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Euro Area Inflation as a Predictor of National Inflation Rates

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Abstract. The stability of inflation differentials is an important condition for the smooth working of a currency area, such as the European Economic and Monetary Union. In the presence of stability, changes in national inflation rates, while holding Euro-area inflation fixed contemporaneously, should be only transitory. If this is the case, the rate of inflation of the whole area can also be interpreted as a predictor, at least in the long run, of the different national inflation rates. However, in this paper we show that this condition is satisfied only for a small number of countries, including France and Italy. Better convergence results for inflation differentials are, instead, found for the USA.

JEL Classification: E31, C32;

Keywords: Inflation Differentials; Euro area; Structural Cointegrated VARs; Permanent-transitory Decompositions;

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1. Introduction

Inflation differentials often characterize large currency areas, such as the European Economic and Monetary Union (EMU) or the United States. Indeed, as stressed by the European Central Bank (ECB), under certain conditions these differentials may also play a useful role as an equilibrating adjustment process (cf. ECB, 2005). However, such an equilibrating adjustment process requires the stability of the inflation differentials. In the context of stochastic processes, and in the presence of series which exhibit a unit root, this requires that the euro area inflation and the national inflation rate should be driven by a common stochastic trend, *i.e.* the inflation differential should behave as a stationary variable.

In reality, one expects an even stronger condition to be satisfied, namely that the national rates of inflation converge or, better, gravitate around the aggregate rate of inflation of the whole area. In other words, that despite temporary deviation, the Euro-area inflation is an anchor for the inflation of member countries.

In this paper we first establish a set of conditions under which convergence is satisfied and then we test if these conditions are met for a group of Euro-area countries. We show that in a cointegration framework the requirement is not only for the existence of a stable one-for-one long-run relation between Euro-area inflation and national inflation, but also for long-run unidirectional causality running from the first variable to the second one.

Moreover, if these conditions are met then it is possible to separate a permanent from a transitory shock by imposing a contemporary causal structure with the euro area inflation ordered first (cf. Ribba, 2003). The important implications are that, in this case, (a) only inflation shocks affecting the whole area may exert permanent effects on the local inflation rates; (b) it is legitimate to interpret the EMU average rate of inflation as a long-run predictor of the national rates.

Unfortunately, in the empirical investigation, covering the period from 1999 to 2011, we find that only for a small number of countries is the set of restrictions not rejected by data.

However, an interesting and somehow unexpected result of the investigation is that Italy belongs to the group of countries showing convergence of its inflation rate. As far as the other two biggest EMU countries are concerned, a convergence result for the inflation rate also characterizes the French economy, whereas an opposite conclusion holds for Germany.

In the final part of this paper, in order to have a comparison with another important currency area, we extend the investigation to the USA. The conclusion for the US economy seems more encouraging since, analyzing the four great US regions, Mid-West, North East, South and West, we find that three of them exhibit converging results of the inflationary dynamics and that only for West is the stationarity of the inflation differential rejected by data. Further, inflation differentials in the US economy exhibit lower volatility with respect to

the Eurozone economy.

A recent survey on the subject of inflation differentials in the Euro area is provided by De Haan (2010). Given the existence of persistent inflation differentials one might wonder if this poses risks for the survival of the currency area and, moreover, if the problem should be tackled by the central bank. On this last question Angeloni and Ehrmann (2007) conclude that the ECB, by keeping a low level of inflation in the whole area, also helps to avoid widening differentials in the Eurozone.

A somewhat different conclusion has recently been reached by Fendel and Frenkel (2009), since the authors find evidence of attention paid by the ECB to inflation differentials among countries. Further, they maintain that considering this variable might have induced the central bank to a less restrictive stance than required by the macroeconomic conditions of the Euro area in the first years of activity.

It is worth pointing out that the main aim of this paper is to investigate the existence of explosive behavior of the inflation differentials among Eurozone countries, by updating the evidence to the end of 2011, rather than to explore causes and consequences of the inflation differential dynamics themselves. Nevertheless, there are some clear policy implications. For example, as for the conduct of monetary policy, in the presence of transitory deviations in national inflation from the aggregate Euro-area path, there is no reason for the central bank to take into account the differentials but, of course, the conclusion might be quite different in the presence of permanent deviations.

The paper is organized as follows. In section 2 we briefly review some results of (part of) the literature concerning the inflation differentials in the Euro area.

Section 3 presents some facts concerning the inflation differentials in the Eurozone and in the USA in the last 13 years.

The econometric approach of the paper, based on cointegrated VARs, is instead presented in section 4. In particular, we establish a set of conditions which allows the EMU average inflation rate to be interpreted as a long-run predictor of the national rates.

In section 5 an empirical investigation comprising 12 euro area countries members is undertaken. Our results show that the annual inflation rate of the majority of countries, more precisely nine out of twelve, has a diverging path. Instead, Belgium, France and Italy exhibit an inflation path converging to the EMU average annual rate. For these countries we also recover the structural shocks associated with the joint, bivariate dynamics of Eurozone inflation and national inflation. In particular, we find that the local inflation shock is not persistent and, moreover, it exerts only a transitory effect on the variables.

One might wonder if these results are so different from those characterizing another important currency area, the USA, and hence in section 6, we extend the investigation to the four great US regions.

Section 7 concludes.

2. Inflation differentials: open questions and literature summary

Persistent and large inflation differentials among countries may pose serious risks for the survival of a monetary union. Two important problems are related, respectively, to the potential, destabilizing effects associated with the monetary policy conduct by the central bank, and with the changes induced in the relative competitive position of the countries members.

Indeed, if the ECB sets the level of the short-term interest rate looking at the average inflation rate of the whole area, those countries experiencing an expansionary phase and with an inflation rate systematically above the average, will receive a pro-cyclical, and hence undesiderable, impulse from the monetary policy choices on aggregate demand, via the contraction in the real interest rates[1]. It is important to stress that this situation has characterized a group of countries, including Greece, Ireland, Portugal and Spain, in the first decade of EMU. For example, as shown in table 1, Spain experienced an inflation rate above the EMU average for 87 consecutive months, between January 2001 and August 2008.

As far as the second problem is concerned, the working of a monetary union of course relies on the adoption of a single currency for the member countries. However, persistent inflation differentials will cause a systematic depreciation in the real exchange rate for countries with inflation below the EMU average and, on the opposite side, real appreciation for those countries with inflation above the EMU average. Hence, other things being equal, the last group of countries will experience persistent foreign trade deficits and a growing external debt[2]. Once again, this situation has characterized the above mentioned group of countries.

In particular, if we compare Greece and Germany, the two countries, respectively, with the highest and the lowest inflation rate in the Euro area, we note that the first country exhibited an average inflation rate of 3.2 per cent while the second had an average inflation of 1.56 per cent. Moreover, Greece was characterized by 150 consecutive months, from 1999:1 to 2011:6, with inflation above the average, whereas Germany had 97 consecutive months with an inflation rate below the EMU average, between January 1999 and January 2007 (cf. Table 1). Clearly, this wide and persistent inflation differential is, at the same time, an indicator and a source of macroeconomic problems.

Some policy implications associated with the presence of persistent inflation differentials are discussed at length in a recent article by De Haan (2010). The author also provides a survey of theoretical and empirical contributions concerning the subject of inflation differentials in the Euro area.

[1] The risk of perverse pro-cyclical dynamics in a fixed exchange rate regime, such as the European Exchange Rate Mechanism (ERM), was forcefully raised by Alan Walters in the 1980s. See, for example, Walters (1988).

[2] An interesting result obtained by Honohan and Lane (2003) concerns the evidence that in the first years of euro an important factor influencing inflation differentials in the European economies is represented by exchange rate effects. On the other hand, the authors find evidence of a limited role exerted by the Balassa-Samuelson effect in explaining inflation differentials.

Pirovano and Van Poeck (2011) test for the stability of inflation differentials. The authors find that for the period from 1999 to 2006 data do not reject the hypothesis of convergence for the majority of countries. On the other hand, by considering the whole sample period 1999 - 2010, there is evidence of persistent divergence in inflationary dynamics for the Euro-area countries. Although the authors conclude that the inflationary dynamics are more unstable in the Euro area in recent years, *i.e.* during the years characterized by the Great Recession, it is worth stressing that it is difficult to draw sound conclusions about the evolution of inflation differentials when such limited sample periods are considered.

A paper by Fendel and Frenkel (2009) explores, instead, the hypothesis that inflation differentials may have played a role in shaping the ECB's monetary policy conduct in the last decade. Their main conclusion, based on the estimation of Taylor rules for the Eurozone, is that the ECB may have taken a less restrictive stance aiming to avoid risks of deflation in member countries experiencing low inflation. It is worth noting, that if this conclusion is correct then the pro-cyclical effect induced by monetary policy choices in the high inflation countries is even stronger.

In another relevant paper in this area of research, Angeloni and Ehrmann (2007) take a more optimistic stance in evaluating the role of monetary policy in the currency area. The authors maintain that the central bank, by keeping the whole area in a low inflation environment, also helps to reduce the inflation differentials.

Beck *et al.* (2009) have analyzed the dynamics of regional inflation in a group of Euro-area countries. They aim to identify the empirical relevance of the national factors in explaining the inflation differentials over the period from 1996 to 2004. The main conclusion of the investigation is that local, structural factors, such as limited competition in labor and good markets, have played a dominant role in explaining the variability of inflation.

In a recent paper, Altissimo *et al.* (2011) study the underlying factors of inflation differentials in a currency area. On the empirical ground, they find two main results: (a) persistent inflation differentials affect the euro area; (b) a pre-eminent role, in explaining the evolution of the inflation differentials, is played by the different responses of Eurozone countries to common, Euro-area shocks.

3. Some simple facts concerning inflation differentials

Tables 1 and 2 summarize some descriptive statistical information related to the inflation differentials in the Euro area and in the US economy for the period 1999:1 - 2011:12. The inflation rate for the Eurozone is the year-on-year rate of change of the Harmonized Consumer Price Index (HCPI) and, for the countries considered in the investigation, the inflation is based on the annual rate of change of the national consumer price index (CPI). On the annual rate of change of the

CPI inflation are also based the statistics for the USA[3].

In particular, table 1 and 2 collect some data concerning the inflation differential, defined as $\pi_i - \pi^*$, where π^* is the average currency zone inflation, and π_i is the inflation of the specific country member (or region, in the case of the USA).

Clearly, in the last 13 years, there is a group of countries in the Eurozone, including Greece, Ireland, Luxembourg, Portugal and Spain which exhibits a wide and positive differential with respect to the average euro area inflation.

Instead, a specular situation characterizes another group of countries, namely Austria, France, Finland and Germany, with a lower inflation rate than the Eurozone average. Thus, given an average inflation rate for the Euro area of 2.013 per cent, for the sample period considered, Germany was the country with the lowest inflation rate, with an average value of 1.578 percent, whereas Greece was the country with the highest inflation rate and an average value of 3.195. Clearly, the cumulative effect of this differential, over the sample period considered, is quite remarkable.

Although there is a different level of aggregation for the US macro areas and hence it is difficult to make fully sensible comparison with the Eurozone evolution[4] of the inflation differentials, nevertheless it is worth noticing that, as a whole, inflation differentials in the USA are more concentrated around a zero mean and, moreover, show lower volatility.

Insert table 1 about here

Insert table 2 about here

4. The approach of the paper

In the presence of difference stationary variables, the convergence of national inflation rates toward the global, Euro-area inflation rate requires the inflation differentials to be a stationary variable. More precisely, a systemic, desirable property for the currency area is that the different national rates would gravitate around the EMU average inflation. Hence, divergence should be only a short-run, transitory phenomenon.

Our strategy is to establish first a set of conditions under which the long-run convergence is satisfied and then to undertake an empirical investigation for a group of Euro-area countries.

[3]For the Euro-area countries, the series are taken from Eurostat. Data concerning the USA are instead taken from FRED at the St. Louis FED Web site.

[4]The four US regions, both for economic strength and population size, are more comparable with the group of big European countries, France, Germany, Italy, and Spain.

To this end, let us assume that the Eurozone annual inflation rate, given by $\pi^* = (ln(P_t^*) - ln(P_{t-12}^*)) * 100$, behaves as an I(1) variable.

If we assume that also the year-on-year inflation rate of the generic member country, i, $\pi_i = (ln(P_{it}) - ln(P_{it-12})) * 100$, is an I(1) variable, then their joint dynamic has the following reduced-form Wold representation:

$$\begin{pmatrix} \Delta\pi_t^* \\ \Delta\pi_{it} \end{pmatrix} = \begin{pmatrix} C_{11}(L) & C_{12}(L) \\ C_{21}(L) & C_{22}(L) \end{pmatrix} \begin{pmatrix} \epsilon_{1t} \\ \epsilon_{2t} \end{pmatrix} \quad [1]$$

where Δ is the first difference operator and L is the lag operator, with $C(0) = I$. $\epsilon_t = (\epsilon_{1t}, \epsilon_{2t})'$ is the (2x1) vector of reduced-form disturbances such that $E(\epsilon_t) = 0$ and $E(\epsilon_t \epsilon_t') = \Omega_\epsilon$.

We state that the inflation rate of country i converges to the inflation rate of the Euro area if the folllowing set of conditions (cf. Ribba, 2003) is satisfied:

(i) the matrix of long-run multipliers, C(1), has reduced rank 1, *i.e.* Euro-area and national inflation are cointegrated.

(ii) the cointegrated vector has the form $(1, -1)'$, *i.e.* the inflation differential is a stationary stochastic process.

(iii) There is unidirectional long-run causality which goes from Euro-area inflation to national inflation, *i.e.* the error-correction term does not enter the equation of the Euro-area inflation. The implication is that the burden of the adjustment to the long-run equilibrium relies on the national inflation rate.

If this set of conditions is satisfied, then the EMU average inflation rate is a long-run predictor of the national inflation rate since, in this case, the following results hold:

$$\lim_{h \to \infty} \frac{\partial E_t(\pi_{it+h})}{\partial \epsilon_{1t}} \neq 0 \quad [2]$$

$$\lim_{h \to \infty} \frac{\partial E_t(\pi_{it+h})}{\partial \epsilon_{2t}} = 0 \quad [3]$$

For, the implication is that the conditional expectation $E_t(\pi_{it+h})$, for h which goes to infinity, depends only on innovations in Euro-area inflation.

Moreover, if the set of conditions from (i) to (iii) is satisfied, then there exists the following Error Correction Model representation:

$$\Delta\pi_t^* = A_{11}(L)\Delta\pi_{t-1}^* + A_{12}(L)\Delta\pi_{it-1} + \epsilon_{1t} \quad [4]$$

$$\Delta\pi_{it} = A_{21}(L)\Delta\pi_{t-1}^* + A_{22}(L)\Delta\pi_{it-1} - \alpha_2(\pi_{t-1}^* - \pi_{it-1}) + \epsilon_{2t} \quad [5]$$

since conditions (ii) and (iii) imply that β the $(2x1)$ vector of cointegration coefficients is given by $\beta = (1, -1)'$ and α the $(2x1)$ vector of adjustment coefficients is given by $\alpha = (0, \alpha_2)'$.

It is worth noticing that the set of conditions from (i) to (iii) also allows π^* to be identified as the trend component of π_i, since the restrictions meet all the conditions required by the Gonzalo and Granger (1995) Permanent-Transitory decomposition (P - T) in cointegrated systems.

Thus, in order to generate a Permanent-Transitory decomposition, the further condition $C_{12}(L) = 0$ equivalent to $A_{12}(L) = 0$, *i.e.* national inflation does not Granger-cause EMU average inflation, is not required. In other words, since we search for conditions which ensure the long-run convergence, then Granger non-causality at all frequencies is not necessary.

An important and further step consists in recovering the structural disturbances affecting the variables. In particular, it is possible to obtain a separation between the permanent and the transitory shock by observing that the condition of weak exogeneity of the Euro-area inflation implies that a contemporary causal ordering, with Euro-area inflation ordered first, produces the following results:

$$\lim_{h\to\infty} \frac{\partial \pi^*_{t+h}}{\partial \eta_{1t}} = \lim_{h\to\infty} \frac{\partial \pi_{it+h}}{\partial \eta_{1t}} \neq 0 \qquad [6]$$

Moreover, both the contemporaneous and the long-run response of Euro-area inflation to a local inflation shock exhibit the following result:

$$\frac{\partial \pi^*_t}{\partial \eta_{2t}} = \lim_{h\to\infty} \frac{\partial \pi^*_{t+h}}{\partial \eta_{2t}} = \lim_{h\to\infty} \frac{\partial \pi_{it+h}}{\partial \eta_{2t}} = 0 \qquad [7]$$

Where $\eta_t = (\eta_{1t}, \eta_{2t})'$ is the (2x1) vector of structural disturbances obtained by the Cholesky orthogonalization of the shocks[5]. The related structural VAR representation is given by:

$$\begin{pmatrix} \Delta\pi^*_t \\ \Delta\pi_{it} \end{pmatrix} = \begin{pmatrix} H_{11}(L) & H_{12}(L) \\ H_{21}(L) & H_{22}(L) \end{pmatrix} \begin{pmatrix} \eta_{1t} \\ \eta_{2t} \end{pmatrix} \qquad [8]$$

where $H(L) = C(L)H(0)$, $\eta_t = H(0)^{-1}\epsilon_t$ and $E(\eta_t\eta_t') = I$. Notice that $H(0)$ is the unique lower triangular matrix (Cholesky factor) such that $H(0)H(0)' = \Omega_\epsilon$.

[5]Hence, this is a case of equivalence between short-run and long-run identifying restrictions in bivariate cointegrated VAR models. There is a small but growing literature on this subject. See, among others, Cochrane (1994), Ribba (2003) and Fisher-Huh (2007). Some new equivalence results, for VAR models including both difference-stationary and trend-stationary variables, have recently been proposed by Keating (2009).

In words: in the presence of an unexpected increase at date t of the Euro-area inflation rate, the long-run forecast of both variables will gradually move towards a higher value; instead, in the presence of an increase of national inflation at date t, holding contemporaneously fixed Euro-area inflation, the long-run forecast of both the variables will be unchanged; however, an upward revision for short horizons might be possible[6].

A recent application of this methodological approach is due to Ribba (2011), where a criticism of the Fama interpretation of the Fisher effect is provided and, moreover, inflation is interpreted as a long-run predictor of short-term nominal interest rates, whereas the converse does not hold. In another recent paper, Paul and Ramachandran (2011) investigate the role of the currency equivalent monetary aggregate as a leading indicator of inflation for India in a cointegration framework. They find that a one-for-one long-run relation between the two variables is not rejected by data and then they test for the presence of long-run unidirectional causality running from the monetary aggregate to the inflation. The authors conclude that also this restriction is not rejected by data.

5. An empirical investigation for the Eurozone economy

In this section we present the results of the empirical investigation concerning the dynamics of the inflation differentials in the Euro area. For the countries included, we test for the existence of an equilibrium long-run relation between the Eurozone inflation and the national inflation. The sample period covered is 1999:1 - 2011:12. In a second step, if on the basis of Johansen's trace and lambda max tests the presence of cointegration is not rejected by data, we also test for the joint restriction of a one-for-one long-run relation between the variables and for the exogeneity of the Euro-area inflation. Thus we test for the set of restrictions defined in section 4 that, if met, allows the Eurozone overall inflation to be identified as the permanent component of the national inflation rates and hence as the long-run predictor of the specific country inflation.

The results of this investigation are summarized[7] in table 3.

Insert table 3 about here

The conclusion is that the instability of inflation differentials characterizes 9 out of the 12 countries considered in this investigation. Instead, the three countries which exhibit both stationarity of the differential and exogeneity of the Eurozone inflation are Belgium, France and Italy.

We have also tested, for the group of countries with converging path of inflationary dynamics, the presence of unidirectional Granger causality at all

[6]Nevertheless, it is worth stressing that the results collected in equations 2-7 hold only in the case where conditions from (i) to (iii) are satisfied.

[7]In order to save space, both in this section and in the next one, we do not report the detailed results concerning the cointegration tests and the analysis of the cointegration space.

frequencies: we find that only the joint dynamic of Euro-area inflation and French inflation shows the existence of bidirectional causality at the business cycle frequencies whereas for Italy and Belgium the national inflation does not Granger causes the currency area, overall inflation[8].

Figures from 1 to 3 present the impulse-response functions, with the 90 per cent confidence bounds[9], for the three member countries with a stable inflation differential. It is worth recalling that we recover the structural shocks by imposing a Wold causal chain with Eurozone inflation ordered first for the three estimated bivariate VARs. We have also shown in section 4 that in presence of cointegration and with the variable ordered first in the causal ordering which is weakly exogenous, this structural representation allows the separation of a permanent from a transitory shock. In other words, in this case there is equivalence between short-run (contemporaneous) and long-run identifying restrictions.

Indeed, as shown in the figures, the national inflation shock exerts only a transitory effect on both the Euro-area and the national inflation rate. In particular, in the case of Italy and Belgium, the response of Eurozone inflation to a local shock is not significant at all horizons. A slightly different result is obtained for France, since in response to a French inflation shock there is a significant increase in Eurozone inflation for some periods. Moreover, for all the three Euro-area countries showing convergence in the inflationary dynamics, it requires around two years for the transitory shock to vanish.

Insert Figure 1 about here

Insert Figure 2 about here

Insert Figure 3 about here

As far as the Eurozone permanent shock inflation is concerned, it drives the evolution of both national and Euro-area inflation from medium to long run. More precisely, it plays a dominant role for national inflation at low frequencies whereas, for the Eurozone inflation, there is a pre-eminent role of the permanent shock at all frequencies.

6. Extending the analysis to the US economy

This section is devoted to the study of inflation differentials for the US economy. In particular, we consider a set of bivariate VARs including the inflation rate

[8] As shown in Granger and Lin (1995), in the context of bivariate cointegrated VAR models, if the error-correction term does not enter the equation of the first variable, *i.e.* in our framework if the Eurozone inflation is the weakly exogenous variable of the dynamical system, then the conclusion is that the second variable (the national inflation in our context) does not Granger cause the first variable in the long run (at frequency zero).

[9] These asymptotic confidence bounds are built on the analytical formulae presented in Amisano and Giannini (1997).

of the four great US regions (Mid-West, North-East, South and West) vis-a-vis the overall US inflation rate. Table 4 shows that three out of four areas exhibit cointegration and stability of inflation differentials. Moreover, in these three areas there is gravitation of the regional rate around the US inflation rate. Only for West is the existence of a long-run equilibrium relation rejected by data for the sample period considered[10].

Insert table 4 about here

As shown in figures from 4 to 6, the local inflation shock exerts only a small, temporary effect for the US inflation rate. Further, the transitory shock does not show persistent effects also on the regional inflation rates, since it becomes not significant after six months in the Mid-West and after around eighteen months both in the North-East and in the South.

As a whole, the dynamic shape of the impulse-response functions is quite similar to those seen for the euro area countries. This not surprising since we have selected the group of regions which shows convergence of inflation to the overall inflation of the currency area.

Rogers (2007) studied the convergence of prices across European and US cities from 1990 to 2004. The author's investigation shows a significant reduction of dispersion of traded goods in the Euro area and, more generally, evidence of price level convergence. Rogers also emphasizes the similarity of results concerning the Eurozone and the US economy.

However, our investigation, covering the more recent period and conducted at a regional rather than at city level, confirms the presence of convergence in the inflation rates only for the USA.

Cecchetti *et al.* (2002) also conclude that there is convergence in the price level index among US cities. Nevertheless, the rate of convergence is slow since they estimate a half-life of convergence of about nine years. It is worth emphasizing that the authors consider a quite different period of investigation, from 1918 to 1995.

Insert Figure 4 about here

Insert Figure 5 about here

Insert Figure 6 about here

A final remark concerns the conclusion reached by Pirovano and van Poeck (2011) according to which the Great Recession has worsened the inflation differentials in the Euro area. Indeed, if this point is correct, then one may conclude

[10] In order to allow comparability with the results obtained for the Euro area, we have chosen the same sample period, 1999:1 - 2011:12.

that the recent economic crisis has not exerted the same effect, *i.e.* widening inflation differentials, in the US economy.

7. Conclusion

The empirical investigation conducted in this paper, covering the period from 1999 to 2011 and based on structural VECM, has shown that the Euro-area inflation can be interpreted as the stochastic trend component, and hence as a long-run predictor of the national inflation rates, only for a small number of Euro-area countries. In other words, there is a dominant result of divergence in the evolution of Eurozone inflation differentials. Exceptions are represented by France, Italy and Belgium.

The comparison of the Euro area with the other important currency area, *i.e.* the USA, reveals that there is a greater convergence in the US regional inflation dynamics, since three out of the four great areas which compose the monetary union exhibit stationarity in the inflation differentials. Moreover, the volatility in inflation differentials is lower in the USA.

However, with regard to the Eurozone economy, we stress that a positive conclusion of convergence of inflation dynamics regards France and Italy, two of the biggest EMU economies, considering that their GDP represents about one third of the overall euro area aggregate output.

The investigation also shows that Germany, the most important European economy, exhibited an inflation rate that diverged from the Eurozone average inflation and, in particular, was systematically below the Eurozone average in the first 13 years of euro. This can be seen as a virtue from the point of view of the national economy but, undoubtedly, it represents a problem for the currency zone as a whole since Germany, also through its low inflation rate, has significantly increased its relative competitiveness.

Thus, if the Eurozone is to survive, one of the unavoidable items among the fundamental ones in the agenda would seem to be a prolonged period in which Germany would adopt macroeconomic policies aimed at increasing domestic demand, together with a higher inflation rate than the average one of the other Eurozone member countries.

References

Altissimo F, Benigno P, Palenzuela DR (2011) Inflation Differentials in a Currency Area: Facts, Explanation and Policy. *Open Economies Review*, 22: 189-233.

Amisano G, Giannini C (1997) Topics in Structural VAR Econometrics. Berlin: Springer-Verlag.

Angeloni I, Ehrmann M (2007) Euro Area Inflation Differentials. *The B.E. Journal of Macroeconomics*, Topics 7(1).

Beck GW, Hubrick K, Marcellino M (2009) Regional Inflation Dynamics within and across Euro Area Countries and a Comparison with the United States. *Economic Policy*, 24: 141-184.

Cecchetti SG, Nelson CM, Sonora RJ (2002) Price Index Convergence among United States Cities. *International Economic Review*, 43: 1081-1099.

Cochrane JH (1994) Permanent and Transitory Components of Gnp and Stock Prices. *Quarterly Journal of Economics*, 109: 241-265.

de Haan J (2010) Inflation Differentials in the Euro Area: A Survey. In de Haan J., Berger H. *The European Central Bank at Ten*, Springer.

European Central Bank (2003) Inflation Differentials in the Euro Area: Potential Causes and Policy Implications. September 2003.

European Central Bank (2005) Monetary Policy and Inflation Differentials in a Heterogeneous Currency Area. *Monthly Bulletin*, 61-77.

Fendel R, Frenkel M (2009) Inflation Differentials in the Euro Area: Did the ECB Care? *Applied Economics*, 41: 1293-1302.

Fisher LA, Huh HS (2007) Permanent-Transitory Decompositions under Weak Exogeneity. *Econometric Theory*, 23: 183-189.

Gonzalo J, Granger CWJ (1995) Estimation of Common Long-memory Components in Cointegrated Systems. *Journal of Business and Economic Statistics*, 13: 27-35.

Granger CWJ, Lin (1995) Causality in the Long Run. *Econometric Theory*, 11: 530-536.

Johansen S (1991) Estimation and Hypothesis Testing of Cointegration Vectors in Gaussian Vector Autoregressive Models. *Econometrica*, 59: 1551-1580.

Keating JW (2009) When Do Wold Orderings and Long-Run Recursive Identifying Restrictions Yield Identical Results? Manuscript, Department of Economics, University of Kansas.

Honohan P, Lane PR (2003) Divergent Inflation Rates in EMU. *Economic Policy*, 18: 357-394.

Honohan P, Lane PR (2004) Exchange rate and Inflation under EMU: An Update. *Economic Policy Web Essay.* Also published as IIIS Discussion Paper No. 31.

Pirovano M, Van Poeck A (2011) Eurozone Inflation Differentials and the ECB. *Working Paper* 2011014 University of Antwerp, Faculty of Applied Economics.

Paul S, Ramachandran M (2011) Currency Equivalent Monetary Aggregates as Leading Indicators of Inflation. *Economic Modelling*, 28: 2041-2048.

Ribba A (2003) Permanent-Transitory Decompositions and Traditional Measures of Core Inflation. *Economics Letters*, 81: 109-116.

Ribba A (2011) On Some Neglected Implications of the Fisher Effect. *Empirical Economics*, 40: 451-470.

Rogers J (2007) Monetary Union, Price Level Convergence and Inflation: How Close is Europe to the USA? *Journal of Monetary Economics*, 54: 785-796.

Walters A (1988) A Critical View of the EMS. *Cato Journal*, 8: 503-506.

Table 1. Statistics on inflation differentials in the Euro area, 1999 - 2011.

Country	Mean	Median	Max.	Min.	Std. Dev.	Consecutive months above (*) or below (**) the EMU average inflation
Austria	-0.144	-0.131	1.248	-0.965	0.448	36** (01:11 - 04:10)
Belgium	0.121	0.054	1.773	-1.538	0.673	26** (02:3 - 04:4)
France	-0.238	-0.250	0.555	-0.720	0.288	49** (99:1 - 03:1)
Finland	-0.147	-0.021	1.807	-2.442	0.963	68** (02:5 - 07:12)
Germany	-0.435	-0.408	0.514	-1.194	0.354	97** (99:1 - 07:1)
Greece	1.182	1.107	3.923	-1.092	0.767	150* (99:1 - 11:6)
Ireland	0.371	0.446	3.615	-4.154	1.767	63* (99:1 - 04:3)
Italy	0.228	0.233	0.993	-0.601	0.343	25* (02:4 - 04:4)
Luxembourg	0.639	0.779	2.495	-2.261	0.834	34* (03:12 - 06:9)
Netherland	0.133	-0.211	3.033	-1.626	1.092	40* (00:5 - 03:8)
Portugal	0.494	0.499	2.855	-1.500	0.933	54* (00:4 - 04:9)
Spain	0.792	0.932	1.750	-0.909	0.598	87* (01:9 - 08:11)

Note: For each country statistics are presented concerning the variable $\pi_i - \pi^*$, *i.e.* the difference between the member country inflation, π_i, and the EMU average inflation, π^*. The last column indicates, for each country, the maximum number of consecutive months in which the national inflation exhibited values above or below the Euro-area inflation rate.

Table 2. Statistics on inflation differentials in the USA 1999 - 2011.

Country	Mean	Median	Maximum	Minimum	Std. Dev.	Consecutive months above (*) or below (**) the USA average inflation
Mid-West	-0.178	-0.167	0.673	-1.420	0.360	30** (03:3 - 05:8)
North East	0.206	0.196	1.210	-0.587	0.353	52* (01:11 - 06:2)
South	-0.025	-0.019	0.597	-0.662	0.275	30** (00:5 - 02:10)
West	0.021	-0.103	1.138	-0.726	0.474	41** (02:10 - 06:2)

Note: See note in table 1.

Table 3. Summary of the results for the joint dynamics of EMU average inflation rate and national inflation rates.

Country	rank C(1) = 1	$\beta = (1, -1)'$ $\alpha = (0, \alpha_2)'$	$C_{12}(L) = 0$
Belgium	yes	yes	yes
France	yes	yes	no
Finland	no		
Germany	no		
Greece	no		
Ireland	no		
Italy	yes	yes	yes
Luxembourg	no		
Netherland	no		
Portugal	no		
Spain	no		
Sweden	no		

Note: The notation is based on equations from (1) to (3) of section 3. A reduced-form bivariate VAR model, including Euro-area inflation and national inflation, was estimated for each country. The rank of the long-run matrix, C(1), and the restrictions on the cointegrating vectors and on the vectors of loading are based on the Johansen (1991) framework. The null of a vector of adjustment coefficients $(0, \alpha_2)$ implies testing for unidirectional long-run causality. In the last column, the null of $C_{12}(L) = 0$ tests for unidirectional causality at all frequencies (Granger-causality).

Table 4. Summary of the results for the inflation differentials in the USA.

Area	rank C(1) = 1	$\beta = (1, -1)'$ $\alpha = (0, \alpha_2)'$	$C_{12}(L) = 0$
Mid-West	yes	yes	no
North East	yes	yes	yes
South	yes	yes	yes
West	no		

Note: The notation is based on equations from (1) to (3) of section 3. A reduced-form bivariate VAR model, including the US inflation and the selected regional inflation, was estimated for each region. See also note in table 3.

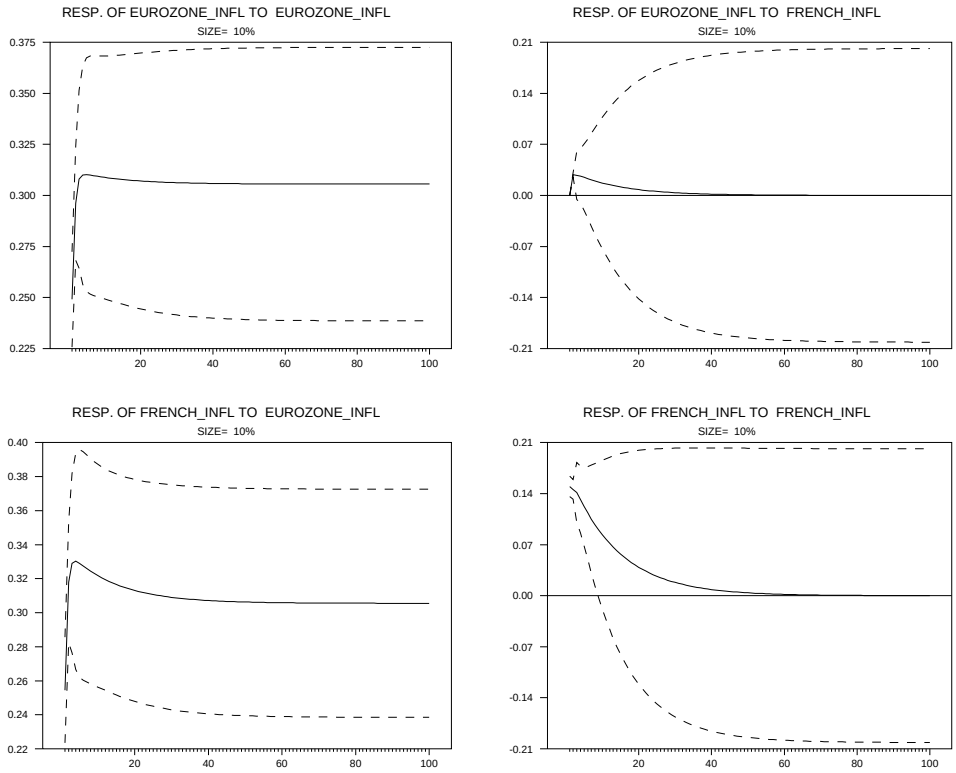

Figure 1 Impulse Response Functions: France

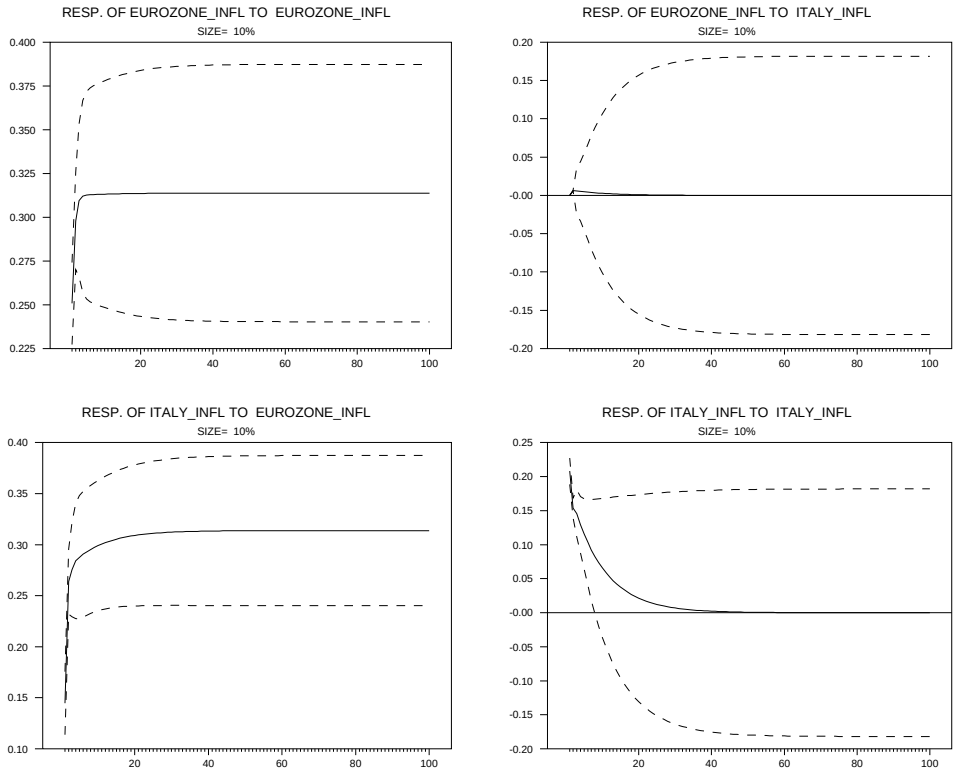

Figure 2 Impulse Response Functions: Italy

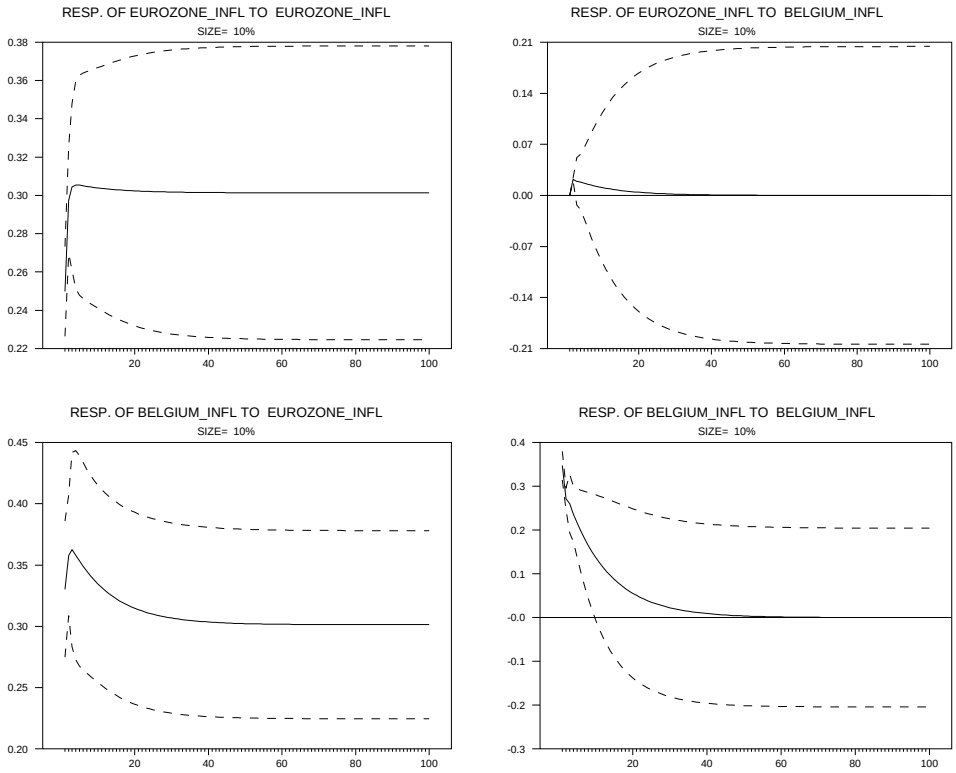

Figure 3 Impulse Response Functions: Belgium

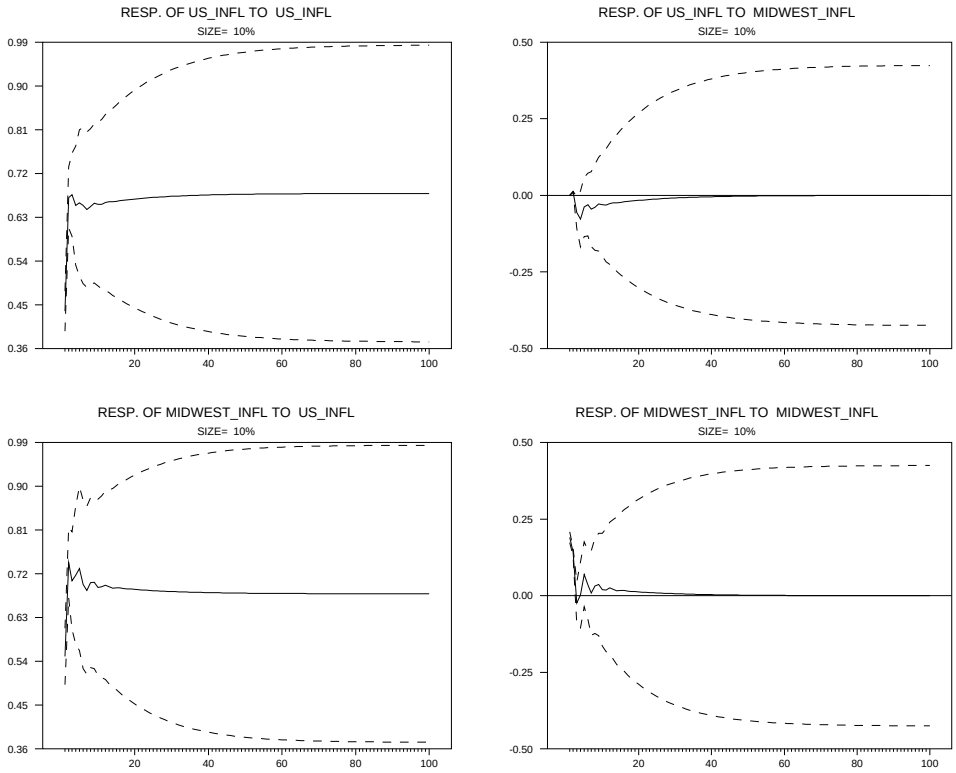

Figure 4 Impulse Response Functions: Mid-West

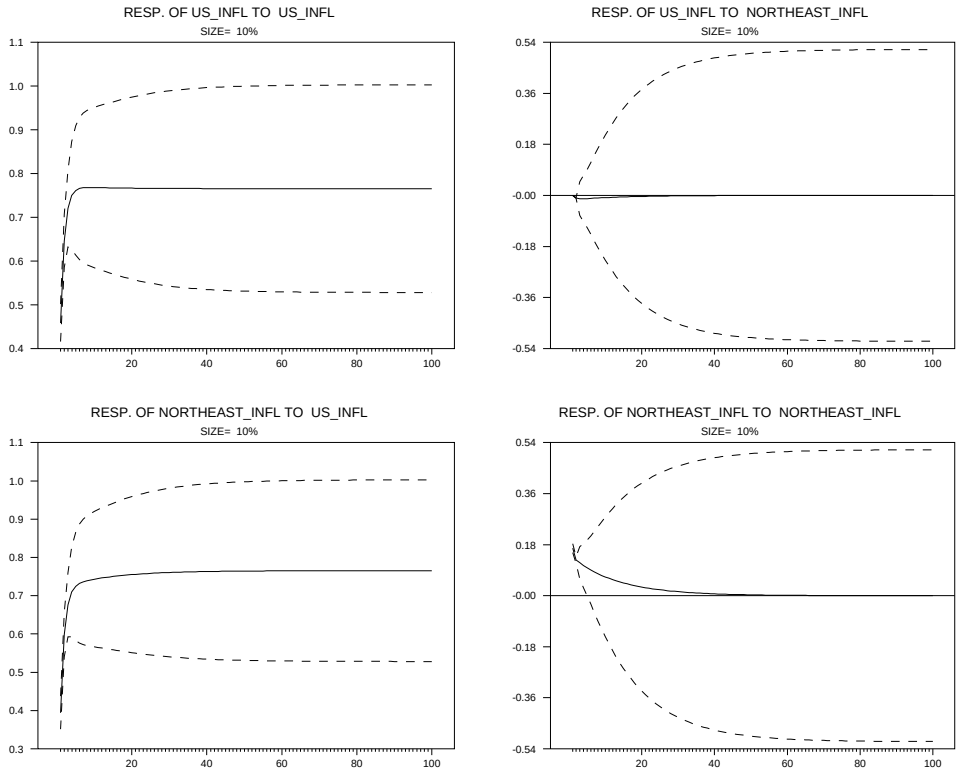

Figure 5 Impulse Response Functions: North East

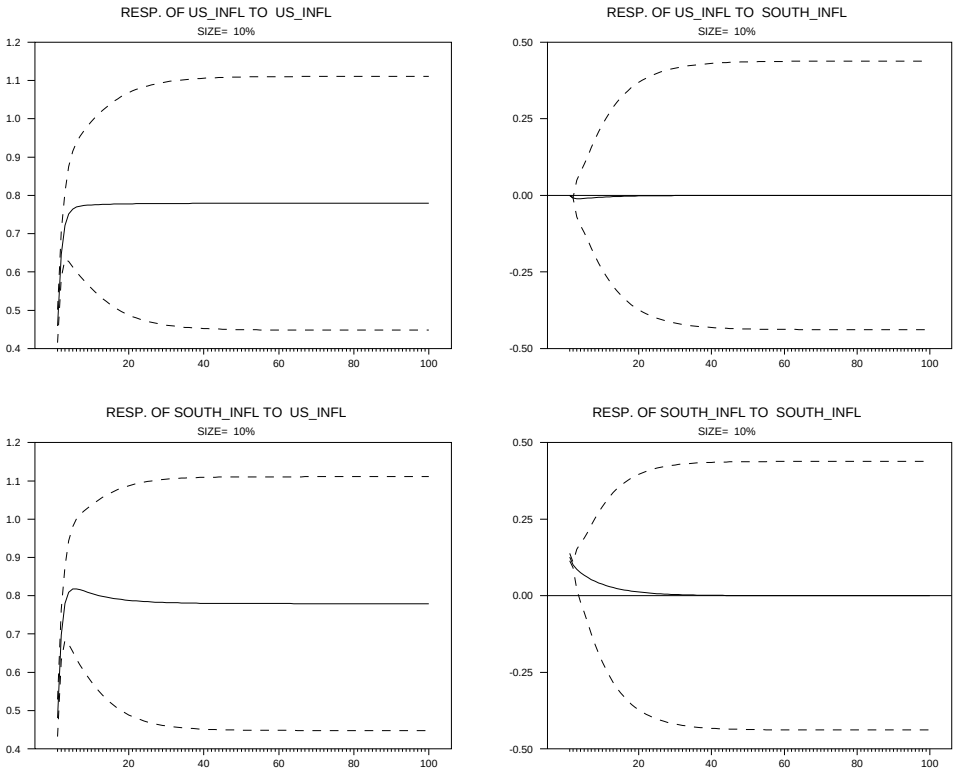

Figure 6 Impulse Response Functions: South

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