POLITICAL ECONOMY RESEARCH INSTITUTE

University of Massachusetts Amherst

The Backward Bending Phillips Curves: A Simple Model

Thomas I. Palley

April 2008

POLITICAL ECONOMY RESEARCH INSTITUTE

Gordon Hall
418 North Pleasant Street
Amherst, MA 01002

Phone: 413.545.6355
Fax: 413.577.0261
peri@econs.umass.edu
www.peri.umass.edu

WORKINGPAPER SERIES

Number 168

The Backward Bending Phillips Curves: A Simple Model

Abstract

This paper develops a simple macroeconomic model of the backward bending Phillips curve that allows easy comparison with the neo-Keynesian and new classical models of the Phillips curve. There are two separate explanations of the backward bending Phillips curve and the model incorporates both. One explanation focuses on near-rational inflation expectations and aggregation of expectations across workers. The other explanation focuses on nominal wage setting behavior and aggregation of nominal wage behavior across sectors. The paper concludes with some observations about the implications of the backward bending Phillips curve for monetary policy.

Key words: Backward bending Phillips curve, minimum unemployment rate of inflation.

JEL ref.: E00, E31, E52

.

Thomas I. Palley
Economics for Democratic & Open Societies
Washington DC 20010
e-mail: mail@thomaspalley.com

March 2008

I The backward bending Phillips curve

The Philips curve has been a central component of macroeconomics. The original neo-Keynesian Phillips curve was based on the empirical work of Phillips (1958), and it posited a negatively sloped long run relationship between unemployment and inflation. In the late 1960s that view was challenged by the theory of the natural rate of unemployment developed by Friedman (1968) and Phelps (1968), which posited a vertical long run relationship between unemployment and inflation. The natural rate view has dominated the economics profession since the late 1970s, with the policy implication that there exists no long run trade-off between inflation and unemployment.

Recently, Akerlof et al. (2000) and Palley (1998, 2003) have developed models of a backward bending Phillips curve that is initially negatively sloped in unemployment – inflation space, then bends back and becomes positively sloped, and ultimately becomes vertical. Such a backward bending Phillips curve is shown in Figure 1. In place of a non-accelerating inflation rate of unemployment (NAIRU) that acts as a constraint on the sustainable minimum unemployment rate, there is a minimum unemployment rate (MUR) that pairs with a minimum unemployment rate of inflation (MURI). The MURI is the inflation rate that obtains at the point of inflexion when the Phillips curve bends backward.

The underlying analytical impulse behind this revived construction of the Phillips curve derives from Tobin's (1972) insight that inflation can help "grease" the wheels of labor market adjustment in a multi-sector economy in which sectors are subject to random demand shocks so that some have unemployment while others are at full employment. Tobin's argument explains why there can be a long run negatively sloped relation between unemployment and inflation. When that reasoning is paired with additional assumptions about nominal wage setting behavior it can generate a backward bending Phillips curve.

Existing models of the backward bending Phillips curve are highly complicated involving either a framework with multiple monopolistically competitive firms.(Akerlof et al., 2000) or a multi-sector framework (Palley, 2003). That complexity obscures the underlying economic logic and also makes it difficult to teach the backward bending Phillips curve. The current paper presents a simple accessible model of the backward bending Phillips curve that resolves this problem. The model neatly complements existing models of the Phillips curve, enabling a clear comparison with both the neo-Keynesian and new classical constructions of the Phillips curve. Additionally, the model includes the effects of worker militancy that operate via nominal wage setting behavior, and this provides a bridge between demand pull (Phillips) inflation favored by new Keynesians and cost-push conflict inflation favored by Post Keynesians

II Macroeconomics and the Phillips curve: five different models

The Phillips curve is one of the most important relationships in macroeconomics. First, it is important because it provides the equation determining the rate of inflation. Second, it is important for policy analysis as the Phillips curve constitutes a structural constraint on policy, limiting the outcomes that can be achieved.

The Phillips curve has proved deeply theoretically intractable. The original Phillips curve (Phillips, 1958) was a purely empirical finding of a relationship between inflation and unemployment. Yet, that finding was quickly incorporated into Keynesian macro models as if it were a theoretical equation. However, as Tobin (1972) observes, it has always been “an empirical finding in search of a theory, like Pirandello characters in search of an author.”

This early incorporation of the Phillips curve into theoretical macro models has confused subsequent understanding and muddied the search for a theoretical explanation. A major problem has been that macro economists, following the conventional assumptions of macroeconomics, sought to explain the Phillips curve using the notion of a representative single aggregate labor market. However, such a foundation cannot generate a theoretically sound negatively sloped Phillips curve, and instead results in a vertical long run Phillips curve. It turns out that constructing a theoretical explanation of a long run trade-off between inflation and unemployment calls for a disaggregated story in which there are many labor markets. These labor markets collectively generate a data pattern that looks like the aggregate Phillips relation discovered by Phillips (1958).[1]

Unfortunately, this poses a problem for teaching macroeconomics. On one hand the Phillips curve is vital for closing the basic macro model and determining inflation, and also for doing simple macro policy exercises using the basic model (e.g. Romer, 2000). Yet, explaining the Phillips curve by recourse to disaggregated micro labor markets is extremely complicated. That sets up an incentive to explain the Phillips curve using an aggregate labor market, but doing so undermines its existence and leads to the conclusion there is no long run negatively sloped Phillips curve.

This section describes five alternative single equation macroeconomic specifications of the Phillips curve. Two of the specifications generate a negatively

---

[1] It is important to distinguish between demand-pull and conflict inflation. The neo-Keynesian Phillips curve is a demand-pull story. Post Keynesians have tended to emphasize conflict inflation. Conflict inflation models can generate a negatively sloped inflation – unemployment relation using a representative firm and representative labor market (Myatt, 1986). This adds another layer of complication to the Phillips curve debate.

sloped Phillips curve. One generates a vertical Phillips curve, and two generate backward bending Phillips curves.

These five models summarize the state of the debate over the Phillips curve and enable comparison of the different positions. Underneath these aggregate relations lies a complicated microeconomics.

The first macroeconomic Phillips curve is the classic neo-Keynesian expectations augmented version (Tobin, 1971) of the original Phillips equation (Phillips, 1958). The model is given by

(1) $\pi = f(U - U^*) + \lambda\pi^e$ $\quad 0 < \lambda < 1$ $\quad$ [Neo-Keynesian Phillips curve]

where π = inflation, U = unemployment rate, U^*= full employment rate of unemployment, λ = coefficient of inflation expectations, and π^e = expected inflation. The algebra of the neo-Keynesian model shows that the Phillips curve is negatively sloped even when expected inflation equals actual inflation, so that there is a permanent trade-off between inflation and unemployment.

That said, the micro foundations of the model have always been problematic. Lipsey (1960) sought to explain the model as representing a process of gradual disequilibrium adjustment in a conventional aggregate labor market. However, according to that story the labor market determines the real wage, in which case the Phillips curve provides a relationship between unemployment and the rate of change of real wages. Moreover, in such a framework there is no long run trade-off since the real wage and employment will adjust to their equilibrium levels regardless of inflation.

The second aggregate model of the Phillips curve is the natural rate model developed by Friedman (1968) and Phelps (1968), which is given by

(2) $\pi = f(U - U^*) + \pi^e$ [New Classical Phillips curve]

The only formal difference between the neo-Keynesian and natural rate models concerns the coefficient of inflation expectations, which is less than unity in the neo-Keynesian version and equal to unity in the natural rate version. In the natural rate model the Phillips curve is vertical when expected inflation equals actual inflation, so that there is no permanent trade-off.[2]

Much attention has focused on the formation of inflation expectations, and whether they are adaptive or rational. This is an important question that has significant policy implications, but when it comes to the debate over the slope of the Phillips curve it is not the critical issue. A comparison of the neo-Keynesian and natural rate models shows that the critical issue is the magnitude of the coefficient of inflation expectations, and whether or not it is unity. That raises the theoretical question of how to understand and explain this coefficient, which leads in the direction of multi-sector models.

Palley (1994, 1997) presents a multi-sector model of the Phillips curve in which workers in sectors with unemployment hold back on nominal wage increases to help restore employment in those sectors. When aggregated, such nominal wage behavior generates a macroeconomic Phillips relation of the form

(3) $\pi = f(U - U^*) + \lambda(U)\pi^e$ $\lambda_1 < 0,\ 0 < \lambda < 1$

Now, the coefficient of inflation expectations is negatively related to unemployment. As unemployment decreases, the coefficient of inflation expectations increases. The

[2] Friedman and Phelps recognized the implications of Lipsey's (1960) analysis of wage adjustment in an aggregate labor market. In such a market there can be no long-run trade-off between inflation and unemployment. A temporary short-run trade-off can exist if workers have adaptive expectations that delay the adjustment of the real wage back to its market clearing equilibrium level. However, that has the unfortunate implication of keeping labor markets in disequilibrium, which lowers welfare according to general equilibrium analysis.

economic logic is that the coefficient of inflation expectations represents the extent that workers are feeding inflation back into nominal wages, and thereby prices. The aggregate coefficient is a weighted average of behavior across sectors. Sectors at full employment have a coefficient of unity. Sectors with unemployment have a coefficient of less than unity. Consequently, the aggregate average coefficient is less than unity, but it increases as unemployment diminishes and more sectors reach full employment.

The Phillips curve now exhibits a permanent negative slope even when expected inflation equals actual, and its slope is given by

$\delta\pi/\delta U = [f_U + \lambda_U\pi]/[1 - \lambda] < 0$

The denominator is negative and the numerator positive, making the slope negative. Moreover, the absolute value of the slope increases as unemployment declines and inflation increases, making the trade-off progressively less favorable. The logic is that as unemployment decreases, more sectors hit full employment and start pushing for higher nominal wages.

Akerlof et al. (2000) develop a backward bending model in a multi-firm economy with heterogeneous wages. When their model is aggregated, it generates a macro Phillips curve given by

(4) $\pi = f(U - U^*) + \pi^e(\pi)$ $\quad\quad \pi^e_1 \gtrless 1, \pi^e(\pi) \leq \pi$

The key feature is that inflation expectations are a positive function of actual inflation, and eventually converge to actual inflation. The slope of the Phillips curve is given by

$\delta\pi/\delta U = f_U/[1 - \pi^e_1] < 0$

The Phillips curve is negatively sloped when $\pi^e_1 < 1$. It is positively sloped when $\pi^e_1 > 1$, and vertical when $\pi^e = \pi$.

The Akerlof et al. story rests on near-rational expectations, and they argue that as inflation increases workers expectation converge to actual inflation. Interestingly, Akerlof et al. assume a coefficient of inflation expectations equal to unity, but there still exists Phillips trade-off. This is because at low rates of inflation workers systematically under-estimate inflation and that under-estimation is equivalent to having a coefficient of inflation expectations that is less than unity. In effect, systematically under-estimating inflating produces the same economic outcomes as having less than full feed-through of inflation expectations.

The fifth and final model (Palley, 2003) also exhibits a backward bending Phillips curve and given by

(5) $\pi = f(U - U^{*}) + \lambda(\pi^{e})\pi^{e}$ $\qquad \lambda_1 > 0, 0 < \lambda \leq 1$

The slope of the Phillips curve is given by

$\delta\pi/\delta U = f_U/[1 - \lambda - \pi\lambda_1] < 0$

The key feature is that the coefficient of inflation expectations depends on the rate of inflation, and increases with inflation. When $\lambda = 1$ the Phillips curve is vertical. The logic is that sectors with unemployment display wage restraint to preserve jobs, but as inflation increases this willingness to display restraint decreases. In effect, the coefficient of inflation expectations is a weighted average across sectors. In sectors with full employment it is unity. In sectors below full employment it is less than unity if inflation is low. However, as inflation rises, those sectors start to display resistance to excessively rapid real wage erosion and the coefficient of inflation expectations rises.

The above five models provide simplified macroeconomic single equation versions of the Phillips curve. However, behind these single equation representations lies a more complicated microeconomics. The balance of the paper excavates the microeconomics behind the backward Phillips curve.

III Microeconomics of the backward-bending Phillips curve

The basic logic of the backward bending Phillips curve derives from Tobin's (1972) insight that when there is downward nominal wage rigidity, inflation can help grease the wheels of labor market adjustment by facilitating relative wage and price adjustment in sectors with unemployment. A backward bend emerges if workers in sectors with unemployment start to display downward real wage resistance once inflation passes a threshold level.

II.1 Labor market micro foundations

The microeconomic logic for such wage behavior and its affect on unemployment is as follows:

(i) Labor exchange is characterized by conflict and moral hazard, and workers therefore resist wage reductions imposed from within the employment relationship for fear that firms are trying to cheat them. That said, workers are willing to accept some real wage reduction imposed from outside the employment relationship via adjustment of the general price level since this is outside the control of individual firms.[3]

(ii) However, workers resist excessively fast inflation-driven real wage reductions. Thus, as inflation increases, more and more workers in sectors with unemployment start to demand nominal wage increases to match inflation.

When such wage setting behavior is placed in a multi-sector economy in which some sectors have unemployment and others are at full employment, it generates a

[3] The microeconomic foundations for such labor market behavior are developed in Palley (1990) and Bewley (1999) provides empirical evidence that is supportive of this microeconomic logic.

backward bending Phillips curve. Initially, nominal demand growth causes inflation in full employment sectors, and creates jobs in sectors with unemployment where nominal wages remain fixed. Faster nominal demand growth generates faster inflation in full employment sectors and more employment creation in sectors with unemployment. However, some workers in sectors with modest unemployment start indexing their wages, thereby partially reducing inflation's grease effect in those sectors. The grease effect is reduced because nominal wages in those sectors start matching inflation, thereby neutralizing the job creation impact of nominal demand growth.[4]

As inflation increases, workers in more and more sectors with unemployment start resisting real wage reductions, progressively eroding the grease effect. At some stage the Phillips curve bends back because adding more grease (nominal demand growth that causes inflation) is outweighed by decreased lubricity (indexing of nominal wages to inflation). Eventually inflation is pushed to a high enough level that all workers are indexing, and the Phillips curve becomes vertical.

Figure 1 illustrates the backward bending Phillips curve. The turning point of the curve can be labeled the minimum unemployment rate of inflation (MURI), and it represents the point where the labor market grease effect of inflation is maximized.

II.2 A simple macro model

The backward bending long run Phillips curve can be modeled as follows

(6) $\pi = gd - gs$

(7) $U = u(\sigma, gd - \lambda(\pi, \psi)\,\pi)$ $\quad u_1 > 0, u_2 < 0, 0 \leq \lambda \leq 1, \lambda_1 > 0, \lambda_{11} > 0, \lambda_{12} < 0, \lambda_2 > 0$

[4] Note there is no inflation fooling or inflation misperceptions involved. Instead, the grease effect comes from the pattern of wage behavior and the willingness of workers in high unemployment sectors to show nominal wage restraint.

where π = inflation rate, gd = growth of nominal demand, gs = productivity growth, U = unemployment rate, σ = dispersion of sector specific nominal demand shocks that have a mean of zero, λ = coefficient of real wage resistance, and ψ = worker militancy variable affecting the degree of real wage resistance.

Equation (6) describes the economy's inflation generating process. The long run equilibrium inflation is equal to the rate of aggregate nominal demand growth minus the rate of productivity growth. Henceforth, for simplicity, it is assumed that gs = 0.

Equation (7) describes the economy's long run unemployment rate generating process. The first argument in the function u(.) has unemployment depending positively on the dispersion of nominal demand shocks across sectors.[5] Such shocks give rise to frictional and structural unemployment that is located in sectors receiving negative demand shocks. The second argument captures the inflation grease effect resulting from the job creation effects of nominal demand growth in sectors with unemployment. In those sectors nominal demand growth is less than fully offset by nominal wage and price increases owing to nominal wage restraint. Note, that what is commonly described as inflation's grease effect is actually the grease effect of nominal demand growth.

Figure 2 describes the structural logic of the Phillips curve. The underlying economic driver is the rate of aggregate nominal demand growth that simultaneously increases the rate of inflation by causing inflation in sectors at full employment, and lowers the rate of unemployment by creating jobs in sectors with unemployment.

The economic logic represented in Figure 2 implies that the long run Phillips curve is a locus of points in inflation – unemployment rate space. This locus emerges

[5] This focus on the dispersion of nominal demand shocks links the Phillips curve with the empirical literature on the unemployment effects of sectoral shifts initiated by Lillien (1982).

because nominal demand growth generates a negative correlation between inflation and unemployment. One of the problems of single equation macroeconomic representations of the Phillips curve is that they make it look as if there is a causal long-run relationship between inflation and unemployment. That is not the case. Instead, there is a correlation spurred by a common factor, nominal demand growth.

The coefficient of real wage resistance, λ, is critical. As can be seen from equation (7), if the coefficient is unity, unemployment is unaffected by nominal demand growth and unrelated to inflation. The aggregate coefficient of real wage resistance is a weighted average of the sectoral real wage resistance coefficients. In sectors with full employment $\lambda = 1$, but in sectors below full employment it may be less than unity at lower levels of inflation – which is why the aggregate average can also be less than unity.

The idea that nominal demand growth lubricates labor market adjustment can be understood as follows. Let z denote the magnitude (lubricosity) of the grease effect. Using equation (6) and the assumption that gs = 0, the grease effect is

(8) $z = gd - \lambda(\pi, \psi)\pi = gd - \lambda(gd, \psi)gd > 0$ if $\lambda < 1$

If gd is positive, this grease effect is always non-negative since $0 \leq \lambda \leq 1$. If gd = 0 then z = 0. Likewise, if $\lambda = 1$ then z = 0. Differentiating z with respect to gd yields

$\delta z/\delta gd = 1 - \lambda - \lambda_1 gd \gtrless 0$

Thus, increases in nominal demand growth can increase the grease effect or decrease it.[6] When gd and inflation are low both of the negative terms will be small and increases in gd will raise the grease effect. When gd is large and inflation high the reverse holds.

[6] The change in the marginal grease effect is given by $\delta^2 z/\delta gd^2 = -2\lambda_1 - \lambda_{11} gd < 0$. This is unambiguously negative showing that the marginal grease effect (lubricosity) of inflation falls.

The evolution of z as a function of gd is shown in Figure 3 and z reaches a maximum when $gd = [1 - \lambda]/\lambda_1$. The logic is as follows. At low inflation, faster nominal demand growth adds to real demand growth because price and wage inflation is held down in sectors with high unemployment that show wage restraint. However, as inflation rises, wage restraint is progressively abandoned which takes back some of the grease effect, and hence the hump shape.

The effect of faster nominal demand growth and inflation on unemployment is given by

$$\delta U/\delta gd = u_2[1 - \lambda - \lambda_1 gd] \gtrless 0$$

When the grease effect is positive (i.e. at low inflation), the unemployment rate falls in response to faster nominal demand growth and inflation. Once the grease effect has peaked, faster nominal demand growth and inflation raise the unemployment rate. This corresponds to being on the backward bending part of the Phillips curve. Finally, when $\lambda = 1$, faster nominal demand growth and inflation have no effect on unemployment. This corresponds to being on the vertical portion of the backward bending Phillips curve. The backward bending inflection point occurs when z is at a maximum, which occurs when $gd^* = [1 - \lambda]/\lambda_1$.

The vertical portion of the Phillips curve is associated with $\lambda = 1$ so that the unemployment rate is given by $u = u(\sigma, gd - gd) = u(\sigma, 0)$. This is the same unemployment rate that obtains when nominal demand growth and inflation are zero.

III Comparison of models

The coefficient of real wage resistance, λ, plays a critical role in the backward bending Phillips curve and it can be related to both the NAIRU and neo-Keynesian

Phillips curve models that were discussed earlier. The NAIRU model assumes that $\lambda = 1$ so that all the grease effect of nominal demand growth is crowded out by equal proportionate increases in nominal wages and prices. The, neo-Keynesian model assumes that λ is a constant lying between zero and unity (Tobin, 1971) so that some part of nominal demand growth is not crowded out. However, neo-Keynesians provided no theoretical explanation for this assumption.

Unfortunately, the 1970s debate over the Phillips curve was side-tracked into a debate over whether inflation expectations were adaptive or rational. However, the real theoretical challenge was how to explain the coefficient λ in econometric aggregate regressions of the Phillips curve. When the economy is viewed as consisting of multi-sector labor markets rather than a single aggregate labor market, that coefficient is a weighted average of the feed through of inflation expectations across all sectors. It can therefore be less than unity if some sectors are showing wage restraint because of local employment conditions. Workers in those sectors can have fully rational expectations about inflation, but such restraint can be the optimum response given their local concern with jobs.

It is worth contrasting the two different specifications of the backward bending Phillips curve developed by Akerlof at al (2000) and Palley (2003). Akerlof et al.'s (2000) focus on the issue of expectation formation and aggregation of expectations across wokers. Thus, they replace rational expectations with near-rational expectations. In their formulation λ is unity, but workers have near-rational expectations that systematically underestimate inflation when it is low but correctly estimate it at higher levels. Since the underestimate is persistent, that preserves the negatively sloped Phillips curve – unlike adaptive expectations in which expectations catch up with actual inflation so that the negatively sloped Phillips curve can only be preserved by accelerating inflation (Friedman, 1968).

The workings of the grease effect in the Akerlof et al. (2000) model can be understood as follows:

(9) $gd = \pi \geq \pi^e(\pi)$ $\qquad\qquad \pi^e \leq \pi,\ \pi^e_1 > 0,\ \pi^e_{11} > 0$

(10) $z = gd - \lambda\pi^e = gd - \pi^e(\pi) > 0$ $\qquad\qquad \lambda = 1$

where π^e = aggregate average of near-rational expected inflation. Equation (9) determines the actual inflation rate which is less than or equal to the aggregate average expected inflation.[7] As inflation rises, aggregate average expected inflation converges to actual inflation. Equation (10) describes the grease effect. There is full feedback of expected inflation into the nominal wage setting process since $\lambda = 1$, but since expectations are near-rational and the average aggregate value is slightly below actual inflation, this leaves space for nominal demand growth to have a grease effect. However, as inflation increases, near-rationality is progressively abandoned by workers at different firms, thereby eroding the grease effect. When $\pi^e = \pi$ the grease effect is fully eroded and the Phillips curve becomes vertical.

The effect of progressive abandonment of near-rational inflation expectations on the Phillips curve can be formally analyzed as follows. Combining equations (9) and (10) yields a grease effect given by $z = gd - \pi^e(gd)$. Differentiating z with respect to gd yields $\delta z/\delta gd = 1 - \pi^e_1 \gtrless 0$ if $\pi^e_1 \lessgtr 1$. The marginal grease effect can therefore be positive or negative. The Phillips curve is negatively sloped when it is positive, and positively sloped

[7] There is an additional technical condition on the behavior of aggregate inflation expectations. When $\pi^e = \pi$ then $\pi^e_1 = 1$ and $\pi^e_{11} = 0$. This condition ensures π^e cannot be greater than π.

when it is negative. Further differentiating z with respect to gd yields $\delta^2 z/\delta gd^2 = \pi^e_{11} < 0$. Thus, the marginal grease effect (lubricosity) is strictly declining, and the Phillips curve bends back when the marginal effect is zero.

Palley (2003) focuses on the nominal wage setting process and aggregation of wage setting behavior across workers. Workers can have fully rational expectations, but they knowingly hold the line on nominal wage increases because of local sectoral unemployment conditions. Consequently, the aggregate average value of λ is less than unity because of intentional nominal wage setting behavior in sectors with unemployment.

This gives rise to a different specification of the grease effect given by

(4') $gd = \pi = \pi^e$

(5') $z = gd - \lambda(\pi^e, \psi)\pi^e \geq 0 \qquad 0 \leq \lambda \leq 1,\ \lambda_1 > 0$

Thus, the focus is shifted from expectation formation and aggregation of expectations to nominal wage setting (the coefficient of real wage resistance) and aggregation of nominal wage setting across sectors. The grease effect disappears when λ is unity.

IV Further analytics

The slope of the Phillips curve and its inflexion point depend on how rapidly workers start to display real wage resistance (i.e how sensitive λ is to π^e). If workers start displaying real wage resistance at low inflation rates, the Phillips curve will be steep and also bend back at a relatively low rate of inflation and high rate of unemployment. If real wage resistance only develops slowly, the Phillips curve will be flatter and will bend back at a higher rate of inflation and lower rate of unemployment.

This connects with the issue of worker militancy, which can be thought of as influencing the coefficient of real wage resistance via the parameter ψ. The effects of increased worker militancy on real wage resistance are shown in Figure 4, which shows the coefficient of real wage resistance as a positive function of gd.

The effect of increased worker militancy on the Phillips curve operates through militancy's impact on inflation's grease effect. Differentiating z with respect to ψ yields

$\delta z/\delta\psi = -\lambda_2 gd < 0$

Increased militancy therefore decreases inflation's grease effect as shown in Figure 5. . This causes the Phillips curve to bend back at lower rates of inflation and higher rates of unemployment, and it also causes the Phillips curve to become vertical at lower rates of inflation. These effects of increased militancy are shown in Figure 6.

The economic logic of these effects is as follows. The Phillips curve becomes vertical when z = 0, which holds when $\lambda(gd, \psi) = 1$. Increases in worker militancy raise the value of λ holding gd constant, so that the Phillips curve becomes vertical at lower rates of nominal demand growth and inflation. Not only does increased militancy diminish the grease effect, it also causes it to peak earlier. This can be seen by differentiating gd* with respect to ψ, which yields

$\delta gd^*/\delta\psi = -\lambda_{12}/\lambda_1^2 < 0$

gd^* is the rate of nominal demand growth and inflation at which the Phillips curve bends back, and increases in worker militancy lower this rate.

Increases in the dispersion of sectoral demand shocks raise the equilibrium rate of unemployment, but have no effect on inflation. This can be seen by differentiating equations (1) and (2) with respect to σ, which yields

$\delta U/\delta\sigma = u_1 > 0 \qquad \delta\pi/\delta\sigma = 0$

Increased dispersion of sectoral demand shocks can be interpreted as raising frictional and structural unemployment, but they leave equilibrium inflation and the grease effect unchanged. Increased dispersion of sectoral demand shocks therefore shifts the Phillips curve horizontally as shown in Figure 7.

Finally, it is interesting to consider the effect of productivity growth. If productivity growth is non-zero, the rate of inflation and unemployment are given by

(6) $\pi = gd - gs$

(7) $U = u(\sigma, gd - \lambda(gd - gs, \psi)[gd - gs])$

Productivity growth therefore lowers inflation for any given rate of nominal demand growth. It also lowers equilibrium unemployment, which can be seen by differentiating (7) with respect to gs

$\delta U/\delta gs = u_1[\lambda + \lambda_1 gs] < 0$

The logic is that faster productivity growth lowers inflation, which lowers nominal wage inflation and allows more job creation in sectors with unemployment from a given rate of nominal demand growth.

V Policy implications

The backward bending Phillips curve has important theoretical and policy implications. One theoretical implication concerns static modeling of monetary policy which is often thought of as operating through changes in the level of interest rates that in turn impact the level of real aggregate demand. A Phillips curve perspective sees monetary policy as operating trough its impact on nominal demand growth. Policy effectively manages nominal demand growth, contingent on the rate of productivity growth, to obtain the desired rate of inflation or unemployment.

This can be represented by the following specification of the policy process

(8) $\pi = gd(i, A) - gs$ $\qquad$ $gd_1 > 0$

(9) $U = u(\sigma, gd(i, A) - \lambda(\pi, \psi)\pi)$

where i = policy interest rate and A = vector of exogenous variables affecting nominal demand growth. Given an inflation target, the monetary authority solves equation (8) for the interest rate that hits the target. If it has an unemployment target, it solves equation (9) for the interest rate that ensures nominal demand growth appropriate for that target.

An important feature of the backward bending Phillips curve is that it restores a trade-off between inflation and unemployment for low rates of inflation. If the monetary authority is aiming for the lowest possible sustainable rate of unemployment, it should aim for an inflation rate equal to the MURI.

The idea of a MURI has implications for current policy. The Fed and other central banks commonly focus on an informal inflation target of two percent, but there is little reason to believe that two percent is the MURI. Historical evidence suggests that the U.S. has experienced lowest rates of unemployment when inflation has been in the 3 – 5 percent range. Moreover, Akerlof et al. (2000) present empirical evidence that the Phillips curve may even bend back at around seven percent inflation.

Another policy implication concerns changes in worker militancy and real wage resistance. Decreases in militancy lower real wage resistance, causing the Phillips curve to bend back at a lower unemployment rate and higher inflation rate – i.e they raise the the MURI and lower the MUR. From a policy standpoint, that means that the monetary authority should raise its estimate of MURI, enabling it to push for lower rates of unemployment. This is relevant for the U.S. economy today, with former Federal Reserve Chairman Alan Greenspan (1999) having openly commented about workers' heightened sense of job insecurity tamping down real wages.

Lastly, increases in the underlying rate of productivity growth also allow the monetary authority to step on the economic accelerator. This is because accelerated productivity growth directly lowers inflation, and it also lowers unemployment by lowering inflation expectations and real wage resistance. That means the monetary authority can increase nominal demand growth, thereby further reducing unemployment but without raising inflation above its initial level.

References

Akerlof, G.A., Dickens, W.T., and Perry, G.L. (1996) "The Macroeconomics of Low Inflation," Brookings Papers on Economic Activity, 1 , 1 -76.

--- (2000) "Near-Rational Wage and Price Setting and the Long Run Phillips Curve," Brookings Papers on Economic Activity, 1 , 1 - 60.

Bewley, T.F., Why Wages Don't Fall During a Recession, Cambridge: Harvard University Press, 1999.

Friedman, M., "The Role of Monetary Policy," American Economic Review, 58 (1968), 1 – 17.

Greenspan, A., "The Federal Reserve's Semi-annual Report on Monetary Policy," presented to the Committee on Banking, Housing, and Urban Affairs, the U.S. Senate, February 23, 1999.

Lillien, D.M., "Sectoral Shifts and Cyclical Unemployment," Journal of Political Economy, August 1982, 777 – 93.

Lipsey, R.G., "the Relationship Between Unemployment and the rate of Change of Money Wage Rates in the United Kingdom, 1862 – 1967: A Further Analysis," Economica 27 (1960), 1 – 31.

Myatt, A., "On the Non-Existence of a Natural rate of Unemployment and Kaleckian Micro Underpinnings to the Phillips Curve," Journal of Post Keynesian Economics, 8 (Spring 1986), 447 – 62.

Palley, T.I., "The Backward Bending Phillips Curve and the Minimum Unemployment rate of Inflation (MURI): Wage Adjustment with Opportunistic Firms," The Manchester School of Economic and Social Studies, 71 (1) (January 2003), 35 – 50.

-------------, "Zero is Not the Optimal Rate of Inflation," Challenge, 41 (January-February, 1998), 7 - 18.

--------------, "Does Inflation Grease the Wheels of Adjustment? New Evidence from the U.S. Economy," International Review of Applied Economics, 11 (1997), 387-98.

-------------, "Escalators and Elevators: A Phillips Curve for Keynesians," Scandinavian Journal of Economics, 96 (1), 1994.

-------------, "A Theory of Downward Wage Rigidity: Job Commitment Costs, Replacement Costs, and Tacit Coordination," Journal of Post Keynesian Economics, 12 (Spring 1990), 466-486.

Phelps, E.S., “Money Wage Dynamics and Labor Market Equilibrium,” Journal of Political Economy, 76 (1968) p.678 – 711.

Philips, A.W., “The Relationship between Unemployment and the Rate of Change of Money wage Rates in the U.K., 1861 – 1957,” Economica, 25 (1958), p. 283 – 99.

Romer, D., “Keynesian macroeconomics without the LM Curve,” Journal of Economic Perspectives, 14 (Spring 2000), 149 – 170.

Samuelson, P.A., and Solow, R.M., “Analytical Aspects of Anti-inflation Policy,” American Economic Review, 50 (1960), 177 – 94.

Tobin, J., “Inflation and Unemployment,” American Economic Review, 62 (1972), 1 - 26.

----------, “Phillips Curve Algebra,” in Essays in Economics, Vol. 2, Amsterdam: North Holland Press, 1971.

Figure 1. The backward bending Phillips curve.

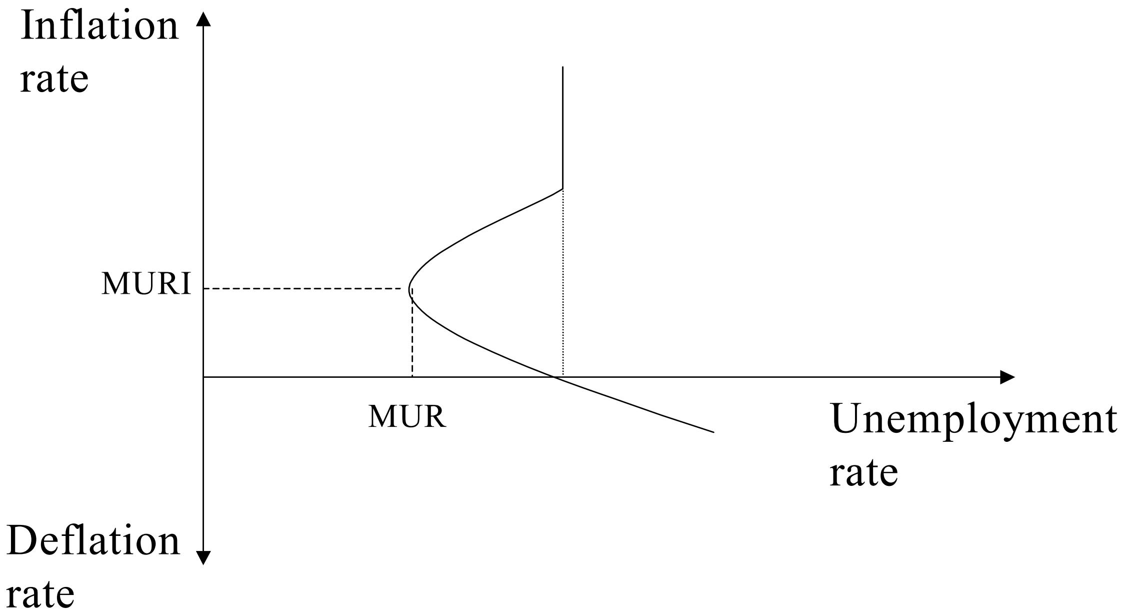

Figure 2. Microeconomic logic of the Phillips Curve

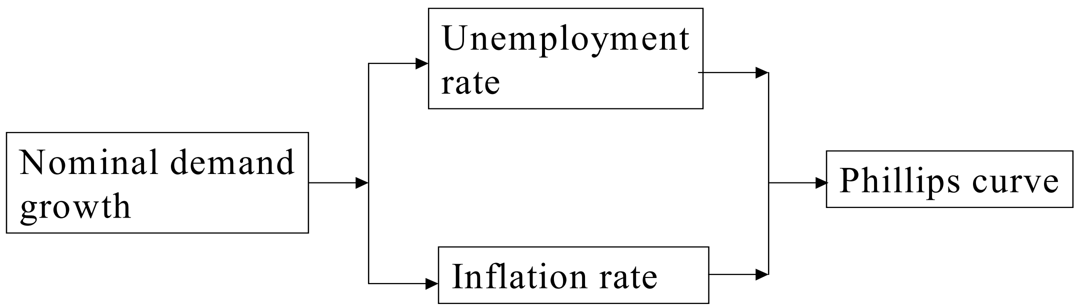

Figure 3. Inflation's grease effect as a function of nominal demand growth.

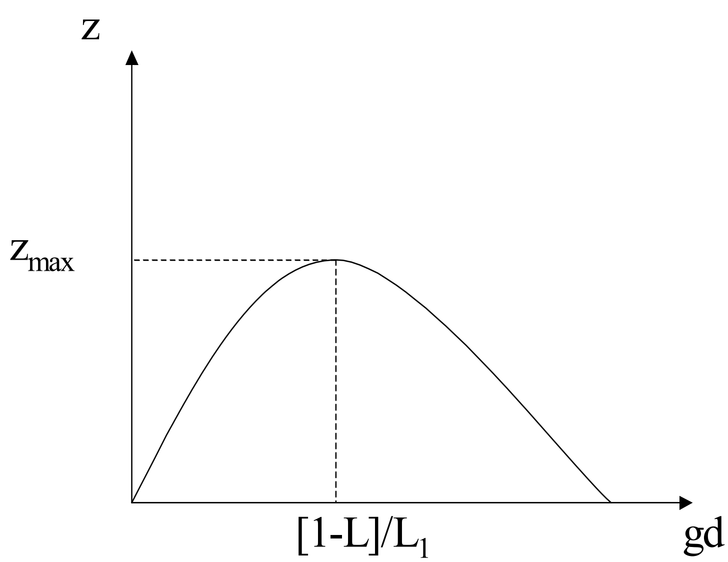

Figure 4. The effect of increased militancy on the coefficient of real wage resistance ($w_2 > w_1$).

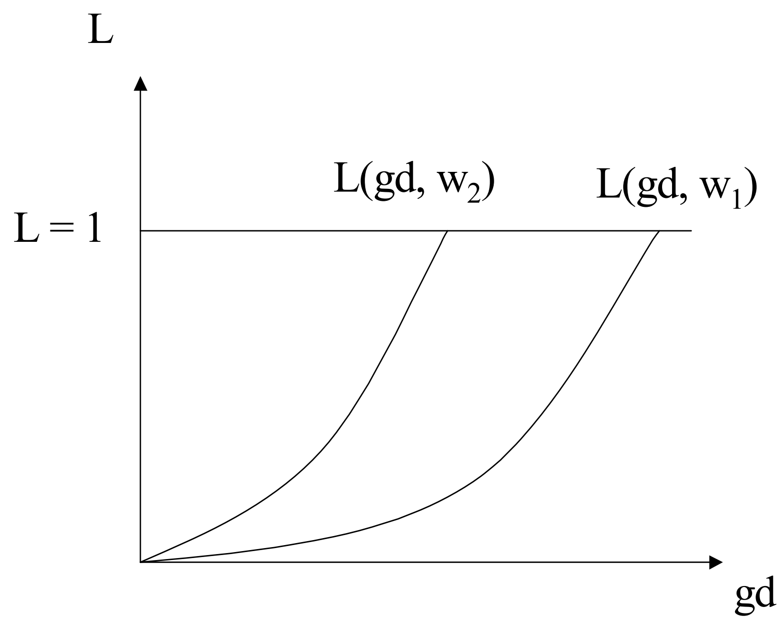

Figure 5. Effect of increased militancy on the inflation's grease effect ($w_1 < w_2$).

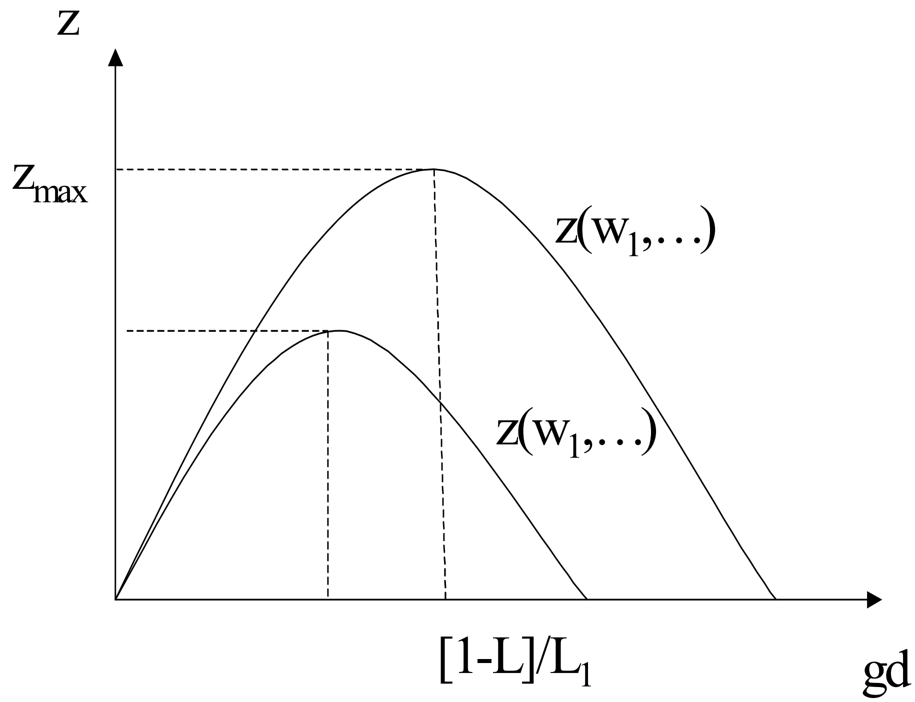

Figure 6. The effect of increased worker militancy on the backward bending Phillips curve.

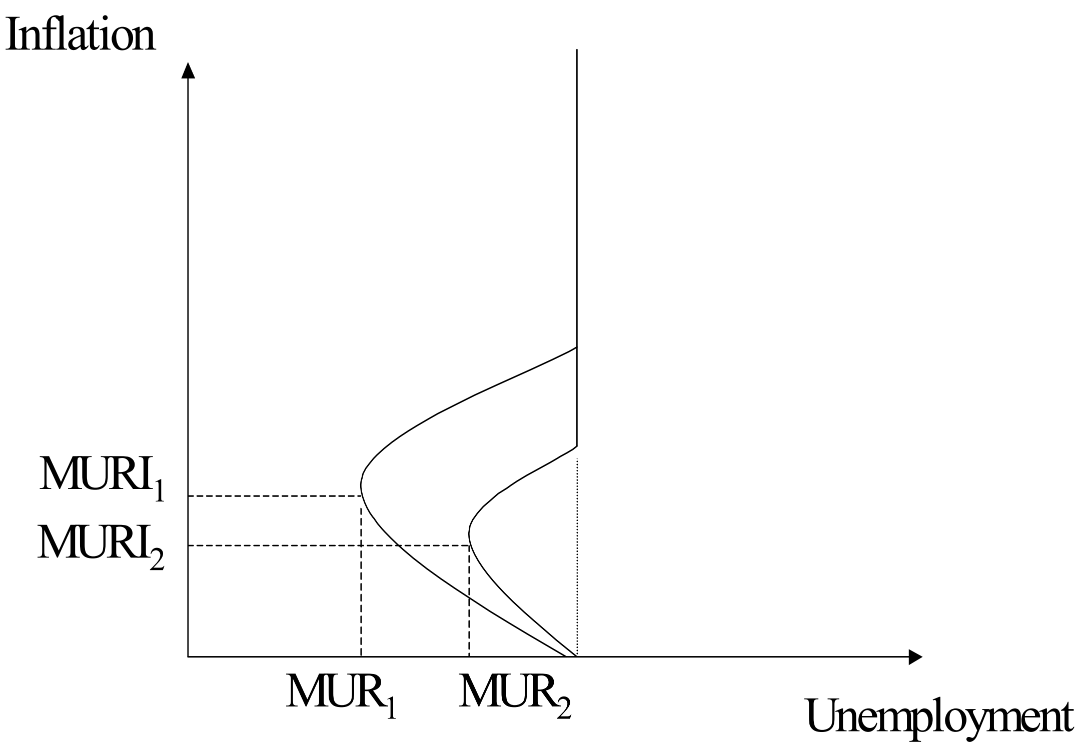

Figure 7. Effect of increased dispersion of sectoral demand shocks on the backward bending Phillips curve ($s_3 > s_2 > s_1$).