Exchange Rates and Inflation in EMU Countries: Preliminary Empirical Evidence [1]

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Abstract

In this paper we assess the role of exchange rate changes in the determination of national inflation rates for EMU member countries. Furthermore, we argue that the reaction of the national inflation rate is different across countries, and that three groups can be identified within the EMU with respect to this reaction: 'fast adjustment', 'slow adjustment', 'no adjustment'. These findings are consistent with other findings in the recent empirical literature on inflation convergence in the EMU.

1. Introduction

The aim of this paper is to provide empirical evidence on the (differential) effects of exchange rate movements on national inflation rates of European Monetary Union countries. While there is widespread acceptance, both from the theoretical and empirical point of view, on the proposition that Euro depreciation positively affects aggregate inflation in the EMU, only recent preliminary empirical work has explicitly tackled the issue of whether and to what extent such a disturbance can cause different effects in different countries within the Monetary Union.

As it is shown in figure 1 [2] , the aggregate EMU inflation rate hides important differences among individual members of the MU. If we allow for an initial period of adjustment (immediately following the birth of the MU), in which the Euro depreciated sharply,

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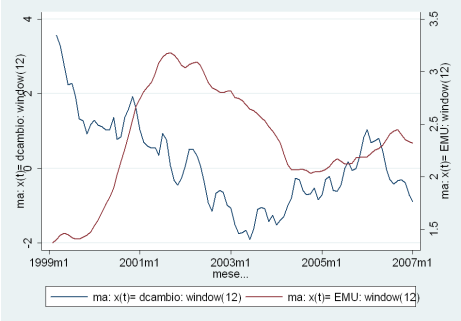
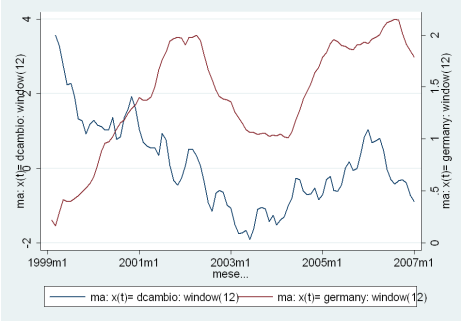
[1] We thank Filippo Spazzini for useful comments.

[2] The figure shows the 12-period moving average of annualized month-on-month inflation rates for the EMU (computed as the simple average of the eleven countries considered in this paper, i.e. all members except Luxembourg and Slovenia) and three individual members against the percentage month-on-month change in Euro/Dollar nominal exchange rate, smoothed in the same way.

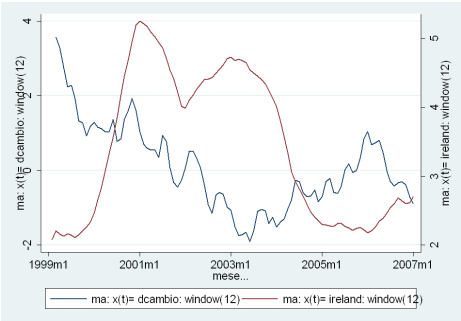
Fig. 1. Inflation rates and Euro/Dollar exchange rate changes



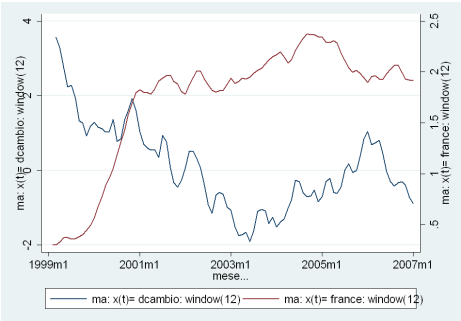
(a) EMU



(b) Germany



(c) Ireland



(d) France

while inflation rose sensibly after having dropped during the preceding years, we can see that the aggregate inflation rate [fig. 1(a)] has been following with a lag the movements of the Euro/Dollar exchange rate ever since. However, this aggregate behavior is the result of different underlying movements of the individual inflation rates: in most member countries, the inflation rate does follow Euro/Dollar movements, although the adjustment may be quick [fig. 1(b)] as well as very slow [fig. 1(c)]; conversely, in some other cases, the inflation rate seems to behave independently of exchange rate movements, as it happens in France [fig. 1(d)].

A recent strand of empirical literature has investigated the issue of inflation convergence/divergence [Angeloni and Ehrmann (2004), Busetti *et al.* (2006)], but few papers explicitly posit the existence of a relationship between the valuation of the Euro (either against the Dollar, or in effective terms) and inflation differentials (Honohan and Lane, 2003, 2005).

The theoretical tools we have for explaining the influence that exchange rates exert upon consumer price inflation, and hence upon inflation differentials in the EMU, are abundant, ranging from purchasing power parity (PPP) and the closely connected "monetary approach", to the "Norwegian model" as presented by Aukrust (1977), to the New Keynesian open-economy Phillips curve [3].

[3] For an excellent survey, see Kara and Nelson (2003).

In a much cited paper, Svensson (2000) has listed three channels through which the exchange rate can affect consumer price inflation: the "direct" channel, i.e. the presence of imported final goods in the consumer price index; the additional aggregate demand channel, arising from the sensitivity of the trade balance to the exchange rate; the imported intermediate input (III) channel, arising from the impact of the exchange rate on *domestic* production costs, in an internationally integrated production process.

It is this latter channel that is of particular interest to us, as it could account for much of the diversity we observe within the EMU. The relevance of the issue notwithstanding, formal models of this channel lack somewhat in the literature. A notable example is McCallum and Nelson (1999), where imports are included as an input in the production function, thereby allowing for an effect of the exchange rate on production costs.

This paper is part of a larger research project, involving empirical as well as theoretical developments, in which the relevance of the productive specialization of countries, and their role in the internationally fragmented production process, will be emphasized in relation to both real and nominal variables.

In the present study, we start focusing our attention on the supply side of the economy, by estimating a simple form of the Phillips curve for eleven EMU countries, in which the exchange rate enters as an exogenous variable. Section 2 presents the model and the data set used. In section 3 the empirical results are discussed and some economic considerations proposed. In section 4 we draw some conclusions and suggest directions of further research.

2. Empirical model and data issues

The aim of our empirical model is to assess the effects of exchange rate variations on the *individual* inflation rates of EMU countries. We estimate the following system of eleven [4] equations for the inflation rates:

$$\pi_{it} = \alpha + \beta_{1i} e_{t-2} + \beta_{2i} e_{t-4} + \beta_{3i} e_{t-8} + \beta_{4i} oil_t + \beta_{5i} gap_{i(t-1)} + \varepsilon_{it} \qquad (1)$$

where π_{it} is the annualized quarter-on-quarter inflation rate for country i between quarters t and $t-1$; e_t and oil_t are, respectively, the percentage changes in the Euro/Dollar exchange rate and in oil price between quarters t and $t-1$; gap_{it} is the output gap for country i in quarter t, expressed in percentage points with respect to potential output, and ε_{it} is a disturbance term. The series for inflation rates, exchange rate and oil price have been smoothed using a 4-period moving average, to adjust for seasonality. The inflation rate is calculated from the Harmonized Index of Consumer Prices [5]. The output gap has been computed using a Hodrick-Prescott filter from the seasonally adjusted quarterly real output. The series span from 1999:q1 to 2006:q4, i.e. for the whole part of the life of the EMU for which data are available. All data are from the ECB Statistical Data Warehouse.

[4] All countries in the Monetary Union are considered, except Luxembourg and Slovenia.

[5] $\pi_{i_t} = 100 \left[\left(\frac{HICP_{it}}{HICP_{i(t-1)}} \right)^4 - 1 \right]$.

Model (1) is a system of equations where all regressors are the same across countries, except for the output gap, which is a country-specific variable. This system can be estimated using Zellner's seemingly unrelated regression estimation method.

Each equation of the model can be seen as a Phillips curve to which the *nominal* exchange rate has been added. This differs somewhat from what is done by Svensson (2000), who includes the *real* exchange rate in his Phillips curve specification. In fact, looking at the ratio between the consumer price indexes during the last seven years, one can be easily convinced that changes in the nominal Euro/Dollar exchange rate are tantamount to real changes. Furthermore, we are more interested here in assessing whether and to what extent nominal exchange rate changes spill into domestic inflation (see section 1).

Some authors (see, for example, Favero and Rovelli, 2003), control for some commodity price index in their Phillips curve specification, as we also do here by including the change in the oil price. This control variable is not lagged, as the effect of energy prices on the consumer price index can safely be assumed to be quite fast [6]. Conversely, the output gap appears with one lag, as the effect of this variable is generally slower.

3. Empirical results

The results of our estimation are shown in table 1 [7]. The point estimates of the coefficients are reported, along with the associated p-values. For each equation, the R-squared associated with the regression is reported in the last column.

As for the 'standard', or 'closed economy' part of the Phillips curve, the results seem to fit both the theory and reality well: the coefficients for 'oil inflation' are generally positive and significant; the coefficients for the national output gaps are generally negative as expected, albeit not always significant; finally, the constant terms are not far from what can be reasonably believed to be the average inflation rate for each country, clearly separating lower inflation countries (such as Germany and Finland) from higher inflation countries (such as Greece and Ireland).

Turning to the 'exchange rate' part of the model, we can observe some interesting facts. First, consistently with the theory (be it the purchasing power parity, the monetary model, or one of Svensson's three channels), we observe that, *in general*, a depreciation of the common currency translates into higher inflation. This is also consistent with what is empirically observed for the aggregate EMU inflation rate [8].

[6] As it is explained in the next section, we also tried different lag structures to assess the robustness of our estimates. One alternative specification included the change in oil prices lagged one quarter.

[7] The results shown here have proven to be fairly robust to specification changes: we estimated the model imposing different lag structures on the exchange rate part, by lagging the oil price change one period, by lagging the output gap two periods instead of one. We also estimated a similar SUR system using monthly data (excluding the output gap from the specification), thereby providing an informal check for robustness to sample size, which is admittedly quite small in the estimation presented here. Finally, we estimated VAR models for some of the countries *individually* (using monthly data on inflation rates, the exchange rate and oil price)), and observed a dynamic response consistent with what is intuitively discussed here.

[8] This can be seen by estimating a single regression with the EMU inflation rate as the dependent variable, or by estimating a VAR model of the EMU inflation rate, the exchange rate change and the oil price inflation. In the latter case, some insights on the dynamics of adjustment can be obtained (see below).

Table 1
SUR estimation results.

	α	β_{1i}	β_{2i}	β_{3i}	β_{4i}	β_{5i}	R^2
π_{at}	1.9089 (0.000)	21.489 (0.000)	−.56672 (0.913)	−5.6365 (0.143)	4.8317 (0.011)	−.58878 (0.000)	0.4505
π_{be}	2.1339 (0.000)	12.947 (0.045)	4.3310 (0.517)	−9.4244 (0.035)	3.8980 (0.107)	−.15372 (0.106)	0.5486
π_{de}	1.7122 (0.000)	13.691 (0.010)	−2.4455 (0.626)	−3.0434 (0.374)	4.0205 (0.030)	−.02949 (0.756)	0.6099
π_{es}	3.2685 (0.000)	4.9032 (0.324)	6.8580 (0.136)	5.2415 (0.109)	9.4150 (0.000)	−.42928 (0.039)	0.6958
π_{fi}	1.4702 (0.000)	−13.926 (0.013)	37.704 (0.000)	4.0499 (0.240)	3.5156 (0.059)	.27582 (0.000)	0.8557
π_{fr}	1.8885 (0.000)	−8.7661 (0.013)	−1.3609 (0.704)	7.0122 (0.004)	3.9365 (0.003)	.15952 (0.062)	0.5425
π_{gr}	3.5813 (0.000)	1.8485 (0.563)	10.416 (0.002)	5.7855 (0.012)	2.3264 (0.061)	.02382 (0.563)	0.7603
π_{ie}	3.3165 (0.000)	−14.604 (0.015)	26.8875 (0.000)	22.699 (0.000)	3.8758 (0.097)	−.06894 (0.047)	0.8479
π_{it}	2.3868 (0.000)	−2.5133 (0.334)	−.17708 (0.946)	13.102 (0.000)	2.7289 (0.005)	−.24615 (0.004)	0.6778
π_{nl}	3.0562 (0.000)	8.0817 (0.252)	29.388 (0.000)	11.749 (0.004)	−2.1425 (0.331)	.00713 (0.964)	0.9217
π_{pt}	3.3581 (0.000)	13.566 (0.114)	2.7664 (0.746)	17.530 (0.003)	1.2341 (0.703)	−.2484 (0.078)	0.5856

P-values associated with the coefficient estimates are shown in parentheses.

Second, our eleven countries can be subdivided roughly into three categories, with respect to their inflation rate's reaction to exchange rate changes: one group, for which the inflation rate reacts quickly (the β_{2i} coefficient is big and highly significant), containing Austria, Belgium and Germany; another group in which inflation rates do adjust, but with a longer lag (one or two years), consisting on Greece, Ireland, Netherlands, Portugal [9]; finally, a third group includes those countries for which an adjustment does not seem to occur (the coefficients associated with the exchange rate change are not statistically significant or of the wrong sign), such as France and Spain [10].

Third, we can notice that countries belonging to the 'fast adjustment' group can also be classified as 'lower inflation' countries (low values of the constant term), while those belonging to the 'slow adjustment' group have significantly higher average inflation rates [11].

Busetti *et al.* (2006) have studied the properties of inflation convergence / divergence whithin the EMU, independently of the exchange rate, identifying two 'convergence clubs', i.e. two clusters of countries showing statistically different behavior. They label

[9] Finland may be thought of as belonging either to the first or second group. A more detailed dynamical analysis should be conducted to fully characterize the dynamics and speed of adjustment.

[10] Again, there is an ambiguous case. Italy could be seen as belonging either to the second or third group: while the coefficient estimates would point toward the second group, visual inspection of the time series reveals a behavior that is more similar to that showed by France and Spain.

[11] Given the very high significance of the constant term, confidence intervals around the point estimates are quite narrow, so that the discrimination between 'low inflation' and 'high inflation' countries is straightforward.

the two clubs 'high inflation' and 'low inflation'. Very interestingly, their clubs coincide roughly with our 'slow adjustment' and 'fast adjustment' groups [12].

Parallely, Honohan and Lane (2003, 2005) believe that convergence/divergence of inflation rates within the EMU is closely related to exchange rate movements.

The present paper could well serve as a connection between the latter two studies, in the same line of research, by suggesting one possible explanation for the different behavior of Busetti *et al.*'s clusters: the differences in the dynamics of inflation rates within the European Monetary Union may be due, in part, to the different ways exchange rate shocks are transmitted to the inflation rate.

4. Concluding remarks and further directions of research

In this paper we estimated a system of eleven equations relating national EMU inflation rates to changes in the Euro/Dollar exchange rate and found robust, albeit preliminary, empirical evidence of a significant effect of exchange rate changes upon national inflation rates of EMU member countries. Furthermore, we argued that this effect is different across countries, and that these countries can be classified in three groups with respect to their behavior: the 'fast adjustment' group, the 'slow adjustment' group and the 'no adjustment' group. We also argued that our findings are consistent with other findings in the recent empirical literature, namely those by Honohan and Lane (2003, 2005) and Busetti *et al.* (2006).

Further research is needed both on the theoretical and the empirical side. From the theoretical point of view, the influence of the exchange rate on price levels and inflation rates through the imported intermediate input needs to be modeled carefully. This could help explain the observed clustering of EMU members (with respect to their reaction to nominal shocks) with their different productive specialization, i.e., with their structural characteristics. From the empirical point of view, of the many ways in which this line of research could be carried further on, we suggest two. 1) A similar study should be conducted at a disaggregated level, seeking to exclude imported final goods from the price indexes considered, in order to isolate the imported intermediate input channel; and 2) the dynamics of adjustment still need to be fully characterized, in order for the empirical evidence on the relationship between exchange rates and inflation to be regarded as convincing.

References

Angeloni, I. and M. Ehrmann, 2004 Euro Area inflation differentials, ECB Working Paper no. 388

Aukrust, O., 1977, Inflation in the open economy: A Norwegian model, in L. B. Krause and W. S. Salant (eds), Worldwide Inflation – Theory and Recent Experience, The Brookings Institution

[12] Of course, we have a third group: in the classification of Busetti *et al.*, Spain belongs to the first club, France to the second. In their analysis, as in ours, Italy shows an ambiguous behavior. As for Finland, it clearly belongs to the 'low inflation' club.

Busetti, F., L. Forni, A. Harvey and F. Venditti, 2006, Inflation convergence and divergence within the European Monetary Union, ECB Working Paper no. 574

Favero, C. and R. Rovelli, 2003, Macroeconomic stability and the preferences of the Fed: A Formal Analysis, 1961–98, Journal of Money, Credit and Banking 35 (4), 545–556

Honohan, P. and P. R. Lane, 2003, Divergent inflation rates in the EMU, Economic Policy 18 (37), 357–394

Honohan, P. and P. R. Lane, 2005, Exchange rates and inflation under the EMU: An update, Institute for International Integration Studies Discussion Paper no. 31

Kara, A. and E. Nelson, 2003, The exchange rate and inflation in the UK, Scottish Journal of Political Economy, 50 (5), 585–607

McCallum, B. T. and E. Nelson, 1999, Nominal income targeting in an open-economy optimizing model, Journal of Monetary Economics 43, 553–578

Svensson, Lars E. O., 2000, Open-economy inflation targeting, Journal of International Economics 50, 155–183