Truth in Teaching Macroeconomics: Mappings of the Aggregate Supply Curve onto the Phillips Curve

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Recently economists have been debating the purpose and content of the economics principles course. Some economists have believed that the principles course, which relies heavily on textbooks, reasonably well characterizes how economists treat the problems of economic growth, inflation, unemployment and income distribution (McConnell 1988, Case 1988, Amacher 1988). Other economists have assessed that the macroeconomics principles course supplies too few of the skills and too little of the insights to prepare students to be economically intelligent citizens (Boulding 1988, Bell 1988, Boskin 1988, Siegfried et al 1991, Calander and Brenner 1992). One of the matters of contention in the debate focuses on how the macroeconomics principles textbooks use graphic analysis. Some economists have considered that the graphic analysis provide a clear and simple way to grasp macroeconomic ideas (McConnell 1988, p. 159). Yet others have thought that some of the graphic models have obscured macroeconomic reasoning (Calander 1992, pp. 158-64). Economists who have acknowledged the limitations of those graphic analyses have reacted differently. Some instructors have responded that it is presumptuous to eliminate models from which instructors for long have extracted considerable mileage. After all all models are simplifications that merely approximate the truth. Other instructors have responded that the graphic analyses oversimplify, or bowdlerize macroeconomic ideas and thus dull the cognitive skills that the principles course aims to sharpen (Saunders 1990, Feld 1990). This essay argues that the mapping of the aggregate supply curve onto the Phillips curve is a case in point.

The Phillips curve relates the rate of inflation to the level of capacity usage. The curve may take one of several related forms. A. W. H. Phillips (1954, 1958) presented the curve, which he supported on the basis of some back-of-the-envelop empirical work using British data, either as a positive relation between average price inflation and the real output rate or a negative relation between average money wage inflation and the unemployment rate (Wulwick 1987). Phillips initially argued that his curve represented demand-pull inflation mainly on the grounds that awards of cost of living adjustments resulted from competitive bidding for labor. Later he (1962) adopted the familiar explanation of inflation as the sum of demand-pull plus cost-push. The lag structure let Phillips eliminate money wage inflation (or price inflation) and maintain the proposed relation between price inflation (or money wage inflation) and capacity usage for the purposes of prediction (Wulwick 1989, pp. 182-83).

On the basis of his curve Phillips suggested that stabilization policy maintain the level of capacity usage associated with a stable price level. Economists interested in stabilization policy in the United States swiftly appropriated the Phillips curve. Yet P. A. Samuelson and R. M. Solow (1960) cautioned economists to avoid rashly concluding that the Phillips curve represented demand-pull inflation, or movement of the aggregate demand curve along the static aggregate supply curve (p. 189). Demand-pull plus cost-push inflation represented by the interaction of a shifting aggregate demand curve and an expectations augmented aggregate supply curve also could explain the Phillips curve. The latter, dynamic explanation gained popularity after E. S. Phelps (1967) and M. Friedman (1968) introduced their theory of the expectations augmented Phillips
curve, which denied the possibility of a usable trade-off between inflation and capacity usage. Intermediate macroeconomics textbooks have shown how to map the expectations-augmented aggregate supply curve onto the expectations-augmented Phillips curve given the assumptions of (1) adaptive expectations and (2) a positive relation between the price level and the level of capacity utilization (Mankiw 1992, pp. 303-04; Hall and Taylor 1991, p. 197; and Dornbusch and Fischer 1994, pp. 496, 513-14).

In contrast, the principles textbooks have mapped the stable aggregate supply curve onto the stable Phillips curve. In particular, the textbooks have claimed that

[a] downward-sloping Phillips curve implies that an aggregate supply curve will be upward-sloping (Arnold 1989, p. 324).


According to the economic reasoning behind the Figure 1, the goods market remains in equilibrium as the aggregate demand curve shifts along the aggregate supply curve relating the actual price level P to the actual real output ratio Yn.

(1) \( P = bY_a \), \( b > 0 \).

Taking logarithms of both sides,

(2) \( \log P = \log b + a(\log Y) \),

and differentiating \( \log P \) with respect to \( \log Y \) yields

(3) \( \frac{d(\log P)}{d(\log Y)} = a \),

or, as an approximation in the discrete terms of Figure 1, given that the subscript \( n \) refers to the capacity level written in terms of a fixed index number,

(4) \( (P - P_0)P_0 = n(Y_a - Y_0) \).

As the option for Figure 1 indicates, the principles textbooks in question treat equation 4 as the Phillips curve in inflation-real output space. The principles textbooks use Okun's law to arrive at the Phillips curve in inflation-unemployment space. According to Okun's law the relative gap between the actual and the capacity levels of real output, \( (Y_a - Y_0)/Y_0 \), is constant, \( Y_a = 1 + c(U_a - U_0) \) or

(5) \( (Y_a - Y_0)/Y_0 = c(U_a - U_0) \), \( c > 0 \),

or

(6) \( Y_a = 1 + c(U_a - U_0) \).

Equations 4 and 5 imply that price inflation is inversely related to the rate of unemployment, that is,

(7) \( (P - P_0)_0 = (1 + c(U_a - U_0)) - Y_n \),

which the Phillips curve in inflation-unemployment space according to Figure 1. It is obvious that the mapping of the stable Phillips curve from the stable aggregate supply curve according to Figure 1 requires the untenable restriction that all movements of the macroeconomy start from some fixed real output ratio and fixed price level \( Y_n, P_n \).

In the absence of that restriction, it is untrue in general that the stable Phillips curve implies a stable aggregate supply curve. Instead of ordinarilv randomizing the movements of the macroeconomy along the aggregate supply curve in order to derive a Phillips curve, this essay asks what conditions must be satisfied by the aggregate supply curve in order that one can map it onto the Phillips curve.

The definition of producer price, \( P \), is the proportionate rate of change of the price level per unit of time, \( T(P)/(dP/dt) \). How has that definition of inflation applied when economists have treated the Phillips curve as a transformation of aggregate supply, which is timeless as in Figure 1? Given that the aggregate supply curve is continuously differentiable, changes in the price level occur in terms of continuous time, or are a monotonous function of time which permits the elimination of time as an explicit independent variable (Dreyfus 1960, p. 235). Accordingly the mapping of aggregate supply onto the Phillips curve implies that inflation is modeled as

(8) \( \frac{dP}{dt} > 0 \)

or, from the definition in equation 1,

(9) \( \frac{d}{dt} \left[ \frac{\frac{dP}{dY}}{\frac{dY}{dt}} \right] > 0 \).

Expanding the terms on the right-hand side gives

\[ \frac{d}{dt} \left[ \frac{dP}{dY} \cdot \frac{dY}{dt} \right] > 0 \]

or

\[ P_n^t - P_n^{t+1} > 0 \]

where

\[ P = \frac{dP(Y)}{dY}, \quad P_n = \frac{dP(Y)}{dY} \cdot Y_n \]

Equation 9 is the mathematical condition that must be satisfied by any curve in price level-output ratio space that can be mapped onto a stable Phillips curve.

Let us experiment with some stable aggregate supply curves to see if they satisfy the mathematical condition of the Phillips curve. The fixed linear aggregate supply curve

(10) \( P = aY + b \), \( a > 0 \), \( b \neq 0 \).

does not satisfy the condition of the Phillips curve, for substituting the results \( P_n^t = a, P_n^{t+1} = b \) into equation 9 gives \( (aY_n + b)/a > 0 \), which is impossible. Alternatively, let us suppose the fixed exponential curve,

(11) \( P = bY_a \), \( b > 0 \).
where \( P_t = \gamma_0 Y_t - 1 \) and \( P_t' = a(a-n)Y_t - 2 \). Substituting these results into the equation expressed in equation 9 gives  \(-aY_t < 2a - 1 > 0\). It follows that \( a < 0 \), which means that the curve (whenever it may represent) in terms of levels \( P_t \) and \( Y_t \) is downward-sloping (which is the case when inflation increases from negative to zero values as the output ratio rises). In contrast, the Phillips curve can be mapped off a fixed aggregate supply curve of the double exponential form,

\[
P_t = \alpha_0 e^{-\alpha_1 t}, \quad \alpha_0, \alpha_1 > 0
\]

because that curve satisfies the condition:

\[
P_t \cdot P_t'' = P_t' = k_1 e^{-\alpha_1 t} > 0, \quad \text{where} \quad k_1 = \alpha_0^2/\alpha_1^2, \quad k_2 = \alpha_0 \alpha_1
\]

Economic theory offers no rationale for the fact that the Phillips curve can be mapped off the double exponential aggregate supply curve in equation 12, but not from the linear and exponential aggregate supply curves in equations 10 and 11.

**CONCLUSION**

This essay shows that the stable Phillips curve can be mapped off a stable aggregate supply curve that is double exponential in form but not an aggregate supply curve which is linear or exponential. Clearly economists who attempt to model the stable Phillips curve as a mapping of a stable aggregate supply curve encounter the problem of inconsistency. Yet many principles of economics books claim that the stable Phillips curve is a mapping of a stable aggregate supply curve. Treating the stable Phillips curve mechanically as a mapping of the stable aggregate supply curve discourages the skill of logical reasoning that the principles course intends to develop.

**NOTES**

1. The idea for this essay arose in a conversation with R.L. Basman. "Truth in Teaching Macroeconomics" was the title of a paper presented by D. Colander at the conference Educating Economists, Middletown College, Spring 1998. The Jerome Levy Economics Institute at Bard College financed this research.

2. R.L. Basman pointed out the double exponential curve to the author.

**REFERENCES**


Unemployment And The GNP Gap: Okun’s Law Revisited

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INTRODUCTION

Okun’s law is one of the widely used tools for policy makers to measure the cost of unemployment and the gain of economic growth. It can be stated in several different ways. In one version, it describes the link between the GNP gap and the unemployment rate. According to Okun [1976, p. 137], the unemployment rate would decline by 0.5 percentage points if real output grew by 1 percentage point above potential output. He also indicated that the 0.3 to 1 link applied only to the sample with the unemployment rates between 3% and 7.5% and that the 0.3 coefficient might change when the unemployment rate was considerably lower or higher than that range. Okun’s law has received extensive evaluations and criticisms in recent years. Gordon [1984] found that there were long lags for unemployment to adjust to changes in real output and that Okun [1976] somewhat underestimated the parameter. Dornbusch and Fischer [1987] indicated that the estimates of potential output and the link between unemployment and the GNP gap have changed in the long run and that it is not an immutable law. Benjamin Friedman [1988] also expressed that Okun’s law has not performed well during the 1980s.

An examination of previous studies reveals that the effect of a change in the GNP gap on the unemployment rate was usually assumed the same in the sample period. This may not be true. When the unemployment rate is greater than the natural rate of unemployment, an increase in real output is likely to have more effect on the unemployment rate due to excess labor supply. These surplus workers are available and can be hired readily at the existing wage rate. When actual real output is greater than potential real output, an increase in real output is going to have less effect on the unemployment rate because it may be getting more difficult to hire additional workers at the current wage rate and because existing workers may be given more hours or overtime to produce extra output. If we plot the unemployment rate and the GNP gap on the vertical and horizontal axes, respectively, the curve is likely to be steeper (Stilier) when the unemployment rate is higher (lower). The issue of functional form or the steepness/flatness of a curve is important in economic analysis. Smyth and Due [1988] maintained that macroeconomic variables such as the unemployment rate and inflation rate may have nonlinear relationship and that the slope may vary with the values of the dependent and independent variables. There were also debates over the functional form of the Phillips curve (PC) in the early 1960s. Ehrenberg and Smith [1988] also indicated that in recent years the FC has become flatter due to downward wage rigidity.

The purpose of this study is to reexamine Okun’s law and to test the proposition that the relationship between the GNP gap and the unemployment rate does not remain the same, but varies with the levels of the variables. Major findings in this study will have significant policy implications since the estimated parameter may help policy makers analyze the link between changes in output and unemployment more accurately.