DALLASFED Working Paper

The Death of the Phillips Curve?

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Working Paper 1801
https://doi.org/10.24149/wp1801

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January 2018

Abstract: Are inflation dynamics well captured by Phillips Curve models, or has this framework become less relevant over time? The evidence for the U.S. suggests that the slopes of the price and wage Phillips Curves– the short-run inflation-unemployment trade-offs – are low and have got a little flatter. For example, the recursive estimate of the unemployment coefficient in the core PCE Phillips Curve has fallen a little from -0.09 to -0.07 since the Great Recession. However, the decline is not statistically significant. Dynamic forecasts from the wage and price Phillips Curves estimated using data ending in 2007q4, almost 10 years ago, are pretty close to inflation today. This suggests that (i) low current inflation is not that surprising, and (ii) factors such as increased globalization, increased e-commerce activity, changes in concentration, the aging of the U.S. population and mismeasurement of the NAIRU are not that important (or offset each other). The Phillips Curve is still a useful, albeit imprecise, framework for understanding inflation.

Keywords: Inflation, Wage Inflation, Phillips Curve, Slack.

JEL Codes: E31, E37

1. Introduction

Are inflation dynamics well captured by Phillips Curve models, or has this framework become less relevant over time? If the slope of the Phillips Curve has flattened, this may explain the "missing" disinflation during the Great Recession and "missing" inflation now, in which case

[1] Email: anthony.murphy@dal.frb.org. I am grateful to David Reifschneider and Jeremy Rudd for assistance with the data. The views expressed here are my own, and not those of the Federal Reserve Bank of Dallas or the Federal Reserve Board.

low inflation is not really a surprise. If factors such as increased globalization, increased e-commerce activity, changes in concentration, the aging of the U.S. population and mismeasurement of the NAIRU are more important nowadays, standard Phillips Curve models are likely to be less relevant since they do not take account of these factors.

Of course, many of these issues are not new – see Staiger, Stock and Watson (2001) for example.[2] Many of the factors listed above are hard to measure, but changes in the fit or stability of the Phillips Curve may provide useful clues about their potential contribution to inflation dynamics. It may well be the case that the contribution of omitted, or poorly measured, factors has not significantly increased over time.

I examine the fit and stability of the Phillips Curve using the models of price and wage inflation discussed by Janet Yellen, the Chair of the Board of Governors of the Federal Reserve System, when she spoke about monetary policy and inflation (Yellen, 2015, 2017). The two Phillips Curve models are reasonably standard, and representative of the inflation models many policy makers implicitly or explicitly use, so the results of this paper generalize.

2. Core PCE inflation

The model of core PCE inflation Phillips Curve in Yellen (2015) is[3]:

$$(1) \quad \pi_t^{core} = \beta_1 + \beta_2 \overline{\pi}_t^e + \beta_3 \pi_{t-1}^{core} + \beta_4 \pi_{t-2}^{core} - \beta_5 (u_t - u_t^{nru}) + \beta_6 rpim_{rpim} + \varepsilon_t$$

where π^{core} is core PCE inflation, $\overline{\pi}^e$ is the Survey of Professional Forecasters (SPF) measure of long run (10 year) inflation, $u - u^{nru}$ is the unemployment gap (the difference between the unemployment rate and the CBO's estimate of the natural rate), and $rpim$ is the relative inflation rate of core imports. Inflation has a forward looking component, even though this is not a New Keynesian Phillips Curve. In the model, inflation depends on expected long-term future inflation as well as past inflation, labor market slack in the form of the unemployment

[2] A decade ago, commentators worried about the Walmart effect and a poorly measured NAIRU. Today, many worry about the Amazon effect and a poorly measured NAIRU.

[3] Core PCE is personal consumption expenditure excluding food and energy. The relative inflation rate of core imports $rpim$ is defined in Yellen (2015).

gap and core imported inflation. The restriction $\beta_2 = 1 - \beta_3 - \beta_4$ is imposed so that, in the long run, inflation equals expected inflation (when the unemployment gap is zero). Implicitly, long run expected inflation equals target inflation, as long as monetary policy is credible. The key parameter of interest in (1) is the slope of the Phillips Curve (β_5).

The estimated Phillips Curve for the period 1990q1 to 2017q2 is:

(2) $$\hat{\pi}_t^{core} = \underset{(4.1)}{0.40}\,\overline{\pi}_t^{e} + \underset{(3.9)}{0.36}\,\pi_{t-1}^{core} + \underset{(2.6)}{0.23}\,\pi_{t-2}^{core} - \underset{(2.2)}{0.07}(u_t - u_t^{nru}) + \underset{(3.7)}{0.54}\,rpim_t \quad SE = 0.49 \quad \overline{R}^2 = 0.70$$

The relative weights on past and expected future inflation are 60:40. The fit of the equation is reasonable, although the 95% confidence bands of $\hat{\pi}_t^{core}$ are wide (approximately ± 1%). The estimates suggest that the Phillips Curve is relatively flat. Formal tests of the stability of the model are somewhat mixed. Recursive estimates of the slope (and other coefficients) are fairly stable (**Figure 1**).[4] The recursive estimates suggest that the slope of the Phillips Curve has become a little flatter since the Great Recession, although the decline in the slope from -0.09 to -0.07 is not statistically significant.

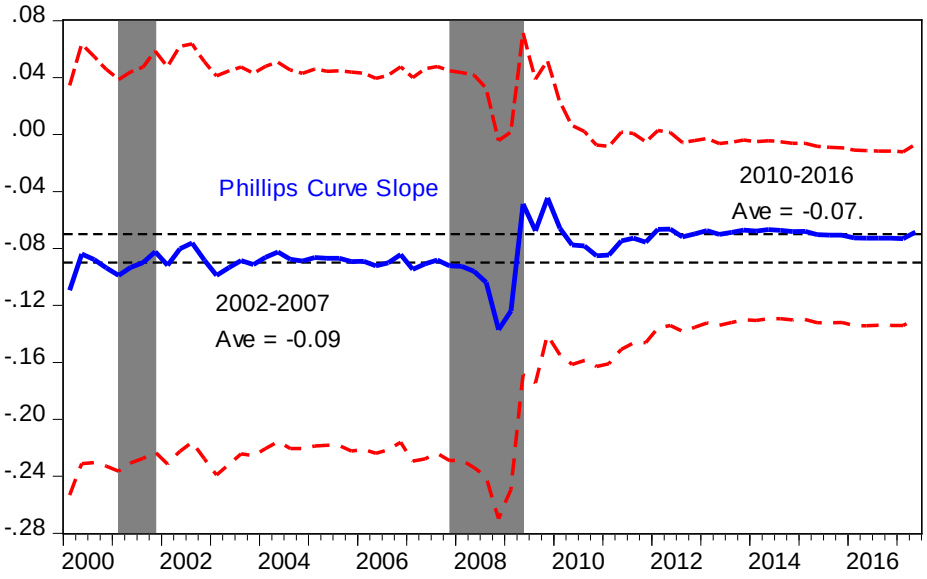

Figure 1: Recursive Estimates of Slope of Phillips Curve with 95% Confidence Intervals

[4] Other Phillips Curve models, such as the Gordon "triangle" model, which exclude long term inflation expectations display more instability. NBER dated recessions are shaded.

A comparison of the estimated *dynamic* effects of a temporary rise in the unemployment rate from Phillips Curves based on two different samples - one sample ending in 2007q4 (represented by the blue line) and the other ending in 2017q2 (the red line) – is informative (**Figure 2**). The estimated effects are about twice as large before the Great Recession as they are now.

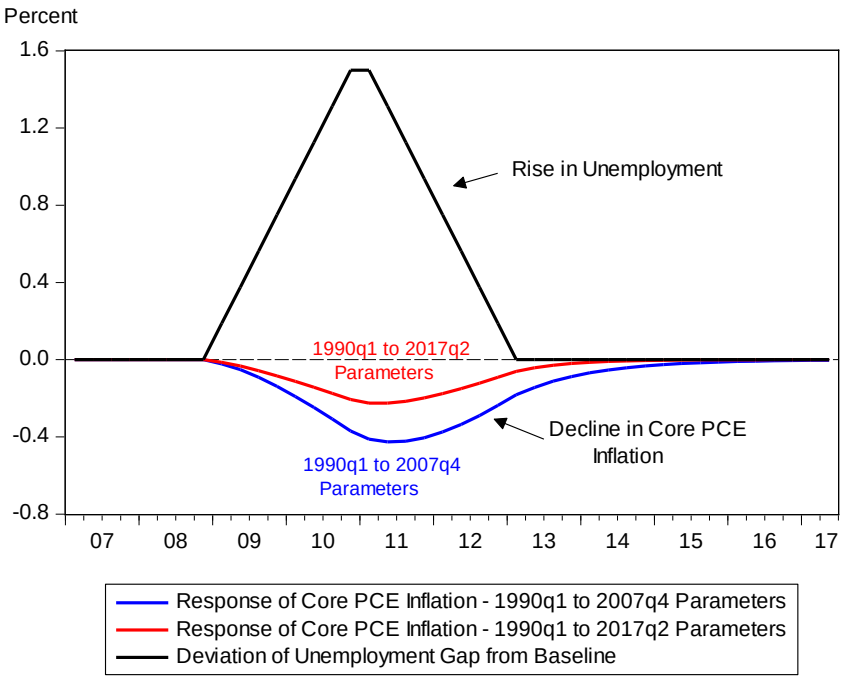

Figure 2: Decline in Estimated Effect on Core PCE Inflation of a Rise in Unemployment

Nevertheless, dynamic forecasts from the Phillips Curve track the underlying movement in core inflation fairly well. **Figure 3** shows the pseudo out-of-sample forecasts from the Phillips Curve estimated using data ending in 2007q4.[5] Although forecast core inflation is lower than actual inflation in many periods, the forecast tracks core inflation reasonably well over this ten year period. Inter alia, the recent "below target" core inflation readings should not have come as a surprise and, according to the model, core inflation should gradually revert to target over time.

[5] The forecasts are dynamic, conditional forecasts treating the paths of the unemployment rate and relative core import inflation as given.

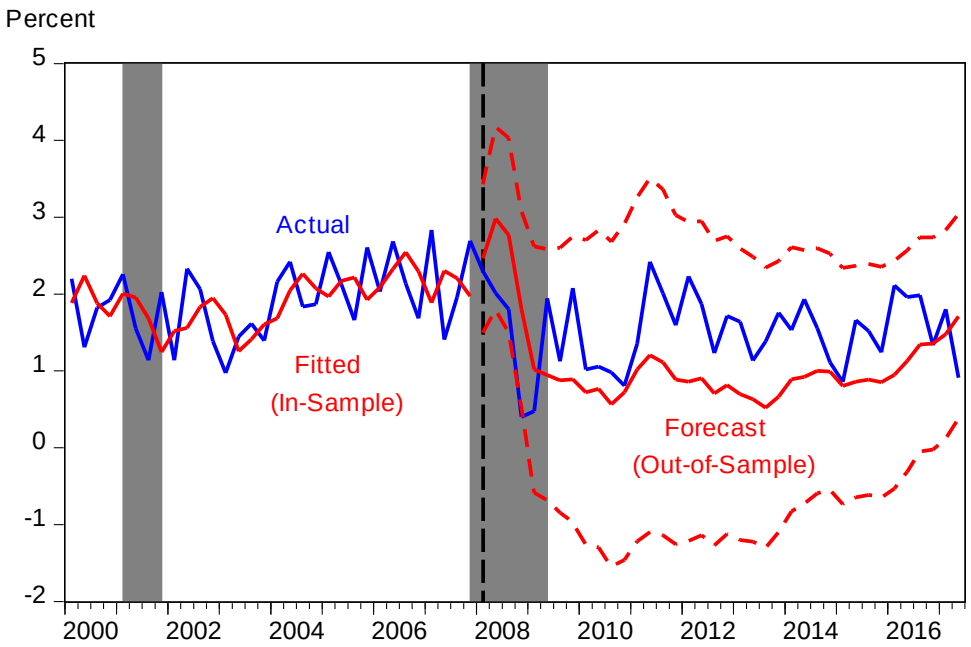

Figure 3: Out-Of-Sample Dynamic Forecast of Core PCE Inflation with 95% Confidence Intervals, Estimation Sample Ending 2007q4

So what forecast of core PCE inflation does the model produce? The conditional forecast of core PCE inflation from Yellen's core PCE inflation model is shown in **Figure 4**. It is a conditional forecast given the latest SPF unemployment path and the CBO's estimate of the NAIRU, an unchanged SPF long-term expectation of 2% PCE inflation, and the forecast values for relative core import price inflation (*rpim*) from a simple AR(2) model. Given the structure of the model and the SPF forecast of a tight labor market, it should come as no surprise that the model suggests that inflation is likely "to stabilize around the [Federal Open Market] Committee's 2 percent objective over the medium term". Of course, the simulated confidence bands (which take account of coefficient uncertainty) are very wide.

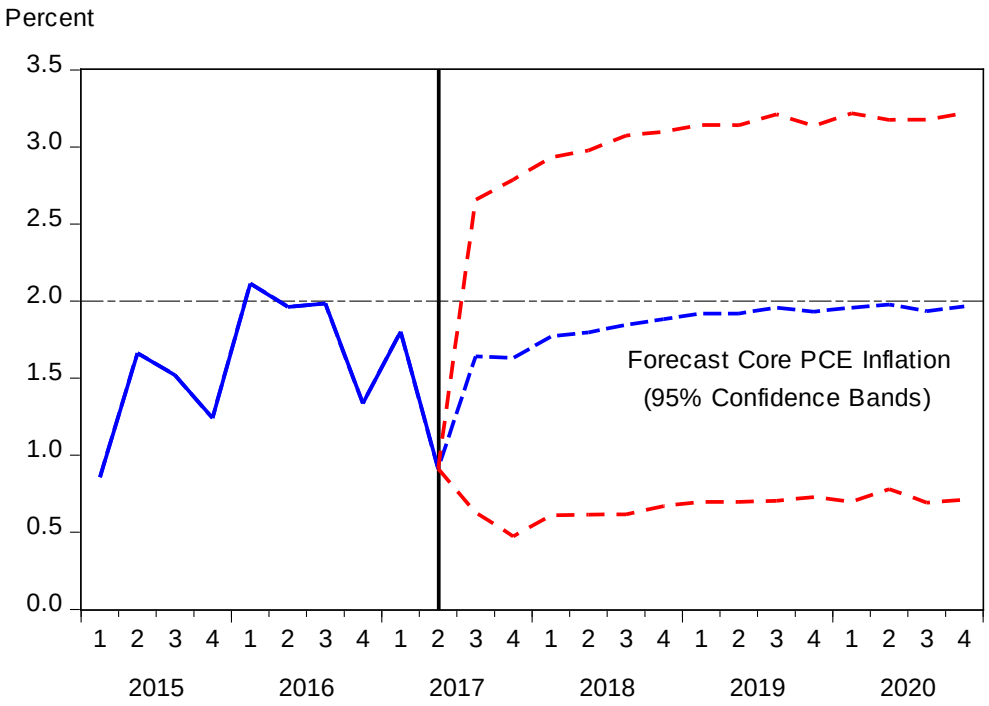

Figure 4: Conditional Forecast of Core PCE inflation

3. Wage Inflation

A version of the wage Phillips Curve set out in Yellen (2017), is:

$$\omega_t = \gamma_1 + \gamma_2 \overline{\pi}_t^e + \gamma_3(\omega_{t-1} + \omega_{t-2} + \omega_{t-3} + \omega_{t-4}) + \gamma_4(u_t - u_t^{nru}) + \gamma_5 \Delta(u_t - u_t^{nru}) + \gamma_6 \overline{prod}_t + v_t$$

where ω is the growth of nominal compensation (ECI wages and benefits) and $\overline{prod}$ is a measure of long run productivity growth.[6] Compensation growth depends on expected long run inflation, recent compensation growth, slack and the change in slack (the unemployment gap and the change in the unemployment gap) as well as trend productivity growth. The restriction $\gamma_2 = \gamma_6 = 1 - 4\gamma_3$ is imposed so that, in the long run, the rate of growth of compensation in real terms equals the underlying trend growth in productivity.

[6] The coefficients on the lagged compensation terms in Yellen (2017) are not restricted to be equal. ECI is the employment cost index produced by the Bureau of labor Statistics. See Yellen (2017) for the details of how trend productivity $\overline{prod}$ is measured.

The estimated wage Phillips Curve for the period 1988q1 to 2017q2 is:

$$\omega_t = \underset{(4.1)}{-0.77} + \underset{(4.5)}{0.62}\,\bar{\pi}_t^e + \underset{(2.7)}{0.09}(\omega_{t-1} + \omega_{t-2} + \omega_{t-3} + \omega_{t-4}) - \underset{(3.0)}{0.18}(u_t - u_t^{nru})$$
$$- \underset{(2.5)}{0.65}\Delta(u_t - u_t^{nru}) + \underset{(4.5)}{0.62}\,\overline{prod}_t \qquad SE = 0.76 \quad \bar{R}^2 = 0.55$$

Unsurprisingly, the wage Phillips Curve does not fit as well as the price Phillips Curve, since the variation in ECI inflation is greater than in core PCE inflation. In addition, the recursive coefficients estimates are not as stable, although many of the changes over time are offsetting. For example, the estimated negative effect of slack (γ_4) has become smaller since the Great Recession, while the estimated negative effect of the change in slack (γ_5) has become larger.[7]

Nevertheless, the estimated dynamic effects of a temporary rise in the unemployment rate is fairly stable. **Figure 5** shows the estimated effects using the same two samples as before - one sample ending in 2007q4 and the other ending in 2017q2. The estimated effects are similar, albeit a little faster for the sample ending in 2017q2 (the red line).

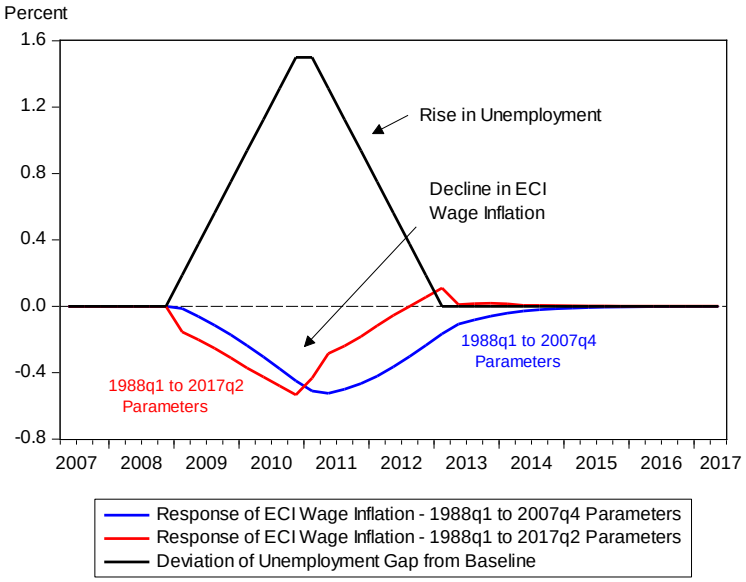

Figure 5: Estimated Effects of a Rise in Unemployment are Fairly Stable

[7] The estimated γ_4 coefficient is not statistically significant before the Great recession.

The dynamic / pseudo out-of-sample forecasts from the estimated wage Phillips Curve using data up to 2007q4 are shown in **Figure 6**. The forecasts track the underlying movements in ECI inflation surprisingly well (declining wage inflation during the Great Recession, followed by very gradual rises in wage inflation), although they are a little on the low side. This suggest that the "low" ECI inflation readings in recent years are actually not that far off the mark. The model attributes the low rates of wage inflation in the last few years to low trend productivity growth and inertia.

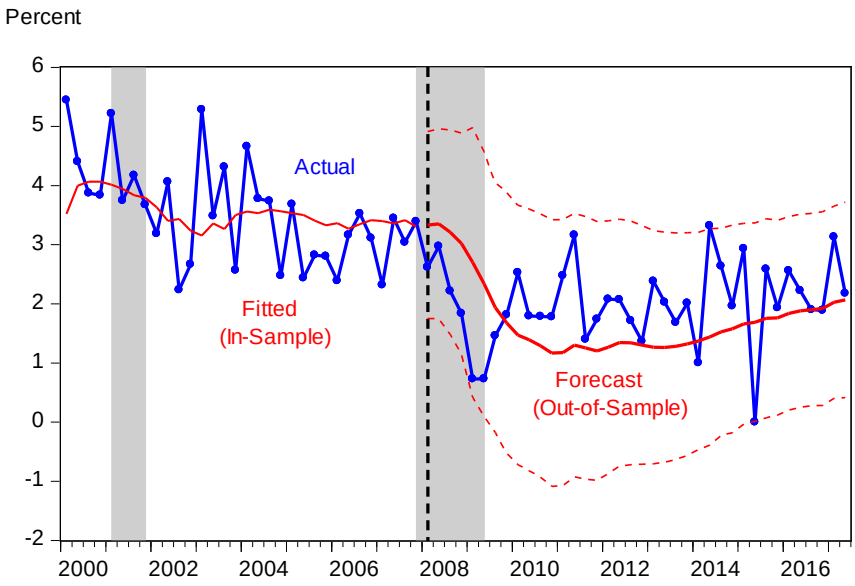

Figure 6: Out-Of-Sample Dynamic Forecast of ECI Inflation Tracks Well
(Forecast and 95% Confidence Intervals, Estimation Sample Ending 2007q4)

4. Conclusion

The Phillips Curve is still a useful, albeit imprecise, framework for understanding inflation (Blanchard, 2016). Longer term movements in inflation since the onset of the Great Recession in 2007 are fairly well captured by the price and wage Phillips Curves in Yellen (2015, 2017), even though the short-run response of inflation to the unemployment rate has declined somewhat over time. The Phillips curve is relatively flat, so recent "low" inflation readings are not particularly surprising. More controversially, the dynamic forecasts from these models suggest that the impact of difficult to quantify factors (such as increased globalization,

increased e-commerce activity, changes in concentration, the aging of the U.S. population and mismeasurement of the NAIRU) may be small.

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