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TWO TOOLS FOR ANALYZING UNEMPLOYMENT

Olivier Jean Blanchard

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This paper was prepared for the Congress of the International Economics Association, September 1989. An earlier version of this paper was presented at the Congres de la Societe Canadienne de Sciences Economiques, May 1989. As will be clear, this paper is the outgrowth of joint work with Peter Diamond, although he bears no responsibility for the contents. I thank Hugh Courtney and Juan Jimeno for research assistance, Katharine Abraham for leading me to data on German vacancies, Ken Arrow, Pierre Fortin, Richard Layard, Robert Solow and Larry Summers for comments. This paper is part of NBER's research program in Economic Fluctuations. Any opinions expressed are those of the author not those of the National Bureau of Economic Research.

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ABSTRACT

This paper shows how one can interpret the joint movements of wages, unemployment and vacancies in the Phillips and Beveridge spaces to learn about the origins of the movements in unemployment. The view of the labor market underlying the conceptual framework emphasizes flows, matching, and Nash bargaining determination of wages. The approach is used to analyze the movements in unemployment in the US, in the UK and in Germany over the last twenty years.

Olivier Jean Blanchard
NBER and
MIT
50 Memorial Drive
Cambridge, MA 02139

1. Introduction

Labour markets in developed economies are characterised by large flows of workers, continual job creation and job destruction. This is true of the USA where, on average, 7 per cent of the labour force goes in or out of employment each month. And it is also true of Western Europe. Even during the depressed 1980s, the monthly movement in and out of unemployment has been equal on average to 4 per cent of the labour force in the UK, 2.5 per cent in France and 2 per cent in Germany[1].

Peter Diamond and I have embarked on a research program designed to understand the macroeconomic implications of this fact. In the process of thinking about the functioning of markets with large flows, we have come to the conclusion that, in identifying the source of movements in unemployment, the joint use of two simple tools is extremely useful. The tools are the oldest of the trade, the Beveridge curve and the Phillips curve. Each contains important information ; but it is in combination that they are most useful[2]. This is the theme I want to develop here. I shall do this first by sketching a conceptual framework in which one can interpret both curves, and then by applying the tools to US, UK and German unemployment over the last 20 years.

2. The Sketch of an Economy with Large Flows

Let me sketch a simple model of an economy with large flows, in which one can interpret movements in the Beveridge and Phillips curves[3].

Think of an economy in which changes in relative demand, in comparative advantage and in technology lead to a permanent state of flux, with continual job creation and

job destruction. If all jobs were in the same place and required the same skills, the reallocation of workers would take place without the coexistence of vacancies and unemployment. But they are not. Workers need to learn new skills, to relocate, to find the right match. And, thus, the matching process takes time, leading to the coexistence of jobs looking for workers -vacancies- and workers looking or at least available for jobs -unemployment. The right image here is not, at least for the major industrialised countries, one of an ineffective matching process, but instead of a very effective one: while some workers and some jobs have a hard time finding a match, the flow of hires is large compared to the stocks of vacancies and unemployed workers.

How should one think of wage setting in such an economy? While wage scales, collective bargaining and other legal and institutional restrictions on bilateral bargaining surely play an important role, I want to abstract from those factors and focus on the implications of bilateral bargaining. Thus, think of wages being determined by bilateral bargaining, with the surplus from a match being divided in some proportion between the firm and the worker. Those assumptions imply that wages will move with productivity and with unemployment benefits. And, more importantly here, those assumptions imply that wages will move with market conditions, the crucial variable being the ratio of vacancies to unemployment. Why is this? This ratio can also be interpreted as the ratio of the average duration of a vacancy to the average duration of unemployment[4]. As the ratio increases, turning down a match to wait for the next one becomes more costly for firms, less costly for workers ; the workers are therefore in a stronger bargaining position and thus are able to extract a higher wage.

Having sketched the general workings of the economy, we can now turn to the curves.

3. The Two Curves : Finger Exercises

Were the intensity of reallocation, the effectiveness of matching, the level of demand and so on to remain constant, the economy would be in a steady state: the flow of workers through the labour market would be high but approximately constant, unemployment would coexist with vacancies, and the wage would reflect the ratio of unemployment to vacancies. All those things change however, leading to movements in wages, vacancies and unemployment, thus movements in the Beveridge and the Phillips spaces.

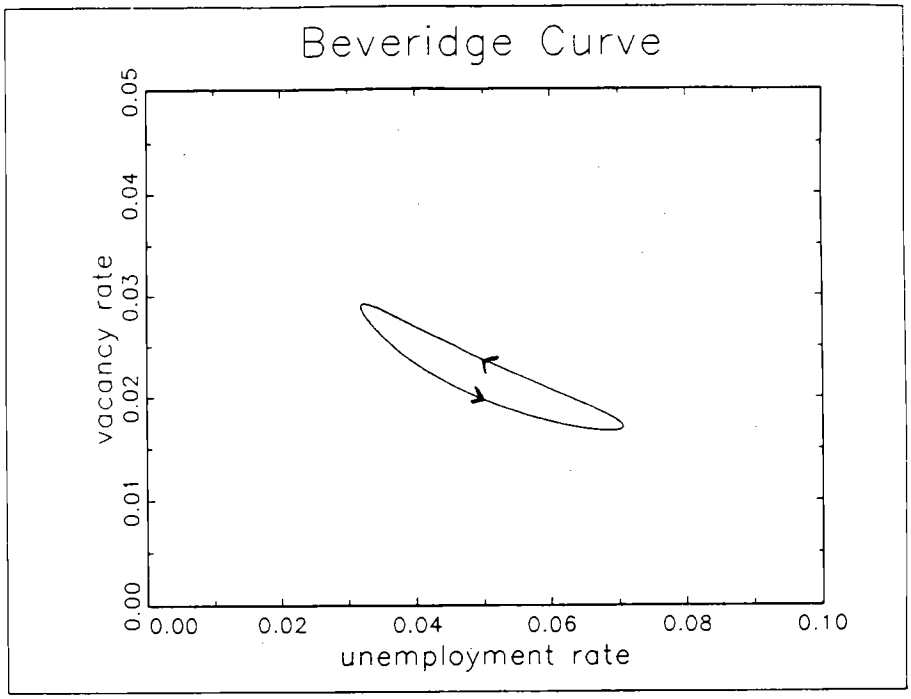
The time has come to bite one bullet: clearly, the approach that I have just sketched characterises the relation between the real wage and unemployment, not between inflation -or its rate of change- and unemployment as depicted in the Phillips curve. We -I mean the profession- know more or less how to go from one specification to the other, by assuming for example that wages in new matches are set in nominal terms for the expected duration of a match, and then by having firms markup prices over wages adjusted for productivity[5]. I have started exploring those issues in this context but shall ignore them here, as it would take me too far from what I want to focus on. I shall do the analysis in terms of real wages, but then look at the empirical Phillips curves with a measure of the change in inflation --which I shall define later-- rather than real wages on the vertical axis.

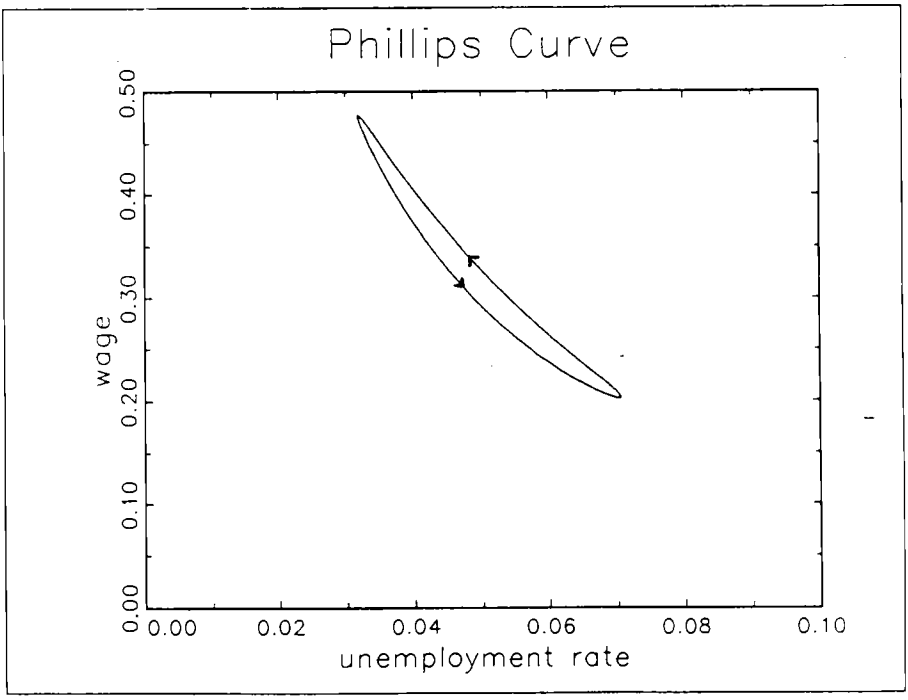
It is traditional to think of movements in unemployment and vacancies as coming primarily from changes in aggregate activity. At certain times, aggregate demand increases, leading to faster job creation and slower job destruction. At other times,

aggregate demand contracts, leading to slower job creation and faster job destruction. An expansion thus leads to an increase in new vacancies and a decrease in the flow of workers into unemployment. As time passes, unemployment decreases, vacancies increase, and both lead to an increase in the wage. The reverse happens in a recession. Figure 1 shows the Beveridge and Phillips curves traced by a simple sine wave in aggregate demand in the formal model underlying our argument, roughly calibrated to fit basic US numbers. The Beveridge curve is not a curve but rather looks like a banana, with counterclockwise movements of unemployment and vacancies. The thickness of the banana depends on the length of the cycle : the longer the economy takes to go from peak to trough, the thinner the banana. The Phillips curve is also not quite a curve, but rather a counterclockwise loop. Both of these counterclockwise movements were indeed noted by early practitioners of those curves.

While changes in aggregate activity may be the prime movers of unemployment and vacancies, macroeconomic events of the last 15 years have made it clear that many other factors are also at work. The graphs of empirical Phillips and Beveridge curves below will also make this abundantly clear. Many factors may shift one or/and the other curve. The first class of factors I want to think about can be called reallocation factors. By this I mean changes in either reallocation intensity or in the effectiveness of the matching process. That such changes could explain a good part of the movement in unemployment even in the US was argued by Lilien (1982) and has been the subject of much debate since. The role of both reallocation intensity and effectiveness is also at the centre of discussions of European unemployment. The case for such shifts is prima facie a strong one. Davis and Haltiwanger (1989) have

figure 1


Beveridge Curve
vacancy rate
0.00
0.01
0.02
0.03
0.04
0.05
0.00
0.02
0.04
0.06
0.08
0.10
unemployment rate

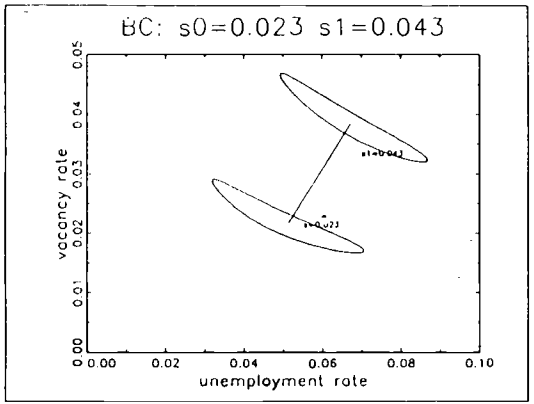

Phillips Curve
wage
0.00
0.10
0.20
0.30
0.40
0.50
0.00
0.02
0.04
0.06
0.08
0.10
unemployment rate

recently shown by looking at changes in employment at the plant level in the US that cyclical variations in the flows of job creation and destruction are small in comparison to average flows. Even during the 1982 demand recession, job creation remained high, of the order of 4 per cent per quarter. Thus, small relative changes in the intensity of reallocation may have substantial effects on unemployment.

How do these reallocation factors affect the curves? Suppose that a faster pace of technological change, or of international specialisation lead to an increase in reallocation intensity, thus to both higher flows of job creation and higher flows of job destruction. In sharp contrast to cyclical movements, both unemployment and vacancies increase, reflecting the higher flows of laid off workers and of newly created jobs. Or suppose instead that the matching process becomes less effective, for example because the average distance, either purely geographic or in terms of skills, between job creation and destruction is larger. In that case, an unchanged flow of workers is associated with longer duration of both vacancies and unemployment, thus higher levels of unemployment and vacancies. In both cases, increased unemployment is unlikely to lead to a wage decrease, as it is associated with increased vacancies, and a roughly unchanged ratio of unemployment to vacancies.

Figure 2 shows the shifts in the Beveridge and Phillips curves which result from increased intensity or decreased matching effectiveness in the formal model. In that simple model, both types of changes have the same dynamic effects on unemployment, vacancies and wages. The basic point is that <u>both</u> curves shift. At a given level of aggregate activity, both unemployment and vacancies increase, and at any given level of unemployment, the wage will be higher because vacancies are higher, in sharp contrast to cyclical movements.

Figure 2



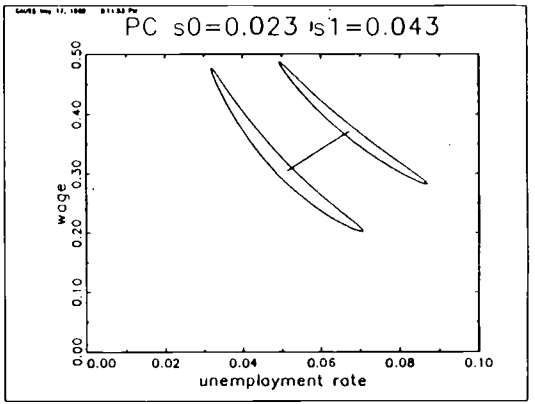
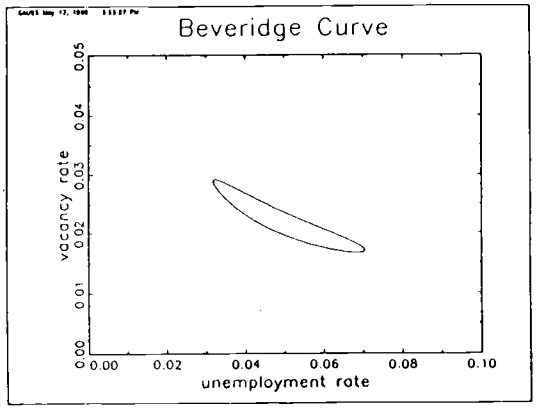
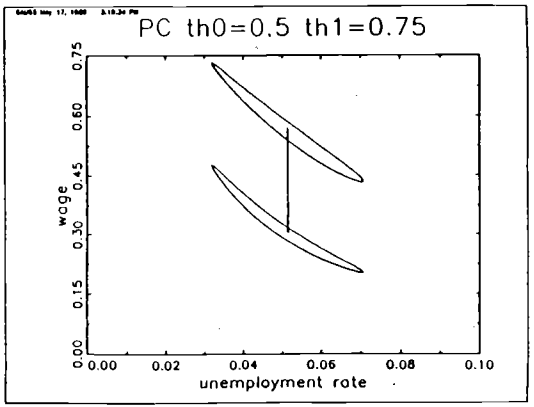


Figure 3





There is another class of factors which may affect unemployment, those factors which lead firms or workers to extract -or to try to extract- a larger part of the product of their match. I shall call them bargaining factors. In our formal model, the simplest such factor is an increase in the share of the surplus from a match going to the worker. Such a change increases the wage given unemployment and thus shifts the Phillips curve. But, to a first approximation, it does not shift the Beveridge curve. The "first approximation" caveat is needed: the change in the wage may affect the intensity of search, the supply of new jobs over time and so on. There are many other factors, which are likely to shift the Phillips curve and do not affect the the Beveridge curve very much. The list is a familiar one from the work on the potential causes of high unemployment. Any change in market conditions for their products which lead firms to increase their markup over wage costs, because of increased monopoly power for example, will also lead to more inflation given unemployment and vacancies, without obvious implications for the Beveridge curve. So will misperceptions of productivity, of the available surplus, something likely to happen after a slowdown in productivity growth for example. In all those cases, the "first approximation" caveat is again obviously needed: a slowdown in productivity growth may be associated with more -less?- required reallocation. Figure 3 shows the effects of an increase in the share of the surplus on wages and unemployment. The figure is thoroughly unexciting, but makes the basic point: only the Phillips curve shifts.

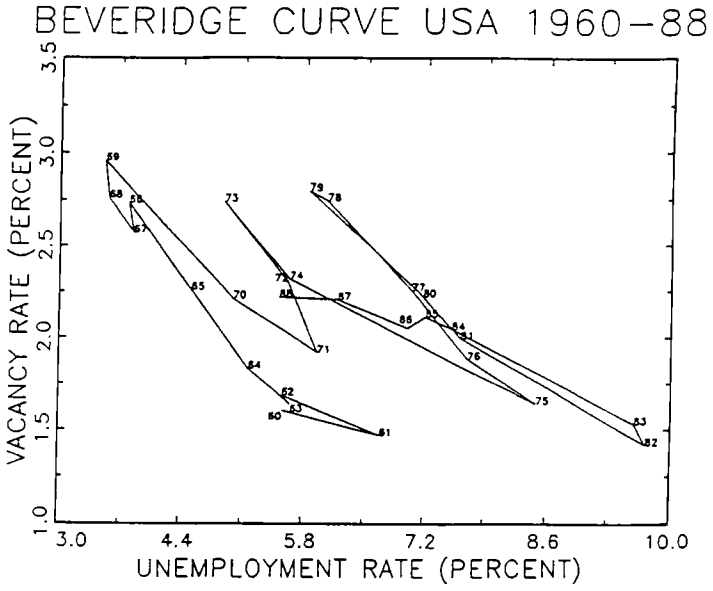
This suggests a simple empirical strategy. Look at the Beveridge and Phillips curves. Look at whether the economy is moving along those curves, or whether the

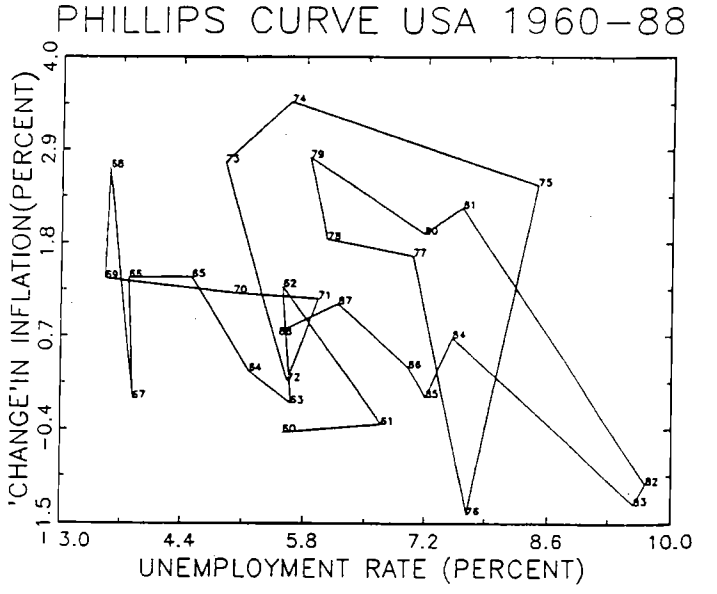
curves are shifting instead. If they are shifting, look at whether both or only one are shifting. This points to the nature of the shock[6].

4. A Simple Application : The US

Figure 4 gives the Beveridge and Phillips curves for 1960-1988 in the USA. A word about the data. The USA has no vacancy series, and thus I use for vacancies the Conference Board Help Wanted Index, as adjusted by Abraham (1987); it is my impression, based in part on how useful the series turns out to be in empirical work, that the series is in fact a better proxy for vacancies than many of the vacancy series published for other countries. In the Phillips curve, the variable on the vertical axis is $\pi_t - .8\pi_{t-1}$, where π is inflation measured using the GNP deflator[7]. I have chosen the number .8 as it is roughly the estimated first order serial correlation coefficient of inflation during this period. I shall call the variable on the vertical axis "change in inflation" for short. But keep in mind that the name is not quite right.

The picture given by the Beveridge curve is fairly clear. One can see large swings along a downward sloping locus, as one would expect from movements in aggregate activity. But there is also evidence of shifts to the right, from 1970 to 1982, and nearly all the way back to the left since 1982. The picture given by the Phillips curve is not as clean. 1974 and 1975 stand out, no doubt due to the increase in the price of materials and energy. But one can also see the inverse relation between inflation and unemployment. Again there is evidence of a shift to the right until the early 80's, and of a shift to the left since then. Thus the fact that both curves


BEVERIDGE CURVE USA 1960–88
VACANCY RATE (PERCENT)
UNEMPLOYMENT RATE (PERCENT)
3.5
3.0
2.5
2.0
1.5
1.0
3.0
4.4
5.8
7.2
8.6
10.0


PHILLIPS CURVE USA 1960–88
'CHANGE'IN INFLATION(PERCENT)
UNEMPLOYMENT RATE (PERCENT)
4.0
2.9
1.8
0.7
-0.4
-1.5
3.0
4.4
5.8
7.2
8.6
10.0

shift together over the period points to shifts in reallocation effectiveness or intensity as the main reason for the increase and more recently the decrease in the non inflationary rate of unemployment.

Let me give a slightly more formal assessment. The right way of using the information on vacancies, unemployment and inflation would be to assume that the joint process for those three variables results from the dynamic effects of three types of shocks, namely cyclical, reallocation and bargaining shocks, and then to use econometrics to recover the shocks and their dynamic effects. This is the approach Diamond and I have followed in an earlier paper to decompose movements in the Beveridge curve (1989a). I shall use here a dirtier, but simpler and more visual one. If we ignore the thickness of the Beveridge and Phillips loops in response to changes in aggregate activity and assume that shocks to aggregate activity lead to movements along downward sloping loci in both the Beveridge and Phillips spaces, we can recover these loci, and then measure and compare the shifts in both curves. If the shifts are similar, this points to reallocation factors. If they are not, this points to bargaining factors.

The approach suffers from one problem: how does one know the slopes of the loci traced by movements in aggregate activity ? Let me avoid that difficulty by estimating the slopes and the shifts in two different, extreme, ways. Hopefully, the truth is somewhere in the middle[8].

In the first, I estimate the slopes of both curves and the shifts by regressing the logarithm of the unemployment rate on inflation, and the logarithm of the unemployment rate on the vacancy rate; I then compare the two series of residuals. This assumes

implicitly that the shifts lead to movements in unemployment, with no effect on either inflation or vacancies. The two regressions give, using annual data for 1960 to 1988 :

$$\text{logu} = 0.04 \underset{(-1.9)}{-7.18} (\pi - 0.8\pi(-1)) + \epsilon_{pc} \qquad R^2 = 0.11 \qquad DW = 0.38$$

$$\text{logu} = 2.4 \underset{(-4.6)}{-0.85} \text{logv} + \epsilon_{bc} \qquad R^2 = 0.44 \qquad DW = 0.14$$

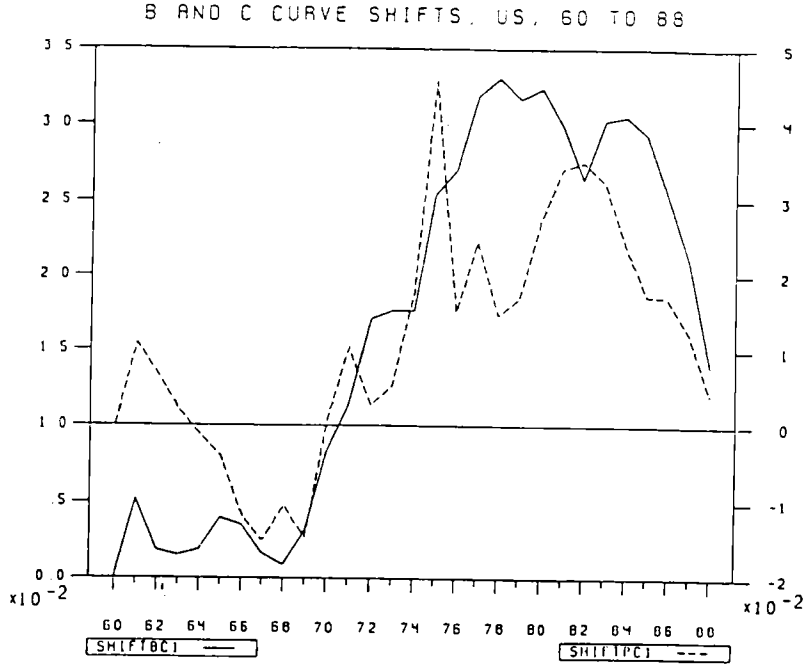
where u and v are the unemployment and vacancy rates, and π is inflation using the GNP deflator. The two series of residuals, the estimated shifts, are plotted in the top panel of figure 5. They clearly move very much together, both on the way up and, since 1982, on the way down. Their correlation is equal to 0.82. At face value, this is a strong evidence for reallocation shifts.

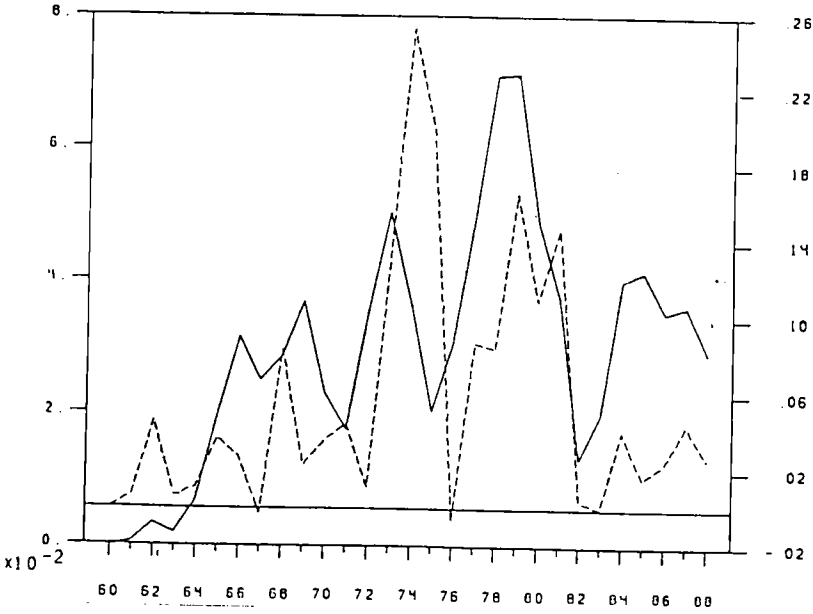
There is however one obvious potential problem with this set of regressions: to the extent that the relation between unemployment and either vacancies or inflation is weak --and indeed it is not very strong, as the R^2's indicate-- the residuals will closely track unemployment, which is the left hand side variable in both equations. Thus, by construction, they will be highly correlated. This suggests trying the opposite strategy, that of running the regressions the other way, with unemployment as the right hand side variable. Those regressions give:

$$(\pi - \pi(-1)) = 0.04 \underset{(-1.9)}{-0.016} \text{logu} + \eta_{pc} \qquad R^2 = 0.11 \qquad DW = 1.5$$

$$\text{logv} = 1.65 \underset{(-4.6)}{-0.51} \text{logu} + \eta_{bc} \qquad R^2 = 0.44 \qquad DW = 0.38$$

These regressions assume that shifts affect inflation and vacancies, but not unemployment. The shifts are those movements in inflation and vacancies which can not be explained by movements in unemployment. The bottom panel of figure 5 gives the time


B AND C CURVE SHIFTS, US, 60 TO 88
3 5
3 0
2 5
2 0
1 5
1 0
.5
0 0
x10 -2
5
4
3
2
1
0
-1
-2
x10 -2
60 62 64 66 68 70 72 74 76 78 80 82 84 86 88
SHIFTBC]
SHIFTPC]


B AND C CURVE SHIFTS; US; 60 TO 88
8.
6.
4.
2.
0.
x10 -2
.26
.22
18
14
10
.06
02
- 02
60 62 64 66 68 70 72 74 76 78 80 82 84 86 88

series for the residuals (each multiplied by minus the inverse of the coefficient on unemployment, so that they have the dimension of shifts in terms of unemployment and are comparable to those in the top part of the figure). As they are uncorrelated by construction with unemployment, they do not look like those in the top part of figure 5. They are still however highly correlated : their correlation coefficient is equal to 0.53. Thus, even in this case, reallocation factors seem to be the main culprit behind the increase in the non inflationary rate of unemployment.

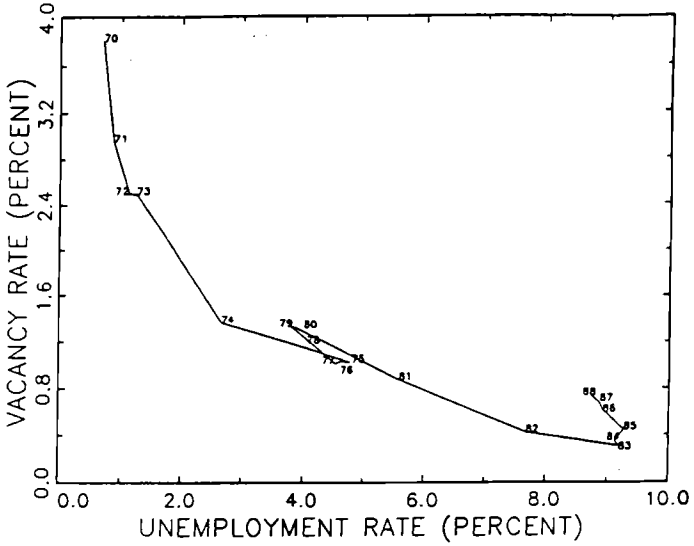
5. A Look at Western Europe

The big news on unemployment over the last 15 years has come not from the US but from Europe. Can we use the same approach there? I shall concentrate on two countries, Germany and the UK, over the period 1970 to 1988[9]. During that period, the German unemployment rate increased from 1 per cent to 9 per cent and now stands at 8 per cent; the UK unemployment rate increased from 2 per cent to 12 per cent and has decreased sharply over the last three years and is now under 7 per cent.

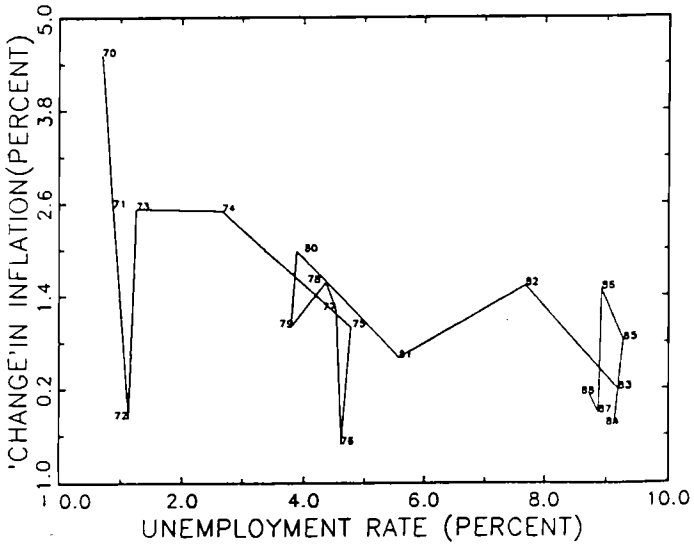
Figures 6 and 7 give Phillips and Beveridge curves for both countries. Following the same approach as above, the measure of inflation on the vertical axis, for both Germany and the UK, is $\pi_t - 0.7\pi_{t-1}$. The number 0.7 is roughly equal to the first order serial correlation coefficient of inflation over that period in both countries. The vacancy rate is constructed using registered vacancies series as published by the OECD. How reliable this measure of vacancies is depends on the relation of registered to total vacancies, and there is evidence of shifts in that relation over the sample period. Thus, when performing estimation below, I also use for Germany a series which incorporates a crude adjustment for changes in coverage of registered vacancies.

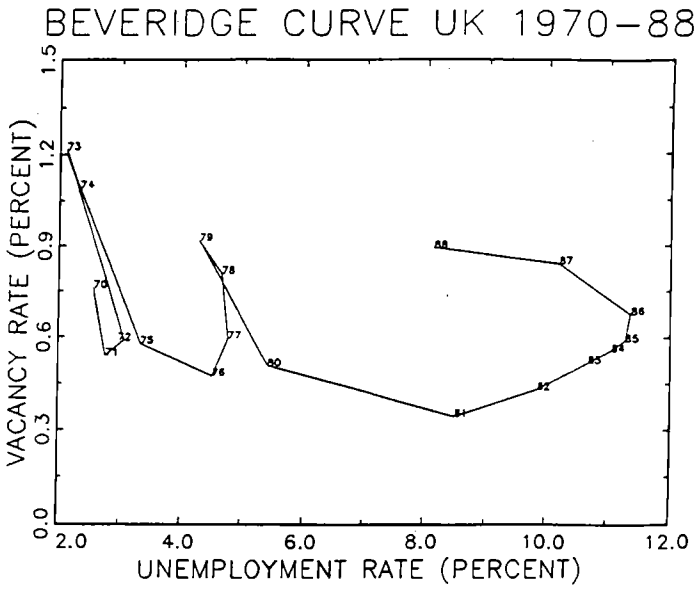
Figure 2

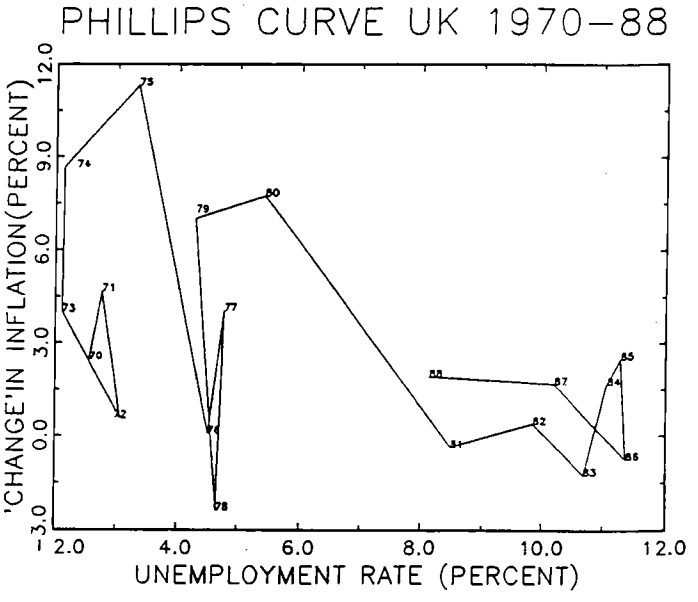
BEVERIDGE CURVE GERMANY 70–88



PHILLIPS CURVE GERMANY 70–88




BEVERIDGE CURVE UK 1970–88
VACANCY RATE (PERCENT)
0.0
0.3
0.6
0.9
1.2
1.5
2.0
4.0
6.0
8.0
10.0
12.0
UNEMPLOYMENT RATE (PERCENT)
73
74
79
78
70
72
71
75
77
76
80
81
88
87
86
85
84
83
82


PHILLIPS CURVE UK 1970–88
'CHANGE'IN INFLATION(PERCENT)
-3.0
0.0
3.0
6.0
9.0
12.0
2.0
4.0
6.0
8.0
10.0
12.0
UNEMPLOYMENT RATE (PERCENT)
75
74
79
80
71
73
77
70
72
76
78
88
87
85
84
82
83
86

The German Phillips curve shows clear evidence of steady shifts to the right throughout the period. This captures the well known fact that high unemployment is now associated with constant rather than sharply declining inflation. Since 1983, the movement appears to be along a new, steep, downward sloping locus, with no shift back to the left. The Beveridge curve shows a nearly steady movement along a downward sloping locus until 1983, and a movement back since 1983. Using only the eye, it is impossible to decide whether this movement is a movement along the curve due to a long decrease in aggregate activity, or as a combination of such a movement and a series of shifts of the curve to the right.

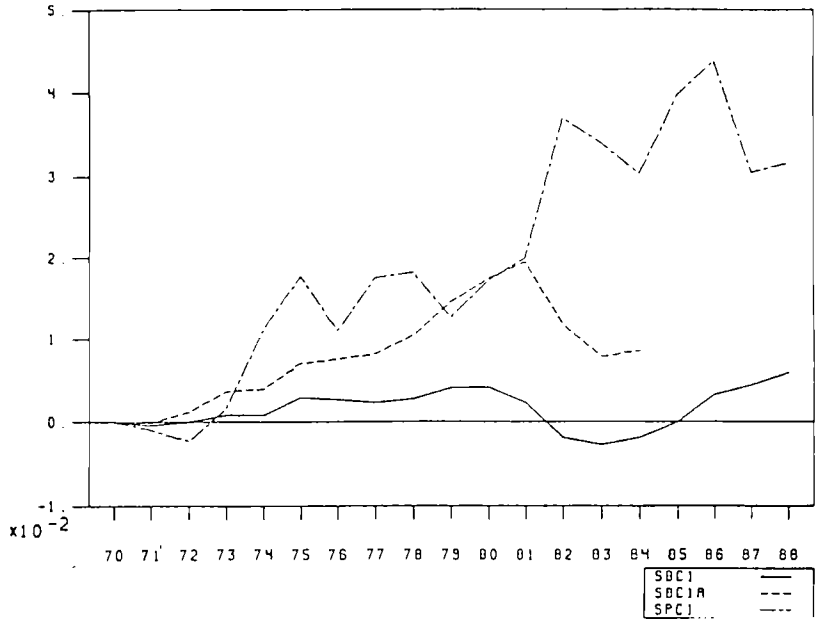
The UK Phillips curve also shows clear evidence of steady shifts to the right. Interestingly, and in contrast to Germany, the decrease in unemployment since 1986 appears associated, at least in part, with shifts back of the curve rather than with movements along a new curve. The Beveridge curve also gives a rather different picture from that of Germany, showing clear shifts to the right since 1975. Decreases in unemployment appear, just as in the case for the Phillips curve, to be associated with shifts to the left of the curve.

The first visual impression is thus of shifts in the German Phillips curve which may not be associated with similar shifts in the Beveridge curve, pointing to the importance of what I have called bargaining factors in German unemployment. For the UK however, Phillips and Beveridge curves appear to have shifted in tandem, pointing to the importance of reallocation factors. To support this impression, let me again use crude econometrics in a way parallel to that used for the US.

I estimate the slopes of the curves for both countries by using pre-1970 evidence, more precisely data from the period 1961-1971. This is evidence from a long time ago, but things have not been the same since...[10] For each country and each curve, I estimate the relation in two ways, by using unemployment either on the left or the right of the regression. As estimating simple Phillips and Beveridge curves is hardly new, the results are given in the appendix. The specification is the same as for the USA. In particular, I use a logarithmic specification for the Beveridge curve; while one wants to adopt a specification which implies that the unemployment and vacancy rates are always positive, thus ruling out a linear specification, there are other possible forms one could consider. Because vacancy rates are so low during the period, the exact specification may make a difference to the results; this is another important caveat.

Figure 8 plots estimated shifts in the German Beveridge and Phillips curves. The top panel gives shifts obtained using the curves estimated with unemployment as the dependent variable; SBC1 and SPC1 denote shifts in the Beveridge and Phillips curves respectively. This is the panel which is more likely to show highly correlated shifts in the curves. The bottom panel gives shifts obtained taking unemployment as the independent variable. The shifts are denoted SBC2 and SPC2. Both panels also give Beveridge curve shifts obtained using the alternative measure of vacancies adjusted for changes in coverage (SBC1a and SBC2a, which I could construct only up to 1984). Both panels give the same general picture; the shifts in the Phillips curves are <u>not</u> reflected in shifts in the Beveridge curve. When the OECD measure of vacancies is used, there are no significant shifts in the Beveridge curve. Put another way, the

B AND P SHIFTS, 70-88, GERMANY



B AND P SHIFTS; 70-88, GERMANY

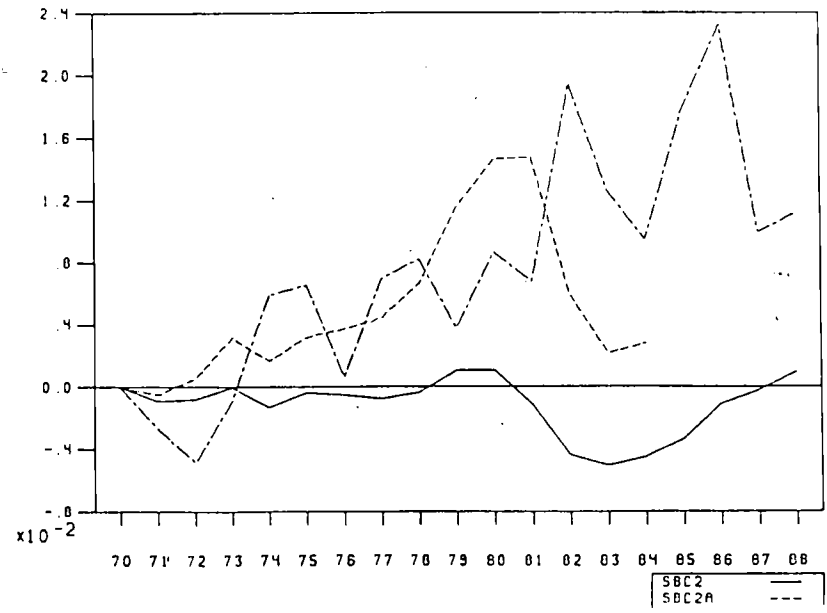
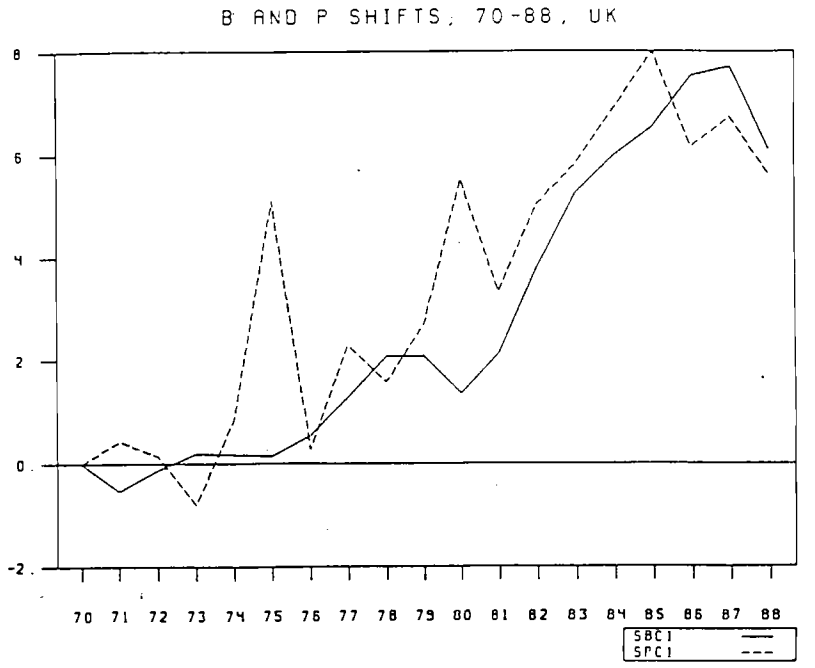
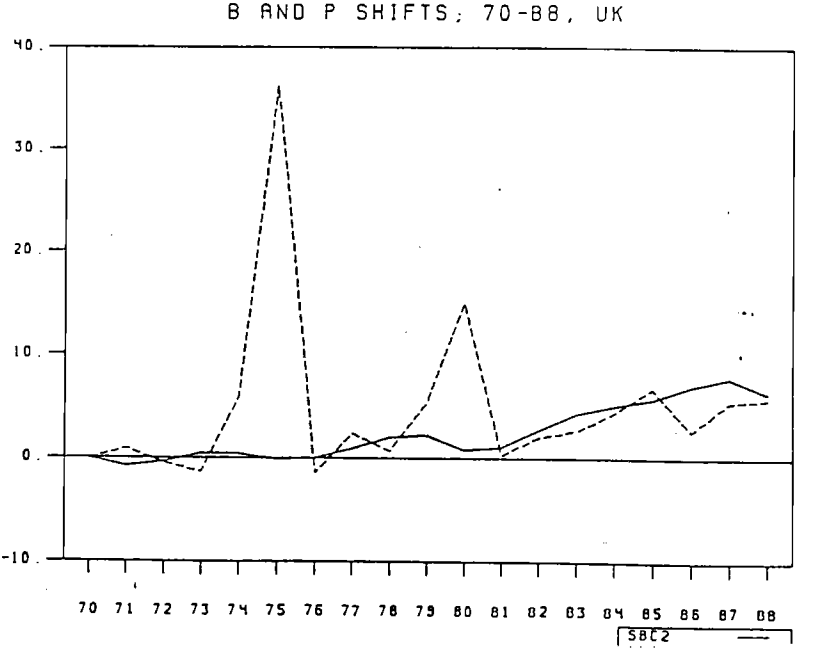


Figure 4


B AND P SHIFTS; 70-88, UK
8
6
4
2
0.
-2.
70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88
SBC1
SPC1


B AND P SHIFTS; 70-88, UK
40.
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70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88
SBC2

Beveridge curves estimated using pre 1970 or post 1970 data are nearly identical. When the alternative measure is used, the Beveridge curve shifts up until 1982, but then shifts back after 1982.

Figure 9 plots estimated shifts in the Beveridge and Phillips curves for the UK. The panels are defined in the same way. When the Phillips curve is estimated using inflation on the left hand side for the period 1961 to 1971, the coefficient of unemployment is very small; this in turn leads to estimated large and variable shifts in the Phillips curve in the bottom panel. That panel is presented for completeness, but should not be given much weight. Focusing on the top panel, econometrics confirm the visual impression. Shifts in the Phillips and the Beveridge curves are highly correlated. Except for the period around 1975, the two curves have shifted in the same way over the period; they are now both shifting down.

A tentative conclusion is thus that different factors lie behind the common increase in unemployment in Germany and the UK. Bargaining factors appear to dominate in Germany, reallocation factors appear to dominate in the UK. This is, if confirmed, an important conclusion. But it leads in turn to another set of questions, one which has been the subject of the debate on hysteresis in European unemployment. What are these mysterious reallocation or bargaining factors which have led to such an increase in unemployment ? Isn't it in fact more likely that the increase in unemployment, which was in large part triggered by contractions in aggregate demand, has itself led to shifts in the curves, that these shifts are not exogenous, but are themselves the result of prolonged unemployment ? In the last section, I touch briefly on these issues, and show how the two curves can shed light on this set of questions as well.

6. Sharpening the Tools. Shifts in the Curves and Persistence

How can sustained high unemployment lead to shifts in one or the other curve ? The debate on persistence in European unemployment has isolated two such channels, both based on differences between the long term unemployed and other workers. I shall argue that one implies shifts in the Phillips curve, but not in the Beveridge curve, while the other implies shifts in both curves. Thus, given our evidence, one appears more relevant for Germany, the other more relevant for the UK[11].

The first channel has been articulated by Layard and Nickell (1987). They argue that the long term unemployed eventually give up on searching for jobs, either because they become discouraged, or because they get used to unemployment, or because the stigma of long term unemployment disappears when there are many long term unemployed. If we think of the long term unemployed as simply dropping out, this suggests shifts in both the Beveridge and the Phillips curve. In both cases, the relevant pool of workers is the pool of workers searching for work, not the total pool of unemployed. This channel of persistence is thus consistent with the observed movements in the UK unemployment, vacancies and inflation.

The other has been articulated by Blanchard and Summers (1986), and relies on the exclusion of the long term unemployed from wage bargaining. While it was told initially in the context of collective bargaining, it may arise as well in a market with bilateral bargaining[12]. Suppose that firms, if they have the choice between workers, always hire the most recently laid off worker. This may reflect the belief of firms that skills may deteriorate -ever so slightly- with unemployment. In this case,

a worker who is just laid off knows that his chances of finding a job are higher than for a typical worker in the pool of unemployed. A large increase in unemployment may have, as a result, little effect on wage bargaining. Put another way, the wage will depend on vacancies much more than on unemployment. In terms of our now familiar curves, the Phillips curve will shift. But if workers with different unemployment duration are nearly perfect substitutes, the Beveridge curve will not shift. This channel of persistence is thus more consistent with the movements in the German unemployment, vacancies and inflation.

7. Conclusion

The pace of this paper has been fast, and the reader will surely want to see the dots on the i's. But the basic argument is a simple one. Thinking about labour markets as markets with large flows gives a simple way of thinking about the Beveridge and the Phillips curves, and to interpret their movements. Using this strategy, I have concluded that:

(1) movements in the non inflationary rate of unemployment in the USA appear to originate in changes in the reallocation process

(2) movements in the non inflationary rate of unemployment in the UK appear to be due to changes in the reallocation process, changes due in turn to prolonged high unemployment

(3) by contrast, persistence of high unemployment in Germany appear to come from bargaining factors.

These are first pass conclusions. There is obviously much more information, including information about the flows themselves, which must be brought to bear on

those issues. But they give a flavour of what can be learned from the joint examination of the Beveridge and Phillips curves.

Appendix 1. A Sketch of a Model

What follows is a sketch of the model developed in Blanchard and Diamond (1989a,b). The economy is composed of identical workers and identical jobs. Workers can be in one of three states: employed, unemployed or out of the labour force. Let E be the number of employed workers, U the number of unemployed, and N the number of workers not in the labour force. The labour force, $L = E + U$, is given.

Symmetrically, jobs are in one of three states: they can be either filled, unfilled with a vacancy posted ("vacancies" for short), or unfilled with no vacancy posted ("idle capacity"). Each job requires one worker. Let K be the total number of jobs, F be the number of filled jobs, V the number of vacancies, and I the number of unfilled jobs with no vacancy posted, that is idle capacity. Thus, $K = F + V + I$. Obviously F and E are identically equal. K is given.

Job creation and destruction

Each of the K jobs in the economy produces, if filled, a gross revenue of either 1 or 0. Profitability for each job follows a Markov process in continuous time. A productive job becomes unproductive with flow probability π_0. An unproductive job becomes productive with flow probability π_1. At any point in time, some jobs become productive, some jobs become unproductive. This is the mechanism used to capture the large gross flows of job creation and job destruction that exist in the economy.

It is conceptually useful to introduce two other parameters, c and s, defined in terms of π_0 and π_1. For given π_0 and π_1, the proportion of potential jobs which are

productive is given by $\pi_1/(\pi_0 + \pi_1)$; we may think of this proportion, which I shall call c (for cycle) as measuring the degree of aggregate activity (or more precisely potential aggregate activity, as the proportion of jobs productive and filled will always be less than c). The instantaneous flow of jobs changing from productive to unproductive (which equals the reverse flow), is equal to $\pi_0\pi_1/(\pi_0 + \pi_1)$ times K; we can think of this ratio, which we shall denote s (for shift), as an index of the intensity of reallocation in the economy.

Matching

The process of matching workers and jobs is captured by a matching function, giving hires, h, as a function of unemployment and vacancies:

$$h = \alpha\, m(U,V)$$

where α is a scale parameter, and m_U, $m_V \geq 0$, $m(0,V)=m(U,0)=0$. The parameter α captures the effectiveness of the matching process, which depends in turn on the dispersion in geographic and skill distributions of jobs and workers, as well as on search intensity.

The equations of motion

Assume for simplicity that the only source of flows out of employment are due to jobs becoming unproductive. Introducing quits would be straightforward. It follows from the assumptions that the behaviour of the labour market is given by a system of two differential equations, which are:

$$dE/dt = \alpha m(U,V) - \pi_0 E$$

$$dV/dt = -\alpha m(U,V) + \pi_1 I - \pi_0 V$$

When a job becomes unproductive, the worker is laid off. Thus, the flow from employment to unemployment from this source is equal to $\pi_0 E$. The flow from unemployment to employment is equal to new hires.

For a job to produce 1, it must not only be productive but also be matched with a worker. To do so, a vacancy must be posted and a worker must be recruited. New vacancies come from jobs which were previously unproductive becoming productive; this flow is equal to $\pi_1 I$. Vacancies decrease for two reasons: some are filled by new hires, a flow from V to F; some of the jobs for which vacancies were posted become unproductive, a flow from V to I.

Using the identities above and replacing π_0 and π_1 by c and s gives a system of two equations in unemployment and vacancies:

$$dU/dt = -\alpha\, m(U,V) + (d+(s/c))(L-U) \qquad (2)$$

$$dV/dt = -\alpha\, m(U,V) + d(L-U) - (s/(1-c)))(K-V-L+U) - (s/c)V \qquad (3)$$

Wage determination

Wages are determined by Nash bargaining within each match, so that the surplus from the match is shared in some proportion by the firm and the worker.

Flows of benefits to unemployed workers and vacancies are equal to zero. The flow of net output from a match is denoted by y. The joint gain from beginning the employment relationship is $(W_e - W_u + W_f - W_v)$. W_e and W_u are the the expected present discounted value of wages when one is currently employed and the expected present discounted value of wages when one is currently unemployed respectively. W_f and W_v are the present expected discounted values of profit from the ownership of a job when the job is currently filled and vacant respectively. This surplus is divided in constant proportion between the firm and the worker:

$$D \equiv W_e - W_u = z(W_f - W_v) \qquad (3)$$

Wages are continuously renegotiated to continuously satisfy this equation. Thus all employed workers are earning the same wage. In what follows, I limit myself to the derivation of the steady state wage. While only an approximation, it is a good one, even out of steady state (the simulations presented in the text are based on the general solution, which is given in Blanchard and Diamond 1989b). To derive the wage, I use the standard arbitrage equation approach:

In steady state, the discount rate times the present discounted value is equal to the flow of benefits. Thus, the W's follow :

$$\begin{aligned}
rW_e &= w + \pi_0(W_u - W_e)\\
rW_u &= (\alpha m/U)(W_e - W_u)\\
rW_f &= y - w + \pi_0(W_i - W_f)\\
rW_v &= (\alpha m/V)(W_f - W_v) + \pi_0(W_i - W_v)\\
rW_i &= \pi_1(W_v - W_i)
\end{aligned}$$

When employed, a worker receives the wage w but the employment relationship ends with flow probability π_0. When unemployed, a worker is receiving no benefit flow and one has the flow probability $\alpha m/U$ of finding a job. Similar interpretations apply to the other W's. Solving those equations for the wage, using equation (3) gives :

$$w/y = (r+\pi_0+\alpha m/U)z/((r+\pi_0)(1+z)+z(\alpha m/U)+\alpha m/V))$$

If, as is the case empirically, $\alpha m/U$ and $\alpha m/V$ are large compared to r and π_0, w is approximately equal to:

$$w \cong y(zV/(zV+U)) = zy/(z+(U/V)) \qquad (4)$$

so that to a good approximation, the wage depends on the marginal product, y, the share of the surplus z, and the vacancy unemployment ratio.

Dynamics

The dynamics of vacancies, unemployment and wages follow from equations 1,2 and 4.

Movements in aggregate activity are captured by a sine wave in the parameter c. Their implications are given in figure 1. Reallocation changes correspond to changes in either s, the intensity of reallocation, or in α the effectiveness of the matching process. Their implications are given in figure 2. Bargaining changes correspond to changes in z, the parameter giving the division of the surplus. Their implications are given in figure 3.

Appendix 2 Estimated Beveridge and Phillips curves for Germany and the UK

The period of estimation is 1962:1 to 1971:1. All series form the OECD data base, except for the adjusted vacancy series for Germany. All equations are estimated with a first order serial correlation correction.

Germany

Beveridge curve, using OECD vacancy series (v)

$$\text{logu} = \underset{(-4.9)}{-9.5 - 1.29\ \text{logv}} + \epsilon \qquad R^2 = 0.81 \qquad \rho = 0.44$$

$$\text{logv} = \underset{(-8.1)}{-6.9 - 0.70\ \text{logu}} + \epsilon \qquad R^2 = 0.83 \qquad \rho = 0.51$$

Beveridge curve, using vacancy series adjusted for coverage (va) :

$$\text{logu} = \underset{(-5.1)}{-7.9 - 1.1\ \text{logva}} + \epsilon \qquad R^2 = 0.82 \qquad \rho = 0.27$$

$$\text{logva} = \underset{(-5.1)}{-6.3 - 0.71\ \text{logu}} + \epsilon \qquad R^2 = 0.84 \qquad \rho = 0.40$$

Phillips curve

$$\text{logu} = \underset{(-2.5)}{-4.3 - 18.6\ (\pi - 0.7\pi(-1))} + \epsilon \qquad R^2 = 0.54 \qquad \rho = 0.48$$

$$\log(\pi - 0.7\pi(-1)) = \underset{(-2.6)}{-.11 - .027\ \text{logu}} + \epsilon \qquad R^2 = 0.84 \qquad \rho = 0.40$$

UK

Beveridge curve, using OECD vacancy series (v)

$$\text{logu} = \underset{(-4.1)}{-.62 - 0.69\ \text{logv}} + \epsilon \qquad R^2 = 0.83 \qquad \rho = 0.64$$

$$\text{logv} = \underset{(-6.8)}{-6.75 - 0.54\ \text{logu}} + \epsilon \qquad R^2 = 0.98 \qquad \rho = 0.98$$

Phillips curve

$$\text{logu} = \underset{(-1.7)}{9.8 - 7.4\,(\pi - 0.7\pi(-1))} + \epsilon \qquad R^2 = 0.54 \qquad \rho = 0.99$$

$$\log(\pi - 0.7\pi(-1)) = \underset{(-1.7)}{.92 - .045\ \text{logu}} + \epsilon \qquad R^2 = 0.30 \qquad \rho = 0.99$$

Footnotes

1 The US numbers are from the monthly Current Population Survey, as adjusted by Abowd and Zellner (1985). Corresponding numbers for movements in and out of employment do not exist for Western Europe. What is available are movements in or out of unemployment registers. The numbers are taken from Burda and Wyplosz (1989).

2 I wish we were the first to make this point but we are not. Solow (1964) may have been the first to use both curves to analyse whether a further decrease in unemployment would be inflationary. More recently Layard and Nickell (1988) have used this approach to analyse the sources of European unemployment.

3 For those who trust equations more than words, the appendix, which is based on Blanchard and Diamond (1989a,b) sketches a formal model which underlies the discussion in the text.

4 Let V be vacancies, U unemployment and m the flow of matches. Then U/V is equal to (U/m)/(V/m). U/m is the average duration of unemployment, V/m is the average duration of a vacancy.

5 In the context of our model, this approach leads to inflation unemployment dynamics not unlike those in Calvo (1983).

6 Were there not a long tradition of looking at the joint behavior of wages, unemployment and vacancies through the Phillips and Beveridge curves, one would probably not want to look at data in this way. The logic of the model just sketched suggests for example the use of the ratio of unemployment to vacancies rather than the

unemployment rate as the variable on the horizontal axis in the Phillips curve. The tradition is however well established and I shall follow it here.

7 Truth in advertising compels me to make an admission here. Instead of estimating the "price-price Phillips curve", an alternative strategy would be to estimate the wage equation by itself, that is the relation between nominal wages, prices, unemployment and vacancies, and productivity. In Blanchard and Diamond (1989b), we have made a first empirical pass at estimating such an equation for the US, with results which are much less clear cut than those presented here. Reasons why this may be are discussed in that paper, but the discrepancy is worrisome.

8 It may not be. If shifts are correlated during the sample period with movements along the curves, the bias will go the same way under both approaches.

9 The December 1988 OECD Economic Outlook gives Beveridge curves for 16 OECD countries for the period 1970-88, which make for fascinating looking. Germany and the UK appear broadly representative of those Western European countries which have suffered high unemployment.

10 More precisely, there are good reasons, empirical and theoretical, to think that since 1970, shifts in the curves have been correlated with movements along those curves. This would lead to an obvious bias if I were to use the whole sample to estimate slopes. I return to this issue below.

11 We have not yet extended our formal model to allow for these effects. What follows is based on a combination of work in progress, educated guesses, and bluff.

[12] See Blanchard and Diamond (1989c) for a formal model.

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