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By Manimay Sengupta

Abstract. We propose an unemployment measure that provides an index of the concentration of unemployment among the unemployed. A set of axioms are used to derive the unemployment measure. The measure is shown to satisfy a number of desirable properties that relate to the sensitivity of an unemployment measure to the inequality in the distribution of the unemployment.

Keywords. Unemployment spells, duration statistics, welfare loss, long-term unemployment.

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1. Introduction

Unemployment has probably more economic, and also political, dimensions than any other economic variable, for it relates directly to the inequality, poverty and welfare of a society. Yet, somewhat surprisingly, not much attention has been paid to the conceptual issues in measuring unemployment. Two conventional statistics are commonly used as unemployment measures. The unemployment rate measures total unemployment as a proportion of the total potential employment given the available labour force, and the mean duration of unemployment measures the average of the durations of the 'in-progress' spells of unemployment. In addition, there are two measures of unemployment duration: the first is suggested in the work of Fowler (1968) and Kaitz (1970); the second suggested recently by Akerlof and Main (1981). While the measurement problems associated with these statistics have received a great deal of attention,[1] relatively less attention has been paid to the analysis of the conceptual bases of these measures. Significantly, despite their obvious welfare implications, the welfare bases of the duration statistics have not been fully explored.

This paper is an attempt to clarify some of the conceptual issues in the measurement of unemployment. Particular emphasis will be placed on incorporating the significance of longer durations of unemployment in the measurement of unemployment. In this light, we shall argue that the measures of unemployment duration noted above do not satisfy some of the desirable properties that one may require such a measure to satisfy. We shall propose a set of properties for such a measure, and a new unemployment measure will be derived axiomatically.

The motivation for the unemployment measure proposed in this paper stems from the contributions of Clark and Summers (1979) and Akerlof and Main (1980), whose work provide evidence of the importance of long-term unemployment in accounting for the total unemployment in the economy. Their work establish that, rather than there being an equal sharing of the burden of unemployment among the unemployed as the

earlier studies seemed to imply, there are significant inequalities in the distribution of this burden. Thus, one of the key issues in measuring unemployment is the degree of concentration of the unemployment burden. There is thus the need to construct an unemployment statistic that measures this concentration while being appropriately sensitive to the inequality in the distribution of the unemployment burden. The measure we propose is addressed to the construction of such an index.

The plan of the paper is as follows. In Section 2, we discuss the significance of long-term unemployment in the measurement of unemployment, drawing on the contributions of Clark and Summers (1979, 1980) and Akerlof and Main (1980). We also critically evaluate the measures of unemployment duration currently in use. In Section 3, we suggest a set of axioms for a measure of unemployment. In Section 4, we provide a formal framework for incorporating the inequality in unemployment durations in measuring unemployment. Drawing on some of the concepts proposed in the measurement of inequality, a class of unemployment measures is defined, which correspond to a normalized welfare loss due to unemployment in terms of an associated social welfare function. We clarify the welfare bases of the unemployment rate and the current measures of unemployment duration by showing that all of these measures are members of this class, and they can all be viewed as an appropriately normalized welfare loss in terms of a "utilitarian" social welfare function. We then specialize this class to develop a family of measures which can be related to the unemployment rate in the following manner: For any given level of unemployment, a measure in this class reduces to the unemployment rate if the total unemployment in the economy is taken to be equally distributed; moreover, this "equal distribution" value of the measure given by the unemployment rate provides the lower bound of the measure. Thus, the difference between the magnitudes of a measure in this class and the unemployment rate corresponds precisely to the inequality in the distribution of the unemployment, and thus provides an index of the concentration of unemployment. In Section 5, an unemployment measure in this class is characterized in terms of certain axioms, which satisfies the properties set out

in the axioms we noted in Section 3. In Section 6, the policy implications of the measure are discussed and the limitations of the measure are noted. We conclude in Section 7.

2. Motivation for a Measure of Unemployment Duration

That unemployment imposes severe social and economic costs on a society is a scarcely disputed fact.[2] Even so, Milton Friedman has argued that reducing unemployment below a certain 'natural' rate impinged on economic efficiency (Friedman (1968)). The essential idea underlying this line of reasoning appears to stem from what has come to be known as the "dynamic" or the "turnover" view of unemployment, associated primarily with Feldstein (1973), Hall (1970, 1972) and Perry (1972). According to this view, the significant part of the observed unemployment is caused by workers moving frequently in and out of the unemployment pool, as they adjust to the structural changes in the economy, or choose to remain unemployed as part of a productive search for new jobs. Most unemployment is accounted for by spells of unemployment which are on average quite short, while "hard core" long-term unemployment is suffered by a small fraction of the unemployed who either suffer recurrent spells of unemployment, or display chronic inability to find and maintain jobs.[3]

This dynamic view of unemployment has come in for severe criticism in recent years. Clark and Summers (1979), in particular, showed that a significant proportion of unemployment in the U.S. is accounted for not by the unemployment of the individuals in transition from one job to the other, but rather by long-term, concentrated joblessness of a relatively small fraction of the unemployed. In 1974 for example, Clark and Summers estimated that 2.4 percent of the labour force who experienced unemployment for more than six months accounted for 41 percent of the total unemployment, while almost 5 percent of the labour force who were out of work for more than twenty-six weeks accounted for two-thirds of all non-employment (which includes the unemployment of those registered as unemployed, as well as those who have stopped looking for work). Akerlof and Main (1980) have reconfirmed the significance of the long spells of unemployment in accounting for the total unemployment by showing that for the U.S. data

on unemployment for the period between 1965 to 1977, individuals with single and multiple spells of unemployment suffered more unemployment than the available statistics on unemployment spells revealed.[4]

The welfare implication of the long-term unemployed accounting for much of the total unemployment in a given period is clear. If most of the unemployment were to be explained by short spells of unemployment suffered by a large proportion of the unemployed, the burden of unemployment would tend to be equally shared among them. On the other hand, if a large proportion of the total unemployment is concentrated in a relatively small fraction of the unemployed, the latter bears a disproportionate amount of the burden. From the policy point of view, as Clark and Summers (1979, 1980) have emphasized, the latter evidence must shift the emphasis from policies that stabilize the labour market to those that are expressly geared to the job creation for the long-term unemployed.

There are two duration statistics for unemployment on which much of the dynamic view of unemployment was based. The first, which we shall denote by T, is the commonly used duration statistic which measures the average length of the 'in-progress' spells of unemployment, i.e., it is the average time spent in unemployment by those who are currently unemployed (or the average length of the interrupted spells, as it is often called). Thus if n is the total number of the unemployed at the date of the survey, and each individual i has been unemployed for a duration s_i (measured, for example, in weeks), then we have

$$T = \sum_i s_i/n \ .$$

A second statistic, to be denoted by S_{TW}, measures the average of all unemployment spells that terminate over a specified period of time (commonly over a calendar year). If τ denotes the number of such spells, and t_i the total length of the spells of unemployment of person i completed during the given period, then one has

$$S_{TW} = \sum_i t_i/\tau \ .^{5}$$

In his pioneering work on the unemployment durations in the U.S. between 1948 and 1969, Kaitz (1970) estimated that the latter measure was only to the order of 40-62 percent of the former. Both of these statistics in general, and Kaitz's relative estimates of them in particular, have played a central role in the advocacy of the dynamic view of unemployment. Feldstein's (1973) influential paper in its support was based almost entirely on the statistic T. Both Hall (1972) and Perry (1972) used the statistic S_{TW} to show that the U.S. labour market was characterized by a high rate of turnover of the unemployed.

It is clear that both T and S_{TW} may well conceal much that may be relevant to capture the unemployment experience of the unemployed. The measure T, being an average of the interrupted spells of unemployment, may significantly underestimate the total amount of unemployment suffered by an individual, since the completed spells of unemployment eventually experienced may be well above the lengths of the corresponding interrupted spells.[6] The measure S_{TW} may also significantly underestimate the unemployment experience of the unemployed, since it essentially weights all completed spells of unemployment in a given period equally. Thus, a large proportion of the unemployed who have experienced only short spells of unemployment in a given period may swamp the long-term unemployment of a significant minority, and thus produce a deceptively low value for the statistic S_{TW}. It is also clear that, by their very definitions, neither of these two unemployment statistics will produce a true picture of the unemployment experience of those who are currently unemployed, as neither of these weights the unemployment spells in terms of their contributions to the total unemployment. In particular, neither of them may reveal that most unemployed persons may be unemployed for a very long period.

To capture the unemployment experience of those who are currently unemployed, Akerlof and Main (1981) have suggested a third measure of unemployment. This measure gives the average of the completed spells of unemployment of those who are currently unemployed. If n is the total number of the persons identified as unemployed at

a given point of time and c_i is the length of the completed spell of unemployment for an individual i, then this measure is given by

$$S_{EW} = \sum_i c_i/n \ .$$

Akerlof and Main (1981) call S_{EW} an "experience-weighted" measure, since, in a steady state, it is equivalent to weighting each of the current (completed) spells of unemployment by its length. Assuming steady state, Akerlof and Main demonstrate with the U.S. data for the period 1948 to 1978 that the estimate of S_{EW} is typically three to five times larger than that of S_{TW} , thus reaffirming the Clark-Summers finding that while most unemployment spells are short, a large proportion of the total unemployment is spent in spells much longer than the average duration.[7]

It is central to our purpose here to argue that, while the measure S_{EW} captures an important aspect of the problem of measuring the incidence of unemployment, it does not reflect a number of other significant aspects of the problem that such a summary statistic may be required to capture. We shall criticize the measure from two standpoints: first, from the point of view of the efficacy of the measure as a guide to policy; second, from the point of view of the welfare basis of the measure. Much of these criticisms apply also to the measures T and S_{TW} .

First, note that the measure S_{EW} , being an average, may not be sensitive to either the total number of the unemployed, or the total unemployment at the point of measurement. Indeed, an increase in the number of the unemployed may show up in a lower value for S_{EW} if the increase in unemployment is on average of a shorter duration than the current average. In fact, regardless of how substantial an increase there is in the number of the unemployed, the value of S_{EW} may go up, remain constant or go down, depending on whether the average duration of unemployment of the increased unemployed pool is larger, the same or smaller than the previous average. For the policy purposes, just reading the statistic S_{EW} thus may well give misleading information.

There is, however, a more important limitation of S_{EW} as a measure of unemployment experience. For suppose the number of the unemployed and the total unemployment both remain the same. Then, the measure S_{EW} will remain unchanged if the unemployment durations for a group of unemployed individuals become shorter at the expense of another group. It will also remain unchanged if, conversely, the unemployment durations become more evenly distributed. On the other hand, consider the case where there is an increase in both the number of the unemployed and the total unemployment. In such a case, a significant lengthening of the unemployment durations for a relatively small group of the unemployed may nevertheless lead to a smaller value for S_{EW}, if the relatively shorter durations of a larger group more than compensate for it. Similarly, the measure may rise when there is a fall in both the number of the unemployed and the total unemployment. Thus the measure S_{EW}, as a measure of unemployment experience, may not provide the correct signals for policy purposes.

It may be argued that a basic prerequisite for a statistic of unemployment duration is that it should register an increase at least when, with the same amount of total unemployment, the durations at the "long end" of the distribution becomes greater. This requirement becomes even more compelling if an unemployment measure is required to correspond to the welfare cost of unemployment. If the cost of unemployment to the unemployed were to increase linearly with duration, a measure such as S_{EW} could be related to such costs. However, there are strong reasons to believe that such costs increase more than proportionately with the duration of unemployment. For example, Hurd (1980) presents a model in which the welfare loss of unemployment to the unemployed - as measured by Hicks' compensating variation to make an unemployed individual as well off as in the absence of unemployment - rises sharply with the duration of unemployment. Such results will be accentuated if other dimensions of welfare loss due to unemployment, e.g. the adverse effect of unemployment on human capital formation, are taken into account.[8]

While bringing in distributional considerations in a measure of unemployment can be justified from the welfare cost point of view, as well as from the point of view of giving a more accurate description of the unemployment experience of the unemployed, they are not its only justification. Following the approach of Atkinson (1970), Kolm (1976) and Sen (1973, 1976), it may be argued that a measure of unemployment, like a measure of inequality and poverty, should not only have a descriptive content, but underlying such a measure there should also be some notion of social welfare. From this standpoint, the case for a distribution-sensitive unemployment measure may also stem from a notion of interpersonal equity - a notion underscored by Sen (1976) in the context of the measurement of poverty. The longer the unemployment of a person, the greater is his sense of deprivation, and if an equity-preferring notion of social welfare underlies the unemployment measure, the greater must be the relative weight placed on his unemployment duration.

It is this welfare-based measurement of unemployment that motivates the unemployment measure that we suggest in this paper. In the following section, we specify some descriptive and normative criteria that one may require a measure of unemployment to satisfy, so that in measuring the concentration of the unemployment, it reflects the welfare significance of the longer durations of unemployment. Then in Section 5, we proceed to derive an unemployment measure that satisfies these requirements.

We finally note that, while they have not explicitly suggested a measure of unemployment, Clark and Summers (1979), in demonstrating the significance of the long-term unemployed in explaining total unemployment, essentially construct a Lorenz distribution relating the proportion of the unemployed and the proportion of the unemployment. A Gini coefficient statistic of unemployment durations will eliminate some of the problems associated with the measures of unemployment discussed above. However, as we shall argue below, the Gini coefficient may not be considered as adequate to capture the deprivation aspect of unemployment, for it will fail to satisfy

some very plausible requirements for an unemployment measure that we shall specify below. The unemployment measure that we derive in Section 5 is aimed precisely at meeting these requirements.

3. A Set of Axioms for an Unemployment Measure

In this section, we introduce a set of properties in the form of axioms for an unemployment measure. These properties are stated so that they are independent of the notion of unemployment duration adopted in measuring unemployment. Thus, the term 'unemployment' used in the statements of these axioms may refer to the lengths of the "interrupted" spells of unemployment (as in the measure T), or those of the "completed" spells of unemployment over a period of time (as in S_{TW}) or the lengths of the "completed" spells of unemployment of those who are currently unemployed (as in S_{EW}).

In view of the discussion in the preceding section, the following two properties suggest themselves as primary requirements for a duration-based unemployment measure:

Axiom 1. Given everything else, an increase in the duration of unemployment of an individual increases the unemployment measure.

Axiom 2. Given everything else, for any two individuals i and j, if i has greater unemployment than j, then any increase in the unemployment of i accompanied by a less or equal reduction in the unemployment of j must increase the unemployment measure.

The justification for the first property is clear: if an unemployment measure is to be sensitive to the unemployment durations at all, Axiom 1 must hold. Axiom 2 is the counterpart of the Pigou-Dalton 'principle of transfers' in measuring inequality. It requires that unambiguous increases in the inequality in the distribution of unemployment - as judged by Lorenz comparisons - should raise the unemployment index. Axiom 2 is thus a very weak requirement on the distribution-sensitivity of an unemployment measure. Its appeal can also be seen to be based on an equality-preferring notion of social welfare: if unemployment is related to a welfare loss in terms of some underlying social welfare

function, then any symmetric strictly quasi-concave social welfare function underlying the measure would induce Axiom 2.[9] However, while this equality-preferring intuition motivates Axiom 2, it also serves a policy-oriented purpose: given other things, a lower unemployment index will carry the information of a more equally shared burden of unemployment.

While Axioms 1 and 2 both relate an unemployment measure to the duration of unemployment, they are silent about the number of the unemployed as well as the extent of the total unemployment. The following axiom, taken in conjunction with Axiom 1, incorporates these two aspects of unemployment in the unemployment measure.

Axiom 3. Given other things, a rise in the number of the unemployed increases the unemployment measure.

Given Axioms 1-3, the limitations of the widely used unemployment measures such as the unemployment rate and the duration measures such as T and S_{TW} are transparent enough. The unemployment rate deals only with the total unemployment and thus completely ignores the unemployment durations of the unemployed. It thus violates Axiom 2, while satisfying Axioms 1 and 3. The duration measures T, S_{TW} and S_{EW}, on the other hand, satisfy Axiom 1, but violate both Axioms 2 and 3.

As noted above, distributional considerations are introduced in a very weak form into an unemployment measure in Axiom 2. A Gini coefficient of unemployment durations will satisfy this property. However, while this requirement must be considered basic in a duration-based unemployment measure if it is to be sensitive to the distribution of the unemployment burden, it may not be considered as adequate. In particular, any measure which is a weighted sum of the lengths of the spells of unemployment - with greater weights for longer spells - will satisfy this property. The Gini measure is a member of this class, which has the important limitation that the way a society "trades off" the unemployment among its unemployed is independent of how equal or unequal the distribution of the unemployment burden is.[10] More specifically, for any measure in this

class, the trade-off of unemployment between any two unemployed individuals will be proportional to the weights attached to their unemployment durations, and thus would be independent of the lengths of these durations. Thus the relative significance of increasing durations of unemployment will not be captured by an unemployment measure in this class. Indeed, if a measure of unemployment is to reflect the increasing welfare costs of longer spells of unemployment, then the two following properties must be taken as desirable for such a measure:

Axiom 4. Given other things, the society's trade-off between the unemployment of any two individuals must progressively place greater relative significance to the unemployment that is increasing.

Axiom 5. Given other things, the unemployment measure is increasing in the unemployment durations at an increasing rate.

Axiom 4 demands that the marginal rate of substitution between unemployment durations be increasing: the rate at which the society must compensate for an increment in an individual's unemployment in terms of increased employment for another increases as the unemployment of the former increases. The important policy significance of this is that a society cannot keep its unemployment level unchanged by reducing the short-term unemployment if, in relative terms, the policy package entails an increase in the long-term unemployment.

While Axiom 4 reflects the relative value that a society places on unemployment of longer durations, Axiom 5 relates more directly to the costs of unemployment in absolute terms. It reflects the fact that these costs tend to increase more than proportionately with progressive increase in unemployment. An alternative way to interpret this axiom is that it reflects the society's concern for a progressive increase in the unemployment of an individual.

Our last axiom gives a property that is central to our derivation of the unemployment measure we propose in this work. The property is closely related to the

one given by Axiom 4, in that it is aimed at capturing the relative significance of longer spells of unemployment in an unemployment measure.

Axiom 6. Given other things, the elasticity of the unemployment measure with respect to a change in the unemployment of an individual relative to another is greater if his spell of unemployment is longer.

Axiom 6 incorporates a clear emphasis on the responsiveness of the unemployment statistic to the duration of unemployment. From a policy point of view, it highlights the requirement that relatively greater reduction in measured unemployment can take place only by reducing the unemployment of the long-term unemployed.

Axioms 1-6 we have noted above each captures a particular aspect of unemployment measurement. However, they are not a formally independent set of axioms, nor will it be necessary to use all of them formally to derive the unemployment measure we propose in this paper. Indeed, a specific version of Axiom 6, together with some normalized values, are seen to lead uniquely to an unemployment measure that satisfies the remaining axioms. However, it is clear that the justification of the measure must be sought in each of these properties taken individually, as they introduce conceptually different considerations in measuring unemployment.

4. A Class of Unemployment Measures

In this section, we define a class of unemployment measures in terms of the welfare loss with respect to a social welfare function. Our motivation for this formulation is two-fold. First, once welfare considerations of longer spells of unemployment are brought into the measurement of unemployment, it is clear that a complete ranking of distributions can be obtained only by specifying the social welfare function which reflects our distributional judgements. Second, inasmuch as the use of an unemployment statistic involves, implicitly or explicitly, adherence to a number of social values, defining an unemployment measure directly in terms of a social welfare function makes it clear

which social judgements are being introduced into the measure, and this facilitates an assessment of the measure in terms of the acceptability of these underlying social judgements. For example, we criticized the measures T, S_{TW} and S_{SW} as measures of unemployment experience in that they did not always reflect the lengthening of the unemployment durations for some if it was accompanied by a lessening of the durations of others. From a normative standpoint, this implies that the long-term unemployment of a relatively smaller group could be compensated by the reduction of unemployment for a relatively larger group. It will be seen that these measures are members of the general class of measures we specify, with an associated social welfare function that makes this normative property of these measures transparent.

We first introduce some notation, and draw on some concepts introduced in the context of the measurement of inequality before specifying the class of unemployment measures we shall be concerned with.

Let t denote the time span for which we are required to measure the level of unemployment in a given economy. Typically t is taken to be a year. Let M stand for the set of individuals in the economy participating in the labour force over the time span t. We let m stand for the cardinality of M. Let N be the subset of M which, according to some given criteria, has been identified as the set of the unemployed. n will denote the cardinality of N. We shall assume that the participation span of each i in N extends over the entire period t.[11] Let v stand for the total potential employment of each i over the period t, with $v \leqslant t$. v could be taken as strictly less than t, if we wish not to count lack of jobs for less than a certain period of time over the span t as unemployment.[12] Let u_i be the duration of unemployment of individual $i \epsilon M$ over the period t. For a particular application of the unemployment measure to be derived, u_i's have to be defined appropriately: For example, as in the measure S_{TW}, we may take the u_i's as the total length of the "completed" spells of unemployment of individual i over the span t. By definition, $u_i > 0$, for $i \epsilon N$, and $u_i = 0$ for $i \epsilon M-N$. Let $e_i = v - u_i$ stand for the period of actual employment of an individual $i \epsilon M$ over the period t. For technical reasons, we

shall assume that for each $i \in M$, $u_i < v$, that is, $e_i > 0$. This does not entail any loss of generality, for e_i's can be arbitrarily close to 0. We denote by u and e the vectors $(u_1, \ldots, u_m)$ and $(e_1, \ldots, e_m)$, respectively. Given u and e, $\bar{u}$ and $\bar{e}$ denote the corresponding mean unemployment and employment level. The m-vectors $(v, \ldots, v)$, $(\bar{u}, \ldots, \bar{u})$ and $(\bar{e}, \ldots, \bar{e})$ will be denoted by the bold-type letters $\mathbf{v}$, $\bar{\mathbf{u}}$ and $\bar{\mathbf{e}}$, respectively.

Let $W(\cdot)$ be a (ordinal) social welfare function defined on the set of possible employment vectors $(e_1, \ldots, e_m)$, induced, under standard assumptions, by a general Bergson-Samuelson welfare function defined on individual utilities. We shall assume that $W(\cdot)$ is continuous and increasing in its arguments. Under these assumptions, for each distribution of employment, a unique level of employment can be found, which, if given to each $i \in M$, will correspond to a distribution with the same level of social welfare as the given distribution. Following the terminology of Atkinson (1970) and Sen (1973) in the context of the measurement of inequality, we shall call this employment level the "equally distributed equivalent" (ede) employment for the economy. The ede employment level thus corresponds to a per capita employment for the economy, adjusted for the inequality in the durations of employment. We shall call a social welfare function $W(\cdot)$ distribution-sensitive if for every employment vector e (distinct from $\bar{e}$), the ede employment in terms of $W(\cdot)$ corresponding to e is strictly less than the mean employment level $\bar{e}$.

Since $W(\cdot)$ is continuous and increasing, it is possible to choose a representation of $W(\cdot)$ whose value for each employment vector will correspond to the appropriate ede employment level. We first develop a general class of unemployment measures in terms of a social welfare function $W(\cdot)$, and then provide a motivation for specializing this class to the (ordinally equivalent) class of social welfare functions whose values give the ede employment levels.

Given a social welfare function $W(\cdot)$, we define a class of unemployment measures as normalized welfare loss due to unemployment:

(1) $$\mathcal{U} = w(m,v,e,n)\left[W(v) - W(e)\right]$$

where w(m,v,e,n) is a normalization coefficient. The class of measures given by (1) incorporates a very wide class of unemployment measures: in particular, the unemployment rate is a member of this class, as also the duration measures T, S_{EW} and S_{TW}. To see this, we consider the three following normalizations: (1) $w(\cdot) = 1/v$; (2) $w(\cdot) = m/n$; and $w(\cdot) = \tau$, where τ is the number of the completed unemployment spells over t, given e. Consider now the following subclasses of $\mathcal{U}$:

(2) $$\mathcal{U}_1 = \frac{1}{v}\left[W(v) - W(e)\right];$$

(3) $$\mathcal{U}_2 = \frac{m}{n}\left[W(v) - W(e)\right];$$

(4) $$\mathcal{U}_3 = \frac{m}{\tau}\left[W(v) - W(e)\right].$$

If now we let $W(e) = \bar{e}$ in each of the classes in (2), (3) and (4), we see that the unemployment rate is a member of the class $\mathcal{U}_1$, and, given the appropriate interpretation of the unemployment durations, T and S_{EW} belong to the class $\mathcal{U}_2$. Similarly, S_{TW} belongs to $\mathcal{U}_3$. The formulation in (1) thus makes it clear that these measures differ only in respect of the aspect of unemployment they are intended to capture, but not in terms of their underlying normative considerations in measuring unemployment. In particular, they each corresponds to a social welfare function that ranks employment distributions in terms of the total employment alone.

The structure of the unemployment measures in $\mathcal{U}_1$, $\mathcal{U}_2$ and $\mathcal{U}_3$ suggests a specification of these classes so that the resulting family of measures can be related to the unemployment rate, the measures T and S_{EW}, and the measure S_{TW}, respectively. We shall illustrate this in the context of the class of measures $\mathcal{U}_1$, with which we shall be concerned in this work; similar arguments can be given for the classes $\mathcal{U}_2$ and $\mathcal{U}_3$. Notice that, if we restrict ourselves to a social welfare function W(·) whose values give the ede

levels of employment, then the corresponding unemployment measure in $\mathcal{U}_1$ will give the unemployment rate as its value if the total unemployment is taken to be equally distributed. Furthermore, if the social welfare function is distribution-sensitive, the unemployment rate will give the lower bound of the associated unemployment measure. In this case, the difference between the magnitudes of the unemployment rate and the unemployment measure will be explained precisely by the inequality in the distribution of the unemployment, and thus, the changes in the concentration of unemployment relative to the total unemployment can be assessed directly by comparing the measure with the unemployment rate.

This last consideration suggests that in the class of measures given by $\mathcal{U}_1$, we restrict attention to the representations of the social welfare functions $W(\cdot)$ whose values correspond to the ede employment levels. Denoting such representations of $W(\cdot)$ by $\Phi(\cdot)$, and using $\Phi(\mathbf{v}) = v$, we get the family of unemployment measures:

$$\mathcal{U}_1' = \left[\frac{v - \Phi(e)}{v}\right]. \tag{5}$$

An unemployment measure in $\mathcal{U}_1'$ can be interpreted as giving the percentage shortfall of the aggregate ede employment from the total potential employment in the economy. Throughout the rest of our work, we shall be concerned with this class of measures. For reference in the sequel, we note the following general properties of an unemployment measure in this class:

(P1) For each measure in this class, the unemployment rate equals the value of the measure if the total unemployment is taken to be equally distributed;

(P2) If the measure is distribution-sensitive, then the unemployment rate provides the lower bound for the measure;

(P3) The value of the measure ranges between zero and one, with a value of zero at full employment.

We can formalize the connection between the unemployment rate and a distribution-sensitive unemployment measure in $\mathcal{U}_1'$ noted in (P.1) and (P.2) by defining an associated class of indices that measure the concentration of unemployment relative to the total unemployment, in terms of the difference between the magnitude of a measure in this class and the unemployment rate. Letting U stand for a distribution-sensitive measure in $\mathcal{U}_1'$, we have, denoting the associated concentration index by $\tilde{U}$ and the unemployment rate by $\overline{U}$:

$$\tilde{U} = U - \overline{U}. \tag{6}$$

Since the value of U coincides with the unemployment rate $\overline{U}$ if the total unemployment were equally distributed, $\tilde{U}$ gives the distributional component of U. We shall refer to $\tilde{U}$ as a concentration index of unemployment. Since the unemployment rate gives the lower bound of U, $\tilde{U}$ is non-negative, and equals zero only at a point of equal distribution of the unemployment.

Using (6), we observe that U has the decomposition

$$U = \overline{U} + \tilde{U}. \tag{7}$$

Equation (7) shows the precise way in which the inequality in the unemployment distribution is accounted for in the measure U. The unemployment rate measures only the total unemployment without taking note of the inequality in its distribution; the measure U augments the unemployment rate by $\tilde{U}$ taking account of the inequality. Clearly, U will fall if (and only if) there is a reduction in the concentration of the unemployment relative to the total unemployment.

The decomposition in (7) has an interpretation in welfare terms which is worth noting. Recalling that $\Phi(\mathbf{v}) = v$ for an unemployment measure in (5), we may write:

$$U = \left[\frac{\Phi(\mathbf{v}) - \Phi(\mathbf{e})}{\Phi(\mathbf{v})}\right], \tag{8}$$

and

(9) $$\overline{U} = \left[\frac{\Phi(v) - \Phi(v-\bar{u})}{\Phi(v)}\right]$$

$$= \left[\frac{\Phi(v) - \Phi(\bar{e})}{\Phi(v)}\right].$$

Hence:

(10) $$\tilde{U} = U - \overline{U} = \left[\frac{\Phi(\bar{e}) - \Phi(e)}{\Phi(v)}\right].$$

Equation (9) shows that, given our framework, the unemployment rate measures the proportionate difference between the maximum welfare potentially available at full employment and the welfare at an equally shared level of unemployment. The unemployment rate therefore may be regarded as an "efficiency" measure of welfare loss due to unemployment. It, however, does not take into account the inequality in the distribution of unemployment, whose effect, in welfare terms, is captured by $\tilde{U}$ in equation (10). Thus, $\tilde{U}$ may be regarded as an "injustice" measure of welfare loss, following Kolm (1969). The magnitude of U in (8), which gives the total proportionate welfare loss going from full employment to the existing level of unemployment, is the sum of these two components: an efficiency component going from full employment to an equally shared level of unemployment, and an injustice component going from the latter to the existing level.[13]

In the foregoing discussion, we have used the unemployment rate as the "base" measure by considering the class of measures $\mathcal{U}_1'$ to define the unemployment index U. One can similarly use, with the appropriate interpretation of the unemployment durations, the classes $\mathcal{U}_2$ and $\mathcal{U}_3$, which will give a corresponding set of unemployment indices with T, S_{EW} and S_{TW} as base measures. These indices will all have properties corresponding to (P.1) and (P.2); however, unlike (P.3) of U, they will not, in general, be normalized in the unit interval. Measures corresponding to $\tilde{U}$ can similarly be developed, and the basic measures can be decomposed in a fashion similar to that of U.

5. The Derivation of the *Unemployment Measure*

We now characterize a particular member from the class $\mathcal{U}_1$, which satisfies our Axioms 1-6. For this purpose, we need to characterize a social welfare function $\Phi(\cdot)$ in (5) appropriately in terms of a specific functional form. We now provide three axioms which will accomplish this, and lead to a unique unemployment measure.

Our first axiom is Axiom 6 applied to $\Phi(\cdot)$. We require that, for all i, $j \varepsilon M$, the elasticity of the function $\Phi(\cdot)$ with respect to a change in the employment of i is greater relative to j if i has relatively less employment than j, and that these elasticities are constant for each $i \varepsilon M$.[14] In order to derive a unique functional form for $\Phi(\cdot)$, we need to specialize this axiom by choosing an appropriate set of values for the elasticity of the function $\Phi(\cdot)$ with respect to the employment levels e_i. This is what we do in the axiom that follows.

Given an employment vector $e = (e_1, \ldots, e_m)$, we denote by $\tilde{e} = (\tilde{e}_1, \ldots, \tilde{e}_m)$ a permutation of e such that $\tilde{e}_1 \geqslant \tilde{e}_2 \geqslant \ldots \geqslant \tilde{e}_m$. For each i in M, let r_i be a number associated with e_i if e_i is the r_i-th highest level of employment in $\tilde{e}$, ties broken arbitrarily. r_i is called the employment rank of $i \varepsilon M$.

Axiom R (Rank-weighted response): The elasticity of $\Phi(\cdot)$ with respect to a change in the level of employment for an individual $i \varepsilon M$ is proportional to the employment rank r_i of i. The proportionality factor is identical for each $i \varepsilon M$, and is independent of the level of employment e_i, $i \varepsilon M$.[15]

The use of rank-orders in Axiom R is motivated by an axiom Sen (1976) uses in the derivation of a poverty measure. The choice of rank-orders in Axiom R is, of course, arbitrary; its justification must lie in the fact that any set of numbers which are decreasing in the employment levels will capture the ordinal comparisons involved in the axiom. The rank-orders are a particularly convenient set of numbers for this purpose, for they are readily defined given the employment levels of the unemployed.

Our next two axioms are a homogeneity requirement for $\Phi(\cdot)$ and a normalization requirement. These requirements will give the function $\Phi(\cdot)$ the appropriate properties that will allow its value to be interpreted as the ede level of employment of the unemployed.

Axiom H (Homogeneity) : $\Phi(\cdot)$ is positively linearly homogeneous.

Axiom N (Normalization) : $\Phi(1, ..., 1) = 1$.[16]

Given axioms R, H and N, we have the following Proposition:[17]

Proposition. The only function $\Phi(\cdot)$ that satisfies Axioms R, H and N is the following:

$$\Phi(e) = \prod_{i \in M} (v-u_i)^{\alpha_i} \tag{11}$$

where $\alpha_i = r_i / \sum_i r_i$, $i = 1, ..., m$.

Proof. The function $\Phi(e)$ specified in (11) satisfies Axioms R, H and N. We shall show that these axioms imply this functional form for $\Phi(e)$.

By Axiom R, we have:

$$\frac{\partial \ln \Phi}{\partial \ln e_i} = k r_i \qquad i = 1, ..., m, \tag{12}$$

where k is a constant. (12) implies that $\ln\Phi$ is linear in $\ln e_i$, with the form:

$$\ln\Phi = \sum_{i \in M} k r_i \ln e_i + \beta \tag{13}$$

where β is an arbitrary constant. Exponentiating both sides of (13), and setting $\exp \beta = \delta$, we get:

$$\Phi = \delta \prod_{i \in M} e_i^{k r_i}. \tag{14}$$

By Axiom H, we have:

$$\sum_{i \in M} \frac{\partial \Phi}{\partial e_i} e_i = \Phi. \tag{15}$$

From (12) and (15), we get:

(16) $$k = 1/\sum_i r_i .$$

Axiom N now specifies:

(17) $$\delta = 1 .$$

Setting $\alpha_i = r_i/\sum_i r_i$, (11) follows from (14), (16) and (17). □

Using (5) and (11), we define the unemployment measure we propose:

(18) $$U = \left[\frac{v - \prod_{i \in M} (v - u_i)^{\alpha_i}}{v} \right]$$

where $\alpha_i = r_i/\sum_i r_i$, i = 1, ..., m.

The concentration index $\tilde{U}$ associated with the index U in (18) is given by:

(19) $$\tilde{U} = U - \overline{U}$$
$$= \left[\frac{v - \prod_{i \in M}(v - u_i)^{\alpha_i} - \bar{u}}{v} \right] .$$

We now verify that Axioms 1-6 are satisfied by the measure given in (18).

The measure given in (18) satisfies Axiom 1, since it is increasing in each u_i. Since $\Phi(e)$ is symmetric, increasing and strictly quasi-concave,[18] it must rank a Lorenz-preferred distribution of employment with the same or higher mean as better (Dasgupta, Sen and Starret (1973, Theorem 1, 181-183) and Rothschild and Stiglitz (1973, Theorem 1 and Remark 1, 189-91)). Thus Axiom 2 holds. To show that Axiom 3 is satisfied, consider two employment vectors e and e′ such that we have:

(20) $$e' \neq e, \quad \text{for all } i \in M\text{: } e'_i \leqslant e_i, \text{ and } (e_i \neq v) \rightarrow (e'_i = e_i) .$$

It is clear that for the corresponding ordered vectors $\tilde{e}$ and $\tilde{e}'$, one has $\tilde{e}$ Lorenz-preferred to $\tilde{e}'$, with a higher mean. Hence by the Theorems of Dasgupta, Sen and Starret (1973) and Rothschild and Stiglitz (1973) cited above, we have $\Phi(e) > \Phi(e')$. Thus Axiom 3 holds. Axiom 4 is satisfied, since U is strictly quasi-convex in u[19] and increasing in each unemployment duration u_i. U is strictly convex in each u_i, satisfying Axiom 5. Finally, Axiom 6 holds, since we have for all i, j, if $u_i > u_j$, $\alpha_i > \alpha_j$, and thus:

$$(21) \qquad \frac{\partial U}{\partial u_i} \cdot \frac{u_i}{U} = \frac{\alpha_i u_i \theta}{(v-u_i)} > \frac{\alpha_j u_j \theta}{(v-u_j)} = \frac{\partial U}{\partial u_j} \cdot \frac{u_j}{U} ,$$

where $\theta = \Phi(e)/vU$.

Thus the unemployment measure satisfies some of the properties which we may consider to be basic for such a measure.

6. Interpretation of the Unemployment Measure

The unemployment measure we have put forward in the preceding section attempts to incorporate the significance of the unemployment durations in an essential way, as is clear from the properties it satisfies. Much of the normative and positive implications of the measure are related directly to these properties. From a normative standpoint, the essential idea is to recognize the disproportionate welfare costs of increasing durations of unemployment, both from the social and from the individual point of view, in accounting for the overall level of unemployment. From a positive, predictive, point of view, as a guide to possible policy, the measure indicates unambiguously the direction of change in the distribution of the unemployment burden. Because it incorporates a measure of inequality of the distribution of this burden, the measure provides information, given the unemployment rate, if the burden is getting less or equally shared as a result of the policies undertaken to alleviate this burden. Indeed, even if a policy package leads to a reduction in the unemployment rate, the level of unemployment given by the measure will not show any appreciable change if it is

accompanied by a lengthening of the unemployment durations of those who remain unemployed. In fact, as the decomposition in (7) indicates, it may show an increase if the policies are concentrated on the "short end" of the distribution, while allowing the long-term unemployment to accentuate. In this, it incorporates precisely the considerations that Clark and Summers and Akerlof and Main have emphasized in the formulation of unemployment policy.

While the foregoing considerations must be central to the justification of the measure, it should be noted that the specific axioms that lead to the measure are, though intuitively plausible, arbitrary. This is particularly true of the specific formulation of Axiom R: The rank-order weights used to specify the axiom, though convenient, is arbitrary. The justification for the formulation must lie in the fact that an unemployment statistic is only a summary indicator of the state of the unemployed, and is prepared in the absence of a detailed welfare comparison of the unemployed individuals. One is thus restricted to only an ordinal comparison of welfare. Judged in the light of this informational restriction, the formulation of Axiom R may be more acceptable, for it is merely a specific way in which greater weights are placed on relatively lower levels of welfare associated with greater durations of unemployment.

The homogeneity and the normalization axioms used to derive the measure - Axioms H and N - are, by themselves, also arbitrary. As we have noted earlier, the main motivation for these axioms is that together they provide the interpretation of the value of the function $\Phi(\cdot)$ in terms of the ede employment level for the unemployed. Moreover, the linear homogeneity of $\Phi(\cdot)$ implies that the unemployment measure is homogeneous of degree zero in v and u, which makes the measure independent of the dimensions of v and u. However, Axiom H does incorporate an implicit limitation of the measure. For, it may be clearly well argued that the function $\Phi(\cdot)$ should take note of the greater relative costs of lower levels of unemployment even when there is the same relative variation in the employment levels of the unemployed. The limitations and the justifications of these axioms are transparent enough.

Finally, it should be noted that, while the limitations of the existing measures of unemployment durations such as T, S_{TW} and S_{EW} in taking note of the concentration of unemployment motivated the measure we have proposed, it is clear that these measures each summarizes quite different aspects of unemployment. Each of these measures provides information about aspects of unemployment which are relevant for an overall view of unemployment. Thus, the measure proposed in this paper is to be viewed as complementary to the existing measures, providing information about a dimension of unemployment - the degree of inequality in the distribution of the unemployment burden - that may be relevant for the unemployment problem at hand.

7. Conclusion

In this paper, we have put forward a measure of unemployment. The measure takes note of the welfare significance of unemployment durations : in particular, it incorporates the emphasis that may need to be placed on long-term unemployment in measuring unemployment. The measure satisfies a number of intuitively plausible properties that may be considered relevant to this end. In providing information about the inequality of the distribution of the unemployment burden, it provides a statistic that may usefully complement the information provided by the existing unemployment measures.

NOTES

1. The literature on how best to measure the unemployment rate so that it provides an effective guide to policy is extensive: on this and related issues, see, for example, Armstrong and Taylor (1981), Bregger (1971), Hughes (1975), Joseph (1976), Liebhafsky et. al. (1980), Metcalf (1984), Shiskin and Stein (1975) and Summers (1981). Following the work of Fowler (1968) and Kaitz (1970), there is now a rich literature on estimating the re-employment probability of the unemployed from the 'in-progress' spell and the gross flow data, and the implied distribution of the completed spells of unemployment. On these issues, see, for example, Beach and Kaliski (1983), Clark and Summers (1979), Cripps and Tarling (1974), Frank (1978), Frank and Freeman (1978), Hasan and De Broucker (1982), Lancaster (1979), Lancaster and Nickell (1980), Marston (1976), Nickell (1979) and Salant (1977).

2. Inter alia, systematic economic analysis of the costs of unemployment begins with Okun (1962) and is pursued in a rich literature. See for example, Black and Russel (1969), Gordon (1973), Kuh (1966), Okun (1973), Perry (1971, 1977) and Thurow and Taylor (1966).

3. For various implications of this view, see also Baily and Tobin (1977), Feldstein (1975, 1976), Holt and David (1966) and Holt et. al. (1971).

4. The work of Hasan and De Broucker (1982) and Layard and Nickell (1987) corroborate this significance of the long-term unemployment in the total unemployment for the Canadian and the British data, respectively.

5. Thus, if we denote by t_{ij} the j-th unemployment spell of individual i over the given period, $j = 1,2,...,$ then t_i is defined as $t_i = \sum_j t_{ij}$.

6. There is also an opposite 'length' bias: the longer the unemployment spell, the greater the chance of being counted as unemployed in the official survey. See Salant (1977) for a thorough discussion of this point.

7. For discussions of the intuitive bases and the various implications of the measure T, S_{TW} and S_{EW}, see Akerlof (1979), Akerlof and Main (1983), Björklund (1983), Carlson and Horrigan (1983), Layard (1981) and Main (1981, 1982).

8. For an early statement of the atrophy of human skills caused by unemployment, see Pigou (1920). The adverse effects of unemployment on human capital formation have been stressed by Phelps (1972), Hargreaves-Heap (1980) and others. Sen (1975) notes that one of the important aspects of employment is that it "gives a person the recognition of being engaged in something worth his while". The greater the unemployment spell, the greater must be one's sense of loss of self-worth. On these and related costs of unemployment to the unemployed, see Blanchard and Summers (1987), Jackman and Layard (1988) and McGregor (1978), among others.

9. For various aspects of the relationship between Lorenz comparisons of distributions and their ordering in terms of quasi-concave welfare functions, see Dasgupta, Sen and Starrett (1973), Rothschild and Stiglitz (1973), and Sen (1973).

10. In the context of the measurement of inequality, this limitation of the Gini measure has been analysed by Blackorby and Donaldson (1978). See also Atkinson (1970) and Dasgupta, Sen and Starrett (1973) for a discussion of the limitations of the Gini measure.

11. This assumption abstracts from the possibility that some unemployment spells may be associated with spells of withdrawals from the labour force. However, this may not involve a substantial restriction on the unemployment measure to be derived. For one thing, most of these withdrawals may be the result of the disincentive effects on labour market participation of longer unemployment spells. Also, many of these withdrawals may in fact reflect the absence of available job opportunities. Thus, these withdrawals may in effect be a continuation of the unemployment spells. See Clark and Summers (1979) for a comprehensive discussion of this issue.

12. See Joseph (1976) and Hughes (1975) for a discussion of this issue.

13. This decomposition of U in welfare terms is similar in spirit to the decomposition of welfare loss given by Diewert (1985) in the context of welfare measurement in applied general equilibrium analysis, and that given by Jorgenson and Slesnick (1984) in the context of the measurement of inequality.

14. Given the class of unemployment measures in $\mathcal{U}_1'$, this formulation of Axiom 6 for $\Phi(\cdot)$, it can be shown, implies Axioms 1-6 for an unemployment measure defined in terms of $\Phi(\cdot)$. We shall, however, verify these properties directly from the unemployment measure we define in the sequel.

15. This axiom is similar to an axiom used in Sengupta and Pattanaik (1989) in characterizing a poverty measure.

16. Linear homogeneity implies that $\hat{e}\,\Phi(1, ..., 1) = \Phi(e)$, where $\hat{e}$ is the ede employment with respect to e. The normalization $\Phi(1, ..., 1) = 1$ thus gives $\hat{e} = \Phi(e)$.

17. In proving the Proposition, we shall assume that $\Phi(\cdot)$ is differentiable. Note also that since $e_i > 0$ for all i, and since $\Phi(e)$ gives the ede employment with respect to e, $\Phi(e) > 0$.

18. The Cobb-Douglas function $\Phi(e)$ in (18) is quasi-concave: strict quasi-concavity follows from a result of Ferland (1972) which establishes the equivalence of quasi-concavity and strict quasi-concavity for a numerical function under certain regularity conditions. These conditions are satisfied by the function $\Phi(e)$. Symmetry of $\Phi(e)$ follows from the fact that the vector $\tilde{e}$ is ordered.

19. It is clear that strict quasi-concavity of $\Phi(\cdot)$ is preserved when we consider $\Phi(\cdot)$ as a function of u, as may be formally verified using standard conditions, e.g. the determinental conditions in Arrow and Enthoven (1961).

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