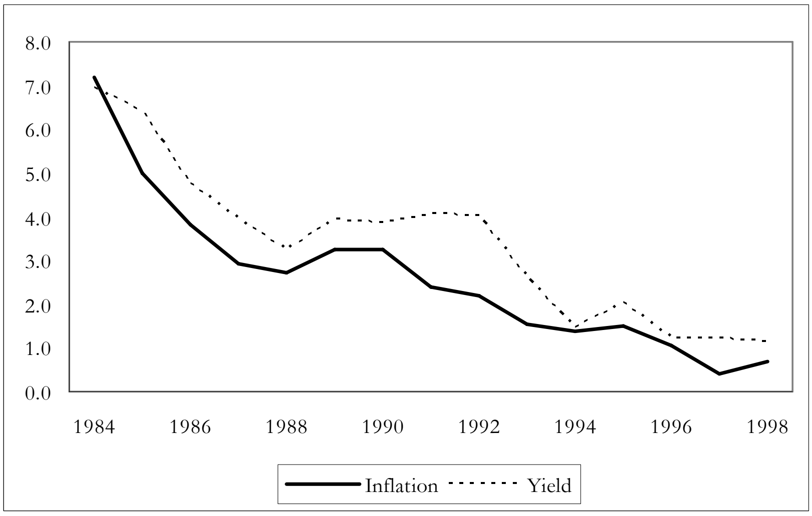

Figure 1 – Standard deviation of inflation and long-term interest rate differentials vis-à-vis Germany for EMU countries: 1984-1998. Percentage values.

Analogously, the dispersion of inflation differentials with respect to Germany decreased over time, mainly starting from the first years of the nineties (Figure 1, continuous line), suggesting that to some extent a convergence of price levels has occurred in Europe.

This is also shown in Figure 2, illustrating the dispersion of the relative price level at the beginning of the period of analysis (horizontal axis) and of the average inflation differential over the period 1984-1998 (vertical axis) for the EMU member countries with respect to Germany. It should be noted that countries exhibiting higher (lower) price levels as compared to the base country are characterized by lower (higher) inflation rates.

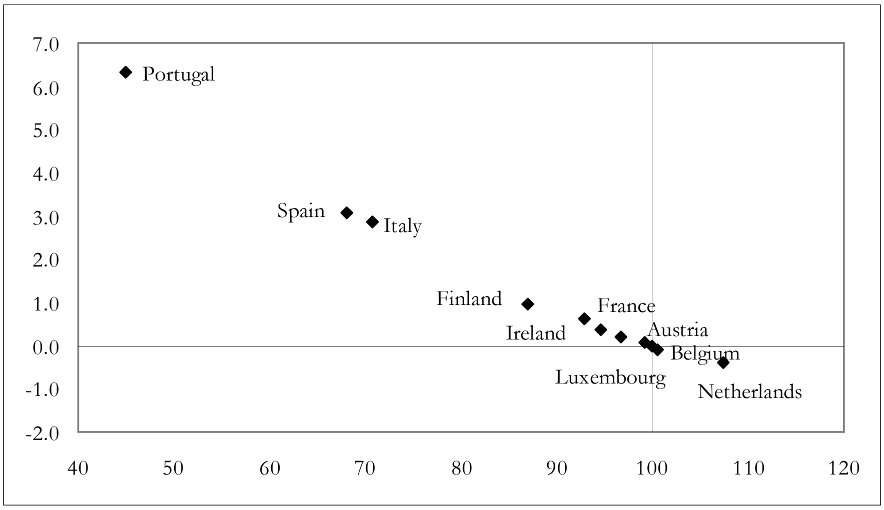

Figure 2 – Relative prices (horizontal axis) in 1984 and 1984-1998 average inflation rate differentials vis-à-vis Germany for EMU countries (vertical axis, percentage values).

The observed *nominal* convergence occurred in Europe during the mid-eighties and nineties was coupled by *real* convergence in several economies. Spain, Portugal and Ireland successfully restructured their economic systems through projects mainly financed by Cohesion Funds (see Basile *et al*., 2001). Interestingly, the huge difference in GDP growth rates across EMU member countries was not accompanied by a relevant differentiation in terms of sector composition of their added value.

Table 1 reports the percentage share of each sector's added value for the ten countries analyzed over the sample period. Each country's average rate of growth is reported in the fourth column.

Table 1 – Distribution and average rate of growth of output (1984*q*1–1998*q*4).

	PRIMARY	**SECONDARY**	**TERTIARY**	**AV. RATE OF GROWTH**
Aus	3.26	33.66	63.08	2.40
Bel	2.22	31.05	66.73	2.33
Fin	5.80	33.26	60.93	2.50
Fra	3.64	29.02	67.34	2.13
Ger	1.54	35.67	62.79	2.11
Ire	8.57	35.94	55.49	5.72
Ita	3.78	32.76	63.46	2.06
Net	4.03	30.45	65.52	2.91
Por	7.06	31.53	61.41	3.25
Spa	6.44	32.44	61.12	2.95

Therefore, it is important to consider the structural features of these economies beyond such stylized facts, in order to uncover the main determinants driving inflation in EMU member countries.

3 Theoretical Framework

Inflation can be defined as the loss of purchasing power undergone by money over time: an increase in the general level of prices increases the number of monetary units required to buy a given good. The rate of growth of the prices level measures the rate of inflation.

Inflation can be classified according to its causes: *excess demand inflation*, *cost-pushed inflation*, and *imported inflation*.

The first type of inflation occurs when an increase of aggregate demand pushes the price level up because of the presence of an inelastic supply of goods and services, or in the extreme case of full employment. In monetary terms, the supply is higher than the demand for money. The economic agents will try and spend in goods and services the excess money balances, but since all production inputs are full employed, the increased aggregate demand will not result in increased supply but rather in a higher equilibrium level price. This is called excess demand inflation, or, more simply, demand inflation. According to the original cause of the excess money supply, we distinguish between financial and credit inflation. In the first case the excess money supply is caused by seigniorage, i.e. by the government issuing money in order to finance public expenditure; in the second case the excess money supply is determined by the excessive credit created by the financial system.

The second kind of inflation is originated by costs. Economic theory states that under perfect market competition equilibrium prices equal marginal costs. However, in practice a number of markets operate under imperfect or even monopolistic competition. In such market structures prices may well differ from marginal costs. Specifically, it is usually assumed that the mechanism of price formation be based on the markup, i.e. on the application of a proportional marginal profit on production costs. This pricing strategy implies that inflation may be determined by costs. For example, a sudden increase of oil price may be transmitted on prices through the markup.

Finally, in open economies, a further cause of inflation, referred to as "imported" inflation, is the nominal exchange rate devaluation. Inflation occurs because, in first instance, the exchange rate devaluation raises the local currency-denominated price of imported consumption goods and production inputs. Subsequently, the change in international relative prices will affect quantities, driving the economic system to a new equilibrium.

The main consequences of inflation are related to the change of relative prices. Relative prices change as a consequence of inflation and this causes uncertainty, distortions and income redistribution. An increase of inflation may exert a number of effects on the economy. *First*, given the nominal interest rate, it will reduce the real interest rate thus stimulating consumption to the detriment of saving and reducing the real burden of debt. *Second*, a raising inflation may reduce the international competitiveness of exporting firms, thus inducing them to reduce the markup.

In this Section the possible theoretical long-run path of the EMU countries' inflation is presented.[1] It consists of two dynamic steady-state relationships extending the scheme proposed by Banerjee *et al.* (2001) and Banerjee and Russell (2002 a).

The starting point of the analysis is the following system:

$$p_t - w_t = -\omega_1 \cdot OG_t - \omega_2 \cdot \phi_t - \omega_3 \cdot \Delta p_t - \omega_4 \cdot t \tag{1}$$

$$w_t - p_t = -\gamma_1 \cdot U_t + \gamma_2 \cdot \phi_t + \gamma_3 \cdot t \tag{2}$$

$$\Delta p_t = -\delta \cdot U_t \tag{3}$$

$$U_t = -\psi \cdot OG_t \tag{4}$$

where p_t indicates the logarithm of the price level, w_t the logarithm of nominal wages, OG_t an output gap measure, ϕ_t the logarithm of productivity, Δ the difference operator, and U_t the unemployment rate. The parameters are all positive. As in Banerjee *et al.* (2001), (1) and (2) represent the formulas for markup[2] and real wages, respectively, (3) identifies the Phillips curve, and (4) the Okun's law. The linear trend in (1) captures the possible effects of

[1] This Section and the subsequent draw extensively on Boschi and Girardi (2005).

[2] The presence of Δp_t in (1) implies that inflation may represent a cost to firms even in the long-run (e.g. because of the difficulties faced by price-setting firms in adjusting prices in an inflationary environment with incomplete information). Thus, an increase in costs may not be fully reflected in higher prices because the markup falls with higher inflation.

taxation and other costs (especially raw materials and energy) on the formation mechanism of markup. Analogously, the trend in (2) represents the possible influence of factors such as unemployment benefits and tax rates on the demand for real wages.

3.1 Cost-push Inflation

Substituting (4) in (2), OG_t can be deleted in (1) and (2) obtaining the relationship between markup and inflation:

$$(p_t - w_t) = -\frac{(\omega_2 \cdot \gamma_1 \cdot \psi - \omega_1 \cdot \gamma_2)}{(\gamma_1 \cdot \psi - \omega_1)} \cdot \phi_t - \frac{\omega_3 \cdot \gamma_1 \cdot \psi}{(\gamma_1 \cdot \psi - \omega_1)} \cdot \Delta p_t - \frac{(\omega_4 \cdot \gamma_1 \cdot \psi - \omega_1 \cdot \gamma_3)}{(\gamma_1 \cdot \psi - \omega_1)} \cdot t \qquad (5)$$

In order to assure that labor and firms have stable income shares in the long-run, the coefficient of ϕ_t in (5) must be unitary. Assuming that firms maximize profits ($\omega_2 = 1$), this condition holds for any values of γ_2 if firms fix prices independently of demand ($\omega_1 = 0$) or if linear homogeneity is assumed ($\gamma_2 = 1$). Therefore, equation (5) becomes:

$$p_t - ulc_t = -\mu_1 \cdot \Delta p_t - \mu_0 \cdot t \qquad (6)$$

where $ulc_t = w_t - \phi_t$ indicates the unit labor cost and where $\mu_1 = (\omega_3 \cdot \gamma_1 \cdot \psi)/(\gamma_1 \cdot \psi - \omega_1)$ and $\mu_0 = (\omega_4 \cdot \gamma_1 \cdot \psi - \omega_1 \cdot \gamma_3)/(\gamma_1 \cdot \psi - \omega_1)$ are non-negative parameters. If $\mu_1 = 0$, the model (1)-(4) becomes analogous to the standard one proposed, for example, by Layard *et al*. (1991) and Franz and Gordon (1993), where inflation does not represent a cost to firms.

In an open economy framework, equation (6) is modified to take into account the possible relevance of the import price on markup, as in de Brouwer and Ericsson (1998) and Banerjee *et al*. (2001):

$$p_t - \delta \cdot ulc_t - (1-\delta) \cdot pm_t = -\mu_1 \cdot \Delta p_t - \mu_0 \cdot t$$

or

$$-s_t - \beta_0 \cdot ppp_t = -\beta_1 \cdot \Delta p_t - b_0 \cdot t$$

where $s_t = ulc_t - p_t = (w_t - p_t) - \phi_t$ indicates the logarithm of labor income share, $ppp_t = (p_t^* + e_t - p_t) = (pm_t - p_t)$ is a competitiveness index, given by the logarithm of the real exchange rate, and $\beta_0 = (1-\delta)/\delta$, $\beta_1 = \mu_1/\delta$, $b_0 = \mu_0/\delta$. If $\beta_0 > 0$, the external sector plays a role in the formation of domestic prices. Adding a stochastic residual, $\varepsilon_{mu,t}$, we obtain the first long-run condition to test:

$$-s_t - \beta_0 \cdot ppp_t + \beta_1 \cdot \Delta p_t + b_0 \cdot t = \varepsilon_{mu,t} \qquad (7)$$

where $\varepsilon_{mu,t}$ is supposed to be stationary.

3.2 Demand Inflation

Generally, under this second approach inflation is studied through a relationship between price changes and a cyclical indicator (see, for example, Stock and Watson, 1999). From equations (4) and (3) this relationship can be represented as:

$$\Delta p_t = \beta_2 \cdot OG_t \qquad (8)$$

where $\beta_2 = \psi \cdot \delta$ is a positive parameter. The potential output required to obtain OG_t is here estimated by means of a constant returns to scale production function[3] of labor (N_t) and capital stock (K_t), $Y_t = F(K_t, A_t \cdot N_t)$ (Binder and Pesaran, 1999) re-written as:

$$\frac{Y_t}{N_t} = A_t \cdot f(\kappa_t) \qquad (9)$$

where $f(\kappa_t) = F\left(K_t, 1\right)$ is a function that satisfies the Inada conditions and $\kappa_t = K_t / \left(A_t \cdot N_t\right)$ indicates the capital stock per effective labor unit. Assuming that the logarithm of the technological progress index A_t is given by $\ln(A_t) = \varphi \cdot t + u_t$ where u_t is a mean-zero $I(1)$ process, equation (9) becomes (in logs):

$$\phi_t = \varphi \cdot t + \ln\left[f(\kappa_t)\right] + u_t$$

Binder and Pesaran (1999) show that the long-run path of productivity is determined mainly by the technological progress, i.e. $E[\Delta\phi_t] = \varphi$. Therefore, the variable OG_t is specified with a linear trend as a proxy of GDP and employment growth associated to the

[3] Alternatively, an algorithm for the extraction of trend from actual output or an explicit statistical model can be used (Clark *et al.*, 1996; Harvey and Jaeger, 1993).

technological progress.[4] The second long-run condition to test is obtained adding a stochastic residual, $\varepsilon_{pc,t}$, to (8)

$$\Delta p_t - \beta_2 \cdot \phi_t + b_1 \cdot t = \varepsilon_{pc} \tag{10}$$

where the output gap measure is $\phi_t - \varphi \cdot t$, $b_1 = \beta_2 \cdot \varphi > 0$ and ε_{pc} is supposed to be stationary.

4 Econometric Methodology

The econometric methodology is based on the VEC methodology (Johansen, 1995). This modeling approach allows to describe in detail both long-run relationships and short-run dynamic interdependencies existing among (a small set of) variables. More specifically, the approach used in this study consists of two steps. In the first step, the empirical investigation is driven by the theoretical specification of the long-run equilibrium paths. This is consistent with the idea that economic theory is able to highlight the long-run equilibrium relationships among variables, but it is less informative about their short-run dynamics (Garratt *et al*., 2003). In the second step, the dynamic structure of the model is specified according to the statistical properties of the short-run parameters.

4.1 The Structural Cointegrating VAR Model

The long-run relationships presented in Section III are approximated by log-linear equations and embedded in a VEC model:

$$\Delta \mathbf{y}_t = \mathbf{a} + \sum_{j=1}^{m-1} \mathbf{\Gamma}_j \cdot \Delta \mathbf{y}_{t-j} + \mathbf{A} \cdot \boldsymbol{\varepsilon}_{t-1} + \mathbf{\Phi} \cdot \mathbf{d}_t + \mathbf{u}_t \tag{11}$$

$$\mathbf{u}_t \sim N\left(\mathbf{0}, \mathbf{\Sigma}_u\right) \tag{12}$$

This model allows to take jointly into account both the short-run dynamics among the variables collected in the vector $\mathbf{y}_t$=[s_t , ppp_t , Δp_t , ϕ_t]′, and the long-run structure represented by the vector of residuals $\boldsymbol{\varepsilon}_t$ of cointegration relations:

$$\mathbf{b} \cdot t + \mathbf{B}' \cdot \mathbf{y}_t = \boldsymbol{\varepsilon}_t \tag{13}$$

[4] Under the assumption that the share of employed workers on population is stationary, as in Garratt *et al*. (2003), (labor) productivity may represent a measure of per-capita output.

In (11) $\boldsymbol{\Gamma}_j$'s are matrices of autoregression coefficients, $\mathbf{A}$ is a matrix collecting the adjustment coefficients of short-run dynamics to long-run paths, $\mathbf{a}$ is a vector of intercepts, $\mathbf{d}_t$ is a vector of dummy variables whose parameters are in matrix $\boldsymbol{\Phi}$, and $\mathbf{u}_t$ is a vector of residuals distributed according to (12). Equation (13) summarizes the $r < k$ equilibrium relationships that are supposed to hold in the economy: matrix $\mathbf{B}$ collects the parameters defined in (7) and (10), vector $\mathbf{b}$ contains b_0 and b_1 (i.e. the slopes for linear deterministic trends – these are restricted to belong to the cointegration space in order to avoid quadratic trends in the level variables), and $\boldsymbol{\varepsilon}_t$ contains the residuals $\varepsilon_{mu,t}$ and $\varepsilon_{pc,t}$.

All four variables in $\mathbf{y}_t$ are considered endogenous *a priori*, while their possible exogeneity will be verified *ex post*.

In order to exactly-identify the cointegrating matrix $\mathbf{B}$, r contemporaneous restrictions on each cointegration relationship are imposed. Out of these r^2 restrictions, r are normalizations necessary to rotate the cointegration space in the directions represented by the equilibrium conditions. The *structural* relationships (7) and (10) provide the remaining $r^2 - r$ constraints plus an additional one needed in order to obtain an over-identified model. Thus, the system (13), solved with respect to the parameters collected in $\mathbf{b}$ and $\mathbf{B}$, becomes:

$$\begin{bmatrix} b_0 \\ b_1 \end{bmatrix} \cdot t + \begin{bmatrix} -1 & -\beta_0 & \beta_1 & 0 \\ 0 & 0 & 1 & -\beta_2 \end{bmatrix} \cdot \mathbf{y}_t = \begin{bmatrix} \varepsilon_{mu,t} \\ \varepsilon_{pc,t} \end{bmatrix} \tag{14}$$

The above theoretical framework can be verified through a LR test of the overall constraints imposed in (14).

If r = 1, the above framework can also serve as a procedure to discriminate among competitive theories. If inflation is interpretable exclusively from a supply-side point of view, imposing an additional constraint to the $r^2 = 1$ exactly-identifying ones (14) becomes

$$b_0 \cdot t + \begin{bmatrix} -1 & -\beta_0 & \beta_1 & 0 \end{bmatrix} \cdot \mathbf{y}_t = \varepsilon_{mu,t} \tag{15}$$

From a demand-side perspective, (14) becomes:

$$b_1 \cdot t + \begin{bmatrix} 0 & 0 & 1 & -\beta_2 \end{bmatrix} \cdot \mathbf{y}_t = \varepsilon_{pc,t} \tag{16}$$

with two additional constraints.

4.2 The Subset VEC Model

The short-run dynamics is modeled using a parsimonious (subset) VEC model, obtained dropping those parameters of the matrices $\mathbf{A}$, $\boldsymbol{\Gamma}_j$ and $\boldsymbol{\Phi}$ with p-values lower than a threshold, according to the Sequential Elimination of the Regressors Testing Procedure

(SER/TP) proposed by Brüggemann and Lütkepohl (2001). Specifically, the statistically significant parameters of $\mathbf{A}$ give useful information about how the economy moves around the long-run equilibrium path. Moreover, the rows of $\mathbf{A}$ containing only zeroes allow to identify possible (weakly) exogenous variables. This model reduction process has two further implications. Firstly, the impulse response functions (and their confidence intervals) may differ, even markedly, from those derived from an unrestricted model (Brüggemann and Lütkepohl 2001). Secondly, dropping the statistically irrelevant variables can improve the quality of the forecasts generated by the model (Clements and Hendry, 2001, p. 119).

5 The Estimated Structural VEC Models

5.1 Preliminary Analysis

Prior to the estimation of the model (11)-(13), the unit root tests have been performed on the time series over the period 1984q1-1998q4. The sample span refers to a macroeconomic framework characterized by an acceleration of the harmonization process of domestic economic policies towards the EU commitments and a progressive liberalization of capital and trade movements. The first few years of the European Monetary System (EMS) are left out because of the turbulence caused by adjustment to the new monetary system. This choice also allows excluding the absorption process of the oil shocks occurred in the seventies, whose effects were particularly severe for small open economies, heavily dependent on foreign energy net suppliers. In order to avoid an arbitrary distinction between the variables of each country model, as suggested by Sims (1980), all of them are modeled as endogenous *a priori*, but their possible weak exogeneity is subsequently tested.[5]

5.1.1 Data Sources and Variables Construction

The elaborations have been performed using the econometric packages J–Multi 3.30 for the unit root tests and the construction of the VEC models, and Pc–Fiml 10.3 for the preliminary analysis and the diagnostic tests. Quarterly non-seasonal adjusted data are from OECD (Statistical Compendium CD–Rom, 2004/2) and IMF (IFS CD–Rom, October 2004). The log level price, p_t, is the consumer price index, the log real unit labor cost, s_t, is the ratio of real wages over productivity, the productivity, Φ_t, is given by the logarithm of the ratio of total output over the total number of employed workers.

The foreign variables in $ppp_t = e_t + p_t^* - p_t = (e_{0t} - e_t) + p_t^* - p_t$ are given by:

$$p_t^* = \sum_{i=1}^{16} w_i \cdot p_{it} \text{ and } e_t^* = \sum_{i=1}^{16} w_i \cdot e_{it}$$

where i denotes the i-th country in the group including the Euro Area member countries, the remaining G7 countries not belonging to the Euro Area, the EMU member countries, and

[5] This decision can also be motivated from a statistical point of view since the erroneous treatment of endogenous variables as weakly exogenous can produce inefficient estimates.

Switzerland. The star, *, denotes the variables of the rest of the world (RoW). The nominal effective exchange rate is given by difference between e_{0t} = log(national currency/US dollar) and e_t^* = log(RoW currency/US dollar). The weights w_i , shown in Table 2, are given by the country i's share of world trade, where the latter is defined as the sum of imports and exports.

Table 2 – Matrix of bilateral flow trade weights.

	AUS	**BEL**	**CAN**	**DEN**	**FIN**	**FRA**	**GER**	**IRE**	**ITA**	**JAP**	**NET**	**POR**	**SPA**	**SWE**	**SWI**	**UK**	**USA**
AUS	.0000	.0291	.0082	.0104	.0083	.0600	.5237	.0050	.1121	.0297	.0394	.0066	.0225	.0198	.0347	.0408	.0496
BEL	.0095	.0000	.0060	.0094	.0072	.2042	.2388	.0095	.0580	.0244	.1879	.0078	.0290	.0238	.0159	.1050	.0635
FIN	.0136	.0363	.0086	.0431	.0000	.0589	.1852	.0086	.0443	.0528	.0542	.0085	.0258	.1456	.0903	.1270	.0973
FRA	.0131	.1161	.0090	.0118	.0075	.0000	.2337	.0122	.1300	.0356	.0658	.0171	.0933	.0180	.0250	.1169	.0952
GER	.0697	.0905	.0091	.0263	.0136	.1574	.0000	.0113	.1117	.0539	.1136	.0139	.0462	.0318	.0450	.1035	.1025
IRE	.0057	.0372	.0092	.0120	.0075	.0814	.1318	.0000	.0367	.0468	.0600	.0046	.0223	.0199	.0171	.3613	.1466
ITA	.0339	.0544	.0125	.0129	.0073	.1920	.2701	.0094	.0000	.0317	.0614	.0134	.0648	.0164	.0377	.0919	.0900
NET	.0146	.1509	.0060	.0172	.0109	.1113	.3135	.0111	.0566	.0296	.0000	.0084	.0293	.0279	.0212	.1153	.0762
POR	.0100	.0409	.0048	.0159	.0081	.1520	.2029	.0064	.0760	.0202	.0559	.0000	.2215	.0188	.0211	.1000	.0456
SPA	.0118	.0422	.0064	.0097	.0081	.2432	.1926	.0093	.1185	.0305	.0506	.0689	.0000	.0148	.0151	.1053	.0730

Note. Partner countries are reported in columns. The weights are averages over the period 1994-1996. The weights sum to unit by row. Each country’s own trade is set to zero. Source: OECD.

5.1.2 Unit Root Tests

The employed econometric methodology allows for series integrated at most of order 1. Testing for unit roots is a way of checking for the absence of $I(2)$ variables in our sample, as this might produce poor results when coupled with standard VEC modelling (see Haldrup, 1998). Therefore, we have run ADF tests on each series, both in levels and differenced, with an optimal regression lag determined according to the BIC criterion with a maximum lag of four. The critical values are taken from Davidson and MacKinnon (1993). The results, reported in Table 3, suggest that all variables are indeed integrated of order one. The only exceptions are the levels of Δp_t for Italy and the Netherlands, and of s_t for Spain, for which the null hypothesis of a unit root is rejected respectively at the 10% and the 5% levels of significance, and the first difference of $\Delta \phi_t$ for Ireland and Spain, for which the null is rejected at the 5% level of significance.

Table 3 – ADF unit root test.

	AUS	BEL	FIN	FRA	GER	IRE	ITA	NET	POR	SPA
s_t	-2.16 (4) *	-1.86 (0) *	-3.03 (4)**	-2.40 (1)**	-1.40 (0) *	-2.24 (0) **	-1.79 (2) *	-1.79 (1) *	-0.94 (0) *	-3.62 (4)**
q_t	-1.15 (1) *	-1.07 (1) *	-0.86 (1) *	-1.93 (1)**	-2.31 (1)**	-2.40 (1) **	-1.63 (1) *	-1.03 (1) *	-2.42 (1) *	-1.76 (1) *
Δp_t	-1.58 (3) *	-2.47 (3) *	-1.72 (2) *	-2.39 (4) *	-2.28 (2) *	-2.78 (3) **	-3.29 (1) **	-2.70 (3) *	-2.34 (3)**	-2.54 (3)**
ϕ_t	-1.83 (4)**	-2.45 (4)**	-3.00 (4)**	-1.27 (0)**	-2.67 (2)**	-2.50 (2)**	-1.16 (0)**	-2.82 (3)**	-2.32 (1)**	-1.24 (1)**
Δs_t	-6.10 (2) *	-6.13 (0) *	-7.72 (0) *	-5.94 (0) *	-4.62 (0) *	-8.99 (0) *	-4.25 (0) *	-8.14 (0) *	-4.22 (1) *	-3.50 (0)**
Δq_t	-5.49 (0) *	-5.15 (0) *	-5.06 (0) *	-5.16 (0) *	-5.54 (0) *	-4.99 (0) *	-5.17 (0) *	-6.08 (0) *	-5.18 (0) *	-5.01 (0) *
$\Delta^2 p_t$	-13.3 (2) *	-8.70 (0) *	-9.10 (1) *	-8.03 (1) *	-7.82 (2) *	-7.88 (2) *	-8.62 (0) *	-11.5 (2) *	-6.91 (2) *	-8.20 (2) *
$\Delta\phi_t$	-4.35 (3) *	-7.99 (0) *	-5.11 (2)**	-7.73 (0) *	-6.25 (0) *	-3.13 (0) *	-3.75 (1) *	-7.25 (0) *	-11.3 (0) *	-2.98 (0) *

5.1.3 Model Specification and Dummy Variables

Table 4 reports a brief description of each model's main features. The sample period is 1984q1–1998q4 for all models. The number of lags has been selected according to the BIC criterion. In order to obtain a satisfactory fit of the model to the data, especially with regard to the residuals normality, dummy variables $dXXY$ have been introduced. $dXXY$ is a series 0,0,…,1,0,…, where XX indicates the year and Y the quarter. These dummy variables are grouped in three main categories according to the source of shock: idiosyncratic shocks (*I*), EMS shocks (*EMS*), and 1995 Mexican crisis shock (*M*).

Table 4 – Models' specification.

Country	Lags	Sample period	Dummy variables	
AUS	4	1985q1–1998q4	d871 d952, d953	*shock* to the labor market (I) *shock* to the real exchange rate (M)
BEL	5	1985q2–1998q4	d924 d952, d953	*shock* to the real exchange rate (EMS) *shock* to the real exchange rate (M)
FIN	4	1985q1–1998q4	d924	*shock* to the real exchange rate (EMS)
FRA	2	1984q3–1998q4	d924 d952, d953 d861, d983 d862	*shock* to the real exchange rate (EMS) *shock* to the real exchange rate (M) *shock* to the inflation (I) *shock* to the productivity (I)
GER	2	1984q3–1998q4	d871, d872 d911, d912 d923, d924 d952, d953, d961	*shock* to the productivity (I) *shock* to the labor market (I) *shock* to the real exchange rate (EMS) *shock* to the real exchange rate (M)
IRE	4	1985q1–1998q4	d924 d972	*shock* to the real exchange rate (EMS) *shock* to the labor market (I)
ITA	2	1984q3–1998q4	d923, d924 d951, d952, d953 d972	*shock* to the real exchange rate (EMS) *shock* to the real exchange rate (M) *shock* to the labor market (I)
NET	4	1985q1–1998q4	d924 d951, d952 d973, d981	*shock* to the real exchange rate (EMS) *shock* to the real exchange rate (M) *shock* to the labor market (I)
POR	3	1984q4–1998q4	d844, d851, d911 d924 d953, d954	*shock* to the labor market (I) *shock* to the real exchange rate (EMS) *shock* to the real exchange rate (M)
SPA	2	1984q3–1998q4	d924 d953	*shock* to the real exchange rate (EMS) *shock* to the real exchange rate (M)

5.1.4 Cointegration Rank

The cointegration rank r has been determined using the trace test and the maximum eigenvalue test. Table 5 reports eigenvalues as well as the trace (upper part) and the maximum eigenvalue test (lower part) results. Both tests have been corrected for the number of degrees of freedom. Critical values are taken from Osterwald and Lenum (1992).

Table 5 – Cointegration rank.

EIGENVALUES									
AUS	BEL	FIN	FRA	GER	IRE	ITA	NET	POR	SPA
0.67	0.52	0.47	0.54	0.45	0.44	0.50	0.41	0.48	0.49
0.48	0.30	0.30	0.21	0.34	0.35	0.25	0.36	0.26	0.27
0.15	0.16	0.24	0.11	0.18	0.19	0.13	0.26	0.17	0.19
0.07	0.02	0.11	0.02	0.00	0.08	0.08	0.04	0.06	0.06

TRACE TEST													
H_0	H_1	5%	1%	AUS	BEL	FIN	FRA	GER	IRE	ITA	NET	POR	SPA
$r=0$	$r\geq 1$	62.99	70.05	114.8	70.52	77.59	65.92	70.35	75.68	69.71	74.46	69.15	72.75
$r\leq 1$	$r\geq 2$	42.44	48.45	50.93	30.46	41.57	21.06	35.49	41.78	29.48	44.48	31.72	33.57
$r\leq 2$	$r\geq 3$	25.32	30.45	13.14	10.69	21.66	7.54	11.41	17.06	12.43	19.38	14.63	15.37
$r\leq 3$	$r=4$	12.25	16.26	4.04	0.88	6.35	0.94	0.06	5.10	4.55	2.47	3.76	3.37

MAXIMUM EIGENVALUE TEST													
H_0	H_1	5%	1%	AUS	BEL	FIN	FRA	GER	IRE	ITA	NET	POR	SPA
$r=0$	$r=1$	31.46	36.65	63.81	40.06	36.01	44.86	34.86	33.89	40.22	29.98	37.42	39.19
$r\leq 1$	$r=2$	25.54	30.34	37.79	19.77	19.92	13.52	24.08	24.72	17.05	25.10	17.09	18.19
$r\leq 2$	$r=3$	18.96	23.65	9.10	9.82	15.31	6.60	11.36	11.96	7.89	16.91	10.87	12.01
$r\leq 3$	$r=4$	12.25	16.26	4.04	0.88	6.35	0.94	0.06	5.10	4.55	2.47	3.76	3.37

The trace test results point to two long-run relationships for Austria and the Netherlands, while only one relationship is detected in all other models. These results are confirmed by the maximum eigenvalue test with the only exception of the Netherlands for which no long-run relationships exist according to the second test. We follow Johansen (1992) in accepting the trace test results in order to avoid inconsistency problems possibly arising with the maximum eigenvalue test. The rest of the analysis thus sets $r = 2$ in the Netherlands's model.

5.1.5 The Specification of the Long-run Structure

In the models of Austria and Netherlands the two cointegrating relationships seem to be identified by the long-run structural theoretical relationships (15) and (16). In all other countries prices appear to be determined in the long-run by the equation (15), excepting for the model of Portugal whose inflation is determined exclusively by demand-side factors. For sake of completeness, the last three columns of Table 6 display the LR test results for the specification of the relationship (second column) alternative to the one discussed at length in the following Subsection regarding those countries' models with rank $r = 1$. The central columns of Table 6 report the estimated parameters (indicated by a star, *) of each model's "best" specification.

Table 6 – The specification of the long-run structure

	Specification	t	s_t	q_t	Δp_t	ϕ_t	χ^2**(gdl)**	**stat**	**[prob]**
Bel	(16)	*			1	*	(2)	17.26	[0.00]
Fin	(16)	*			1	*	(2)	13.94	[0.00]
Fra	(16)	*			1	*	(2)	32.27	[0.00]
Ger	(16)	*			1	*	(2)	27.25	[0.00]
Irl	(16)	*			1	*	(2)	16.73	[0.00]
Ita	(16)	*			1	*	(2)	23.69	[0.00]
Por	(15)	*	–1				(3)	25.11	[0.00]
Spa	(16)	*			1	*	(2)	17.13	[0.00]

5.2 The Estimated Long-run Structure

For each model, the chosen long-run structural specification is shown in Table 7, where the estimated coefficients and their corresponding standard errors are reported.

The statistics of the LR test for the over-identifying restrictions have a χ^2 distribution with a number of degrees of freedom depending on the number of restrictions. The probabilities associated to the statistics' realizations are reported in square brackets.

The signs of the estimated parameters are consistent with the economic theory and statistically significant. Moreover, LR test results do not reject the over-identifying restrictions. To summarize, all countries with high rates of growth are characterized by demand-side inflation (see Table 1). A significant exception is Ireland whose long-run structure is more similar to that of the countries belonging to the "core Europe", i.e. Germany, Austria and the Netherlands, whose specification of the markup is almost identical.

In order to better compare the estimated long-run structure, Table 8 reports each model's net markup (first three columns) as long as the estimated coefficients μ_0 (fourth column) and μ_1 (fifth column) derived from the estimation of the structure reported in Table 7. Consistently with the economic theory, inflation is an extra cost to firms in all economies whose prices are determined according to equation (15), excepting for Finland. Unlike other countries, in Austria, Germany, the Netherlands, and Ireland, whose economic structure is rather similar, the import price level pm_t does not appear to be a determinant of the net markup. Specifically, in Belgium, Finland, and Spain the markup is determined in the same proportion by pm_t and *ulc*, while in Italy and France the unit labor cost has a bigger influence on the markup than the import prices. The economic structure of France, in particular, looks very similar to that of the core Europe's countries being characterized by a proportion of ulc_t over pm_t of 8 as determinants of the markup. The fourth column of Table 8 shows how the exogenous component of inflation, captured by the slope of the linear time trend, is small and ranging between 0% for Ireland and Italy, and 1.5% for Germany and Spain. It is advisable to notice that the exogenous component of German inflation coincides with the minimum inflation rate compatible with the German economic structure benchmarked by the Bundesbank (see Sinn and Reutter, 2000). Finally, the fifth column of Table 8 shows the variation of markup induced by an annual increase of 1% (corresponding to a 0.25% increase on a quarterly basis) in inflation. The highly heterogeneous results can be summarized noticing that inflation represents an high cost to those countries whose prices are determined to a lesser extent by imports prices, i.e. Germany, Austria, Netherlands, and Ireland, where the reduction of markup ranges from 3% to 7%. In all other countries, inflation does not represent such a high cost, being the markup contraction comprised between 0% of Finland and 1% of Spain.

The markup/inflation trade-off estimated for France, 0.4%, is quite similar to the 0.7% obtained by Banerjee and Russell (2002), while the values for Germany (1.2%) and Italy (2%) are quite different. This may be due to a number of reasons, including the different sample periods, the treatment of seasonality, the specification of the deterministic part of the cointegration space and the measurement of variables.

Table 7 – Estimates of equations (15) and (16).

$\boldsymbol{\varepsilon}_t$			$\mathbf{b}\cdot t+\mathbf{B}'\cdot\mathbf{y}_t$		
	t	s_t	ppp_t	Δp_t	ϕ_t
			Austria		
$\varepsilon_{mu,t}$	0.0013	–1.0000		11.4410	
	(0.0003)			(1.8844)	
$\varepsilon_{pc,t}$	0.0013			1.0000	–0.2507
	(0.0002)				(0.0418)
			$\chi^2(2)$ 1.81 [0.41]		
			Belgium		
$\varepsilon_{mu,t}$	0.0054	–1.0000	–0.5515	4.2497	
	(0.0012)		(0.1291)	(1.6379)	
			$\chi^2(1)$ 2.53 [0.11]		
			Finland		
$\varepsilon_{mu,t}$	0.0012	–1.0000	–1.0606		
	(0.0005)		(0.0763)		
			$\chi^2(2)$ 5.26 [0.07]		
			France		
$\varepsilon_{mu,t}$	0.0014	–1.0000	–0.1407	1.9751	
	(0.0003)		(0.0339)	(0.8569)	
			$\chi^2(1)$ 2.82 [0.09]		

$\boldsymbol{\varepsilon}_t$	$\mathbf{b}\cdot t+\mathbf{B}'\cdot\mathbf{y}_t$				
	t	s_t	ppp_t	Δp_t	ϕ_t
			Germany		
$\varepsilon_{mu,t}$	0.0037	–1.0000		12.0290	
	(0.0010)			(4.3173)	
			$\chi^2(2)$ 0.21 [0.90]		
			Ireland		
$\varepsilon_{mu,t}$	0	–1.0000	0	29.3130	0
				(6.6052)	
			$\chi^2(3)$ 7.51 [0.06]		
			Italy		
$\varepsilon_{mu,t}$		–1.0000	–0.6481	4.2779	
			(0.0594)	(0.6866)	
			$\chi^2(2)$ 1.15 [0.56]		
			Netherlands		
$\varepsilon_{mu,t}$	0.0025	–1.0000		12.0390	
	(0.0006)			(2.2240)	
$\varepsilon_{pc,t}$	0.0019			1.0000	–1.0000
	(0.0001)				
			$\chi^2(3)$=1.94 [0.58]		

$\boldsymbol{\varepsilon}_t$	$\mathbf{b}\cdot t+\mathbf{B}'\cdot\mathbf{y}_t$				
	t	s_t	ppp_t	Δp_t	ϕ_t
			Portugal		
$\varepsilon_{pc,t}$	0.0020			1.0000	–0.3461
	(0.0006)				(0.1136)
			$\chi^2(2)$=4.98[0.08]		
			Spain		
$\varepsilon_{mu,t}$	0.0080	–1.0000	–1.0589	7.8374	
	(0.0007)		(0.1085)	(2.1699)	
			$\chi^2(1)$=0.84 [0.36]		

Table 8 – Net markup, trade-off between markup and inflation, extra-costs.

	NET MARKUP			EXTRA-COSTS	MARKUP/INFLATION
	p_t	ulc_t	pm_t	$\mu_0 \cdot 400$	μ_1
AUS	1	–1		0.52%	–11.44
BEL	1	–0.64	–0.36	1.40%	–2.74
FIN	1	–0.48	–0.52	0.24%	
FRA	1	–0.88	–0.12	0.48%	–1.73
GER	1	–1		1.48%	–12.03
IRE	1	–1			–29.31
ITA	1	–0.61	–0.39		–2.60
NET	1	–1		1.00%	–12.04
SPA	1	–0.49	–0.51	1.56%	–3.81

As for the four biggest European economies, namely Germany, France, Italy, and Spain whose aggregate GDP is over 80% of the Euro Area's GDP, and for Belgium and Finland, the absence of cost-push inflation points to an excess of production capacity. Regarding Ireland, the estimated long-run structure is at odds with the sustained economic growth characterizing the economy over the sample period. This may be due to the presence of a number of export-oriented multinational firms. As for the remaining countries, whose long-run structures include the Phillips curve, the results are heterogeneous. Table 9 reports the potential, i.e. not augmenting inflation, annual rate of growth of output and employment derived from equation (16).

Table. 9 – Potential output growth.

Austria	**Netherlands**	**Portugal**
2.08 %	0.76 %	2.32 %

The lowest value refers to the Netherlands, implying that its economy is characterized by full employment, as also indicated by the estimated value of the productivity coefficient in equation (16). Notice the high value of potential growth of Portugal, possibly due to the slow transition of the Portuguese economy from the prevalence of the primary sector to the secondary and tertiary sectors. This is witnessed by the large share of the agricultural sector on the Portuguese economy (over 7%) when compared to that of the other European countries.

The long-run structure of Austria and Netherlands, whose models include two cointegration relationships, may be better described by embedding the second long-run restriction into the first one, thus obtaining a new stationary relationship (since a linear combination of two stationary relationships is stationary itself). This leads to a single long-run relationship between the output gap and the net markup. Table 10 reports the effect on the net markup of an annual one percent increase in the output gap.

Table 10 – Markup and output gap

Austria	**Netherlands**
–0.72%	–3.01%

Table 10 clearly shows that the markup is anti-cyclical, consistently with Gali (1994) according to which private firms do set prices depending on demand. This can be justified by the two following argumentations. The first line of reasoning relies on the increase of the marginal costs faced by firms due to the employment of production inputs in a period of economic expansion. The second one considers the pressure exerted on wages and other costs by an increase of aggregate demand.

5.3 The Estimated Short-run Structure

In this Section we discuss the dynamic properties of each country's estimated VEC model. Table 11 reports the main diagnostic tests for the single equations.

Table 11 – Diagnostic tests of the dynamic models.

		AUS	**BEL**	**FIN**	**FRA**	**GER**	**IRE**	**ITA**	**NET**	**POR**	**SPA**
σ_u	Δs_t	0.0082	0.0081	0.0172	0.0051	0.0083	0.0080	0.0065	0.0079	0.0120	0.0057
	Δq_t	0.0201	0.0176	0.0150	0.0155	0.0136	0.0271	0.0167	0.0188	0.0186	0.0166
	$\Delta^2 p_t$	0.0033	0.0038	0.0039	0.0023	0.0041	0.0039	0.0028	0.0036	0.0064	0.0044
	$\Delta\phi_t$	0.0081	0.0077	0.0166	0.0052	0.0072	0.0058	0.0061	0.0055	0.0104	0.0028
A		F(4,31)	F(4,27)	F(4,42)	F(4,39)	F(4,36)	F(4,34)	F(4,39)	F(4,29)	F(4,34)	F(4,43)
	Δs_t	1.12	0.86	*2.93*	*3.31*	1.83	2.50	1.41	1.13	*2.71*	0.64
	Δq_t	1.95	0.32	1.49	1.29	1.37	1.24	1.96	0.68	1.21	0.57
	$\Delta^2 p_t$	1.37	0.30	2.59	2.58	0.80	0.82	0.41	2.59	0.22	*2.66*
	$\Delta\phi_t$	0.26	0.54	*3.30*	1.97	1.12	1.61	1.18	**5.28**	**5.64**	0.63
N		$\chi^2(2)$	$\chi^2(2)$	$\chi^2(2)$	$\chi^2(2)$	$\chi^2(2)$	$\chi^2(2)$	$\chi^2(2)$	$\chi^2(2)$	$\chi^2(2)$	$\chi^2(2)$
	Δs_t	0.17	5.17	1.14	1.43	3.88	*7.15*	1.93	0.10	4.23	**21.09**
	Δq_t	**16.49**	2.70	*7.22*	2.88	1.20	**9.55**	4.19	**16.78**	5.62	2.01
	$\Delta^2 p_t$	*6.44*	2.15	0.18	0.00	0.57	0.81	3.43	3.09	4.77	1.93
	$\Delta\phi_t$	0.15	1.53	0.42	0.88	5.29	**9.48**	2.74	1.35	5.95	4.29
AS		F(4,27)	F(4,23)	F(4,38)	F(4,35)	F(4,32)	F(4,30)	F(4,35)	F(4,25)	F(4,30)	F(4,39)
	Δs_t	0.33	0.94	0.47	0.55	0.15	0.49	0.51	0.20	0.27	0.44
	Δq_t	0.24	0.33	*2.73*	0.39	0.96	0.19	0.74	0.23	0.25	0.60
	$\Delta^2 p_t$	0.69	0.17	0.59	0.09	0.98	0.48	2.40	0.78	0.23	1.83
	$\Delta\phi_t$	0.21	0.36	1.08	0.23	0.27	0.40	0.59	0.08	0.53	0.43

Note. Statistics in bold (italics) indicate statistical significance at the 5% (10%) level.

The statistical fit of the inflation equation is satisfactory in almost all models. This supports the choice of the theoretical framework used for the analysis of the price dynamics in the EMU countries. The only exception is Spain whose equation of productivity growth shows the lowest standard error. The residuals do not appear to be serially correlated in 33 (38) equations at the 5% (1%) level of significance. The models of Netherlands and Portugal, whose single equations residuals are serially correlated, do not present autocorrelation at a system-wide level (not reported). This supports the choice of the number of lags for each model. The results of the autocorrelation tests on the squared residuals are even more satisfactory. Autocorrelation is rejected for all equations at the standard 5% level excepting the equation of Δq_t in the model of Finland, where autocorrelation is rejected at the 4% level. Finally, the residuals of all equations of 5 out of 9 models appear to be normally distributed, while in the remaining 4 models non-normality emerges only for the equations of the competitiveness index and, in the model of Spain, for the Δs_t equation. At a system-wide level, only the models of Netherlands and Spain show non-normal residuals.

The dynamic properties of the single models are analyzed conditioning on the elimination of the statistically insignificant short-run coefficients through the SER/TP approach developed by Brüggemann and Lütkepohl (2001). The models are estimated with a 3SLS procedure. The parsimonious models are obtained setting a threshold significance level of $t = 1.60$ for the short-run parameters and following the BIC criterion.[6]

Table 12 reports the restrictions determined for vector $\mathbf{a}$ (column two), matrix $\mathbf{A}$ (column three), matrices $\mathbf{\Gamma}_j$ (column four), and matrix $\mathbf{\Phi}$ (column five) for each model (11), as well as the LR test statistics (column seven) which are χ^2 distributed, with the number of degrees of freedom given by the number of total short-run restrictions (column six). All LR statistics are well below the 5% and 10% level critical values, therefore showing how the data do not reject the imposed restrictions.

Table 12 – Short-run restrictions.

	NUMBER OF RESTRICTIONS				χ^2	**STATISTICS**	**5% C.V.**	**10% C.V.**
	$\mathbf{a}$	$\mathbf{A}$	$\mathbf{\Gamma}_j$	$\mathbf{\Phi}$				
Aus	1	3	22	11	37	36.53	52.19	48.36
Bel	2	1	41	11	55	37.53	73.31	68.80
Fin	0	1	18	12	31	24.61	44.99	41.42
Fra	1	2	10	19	32	18.51	46.19	42.59
Ger	2	1	5	30	38	32.72	53.38	49.51
Ire	2	1	21	10	34	15.38	48.60	44.90
Ita	2	1	9	18	30	13.67	43.77	40.26
Net	1	3	34	21	59	35.60	77.93	73.28
Por	1	2	13	12	28	15.60	41.34	37.92
Spa	1	0	4	9	14	7.69	23.68	21.06

[6] The choice is justified by the opinion that it is preferable to maintain the coefficients with uncertain significance rather than deleting them. Therefore, we adopt a "conservative" strategy, in the terminology of Krolzig and Hendry (2001).

Table 13 shows the speed of adjustment coefficients along with the corresponding standard errors of each model. From the analysis of the coefficients of matrix **A** emerges that 33 out of 48 (lagged) cointegration residuals are statistically significant. This finding points to the existence of a strong adjustment effect running from the ε terms to the first differenced variables. Conversely, an adjustment mechanism for the real exchange rate cannot be detected. This implies that the real exchange rate can be considered as a candidate to be one of the common trends of the system. The weakly exogeneity of the real exchange rate characterizes all models, excepting those of Spain, Austria, and Finland. Specifically, the equations describing inflation dynamics are influenced by all cointegration errors determined in the previous Subsection.

Table 13 – Speed of adjustment coefficients and their associated standard errors.

	ε_{t-1}	Δs_t	Δppp_t	$\Delta^2 p_t$	$\Delta\phi_t$
AUS	$\varepsilon_{mu,t-1}$	0.205 (0.046)	0.146 (0.045)	–0.072 (0.011)	–0.119 (0.048)
	$\varepsilon_{pc,t-1}$			–0.529 (0.095)	
BEL	$\varepsilon_{mu,t-1}$	0.092 (0.019)		–0.055 (0.012)	0.028 (0.005)
FIN	$\varepsilon_{mu,t-1}$	0.217 (0.068)	0.327 (0.072)		–0.216 (0.073)
FRA	$\varepsilon_{mu,t-1}$	0.166 (0.029)		–0.094 (0.024)	
GER	$\varepsilon_{mu,t-1}$	0.021 (0.006)		–0.011 (0.002)	0.015 (0.003)
IRE	$\varepsilon_{mu,t-1}$	0.088 (0.019)		–0.014 (0.004)	–0.077 (0.017)
ITA	$\varepsilon_{mu,t-1}$	0.172 (0.028)		–0.052 (0.009)	–0.059 (0.024)
NET	$\varepsilon_{mu,t-1}$	0.057 (0.017)		–0.083 (0.007)	
	$\varepsilon_{pc,t-1}$	–0.548 (0.112)		–0.142 (0.044)	0.382 (0.076)
POR	$\varepsilon_{pc,t-1}$			–0.558 (0.066)	0.408 (0.111)
SPA	$\varepsilon_{mu,t-1}$	0.062 (0.014)	0.100 (0.043)	–0.086 (0.011)	0.004 (0.001)

Focusing on supply-side error corrections, which are included in nine out of ten cases, the absolute value of the speed of adjustment coefficient of the equation of $\Delta^2 p_t$ is systematically lower than the corresponding coefficient of Δs_t in all models, excepting those of the Netherlands and Spain. This suggests that if inflation is cost-pushed, the supply-side disequilibrium is corrected mainly through adjustments occurring in the labor market rather than as a consequence of monetary policy decisions.

6 Conclusion

By adopting a single currency, the EMU countries waived their monetary policy, which has since been taken on by the European Central Bank.

Maintaining price stability within the Euro Area is the main task of the ECB, which has quantified it as an average inflation rate ranging from 0% to 2% in order to minimize the inflation costs related to redistribution effects, uncertainty and market distortions. The main goal of the present study is to assess the validity of the choice of monetary policy as the right instrument to maintain price stability.

We consider all main countries belonging to the Euro Area, namely Austria, Belgium, Finland, France, Germany, Ireland, Italy, Netherlands, Portugal, and Spain. The sample period goes form the first quarter of 1984 to the fourth quarter of 1998, including a time horizon characterized by a relatively stable macroeconomic framework where oil shocks are absorbed by the system, the constraints implied by the exchange rate arrangements are binding and the financial system is progressively being liberalized.

The econometric strategy, based on the estimation of a VEC model for each country, develops in two successive phases: in the first phase the long-run paths of the EMU countries' economies are specified; in the second phase the dynamic properties of the single models are analyzed.

The long-run structure includes two economic relationships linking, through a dynamic equilibrium, inflation to the markup and the output gap respectively, thus allowing for a distinction between cost-pushed and demand-pushed inflation.

The coefficient estimation is conditioned on the execution of unit root tests on all variables. *A priori* all variables are treated as endogenous in each VAR model, while their weak exogeneity is tested *ex post* in order to avoid imposing an arbitrary distinction upon them. The cointegration rank is determined according to the trace test and the maximum eigenvalue test.

The specification of cost-pushed inflation expresses the markup as a function of the real unit labor cost, the import prices, and the linear trend as a way to capture the influence of national structural factors.

The specification of demand-pushed inflation relies on a version of the Phillips curve featuring the inflation rate as a function of the unemployment rate, and the Okun's law, with the unemployment depending on the output gap. Moreover, the productivity is included as a further explanatory variable, while a linear trend is intended to *proxy* the growth of output and employment due to technological progress.

Both the cointegration relationships are supported by the data in the models of Austria and the Netherlands, in the model of Portugal only the demand-side long-run relationship holds, while in the rest of the countries the supply-side relationship holds.

For those economies characterized by cost-pushed inflation, the net markup is calculated showing that inflation represents a cost to firms due to the corresponding loss of competitiveness. The above loss is higher in those economies where inflation is not affected by import prices. The first important result is that demand-pushed inflation is detected in those countries characterized by a sustained output growth, the only exception being Ireland, whose long-run structure includes only a cost-push determination of inflation.

An excess of production capacity, i.e. an insufficient level of aggregate demand, therefore characterizes all other countries, whose long-run structure does not include a demand-pushed inflation equation.

The second part of the paper presents a short-run dynamic analysis of the parsimonious VEC models. The statistically insignificant coefficients, i.e. those to which corresponds a value of the t statistics lower than the threshold value of 1.60, are deleted. The LR test results suggest that the data do not reject the parsimonious specification of all models. Almost the 70% of the speed of adjustment coefficients related to the error correction terms are statistically significant, thus confirming the presence of strong feedback mechanisms running from the error correction terms to the first differenced variables.

The above results suggest that the ECB should take into account that the actual determinants of inflation differ in the single countries belonging to the Euro Area, and that the best objective of monetary policy is the only demand-pushed inflation. A tight monetary policy pursued in those countries whose inflation is mainly driven by costs would result in a contraction of economic activity without exerting relevant effects on price dynamics. This would be the consequence of higher financing costs for firms and a lower aggregate demand determined by an increasing interest rate. These are precisely the effects observed in the most recent years, when most of the European economies have been characterized by close to zero output rates of growth. In 2003 the ECB has redesigned its strategy setting a rate of interest of 2% as its main objective, but there is still room for a modification of the monetary policy strategy capable of considering the different factors driving inflation in EMU countries.

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