Scand. J. of Economics 96(1), 111–116, 1994

Escalators and Elevators: A Phillips Curve for Keynesians

Thomas I. Palley

New School for Social Research, New York, NY, USA

I. Introduction

The negatively sloped long-run Phillips curve remains an issue of contention. This paper presents a theoretical model of the Phillips curve in which nominal demand growth reduces unemployment caused by stochastic shifts of demand between sectors.[1] The model can be understood through the following metaphor. Keynesian economies are "escalator" economies in which markets adjust back to equilibrium slowly, so that nominal demand growth presents a means of speeding up the escalator process. Contrastingly, new classical economies, as set forth by e.g. Lucas (1973), are "elevator" economies in which adjustment is instantaneous. Consequently, there is no role for nominal demand growth in the adjustment process, and to the extent that policy sponsored nominal demand growth is uncertain, it may actually disrupt the economy by sending the elevator to the wrong floor.

II. Unemployment and Sectoral Demand Shocks: A Static Model

Consider an economy in which there are k sectors, and nominal demand in each sector is given by

$$D_{i,t} = D + e_{i,t} \tag{1}$$

where $D_{i,t}$ is nominal demand in the i-th sector in period t, $e_{i,t}$ denotes shock to nominal demand in the i-th sector, and $E(e_{i,t}) = 0$. The sum of sectoral nominal demand shocks is zero, so that aggregate nominal demand is non-stochastic, but its sectoral distribution is uncertain.

[1] This explanation is present in the folklore of neo-Keynesian economics; see Tobin (1972). However, it has not been successfully modeled. Evans (1985) models an economy with sectoral demand shifts, but his treatment of sectoral nominal wage adjustment makes the long-run Phillips curve vertical.

Sectoral goods market clearing is given by

$$D_{i,t} = p_{i,t} y_{i,t}, \tag{2}$$

where $p_{i,t}$ is the price of goods produced in the i-th sector and $y_{i,t}$ is output produced in the i-th sector.

Production in the i-th sector is given by

$$y_{i,t} = bN_{i,t}. \tag{3}$$

Below full employment, firms are mark-up pricers; above full employment, prices adjust to clear the goods market. Prices are therefore given by

$$p_{i,t} = \text{Max}\left[(1+m)\, w_{i,t}/b,\ D_{i,t}/bN^s_{i,t}\right], \tag{4}$$

where m is the mark-up rate and $N^s_{i,t}$ denotes labor supply in the i-th labor market. Sectoral labor supplies are given by

$$N^s_{i,t} = N_{i,t-1}/n_{t-1}, \tag{5}$$

where n_{t-1} is the last period's aggregate employment rate. Per (5), labor supplies are allocated across sectors so as to equalize beginning of period sectoral employment rates.[2] Finally, aggregate labor supply is given by

$$N^s_t = \sum_{i=1}^{k} N^s_{i,t} = N. \tag{6}$$

Given sectoral nominal wages, the solutions for sectoral output, employment, and unemployment rate are

$$y_{i,t} = D_{i,t}/p_{i,t}, \tag{7}$$

$$N_{i,t} = \text{Min}\left[D_{i,t}/(1+m)\, w_{i,t},\ N^s_{i,t}\right], \tag{8}$$

$$U_{i,t} = 1 - N_{i,t}/N^s_{i,t}. \tag{9}$$

The logic of the model is shown in Figure 1. Each sector has an L-shaped supply schedule, the height of which is determined by the nominal wage. Negative nominal demand shocks cause unemployment, while positive demand shocks that push sectors beyond full employment raise prices.

III. Demand Growth, Nominal Wage Adjustment and the Phillips Curve

Understanding inflation requires dynamizing aggregate nominal demand. Sectoral nominal demand growth is given by

[2] Allocation of sectoral labor supply is independent of relative wages. One rationalization is that unemployment gives such great disutility that workers seek to maximize the likelihood of being employed, and this results in the equalization of sectoral employment rates.

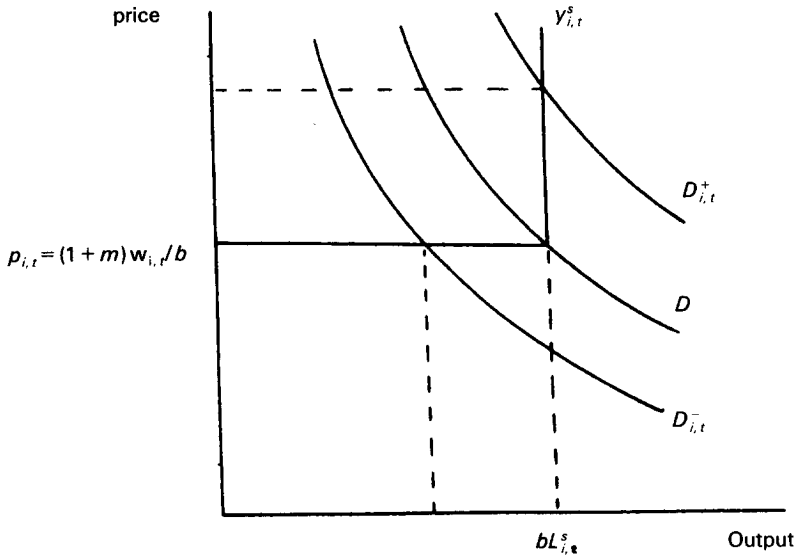

Fig. 1. Product market demand and supply schedules for the ith sector.

$$gd_{i,t} = gd + ed_{i,t} \tag{10}$$

where $gd_{i,t}$ denotes the rate of nominal demand growth in sector i in period t, gd the exogenous trend rate of aggregate nominal demand growth and $ed_{i,t}$ the shock to sector i rate of nominal demand growth. Sectoral nominal demand growth shocks are assumed to be drawn from a two point zero mean uniform distribution given by ed^+ and ed^-: 50 per cent of sectors receive positive shocks, ed^+, while 50 per cent of sectors receive negative shocks, ed^-. Trend aggregate nominal demand growth, gd, is non-stochastic.

Sectoral nominal wage adjustment is governed by

$$gw_{i,t} = \begin{cases} -h & ed_{i,t} < 0 \\ gd + ed^+ - (1 - n_{t-1})/n_{t-1} & ed_{i,t} > 0 \end{cases} \tag{11}$$

where $gw_{i,t}$ is sectoral nominal wage inflation, h the rate of nominal wage deflation and n_{t-1} the last period's aggregate employment rate. Per (11), nominal wage adjustment is asymmetric. In sectors receiving negative demand shocks there is nominal wage deflation; in sectors receiving

positive demand shocks, nominal wages are bid up to market clearing level.[3]

The change in the sectoral rate of unemployment is

$$dU_{i,t} = \begin{cases} -(gd + h - ed^{-})\, n_{t-1} & ed_{i,t} = ed^{-} \\ -(1 - n_{t-1}) & ed_{i,t} = ed^{+}. \end{cases} \tag{12}$$

The unemployment rate increases in sectors receiving negative shocks.[4] Trend growth of nominal demand combined with nominal wage deflation serve to reduce unemployment, but these effects are overwhelmed by the negative demand shock. Unemployment is eliminated in sectors receiving positive nominal demand shocks, so that the decrease equals the existing rate of unemployment, $1 - n_{t-1}$.

Given the above adjustment processes, the economy is in macroeconomic equilibrium when the aggregate unemployment rate is constant so that[5]

$$dU_t = -0.5(1 - n_{t-1}) + 0.5(ed - gd - h)\, n_{t-1} = 0, \tag{13}$$

where *ed* denotes the absolute value of demand growth shock. Solving (13) yields

$$n^* = 1/(1 + ed - gd - h) \tag{14}$$

$$U^* = (ed - gd - h)/(1 + ed - gd - h). \tag{15}$$

Using (11) yields equilibrium inflation given by

$$gp_t = 0.5(gd + ed - (1 - n^*)/n^*) - 0.5h. \tag{16}$$

The first term represents inflation in sectors at full employment, while the second represents deflation in sectors below full employment. Substituting (14) into (16) then yields

$$gp_t = gd. \tag{17}$$

---

[3] As a simplifying measure, the absolute rate of wage deflation is treated as independent of the rate of unemployment. In sectors receiving positive demand shocks, existing unemployment is eliminated; thus, part of nominal demand growth translates into output and employment growth. Per (8), $gw_{i,t} = gd_{i,t} - gn_{i,t}$, where $gn_{i,t} = (N_{i,t} - N_{i,t-1})/N_{i,t-1}$. Using the definition of $gn_{i,t}$, combined with (5) yields $gn_{i,t} = (1 - n_{t-1})/n_{t-1}$.

[4] It is assumed that $gd + h < |ed^{-}|$, so that sectors receiving negative nominal demand growth shocks have increased unemployment.

[5] Note that though the equilibrium aggregate employment rate is constant, individual sectors continue to be buffeted by employment shocks. Per (13), it is assumed that 50 per cent of sectors receive positive shocks, and 50 per cent negative shocks; these proportions can be varied.

Lastly, substituting (17) into (15) and rearranging, yields the Phillips equaton which is given by

$$gp_t = 1 + ed - h - 1/(1 - U^*). \tag{18}$$

Differentiating (18) with respect to U^* yields

$$\mathrm{d}gp_t/\mathrm{d}U^* = -1/(1 - U^*)^2$$

so that the Phillips curve is negatively sloped, and convex to the origin. Differentiating (15) and (17) with respect to ed yields

$$\mathrm{d}U^*/\mathrm{d}ed = 1/(1 + ed - gd - h)^2 > 0 \qquad \mathrm{d}gp/\mathrm{d}ed = 0.$$

Increases in the variance of demand shocks, measured by ed, raise the equilibrium unemployment rate; cf. Lillien (1982). However, equilibrium inflation is unchanged, which contradicts claims made by neo-Keynesian Phillips curve theorists such as Archibald (1969), Tobin (1972) and Brechling (1973).

The above model can be refined to allow inflation expectations to affect nominal wage adjustment in sectors receiving negative shocks.[6] In this case the nominal wage adjustment equation becomes

$$gw_{i,t} = \begin{cases} -h + aE_t[gp_t] & ed_{i,t} < 0 \\ gd + ed_{i,t} - (1 - n_{i,t})/n_{i,t} & ed_{i,t} > 0, \end{cases} \tag{11'}$$

where a is the coefficient of feedback of inflation expectations into nominal wages in sectors with unemployment $(0 < a < 1)$ and $E_t[gp_t]$ is rationally expected inflation. The model's solutions are then given by

$$gp_t = [1 + ed - h - 1/(1 - U^*)]/(1 - a) \tag{19}$$

$$gp_t = gd. \tag{20}$$

Inflation expectations have no impact on equilibrium inflation, but they do worsen the Phillips trade-off. This is because inflation expectations cause nominal wages and prices to rise in sectors with unemployment, and this crowds out the employment benefits of nominal demand growth. If $a = 1$, the Phillips curve is vertical, and the unemployment rate is independent of nominal demand growth. The reason is that economy wide inflation gets fully incorporated into sectors with unemployment, so that the effects of nominal demand growth are completely neutralized.[7]

---

[6] A possible rationale is that workers in sectors with unemployment watch wages in other sectors, and are only prepared to accept a gradual relative decline.

[7] Other possible refinements to the model include distinguishing between unionized and non-unionized sectors, so that in non-unionized sectors $a < 1$, while in unionized sectors $a = 1$. In this case, it can be shown that increases in the proportion of unionized sectors leave

IV. Conclusion

A model of the Phillips curve consistent with a Keynesian view of the economy has been presented. At the core of the Phillips curve lies the issue of nominal wage adjustment in sectors below full employment. To the extent that these sectors do not fully compensate for inflation owing to the presence of unemployment, then nominal demand growth can help reduce unemployment resulting from sectoral demand shifts. With regard to specific results, the model showed that inflation is determined by the rate of aggregate nominal demand growth, and not by the rate of unemployment as claimed in the neo-Keynesian Phillips curve literature; cf. Lipsey (1960). This identification of the causal role of nominal demand growth serves to link the theory of the negatively sloped long-run Phillips curve with monetary theory, and remedies an absence which contributed to displacement of the Phillips curve by natural rate theory. The model also showed that increased variance of sectoral demand shocks increases unemployment, but has no effect on inflation: again, this contrasts with assertions in the Phillips curve literature.

References

Archibald, G. C.: The Phillips curve and the distribution of unemployment. *American Economic Review 59*, 124–9, 1969.

Brechling, F.: Wage inflation and the structure of regional unemployment. *Journal of Money, Credit, and Banking 5*, 355–79, 1973.

Evans, G.: Bottlenecks and the Phillips curve: A disaggregated model of inflation, output, and employment. *Economic Journal 95*, 345–357, 1985.

Lillien, D. M.: Sectoral shifts and sectoral unemployment. *Journal of Political Economy 90*, 777–93, 1982.

Lipsey, R. G.: The relation between unemployment and the rate of change of money wages in the United Kingdom, 1862–1957. *Economica 27*, 1–31, 1960.

Lucas, R. E., Jr.: Some international evidence on output-inflation tradeoffs. *American Economic Review 63*, 326–34, 1973.

Tobin, J.: Inflation and unemployment. *American Economic Review 62*, 1–26, 1972.

First version submitted May 1992;
final version received May 1993.

---

equilibrium inflation unaffected, but increase the unemployment rate, and also steepen the slope of the Phillips curve. A second refinement is the incorporation of productivity growth and supply side shocks. Suppose aggregate productivity growth is non-stochastic, but its distribution across sectors is random. In this case it can be shown that increased aggregate productivity growth lowers the equilibrium rate of inflation and unemployment.