The Remarkable Place of the UV-Curve in Economic Theory

Rodenburg, Peter

University of Amsterdam

16 November 2007

TI 2007-088/1
Tinbergen Institute Discussion Paper

The Remarkable Place of the UV-Curve in Economic Theory

Peter Rodenburg

University of Amsterdam, and Tinbergen Institute.

Tinbergen Institute
The Tinbergen Institute is the institute for economic research of the Erasmus Universiteit Rotterdam, Universiteit van Amsterdam, and Vrije Universiteit Amsterdam.

Tinbergen Institute Amsterdam
Roetersstraat 31
1018 WB Amsterdam
The Netherlands
Tel.: +31(0)20 551 3500
Fax: +31(0)20 551 3555

Tinbergen Institute Rotterdam
Burg. Oudlaan 50
3062 PA Rotterdam
The Netherlands
Tel.: +31(0)10 408 8900
Fax: +31(0)10 408 9031

Most TI discussion papers can be downloaded at http://www.tinbergen.nl.

The Remarkable Place of the UV-Curve in Economic Theory

Peter Rodenburg*
Department of European Studies and
Faculty of Economics and Econometrics
University of Amsterdam
Spuistraat 134, 1012 VB Amsterdam
The Netherlands
Tel: +31 (0)20-525 4660
E-mail: P.Rodenburg@uva.nl
http://home.medewerker.uva.nl/p.rodenburg/

Abstract

The purpose of this paper is to provide an analysis of the impact the UV-curve had on economic theory and to provide an account of the subsequent radical changes in its place and role over the decades since its first appearance in 1958. The paper traces the historical development of the UV-curve and argues that the role of the UV-curve has changed from a measuring device to a graphical representation of full employment to an axiom necessary for matching models of unemployment. This changing role is best understood in the light of a paradigmatic change from Keynesianism to neoclassical search theory.

Keywords: UV-curve, Beveridge curve, UV-analysis, Matching models, Theories of Unemployment, History of Economic Thought, Induction, Full employment, Measurement of unemployment

JEL classification: B, E, J

* An earlier version of this paper was presented at the 6th Annual Conference of the European Society for the History of Economic Thought (ESHET) in Rethymno, Crete, Greece, 14-17 March 2002 and for the LSE measurement group of the Centre for Philosophy of Natural and Social Sciences (CPNSS), London, UK. I would like to thank the organisers and participants of both meetings. I would like to thank Mary Morgan, Walter Eltis, John Davis, Marcel Boumans and Harro Maas, for their helpful comments on earlier drafts and for helpful discussions.

The Remarkable Place of the UV-Curve in Economic Theory

1 Introduction

Ever since John Stuart Mills' *Principles of Political Economy* (1848) and John Neville Keynes' *Scope and Method of Political Economy* (1890), economic science is conceived as a deductive science. Particularly since the rise of axiomatized neoclassical microeconomics in the 1870s and the demise of inductive approaches, such as Schmoller's German Historical School, economics became overly deductive of nature. Philosophers of science, however, may argue that induction is able to provide a richer approach to science than deduction, as inductive inference can provide us novel insights and amplify and generalise our experience. Inductive inference is therefore, as Charles Pierce (1961), puts it ampliative, whereas with deduction we can never get more out of the arguments (axioms) than we put in.

In 1958 two novel empirical relationships came into being in macroeconomics in an – apparent – inductive way which both had a substantial impact on economic thinking: the Phillips-curve and the UV-curve (or Beveridge-curve as it was named in the 1980s after William Beveridge). The UV-curve features the inverse relation between the unemployment and vacancies in an economy. Since the UV-curve was meant in the first place as a practical measurement device to guide economic policy, its place in economic theory was not immediately clear and the novel features and insights of the UV-curve forced economists to rethink macroeconomics and incorporate these insights into (mainstream) economic thinking.

Whereas the history of the Phillips-curve, its impact on, and its place in economic thought is well documented in the relevant literature[1], a thorough analysis of the impact of the inductively established UV-curve on economic thought seems missing in the literature. This is even more remarkable since the place and role of the UV-curve in economic thinking has changed radically over the decades since its first appearance. The purpose of this paper is therefore to provide such an analysis and to investigate a rare case where – apparent – inductive inference gave rise to novel insights, which puzzled economists and forced them to theorize.

[1] See, for example, Leeson (2000).

The paper is organized as follows. In order to get a good understanding of the place and influence of the UV-curve Section 2 will analyse how the UV-curve came into being in the first place. Section 3 discusses various attempts to incorporate the simultaneous occurrence of unemployment and vacancies in economic theory and to provide a theoretical foundation for the UV-relation. It also discusses the rivalry with the Phillips-curve. Section 4 discusses the stability of the UV-curve debate, whereas Section 5 analyses the rise of a new paradigm - search theory and matching models – that rely on the UV-curve as an axiom for deduction. Finally conclusions are drawn in section 6.

2 The birth of UV-curve

UV-curve originated from the work of two British economists, Dow and Dicks-Mireaux (hereafter DDM) in 1958.[2] In their seminal paper, *The Excess Demand for Labour: A Study of Conditions in Great Britain, 1946-1956*,[3] they sought to establish a measure for excess demand, as they were primarily concerned about inflation in the goods market. In the post-war period Keynesianism was the dominant paradigm, and economists held a strong belief in aggregate demand management by the government. However, in the 1950s the British unemployment rate was very low, around 1.5% on average, and, in such a situation, fluctuations in aggregate demand could easily lead to inflation. DDM therefore sought an indicator that could guide Keynesian fiscal policy in such a way that unemployment could be removed if necessary while avoiding inflation. They suggested using data on vacancies and data on unemployment in order to measure excess demand in the labour market as an indicator for the excess demand in the goods market, since the data on unemployment represents excess supply of labour in the labour market, and that on vacancies represent excess demand for labour. The application of this simple idea was possible for Britain since data for both vacancies and unemployment were available. The collection of (trade union) unemployment data had begun in the 19th century, while the British Government had collected data on unfilled vacancies from notification at labour exchanges since 1946. By 1958, DDM had available an 11-years' time series of both vacancy and unemployment data for Britain. Vacancy data are, however, notorious for their incompleteness for two reasons. First, unlike unemployment, where unemployed workers have a strong financial incentive to register as unemployed, there are no direct financial incentives for firms to notify vacancies or penalties for not reporting vacancies. And, secondly, unlike unemployment,

[2] At that time DDM were associated with the National Institute of Economic and Social Research (NIESR) in London, an independent non-profit organization founded in 1938.
[3] A slightly rewritten summary of this article can be found in Dow (1970: 337-343).

there are no checks on double counting where vacancies are notified at more than one labour exchange, or on undercounting where one vacancy is posted for a number of workers doing the same task. Moreover, firms could be disappointed by the previous mediation of labour exchanges, and look for other ways of hiring workers. William Beveridge (1944: 88) therefore argues that: "the vacancies notified to the exchanges and not filled by them do not necessarily remain unfilled and cannot be taken as a measure of unsatisfied demand; most of them get filled in other ways". DDM argue, however, that, though there are good reasons to distrust the vacancy numbers, there are also reasons to have a certain confidence in the variation in vacancy numbers. The recording of vacancies might be incomplete, they argue, but the *behaviour* of vacancies shows that vacancy statistics can be considered as rather reliable indicators. This is especially clear when the behaviour of vacancies is compared with that of unemployment (see Figure 1; in panel B, data are seasonally corrected and the unemployment curve inverted).

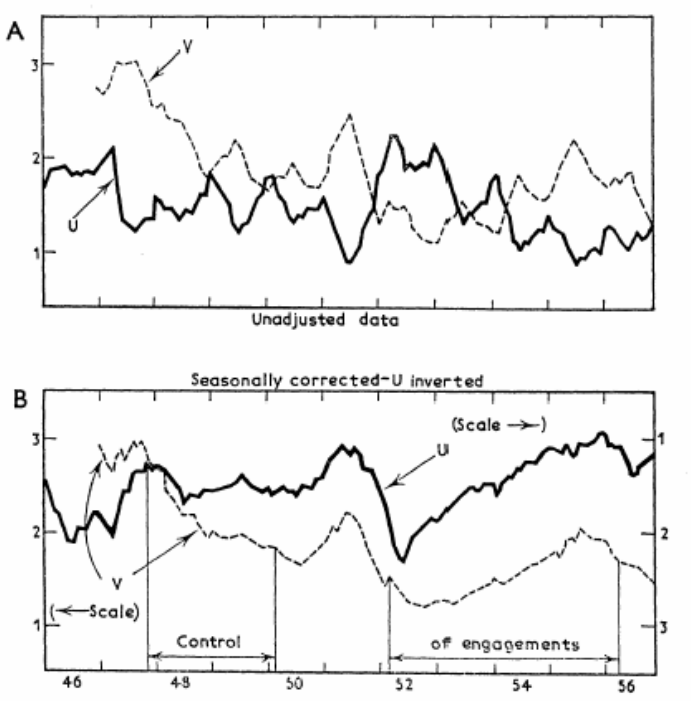

Figure 1: Unemployment and vacancy rates, 1946 –1956 (in percentages, Great Britain)
Source: Dow and Dicks-Mireaux, 1958: 3.

The two curves exhibit a remarkable inverse relationship, which leads DDM to conclude: "These observations give one a certain confidence in the vacancy statistics" (DDM, 1958:2). Thus, though vacancy data are probably incomplete, and therefore do not give accurate information about the

absolute number of vacancies, they can be used to give an *ordinal* measure of excess demand rather than a cardinal measure.[4]

An important feature that DDM assumed about the behaviour of unemployment is that unemployment above a certain level would be decreasingly sensitive to demand. That is, a further increase in demand should lead to a disproportionately small decline in unemployment rates (and vice versa for vacancies). DDM base that assumption on the rationale that when "demand increases, *u* will decrease continuously (..), but since it cannot shrink below zero it must be supposed to become decreasingly sensitive" (DDM, 1958: 20). DDM point out, however, that it also can be observed empirically in the downswing of 1952 and the boom of 1955. According to DDM, this feature is better observed when the data is presented in Unemployment-Vacancy (UV) space and successive observations are connected (Figure 2).

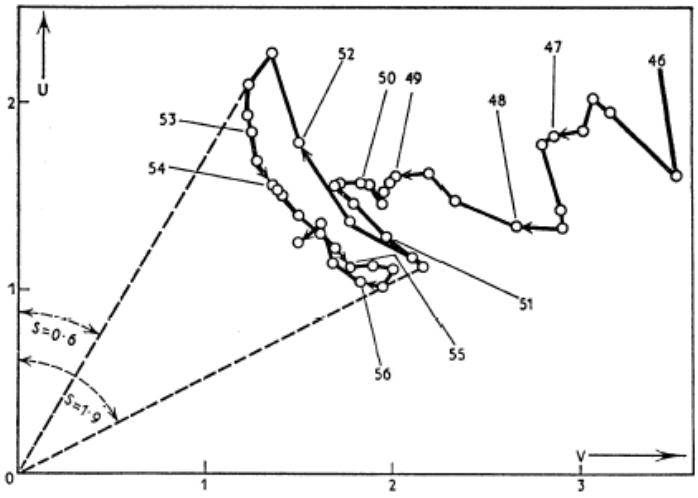

Figure 2: Relation between unemployment and vacancy rates (seasonally-corrected quarterly figures)
Source: Dow and Dicks-Mireaux, 1958: 4.

[4] In addition, DDM employed two analyses of unemployment and vacancy data, and found indications that the measurement error of vacancies is fairly stable. First, they compared the effect of seasonal changes on vacancies with the effect of seasonal changes on unemployment. The amplitude of the seasonal variations turned out to be of the same order, suggesting a stable measurement error (DDM, 1958: 26). Second, DDM considered changes in notification of vacancies when the Statutory Regulations for labour exchanges changed. For the period 1946-1956, there were two periods when notification of vacancies to labour exchanges was compulsory in the UK: namely, October 1947-March 1950 and February 1952-April 1956. However, the change from voluntary to compulsory notification had only a modest effect on the rate of notified vacancies. DDM again interpret this as evidence that the measurement error in measuring vacancies is fairly stable.

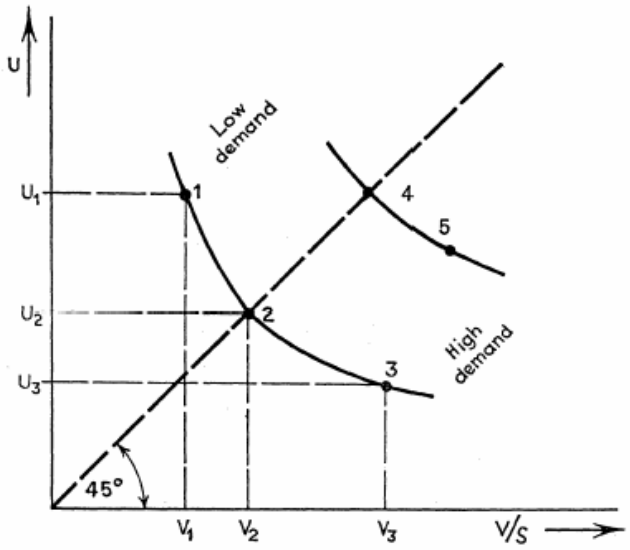

Figure 3: Idealized UV relation [where *v/s* = adjusted vacancy rate (see text below)]
Source: Dow and Dicks-Mireaux, 1958: 4.

Following this rationale, DDM derive an idealized UV-curve as a rectangular hyperbola (Figure 3).[5] The curve shows, first, an inverse relation between vacancy and unemployment rates. When the economy is in recession, it experiences high unemployment rates and low vacancies rates (point 1). In an upswing (point 3), the reverse is true: there is a high vacancy rate with a low unemployment rate. Each point on the UV-curve represents a different degree of aggregate demand, and, across the various stages of the business cycle, the economy moves along the idealized UV-curve. Secondly, the hyperbolic and convex shape of the UV-curve represents the feature that a further increase in demand leads to a disproportionately small decline in unemployment rates. This "increasing insensitivity of unemployment", as DDM called it, clearly resembles the neoclassical idea of decreasing returns to input factors found in production and utility functions. Later empirical studies estimate this hyperbolic UV relation as $\log v = \beta_0 + \beta_1 \log(1/u) + \varepsilon$.

The derivation of a hyperbolic-shaped UV-curve is a crucial step in the measurement procedure of excess demand, but this idealized curve does not seem to follow easily from all the observations. The data from 1946 to 1950, for example, do not fit the hyperbolic shaped UV-curve at all (see Figure 2). DDM therefore conclude that the observations from 1946 to 1950 do not lie on the UV-

curve because of shifts in the level of maladjustment *m* (DDM, 1958:3), i.e. *changes* in the kind of labour supplied and that demanded. DDM attribute the causes of maladjustment to skill mismatch, geographical maldistribution, seasonal variations in demand, and the effect of turnover of labour between firms (DDM, 1958:3). The level of maladjustment *m* is defined as the level of unemployment that equals the adjusted vacancy rate *v/s*.[6] As explained above, the real vacancy rate happens to be subject to measurement error due to under- or overestimation of vacancies. DDM therefore argue that the vacancy rate *v* should be corrected for this measurement error or 'statement error', and that *v/s* instead of *v* should be considered as the true number of vacancies, where *s* is the 'statement error' defined as:[7]

$$s = \frac{\text{unfilled vacancies reported to labour exchanges}}{\text{true number unfilled vacancies}}$$

The level of maladjustment *m* will thus be the level of unemployment, where $u = v/s$ (DDM, 1958: 20), and at this point there no excess demand *d.*

The convenience of the assumption that the UV-curve is a rectangular hyperbola is that it relates *u, v, s* and *m* in an easy way which makes it possible to derive both excess demand *d* or the level of maladjustment *m*. Given an estimate of *s*, and observations of *u* and *v*, and the corresponding level of maladjustment *m*, then excess demand *d*, which is defined as $d = m - u$, can be calculated. Clearly, (changes in) the value of the statement error *s* could significantly influence the measurement outcomes. For the moment we will assume *s* to be unity.

After deriving an idealized UV-curve, DDM construct a line of zero excess demand. Under the assumption that employers give correct statements about their vacancies (thus conditional on $s=1$), this is an upward sloping line through the origin at a 45º degree angle that separates the areas of excess supply and demand for labour. Each point on that line corresponds to a case where employment equals unfilled vacancies. These two constructs enabled DDM to measure excess demand for labour according to the following general principles (DDM, 1958:5-6):

---

[5] DDM reckon that other curves would be possible, as they argue (about Figure 2): "A curve like a rectangular hyperbola seems plausible. Any curve, of whatever shape, which falls from left to right will preserve the correct ranking of observations" (DDM, 1958:22).

[6] In their seminal article, DDM seem to use different, and conflicting notions of the idea of maladjustment. Whereas they define it as a level of unemployment: namely u_2, they later define maladjustment in accordance with Pythagoras as the square root of *u* times *v/s*, thus as: $m = \sqrt{uv/s}$ (p. 22).

[7] Maladjustment is then defined as the amount of unemployment at the point where $u=v/s$ (DDM, 1958: 20).

(i) Vacancies and unemployment rates are plotted in a UV-space. Vacancies have to be corrected for the degree of over- or underestimating to give the real vacancies rate *v/s*.

(ii) Zero net excess demand is defined as all situations where *u=v/s*, and corresponds to the 45º degree line through the origin.

(iii) Successive points on the 45º degree line correspond to different degrees of maladjustment.[8]

(iv) For any given degree of maladjustment, there will be a series of points corresponding to different degrees of demand and lying on a curve convex to the origin. (Thus, for the degree of maladjustment measured by u_2 (Figure 3), there will be points 1, 2, 3…).

(v) Excess demand is measured as vacancies less estimated maladjustment.

Thus, for example, at point 3 on figure 3, the excess demand can be measured as $v_3 - v_2$. For situations of net deficient demand, like point 1, deficient demand is measured as estimated maladjustment less unemployment, that is, $u_1 - u_2$. For the year 1956, for example, DDM find that a vacancy rate of 1.7 percent was offset by an excess supply of labour of 1.2 percent, yielding a net excess demand of 0.5 percent. Therefore, vacancies up to 1.2 percent refer to the level of maladjustment, since they can be matched by an equal amount of labour.

DDM had some reservations with respect to the precision of their method. In particularly they mention three sources of imprecision, all of which seem to relate to ignorance about the statement error *s*. Lack of knowledge about the 'true' number of vacancies prevents us from knowing this correction factor. First, DDM point out that the statement error affects the net zero demand locus, since it should be redefined as $u = v/s$ when the statement error is taken into account (DDM, 1958:20). When *s* is not unity, the $u = v/s$ locus (or net zero demand locus) will have a slope greater or smaller than 45º. This means that the point of zero excess demand (the intersection of the net zero demand locus and the UV-curve) cannot be identified exactly, without precise knowledge about *s*. Second, DDM note that, apart from changes in demand, changes in the statement error and changes in maladjustment both affect unemployment and unfilled vacancies. However, since the statement error is unknown, it is impossible to distinguish between changes in the statement error and changes in the degree of maladjustment. The observations for 1946 to 1950, for example (in Figure 2), were obviously not located on an idealized hyperbolic UV-curve. This indicates, according to DDM, that in that period the British economy was subject to shifts in either the degree of over- or

[8] Maladjustment is, however, measured in terms of the corresponding unemployment rate.

underestimating the real vacancies rate or in the degree of maladjustment. However, it is not possible to identify which one of these two possibilities applied. DDM reckon changes in maladjustment to be the most likely reason, since the UK post-war economy gradually moved from directed labour to a market economy and consequent dislocations had to be overcome. In addition, the data for separate industries do not support steep declines in the statement error (DDM, 1958: 26).

Finally, DDM argue that the statement error itself might be a source of inaccuracy since it might be a function of demand. For example, in times of a slack labour market, employers may not even report vacancies at labour exchanges at all since they are easily filled. However, the two tests on the vacancy data that DDM apply (see footnote 4) solved most of the disadvantages of their method. Not only do they conclude that the statement error is stable, but they also infer that its value is close to unity. A unity value of *s* implies that the zero net demand line can be considered to have a slope of 45º, and that the statement error is unlikely to be a function of demand (DDM, 1958: 28). This enabled them to conclude that the shift in the pre-1950 data was caused by a shift in maladjustment.

3 The impact of the UV-curve on economic theory

The UV-curve was put forward by DDM as a practical measurement device to guide economic policy. Its place in economic theory was therefore not immediately clear. The UV-curve obviously had some attractive features, in the sense that it provides a macro-framework that shows that unemployment and vacancies coexist simultaneously in the absence of excess demand, or that some unemployment will exist even at very high levels of demand, but its explanatory power was low since it provided no new insights, other than those that already existed, about what mechanisms caused the simultaneous existence of unemployment and vacancies. And more importantly, although the UV-curve was empirically supported, there was no theoretical foundation for it.

In retrospect, several effects of the introduction of the UV-curve in economics can be distinguished. In my opinion the most important ones are the following. Firstly, it introduced a method, which later became known as UV-analysis, for the decomposition of unemployment into different types for the guidance of economic policy. This was clearly consistent with DDM's purpose of doing measurement for guiding Keynesian policies. Secondly, the simultaneous coexistence of unemployment and vacancies was at odds with neoclassical notions of market clearing. It was, for example, not clear how this UV-curve should be explained in a simple Marshallian supply and demand analysis. The growing awareness that labour markets may not clear instantaneous as other markets necessitated a theory of simultaneous coexistence of unemployment and vacancies in

equilibrium. And thirdly, both the UV-curve and the Phillips-curve were used to clarify the post-war policy debate on 'full employment' that was instigated by Keynes' General Theory and Beveridge' 1942 report on social security. Though the empirical and theoretical relation between the UV-curve and the Phillips-curve was not clear, both curves were interpreted to bear (implicit) contradictory notions of the full employment level of unemployment. Let us examine these three issues in closer detail

3.1 UV-analysis and the decomposition of unemployment

Economists of the National Institute of Economic and Social Research (NIESR) in London, familiar with the UV framework through the work of NIESR-member Dow, made further contributions to the UV-curve framework, and applied it to regional studies.[9] In October 1966 NIESR began a study on regional economic development in Great Britain.[10] The original idea was:

> "to provide a measure of the differences of degree of imperfection between the labour markets of the United Kingdom regions: We wanted to be able to say something about the extent to which the regions' different rates of unemployment could be attributed to differences in labour market imperfections, as opposed to differences in effective demand" (Brown, 1976: 134).

Therefore, they used an analysis of *u* and *v* data for both regions and industries as the framework for these regional studies and called this approach 'UV analysis' (Brown, 1976:134). They identify the level at which unemployment and vacancies are equal for regions or industries as the level of non-demand deficiency unemployment, and consider this a measure of the inefficiency of regional labour markets. The contribution of NIESR lies in the fact that they further decomposed the non-deficient demand component of unemployment into a structural (u_s) and a frictional (u_f) component of unemployment, so that a classification arises that corresponds to the 'traditional' classification; that is, a division of unemployment into frictional, structural, and deficient demand unemployment.

At the sector level, the level of structural unemployment u_s is determined as the difference between excess supply and demand of labour per sector of the economy (industry or region), while

[9] Members of NIESR in the late 1960s and early 1970s were, among others, Arthur Brown, David Worswick, John Bowers, Paul Cheshire, Edward Webb and Robert Weeden.

[10] The results were presented in Brown (1973), Cheshire (1973), Weeden (1973), Webb (1974), and Weeden (1974), while the framework is explained in close detail in Cheshire (1973).

the level of frictional unemployment is the minimum of unemployment and vacancies for each sector (see Figure 4).

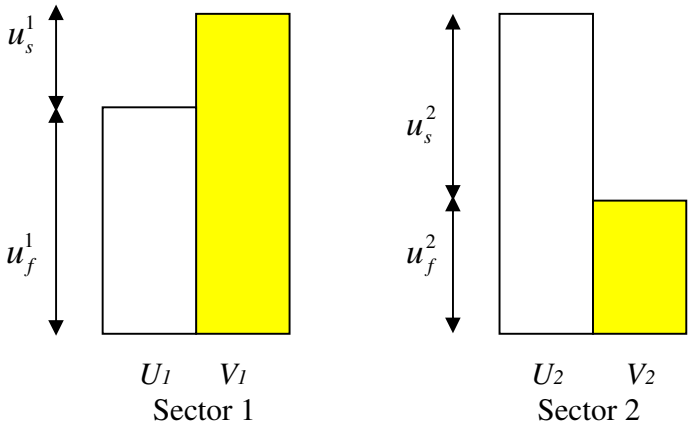

Figure 4: NIESR's measurement of frictional and structural unemployment per sector
Based on: Cheshire, 1973: 13.

At the aggregate level, for example, for a two industry economy with unemployment U_1 and U_2, and vacancies V_1 and V_2 in the respective industries, and $V_1 > U_1$ and $V_2 < U_2$, aggregate frictional unemployment is defined as the sum of $u_f^1 + u_f^2 (= U_1 + V_2)$, and aggregate structural unemployment as the minimum of differences between *Ui* and *Vi*, thus as u_s^1 $(= V_1 - U_1)$ or $u_s^2 (= U_2 - V_2)$, whichever is the smaller. Demand deficiency unemployment is $(U_1 + U_2) - (V_1 + V_2)$ (Cheshire: 1973, 13).

Armstrong and Taylor (1980) suggest decomposing structural unemployment even further in a geographical, an occupational, and a simultaneous occupational-geographical component for regional studies. Thirlwall (1969) provides an analytical treatment of this approach. Based on these measures of classes of unemployment, NIESR (Cheshire: 1973) derives a conceptual framework using the simplifying assumption of a fixed level of frictional unemployment. This idea of frictional unemployment as 'frictions within sectors' and structural unemployment as 'frictions between sectors' is often found in labour market studies in the 1970s.

In the 1970s, UV-analysis reached the highest stage of its popularity, and most studies date from this era. UV-analysis turned out to be a very simple and easy to use device for analysing the nature of unemployment. In most studies, unemployment was decomposed into two classes: deficient demand and non-deficient demand, so the UV-analysis indicated which part of unemployment was caused by deficient demand and could be removed by Keynesian expansionary policy.

Finally, two aspects are noteworthy with respect to the use of UV-analysis. Firstly, UV-analysis seems to have been most popular in Europe, most notably in Great Britain. For the US there do not seem to be many studies. This is likely to be attributed to the fact that, in the US, the preferred framework for analysis of unemployment was the Phillips-curve and concepts derived from it, such as the natural rate of unemployment. Secondly, UV-analysis was particularly popular for regional studies.[11]

3.2 The UV-curve in a Marshallian framework

The simultaneous existence of unemployment and vacancies seems at odds with the Marshallian supply and demand framework. Hansen (1970) integrates elements of Gordon (1966) and Holt and David (1966) to provide a comprehensive, neoclassical theory of friction in a supply and demand framework, and shows that unemployment and vacancies can coexist. The starting point for Hansen is the division of the labour market into homogenous and frictionless submarkets, where on each submarket there only exists excess supply or excess demand for labour (in the same way that NIESR did). Frictions, however, do exist between submarkets, and unemployment can still exist since excess demand in one submarket cannot be matched by excess supply in another submarket.[12] Submarkets thus have excess supply or demand, and, according to Hansen, this means:

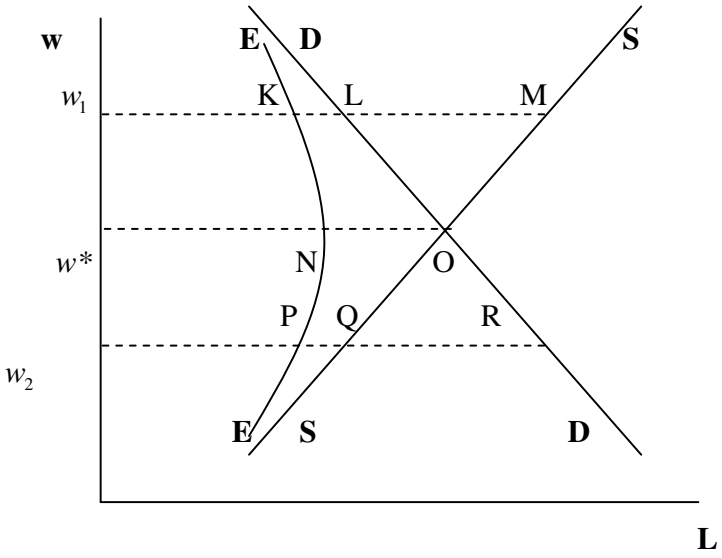

Figure 5: Employment function in an S-D diagram
Source: Based on Hansen, 1970: 7.

[11] See, for example, Cheshire (1973), Webb (1974), Armstrong and Taylor (1980).
[12] All unemployment is thus structural unemployment since frictional unemployment is absent.

> "that actual unemployment is never *on* the supply curve (if the wage rate is below equilibrium) or the demand curve (when below equilibrium), but let us assume, to the left of both the demand and supply curve" (Hansen: 1970:6).

This is represented in Figure 5 where the quantity of labour is plotted on the horizontal axis and the wage level on the vertical axis.[13] If the wage (w_1) is above the market clearing level (w*), unemployment arises corresponding to the distance KM, while vacancies exist equal to KL. At the market-clearing wage w*, vacancies and unemployment are equal and correspond to NO, and, for wages below the market clearing level (w_2), an excess demand occurs with PR vacancies and PQ unemployment. The locus **EE** is referred to as the 'market clearing path', and it relates the actual quantity of employment to the forces of supply and demand. The shape of the curve is based on the assumption that, as the pressure of demand increases, matching become easier. The distance between **EE** and the supply and demand curve thus represents DDM's 'degree of maladjustment' in the economy. Plotting vacancy rates against unemployment rates will yield the ordinary UV-curve.

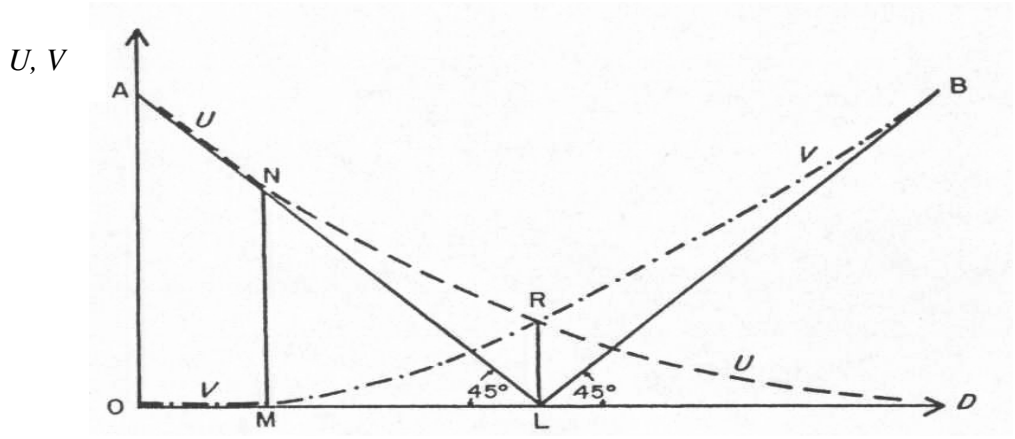

Figure 6: Demand for labour, unemployment and vacancies
Source: Brown, 1976: 136.

The NIESR presents the same phenomenon by plotting vacancies and unemployment against aggregate demand (Webb, 1974; Brown, 1976), yielding Figure 6. When demand for labour is low, such as in O, unemployment occurs corresponding to OA. Unemployment falls, according to line AL,

[13] Bowden (1980) stresses that the real wage rate w/p would be more appropriate.

when aggregate demand increases. For every new additional vacancy there are many unemployed workers, and it will be easy to find an unemployed worker who meets the job requirements. However, after a certain point (point M) it will be harder to find appropriate, workers and vacancies will exist as well as unemployment. Hence, in full employment (point L), there will exist an equal amount of unemployment and vacancies. When demand for labour further increases, vacancies will increase according to line *VV* and unemployment falls along line *UU*.

3.3 Notions of full employment and the relation with the Phillips-curve

Though DDM never made the claim explicit, the UV-curve analysis bears an implicit notion of full employment in terms of equilibrium between *excess* supply and demand for labour, and lies at the intersection of the UV-curve and the 45 degree line. This corresponds not, however, with the neoclassical definition of an equilibrium outcome in terms of equilibrium between total aggregate supply and demand of labour with an implicit reference to an equilibrium wage rate. It is rather more akin to William Beveridge's definition of full employment, who expressed full employment in terms of unemployment and vacancies (1944: 18).[14]

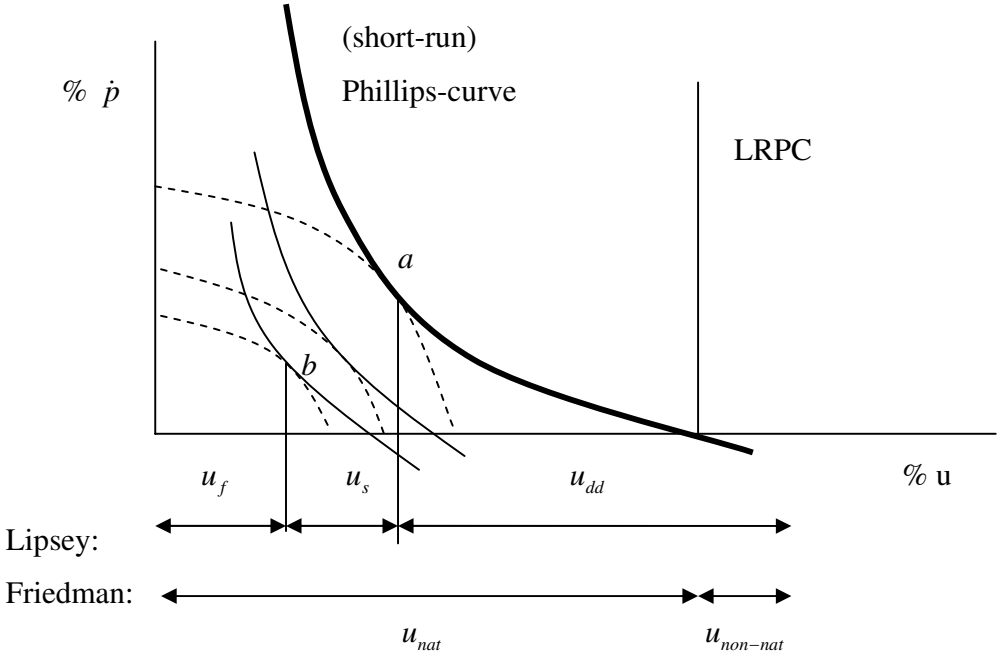

Figure 7: Classification of unemployment according to Lipsey and Friedman
Source: Based on Lipsey, 1965.

[14] This seems the most plausible reason why the UV-curve in the 1980s also became known as the Beveridge-curve. To Beveridge 'full employment' means "having more vacant jobs than unemployed men". (1944: 18-19).

The Phillips-curve provides other operational definitions of full employment and the way to get there.[15] Two important definitions are Lipsey's and Friedman's. Lipsey (1965) defines full employment as the lowest level of unemployment that could be attained given the government's dual policy targets: both an acceptable rate of inflation and an acceptable rate of unemployment. These dual policy targets can be represented as indifference curves (the dotted lines in Figure 7) and full employment is then derived as the minimum combination of both acceptable inflation and unemployment, i.e. where an indifference curve and the Phillips-curve coincide (point *a*). Unemployment rates above the level of point *a* (full employment) are considered as deficient demand unemployment (u_d), which the government can reduce by an expansionary fiscal policy. In Lipsey's account full employment is thus subjectively determined by the government's preferences. In full employment, the remaining unemployment consists of both frictional unemployment (u_f) and structural unemployment (u_s). In Lipsey's account, the government might be able to reduce the level of full employment by the reduction of structural unemployment (u_s). This implies a shift of the Phillips curve to the left until a lower full employment state is realized at a lower indifference curve at point *b.* Shifts of the Phillips-curve to the left could be brought about by, for example, "reducing inequalities in excess demand between various labor markets, and reducing the time taken in changing the supply of labor into the form in which it was being demanded" (Lipsey, 1965: 213). The trade-off of costs and benefits of policy measures, such as retraining the unemployed, determines the level of reduction of structural unemployment. Finally, the level of frictional unemployment is exogenous and unavoidable.

[15] The relation between the Phillips-curve and the UV-curve was formally derived as follows. The UV-curve can be written as:

$$v = \gamma \frac{1}{u} \qquad \gamma > 0 . \tag{1}$$

The increase in wages can be written as a function of excess demand for labour: $\Delta w = f(XD)$. With the difference between vacancies and unemployment taken as excess demand, this relation becomes:

$$\Delta w = \alpha(v - u) + \beta . \tag{2}$$

Substituting (1) in (2) then gives:

$$\Delta w = \frac{\alpha\gamma}{u} - \alpha u + \beta , \tag{3}$$

which is the original 1958 Phillips-curve relation, i.e. the relation between wage increases and unemployment.

Friedman (1968) provides another operational definition of full employment based on what now is known as the Long Run Phillips-curve (LRPC). Friedman (and Phelps, 1967) deny the existence of a trade-off between unemployment and inflation. Workers form rational expectations about future inflation, and, when they realize they will be fooled by decreases in real wages as a consequence of inflation shocks, they will withdraw labour from the market. The long-run Phillips-curve is therefore vertical and unemployment cannot be pushed below its 'natural rate' (u_{nat}). Long-run equilibrium in the labour market can only exist when there is equilibrium in both the labour and the financial market.

Obviously the different frameworks – UV-curve and Phillips-curve – bear different and conflicting notions about the nature of equilibrium and full employment. Figure 8 presents the relation between the notions of Lipsey (L), Dow and Dicks-Mireaux (DDM), and Friedman (F), and their corresponding level of full employment. It will be clear that in all accounts the exact level of full employment is primarily determined by the position of the empirical UV- or Phillips-curve.

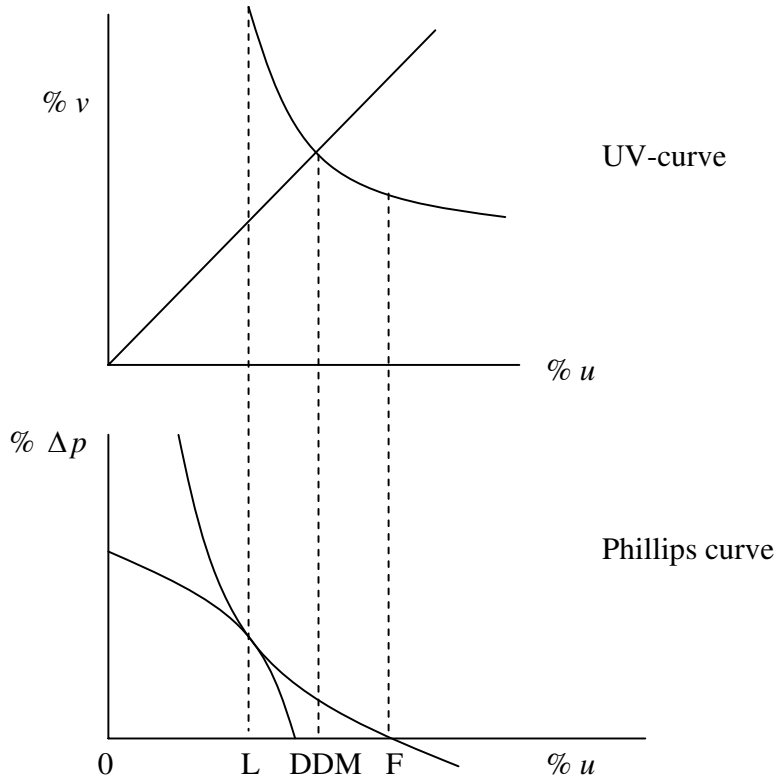

Figure 8: Relation between concepts of full employment in UV- and Phillips-curve frameworks
Source: Based on Gordon, 1966.

4 The UV-curve stability debate

The work of DDM as well as theoretical analyses by Holt and David (1966) and Gordon (1966) inspired a series of empirical studies in the late 1960s and throughout the 1970s, estimating the relation between unemployment and vacancies. Cohen and Solow (1967) found a stable relationship between unemployment and vacancies,[16] however, almost immediately after Cohens and Solows publication other empirical studies found supposed 'breakpoints' in the UV-curve, suggesting shifts of the curve further or closer to the origin corresponding to higher or lower levels of structural unemployment. This obviously raised questions about the stability of the UV-relation and the usefulness of the UV-curve as a structural relation for economic analysis and measurement, and resulted in an enormous amount of empirical studies since the 1970s with an abundance of specifications of the UV-curves all of which incorporate additional variables, dummy variables or lagged variables. The discussion took place roughly speaking following national boundaries. The discussion in the USA focused on the behaviour of the Help-Wanted Index[17] – as a proxy for vacancies – in relation with unemployment for US data for the period 1951-1966.[18] Cohen and Solow (1970) find a systematic pattern connected with business cycle fluctuations. During downswings the regression overestimates the HWI and underestimates it in an upswing. This phenomenon, confirmed in almost all later empirical studies, reveals 'counter clockwise' loops in the UV-relation (see Figure 9). The generally accepted explanation was that vacancies respond much faster to changes in aggregate demand than unemployment does. The adjustment process of labour is just more time consuming than the posting of a vacancy. The finding of these 'counter clockwise loops' was obviously of economic interest, and in a certain way even reassuring since they could be related with the 'loops' found in the Phillips-curve. But the loops made precise observation of shifts rather difficult.

[16] Solow's empirical study was motivated by the debate in the early 1960s that became known as the 'structuralist /deficient demand' debate, or, as it was sometimes referred to, the 'structuralist/antistructuralist' debate on the nature of unemployment in the USA. The claim of the structuralists was that the high unemployment in the USA in the 1960s (around a 5 percent level) was caused by an increase in structural unemployment.

[17] The Help Wanted Index of the National Industrial Conference Board is a weighted average of indexes of the number of help-wanted advertisements posted in leading newspapers of 52 cities in the United States.

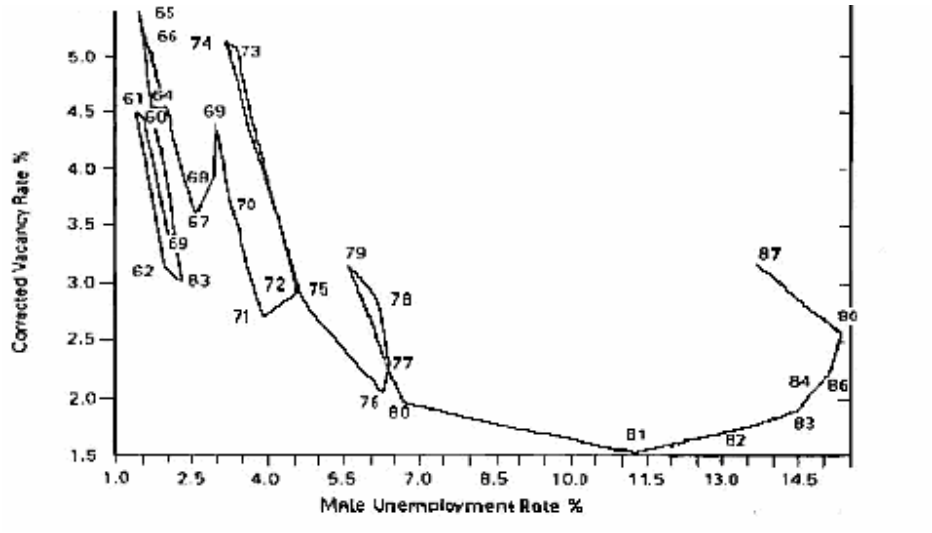

Figure 9: Loops and breakpoints in the empirical UV-curve for Great Britain (1959 –1987)
Source: Jackman et al., (1989: 378)

Year	Author	Cause of shift
1970	Bowers et.al.	combination of factors
1972	Gujarati	Redundancy Payment Act (1965), National Insurance Act (1966)
1972	Taylor	"labour shake out" (labour dishoarding)
1973	Foster	various reasons
1974	Foster	increase in 1940s birth rates
1975	Evans	increase in structural unemployment
1977	Evans	fluctuations in registered unemployment and registered vacancies
1982	Van der Berg	increase in female labour supply and geographical spreading of labour force
1987	Budd et al	deterioration of human capital (due to long term unemployment)
1989	Jackman et al	decrease of search intensity
2001	Wall & Zoega	business cycles

Table 1: Supposedly causes of shifts of the UV-curve

[18] Cohen and Solow (1967, 1970), Gujarati (1969), Burch and Fabricant (1968, 1971), all in *The Review of Economics*

A more comprehensive discussion focused on the stability of the British UV-curve for the period 1958-1971.[19] These studies all find 'breakpoints' or shifts of the UV-curve for the British economy, but disagree about what causes the shifts. Econometric analysis usually provided no or only very little evidence for the alternative hypotheses tested. Table 1 summarises the main contributions to the discussion and the presumed causes of the shift of the British UV-curve. After three decades of testing and specifying the UV-curve Jackman et al (1989: 392) admits that: "we must remain agnostic as to the causes of the change", rendering the UV-curve as an unstable relationship.

The economy turns out to be subject to a set of unknown factors, which affect the UV-curve in three ways simultaneously. Changes in aggregate demand in the economy cause movements along an otherwise stable UV-curve, while at the same time structural changes in the economy (whatever they may be) or shocks that affect the labour force cause movements of the curve itself. And finally, economic policy aimed to make matching in the labour market more efficient shifts the UV-curve inwards deliberately. And we are not able to distinguish between these movements. As a consequence of these simultaneous movements, the exact shape of UV-curve cannot be estimated and hence classes of unemployment cannot be determined exactly. This bears resemblance with the identification problem of supply and demand curves in macroeconomics, where price-elasticities of supply and demand cannot be estimated when it is unknown whether price or quantity changes are caused by shifts of the supply or the demand curve. This identification problem could be overcome if economic theory could provide good reasons for a particular shape of the UV-curve or could give good reasons for conditions where UV-shifts are absent. In that case it would be possible to estimate the UV-curve and trace out its shifts. But unfortunately, economic theory – neither Keynesian or Neoclassical – is able to do so, leaving the UV-curve underdetermined.

5 A new paradigm: towards flows and microfoundations

In the 1980s, studies using UV-analysis became rare. While Armstrong and Taylor in 1980 still argue that UV-analysis "continues to have considerable potential for further development" (p.100), it was almost completely abandoned only a few years later, as Muysken's article *A Post-Mortem on the UV-analysis* (1988) illustrates. Opponents of the UV-analysis were found in a neoclassical paradigm

---

and Statistics.

[19] Bowers, Cheshire and Webb, 1970), Gujarati (1972a, 1972b, 1973), Taylor (1972), Foster (1973), Knight and Wilson (1974), Evans (1975, 1977), Holden and Peel (1975, 1977), Warren (1977), Parikh (1977), Bewley (1979), almost all in *The Economic Journal* and *Applied Economics*.

which finally took over Keynesian, macroeconomic thinking on unemployment and was labelled as 'search theory', 'flow approach' or 'new microeconomics'.

Economists of this new paradigm, like Phelps and Holt, argued that the UV-analysis suffered from two flaws: i) it was a static approach that analysed stocks rather than flows, and ii) it lacked a microeconomic foundation; it was a black box that didn't provided any explanation. Two issues the new paradigm did address. The new paradigm was motivated by the fact that macroeconomic rational expectations theories of unemployment lacked a microeconomic foundation. Phelps and Holt (1970) sought these foundations in the individual search behaviour of agents. Unemployed make rational decisions to accept a job offer or reject it when they expect higher payoffs from other future job offers. Unemployment is hence seen as a productive investment.

Characteristic of search theory is that it analyses equilibrium unemployment in terms of flows in and out of unemployment rather than a static difference stocks as the UV-analysis did. Unemployment and vacancy figures alone are not informative about structural unemployment since the duration of unemployment has to be taken into account as well. A reduction of the velocity of circulation in the pool of unemployed will increase the number of long-term unemployed. Changes in unemployment duration therefore hampers tests of changes in structural unemployment and hence the UV-analysis.[20] The problem of unemployment duration became a central research question in the late 1970s and early 1980s when unemployment rose sharply and most notably European countries experienced persistent long-term unemployment. This led to the formation of new theories of unemployment such as hysteresis theory.

A particular brand of this search theory is matching models, which draw back on the pioneering work of Butters (1977), Hall (1979), Pissarides (1979, 1985), Bowden (1980), Diamond (1982) and Blanchard and Diamond (1989, 1994). The key idea of matching models is that the complicated and stochastic process of job search is captured in one single, well-behaved, aggregate, mathematical function, called the matching function. The idea of a labour market divided in frictionless submarkets is abandoned and replaced by one mathematical function accounting for the flows in the labour market. In it most elementary form the matching function is:

$$M = m (U, V) \qquad (1)$$

[20] Burch and Fabricant (1968: 279-280) stress this point as they argue that one cannot conclude from the finding of a shift in the HWI - Unemployment relation that there was an increase in structural unemployment due to changes in duration of unemployment.

This function expresses matches between unemployed and vacancies in a discrete, aggregate way. Thus without explicit reference of the source of friction the equilibrium outcome is defined in a small set of variables.

Three assumptions concerning the matching function are usually made. A first, and necessary, assumption is:

Assumption 1: $M = m(U, V)$ is non-decreasing in U and V.

This assumption means that there is a non-decreasing 'marginal productivity' of unemployment and vacancies. Only more unemployed (or only more vacancies) do not induce more matches. A second assumption ensures the stability of the curve for analyses.

Assumption 2: Inflow in employment equals outflow out of employment

Finally a third, though not necessary, assumption is usually added.

Assumption 3: $M = m(U, V)$ is homogeneous of degree one.

This assumption, which states that a 10 percent increase in both vacancies and unemployment will lead to a 10 percent increase in matches, is added because of its convenience.[21] It ensures that the efficiency of matching does not depend upon the size of the market and hence a constant unemployment rate along a balanced growth path in a growing economy is assured. At the same time it enables us to write the matching function as a function of only one variable, θ the ratio of v/u, which is referred to as the labour market tightness. The matching function is then written then:

$$M = m(U, V) = m(1, \theta) \qquad (2)$$

In a UV-space the matching function is stable, convex to the origin and exhibits diminishing returns to the input factors; i.e. it corresponds with the empirically found UV-curve. The role of the matching

[21] Increasing returns to matching for example make an analysis much more complicated since multiple equilibria could be possible (Petrongolo and Pissarides, 2000: 4)

function is to provide a framework for analysing flows of unemployed without bothering about the underlying matching process. How the matches between individual unemployed and unfilled jobs are made is not made explicit, since the matching function only gives an aggregate outcome. The underlying frictions in the labour market and their effect on unemployment is not analysed individually, but the outcome effect as a whole is considered. It is therefore used in a similar way as production and utility functions. For the same reason as for production or utility functions often a Cobb-Douglas type of matching function is assumed.[22]

$$M = NU^{\alpha}V^{1-\alpha} \qquad (3)$$

The economic interpretation of α is as the contribution of the unemployed to the search process. N can be interpreted as a technology-parameter. Other matching models incorporate additional variables like search effectiveness or search intensity. The matching function is then defined as:

$$M = m(cU, V) \qquad (4)$$

Structural shifts of the UV-curve are then explained by changes in the factor c, the search effectiveness (see for example Nickell, Layard and Jackman, 1991).

After unemployed and vacancies are brought together by this stochastic matching technology, matching models focus consequently on the division of the outcome of this productive match, often as a bargaining process, where the surplus is divided according to a surplus-sharing rule. Two equilibrium-generating mechanisms are usually explored: the effect of wage adjustments and the effects of labour tightness adjustment. The equilibrium outcome, i.e. the values of the variables U, V and W (wage) are determined by equilibrium conditions and is at the intersection of the stable UV-curve and the job creation curve, a straight line with as slope θ, the labour market tightness.

The strength of this new paradigm appears that it circumvents the problems inherent to UV-analysis. The new framework enables economists to analyse heterogeneous groups of workers with different characteristics in terms of probabilities of in- or outflow.[23] Workers with a higher rate of job

[22] Though there are attempts to assess matching functions empirically, none of them commands universal support and none convincingly says why the aggregate matching function should be of the Cobb-Douglas form.

[23] When L is the size of the labour force, N the number of employed workers and U the number of unemployed workers $N+U=L$ holds. With s being the separation rate, the inflow in unemployment is sN, while the outflow is fU with f being the rate of job finding. In equilibrium (i.e. de absence of deficient demand) inflow equals outflow, hence $sN = fU$.

finding, experience shorter unemployment durations and lower rates of structural unemployment. So, workers and job vacancies are no longer considered as homogeneous and both therefore have to spend time and resources in order to find a good match. Even in the absence of deficient demand for labour, unemployment and vacancies coexist as a consequence of this time-consuming search process. So the new paradigm does not only provide a profound analysis of flows, in addition it provides a theoretical explanation for simultaneous coexistence of unemployment and vacancies.

6 Conclusions

The decline of the UV-analysis is usually attributed to methodological flaws. The UV-analysis had some drawbacks which made the method even in its heyday subject to debate. (Armstrong and Taylor, 1980: 122). Advocates of the UV-analysis reckoned as main, though passable problems, the difficulty of reliable data collection (especially of vacancies), the problem of no intersection between UV-curve and 45 degree line, and, to a lesser degree, the shifts of the UV-curve (Brown, 1976: 142, Armstrong and Taylor, 1980: 123). The shifts were not considered a serious threat to the UV-analysis mainly because of the optimistic belief in the 1970s and 1980s that the underlying cause or causes of the shift of the UV-curve could be identified and could be accounted for in the specification of the UV-curve. The identification problem of the UV-curve had as consequence that it became impossible to distinguish between different movements of the UV-curve: movement along the UV-curve, necessary for measurement, deliberate attempts to move the UV-curve inwards by economic policy in order to reduce structural unemployment, and unintended structural shocks of the UV-curve for reasons yet unknown. The underdetermination of the UV-curve clearly makes measurement of classes a risky affair.

It is however remarkable and perhaps even ironic to see that matching models of unemployment, that succeeded the UV-analysis as a framework for analysis of unemployment also make critical use of the idea of the UV-curve as a structural, invariant relationship and don't seem to be hindered by underdetermination problems of the UV-curve. How can we account for this contrast? A first explanation might be that the UV-analysis was set up as a measurement device in the first place. Since the UV-curve couldn't be exactly identified, its use as a measurement device for classes of unemployment became dubious. In addition, the distinction of unemployment in classes could be tricky, since "the various categories of unemployment are not always as distinct and separate as has

---

Rewriting this equation yields the equilibrium (or non-deficient demand) unemployment rate $u^* = U/L = s/(s+f)$. This level of unemployment is thus expressed in terms of separation and job quite rates.

been suggested" (Hughes and Perlman, 1984:32-33). Workers who become unemployed as a consequence of lack of aggregate demand may remain unemployed for the long term and lose professional and social skills necessary for their occupation. Consequently they should be considered as structural unemployed. The distinction between cyclical and structural unemployment is therefore blurred by 'various unemployment–persistence mechanisms' (Lindbeck, 1999: 2), and search models try to provide insight into these mechanisms. Matching models on the other hand, were established for other purposes, namely as devices for analytical exploration of mechanisms that generate unemployment. In matching models the identification problem is simply circumvented by deriving the UV-curve to specific forms, such as described by a Cobb-Douglas function.

A second explanation could well be the inability of the UV-analysis to deal with flows in and out of unemployment and changes in unemployment duration. Search theory, in contrast, is – under the assumption of equilibrium in and outflow – able to do so, and provides answers to questions that became relevant in the 1980s when long-term unemployment started to occur. On the other hand, search theory isn't able to deal with cyclical unemployment.

These arguments seem not exhaustive, though. Clearly a paradigmatic element has to be taken into account too in the decline of UV-analysis. The UV-analysis was developed at a time when economists had a strong belief in the effectiveness of Keynesian, aggregate demand management. The main concepts that UV-analysis aimed to measure, such as excess demand and cyclical unemployment, are important Keynesian concepts, and they were measured in the first place for the guidance of Keynesian economic policy. Since this belief in Keynesianism was much more profound in Great Britain and continental, Western European countries than in the USA, it is no surprise to see that UV analysis gained popularity almost exclusively in Europe. In the USA, economists had a deeper suspicion to active Keynesian macroeconomic policies. Indeed, in the 1960s, American economists like Friedman and Phelps attacked the Keynesian disequilibrium theory that formed the foundation of UV-analysis and stressed the compatibility of unemployment with equilibrium by putting forward the idea of a natural rate of unemployment. With the fall of Keynesian thinking in the 1970s, measurement of Keynesian concepts, as offered by UV-analysis, became more or less redundant, and contemporary economics became less concerned with cyclical or deficient demand unemployment.

Though the problem of cyclical unemployment is rather ignored by contemporary mainstream economics, such as search theorists, the problem of identification and quantification of the nature of unemployment will not go away. It lies at the heart of the 'structural/deficient demand' debate in the

1960s in the USA and the more recent debate on 'sectoral shifts' or 'reallocation shocks' vs. 'aggregate disturbances' (Lilien: 1982, Abraham and Katz: 1986, Brainard and Cutler: 1993) in modern macroeconomics.[24] The words of Lipsey (1965: 218) therefore remain as relevant as they were in the 1960s: "The issue of structuralist versus deficient-aggregate-demand theories will arise at other times and at other places. It seems therefore that an effective method of testing between these two theories should be developed, so that the procedure will be ready when the debate breaks out again". UV-analysis tried to provide such a method, but failed to be effective. However, as long as we have no such a method, the problem of identification and quantification of the nature of unemployment will remain a key issue in labour economics and – since we have so little monitoring or measuring devices in the labour markets – the UV-curve a prime monitoring device for the performance of the labour market.

It is therefore no surprise that even in contemporary economic mainstream thinking, shifts of the UV-curve are recognized, and the instability of the UV-curve is taken as an indictor of the performance of the labour market in terms of efficiency in matching unemployed and vacancies – even though this is hindered by changes in in- or outflows.[25] As such, the UV-curve serves an important diagnostic function, even for current search theorists, more or less like 'PV' or 'indicator diagrams' do in mechanical engineering (see Figure 10). In these diagrams, the pressure and volume in a combustion engine are simultaneously recorded and plotted as a function of the engine's working cycle, for the purpose of diagnosing the state of the engine and fine-tuning of the operation of the machine. Or in this case: the labour market.

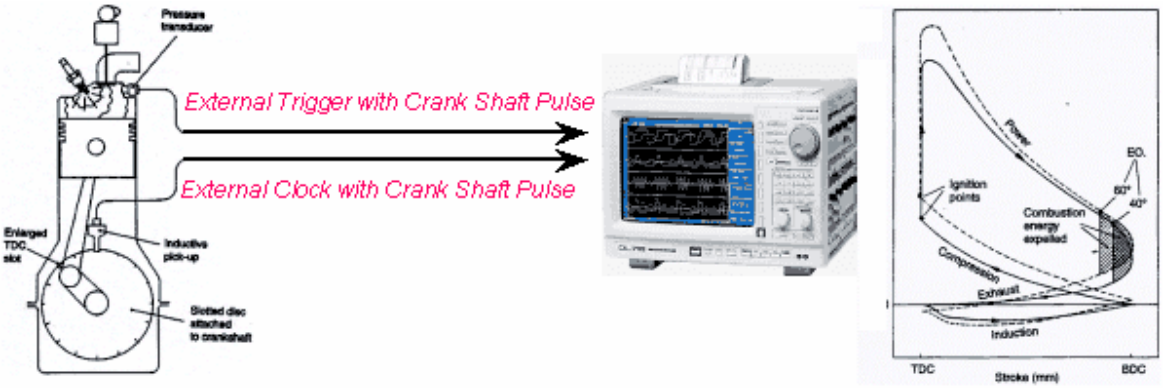

Figure 10: The recording of an indicator diagram for diagnostic purposes.
Source: Yokogawa Electric Corporation[26]

[24] The issue in this latter debate is again how to identify the effects of aggregate demand changes from structural changes (at the level of sectors).
[25] See, for example, Gregg and Petrongolo (1997)
[26] http://www.yokogawa.com/tm/pdf/appli/tm-appli_auto12.pdf

Finally, in retrospect, it can be argued that measurement with the UV-device had a significant impact on economic theory. The place of the UV-curve in economic theory was not immediately clear and competing notions derived from the UV- and Phillips-curve framework dominated macroeconomic thinking, particular in the 1960s. Current matching models of unemployment still apply the idea of structural co-movement of U and V data by using a matching function. The correlation between U and V data is therefore still valid, but economists are no longer seeking causal structure at the macro-level. And through a shift in paradigm the inductively established empirical UV-curve became a deductively derived UV-curve, firmly rooted in and reinforcing neoclassical economics.

Reference

Abraham, K.G. (1983), Structural/Frictional vs. Deficient Demand Unemployment: Some New Evidence, *The American Economic Review*, vol. 73, no 4, 708-724

Abraham, K.G. (1983), Structural/Frictional vs. Deficient Demand Unemployment: Reply, *The American Economic Review*, vol. 76, no 1, 273-276

Abraham, K.G. and Katz, L.F (1986), Cyclical Unemployment: Sectoral Shifts or Aggregate Demand Disturbance, *The Journal of Political Economy*, vol. 94, no 3, 507-522

Armstrong H. and Taylor, J. (1980), The Measurement of Different Types of Unemployment, in: Creedy, J. (ed.), *The Economics of Unemployment in Britain*, Buttersworths, London

Berg, D.J. van der (1982), Specification and Estimation of the Unemployment-Vacancy Curve in the Period 1956-1979, *De Economist*, vol. 130, no. 3, 397-419

Beveridge, W. (1944), *Full Employment in a Free Society*, George Allen & Unwin Ltd, London

Bewley, R.A. (1979), The Dynamic Behaviour of Unemployment and Unfilled Vacancies in Great Britain: 1958-1971, *Applied Economics*, vol. 11, 303-308

Blanchard, O.J. and Diamond, P.A.(1989), The Beveridge Curve, *Brookings Papers on Economic Activity*, vol. 1989, no. 1, 1-60

Bleakley, H. and Fuhrer, J.C. (1997), Shifts in the Beveridge Curve, Job Matching and Labor Market Dynamics, *New England Economic Review*, sept/oct., 5-19

Borsch-Supan A.H. (1991), Panel Data Analysis of the Beveridge curve: Is there a Macroeconomic Relation between the Rate of Unemployment and the Vacancy Rate?, *Economica,* vol 58, no 231

Bowden, R.J. (1980), On the Existence and Secular Stability of u-v Loci, *Economica,* vol 47, no 185, 35-50

Bowers, J.K., Cheshire, P.C. and Webb, A.E. (1970), The Change in the Relation between Unemployment and Earning Increases: A Review of some Possible Explanations, *National Institute Economic Review*, no.54, 44-63

Bowers, J.K. (1976), Some Notes on Current Unemployment, , in: Worswick, G.D.N. (ed.), *The Concept and Measurement of Involuntary Unemployment*, George Allen & Unwin Ltd, London

Brown, A.J. (1973), *The Framework of Regional Economics in the United Kingdom*, National Institute of Economic and Social research, Regional Papers I, Cambridge University Press

Brown, A.J.(1976), UV-analysis, in: Worswick, G.D.N. (ed.), *The Concept and Measurement of*

Involuntary Unemployment, George Allen & Unwin Ltd, London

Burch, S.W. and Fabricant, R.A. (1968), A further Comment on the Behavior of Help-Wanted Advertisement, *The Review of Economics and Statistics,* vol. 50, no 2, 278-281

Burch, S.W. and Fabricant, R.A. (1971), Cyclical Behaviour of Help-Wanted Index and the Unemployment Rate: A Reply, *The Review of Economics and Statistics,* vol. 53, no 1, 105-106

Budd, A., Levine, P. and Smith, P. (1987), Long-term Unemployment and the Shifting U-V Curve, A Multi-Country Study, *European Economic Review*, vol. 31, 296-305

Butters, G.R., (1977), Equilibrium Distributions of sales and Advertising Prices, *The Review of Economic Studies*, Vol. 44, 465-491

Cheshire, P.C. (1973), *Regional Unemployment Differences in Great Britain*, National Institute of Economic and Social research, Regional Papers II, Cambridge University Press

Cohen, M.S. and Solow, R.M. (1967), The Behaviour of the Help-Wanted Advertising, *The Review of Economics and Statistics,* vol. 49, no1, 108-110

Cohen, M.S. and Solow, R.M. (1970), The Behaviour of the Help-Wanted Advertising: A Reply, *The Review of Economics and Statistics,* vol. 52, no 4, 442-443

Diamond, P.A. (1982), Wage Determination and Efficiency in Search Equilibrium, *Review of Economic Studies*, Vol. 61, Issue 3, 457-475

Diamond, P.A. (1982), Aggregate Demand Management in Search Equilibrium, *Journal of political Economy*, Vol. 90, Issue 5, 881-894.

Diamond, P.A. (1984), *A Search-Equilibrium Approach to the Micro Foundations of Macroeconomics*, MIT Press, Cambridge USA

Dow, J.C.R. and Dicks-Mireaux, L. (1958), The Excess Demand for Labour: A Study of Conditions in Great Britain, 1946-1956, *Oxford Economic Papers*, vol. 10, 1-33

Dow, J.C.R. (1970), *The Management of the British Economy 1945-1960*, Cambridge University Press

Evans, G.J. (1975), A Note on Trends in the Relations between Unemployment and Unfilled Vacancies, *The Economic Journal*, vol. 85, no 337, 135-139

Evans, G.J. (1977), Notes on the Changing Relationship between Registered Unemployment and Notified Vacancies, 1961-1966 and 1966-1971, *Economica*, vol. 44, no 174, 179-196

Foster, J.I., (1973), The Behaviour of Unemployment and Unfilled Vacancies: Great Britain, 1958–1971; A Comment, *The Economic Journal*, vol. 83, no 329, 192-201

Foster, J.I., (1974), The Relationship between Unemployment and Vacancies in Great Britain 1958-72:

Some further Evidence, in: Laidler, D. and Purdy, D.L. (eds.), *Inflation and Labour Markets*, Manchester University Press, 164-196

Friedman, M. (1968), The Role of Monetary Policy, *American Economic Review*, March, no.1

Gregg, P. and Petrongolo, B. (1997), *Random or Non-random Matching? Implications for the use of the UV-curve as a measure of Matching Effectiveness*, Centre for economic Performance, discussion paper no. 348

Gujarati, D. (1969), Cyclical Behaviour of Help-Wanted Index and the Unemployment Rate, *The Review of Economics and Statistics,* vol. 51, no 4, 482-484

Gujarati, D. (1972a), The Behaviour of Unemployment and Unfilled Vacancies: Great Britain, 1958–1971, *The Economic Journal*, vol. 82, no 325, 195-204

Gujarati, D. (1972b), A Reply to Mr. Taylor, *The Economic Journal*, vol. 82, no 328, 1365-1368

Gujarati, D. (1973), A Reply to Mr. Foster, *The Economic Journal*, vol. 83, no 329, 201-203

Gordon, A.R. (1966), *The Goal of Full Employment*, John Wiley & Sons Inc., New York

Hall, R. E. (1979), A Theory of the Natural Unemployment Rate and the Duration of Unemployment, *Journal of Monetary Economics,* 153-169

Hancock, K.J. (1963), Unemployment in Australia, *Summer School of Business Administration*, vol. 8, 35-54

Holden, K. and Peel, D.A. (1975), The Determinants of Unemployment and UV Relationship, *Applied Economics,* vol. 7, 251-255

Holden, K. and Peel, D.A. (1977), The Relationship between Unemployment and Vacancies: Reply *Applied Economics,* vol. 9, 81-82

Holt, C.C and David, M.H. (1966), The Concept of Job Vacancies in a Dynamic Theory of the Labor Market, in: *The Measurement and Interpretation of Job Vacancies: A Conference Report of the National Bureau of Economic Research*, NBER, New York, 1966

Hosios, A. J. (1990), On the Efficiency of Matching and Related Models of Search and Unemployment, *Review of Economic Studies*, vol. 57, 279-298

Hughes, J. J. and Perlman, R. (1984), *The Economics of Unemployment*, *A Comparative Analysis of Britain and the United States*, Wheatsheaf Books Ltd

Jackman, R., Layard, R. and Pissarides, C. (1989), On Vacancies*, Oxford Bulletin of Economics and Statistics,* vol. 51, no 4, 377 - 394

Kalachek, E. and Westebe, R. (1961), Rates of Unemployment in Great Britain and the United States, 1950-1960, *The Review of Economics and Statistics*, vol. 43, no 4, 340-350

Katz, L. (1988), Some Recent Developments in Labor Economics and Their Implication for Macroeconomics*, Journal of Money, Credit and Banking,* vol. 20, no. 3

Knight, K.G. and Wilson, R.A. (1974), Labour Hoarding, Employment and Unemployment in British Manufactoring Industry, Applied Economics, vol. 6, 303-310

Kuipers, S.K. and Buddenberg F.H. (1978), Unemployment on Account of Market Imperfections in the Netherlands since the Second World War, De Economist, vol. 126, no. 3, 390-412

Layard, R. and Nickel, S. (1986), Unemployment in Britain, *Economica*, vol. 53, 121-169

Layard, R., Nickell, S., and Jackman, R. (1991), *Unemployment: Macroeconomic Performance and the Labour Market*, Oxford University Press

Leeson, R. (2000), *A.W.H. Phillips: Collected Works in Contemporary Perspective*, Cambridge University Press, Cambridge

Lipsey, R.G. (1965), Structural and Deficient-demand Unemployment Reconsidered, in: McCormick B.J. and Owen Smith E. (eds.), *The Labour Market*, Hammondsworth, 245-269

Lindbeck, A. (1999), *Unemployment – Structural*, Institute for International Economic Studies, Stockholm University, seminar paper no. 676

Malinvaud, E. (1994), *Diagnosing Unemployment*, Cambridge University Press

Muysken J. and Meijers, H.(1988), *A Post-Mortem on UV-analysis*, Research Memorandum 88-031, University of Maastricht

Muysken, J. (1989), Classification of Unemployment: Analytical and Policy Relevance, *De Economist* vol.137, no. 4

Parikh, A. (1977), The Relationship between Unemployment and Vacancies: Comment, *Applied Economics,* vol. 9, 77-80

Peirce, C.S. (1931–1966), *The Collected Papers of Charles S. Peirce*, 8 vols., C. Hartshorne, P. Weiss, and A. W. Burks (eds.). Cambridge: Harvard University Press

Petrongolo, B. and Pissarides C.A., (2001), Looking into the Black Box: A Survey of the Matching Function, *Journal of Economic Literature*, vol. 39, 390-431

Phelps E.S. (1968), Money-Wage Dynamics and Labor-Market Equilibrium, *Journal of Political Economy,*76, 678-711

Pissarides, C.A. (1979), Job Matching with State Employment Agencies and Random Search, *The*

Economic Journal, Vol. 89, Issue 356, 818-833

Pissarides, C.A. (1985), Short-Run Dynamics of Unemployment, Vacancies, and Real wages, *The American Economic Review*, Vol. 75, Issue 4, 676-690.

Pissarides, C.A. (1986), Unemployment and Vacancies in Britain, *Economic Policy: A European Forum*, vol 1 no 3, Cambridge University Press

Pissarides, C.A. (1994), Search Unemployment with On-the-job Search, *Review of Economic Studies*, Vol. 61, Issue 3, 457-475

Pissarides, C.A. (1999), *Equilibrium Unemployment Theory*, MIT Press

Reid, F. and Meltz, N.M. (1979), Causes of Shifts in the Unemployment-Vacancies Relationship: An Empirical Analysis for Canada, *The Review of Economics and Statistics*, vol.61, no 3, 470-475

Solow R.M. (1964), *The Nature and Source of Unemployment in the United States,* (Wicksell Lecture 1964) Almqvist & Wiksell, Stockholm

Storer, P. (1994), Unemployment Dynamics and Labour Market Tightness: An Empirical Evaluation of Matching Function Models, *Journal of Applied Econometrics*, vol. 9 no 4, 389-4519

Taylor, J. (1972), The behaviour of Unemployment and Unfilled Vacancies: Great Britain, 1958 – 1971, An Alternative view, *The Economic Journal*, vol. 82, no 328, 195-204

Thirlwall, A.P. (1969), Types of Unemployment, with Special Reference to "Non-Demand Deficient" Unemployment in the UK, *Scottish Journal of Political Economy*, vol. 16, no. 1

Wall, H.J. and Zoega G. (2001), *The British Beveridge Curve: A Tale of Ten regions*, CEPR discussion paper 1771

Warren, R.S. (1977), The behaviour of Unemployment and unfilled Vacancies in Great Britain: a Search-Turnover View, *Applied Economics*, vol. 9, 237-242

Warren, R.S. (1980), Unemployment and Unfilled Vacancies in U.S. Manufacturing: A Search-Turnover View, *The Review of Economics and Statistics*, vol. 62, no 2

Webb, A.E. (1974), *Unemployment, Vacancies and the Rate of Earnings: A Regional Analysis,* National Institute of Economic and Social research, Regional Papers III, Cambridge University Press