Inflation Dynamics in the Euro Area: One Structural Estimation*

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Abstract

Rudimentary empirical evidence indicates that a New-Keynesian Phillips curve in its "hybrid form," i.e., one that embodies both forward- and backward looking behavior, is consistent with inflation dynamics in the Euro area for 1997–2010, when the output gap is approximated by a survey measure of capacity utilization.

Keywords: Inflation dynamics; New-Keynesian Phillips curve, Euro area, capacity utilization

JEL: E31, E32.

*This note documents results presented in an article (in Danish) on A. W. H. Phillips' life and curve: "Alban er død, men hans kurve lever". The following, however, can be read independently.

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1. Introduction

This note presents a rudimentary estimation of a "New-Keynesian" Phillips curve on recent Euro-area data (1996Q2–2010Q2). Using GMM estimation techniques it is found that a "hybrid version" of the curve that emphasizes both forward- and backward looking behavior in price setting fits data well. As a measure of the output gap, I use a survey measure of capacity utilization, which is shown to significantly contribute to the inflation dynamics in the Euro area.

2. Estimation strategy and data

Following the standard New-Keynesian theory (see Woodford, 2003), inflation dynamics under staggered price setting and sticky prices can be represented as

$$\pi_t = \beta \mathrm{E}_t \left[\pi_{t+1}\right] + \widetilde{\lambda} mc_t, \qquad 0 < \beta < 1, \quad \widetilde{\lambda} > 0, \tag{1}$$

where π_t is inflation, mc_t is real marginal costs and $\mathrm{E}_t\left[.\right]$ is the rational expectations operator; see, e.g., Galí and Gertler (1999) for derivation and discussion. Under mild restrictions, (1) can be rewritten in terms of the output gap x_t:

$$\pi_t = \beta \mathrm{E}_t \left[\pi_{t+1}\right] + \lambda x_t, \qquad \lambda > 0, \tag{2}$$

which has a more familiar "expectations-augmented" Phillips-curve flavor. In empirical work, (2) poses some problems. First, it has been hard to reject that price setting is not exclusively rational in the sense that lagged inflation is a significant determinant of current inflation. Second, since the output gap by definition depends on the hypothetical, and thus unobservable, flex-price output level, one must apply various proxies, or, alternatively try to rely on marginal cost representations.[1] I use a proxy for the output gap, namely a measure of capacity utilization.

Allowing for deviations from rational expectations (say through rule-of-thumb behavior, indexation schemes, rational inattention, *inter alia*), the "hybrid" version of the Phillips curve is given by

$$\pi_t = \beta \phi \mathrm{E}_t \left[\pi_{t+1}\right] + \left(1 - \phi\right) \pi_{t-1} + \lambda x_t, \qquad 0 < \phi < 1, \tag{3}$$

[1] This is what Galí and Gertler (1999) do on US data by using the labor share as a proxy for marginal costs.

where ϕ can be interpreted as the fraction of forward-looking, and rational, price setters. From (3) one finds the equation to be estimated as

$$\pi_t = \beta\phi\pi_{t+1} + (1-\phi)\,\pi_{t-1} + \lambda x_t + \varepsilon_t, \tag{4}$$

where $\varepsilon_t \equiv \beta\phi\,(\mathrm{E}_t\pi_{t+1} - \pi_{t+1})$. Following closely Galí and Gertler (1999), (4) is estimated using the General Method of Moments (Hansen, 1982).[2] This involves a number of orthogonality restrictions, or, moment conditions,

$$\mathrm{E}_t\left\{\left[\pi_t - \beta\phi\pi_{t+1} - (1-\phi)\,\pi_{t-1} - \lambda x_t\right]\mathbf{z}_{t-1}\right\} = 0, \tag{5}$$

where $\mathbf{z}_{t-1}$ is the vector of instrument variables. In the estimation, the discount factor β is fixed at 0.99 (this was found to have no influence on the results), so (5) identifies the parameter vector $\theta \equiv (\phi, \lambda)$ with at least two instruments.[3] I use more instruments, which allows for an evaluation of the validity of the specification and instruments by using the Hansen test for overidentifying restrictions. An optimal weighting of moment conditions is adopted, which allows for serial correlation and heteroscedasticy of the errors using the Newey-West method with the Bartlett kernel. The number of lags is chosen to depend on the number of observations; in Cliff (2003) the number of lags is 3 in this case with 57 observations. The instrument vector is relatively small:

$$\mathbf{z}_{t-1} = \left(\pi_{t-2,}\pi_{t-3}, x_{t-1}, x_{t-2}, w_{t-1}, w_{t-2}\right),$$

where w_t denotes nominal wage growth. The instrument variables are chosen in conformity with recent literature (Galí and Gertler, 1999; Paloviita, 2006; Rumler, 2007).

All data are quarterly observations for the Euro-16 area from 1996Q2 up to and including 2010Q2. Inflation is given by industry producer price inflation, and nominal wage growth is derived from compensation per employee in industries. As proxy for the output gap, I use the European Union Commission's survey measure of capacity utilization in industries. Precise definitions and sources are provided in the appendix.

[2] For estimation, I have applied Michael T. Cliff's MATLAB routines (Cliff, 2003), which is kindly made available at http://www.feweb.vu.nl/econometriclinks/mcliffprogs.html

[3] The estimation also involves a constant term (as does the vector of instruments), which is ignored here. It only serves as a scaling factor since the output gap measure has a non-zero mean.

ϕ	λ	J-test
0.635	0.106	4.35
(0.040)	(0.026)	(0.36)

Parameter estimates with standard errors in parentheses.

J-test is the Hansen test for overidentifying restrictions

with the associated P-value in parenthesis.

Table 1: Parameter estimates

3. Result

The estimation result is shown in Table 1. Both parameters are estimated quite precisely (significant at the 1% level), and the J-test does not reject the validity of the instruments. The results suggest that more than half of the firms set prices in a forward-looking fashion.[4] The elasticity of inflation with respect to the current output gap measure is comparable in magnitude to what is reported by Galí *et al.* (2001), Paloviita (2006), Rumler (2007) and Hondroyiannis *et al.* (2008) who use different measures and different sample periods.

In conclusion, this simple exercise indicates that the "hybrid" version of the New Keynesian Phillips curve fits data for the Euro area reasonable well. Figure 1, which shows actual and fitted inflation, confirms this conclusion.

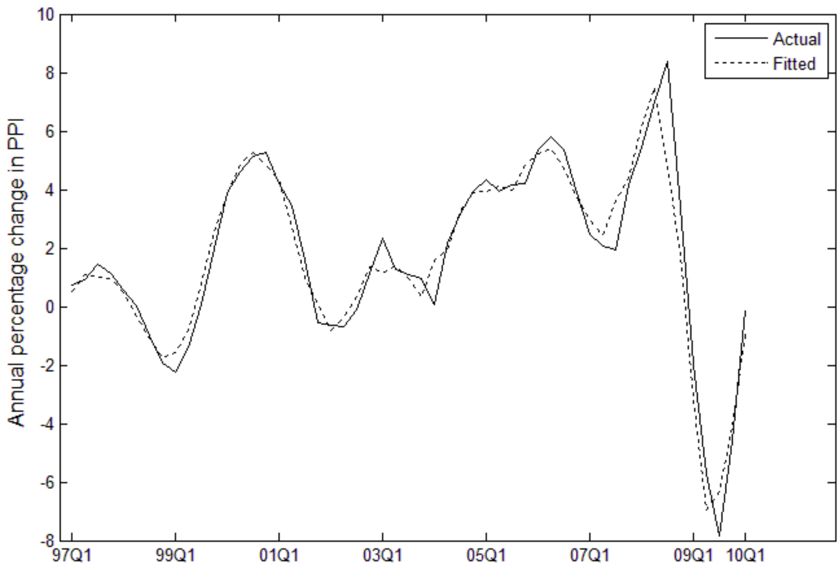

Figure 1: Actual and fitted producer-price inflation in the Euro-16 area; 1997Q1 - 2010Q1

[4] The estimate is in the upper range of those presented by Rumler (2007) for 1980-2003. Paloviita (2006) finds that the inflation process in Europe has become more forward-looking over time. My result on more recent data appears to support this.

Appendix

A. Data description

All data are available at `ecb.int/stats/`. The details of each series are:

- π_t
  - Dataset name: Short-Term Statistics
  - Code: STS.M.I5.N.PRIN.NS0020.4.ANR
  - Official description: PPI Euro area 16 (fixed composition), Total Industry (excluding construction) - NACE Rev2, Eurostat, Annual rate of change
- x_t
  - Dataset name: Opinion Surveys
  - Code: SUR.Q.I5.S.ECFIN.MAN013.TT
  - Official description: Euro area 16 (fixed composition), EU Commission, DG-ECFIN, Industry survey - current level of capacity utilisation, Total, Seasonally adjusted, not working day adjusted - Percentages
- w_t[5]
  - Dataset name: ESA95 National Accounts
  - Code: ESA.Q.I5.S.1000.COMEMP.0000.YC_E.V.U.I
  - Official description: Euro area 16 (fixed composition) - Compensation Per Employee: total industry, Current prices, ECU/euro, Seasonally and partly working day adjusted, mixed method of adjustment, Index.

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[5] The raw data is converted into annualized rate of changes.

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