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Is the Phillips curve still alive? Evidence from the euro area[☆]

Irma Hindrayanto^a, Anna Samarina^{a,b,*}, Irina M. Stanga^a

^a De Nederlandsche Bank, Amsterdam, The Netherlands

^b University of Groningen, Groningen, The Netherlands

HIGHLIGHTS

- The Phillips curve is estimated for the euro area and its five largest economies.
- We employ an unobserved component model for inflation and unemployment.
- The Phillips curve slope is negative and significant in EA and three countries.
- The slope has not changed substantially since the Global Financial Crisis.

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ABSTRACT

We estimate the Phillips curve for the euro area and its five largest economies over 1985–2017 using an unobserved component model for inflation and unemployment. Inflation expectations are modeled as the trend component of annualized HICP inflation. We have three results. First, the relationship between unemployment and inflation is negative and significant in the euro area, Germany, France, and the Netherlands. Second, the Phillips curve slope is heterogeneous across countries. Third, the slope has not changed significantly since the Global Financial Crisis.

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1. Introduction

A growing number of economists in recent years have argued that the Phillips curve “has broken down” (Summers, 2017), i.e. the relationship between inflation and economic activity does not hold any longer. The empirical evidence is mixed, with some recent studies still finding a significant Phillips curve slope (e.g., Gordon, 2013; Ciccarelli et al., 2017). One key issue for estimating the Phillips curve refers to inflation expectations which are by nature unobservable and not easily measurable. Most studies employ survey-based measures of inflation expectations, which have two main shortcomings. First, survey measures report only expectations of professional forecasters rather than perceptions of the public at large and they might not be representative (Coibon et al.,

2018). Second, data on surveyed expectations does not go back far in time, which limits the econometric analysis.

In this paper we estimate an unobserved components (UC) Phillips curve and model inflation expectations based on a different approach. We follow Harvey (2011) who proposed a modification of the backward-looking Phillips curve by decomposing inflation into permanent (trend) and transitory (cyclical) components. It can be shown that the trend is equal to long-run forecast of inflation given the available data up to the current period (Beveridge and Nelson, 1981). Therefore, we interpret the trend as a proxy for medium- to long-term inflation expectations. The cyclical component consists of a slack variable, i.e. output or unemployment gap, which is restricted to be stationary by construction. The relationship between inflation, its trend and the slack variable is what we call the UC Phillips curve.

Our approach has several advantages. First, compared to survey-based measures, trend inflation is not biased towards perceptions of a specific sector but implicitly reflects the overall economy. Second, it allows to extend the analysis further into the past instead of depending on the limited availability of survey data on inflation expectations. Third, the UC model accounts for the possibility that inflation is non-stationary. Some studies assume stationarity in

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* Correspondence to: De Nederlandsche Bank, Westeinde 1, 1017 ZN Amsterdam, The Netherlands.

E-mail addresses: a.i.w.hindrayanto@dnb.nl (I. Hindrayanto), a.samarina@dnb.nl (A. Samarina), i.m.stanga@dnb.nl (I.M. Stanga).

the inflation process as they include a lagged dependent variable in the model. This assumption is non-trivial and might lead to biased results (Cogley et al., 2010). We estimate the UC Phillips curve using unemployment gap as a measure of economic slack for the euro area and its five largest economies (Germany, France, Italy, Spain, and the Netherlands) over the period 1985–2017. Additionally, we examine whether the Phillips curve slope has changed after the Global Financial Crisis (GFC).

2. Theoretical background

The inverse relationship between wage inflation and unemployment was first proposed by Phillips (1958). The idea of a stable trade-off between inflation and output was criticized by Friedman (1968) who emphasized the role of inflation expectations. Unemployment below its natural rate can be achieved only temporarily by generating inflation in excess of what the public anticipates. However, as expectations adjust towards higher inflation, workers bargain for higher nominal wages in response to higher inflation. As a result, unemployment moves back to its natural rate and the new equilibrium is established at a higher inflation rate. Hence the Phillips curve is vertical in the long-run.

Even with rational expectations, a short-run trade-off between inflation and unemployment can persist. This trade-off is generated by frictions in price adjustments which prevent money neutrality. The New Keynesian Phillips Curve is derived in micro-founded models from the price-setting behavior of firms under the assumption of price stickiness. Since a firm is interested in its average relative price for the period over which the price remains fixed, it chooses its price based on production costs and expectations about how these costs will change until the next opportunity to reset prices (Clarida et al., 2000). This renders a relationship between inflation, inflation expectations, and a measure of economic activity such as unemployment gap:

$$\pi_t = \beta E_t \pi_{t+1} - \gamma u_t.$$

Empirical support for the Phillips curve is mixed and inconclusive. Failure to find evidence for the relationship between inflation and unemployment could stem from weaknesses in the econometric approaches used to estimate it. It is important to account for the possibility of non-stationarity of variables, endogeneity of inflation and unemployment as well as data limitations due to surveys. We address these issues and investigate whether the Phillips curve slope is still alive in the euro area.

3. Methodology and data

Unemployment is modeled as a trend-stationary process, implying that structural changes in labor markets are slow and steady. To estimate the unemployment gap, we use a trend-cycle model set up as:

$$u_t = \mu_t^u + \psi_t^u + \varepsilon_t^u, \quad \varepsilon_t^u \sim NID(0, \sigma_{\varepsilon,u}^2), \quad t = 1, \dots, T, \quad (1)$$

$$\mu_t^u = \mu_{t-1}^u + \eta_t^u, \quad \eta_t^u \sim NID(0, \sigma_{\eta,u}^2), \quad (2)$$

$$\begin{bmatrix} \psi_t^u \\ \psi_t^{u*} \end{bmatrix} = \rho \begin{bmatrix} \cos(\lambda) & \sin(\lambda) \\ -\sin(\lambda) & \cos(\lambda) \end{bmatrix} \begin{bmatrix} \psi_{t-1}^u \\ \psi_{t-1}^{u*} \end{bmatrix} + \begin{bmatrix} \kappa_t \\ \kappa_t^* \end{bmatrix}, \quad \begin{bmatrix} \kappa_t \\ \kappa_t^* \end{bmatrix} \sim NID(0, \sigma_{\kappa}^2 I_2), \quad (3)$$

where μ_t^u is a random walk process, ψ_t^u is a stochastic cycle with frequency λ , and ε_t^u is a disturbance term. The reduced form of the stochastic cycle is a stationary ARMA (2, 1) process. The trend (μ_t^u) can be seen as a proxy of the natural rate of unemployment and the cyclical component (ψ_t^u) represents unemployment gap. The term ψ_t^{u*} appears as a matter of construction in order to form ψ_t^u . Its

interpretation is not particularly important (Harvey, 1989, pp. 38–43).

Following Harvey (2011), the UC Phillips curve is defined as:

$$\pi_t = \mu_t^\pi + \gamma_t^\pi + \beta x_t + \varepsilon_t^\pi, \quad \varepsilon_t^\pi \sim NID(0, \sigma_{\varepsilon,\pi}^2), \quad t = 1, \dots, T, \quad (4)$$

$$\mu_t^\pi = \mu_{t-1}^\pi + \eta_t^\pi, \quad \eta_t^\pi \sim NID(0, \sigma_{\eta,\pi}^2), \quad (5)$$

$$\gamma_t^\pi = -\sum_{j=1}^{s-1} \gamma_{t-j}^\pi + \omega_t^\pi, \quad \omega_t^\pi \sim NID(0, \sigma_{\omega,\pi}^2), \quad (6)$$

where π_t is the annualized rate of inflation, measured as the first difference of the log quarterly headline HICP multiplied by 400, μ_t^π is the trend component of inflation, γ_t^π is the seasonal component, and $x_t = \hat{\psi}_t^u$ is the estimated unemployment gap resulting from Eq. (3). Regressors such as import prices, oil prices, or exchange rates can be added to Eq. (4) when necessary. The stochastic trend component μ_t^π is assumed to be a random walk process as defined in Eq. (5). The disturbance term ω_t^π in Eq. (6) allows the seasonal effect of inflation (γ_t^π) to change over time.

The above set of equations differs from the commonly used specification of the Phillips curve (e.g., Ciccarelli et al., 2017) since we capture some key determinants such as long-term inflation expectations with the stochastic trend component. In order to test whether the slope of the UC Phillips curve has changed after the GFC, we construct a dummy variable D_t which takes a value of 1 from 2008Q1 until the end of the sample and 0 otherwise. We interact the unemployment gap with D_t and the UC Phillip curve equation becomes:

$$\pi_t = \mu_t^\pi + \gamma_t^\pi + \beta x_t + \theta(x_t \times D_t) + \varepsilon_t^\pi, \quad \varepsilon_t^\pi \sim NID(0, \sigma_{\varepsilon,\pi}^2), \quad t = 1, \dots, T. \quad (7)$$

The significance of this interaction term will indicate whether the slope of the Phillips curve is different in the post-GFC period as compared to the pre-GFC period. The definitions of the state variables μ_t^π and γ_t^π from Eqs. (5)–(6) are unchanged.

The quarterly data for unemployment and HICP over 1985Q1–2017Q4 is compiled from the EABCN Area Wide Model¹ for the aggregated euro area. Eurostat and OECD databases are used to collect HICP and unemployment rates for the individual countries. The unemployment rate is expressed as the ratio to the civilian workforce in ILO definition.

4. Results

Fig. 1 shows the annualized rate of inflation and the unemployment rate together with their estimated trends and cycles for the euro area.² Over the whole sample period, trend inflation shows a gradual downward movement: while the average trend inflation was 2.2% over 1985–2017, it decreased to 1.5% during 2008–2017. Note that the trend inflation, which is our proxy for inflation expectations, is comparable to the Consensus Economics survey-based measures for the euro area. This implies that we might not need to depend on the (often short series) survey data to extract the underlying inflation rate.

Table 1 reports the estimates of the Phillips curve slope coefficient and its interaction term with the post-GFC dummy, for the euro area and its five largest countries.

We have three main findings. First, we find a negative and significant relationship between the cyclical components of inflation

¹ <https://eabcn.org/page/area-wide-model>.

² All calculations were performed using STAMP 8.3 from Koopman et al. (2010): <http://stamp-software.com/>.

Fig. 1. Trend-cycle decomposition of EA inflation and unemployment (1985Q1–2017Q4). Note: Survey-based inflation expectations one- and two-years ahead (2003Q2–2017Q2) from Consensus Economics are added in the bottom-left panel.

Table 1
Estimates of the UC Phillips curve slope (1985Q1–2017Q4).

	Euro area	Germany	France	Italy	Spain	Netherlands
Unemployment gap	−0.63**	−0.57***	−0.63**	−0.15	−0.35	−0.62**
<i>t</i> -statistics	[−2.11]	[−2.82]	[−1.99]	[−0.46]	[−1.08]	[−2.25]
Unemployment gap × Post-GFC	0.12	−0.24	−0.24	−0.32	−0.46	0.03
<i>t</i> -statistics	(0.33)	[−0.27]	[−0.43]	[−1.01]	[−1.00]	[0.07]
N	131	131	131	131	131	131

Notes: The dependent variable is $q - o - q$ annualized HICP inflation rate as in Eq. (7). The Table reports coefficient estimates with corresponding *t*-statistics in parentheses. ***, **, * denote statistical significance at 1%, 5%, and 10% level.

and unemployment for the euro area as a whole and three of its largest economies. An unemployment rate of 1% below trend is associated with annualized inflation that is roughly 0.6% above its trend. Second, this relationship does not change significantly in the post-GFC period – the interaction term of the unemployment gap with the post-GFC dummy is insignificant in all cases. Third, the Phillips curve slope is heterogeneous across euro area countries. Overall, the estimated slope coefficient for the euro area and three of the largest countries is around −0.6 (EA, Germany, the Netherlands, France), while for Italy and Spain it is insignificant and relatively small.

The finding that the Phillips curve slope is heterogeneous across euro area countries is not surprising given their different structural characteristics. This heterogeneity could be related to differences in labor markets characteristics, such as labor market participation, rigidity, and regulation. Further analysis of the factors driving heterogeneity in the slopes of the Philips curve is needed, which is beyond the scope of this paper.

We perform several robustness checks.³ To account for global drivers of domestic inflation, we add import price inflation as an explanatory variable in the Phillips curve. The slope estimates become somewhat larger in magnitude but the overall picture remains the same. We also fit the Phillips curve using alternative

inflation measures (private final consumption expenditure deflator and core CPI). This does not affect the results substantially.⁴

5. Conclusions

We estimate the UC Phillips curve for the euro area and its five largest economies and employ an unobserved components model to address several econometric and data limitations. We find that the Philips curve is still alive. The results show that if the unemployment rate lies below its trend, inflation should move above its trend (*ceteris paribus*). We also argue that the estimated trend of inflation is a potential proxy to quantify inflation expectations without resorting to surveys. Moreover, we find heterogeneity in the inflation–unemployment relationship across euro area countries, perhaps due to their differences in structural characteristics of labor markets and productivity.

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³ Results are available on request.

⁴ We did not estimate the wage Phillips curve due to unavailable wage data before 1995.

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