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AGGREGATE PHILLIPS CURVES ARE NOT ALWAYS VERTICAL: HETEROGENEITY AND MISMATCH IN MULTIREGION OR MULTISECTOR ECONOMIES

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The aggregation of sectoral or regional Phillips curves yields an inflation–unemployment trade-off that is not vertical in the long run if there are mismatches between supply and demand in the regional or sectoral labor markets. This remains true even when the individual Phillips curves are all vertical. This result stems from variations in the slope of the individual short-run Phillips curves, rather than from changes to the equilibrium level of unemployment. It implies a role for the management of the distribution of demand over different sectors or regions, in order to minimize the natural rate of unemployment.

Keywords: Natural Rates of Unemployment, Mismatch, Distribution of Demand

1. MOTIVATION

Conventional models define the natural rate of unemployment as the rate that is consistent with unchanging inflation in prices or wages. Such a level of unemployment would depend on the structural characteristics of the economy and would—in the long run—remain unaffected by shifts in the level of aggregate demand. This implies that aggregate demand can only influence output and unemployment permanently in certain special cases: (1) if the costs of anticipated inflation vary with the rate of inflation [Friedman (1977)]; (2) if current demand and employment levels turn out to be path dependent [Cross (1993)]; or (3) if wages and prices are strictly state dependent [Caplin and Leahy (1991)].

Does this mean that a long-term output–inflation trade-off can never hold otherwise? By adapting an idea of Brechling (1973), this paper shows that it can. Aggregating wage bargains in a union of labor markets that display mismatches between supply and demand in the underlying markets will always produce such a trade-off, even if expected inflation is fully accommodated and the expectations

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are rational. This result is important because it implies that either inflation or the natural rate of unemployment will typically be higher than they need to be. Of course, other models have argued that mismatch will raise the natural rate of unemployment [Layard et al. (1991)]. The point being made here is that inflation also will be affected: Mismatch affects the slope, as well as the location, of the Phillips curve. That means that the aggregate curve cannot be vertical, even when the underlying long-run Phillips curves are all vertical.[1]

The implication is that the role of demand management is not so much to manipulate *aggregate* demand or employment levels. Rather, it is to manipulate the *distribution* of demand over sectors or regions. However, it is important to emphasize that these results depend on something very different from the technical issues highlighted in the recent literature. In this case, they derive from a sectoral or a spatial aggregation of Phillips curves in a world where the underlying labor markets differ from one another in terms of structure. They are not the consequence of time-varying parameters, as in Gordon (1997). Nor do they depend on *how* the nonlinearity of excess demand affects wages in the short run [Clark and Laxton (1997)] or the long run [Akerlof et al. (1996)]. Nevertheless, should there be additional time aggregation or nonlinear effects, then my results will hold with added force.

2. DEFINITIONS

Consider an economic union of n distinct labor markets. Let $\dot{w}_{it}$, u_{it}, and $x_{it} = (D_{it} - S_{it})/S_{it}$ be the percentage increase in wages, the unemployment rate, and the proportionate excess demand for labor in the ith economy (country, region, sector), respectively. The systemwide increase in wages is given by $\dot{W}_t = \sum a_i \dot{w}_{it}$, where $\sum a_i = 1$ and the $a_i > 0$ terms are the country/regional or sectoral weights in the union. We adopt the standard approach of a weakly convex transformation between u_{it} and x_{it} at t: $g_i(u_{it}) = x_{it}$, where $g_i'(u_{it}) < 0$ and $g_i''(u_{it}) \geq 0$. Finally, we write the aggregate unemployment rate as $U_t = \sum a_i u_{it}$.

Suppose we take, as Brechling (1973) does, a simple but standard expectations-augmented Phillips curve of the Friedman–Phelps type:

$$\dot{w}_{it} = b_i x_{it} + k_i \dot{P}_t + c_i \left(\dot{w}_{it}^e - k_t \dot{P}_t^e \right), \tag{1}$$

so that a single price rules in the union's product markets, but differences in wages can remain between regional or sectoral labor markets. The Phillips curves themselves will become vertical in the long run if wages fully adjust to any price increases, that is, if $c_i = 1$. Nordhaus (1994) maintains that this specification captures the essence of modern inflation theory.

Now, the system of short-run Phillips curves can be written as

$$\dot{\boldsymbol{w}}_t = B\boldsymbol{x}_t + \boldsymbol{k}\dot{P}_t + C\left(\dot{\boldsymbol{w}}_t^e - \boldsymbol{k}\dot{P}_t^e \right), \tag{2}$$

where B and C are $n \times n$ matrices and $\dot{\boldsymbol{w}}_t$, $\boldsymbol{x}_t$, and $\boldsymbol{k}$ are column vectors with typical elements $\dot{w}_{it}$, x_{it}, and k_i, respectively. If B and C are diagonal, then wages in each country are determined only by demand conditions and expectations in their own country or sector; there are no intercountry or intersectoral spillovers. However, that seems unlikely in a modern economy and no such restrictions will be imposed.

In the past, three different definitions of equilibrium in the aggregate labor market have been used [Brechling (1973)]. They are: (1) where each underlying market is (and is expected to be) in equilibrium individually; or (2) where the markets are in equilibrium in aggregate, so that excess demand in one place exactly balances excess supply in another and there are no net demand or supply forces to change the aggregate wage bargain; and (3) where the wage bargains in the different markets respond differently to the excess demand or supplies generated within those markets, *including* the excess demands or supplies that are created by spillovers from the imbalances in other markets, in such a way that the expected change in wages is zero on average.

At first sight, it might appear that Definition (1) is actually a special case of Definition (2). However, it is not. Definition (1) allows wages to adjust only to conditions in their own market, whereas Definition (2) allows them to respond only to conditions in the average of the markets, and Definition (3) allows wages in each market to adjust—differently in each case—to the pressures in each and every market (their own and others) such that, overall, the average adjustment is zero. In general, only in the last case, Definition (3), is there no expectation that average wages would change again. The markets as a whole can then be said to be in equilibrium, even if individually they are not.

Ambiguities arise, however, because the concept of a natural rate of unemployment remains undefined in all but the first definition of equilibrium given above. In the other two cases, there is an infinity of natural rates, each one associated with a different distribution of excess demands (and hence of wage increases) across the component markets.

3. ANALYSIS

Case 1. In our simplest definition of equilibrium, three conditions must hold:

(i) Expected wage changes in the ith component market must equal the actual wage changes in that market; hence $\dot{\boldsymbol{w}}_t^e = \dot{\boldsymbol{w}}_t$ in every market.

(ii) Actual wage changes are fully adjusted to expected wage changes in every market; hence, $C = I$ in equation (2) above.

(iii) expected price changes must equal actual price changes, that is, $\dot{P}_t^e = \dot{P}_t$.

If these conditions are all satisfied, (2) collapses to

$$Bx_t = \mathbf{0}. \tag{3}$$

Hence, as long as B is invertible (i.e., wage bargains in any one labor market are not totally dependent on those in the other markets), this implies that excess demand in each and every market must be zero. The rate of wage increases is then undetermined but constant. Let u_{it}^* be the natural rate of unemployment,

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corresponding to $x_{it} = 0$. The aggregate unionwide natural rate of unemployment is then $U_t^* = \sum a_i u_{it}^*$. That measure is well defined. But unless $g_i(\boldsymbol{u}_t) = g_j(\boldsymbol{u}_t)$ for all i, j and some u_t, the underlying natural rates will all be different and the distribution of unemployment rates will influence the natural rate for the union.

Case 2. Definition 1 does not allow any differences in the excess demand pressures in different regional or national markets. This is extremely restrictive. For example, it is clear that unemployment varies widely across Europe—more widely in fact than across other comparable economies. Wage-change differentials have consistently reflected those differences. Blanchard and Katz (1992) make the same point about the size and persistence of the differences in demand and activity levels across U.S. regions. In other words, it is not reasonable to assume that all regions/countries will have the same excess demands for labor.

Our second definition of equilibrium would require expected wage changes in all regions/countries to equal the unionwide *mean* of the actual wage changes; that is, $\dot{w}_{it}^e = \dot{W}_t$ for all i. That replaces condition (i) in Case 1. Conditions (ii) and (iii) remain in place. In this setup, equation (2) reduces to

$$\boldsymbol{a}' B \boldsymbol{x}_t = 0 \quad \text{where} \quad \boldsymbol{a}' = (a_1 \ldots\ldots a_n) \tag{4}$$

since $\dot{W}_t = \boldsymbol{a}'\dot{\boldsymbol{w}}_t$. This condition can be satisfied by a large number of $\boldsymbol{x}_t$ vectors, and hence $\boldsymbol{u}_t^*$ vectors because the excess demands now only have to be zero on average. The natural rate of unemployment for the aggregate economy is therefore undefined. In fact, each different distribution of unemployment (excess demands for labor) within the aggregate equilibrium will imply a different natural rate of unemployment at the aggregate level.

Such an ambiguity can be resolved by finding the distribution of u_{it}^* values that leads to the minimum natural rate of unemployment at the union level. That is to minimize

$$U_t^* = \boldsymbol{a}'\boldsymbol{u}_t^* \quad \text{s.t.} \quad \boldsymbol{a}' B \boldsymbol{x}_t = 0 \quad \text{and} \quad x_{it} = g_i(u_{it}), i = 1 \ldots n. \tag{5}$$

In order to abstract from any additional effects when market interactions mean that excess demands/supplies will spill over from one market to affect wage fixing in another, we take B in Case 2 to be diagonal. In that case, the appropriate Lagrange function will be

$$L = \ldots a_i u_{it}^* + a_j u_{jt}^* + \cdots + \lambda\left[\ldots a_i b_{ii} g_i\left(u_{it}^*\right) + a_j b_{jj} g_j\left(u_{jt}^*\right) + \cdots\right].$$

Differentiating with respect to u_{it}^* and u_{jt}^* and eliminating λ then yields the necessary conditions for a minimum as

$$b_{ii} g_i'\left(u_{it}^*\right) = b_{jj} g_j'\left(u_{jt}^*\right) \quad \text{for } i, j = 1 \ldots n. \tag{6}$$

Thus, if the marginal impact of an extra unit of unemployment, and hence of an extra unit of excess supply or demand, on wage determination is the same in every market (i.e., if $b_{ii} = b_{jj}$ and $g_i'(u_{it}) = g_j'(u_{jt})$, for all i and j), then equation (4)

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implies zero excess demand in every market[2]; and a *unique* minimum natural rate of unemployment at the union level exists when there is a zero dispersion of regional/national unemployment rates around their natural rates. This will hold if all regions/countries have identically sloped long-run Phillips curves. That implies some convergence in structures, at least as far as wage bargaining procedures and labor immobility are concerned.

More generally, however, the natural rate will depend on how unemployment is distributed across regional and national markets, with some distributions implying a higher overall natural rate than others. There will still be a unique *minimum* natural rate for the union, but whether that has any relevance for judging performance and the need for policy interventions depends on whether governments actually take the steps necessary to generate the exact unemployment distribution that will yield that minimum natural rate. If they do not, then both the observed and the target natural rates will be higher than they need to be.

Case 3. Assuming B to be diagonal and that the Phillips curves have identical slopes is still very restrictive. We need to consider the case in which both wage settlements and the expected settlements react to supply and demand pressures in all markets. Then, wages in region i may rise even when there is zero excess demand in region i, either because there is excess demand in region j that spills over into region i, or because wages are rising in region j and therefore are *expected* to rise in region i. The former implies a nondiagonal B, and the latter that expected wages adjust toward a linear function of some or all actual wage changes; that is, wage linkages $\dot{\boldsymbol{w}}_t^e = H\dot{\boldsymbol{w}}_t$, where H is a nondiagonal matrix. Combining both generalizations with $C = I$ and $\dot{P}_t^e = \dot{P}_t$ from conditions (ii) and (iii) of Case 1, equation (2) is reduced to

$$\dot{\boldsymbol{w}}_t = DB\boldsymbol{x}_t \quad \text{and} \quad \dot{W}_t = \boldsymbol{a}'DB\boldsymbol{x}_t, \tag{7}$$

where $D = (I - CH)^{-1}$ is nondiagonal and nonsingular even if $C = I$, i.e. *even when* the underlying Phillips curves are all vertical.

Once again, there may be many natural rates of unemployment for the aggregate economy that are consistent with a constant level of wage changes, each one corresponding to a different distribution of unemployment rates across the component markets. So we face the same undefined natural rate of unemployment problem as before, but with the additional feature that there is now a trade-off between the rate of aggregate unemployment and the average rate of wage changes. Hence, even *long-run* Phillips curves with fully accommodated expectations are downward sloping after aggregation, whatever the slopes of the underlying regional or sectoral Phillips curves.

Indeterminacy in the natural rate can still be resolved by picking the unemployment distribution that minimizes

$$U_t^* = \boldsymbol{a}'\boldsymbol{u}_t^* \quad \text{s.t.} \quad \dot{W}_t = \boldsymbol{a}'DB\boldsymbol{x}_t \quad \text{and} \quad x_{it} = g_i(u_{it}), i = 1 \ldots n. \tag{8}$$

The corresponding Lagrange function is

$$L = \ldots a_i u_{it}^* + a_j u_{jt}^* + \cdots + \lambda \left[\dot{W}_t \cdots - \sum b_{ik} g_k \left(u_{kt}^* \right) - \cdots \right]$$
$$\times \left(\sum a_k d_{kj} \right) \left[\sum b_{jk} g_k \left(u_{kt}^* \right) \right].$$

This time differentiating with respect to u_{it}^* and u_{jt}^* and eliminating λ yields the necessary conditions as

$$a_i \left(\sum a_k d_{kj} \right) \left[\sum b_{jk} g_k' \left(u_{kt}^* \right) \right] = a_j \left(\sum a_k d_{kj} \right) \left[\sum b_{ik} g_k' \left(u_{kt}^* \right) \right] \qquad \textbf{(9)}$$

for $i,\ j = 1 \ldots n$. However, because of the presence of the terms involving d_{ki} and d_{kj}, the minimum natural rate will not emerge when each individual market has zero excess demand *even* when all of the Phillips curves are identical and do not interact [i.e., $b_{ii} = b_{jj}$, $b_{ij} = 0$ if $i \neq j$, $g_i'(u_{it}) = g_j'(u_{jt})$], and certainly not if they are all different in slope. Whether that is of any importance again depends on whether the governments concerned actually take the steps necessary to achieve it by generating an appropriate distribution of unemployment rates. If they do not, the natural rates will be higher than they need to be.

3.1. Interpretation

Equation (9) shows that those markets with strong positive spillover effects or strongly positive demonstration effects (i.e., large $b_{ik} > 0$ and large $\sum a_k d_{ki}$ values, respectively) need to have higher unemployment rates [i.e., low $g_{k'}(u_{kt}^*)$ values] if the aggregate natural rate of unemployment is to remain at a low value. However, there is no obvious reason to suppose that the governments involved would ever agree to that pattern of demand across their markets, or that they could necessarily arrange to deliver such a pattern even if they wanted to. It would, for example, require Germany to run relatively high rates of unemployment in order to keep unemployment low elsewhere in Europe, and, to a lesser extent, that California and the Northeast should do the same for the United States as a whole. That is asking too much of altruism.

4. TWO SPECIAL CASES

In this section we consider two examples in which Case 3 applies, and where the aggregate Phillips curves are not vertical in the long run.

4.1. Models of Mismatch

One of the most influential models of the interaction between wages, prices, and unemployment is the labor market model of Layard et al. (1991).[3] It is also one of the few that has been used to show that mismatch (an unequal distribution of unemployment rates) affects the equilibrium rate of unemployment.

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However, it has not been shown that mismatch *also* affects the slope of the trade-off between wages and unemployment (or indeed between wage or price inflation and unemployment).[4] That has led to the impression that mismatch is really only an empirical issue. If that were true, the issue would be straightforward: how much would the natural rate fall if mismatches were resolved? However, once the slope of the Phillips curve is affected as well, we enter a quite different world, in which Phillips curves in economies with heterogeneous labor markets cannot remain vertical. Such an observation would change the theoretical underpinning of our most popular economic models, and the policy prescriptions associated with them.

The general form of the mismatch model has the wage level in region or sector i as a convex function of the level of unemployment in the same region/sector:

$$\begin{aligned} \log w_i &= \gamma_{0i} + \gamma_1 \frac{\left(1 - u_i^{\lambda}\right)}{\lambda} \qquad -\infty < \lambda \leq 1 \\ &= k_{0i} - k_i u_i^{\lambda} \quad \text{where} \quad k_1, \gamma_1 > 0,\ i = 1 \ldots n, \end{aligned} \tag{10}$$

and λ determines the degree of convexity in a transformation of some general nonlinear function $g(u)$ [Layard et al. (1991, p. 311)]. The limits on λ ensure that wage responses are at least weakly convex: $\lambda = 1$ implies proportionality (linearity), $\lambda = 0$ implies constant curvature (a log response), and $\lambda \to -\infty$ implies increasing wage rigidity around γ_{0i}. This wage equation therefore implies that

$$\sum a_i \log w_i = \sum a_i k_{0i} - k_1 \sum a_i u_i^{\lambda}. \tag{11}$$

However, approximating each $\log w_i$ around the aggregate or mean wage level, $W = \sum a_i w_i$, and summing over i, yields

$$\sum a_i \log w_i \cong \log W - \frac{1}{2}\frac{\sigma_w^2}{W^2}, \tag{12}$$

where $\sigma_w^2 = \sum a_i (w_i - W)^2$ is the dispersion of wages around their aggregate level. Similarly expanding u_i^{λ} around the aggregate rate of unemployment,

$$\sum a_i u_i^{\lambda} \cong U^{\lambda} + \frac{1}{2}\lambda(\lambda - 1)U^{\lambda-2}\sigma_u^2, \tag{13}$$

where σ_u^2 is the corresponding dispersion of the unemployment rates around their mean. Substituting (12) and (13) into (11), and taking derivatives, now implies

$$\frac{dW/W}{dU} = -\gamma_1 U^{\lambda-1}\left[1 + \frac{1}{2}(\lambda - 1)(\lambda - 2)\frac{\sigma_u^2}{U^2}\right] \Bigg/ \left(1 + \frac{\sigma_w^2}{W^2}\right). \tag{14}$$

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That yields one particular form of equation (2)[5] if σ_u^2 and σ_w^2 do not change in the short term. Thus $(dw/w)/du$, the slope of the aggregate Phillips curve, is negative and finite for *any* value of $\lambda \leq 1$ as long as $U \neq 0$. In fact, we can rewrite (14) as

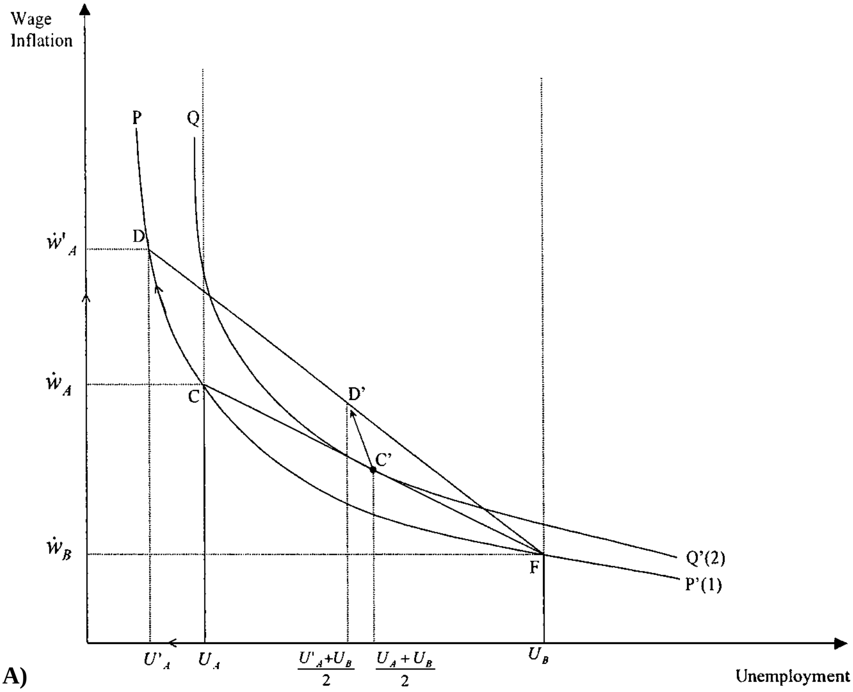
$$\frac{dW/W}{dU} = -\gamma_1 U^{\lambda-1} \frac{\left[1 + \frac{1}{2}(\lambda - 1)(\lambda - 2)c_u^2\right]}{\left(1 + c_w^2\right)} < 0, \qquad \textbf{(15)}$$

where c_u is the coefficient of variation from the distribution of unemployment rates, and c_w is the coefficient of variation from the wages distribution. Hence, in this world, the aggregate Phillips curve is never vertical. Its slope is an *increasing* function of mismatch, σ_u^2, but a *decreasing* function of the disparity in wage levels.[6]

In fact, equation (15) shows that the slope of the aggregate Phillips curve becomes steeper with increasing values of c_u, but flatter with c_w. In other words, the effect of mismatches in the labor market is stronger than variations in the average level of wages or unemployment, although rising wage inequalities (or lower wage levels) could be used to redress the difficulties caused by either. This is an important result. It says that managing the *distribution* of aggregate demand is more important than managing the *level* of aggregate demand: Movements in the Phillips curve are more effective than movements up or down it. However, increasing wage rigidities, both relative and absolute, will always reduce the effectiveness of either policy.

4.2. A Demand Expansion Example

Suppose we have two identical economies, A and B, of equal size but without migration between them. They form a union, so that the same price level holds in each. They also have two identical short-run Phillips curves, drawn as PP′ in Figure 1. Figure 1 is divided into four panels, 1A–1D, corresponding to the initial position and the three stages in the adjustment process following any changes in the individual markets. We assume convexity as usual; and that, for some institutional reason, country A has chosen a lower unemployment rate and a higher rate of wage inflation than country B. Hence, we start with $\dot{w}_A > \dot{w}_B$ and $U_A < U_B$: points C and F in Figure 1A, respectively. Those differences may reflect the asymmetric effects of monetary policy or differences in preferences. They are not important in themselves. But convexity is important because a unit reduction in unemployment at U_B will create a *smaller* increase in wages than a unit reduction in unemployment at U_A. Convexity also implies that the short-run Phillips curve for the aggregate economy lies above that for the two individual economies because the point $C' = [(\dot{w}_A + \dot{w}_B)/2, (U_A + U_B)/2]$ lies on the aggregate curve QQ′, above the national curves PP′. In fact, the aggregate curve is distinct from the average curve to the extent that the second and higher moments are important in the unemployment distribution, because $E[g(u)] \neq g[E(u)]$; see Demertzis and Hughes Hallett (1998) for an explicit analysis.



A)

Figure 1. This diagram shows a nonintersecting set of short-run Phillips curves, arranged in ascending order of expected inflation rates [Friedman (1977)] and ascending orders of unemployment inequalities [Demertzis and Hughes Hallett (1998)]. It produces one long run curve. Curve 1, PP′, represents the short run curves for countries A and B; curve 2, QQ′, the initial aggregate Phillips curve for the union (i.e. when U_A and U_B are the national natural rates of unemployment); and curve 3, QQ′, the intermediate aggregate Phillips curve (i.e. while A is adjusting, but B has not started). Point D′ lies at the tangency between the new aggregate Phillips curve 3 and DF; point E′ at the corresponding point of tangency with EF; point F′ at that with EG; and H′ at that with EH. The long run Phillips curve is therefore traced out by points C′, H′ etc.

Now suppose country A expands demand. The adjustment process has three stages. First, unemployment will fall, and wages will rise in country A. We go from C to D on country A's Phillips curve (Figure 1A). Wages and unemployment in the union (Europe) therefore go from C′ to D′, these changes being only half the size because nothing has happened in country B. That implies a new aggregate Phillips curve, RR′, shifted upward and outward by the greater disparity in unemployment rates (Figure 1B). However, in the longer run, this increase in $\dot{w}_A$ will increase prices for all. In fact, if country A's prices fully accommodate wage increases, $\dot{p}_1 = 1/2\dot{w}_A$.[7] This shifts country A's short-run Phillips curve up in the usual way. We go from D to E, and a further outward shift from D′ to E′ for Europe as a whole (Figure 1B).

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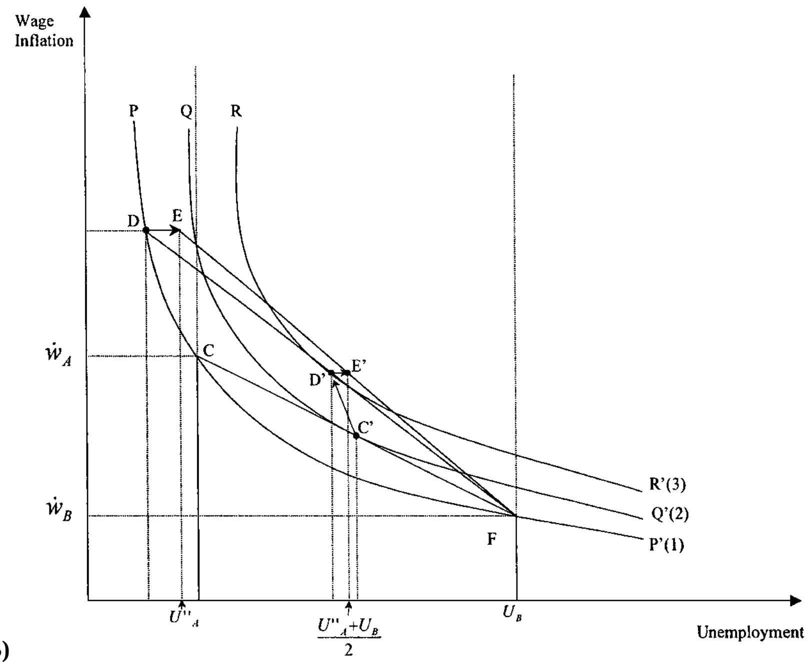
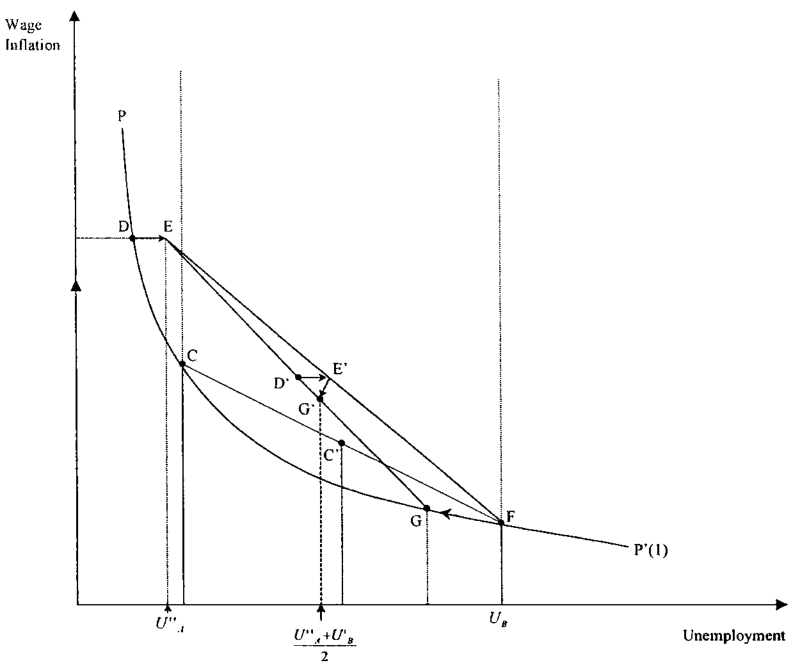


B)



C)

Figure 1. (Continued.)

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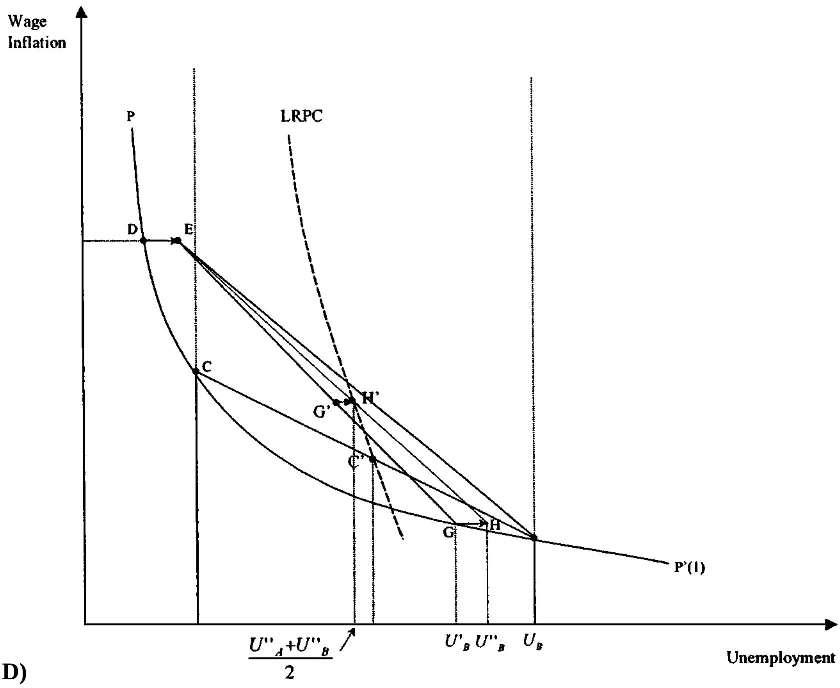

D)

Figure 1. (Continued.)

Until now, country B's short-run Phillips curve has remained unaffected. However, real wages will have fallen in country B, while they have returned only halfway to their original value in country A. The second stage therefore starts with some demand being transferred from A to B—a portion of the original expansion in fact. Hence, unemployment falls in B. This fall in unemployment will trigger some rise in $\dot{w}_{\mathrm{B}}$, and we get to G and G′, respectively, in Figure 1C. However, the price rises triggered by the expansion in country A (i.e., $\dot{p}_1 = 1/2\dot{w}_{\mathrm{A}}$) need to be accommodated as well. This starts a third stage of adjustment. However, because the domestically generated part of the increase in country B's wages will be smaller than would have appeared in country A had the same change in unemployment occurred there (we are on a flatter part of the PP′ curve), the wage rises in B will be smaller than those in A—even if all the price increases are fully accommodated. This means that we get further economywide price increases, but also smaller than before: $\dot{p}_2 = 1/2\dot{w}_{\mathrm{B}} < \dot{p}_1$. Consequently, at the end of this round of adjustments, the increase in real wages is smaller in country B than it was in country A—and the increase in real wages in A, although reduced, is still higher (and unemployment lower) than before the original expansion. Hence, some of the extra demand that was originally created in A, and then transferred to B, will be retained in B.[8] We therefore go from G and G′ to H and H′ in Figure 1D. And, even if these latest

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price rises trigger a second round of wage increases in country A (and in this model they will, starting the whole process off again), each round will leave a *net* gain in real wages in A and a *net* fall in unemployment in B. Thus, real wages in B, although not falling, will rise slower than in A; and unemployment in A, although now rising, will not return all the way to its starting point.

In other words, the redistribution of the original expansion, from A to B, takes some of the price pressure off country A, and produces correspondingly smaller cost pressures (rises in real wages) in country B. This reallocation of demand therefore allows us to reach a lower natural rate of unemployment, for the economy as a whole, than we had before. So, while nominal wage rates have risen, unemployment has fallen in aggregate. Figure 1 summarizes one round of adjustments. The A part of the process is to go from C to E via D; the B part is then to go from F to H via G. This implies that the economy as a whole goes from E′ to H′ (via D′, E′, and G′ according to our sequencing). That implies an upward-sloping aggregate Phillips curve.

5. CONCLUSIONS

This paper has established four things:

(1) The minimum natural rate of unemployment is a well-defined criterion for measuring the inefficiencies in labor market behaviour—whether those inefficiencies are caused by policy failures, structural differences in the natural rates, or cyclical divergence.

(2) Phillips curves cannot be vertical in general. This follows from the aggregation of the underlying (national, regional, sectoral) curves, wherever there are structural differences either between different labor markets, or in their reactions to changes in and spillovers from other markets. This holds true even if the underlying Phillips curves are vertical—indeed we have imposed that in this paper.

(3) Hence, there is still a role for managing the *distribution* of demand, even if the level of aggregate demand is not an explicit target of policy.

(4) Because governments will not have taken conscious steps to generate exactly the distribution of excess demands (unemployment) across sectors or regions that gives the unique minimum natural rate within their own economies—let alone across an emerging union of economies—the actual natural rates usually will be higher than they need to be by an amount that varies systematically with the distribution of actual unemployment or activity levels.

NOTES

1. Not that there should have been any such presumption. Fischer (1996) cites a long list of studies that have found long-run Phillips curves which are not vertical at comparatively low inflation rates—conventionally defined as inflation at less than 8% per year. The OECD economies certainly lie within that boundary at present.

2. This holds because $g'(u_{it}) \leq 0$, and $a_i > 0$, for all i and t.

3. Other models that consider mismatch effects are those of Archibald (1969), Johnson and Blakemore (1979), and Demertzis and Hughes Hallett (1998).

4. See Layard et al. (1991, pp. 47, 311–315, 550).

5. We get this result by substituting for the first term of (2) using (14), where $\mathbf{x} = g(\mathbf{u})$ is evaluated around the current values of U and W.

6. In fact, the only case in which mismatch has no impact on the inflation–unemployment trade-off is when the underlying wage functions are all linear ($\lambda = 1$).

7. Assuming a constant markup in each economy. Earlier we also had assumed two identical economies with a single market and perfect arbitrage between perfectly tradable goods.

8. The argument here is essentially that inflation is a beggar-thy-neighbor phenomenon within the union because firms in a single market will expand investment and output where real wages are relatively low, and contract output where they are relatively high. If real wages rise and fall by different amounts in different places, then there can be a net gain (as in this case). Thus, the aggregate Phillips curve will not be vertical in the long run as long as some labor immobility restricts different economies to different regions of their nonlinear short-run Phillips curves.

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