Analysis

# Reports of the Phillips curve's death are greatly exaggerated

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Inflation has remained low in the euro area in recent years. This has raised doubts over the traditional view of inflation dynamics held before the financial crisis, where inflation is understood to be a function of inflation expectations and production costs. Alternative factors have been proposed to explain the low inflation rate, including the various effects of globalisation and digitisation. In our analysis, we demonstrate that the Phillips curve remains an effective tool for understanding inflation dynamics in the euro area. The recent period of low inflation can be attributed to sharp falls in the price of oil, subdued inflation expectations and a negative output gap. The development of inflation expectations remains central to predicting the path of inflation.



## Understanding inflation dynamics is key for conducting monetary policy

The objective of the ECB's monetary policy in the euro area is to maintain price stability, defined by the Governing Council as keeping inflation below but close to 2% over the medium term. Managing inflation through monetary policy is not entirely straightforward, as inflation is sensitive to a wide array of economic factors and monetary policy itself has a delayed effect on pricing.

Identifying the factors that determine inflation and understanding their effects is fundamental for the conduct of monetary policy. To illustrate this, certain factors – such as discrete changes in the tax code or individual movements in the price of oil – generally have a temporary, one-off impact on inflation and do not necessarily call for a monetary policy response. Shifts in inflation expectations, on the other hand, can lead to sustained volatility in the inflation rate and must be met with appropriate policy measures. To reiterate, monetary policy's effects on inflation are delayed, so the conduct of policy must also be forward-looking with respect to the inflation forecast. Well-timed policy has the ability to maintain price stability and moderate the effects of business cycles on the economy.

This article explores inflation dynamics through the lens of the New Keynesian Phillips curve[1], where inflation is viewed as a function of inflation expectations and marginal production costs. Marginal production costs can be thought to comprise commodity prices as well as cost-push pressures related to the business cycle. Additionally, the New Keynesian Phillips curve can be used as a framework for predicting the path of inflation, when projected values of the function's

variables are used as its input.

It has recently been argued that inflation might be subject to a variety of factors that lie outside the parameters of the Phillips curve.[2] One frequent argument is that the increasingly competitive conditions ushered in by globalisation and digitalisation might have a mitigating impact on inflation.[3] The global output gap has also been suggested as an influencing factor together with the degree of domestic economic slack. Others have proposed that inflation and the output gap share a nonlinear relationship.[4] Finally, it is argued that globalisation has weakened employees' bargaining power, lowering wage inflation and, subsequently, consumer price inflation.

Despite these hypotheses, our analysis suggests that the New Keynesian Phillips curve does well in approximating inflation dynamics in the euro area. The low rate of inflation in recent years is largely explained by significant falls in the price of oil, subdued inflation expectations and a negative output gap. As such, the Phillips curve appears to retain its effectiveness in forecasting inflation for the conduct of monetary policy.

## Inflation as depicted by the New Keynesian Phillips curve

According to the New Keynesian Phillips curve, current inflation is a function of inflation expectations and production costs. The importance of inflation expectations is explained by price stickiness; since the nominal values of wages and prices are updated infrequently, expected price movements must be taken into account when setting present-day wages and prices.[5] Therefore, inflation expectations, whether low or high, have an immediate effect on current inflation. This has the risk of becoming self-perpetuating, creating a scenario where low inflation is by and large the result of low inflation expectations.

Another key factor when considering price changes is the overall development of cost pressures associated with output, i.e. the level of marginal costs.[6] Both domestic and international factors influence the formation of marginal costs. In the New Keynesian Phillips curve, domestic cost pressures are often measured by the output gap,[7] which estimates the degree of capacity utilisation within the economy. During cyclical downswings, firms are faced with unused capacity in production but enjoy relatively unrestricted access to labour, while during upswings, this situation is reversed. Production costs are particularly sensitive to developments in unemployment. The very fact that production costs are influenced by cyclical conditions forms the relationship between inflation and business cycles.

Exchange rates and the development of commodity prices, particularly oil, are the most significant international factors that contribute to output costs. Oil is ubiquitous to most production chains

and at the very least determines transportation costs. Currency depreciation contributes to inflation by raising the prices of imported goods.

The economic factors that serve as the Phillips curve's inputs can be approximated by a number of alternative methodologies. As a result, the model does not produce an entirely unambiguous estimate of inflation. Inflation expectations can be survey-based (e.g. the ECB's Survey of Professional Forecasters, or SPF) or market-based (e.g. the prices of inflation swaps on financial markets).[8] In our analysis, inflation expectations are based on the mean of SPF results and swap values.[9] Data on the output gap are obtained from ECB estimates. External cost pressures are represented by the euro–dollar exchange rate and the dollar price of Brent Crude. Based on these data, the Phillips curve can be applied to explain month-on-month changes in the Harmonised Index of Consumer Prices (HICP) in the euro area.[10]

In our analysis, the equation[11] for the Phillips curve is:

$$Inf_{MoM,t} = 0{,}96Inf_{Exp,t} + 0{,}12y_t - 0{,}010fx_t - 0{,}012fx_{t-1} + 0{,}017oil_t + 0{,}005oil_{t-1} + e_t,$$

where $Inf_{MoM,t}$ is the monthly, seasonally adjusted annual rate of the total index, $Inf_{Exp,t}$ inflation expectations one-year-ahead and $y_t$ the output gap. The variables $fx_t$ and $oil_t$ are external cost pressures, i.e. monthly changes in the exchange rate and oil price, where one-month lagged values are also factored in. The share of inflation left unaccounted for by the model's input variables is represented by the residual $e_t$. The variables are accompanied by multipliers based on appropriate estimates.[12]

By inputting these data into the Phillips curve, it is possible to assess the impact each of the variables has on the inflation rate. Our results show that a single percentage point shift in inflation expectations produces a similar shift in the inflation rate. The effects of the output gap are much less, at approximately one tenth of a percentage point, whereas a 10% depreciation in the exchange rate or a 10% hike in the price of oil both raise inflation by approximately 0.2 of percentage point over the course of a few months. These results are consistent with the conventional understanding of inflation formation.

## Why might the Phillips curve fail to capture inflation?

Recently the Phillips curve has been criticised for having lost its ability to approximate the dynamics of inflation. This critique is based on observations where economic growth, and the

accompanying closing of the output gap, has not led to expected gains in the inflation rate, effectively implying that inflation has become less sensitive to the business cycle. Evidence of this arose during the financial crisis when the United States' deeply negative output gap did not result in a negative rate of inflation.

One theory holds that inflation dynamics have been altered by the increased global integration of the goods and labour markets: global economic conditions (i.e. the global output gap) may weigh more heavily on domestic price formation. Others point towards the disruptive effects of technology and digitisation on the formation of wage-push inflation. It has also been suggested that the output gap and inflation do not actually share the linear relationship widely assumed in economic models.

The expansion of global trade has had obvious impacts on commodity prices and imports, but it might have also influenced inflation dynamics through other channels. In a speech, Yellen (2017) touched upon the potential for global value chains and the threat of outsourcing to reduce workers' leverage in wage negotiations. Autor et al. (2016) observe that in the United States unemployment has increased and wages declined particularly in the regions whose industries are under the most pressure from Chinese imports.

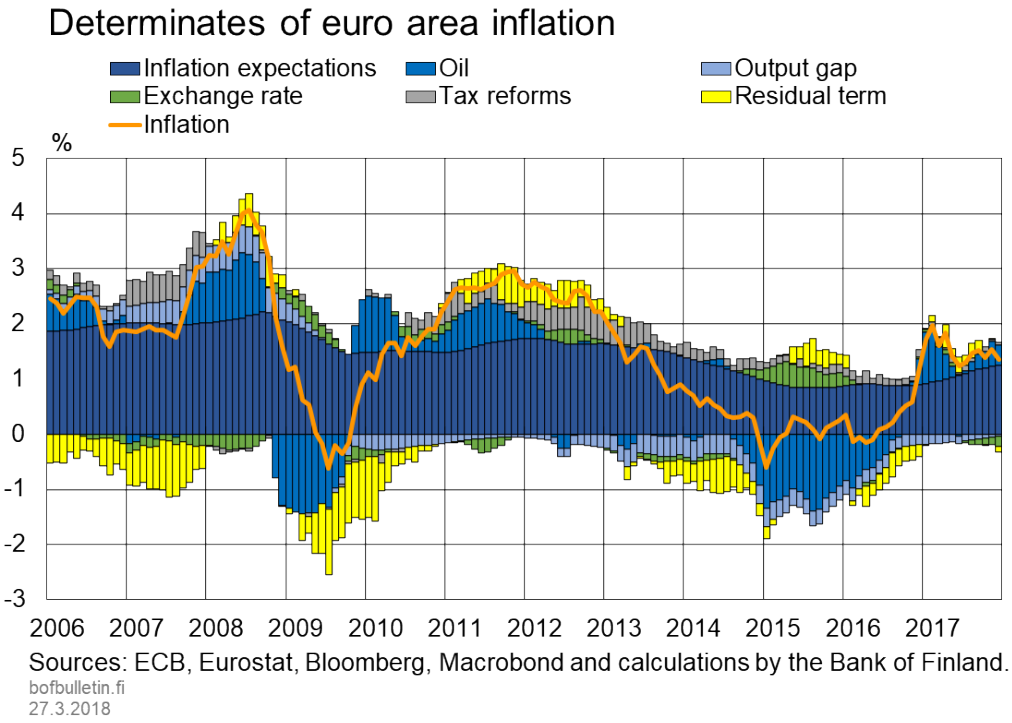
In the advanced economies, the rise of global value chains may have reduced the domestic output gap's role in price formation, causing inflation dynamics to become more dependent on global economic conditions (Auer et al., 2017). Domestic cost factors would then have less of an influence on price formation and the development of marginal costs.

This disruptive potential of technological innovation and digitalisation is well evident in the increased adoption of automation. Concerns have been raised about automation's ability to restrict wages growth, especially for middle-income earners in professions undergoing rapid technological change (IMF, 2017). In addition, structural changes on labour markets have reduced uniformity in the labour supply, reducing the bargaining power of workers in wage negotiations. For example, the prominence of zero-hour contracts, fixed-term positions and part-time work have all increased (Haldane 2017). Digitisation has also increased competitive pressures on the goods markets, owing to what has been termed 'Amazonisation', where online commerce has caused traditional retailers to see their pricing power diminished, effectively reducing their profit margins and lowering prices (see discussion, Curran & Jamrisko 2017).

Finally, according to traditional theory, the output gap has a linear relationship with the inflation rate; however, it is plausible that inflation might become more sensitive to output in economic upswings and less so when cyclical conditions deteriorate (Chart 1). This could explain inflation's seemingly obtuse behaviour during the financial crisis as well as the post-crisis recovery.

According to Gross & Semmler (2017), the Phillips curve would suggest these sorts of nonlinearities in the euro area.

Chart 1.



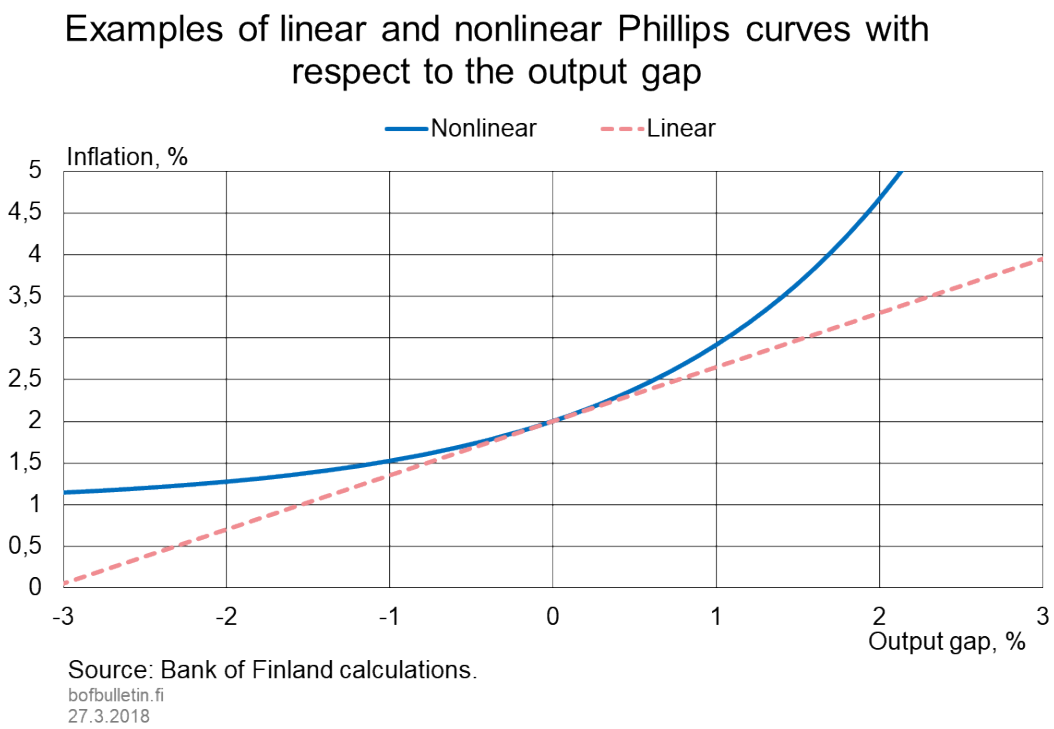

## Using the Phillips curve to approximate euro area inflation dynamics

In our analysis, we apply the New Keynesian Phillips curve to approximate inflation dynamics based on inflation expectations, the output gap, the oil price and the exchange rate. Should these endogenous factors fail to capture the dynamics of inflation, then our model's residual term ought to grow over time.[13] In such an event, alternative factors (such as those outlined in the previous section) would be greater determinants of euro area inflation.

However, the Phillips curve does relatively well in capturing the recent path of inflation (Chart 2). The inflation rate fell from just over 2% in 2012 to almost zero for the duration of 2015 and 2016. This is explained by three factors. First, the fall in the price of oil dragged down inflation by over 1 percentage point. Second, the cyclical downswing created a sustained negative output gap, which further subdued inflation. According to current estimates, the negative shift in the output gap caused by the financial crisis lasted for approximately 8 years, beginning in 2009. Third, inflation

expectations weakened drastically after 2013.

Chart 2.




Source: Bank of Finland calculations.
bofbulletin.fi
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Our model also explains the inflation rate's acceleration to approximately 1.5% in 2017. The uptick in inflation was backed by trends anticipating inflation growth as well as the lifting of factors that temporarily inhibited inflation. Inflation was spurred on by increases in the prices of food and oil in early 2017 as well as the dissipation of base effects caused by fluctuations in the oil price a year earlier. Most significant for sustained inflation growth was the recovery of inflation expectations from 2015's subpar levels. In addition, the gradual narrowing of the output gap and increase in domestic cost-push pressures has also supported the acceleration in inflation.[14]

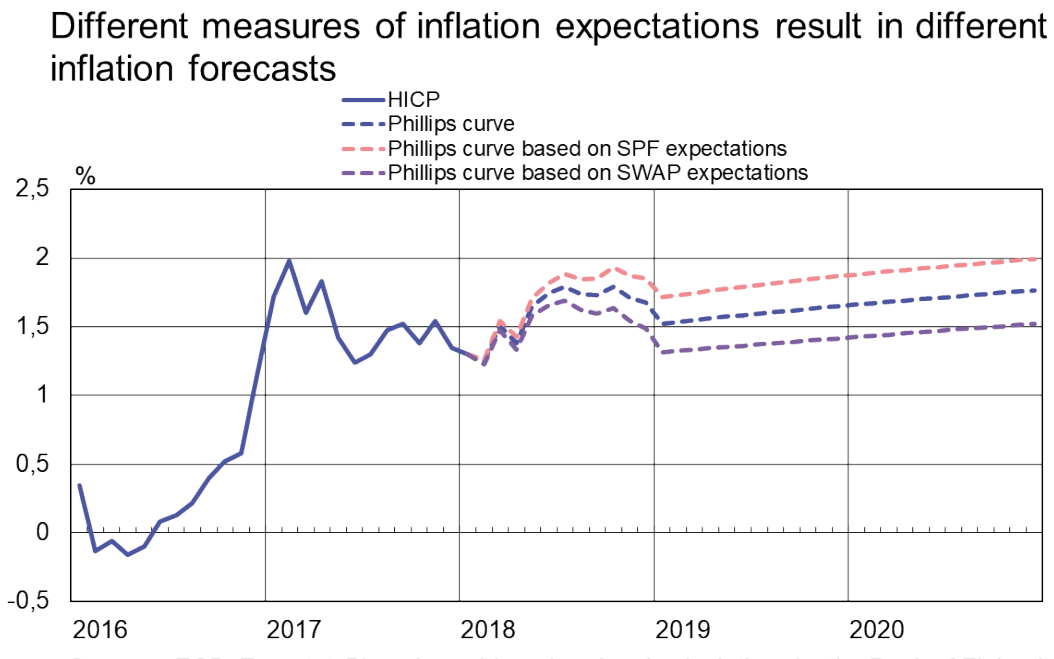
Our model based on the Phillips curve appears to capture the euro area's inflation dynamics reasonably well, although its ability to do so was considerably weaker during the crisis years. The financial crisis was, however, a period of exceptionally turbulent economic conditions. It is not surprising that models designed to approximate the dynamics of the economy in normal conditions fail to do so during crises. It is also significant that our model's residual term, as discussed earlier in this section, did not exhibit growth over time. As our model appears to approximate recent inflation dynamics relatively well, it should be safe to conclude that the reports of the Phillips curve's death are greatly exaggerated.

## Inflation expectations key for the long-term inflation outlook

The Phillips curve presented in this article can be used to forecast the path of inflation by supplementing variables with their projected values. In Chart 3, the centre dotted line represents the projected path of inflation for the immediate years ahead when inflation expectations are based on the mean value of the SPF and expectations held by financial markets (i.e. the prices of inflation swaps). Should inflation expectations prove to be higher than this (e.g. closer to the estimates given in the SPF), inflation would be considerably stronger. Similarly, inflation would be lower if expectations leaned towards the more modest estimates held by market participants. Chart 3 illustrates how inflation expectations guide inflation over the medium-term. Our example shows that estimates on where inflation will fall in three years range between 1.5% and 2%, depending on the course of inflation expectations.

The model's inflation forecast is not, however, solely determined by inflation expectations, but also its other variables. In other words, changes in the output gap, oil price and exchange rate will also alter the forecast path of inflation. The inflation paths depicted in Chart 3 are based on the assumption that the price of oil and the exchange rate remain constant at early 2018 levels. The output gap is assumed to develop along the path as predicted in the Eurosystem's macroeconomic projections published in December 2017.

Chart 3.



Calculations reveal that even if the oil price were to remain unchanged with respect to its levels in early 2018, its price increases in 2017 will continue to contribute to inflationary pressures throughout the year. This base effect, caused by atypical price volatility during the index reference period, will have vanished by 2019–2020. In a similar vein, the effects of previous shifts in the exchange rate will continue to be felt in 2018's inflation path. These factors, however, will have a one-off impact on the inflation rate and disappear over the longer term. Should the oil price and exchange rate remain unchanged, inflation forecasts for 2019–2020 will largely be determined by the performance of inflation expectations and the output gap. Under these circumstances, the inflation rate is expected to steadily accelerate. The output gap's transition from negative to positive, caused by the recovery in the real economy, will raise inflation by a mean of approximately 0.1–0.2 of a percentage point by the end of the forecast horizon. Over the longer term, inflation expectations are the most important factor that determine the inflation rate.

## Inflation dynamics can still be approximated by the Phillips curve

In this article, we have demonstrated that the New Keynesian Phillips curve can effectively approximate inflation dynamics within the euro area. The shortfall in inflation during 2015–2016 is largely explained by the effects of the negative output gap as well as significant drops in the oil price and inflation expectations. The base effect caused by the earlier fall in the oil price has since dissipated and the oil price itself has firmed up. These factors have contributed to inflation growth. Furthermore, the output gap has closed on the back of strong economic growth. Yet with inflation expectations only improving slightly, the rate of inflation remains subdued on the whole.

It has been argued that the recent period of low inflation might be caused by changes in inflation dynamics that are unaccounted for in the Phillips curve. Evidence of this, however, remains weak. According to the ECB (2017b) and Mikolaju & Lodge (2016), the influence of global factors on euro area inflation dynamics has remained slight, commodity prices notwithstanding. Neither Yellen (2017) nor Draghi (2017) attribute much weight to the global output gap's effects on inflation dynamics. Globalisation may have reduced workers' leverage in wage negotiations, lowering wage-push inflation, but the IMF (2017) notes that slow wage growth can at least partially be attributed to weak productivity growth. It remains unclear what effects digitalisation might have on inflation. According to the ECB (2015), electronic commerce's impact on inflation has remained slight, at approximately 0.1 of a percentage point on annual inflation. Finally, there is still insufficient evidence to conclude that the relationship between the output gap and inflation is nonlinear (Yellen, 2017).

According to our analysis, the Phillips curve's residual term does not display growth over time,

suggesting that 'traditional' factors still play a central role in determining inflation. Despite this, our model does not reveal why inflation expectations have remained low. Indeed, low expectations appear to be the primary cause for inflation's subdued performance. It is plausible that the disruptive potential of globalisation and digitalisation on the goods and labour markets is manifested in inflation expectations. However, while it is important not to underestimate the impact of prevailing megatrends, the Phillips curve remains a formidable tool for understanding the dynamics of inflation.

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## Notes

1. Several variants of the Phillips curve exist. The eponymous curve was proposed by William Phillips, who in 1958 published a paper demonstrating an inverse relationship between unemployment and wage inflation in Great Britain over 1861–1957. The New Keynesian Phillips curve was first empirically tested by Galí and Gertler (1999). For an extensive overview of recent empirical findings concerning the New Keynesian Phillips curve, refer to Mavroeidis, Plagborg-Møller and Stock (2014). ↑
2. For example Carney (2017), Constâncio (2017), Draghi (2017) and Yellen (2017) evaluate possible causes for low inflation outside of the Phillips curve. ↑
3. Auer, et al. (2017) and Gross & Semmler (2017). ↑
4. Dhyne et al. (2005) calculate that the price of a product or service in the euro area changes on average once over an approximately 12-month period. ↑
5. A hybrid variant of the New Keynesian Phillips curve does exist, where lagged (i.e. realised) inflation also serves as a variable determining the level of inflation. Price indexation could serve as justification for this. The backward-looking variable (i.e. lagged inflation), however, risks overweighting the effects of recent years' large but transient shocks to the economy, such as the previously mentioned volatility in the price of oil. For this reason, a strictly forward-looking variant of the Phillips curve has been adopted for the purpose of this ↑

analysis. Galí, Gertler and López-Salido (2001) explore the differences between the variants of the model but conclude that a strictly forward-looking model is effective in depicting euro area inflation.

6. Marginal costs are defined as the increase in costs when production is increased. ↑
7. See e.g. Galí (2008). ↑
8. Inflation swaps are financial instruments used to hedge against future inflation. Inflation expectations extracted from inflation swaps are often used as a measure of the market's inflation expectations. For further detail, see Bank of Finland Bulletin (2016). ↑
9. Inflation expectations covering a one-year time horizon are sourced from SPF results. Data extracted from the price of inflation swaps are also used to represent inflation expectations over a one-year period but with an inspection horizon beginning one year into the future. ↑
10. Consumer prices are based on the seasonally adjusted index released by the ECB. These adjustments control for price volatility caused by seasonal disturbances such as discount shopping days and holidays. ↑
11. The estimate's inspection horizon is 1999M1–2017M12. ↑
12. These multipliers are obtained by applying the ordinary least squares (OLS) method and are all statistically significant. ↑
13. The effects of tax reforms have been factored into our analysis, complementing the Phillips curve's internal parameters. Inflation is particularly sensitive to consumption tax, as it directly affects the prices of goods and services. This can be controlled for by referencing a price index series at constant tax. ↑
14. According to their most recent estimates, the IMF, European Commission and OECD all expect the output gap to turn positive no later than some time in 2018. ↑

## Keywords

inflation, inflation expectations