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UNDERSTANDING THE RETURN OF INFLATION‡

The Slanted-L Phillips Curve†

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As Tobin (1972, 9) aptly stated at the time, the Phillips curve is "an empirical finding in search of theory, like Pirandello characters in search of an author."

Since Tobin's (1972) writing, the search has persisted. Before the inflation surge of the 2020s, the literature converged on the New Keynesian Phillips curve. Employed by all major policy institutions, it has two central properties: (i) Linearity: It is a log-linear relationship between inflation and some measure of economic activity such as labor market tightness. (ii) Flatness: a percentage reduction in, for example, the unemployment rate results in only a modest increase in inflation. A widely cited estimate by Hazell et al. (2022), for example, suggests that a 1 percentage point drop in unemployment increases inflation by 0.33 percentage points, provided that inflation expectations remain anchored. That estimate is based on data from the period 1978–2018.

The modern incarnation of the Phillips curve was subject to a severe stress test during the inflation surge of the 2020s in the United States. It is hard to claim that it emerged from the test with flying colors. As we show in Benigno and Eggertsson (2023)—henceforth, BE—both Wall Street professional forecasters (Survey of Professional Forecasters) and policymakers at the Federal Reserve (Summary of Economic Projections) were caught flat-footed. Both failed to anticipate the surge, which started in mid-2021. Moreover, as inflation escalated, they consistently predicted inflation to revert quickly to the Federal Reserve's inflation target. Yet, contrary to these predictions, the surge accelerated well into 2022 until the Federal Reserve started raising rates.

The inflation surge of the 2020s created the largest inflation spike in the United States since the Great Inflation of the 1970s. BE suggest that the economic profession failed to anticipate the surge because it disregarded what was, once upon a time, considered a conventional wisdom: the Phillips curve is highly nonlinear. Ironically, the very curve Phillips (1958) first proposed is, in fact, highly nonlinear. Indeed, it is one of the central points of Phillips's (1958) seminal paper. Phillips (1958, 283) suggests that with "very few unemployed we should expect employers to bid up wages quite rapidly, each firm and each industry being continually tempted to offer a little above the prevailing wage." In contrast, when unemployment is high, "workers are reluctant to offer their services at less than the prevailing rate," so "wages fall only very slowly."

BE argue that the nonlinearity of the Phillips curve was overlooked for a simple reason: empirical evidence for the nonlinearity can only be found in US aggregate data from before the Great Inflation of the 1970s. Since the Great Inflation of the 1970s serves as the central reference point for most modern observers analyzing inflation dynamics, and tight labor markets played no role in explaining it, this created a blind spot.

Figure 1, extracted from BE, presents a scatterplot of the inflation rate and labor market tightness in the United States on a quarterly basis for the period 2009–2023 (for earlier

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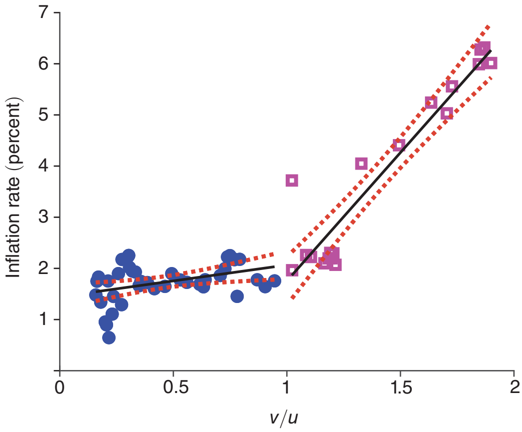

Figure 1. United States 2009–2023: CPI Inflation Rate and Vacancy-to-Unemployed Ratio (v/u)

periods, refer to BE). Labor market tightness is defined as the ratio between firms' vacancy rates (v) and workers' unemployment rates (u). The labor market is tight when there are more jobs that firms are looking to fill than there are workers looking for jobs—that is, $v/u > 1$. While the exact cutoff point—one—is not precisely estimated by BE, Beveridge (1944) argues for it on theoretical grounds. BE use the term "labor shortage" to describe the labor market conditions when $v/u > 1$—a term commonly used in the United States during the 2020s' inflation surge.[1] Figure 1 suggests a nonlinearity when $v/u > 1$, a claim that BE establish is statistically significant looking at a longer sample. A key empirical observation is that, outside of the 2020s, one needs to look before the Great Inflation of the 1970s to find extended periods of labor shortage. BE documents that, aside from the 2020s, there have been four occasions when $v/u > 1$: World War I, World War II, the Korean War, and the escalation of Vietnam War spending (along with President Johnson's tax cuts) in the late 1960s.[2] Like the 2020s, all these periods were marked by an inflation surge.

This paper presents international evidence that the Phillips curve is nonlinear, using the unemployment rate as a proxy for labor market tightness instead of v/u.[3] The focus is on the period from the first quarter of 2009 to the third quarter of 2023, which corresponds to the last of the four subperiods analyzed in BE. Labor shortage becomes prominent toward the end of this period. Our question is whether similar labor shortages were observed in other industrialized countries and, if so, whether they also triggered an inflation surge.

The general conclusion is that for the sample of seven other major industrial countries, the pattern mirrors that of the United States. As we will see, the results become particularly stark once we focus on unemployment as a measure of slack instead of v/u. What emerges is a slanted-L-shaped Phillips curve in unemployment-inflation space.

At a broad level, the economic mechanism behind the slanted-L Phillips curve aligns with BE. If the economy operates below full capacity, with idle workers and vacant factories, an increase in nominal spending boosts output (reduces unemployment) with a modest impact on prices. While most factors of production can be increased over some period, one way or another, there is one factor fixed over any relevant time horizon: the number of people. Thus, at some point, a firm responding to higher demand will eventually run out of people to hire. This intuitive, and perhaps obvious, observation is what gave rise to the old conventional wisdom that, as a matter of pure logic, the Phillips curve has to be nonlinear at some point. If firms cannot ramp up production due to a lack of labor, any additional increase in nominal spending results in increased inflation rather than higher output. Alternatively, with output hitting a wall, firms can resort to rationing goods and services instead of raising prices, but we will abstract from this possibility.[4] Our proposed Phillips curve, in the unemployment and inflation space, is therefore

[1] For instance, several stores announced closures during specific hours attributed to labor shortage when the labor market was at its tightest. Similarly, many restaurants seated customers at only a third of their capacity due to labor shortage.

[2] Hall and Sargent (2022) discuss evidence of extraordinary monetary and fiscal stimuli, referring to three wars by including COVID-19 alongside World War I and World War II.

[3] Our reliance on unemployment data is due to lack of comprehensive, comparable data on firm vacancies across countries—a topic reserved for future research.

[4] Rationing does, in fact, often become the norm in episodes featuring labor shortages during wartime because governments try to contain inflation by price controls.

a slanted L, with the lower leg of the L slightly downward slanted for reasons we clarify shortly. While the slanted-L Phillips curve suggests that demand shocks have a much larger inflation impact once the economy enters the vertical part of the slanted L, it also implies that supply shocks create much larger movements in inflation in that region. The large impact of supply shocks on inflation during labor shortages is discussed in detail and established both empirically and theoretically in BE.

The general perspective proposed in this paper, somewhat surprisingly, reconciles the work of Keynes (1936, 1940) and Friedman (1964, 1993). Keynes's (1936) general theory posits that rigidly downward wages rationalize why an increase in nominal spending increases real output and employment. Yet, Keynes (1940, 4) also develops a theory of "demander's" inflation, similar to the neoclassical account of the surge in inflation during World War II, which occurs when "government, investors, and consumers want in real terms … more than … available producible output," noting that "… in peacetime … the size of the cake depends on the amount of work done. But in wartime, the size of the cake is fixed."

The view that the economy is fundamentally asymmetric, as implied by the slanted-L Phillips curve, is shared by Friedman's (1964, 17) plucking model: "Output is viewed as bumping along the ceiling of maximum feasible output, except that every now and then it is plucked down by a cyclical contraction."[5] In what follows, Section I describes the evidence, and Section II presents a simple model. The online Appendix details the data and estimation.

I. International Evidence on the Slanted-L Phillips Curve

Figure 2 shows data on unemployment and inflation in eight advanced economies from the first quarter of 2009 to the third quarter of 2023. The evidence broadly fits our hypothesis. When unemployment declines, inflation gently increases. Once unemployment goes below some critical threshold, however, inflation surges quickly. This threshold, however, differs from country to country.

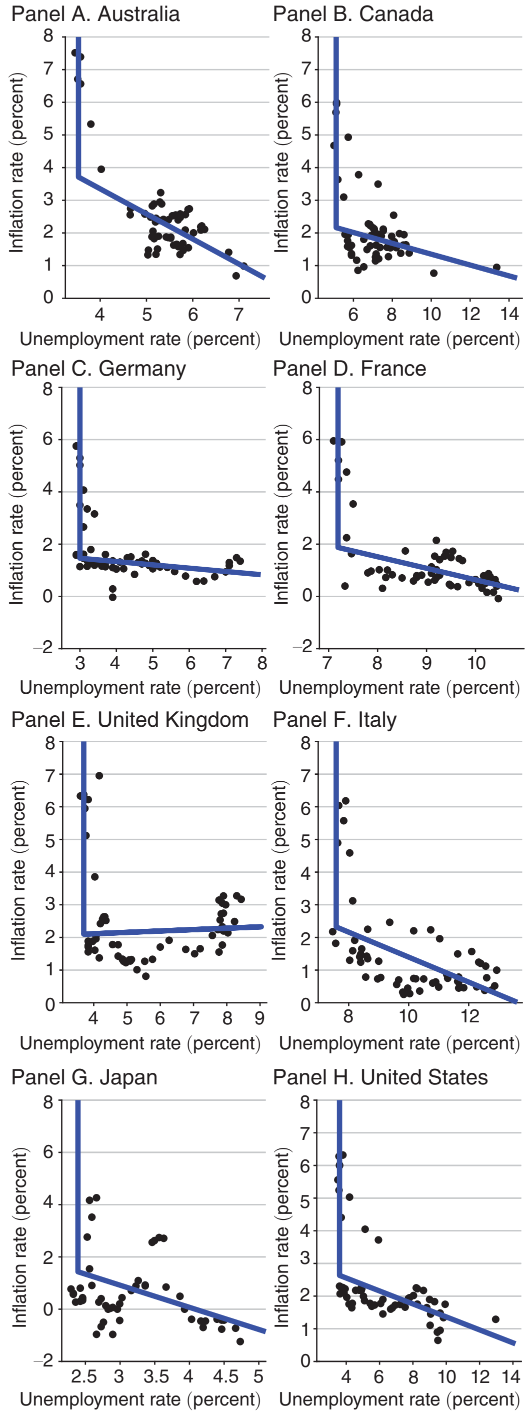

Figure 2. International Evidence on Inflation and Unemployment Trade-Off, 2009–2023

[5] See Dupraz, Nakamura, and Steinsson (2019) for a recent attempt to resurrect Friedman's (1964) plucking model.

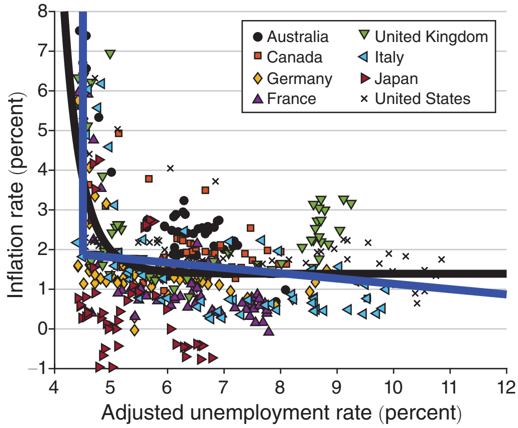

Figure 3. International Evidence on Inflation and Unemployment Trade-Off, 2009–2023 (Pooled Data)

To formalize the visual impression given by the data, we draw an L with a slant without any attempt to add controls or claim identification. At the corner of the L in each country is our measure of the unemployment rate consistent with maximum employment. We label this u^f.[6] The slanted right leg of the L is estimated via ordinary least squares regression on the remaining data points.

Figure 3 combines the data from these countries. The thick blue line shows the slanted L, with the slanted leg obtained via the regression[7]

$$\pi_{i,t} = \underset{(0.2438)}{2.4722} - \underset{(0.0359)}{0.1336} \times u_{i,t}^{dev} + \varepsilon_t,$$

where i represents each country (Australia, Canada, Germany, France, the United Kingdom, Italy, Japan, and the United States). Here, $u_{i,t}^{dev}$ is the adjusted unemployment rate constructed to be comparable across countries.[8] The thick black line in Figure 3, however, employs nonlinear least squares to estimate the original curve proposed by Phillips (1958):

$$(1) \qquad \pi_{i,t} = a + b\left(\frac{1}{u_{i,t}^{dev}}\right)^c,$$

where a, b, and c are estimated coefficients. Remarkably, estimating the curve initially proposed by Phillips results in an object that strongly resembles the slanted-L Phillips curve.[9]

II. A Model of the Slanted-L Phillips Curve

A representative household maximizes utility

$$\sum_{t=0}^{\infty} \beta^t U(C_t),$$

where $0 < \beta < 1$ is the rate of time preference and $U(\cdot)$ is a concave function of the consumption good C, subject to

$$P_t C_t + B_t = (1 + i_{t-1}) B_{t-1} + W_t L_t + \Psi_t,$$

where P_t is the price level, B_t is the one-period risk-free bond that pays interest rate i_t, W_t is the nominal wage, L_t is employment, and Ψ_t are firms' profits. Each period, the household receives an employment endowment $\bar{L}$, so equilibrium employment will be bounded by $0 < L_t \leq \bar{L}$. The household incurs no disutility of working.

Firms produce the consumption goods using the technology $Y_t = A_t L_t^{\alpha}$, where Y_t is output, A_t is a technological factor, and the parameter α is between zero and one. Firms maximize profits taking prices and wages as given, yielding optimal labor demand:

$$(2) \qquad L_t^d = \left(\frac{1}{\alpha A_t} \frac{W_t}{P_t}\right)^{-\frac{1}{1-\alpha}}.$$

If wages are flexible, they adjust so that the supply of labor is equal to demand, $L_t^d = \bar{L}$, which we refer to as full employment—that is, $L^f = \bar{L}$. The unemployment rate at full employment is $u^f = 1 - L^f/\bar{F}$, where $\bar{F}$ is the labor force that is divided between unemployed and employed. For simplicity, we assume that at full employment the unemployment rate is zero.[10] Friedman's (1964) notion of maximum feasible output is defined as production if all labor is employed—that is, $Y_t^f = A_t (L^f)^{\alpha}$—which will

[6] It is approximated by calculating the average of the observations within the range from the lowest unemployment level to 0.2 percent above it.

[7] The number of observations is 417, and the $R^2 = 0.032$.

[8] For each country, this variable is calculated by subtracting the country-specific unemployment rate at full employment, u^f, and adding the average u^f across all countries.

[9] Phillips originally fitted his curve to unemployment and wage inflation instead of price inflation.

[10] In BE, we model frictional unemployment via search and matching so that $u^f > 0$.

be the equilibrium outcome if real wages, w^f, freely adjust:

$$w^f = \alpha\left(L^f\right)^{\alpha-1} = \alpha\left(\frac{Y_t^f}{A_t}\right)^{\frac{\alpha-1}{\alpha}}.$$

Consider a macroeconomic policy regime that controls nominal spending, $D_t = P_t Y_t$. At full employment, the price level is

$$P_t = \frac{D_t}{A_t\left(L^f\right)^{\alpha}}.$$

Hence, variations in nominal spending have no effect on real output and employment when wages are flexible. Nominal prices and wages are simply proportional to nominal spending. This environment, in other words, describes the vertical wall of the slanted-L curve representing Friedman's (1964) ceiling of a plucking model or Keynes's (1940, 4) "fixed cake" at wartime. Any increase in nominal spending has no effect on output or employment. Instead, it translates directly into inflation.

We capture the slanted leg of the L supply curve in two steps. First, we assume that workers refuse to accept a job that pays below the prevailing wage, W_t^{norm}, but are willing to accept any work that pays above it. This implies that the equilibrium nominal wage rate is[11]

$$W_t = \max\left\{W_t^{norm}, P_t w^f\right\},$$

where the first element, W_t^{norm}, captures the wage norm prevailing in the market. If $W_t^{norm} > P_t w^f$, then the equilibrium wage is above the full employment wage so that only part of available workers are employed. In this case, labor is rationed; that is, there is unemployment. If, however, $W_t^{norm} < P_t w^f$, firms bid up wages until all labor is employed.

Second, we assume that the wage norm takes the form[12]

$$W_t^{norm} = \left[W_{t-1}\left(\Pi_t^e\right)^{\gamma}\right]^{\lambda}\left(P_t w^f\right)^{(1-\lambda)},$$

where Π_t^e is expected inflation and the parameters γ and λ satisfy $0 \leq \gamma \leq 1$ and $0 \leq \lambda \leq 1$.

Keynesian downward nominal wage rigidity is captured by setting $\gamma = 0$ and $\lambda = 1$ so that workers refuse to work if the nominal wage is below the last period's wage.[13] Our more flexible specification is more in line with Phillips's (1958) idea that we summarized in the introduction. In general, we allow the wage norm to react to market conditions via $P_t w^f$ and inflation expectations.

The equilibrium real wage is then

$$(3)\quad w_t = \max\left\{\left(w_{t-1}\frac{\left(\Pi_t^e\right)^{\gamma}}{\Pi_t}\right)^{\lambda}\left(w^f\right)^{1-\lambda}, w^f\right\}.$$

Using these ingredients, we can characterize an L-shaped Phillips curve in a generic period t, preceded by a period $t-1$ in which wages are at some rate $w_{t-1} = \phi w^f$ for a constant $\phi > 0$.

Denote the natural logarithm of P_t, D_t, Y_t, and A_t with lower cases, and define $\pi_t = \ln \Pi_t$, $\pi_t^e = \ln \Pi_t^e$, and $\upsilon_t = \ln \phi - a_t/\lambda$. Then, combining labor demand by the firms, the expression for real wages, the production function, and the definition of unemployment, we obtain the L-curve:

$$(4)\qquad u_t = u^f$$

if $d_t \geq p_t + y_t^f$ and

$$(5)\qquad \pi_t = -\kappa u_t + \upsilon_t + \gamma \pi_t^e$$

if $d_t < p_t + y_t^f$, where $\kappa \equiv (1-\alpha)/\lambda$. This pair of equations provides natural microfoundations for the L-shape function shown in Figures 2 and 3. Equation (4) is the vertical part of the L, while equation (5) is the slanted leg that becomes more slanted the higher κ is—that is, the more flexible wages are.

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[11] As in Eggertsson, Mehrotra, and Robbins (2019).

[12] In BE, we generalize this concept within a search and matching framework and distinguish between new and existing wages.

[13] For a good overview for the evidence or nominal wage rigidities, see Schmitt-Grohe, Uribe, and Woodford (2022).

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