# Where Is the Phillips Curve?

A closer look at the Phillips curve helps us understand why our low unemployment rate hasn't led to a bigger rise in prices or wages.

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BY SHIGERU FUJITA

The Phillips curve is an old idea made newly urgent thanks to our long recovery from the Great Recession. In his 1958 study of the UK economy between 1861 and 1913, Alban William Phillips of the London School of Economics discovered that wages and unemployment move in opposite directions over time. The subsequent literature applied this idea to prices of goods and services. In the modern literature, the relationship between inflation and some measure of unused resources is often called the price Phillips curve or simply the Phillips curve; when wage growth is considered instead of inflation, it is called the wage Phillips curve.

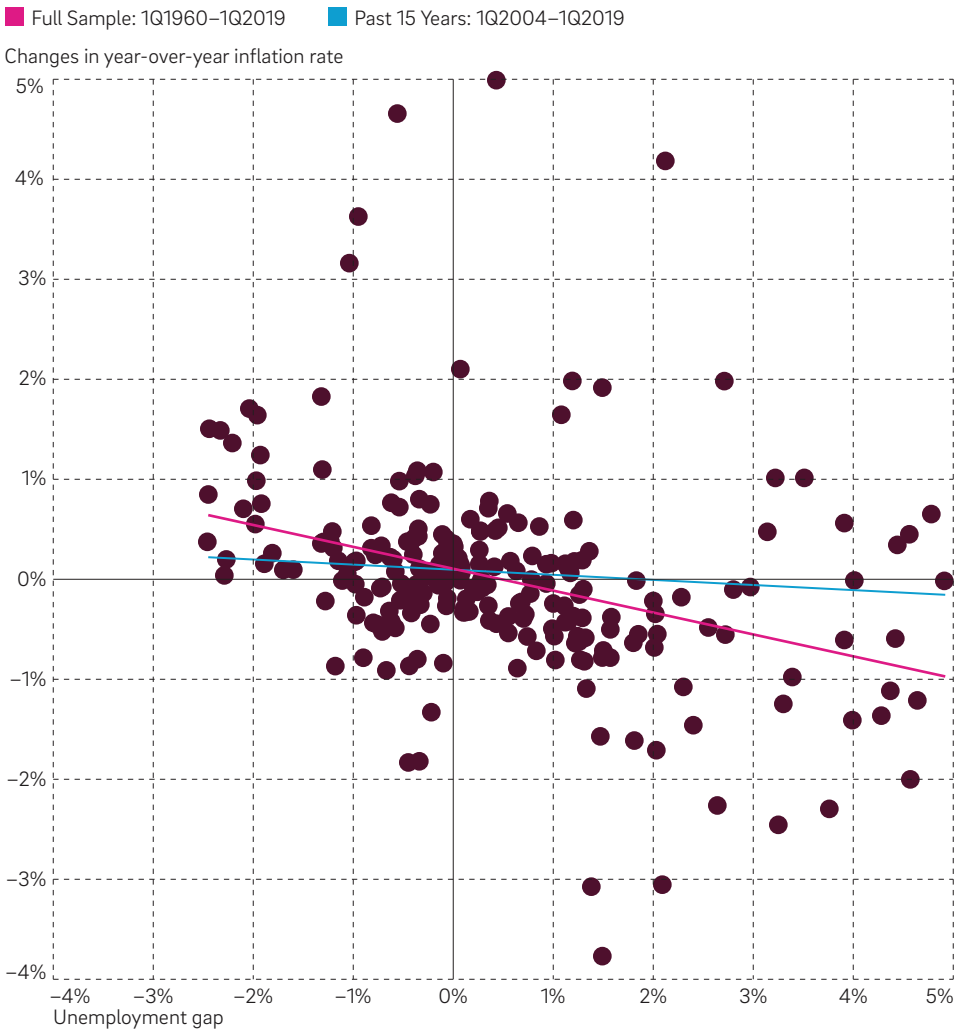
The Phillips curve represents an empirical relationship between available but unused resources (resource slack) in the economy and either the inflation rate or wage growth. The best-known measure of resource slack is the jobless (or unemployment) rate. The Phillips curve postulates that higher unemployment is associated with lower inflation or wage growth, and that lower unemployment is associated with higher inflation or wage growth. Figure 1 plots a version of the Phillips curve using the data over the period 1960-2019. Each dot represents the combination of the inflation rate and the "unemployment gap" at each point in time. As explained below in more detail, the unemployment gap represents the deviation of the unemployment rate from its slow-moving trend. The red, or regression, line summarizes the average relationship between the two variables,

FIGURE 1

**The Phillips Curve Relationship in the U.S.**

As the labor market tightens, inflation typically rises—but not so much in recent years.

Change in year-over-year inflation rate by unemployment gap, 1Q1960–1Q2019




**Source:** Bureau of Labor Statistics, Congressional Budget Office, Bureau of Economic Analysis.

and the slope of this line is indeed negative. The idea behind the Phillips curve is intuitive. A tight labor market, exemplified by a low unemployment rate, is associated with higher wages, and the higher labor cost pushes up inflation.

Recent years have seen a surge in research into the stability of the Phillips curve. The traditional Phillips curve assumes that the degree of the negative relationship, or its slope, is stable over time. For example, in Figure 1, the slope is 0.20, which means that a decline in the unemployment gap by 1 percentage point is on average associated with a 0.20 percentage point increase in the inflation rate. Although such an empirical relationship is never exact at each point in time, recent experience suggests that the relationship is not even close to constant. In particular, even though the unemployment rate has fallen substantially during the past several years, inflation has not measurably and consistently increased. This phenomenon represents a flattening of the Phillips curve and is shown by the blue line, which gives the relationship over the last 15 years. One can see that this line is much flatter than the red line, the one based on the entire sample.

The flattening of the Phillips curve carries important implications for monetary policy, but is the flattening real? And if so, why is it flattening? In this article, I review the recent literature on these issues and then discuss the implications for monetary policy, but first I define the Phillips curve more precisely.

## What Is the Phillips Curve?

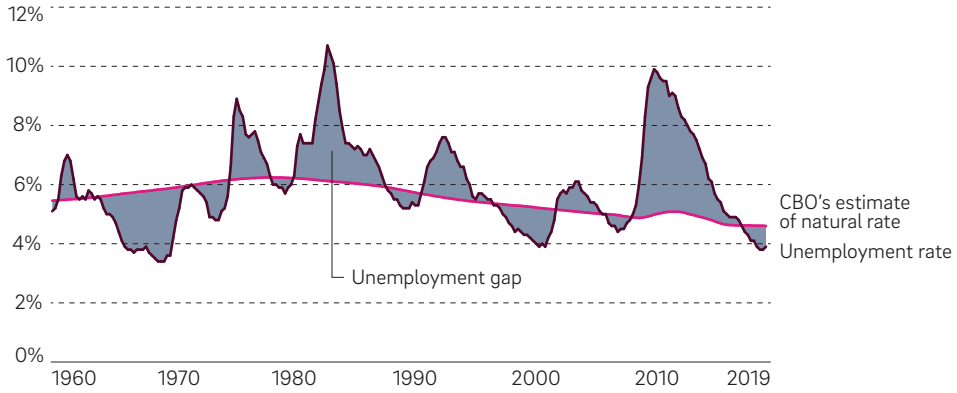
The Phillips curve relates price (or wage) inflation to the resource slack of the economy, capturing the intuitive idea that price or wage inflation should be inversely related to resource slack. The exact formulation of the Phillips curve, however, depends on how we measure inflation and resource slack.

For the purpose of estimating the Phillips curve, one well-known measure of the general price level of the economy is the core personal consumption expenditure (PCE) index. Many economists—including those at the Federal Reserve—use the rate of change in this index to measure inflation.[1]

FIGURE 2

### Natural Rate of Unemployment

Unemployment rate and estimate of natural rate, 1960–2019




**Source:** Bureau of Labor Statistics, Congressional Budget Office.

The best-known measure of resource slack is the unemployment rate, which the Census Bureau and the Bureau of Labor Statistics calculate as the share of jobless workers within the labor force. For the purpose of the Phillips curve, the literature typically considers the difference between the unemployment rate and the "natural" rate of unemployment. The literature calls this difference the unemployment gap. The actual unemployment rate increases or decreases depending on the cyclical conditions of the economy, and the natural rate is the hypothetical and unobserved level of the unemployment rate that would have prevailed in the absence of such cyclical variations.

Note that the natural rate of unemployment is not zero. Unemployment would not disappear even under stable economic conditions. For example, moving from one job to another takes time, and workers between jobs are counted as unemployed. One can view the natural rate as the trend unemployment rate, which changes only slowly over time, independent of cyclical conditions of the economy (Figure 2). How one measures the natural rate affects the gap and thus the Phillips curve itself, so the measurement of the natural rate is integral to the estimation of the Phillips curve.

## Is the Phillips Curve Really Flattening?

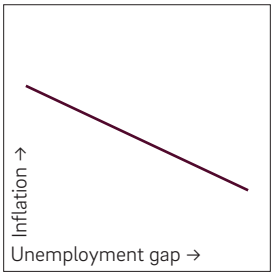
A recent paper by Stock and Watson (2019) provides a useful summary of the Phillips curve estimation under various formulations.[2] In their baseline formulation, they construct the unemployment gap by taking the difference between the official unemployment rate and the natural rate of unemployment estimated by the Congressional Budget Office (CBO). They then look at the unemployment gap's relationship with the core PCE inflation rate. They estimate the Phillips curve over three consecutive periods: 1960-1983, 1984-1999, and 2000-1Q2018 (Figure 3).

FIGURE 3

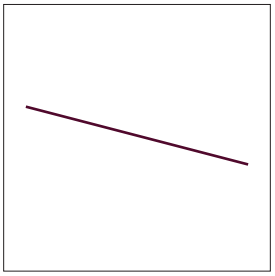
### The 21st Century Phillips Curve Is Flatter

Change in year-over-year core PCE inflation rate and unemployment gap

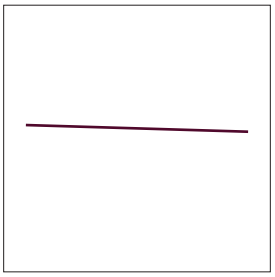
**1960–1983**
Slope: **–0.47**




**1984–1999**
Slope: **–0.26**



**2000–2018**
Slope: **–0.07**



**Source:** Stock and Watson (2019).

During the first two periods, the two variables are indeed strongly negatively related, with the slope coefficient of 0.47 and 0.28, respectively. However, for the last period, they estimate the slope coefficient to be only 0.03, which is not significantly different from zero. Statistically speaking, the small but negative slope cannot be distinguished from no change in inflation at all in response to the changes in the unemployment rate. The fact that the slope has decreased (in absolute value) over time represents the flattening of the Phillips curve.

But there are many different ways to specify the Phillips curve. Maybe the flattening is simply an artifact of some mismeasurement of the data, and using the correct data can uncover a Phillips curve relationship that is stable over time. In particular, the unemployment gap, as described above, may not appropriately reflect the size of labor market slack, because there is much uncertainty surrounding the measurement of the natural rate. Suppose that, for some reason, the natural rate is actually lower than the one estimated by the CBO, especially in recent years. If so, resource slack in the economy is actually larger than implied by the gap based on the CBO's natural rate, and therefore wage and price pressures are weaker than suggested by the CBO's measure.

Another possibility is that different types of jobless workers may pose different levels of wage pressure. For example, workers who are unemployed for a long period of time and workers who have just entered the pool might produce different levels of wage pressure. This is plausible if the "employability" of workers decreases as the duration of unemployment lengthens. In this case, longer average duration implies lower wage pressure, independent of the overall unemployment rate. Yet another possibility is that some workers who drop out of the labor force (and are not counted toward official unemployment) are actually available and willing to work. In this case, the official unemployment rate underestimates the extent of labor market slack.[3]

Stock and Watson estimate the Phillips curve using 10 measures of resource slack. Importantly, all 10 measures produce the flattening of the curve similar to the one based on the baseline specification. Thus, the weak responsiveness of inflation appears to be robust regardless of the measure of resource slack. Many other studies find similar results, even though these papers use different specifications and data.[4]

Stock and Watson also estimate the wage Phillips curve by replacing the core PCE inflation rate with the growth rate of average hourly earnings. They consider the same 10 measures of resource slack. Relative to the price Phillips curve, the wage Phillips curve appears to be more stable, but overall, they find a similar flattening of the wage Phillips curve in recent years.[5]

## Is the Phillips Curve Nonlinear?

Even though the Phillips curve does appear to have flattened in recent years, a potential concern is that, as the labor market tightens, wage and inflation pressures suddenly surface. This possibility is particularly relevant in the recent situation. As of July 2019, the unemployment rate stood at 3.7 percent, the lowest level since the late 1960s, and even though inflationary pressure had not measurably surfaced yet, further declines in the unemployment rate may finally unleash the underlying inflation pressure.

The standard formulation of the Phillips curve presumes that the inflation rate and resource slack are linearly related, so that the sensitivity of inflation is the same for any level of the unemployment gap, i.e., the slope of the Phillips curve is constant. The linear Phillips curve thus cannot capture the concern above.

Instead, one could specify a nonlinear Phillips curve where the responsiveness of inflation to the unemployment gap changes, depending on the level of the unemployment rate. Suppose that the natural rate of unemployment is currently at 4.5 percent. Consider, hypothetically, declines of 0.5 percentage point in the unemployment rate, one from 4.5 percent to 4 percent and the other from 3.5 percent to 3 percent. In the linear model these two changes are associated with the same amount of inflationary pressure, while in the nonlinear model the responsiveness of inflation is allowed to differ. One can then test statistically whether the latter case results in a larger inflation response.

Many studies in the literature entertain this idea, but there is no consensus about the presence of nonlinearity.[6] The weak evidence, however, could simply be due to the fact that there are too few historical episodes where the unemployment rate fell substantially below the natural rate. Without more such episodes, we cannot test the hypothesis. Some economists get around this problem by using regional data.

## Evidence from the Regional Data

The Phillips curve can be applied to regional data. That is, one can relate differences in resource slack to differences in inflation rates across different regions. One can further combine the cross-regional data with time-series changes in these variables within the same region. One major advantage of regional analysis over national-level time-series analysis is that it overcomes the small-sample problem discussed above: Even though there are only a few episodes in the national-level data in which the unemployment rate fell significantly below the natural rate, there are many more such episodes if one looks at historical data across different regions, allowing researchers to more accurately estimate the slope of the Phillips curve.

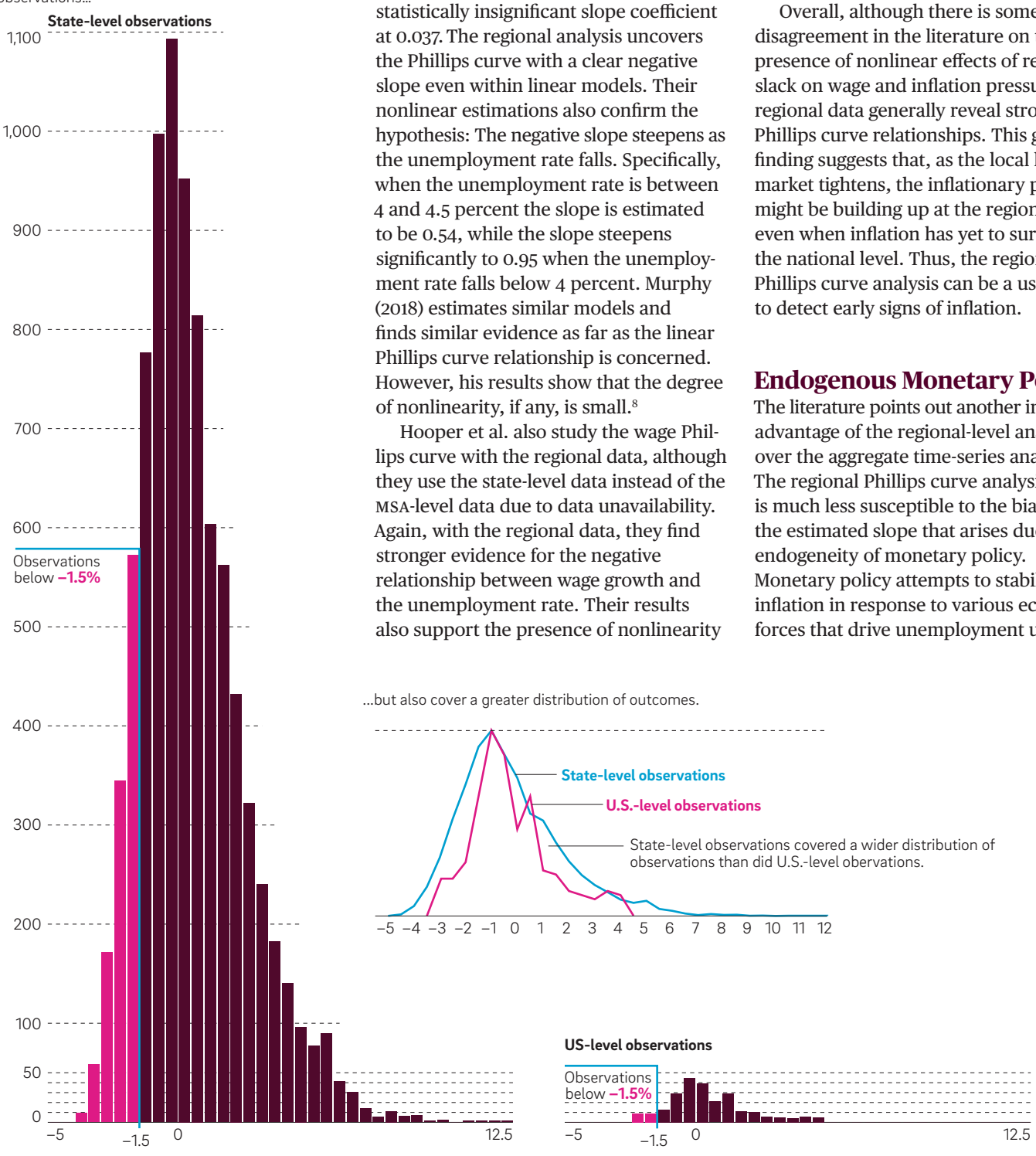
Hooper et al. (2019) present the distribution of the unemployment rate for the U.S. and for individual states between 1980 and 2017. There are very few national-level observations for an unemployment rate below 4 percent, while at the state-year level more than 15 percent of observations correspond to unemployment rates below 4 percent. Figure 4 presents similar pictures but in terms of unemployment gaps. The first panel plots the unemployment gap based on the national data over the period 1Q1959-1Q2019, while the second panel displays the state-level historical data over the period 1Q1976-1Q2019. There are only 18 observations (about 7 percent) below a −1.5 percent unemployment gap in the national-level data, whereas there are more than 1,100 observations (about 13 percent) below −1.5 percent in the state-level historical data.

Hooper et al. estimate the Phillips curve using the data across metropolitan statistical areas (MSAs) over the period 1990-2017. These authors estimate the traditional linear model as well as

FIGURE 4

## Distributions of Unemployment Gaps: National-level Data versus State-level Data

For each percent unemployment gap, number of national observations, 1Q1959–1Q2019, and state observations, 1Q1976–1Q2019




**Note:** Bars represent half-percent increments.

**Source:** Bureau of Labor Statistics, Congressional Budget Office.

two nonlinear models where the inflation response depends on the level of the unemployment rate.[7] According to their linear model, the Phillips curve slope is 0.44 and highly statistically significant. Importantly, these authors also estimate a similar model using the national-level data over roughly the same sample period and find a much smaller and statistically insignificant slope coefficient at 0.037. The regional analysis uncovers the Phillips curve with a clear negative slope even within linear models. Their nonlinear estimations also confirm the hypothesis: The negative slope steepens as the unemployment rate falls. Specifically, when the unemployment rate is between 4 and 4.5 percent the slope is estimated to be 0.54, while the slope steepens significantly to 0.95 when the unemployment rate falls below 4 percent. Murphy (2018) estimates similar models and finds similar evidence as far as the linear Phillips curve relationship is concerned. However, his results show that the degree of nonlinearity, if any, is small.[8]

Hooper et al. also study the wage Phillips curve with the regional data, although they use the state-level data instead of the MSA-level data due to data unavailability. Again, with the regional data, they find stronger evidence for the negative relationship between wage growth and the unemployment rate. Their results also support the presence of nonlinearity in the wage Phillips curve. Leduc et al. (2019), however, cast doubt on the presence of nonlinearity in their estimation of the wage Phillips curve. In contrast with other studies, Leduc et al. isolate movements of unemployment rates that are driven only by changes in labor demand and then examine how those demand-driven movements influence wage growth.[9]

Overall, although there is some disagreement in the literature on the presence of nonlinear effects of resource slack on wage and inflation pressures, the regional data generally reveal stronger Phillips curve relationships. This general finding suggests that, as the local labor market tightens, the inflationary pressure might be building up at the regional level, even when inflation has yet to surface at the national level. Thus, the regional-level Phillips curve analysis can be a useful tool to detect early signs of inflation.

## Endogenous Monetary Policy

The literature points out another important advantage of the regional-level analysis over the aggregate time-series analysis: The regional Phillips curve analysis is much less susceptible to the bias in the estimated slope that arises due to endogeneity of monetary policy. Monetary policy attempts to stabilize inflation in response to various economic forces that drive unemployment up or

down. Therefore, monetary policy is also endogenous, that is, part of the national economy. And to the extent that the Federal Reserve's monetary policy has been successful in stabilizing inflation, one may not actually observe the Phillips curve in the aggregate time-series data, even when such negative relationships actually exist. This is a logical explanation of why the Phillips curve can disappear at the national level even when the relationship exists at the local level. Fitzgerald and Nicolini (2014) point out this possibility, and McLeay and Tenreyro (2019) explore the idea further by using a New Keynesian dynamic stochastic general equilibrium (DSGE) model. Using this model as a laboratory, McLeay and Tenreyro run the experiments on how the observed Phillips curve relationships change under different monetary policy rules. They show that a disappearing Phillips curve relationship is a natural consequence of successful monetary policy. [10]

The national-level data are likely to be contaminated by the endogeneity of monetary policy, but the regional data are much less prone to this endogeneity, because cross-regional differences in unemployment rates and inflation are unaffected by monetary policy. The reemergence of the Phillips curve in the regional data supports this argument.

## Mismeasurement of Inflation

As discussed above, many researchers have considered alternative measures of economic slack in estimating the Phillips curve. Their results are similar even when they use different measures. But the weakening Phillips curve relationship (at the national level) may stem from the measurement of inflation. Stock and Watson explore this idea.

Price measurement is challenging for a number of reasons. First, the market price of a particular good or service may be unavailable. For example, it is not possible to obtain the market price of a particular health care service. A more extreme example is services provided by churches and, more generally, by some nonprofit organizations, which are not even priced. But they are part of our consumption basket and thus should be (and indeed are) part of the overall PCE price index.[11]

The second challenge concerns the quality adjustment of new goods. In calculating the price index, the basket of goods and services must be updated as new products are introduced into the market, replacing their older versions. New products tend to be priced higher, but the higher prices could be simply due to quality improvements. The price changes due to quality improvements should be removed from the observed price changes. But estimating the portion of the price change due to quality improvement is a daunting task. There are many other challenges in price measurement.[12]

Note that these challenges have always been present, but the problems might have become more severe in recent years, obscuring the aggregate-level Phillips curve relationship. To explore this idea, Stock and Watson divide the PCE price index into 17 subcategories of goods and services that differ in the degree of difficulty in measuring their prices. They then examine the Phillips curve relationship for each category separately. They find that Phillips curve slopes differ significantly between these categories. The slopes tend to be higher in services whose prices are determined in local markets and are relatively well measured, such as rent, recreational services, and food services. By aggregating those 17 subcategories weighted based on their cyclical sensitivities, these authors construct an alternative to the PCE inflation rate, which they call the cyclically sensitive inflation (CSI) index. They show that the CSI-based Phillips curve is alive and well, even in recent years when the traditional Phillips curve appears to be dormant.

A general implication of Stock and Watson's exercise is that there are some categories of goods and services for which the Phillips curve relationship is clearly visible. They put more weight on these cyclically sensitive goods and services when constructing the overall price index, which allows them to "recover" the Phillips curve. But the authors do not get into the details of what exactly has caused inflation to be less sensitive to resource slack. Moreover, given that monetary policy is concerned with overall price stability–not the stability of a subset of the price index–it is not clear why and how Stock and Watson's findings should be utilized in monetary policy.

## Summary and Implications for Monetary Policy

Aggregate data suggest that inflation has become less sensitive to resource slack. However, regional-level analysis reveals that the two measures remain strongly negatively related, although the evidence on nonlinearity is mixed. So one may

FIGURE 5

### Inflation Rate Stuck Below 2 Percent

Year-over-year core PCE inflation rate, January 2008 to June 2019


**Source:** Bureau of Economic Analysis.

conclude that the Phillips curve relationship itself is still alive. Moreover, endogenous monetary policy supports the idea that successful monetary policy in recent years is actually the reason for the flattening of the national-level Phillips curve.

The flattening of the Phillips curve, if indeed it resulted from successful monetary policy, is excellent news for policymakers. There are, however, a few reasons to be cautious about this rosy conclusion. First, in all but a handful of months over the last 10 years, the core inflation rate has been below the Fed's target level of 2 percent (Figure 5). Similarly, even though inflation expectations have been stable overall, some measures of inflation expectations—in particular, the one based on inflation-indexed bonds—have been consistently below the 2 percent target in recent years. Over the same period, the U.S. labor market has consistently been improving. Some policymakers have raised a concern that inflation expectations are drifting away from the target.[13] This observation casts some doubt on the assumption that monetary policy successfully controls inflation expectations and actual inflation.

Second, the environment surrounding American workers seems to be undergoing various structural changes, including an expansion of the gig economy, workplace automation via advances in artificial intelligence and robotics, and increasing employer concentration. These structural changes might be weakening worker bargaining power, thus suppressing wage growth.[14] It is not surprising, it is even natural, then, that the wage Phillips curve is flattening.[15] The price Phillips curve would not be immune to these structural changes, either. The changes in the wage-unemployment relationship would influence the inflation-unemployment relationship. Furthermore, the structural changes (or their underlying causes) might directly affect the pricing margin (i.e., the difference between the product price and the input cost) independently of the degree of labor market slack.

Given these caveats, there is no guarantee that monetary policy that has successfully stabilized inflation in the past will be similarly successful in the future. Monetary policy needs to be adjusted to the changing environment.

In regard to the research efforts on the Phillips curve, existing studies tend to focus on empirical relationships without clear theoretical underpinnings. Such theoretical frameworks would help identify the true underlying relationship between labor market slack and inflation (or wage growth) and thus provide a basis for sound monetary policy. EI

## Notes

**1** The PCE price index gives the average price level of individual goods and services, based on the representative expenditure shares of goods and services. The core measure excludes gasoline and food prices from the underlying basket. The consumer price index (CPI) is an alternative measure.

**2** One needs to estimate the slope of the Phillips curve via some econometric technique, allowing for some noise affecting the observed data. If the underlying true relationship is strong enough, one should be able to recover the true value of the slope once enough data points are accumulated.

**3** Individuals exit the labor market for many different reasons. For example, some voluntarily retire or focus on raising their kids. But some might be discouraged by an unsuccessful job search. One could count this latter group as part of the labor market slack. See, for example, Kashkari (2017) for this view.

**4** See Dotsey et al. (2018) and Hooper et al. (2019).

**5** Hooper et al. (2019) and Leduc and Wilson (2017) present similar findings.

**6** See, for example, Ball and Mazumder (2011), Nalewaik (2016), Albuquerque and Baumann (2017), Murphy (2018), and Gagnon and Collins (2019).

**7** These authors use unemployment rates instead of the unemployment gap. This specification is equivalent to assuming that natural rates are constant over the period. For inflation, the PCE index is not available at the MSA level and thus these authors instead use the consumer price index (CPI). As in the national-level analysis, they focus on core inflation rates excluding food and energy.

**8** To be more precise, Murphy focuses on testing for the presence of a particular form of nonlinearity, and Hooper et al.'s specification seems less restrictive in capturing the underlying nonlinear effects. The differences in the exact specifications might explain the differences in the results.

**9** Isolating demand-driven movements in unemployment rates is appropriate, given the policymakers' interest in whether stimulative monetary policy leads to a sharp and sudden rise in wage growth.

**10** In the academic literature, the behavior of the central bank is often described by a simple mathematical formula, the "monetary policy rule." A typical rule assumes that the central bank sets the interest rate to minimize variations in inflation and output. One can also consider different rules. What McLeay and Tenreyro show is that, under the rule that replicates the recent actual behavior of the Federal Reserve, the Phillips curve tends to disappear at the national level.

**11** Prices of these services are estimated from the costs of providing the services. In principle, to the extent that those costs are tied to wages of the service providers, the same Phillips curve idea applies to these services as well.

**12** See Stock and Watson (2019) and references therein.

**13** See Bullard (2017), for example.

**14** See Krueger (2018) and references therein. It is also widely recognized in the academic literature that labor's share of national income has fallen significantly over the last two decades. See for example Bergholt et al. (2019). This decline is likely related to these structural changes.

**15** Note that, as discussed above, Leduc et al. (2019) find a flattening wage Phillips curve even in their regional-level analysis.

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