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Non-linearities in euro area inflation persistence

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ABSTRACT

This paper investigates the nature of inflation dynamics with a special focus on inflation persistence. Using data from euro area member-states we estimate dynamic non-linear panel models addressing in detail econometric issues concerning unobserved heterogeneity, genuine state dependence, and the initial conditions problem. After controlling for observed and unobserved heterogeneity, our results suggest that the degree of inflation persistence is genuine and varies depending on whether the inflation rate is too high, within the range of ECB's target of price stability, too low or negative. This implies that policies to stabilize inflation in the short run will have longer-run effects.

1. Introduction

Over the last four decades inflation dynamics in many European countries have undergone tremendous changes regarding average inflation levels, persistence and volatility. The 'Great Inflation' period of the 1970s and early 1980s was succeeded by a decade of declining inflation rates and progressively reduced volatility (middle 1980s to middle 1990s). The changes in inflation behaviour became particularly pronounced for most member-states of the European Monetary Union (EMU) soon after the introduction of the euro. The framework for the conduct of monetary policy along with the European Central Bank's (ECB) policy strategy proved quite successful in taming consumer-price inflation and anchoring inflationary expectations. However, low-inflation environments face the possibility of deflationary episodes as moderate fluctuations around a low level of inflation can turn inflation to deflation (Bordo and Filardo, 2005). This is exactly what happened to a certain number of euro area countries after the outbreak of the 2008 economic crisis.

Against this background it is of great interest to ask whether deflation episodes can contribute to further downward price pressures turning deflation itself into a more permanent situation. This amounts to asking whether negative inflation exhibits the same pattern of persistence as positive inflation does. Though resolving the uncertainty surrounding this issue is of paramount importance for the conduct of monetary policy, the literature has not provided a definite answer. However, certain theoretical arguments have been proposed in justifying the non-linearities of inflation persistence. Low competition in product markets, as well as rigid labour markets, allow firms to reset their prices upwards during good times and to delay a (downward) price adjustment during periods of economic slack. In such circumstances firms tend to be more responsive to negative supply shocks (e.g. firms set higher prices when confronted with higher input prices) and less responsive to positive supply shocks (e.g. prices may be left unchanged after a decrease in input prices), or to react to product and labour market slack only after economic activity measures (e.g. unemployment) have reached a certain threshold value (Barnes and Olivei, 2003; Peach et al., 2011).[1] This firms' behaviour possibly explains why inflation persists at disproportionally high levels during periods of low economic activity. Moreover, the services' sector, which prevails in EU countries, differs from the rest productive sectors of the economy in two important aspects: services are largely non-tradable and labour intensive. The first feature makes firms of the services sector immune to

[1] The weakness of linear Phillips curves to describe the linkage between inflation and unemployment for certain time intervals during the "Great Moderation" era of the US economy led Barnes and Olivei (2003) and Peach et al. (2011) to adopt a piecewise linear specification of the Phillips relationship. Using US data, the two papers show that inflation responds asymmetrically to unemployment changes depending on the level of unemployment.

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international price competition and thus less prone to price declines. The second feature adds to downward price rigidity through downward wage rigidity.[2]

Motivated by the idea that inflation persistence might not be symmetric across different states of inflation, this paper investigates the existence of non–linearities in the responsiveness of current inflation to its own lag for euro area countries. From this perspective, it belongs to a class of papers that search for various forms of instability in inflation dynamics using as building blogs traditional Phillips curve relationships (e.g. Laxton et al., 1999; Aguiar and Martins, 2005; Baghi et al., 2007; Musso et al., 2009). So, while we are not the first to address the issue of non-linearity, this is the first attempt that explicitly links variations in inflation inertia with different ranges of the inflation level, namely, deflation, too-low inflation, price stability, and medium to high inflation.

Another contribution of the paper lies in the adopted methodological approach. Specifically, we employ a dynamic random effects ordered probit framework, which allows us to capture the presence of asymmetric features in the response of current inflation with respect to its own lag. Our results are consistent with the idea that the relationship of current inflation to its own lag varies, depending on whether the inflation rate is too high, within the range of ECB's target of price stability, too low or negative.

The paper proceeds as follows. Section 2 presents the data used and the empirical framework, Section 3 considers the empirical results and their implications and investigates the robustness of our results to alternative model specifications, while Section 4 concludes.

2. Data and methodology

Our country sample includes the 11 European countries that have been full members of EMU since 1999.[3] All data used in the estimations is obtained from Eurostat and is of quarterly frequency, spanning the period 1997:Q1 to 2015:Q3. The measure of inflation is the annualized Harmonized Index of Consumer Prices (HICP hereafter) inflation rate. We prefer headline over core inflation because the inflation target of the ECB is explicitly stated in terms of headline measures and its policy makers pay less attention to core measures. Economic slack is proxied by the seasonally adjusted unemployment rate to eliminate measurement problems and uncertainty surrounding alternative proxies like the output gap.

In the empirical literature of inflation persistence there are two main methodological approaches as to measure persistence. The first and most common methodology utilizes a simple univariate time-series framework and assumes that inflation follows an autoregressive process of order p(AR(p)). From this model various measures of inflation persistence, such as the "sum of autoregressive coefficients", the "spectrum at zero frequency", the "largest autoregressive root" and the "half-life", can be derived. The second approach utilizes multivariate econometric models and assumes that inflation depends not only on its own lag but on other variables as well. The advantage of the multivariate approach is that it offers a deeper analysis of persistence, since it incorporates other economic variables that affect the evolution of inflation. In this paper we use the multivariate approach and in particular a dynamic Phillips curve framework. Moreover, since we are examining a set of countries under a single central bank rather than a single country, time-series analysis is not appropriate and we use longitudinal models, which among others eliminate country heterogeneity.

In its simplest form the dynamic Phillips curve assumes that the current level of inflation ($HICP_{it}$) depends on its own lag ($HICP_{it-1}$) and the current level of unemployment (u_{it}) as well as other explanatory variables (χ_t). This model for country $i=1,\dots,N$ in time $t=2,\dots,T$ takes the form of

$$HICP_{it} = cHICP_{it-1} + \theta u_{it} + \chi_t'\beta + \alpha_i + \varepsilon_{it}. \quad (1)$$

In Eq. (1) the level of inflation persistence is proxied by the size of coefficient c, which by construction is assumed to be constant. Our main argument in this paper is that inflation persistence is not constant, i.e. not linear, but varies depending on the level of previous quarter's inflation. In order to test our assumption we need to distinguish among different levels of inflation, namely disinflation, low inflation, inflation around the target set by ECB and high inflation. One way to do this is to construct an ordered variable representing the four aforementioned levels of inflation for each country i in period t and use this to estimate a dynamic Phillips curve instead of Eq. (1). Our new dependent variable is:

$$\pi_{it} = \begin{cases} 1 \text{ if } HICP_{it}<0 \\ 2 \text{ if } 0\le HICP_{it}<1 \\ 3 \text{ if } 1\le HICP_{it}<2.5 \\ 4 \text{ if } 2.5\le HICP_{it} \end{cases} \quad (2)$$

Identifying true inflation persistence, i.e. the effect of previous inflation status on the probability of current inflation status, as opposed to heterogeneity, suggests a modelling approach that incorporates both observable and unobservable influence on inflation. Since the level of inflation is an ordered variable, the dynamic random effects ordered probit framework represented by equation below is the most appropriate.[4]

$$\pi_{it}^{*} = \gamma_1\pi_{it-1}^{1} + \gamma_2\pi_{it-1}^{2} + \gamma_4\pi_{it-1}^{4} + \theta u_{it} + \chi_t'\beta + \alpha_i + \varepsilon_{it} \quad (3)$$

The subscript $i = 1,\dots,N$ denotes countries that are included in our sample and the subscript $t = 2,\dots,T$ represents the time periods for which the model is estimated. π_{it} is an ordinal variable representing the level of inflation and takes the values {1, 2, 3, 4} depending on the value of π_{it}^{*}, a latent measure of the level of inflation accordingly to Eq. (2). u_{it} is the level of unemployment and x_t contains strictly exogenous variables. In particular it includes year dummies to capture any trend effect, as well as an indicator variable of whether the country has physically adopted Euro as its currency. Obviously $\pi_{it-1}^{i=1,2,4}$ is the level of inflation of country i in the previous quarter. The random error term in this model is composed of two terms. The country specific error term α_i captures unobserved heterogeneity which differs between countries but remains constant for each country,[5] while ε_{it} is the usual error term with zero mean, uncorrelated with itself, with x_{it} and α_i as well as homoscedastic.

In these models special attention should be paid to the treatment of the initial conditions problem, which arises when the beginning of the examined period does not coincide with beginning of the stochastic data generating process. More specifically in a dynamic random effects ordered probit model, the presence of the lagged dependent variable means that there is a correlation induced between the first observation of dependent variable π_{i1} and the unobserved heterogeneity α_i. To treat the initial conditions issue we adopt the solution suggested by Wooldridge (2005).[6] Wooldridge suggests using a conditional

[2] A number of papers explain inflation's persistence through indexation of price contracts (Christiano et al., 2005), rule-of thumb behaviour (Gali and Gertler, 1999) or alternative contract assumptions (Fuhrer and Moore, 1995). See, Fuhrer (2011) and Woodford (2007) for a review of the related literature.

[3] These are Austria, Belgium, Finland, France, Germany, Ireland, Italy, Luxembourg, the Netherlands, Portugal and Spain.

[4] The choice of an ordered model stems from the nature of our dependent variable while the choice of random effects comes from the fact that in non-linear models fixed effects are problematic. Maximum likelihood estimator is inconsistent in probit models with fixed effects because it suffers from incidental parameter problem (Neyman and Scott, 1948).

[5] In the random-effects models, it is assumed that α_i in Eq. (3) is purely random. This assumption implies that α_i is uncorrelated with the regressors.

[6] In the literature there are two other solutions proposed by Heckman (1981a, 1981b) and Orme (1996) to the problem of initial conditions. Both involve a separate equation for the initial period and need proper instrument(s) for identification, which should determine initial period's inflation but not subsequent. As such instrument is difficult to find we apply Wooldridge's estimator. Arulampalam and Stewart (2009) show that all three estimators provide similar results and none consistently performs better than the others.