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"WHAT HAPPENS WHEN PUBLIC SECTOR EMPLOYEES ARE MADE REDUNDANT : SOME EXPLORATORY RESULTS USING A MICRO-SIMULATION MODEL".

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1. Introduction

One of the main themes of the current economic strategy adopted by the Thatcher government since election in May 1979, has been an attempt to reduce public sector expenditure. Indeed, the first comment in the Government's Expenditure Plans for 1980-81 was that "Public expenditure is at the heart of Britain's present economic difficulties". (Cmnd 7746, 1979). Public expenditure in 1978-9 amounted to some £69.79 billions or 42½% of total G.N.P. Of this some £18.69 billions was spent by the local authority sector which has been identified by the Environment Secretary, Michael Heseltine, as a major area for cut-backs in spending, (Guardian, 24/11/79), (although the difficulties he faces in imposing cash limits are already being seen). The public sector in general, and local authorities in particular employ a large number of people, the public sector being by far the largest employer in the country. Perhaps more significantly though the public sector has expanded rapidly over the last two decades, both in terms of expenditure and employment, as is shown in TABLE 1. This trend has been mirrored by local authorities and TABLE 2 gives a breakdown of numbers employed in different service types for England and Wales in 1972 and 1978. It is hardly surprising that a large proportion of the expenditure of a local authority is in labour costs. Leeds Metropolitan District for example in 1978/79 spent £108,967,519, or 56.2% of its total expenditure on employees' wages. (Leeds MD. 1979).

It does not take much imagination therefore to envisage that a reduction in public sector expenditure will lead to a cut in public sector employment, and this is the stated aim of the present government, (H.M.S.O. 1980). What will eventually emerge in terms of actual numbers made redundant remains to be seen. What we are concerned with in this paper is

TABLE 1

	Total Govt. Expenditure £ millions (current prices).		Employment in Government Services.
1956	6,942	1966	3,532,000
1960	8,958	1970	3,969,000
1965	12,990	1974	4,582,000
1970	18,948	1978	5,026,000
1978	62,428*		

* (the figure for 1978 is the nine monthly figure multiplied by 1.333).

	1972 England and Wales		1978	
	F.T.	P.T.	F.T.	P.T.
Lecturers and teachers	453.2	161.1	541.5	159.5
Other Education	201.3	400.6	214.2	500.2
Construction	107.0	0.4	137.5	0.5
Transport services	35.7	0.4	22.1	0.4
Social services	149.8	120.6	135.8	165.6
All other depts.	524.3	86.7	514.4	99.6
Police force	98.6		109.2	

TABLE 2

EMPLOYMENT IN L.A.'s

F.T. = Full time

P.T. = Part time

FULL TIME EQUIVALENT Dec. 1978 C.E.

2,340,400

to assess the consequences, both in economic and social terms, of making a significant number of public sector workers unemployed in an urban area. We do this under a number of assumptions concerning future projections for labour demand. There is a certain concensus amongst economic forecasters at the time of writing that unemployment will continue to rise above its present 2.0 m level (August 1980). The spatial concentration of unemployment is already apparent (See TABLE 3), and the fate of Northern towns and cities with a declining manufacturing base is bleak, as the forecasts for 1983 show. Thus, in certain areas and under certain projections, those made unemployed may expect to have a lengthy period on the books of their local job centre.

In assessing the consequences of a reduction in public sector employment we are particularly concerned with the following factors:

(i) How long do individuals remain unemployed after redundancy?

(ii) What are the costs and benefits to the government and the economy of these policies? It is widely anticipated that government spending on benefits will rise substantially as unemployment increases. Thus public sector spending may only be transferred from one heading to another if individuals merely move from the payroll to the dole queue. In addition tax revenues are lost and overall consumption typically declines. Thus the demand for goods falls and further economic decline may ensue.

(iii) What are the socio-economic characteristics of those remaining unemployed? For example, is unemployment concentrated amongst the elderly, the unskilled, those in public sector rented accommodation and those with large families?

To attempt to answer these sorts of questions we employ a micro-simulation model of the urban system. This is fully described in subsequent sections, but a few initial remarks are worth making here. Attempts to model socio-economic change in urban systems have given rise to a quite varied set of techniques, all of which have certain merits and drawbacks. We believe in the basic philosophy that the approach adopted should be tailored to the questions being asked and the type of answers sought. Micro-simulation affords an excellent way of dealing with large amounts of variability between actors (in our case individuals and jobs) and also allows for the retention of a significant amount of information about the actors, (see Clarke, Keys, and Williams, 1979, for a discussion). In the analysis of changes in labour markets, and in attempting to shed some light on the list of questions discussed above, we are convinced that the micro-simulation methodology is an appropriate one.

The rest of the paper is divided as follows. The next section discusses the role of the public sector in the U.K. and its growth since the end of the 2nd World War. Section three outlines a systems analysis of an urban labour market in the context of the micro-simulation methodology, and section four describes in some detail a micro-simulation model of the urban labour market. The way in which we deal with the costs and benefits, and the assumptions made about the public sector redundancies is discussed in section five. The results of running a model over a five year period under different assumptions about future labour demand, for the Leeds Metropolitan District are presented, with details of the cost-benefit equations and socio-economic indicators of the unemployed. Some conclusions are made in the final section.

TABLE 3.

Unemployment Rates for the Standard Regions

	1966 %*	1978 %*	1980 %**	1983**
North	2.5	8.8	9.3	13.1
Yorkshire & Humberside	1.1	6.0	6.5	11.0
East Midlands	1.0	5.0	5.5	9.1
East Anglia	1.4	4.9	4.8	9.9
South East	0.9	4.2	4.1	8.7
South West	1.7	6.5	5.8	12.6
West Midlands	0.8	5.6	6.4	13.7
North West	1.4	7.5	8.0	13.4
Wales	2.8	8.4	8.7	14.8
Scotland	2.7	8.2	8.8	12.7
Northern Ireland	5.9	11.5	11.6	18.4
United Kingdom	1.5	6.1		

(Source: *Regional Statistics 1980 Vol 15)

**Cambridge Economic Policy Review, Vol 6. No. 2, 1983 figures are their forecasts).

2. The Public Sector in the United Kingdom

In this section we wish to briefly outline some of the salient features of the role of the public sector in the U.K. economy both at a national and regional/metropolitan level. This is done so as to provide some background to the current policy initiatives being implemented and also to highlight some of the current employment problems in the British economy. For a thorough discussion of these we refer the reader to Broadbent (1977) or Thrift (1979).

There exist several contrasting and contradictory theories pertaining to the role of the state in advanced capitalist economies. These range from mainstream economics typified, for example, by welfare economics where the state is seen to intervene when the perfect competition of the market fails to provide the optimum supply of a certain good, to more radical theories from both left and right wings of the political spectrum*. What we would like to concern ourselves with is some of the less incontrovertible trends to emerge in relation to the state and the economy. (It is of course, assumed that these two terms do not necessarily imply distinct and non-overlapping sets).

If we accept that government economic policy since the last war has been characteriesed by an attempt to steer the British economy towards certain goals and to alleviate some of the worst features of economic performance through subsidy schemes and the like we must also accept that it has, in the main, been largely unsuccessful and has been dominated by short-term paliatives. The part played in economic policy by public

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* (see, for example, O'Connor, (1973) for an explicitly Marxist analysis and Rogge (1978) for a distinctly conservative approach).

spending has been considerable. In successive efforts to stimulate demand or control inflation public spending has either been expanded or contracted (for details see Broadbent 1977, p. 64-67). As the public sector employs in the order of 25% of total employment then the implications of growth or decline in the public sector become apparent. Conveniently, we can distinguish three fairly distinct parts that go to make up the public sector.

(i) Central government, and related institutions that fall under central government control. Here the principal employers are such bodies as the Department of Health and Social Security, including the N.H.S., the Department of the Environment, the Armed Services and the various government departments that go to make up the Civil Service.

(ii) Local government, which we have already noted is an important employer in terms of percentage of total employment and a vast consumer of public spending.

(iii) Public corporations and nationalised industries : which have increased in both number and size since the war. Notably most of these form the basic infrastructure of the economy (eg. the public utilities, steel, coal, oil, rail, etc. - hence their nationalisation) and enjoy something close to a state monopoly.

Clearly, the location of particular facets of the public sector can have implications for local labour markets. The location of new headquarters for many of the "civil serice" sectors - such as the D.H.S.S. in Sunderland, etc., coupled with the encouragement of decentralisation of existing employment from the South-East connurbation has been posited as evidence of 'aid' to the depressed regions. In addition, many of the nationalised industries have been encouraged to locate plant in areas of higher than

average unemployment. Of course, the corollary of this is that when the public sector contracts, or nationalised industries experience the effects of a recession, those regions or towns that have a large percentage of public sector employment are most at risk. Witness what is already being called the 'Corby Effect', and the similar consequences of the British Steel closure at Consett. Coupled with this factor is the depressed regions vulnerability to the poor performance of the "real economy". This doubled edged sword means that prospects for public sector employees made redundant may vary according to conditions in the local labour market. This partly forms the subject of our analysis in section 6.

If we now turn to look at the present government's policies concerning public expenditure and employment we can single out some important features.

(i) The White paper on public spending plans 1980-81 (Cmnd 7746) revealed little detail as to the exact nature of public expenditure cuts. However, the main reductions were aimed at spending on housing, education, health and social services and aid to nationalised industries.

(ii) Longer term plans, as outlined in the government's expenditure plans, to 1984 (Cmnd 7841) are aimed at continued reductions in public sector expenditure. By 1983-84 expenditure is planned to be 4% lower, in real terms, than in 1979-80. Significantly, this is planned to be 11½% lower than in the plans of the previous Labour Government by 1982-83. At 1979 survey prices this means the following major reductions between 1978-79 and 1983-84:

	£ millions
Housing	2,466
*Government lending to nationalised industry	1,243
Industry, energy, trade and employment	1,443

with increases in defence spending, law, order and protective services and social security, the latter as a consequence of the projected rise in unemployment.

On staffing levels "The Government's expenditure plans now imply a continuing reduction over the next few years" and "In local government.... manpower is expected to decline overall during the next few years". (p. 8).

In addition to these policies there are a number of features of macro-economic policy that is claimed are having damaging effects on employment prospects in Britain. These include the very high level of interest rates imposed by the Chancellor that make borrowing expensive for firms and thus investment and the possibility of job creation, it is argued, are made difficult. Coupled with high interest rates is the resurgence of the value of the pound on the international money market. This leads to imports costing less and to the higher price of British goods on foreign markets. It is argued that this is leading to the decline of certain sectors of manufacturing industry. Whether the government's economic policies, as it claims, will lead to the long-term revitalisation

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* Recent events (January 1981) cast much doubt over this figure being achieved.

of the British economy remains to be seen, but present unemployment prospects can only be described as grim. With these thoughts in mind, we outline an approach to modelling the labour market.

3. An Analysis of Labour Market Processes*

In the above discussion, we have touched upon some of the economic and social effects of reductions in the demand for labour. These effects are the result of a wide variety of individual actions resulting from this reduction in demand. In this section a framework which allows these individual actions to be modelled is presented. In the next section the way in which this scheme is implemented in a micro-simulation model, is described. The framework is developed using the notion of state transitions. The relationship between this and the model developed will be apparent in the next section.

Holt and David (1966) present a scheme which can be taken as a useful starting point for the definition of a flow chart of the labour market. In describing the labour market in this way they saw it as:

> "a complex stochastic process that involves interaction among many participants. Their actions are governed by fairly complex relationships arising from the objectives and constraints of firms and families. Thus, the labour market is not considered in terms of such relatively simple constructs as supply and demand schedules" (p. 74).

By taking such a view Holt and Daniel are implicitly appealing to systems theory as an aid to understanding and then to a state transition representation in order to formalise their model.

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* This section is, to some extent based upon Keys (1980), and more discussion of various points is given there.

It is preferable here to define the flow chart corresponding to the model to be developed later in the paper rather than give Holt and David's presentation. The close comparisons will, however, be obvious. The labour market is considered as a usual economic market and is seen to comprise three fundamental sectors: the supply, the demand and the market (or allocation mechanism). These three central sections are each influenced by external events, and in particular by one type of event. The supply pool is under the direct and important influence of demographic change. These changes act through the medium of the households and affect the individuals in that household. This is in immediate agreement with the Holt and David viewpoint where the objectives and constraints of the family determine the actions of the constituent individuals in the labour market. In a similar fashion, the demand pool is directly affected by the overall economic condition which, via the firms in the economy, will determine the level of labour demand. Thirdly, the allocation mechanism which allows supply and demand to interact is affected by the information network in the system and the ability of supply and/or demand pools to be mobile in order to achieve a mutually suitable allocation. In reality, of course, the relatively immobile nature of employment demand requires that the suppliers of labour should be mobile and not the demanders.

Having given a broad overview of the conceptual framework, it is now appropriate to put some flesh on these bones and give a detailed description of the flowchart in Figure 1. In this diagram the supply pool is comprised of a set of individuals (I), and the demand pool of a set of jobs (J). As noted the individuals are all members of a family which forms a household (H,I). Similarly, each job belongs to a group which together form a firm or sub-unit of a firm, (F,J). The allocation

mechanism represented by the shaded area A, interfaces the supply and demand pools and yields the allocation of individuals to jobs (H,I,J,F). The family is subject to demographic processes imposing themselves upon the household and again the firm is subject to similar processes acting from the macro-economic environment. The allocation mechanism is dependent upon the ways in which information can flow between supply and demand and this is considered as an exogenous input to the allocation mechanism.

A concern of the micro-simulation approach to be used is with the different types of individual and firms found in the labour system. To include individual and firm attributes in such a model will result in many different states within the system. Each state is dependent upon the state of its elements, the individuals, the households, the firms, and the jobs, that, the system state is the quadruple (H,I,J,F). Each of these four components is itself a set of smaller units and so can be written alternatively as a full set of single items. For example, H can be decomposed into the separate households within the system. A result of considering the components of H,I,J and F is that the system is now defined at the level of decision-making units. A household is the level at which housing and budgeting decisions are made, an individual is concerned with personal issues, a job (in what may be seen as a slightly contrived interpretation) can decide the level of output from a machine, and a firm is concerned with aggregate issues of production and marketing. This level of resolution is of value as will be shown in the next section.

A further outcome of this individual level representation is that it is possible to differentiate between different units of the same type. For example, households will differ in many ways, of which some will affect

the labour market processes differentially. Thus each element of H,I, J and F can be seen as being represented by a sequence of identifying attributes. A household can be represented by size and tenure of dwelling, firms by location and ownership, an individual by age and sex and a job by occupation and industry for example.

In the model of Clarke, Keys and Williams (1979) such a vector of attributes contained, amongst other variables, the following string of labour market attributes: size of household, tenure of house, age, sex, education, marital status, labour market status, wage. In that model the "labour market status" variable was defined to include "in education", "unemployed", "retired" and "not in the labour force" as well as various employment types.

Each of the arrows in Figure 1 denotes causal links between two classes of the system. What is not specified there is the exact cause and effect of the link. This is provided by a theoretical basis for the transitions. The remaining part of this section is taken up with a discussion of the theory which can be invoked to provide this basis.

Firstly, then, consider the entries to the supply pool. These are of two types: from the household and from the set of workers in work. The former are comprised of school-leavers, secondary workers re-entering the labour market, immigrants to the area of interest who have no job. The latter are workers who wish to or are forced to seek a job different from their present one. Movements of this type may be due to voluntary change, or change forced by the employer through firing or redundancy. In this case, the movements are a result of the firm's action to remove the job with which that individual is associated. The entries to the demand pool are also of two types, originating either from the firm creating

new jobs (as the household created new workers) or by the removal of the individual from the worker-job association. This latter type is caused by changes originating in the household such as retirement, death or the desire to change job. Finally, the allocation A adjoins individuals and jobs in some way to yield a new set of workers in work (H,I,J,F). The probabilities corresponding to such an allocation are those which are given in the accounts.

Although all these effects are taking place simultaneously, they do not affect any one person or job simultaneously but sequentially. In order to model the effects of any one action, in the household say, several steps need to be considered and this requires a dynamic representation and leads ultimately to a dynamic model.

Each of the transitions will be seen as the outcome of a decision made by an actor within the system. The general context of such decisions has been described by, amongst others, Clarke *et al.* (1979), and Williams and Ortuzar (1979). The formal decision problem is seen as a consideration of the set:

$$(A,\underline{O},\underline{C},\underline{Q}) \qquad (3.1)$$

where A is the actor or actors making the decision;

$\underline{O}$ is the set of options open to that actor,

$\underline{C}$ is the set of constraints delimiting what is feasible for actor A, and $\underline{Q}$ is the set of objectives by which the actor decides which option to take.

In the current context the actor will be either a person, a household, a firm or a combination of these.

In order to be able to understand the model response to parameter changes and the natural dynamics of the model it is necessary to understand the theoretical statements upon which the model is built. It will be seen that suitable micro-level theories can be found for each transition, in the next section the implementation of these theories will be discussed and it will be seen that for reasons of data availability some aggregation must be made. Also, in this section similar models to the micro-simulation model used will be discussed in order to examine the theoretical underpinnings that have been made in them. To enable a systematic discussion to take place the transitions are classified as supply-side, based on household decisions, and demand-side, based on the firm, and the market allocation.

The supply-side transitions relate to those decisions made in the household concerning the participation of individuals in the labour force. Similarly, the demand-side transitions relate to firm-based decisions to increase or decrease the number of jobs they make available on the market. In particular they will lead to a pool of workers looking for jobs and a pool of jobs requiring workers. The market allocation transitions will allocate individual workers to individual jobs. In the attribute string representation, this sequence of decision-making contexts can be explicitly represented. Each unit first enters the supply or demand pool and is then allocated. In a more aggregate framework this pair of decisions is represented purely as a single probability, the probability of a person or job changing their state. As the state includes the characteristics of a job and an individual, the nature of the decision is subsumed within a single probability and this does not allow the separate consideration of the two decision contexts or the effects of different market conditions to be taken into account. Therefore, the discussion to follow is directly related to

the disaggregate attribute string representation method. It is split into three sections, supply-side transitions, demand-side transitions, (both as defined above) and the market allocation.

Supply-side transitions

Here three transitions are relevant, school-leaving, retirement, and the re-entry to the labour force of secondary workers (typically married women). An implicit assumption made here is that the primary worker in any household is always in the labour force and hence the discussion here is mainly to do with the entry into the labour force of workers previously out of the labour force. The exception, retirement, is, in Britain, for the majority automatic at a certain age, 65 for men and 60 for women. The increase in voluntary redundancy with the provision of a "golden handshake" and no loss in any pension rights, may lead to an increase in the number of early retirements and this may then necessitate a formal theory to determine which workers are more susceptiable to this type of transition. As it is presently only an option for the minority and since some of this minority still remains in the labour force until the legal retirement age, the topic will not be discussed further than to note the work of Rones (1978) in the U.S.A.

It remains to discuss firstly the decision to leave school and enter the labour force. This decision has been studied since the early 1960's within the framework of human capital theory, (Becker 1964). In the theory the individual and his family are considered to invest in an individual's formal education in order to achieve higher income once the individual is in the labour market. It is an investment because the individual and family will lose earnings that may have been received during the extra time at school and college and may also need to support the person financially when they may be out at work and supporting themselves.

This immediately implies that the ability of a household to be independent of extra earnings is of great importance in the decision to stay in education or not. Apart from this the ability of an individual to remain in education is vital and is independent of the financial state of the household.

In the choice model framework set out in the previous section the set of constraints depends upon the individual's innate ability to remain in education and the household's ability to do without the income that may be earned during the spell in education. The model should therefore include directly or indirectly some measure of these variables. The individual's educational ability is an unobservable and unmeasurable quantity and as such can be accounted for in the model by random behaviour. In the micro-simulation approach here adopted, this random behaviour is modelled by the Monte-Carlo sampling technique and it is argued that this is a suitable method of generating behaviour which can be seen as originating from these variables. The choice models need only concern themselves with the observable variables and in this case the model is of the form:

$$P(\text{leaving school and entering the labour force}) = F(\text{household's ability to forego potential earnings}). \qquad (3.2)$$

The model of Crouhy et al. (1976) took the right hand side of (3.2) to be a function of parent's education alone basing this on empirical work in the U.S. which showed that parental education and occupation are of greater importance than income.

Now consider the decision facing secondary workers as to whether to work or not. Early work in this area was undertaken in the U.S. by Mincer (1964) but since then work has been performed in the U.S. recently by McNabb (1977) and Greenhalgh (1977). The decision of to work or not is

usually considered to be made as a function of household needs and not of individual needs. To encompass this, Mincer modified the usual neo-classical dichotomous trade-off between work for money and leisure to become a trichotomous trade-off between work for money, unpaid work in the house and leisure. Following this theoretical statement Mincer then considers the trade-off between the foregone earnings of the secondary worker against the household budgetry needs expressed as a function of household size and structure. This purely economic analysis failed to take into account the level of supply and demand which may exert an effect upon the supply decision. Two such effects have been hypothesized, the so-called added worker effect and the discouraged worker effect which are in conflict and to some extent cancel each other out. The former suggests that in times of high unemployment more secondary workers will seek work because they perceive that the chances of finding work are low. Studies have consistently shown that the "discouraged worker" effect is stronger than the "added worker" effect both in the U.S. (Tella, 1964, 1965 and Dernburg and Strand, 1966) and in the U.K. (McNabb 1977, and Greenhalgh, 1977). The decision model to be considered here is of the typical form:

> P (secondary worker working) = F (supply and demand in the labour market, household structure, earning potential of secondary worker). (3.3)

Orcutt *et al.* (1976) consider the above effects but do not have any measure of the husbands employment state directly but include this indirectly by the levels of benefit payments and income the previous year.

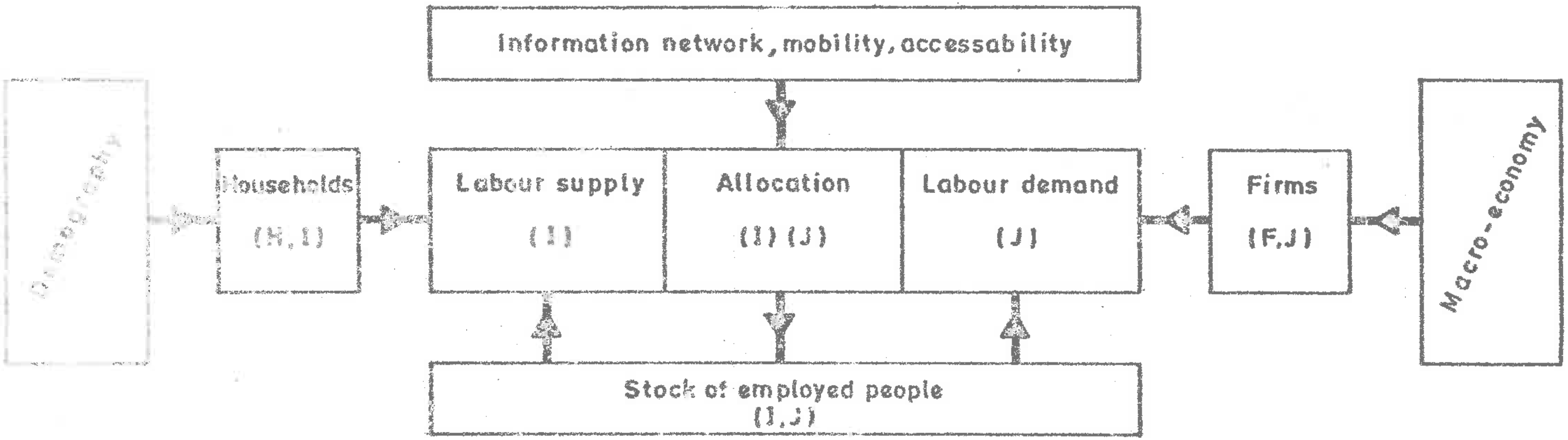

Demography
Households
(H,I)
Labour supply
(I)
Allocation
(I) (J)
Labour demand
(J)
Firms
(F,J)
Macro-economy
Information network, mobility, accessability
Stock of employed people
(I,J)

FIGURE 1.

Demand-side Transitions

Due to the symmetry of the labour market transition the two flows relevant here correspond closely to those in the supply side. The transitions are the creation of new jobs, and the removal of old jobs causing redundancies corresponding to entry and withdrawal from the labour force of jobs. The two transitions can be seen as results of the same decision process, that of determining the level of labour required by a firm or production unit and the type of labour required. A decrease in requirements leading to redundancy and an increase to the creation of new jobs.

Studies of such decisions date back to the late 1950's and the early theories have been subject to a continual process of revision since that time. In all the studies the problem is considered as that of determining the level of optimal labour input to produce a given amount of goods subject to a fully specified production process. As such it falls neatly into the paradigm expressed by (3.1) and the objective under which the decision is made is that of minimising costs, (Krechling, 1965 and Ball and St. Cyr, 1965 in U.K., Haymes, 1969, Solow, 1968, in the U.S.). The analytic solution to this problem is then framed as a regression equation and estimated.

The analysis concentrated initially upon labour demand as being the only input to a production process which is able to respond in the short-run to changes in output level. It has now been extended to allow changes in capital input to also be made in the short-run (Nadiri and Rosen, 1969, 1973). Recent surveys of the many studies have been provided by Killingsworth (1970), Hazeldine (1976) and Briscoe and Peel (1975) and it is not the purpose to fully describe the difference between models here.

It will suffice to note that, following Hazeldine, two classes of models can be identified. In one, the labour input is determined purely as the number of men and/or women employed. This is the earlier approach to the problem and Fair (1969) was the first to modify this type of model to allow for labour hoarding. In his model the number of workers and the amount of hours worked is estimated separately in a two-equation model. This development led the way for Nadiri and Rosen to extend the models to a more complete specification. Having determined the level of labour input at any time the change in demand from the previous time will then indicate the probability of a new job being formed or a redundancy of a certain type of worker occurring. This can be described by:

$$P\ (\text{redundancy, of a given type of worker or new job being formed of a given type}) = P\ (\text{output of the firm, wage rate, the production process used}) \qquad (3.4)$$

Previous models of this type of decision are due to Kain *et al.* (1976), Orcutt (1976) and Wishart (1976). The NBER model (Kain *et al.*, 1976) uses trend forecasts based on the changes between 1961 and 1971 in Chicago and Pittsburgh, the areas to which the model is applied. Orcutt *et al.* have built into their model a macro-economic model from which the forecasts of labour, income, wage rates and unemployment level are obtained, but they do not produce a level of labour demand. The MANSIM model (Wishart, 1976) is different in its intention to the large scale urban and national models of Kain and Orcutt, as it models the labour market in a specific organisation, the Civil Service. As such, the demand is provided by the

users, and hence there is little need to model demand in the same manner as the larger scale models do.

The Market Allocation

In this sub-section apart from the market itself, or the allocation mechanism, two other transitions need to be considered. These relate closely to the state of the market and hence are discussed here. They are the firing of workers by employers, and the voluntary quitting of a job by a worker. The former of these depends upon the performance of the worker and the expected performance of that worker by the management. The ease with which a replacement worker can be found will affect the likelihood of firing and hence this transition can be defined:

$$P(\text{a worker being fired}) = P(\text{level of unemployment and vacancies, workers expected and actual performance}). \quad (3.5)$$

Similarly, the likelihood of a worker quitting is dependent upon the likelihood of their finding a new job. A worker will quit if it is felt that a greater utility (either financial, psychological or both) will be found by obtaining another job. Thus:

$$P(\text{a worker quitting}) = P(\text{level of unemployment and worker's perception of potential and actual utility}) \quad (3.6)$$

These two models can be coalesced as they have a common structure revolving around the utility which a worker can provide and that which he receives or is expected to receive from the job. If he does not provide sufficiently, the management will be inclined to fire him and if he

provides too much for the utility he receives he may look elsewhere for a job providing a greater level of remuneration. This can be described by:

P (a job and worker separating) = P (level of unemployment difference between utility provided and received). (3.7)

Models of turnover are included in the NBER model and the MANSIM model. MANSIM estimates the rate of leaving the Civil Service and of movement by either specifying absolute rates or a function of length of service or by specifying the expected numbers of leavers and the likelihood of a particular individual leaving, the attributes affecting these weights are not given. The NBER model uses survey data to estimate job turnover, rates by race, industry, occupation and workplace zone.

The remainder of this sub-section is taken up with a discussion of the allocation mechanism, the central underlying theory of which is provided by search theories. Early statements of this theory are contained in Phelps *et al.* (1971) and in this a micro-economic foundation for the empirically observed Philips curve and the U-V relation are given. The search models are one class of the wider area of optimal stopping models (Chow *et al.*, 1971) as discussed by Weibull (1977). Each individual searching for a job is assumed to investigate offers which appear at random intervals. With each offer is associated a utility (usually measured as a wage) and if the searcher is prepared to accept this utility the job is taken. The level of utility at which a job is refused or not is referred to as the "acceptance utility" and this is taken to decrease with time, at the start of the search it is higher than at the end. The individual's attributes will tend to determine the rate at which acceptance utility declines. The early models have no notion of spatial effects upon the

search process and the spatial distribution of supply and demand can be held to have a significant effect upon the resulting success of finding employment. Miron (1978) and David (1974) have extended the basic model to a search over space and linked up immigration to the levels of demand and supply but these models are simple and consider inter- as opposed to intra-urban migration and search. Liddle and Roper (1979) have attempted to outline a model of employers search behaviour, an area which has been ignored up to present, and this is important because the way in which employers notify their vacancies determines which type of workers will receive information upon them. This will then have ramifications in the distribution of unemployment in an urban area (see Keys, 1978). The general model of the allocation mechanism can then be given as:

$$\begin{aligned} &P \text{ (job } j \text{ and searcher } i \text{ being allocated to each other)} \\ = \; &P \text{ (information network, expected utility of searcher} \\ &\text{utility offered by the employer).} \end{aligned} \qquad (3.8)$$

The MANSIM model allocates individuals to jobs by estimating a likelihood of promotion as a function of seniority, age and education level. A probability of each individual receiving the promotion is then found and using Monte-Carlo sampling an individual identified for each vacancy. The NBER model on the other hand, implements a heuristic model of job search on behalf of the worker over space. Firstly, the searcher is allocated to a new job in the same zone, industry and occupation, if available. If this is unsuccessful a search over all industries for a job of the same occupation type is made. If then no job is found the worker is unemployed.

A connection between the market allocation and the quit and firing transitions is provided by search for jobs whilst remaining in employment. Models of turnover in the labour market built within a job search framework

are also influenced by human capital considerations and this type of transition is therefore determined by household or firm considerations, as are the supply and demand side transtions, and by the utility receiver arguments used in the allocation transition.

The above section has presented a framework for modelling the actions of individuals in the labour market and a theoretical underpinning for this modelling approach. This representation allows a wide variety of different attributes to be included in the model and hence a large amount of information can be retained. In the next section this representation and solution method will be made explicit in discussion of the micro-simulation model used to address the policy questions developed in the earlier sections of the paper.

4. Micro-simulation of the system of interest

Having discussed a methodology for modelling the labour market we can now discuss the more general micro-simulation framework in which the model is embedded. A thorough outline of the micro-simulation methodology can be found in Orcutt *et al.* (1976) and details of our own models in Clarke *et al.* (1979, 1980a, 1980b). What we wish to discuss here are the main aspects of the approach and we refer the reader to the above references for further details.

As the term implies, micro-simulation involves the manipulation of samples of micro-units (individuals, households, etc.) multiply-classified by the various demographic, social, economic and activity attributes relevant to a particular context. This is in contrast to macro-approaches where individuals are grouped into classes, these classes then form the inputs into aggregate models. We do not view these two approaches as conflicting methodologies, indeed, we use them both in our models to

components [illegible] other, as we describe below.

The representation of actors in a socio-economic system is an important issue. The use of a micro-level representation has a number of advantages for certain types of applications which we now discuss. To begin, we may give an example of what we mean, using a hypothetical household and the individuals within that household.

HOUSEHOLD ATTRIBUTES

Household identifier	Age of Head of household	No. of individuals in household	tenure category (public sector = 2)	marital status of head (married)	No. of workers in household
482	28	4	2	1	1

Socio-economic status of head	Employment type of head	Total household income in last year
3	15	6502

INDIVIDUAL ATTRIBUTES

Individual Identifier	Sex	Age	Marital Status	Education Status	Employment Category	Income	Benefit
482.1	1	28	2	3	15	6270	232
482.2	2	26	2	1	22	0	0
482.3	2	4	1	0	0	0	0
482.4	1	2	1	0	0	0	0

This cross-classified information provides the modeller with the appropriate attributes in which to process the household and individuals through socio-economic events. Of course, the actual nature of the attributes considered

will be determined partly by the processes we are considering and partly by the information that is available. The processing is undertaken by Monte-Carlo sampling, where a randomly generated number is compared with the probability of an event occurring, itself derived from the attributes of the individual or household. If the random number is less than the probability of the event occurring, then the event is deemed to have taken place, otherwise it does not. For example, in our household above, the probability of the wife giving birth to another child will be related to her age (26), the age of her husband (28), the age and number of her existing children (4,2 and 2), and her employment status (22 - not in the labour force). The ability to consider a large number of attributes in certain socio-economic processes is clearly of considerable advantage as the amount of inter-dependence between both attributes and events is well documented. Using more conventional aggregate approaches, problems of high dimensionality arise when considering a correspondingly large number of attributes (see Clarke *et al.*, 1980a). Formally, if the value of $\underline{x}_i = (x_i^1 \ldots x_i^m \ldots x_i^M)$ of M attributes are associated with each of N individuals ($i = 1, \ldots N$) in a population P, then the storage of the NM elements associated with the N vectors ($\underline{x}_1, \ldots \underline{x}_i, \ldots \underline{x}_N$) will typically be very much smaller than the number of elements in the occupation number matrix. This quantity is given by $\sum_{\mu=1}^{M} \alpha^{\mu}$ where α^{μ} is the number of classes associated with the μ^{th} attribute. In addition, most of the NM elements will be non-zero (unless zero is an attribute class) while the occupation number matrix typically, will have a high percentage of zero elements. In addition, the list processing methodology enables the modeller to retain a large amount of information pertaining to the population (or sample) that is being studied. This is an obvious advantage when assessing the implications of policy. Indicators that form the outputs of the model

can take the form of a wide range of different aggregations over source information, whereas with aggregate approaches the information obtainable is only available in the same form as the aggregation scheme adopted.

The structure of our micro-simulation model is outlined in Figure 2, and we now describe each section in turn, and this is followed by a more detailed discussion of the allocation procedure in the labour market sub-model.

(1) Generation of an Initial Population

Two alternative procedures may be adopted for specifying a sample of households and individuals with appropriate characteristics that is representative of the population being studied, in our case the Leeds Metropolitan District. One could survey individuals in an appropriately selected sample, but this way may be a costly and time-consuming undertaking. Alternatively, and the approach we have adopted, it is possible to synthesize a population from primary or secondary data sources. The number of households $N(\underline{k})$ with attributes $\underline{k}$, can be generated by sampling from a distribution $p(k)$ which represents the joint probability of a household with attributes $(k_1, k_2, \ldots k_n)$. This distribution is synthesized from secondary data sources by decomposing the joint distribution into the product of conditionals,

$$p(\underline{k}) = p(k_1)\ p(k_2|k_1)\ldots p(k_n|k_1\ldots k_{n1})$$

and exploiting the independence between categories where reasonably justified. This method is further discussed in Clarke *et al.* (1979) and Pownall (1977). The individual and household attributes we consider in this application are as follows:

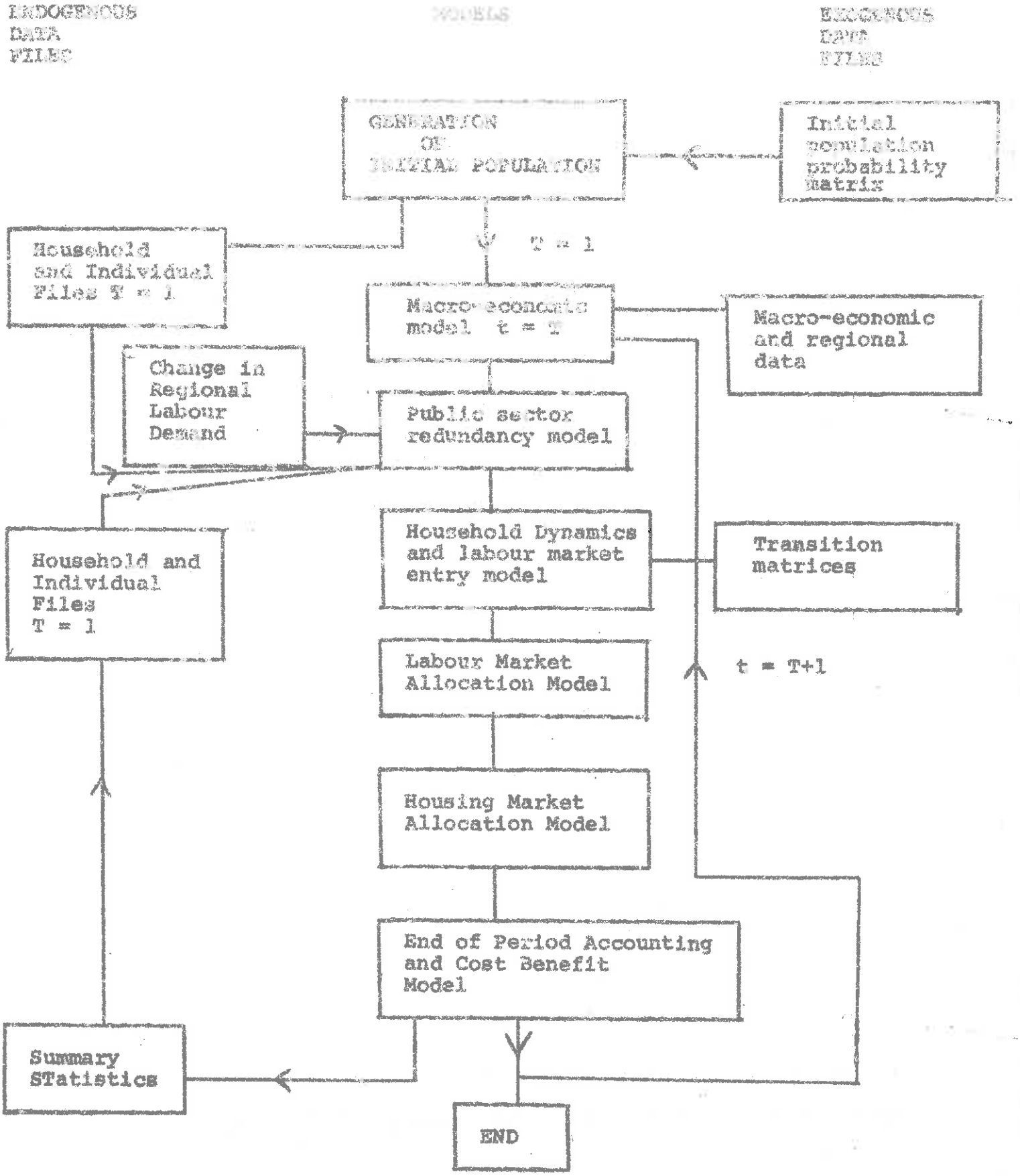


FIG 2 Overview of the Microsimulation Model

HOUSEHOLD

Household identification label, educational status of head, age of head, sex of head, marital status of head, occupation of head, race of head, household, household income, number of individuals, number of children, housing tenure, size of house, spatial location.

INDIVIDUAL

Individual identification label, educational status, age, age cohort, sex, marital status, occupation, race, number of weeks worked in last year, wage, wage trajectory, full-time or part-time, previous occupation, redundancy label, income in previous job if made redundant, number of years since last worked.

Of course, not all of this information was availabe at Metropolitan District Level, and in many cases a compromise on the spatial level at which information was used in the model had to be made.

(2) Macro-economic Model

The purpose of the macro-economic model in this context is to provide estimates of the demand for labour over the system. Theoretically, this can be generated using a smallest-unit approach as is being done for the supply of labour. However, the sophisticated macro-economic models now available provide forecasts suitable for our purpose.

After considering a variety of different models it was decided to use those of the Warwick Manpower Research Group (Elias and Keogh, 1979). This was done for two reasons, firstly, they had been able to produce a variety of different regional forecasts for different policy options. These were

based upon those of the Cambridge Economic Policy Group (C.E.P.G., 1979). Secondly, they were regional; this meant that they provided a better, but not altogether satisfactory forecast for the area of concern, Leeds Metropolitan District.

The Warwick Group's forecasts which were used are of labour demand by industry for the region of Yorkshire and Humberside. This was altered to provide a forecast of demand at the occupational level and also disaggregated by sex. This was acheived by applying conditional probabilities of a worker in industry i being in occupation j. These were derived from the sample of employees which take part in the New Earnings Survey (D.o.E, 1978).

(3) Household Dynamics and Labour Market Entry Model

A central concern of dynamic models of households and individuals is the updating of the attribute lists to account for the wide variety of socio-economic phenomena, and their related effects that occur over time. Demographics is an important and complex component of change. In our model we account for the following events:

ageing

death

birth

marriage

divorce

migration

leaving home

retirement

job changes.

These events are related to the attributes of individuals or in certain cases, households. So, for example, the probability of death is considered as dependent on the age and sex of an individual, although clearly many more attributes could be included (data permitting). If death is deemed to have occurred then this has important ramifications. Not only does that individual die, the size of his or her household changes, the marital status of his or her spouse (if relevant) changes, from married to widowed, household income may change and so on. The individual, if previously in employment, will leave a job vacant (perhaps) and if a single person with no dependents in the same dwelling unit, his or her dwelling will appear on the housing market (if privately owned). Similar causal relations exist for the other demographic processes listed above. The number of attributes considered in any process is limited by the availability of appropriate data, and, as we have no primary data, obtained from secondary sources, such as O.P.C.S. reports, the Census, GHS, FES, etc.

There are several theoretical questions pertaining to this sub-model, such as, in which order should these phenomena be considered? Clearly, if an individual is deemed to have died then the test for giving birth or retirement is redundant. This is where assumptions governing the theoretical construct of the model are made. In addition, the problem of causality is apparent in many of the processes being considered here.

For each time period, in our case a year, all of the individuals and households have their attributes updated if appropriate. This updated population then forms the input for the next year's simulation, and so on. To ensure that our micro-model is producing results consistent with aggregate accounts, the total number of events, such as births, deaths, marriages can be compared with the expected number for the population as a whole. Possible sources of variation are due to having an insufficiently

large sample and through Monte-Carlo variation, although this latter source is usually negligible.

As to the efficiency of these types of models, the main time consumer is the input and output of data (i.e. list processing). Storage problems, for the reasons outlined earlier, are avoided.

The Labour Market Allocation Model

The processes modelled in the above sub-model lead to two lists, one of vacant jobs and the other of workers seeking jobs. The task of allocating the elements of these lists to each other is performed in the method now described. Whilst it would be possible to theoretically construct a model which can replicate at the micro-level the process of searching for a job, the data required for such a model prohibits its implementation. A model of allocation at the meso-level is used instead and the allocation of individual workers and jobs is then made in accord with this.

The meso-scale allocation is made on the basis of information-minimising (Snickars and Weibull, 1977). This is a method of updating a known allocation, Q_{ij}, of workers of type i to jobs of type j in accordance with the number of workers and jobs to be allocated. This method requires that workers and jobs are classified in some way. In the current example workers are classified by the occupations they previously held and jobs are classified by their occupation type. The jobs and workers are also classified by the sex of a worker and the sex for which a job is suitable. If there are S_i workers of type i and D_j jobs of type j then if P_{ij} is the allocation between these workers and jobs, P_{ij} is determined by solving the following mathematical programme:

$$\min_{\{P_{ij}\}} \; - \sum_{ij} P_{ij} \ln (P_{ij}/Q_{ij})$$

$$\sum_i P_{ij} = D_j$$

$$\sum_j P_{ij} = S_i$$

$$P_{ij} \geq 0$$

In order to allow both constraints to be equalities the same number of jobs as workers must be present. This is achieved by introducing a category of jobs classed as "unemployed" and a category of workers classed as "vacancies". The appropriate row or column is set to the excess of workers over jobs or vice versa. The matrix Q_{ij} is determined from the Census for 1971 which gives the number of workers in class i moving to a job of type j. This then introduces some notion of mobility between occupations into the model. The matrix P_{ij} gives the allocation which will actually occur in the situation with the demand and supply as determined by the various processes.

To allocate the individuals to specific jobs the probability of a randomly chosen individual moving to a job of type j is determined from the matrix P_{ij}. Using Monte-Carlo methods a job class is then chosen and then a specific job in that class. The individuals wage trajectory and job type is then altered as appropriate. An individual allocated a job classed as "unemployed" is unemployed and similarly, a job allocated to a "vacancy" is unfilled.

5. An Income and Benefits Model

At the heart of our model to assess the economic consequences of reducing public sector employment are: a) the model of the labour market (described in sections 3 and 4) and b) a model that generates both net income and benefits derived from a variety of sources. In this section we describe this latter model.

A full treatment of all sources of both earned and unearned income is clearly beyond the scope of this exercise. These sources vary both in their amount and extent, and for obvious reasons, it is difficult to obtain reliable information on individual incomes from all sources, (see the Royal Commission on the Distribution of Income and Wealth (HMSO, 1977) for a full discussion). In this study we are mainly concerned with income that is derived either from employment in the form of wages or salaries, or from the state in the form of a wide range of benefits.

The income generation model is outlinelin Figure 4. The following calculations and assumptions are made:

(i) No account is made of unearned income (defined as investment income, rents, interest and dividends from U.K. companies). Although this source amounts to 12.1% of total income in the United Kingdom (Board of Inland Revenue, 1979), it is by no means equally distributed amongst the population. In fact, the top 10% of persons with incomes accounted for 51.1% of all investment income in 1976/77.

(ii) Earned income - the allocation of a wage to individuals in employment is performed in the following manner. For each occupation a linear regression relating the wage earned to the age and sex of the worker is performed. This is based upon the mean wages as published in the New Earnings Survey. Each worker is then randomly determined to earn a proportion of the mean wage, this proportion

lies within the normal distribution of range 0.75 and 1.25. This provides a multiplier for each individual wage earner. Given the age, sex, occupation and the value of this multiplier for a worker it is possible to establish the earnings from the appropriate year. When individuals change jobs they receive a new multiplier to reflect the changing wage rate even if they move between jobs in the same occupation category.

(iii) Once total gross income has been finalised it is then necessary to derive an income net of transfer payments. The first part of this involves taxation. In our model, because we have information on household size and family structure, it proves relatively straightforward to determine each individual's personal allowances (these are shown in Figure 3), and thus derive a tax coding for all individuals in employment. What we do not consider are allowances such as tax relief on mortgage interest payments and insurance premiums, although if we had the necessary information this could be undertaken. This tax coding can be changed if and when circumstances change, for example if a family increases in size due to the birth of a child. To calculate the amount of taxation paid by wage earners total allowances are subtracted from gross income. The remainder is then taxed at the appropriate rate for each income band.

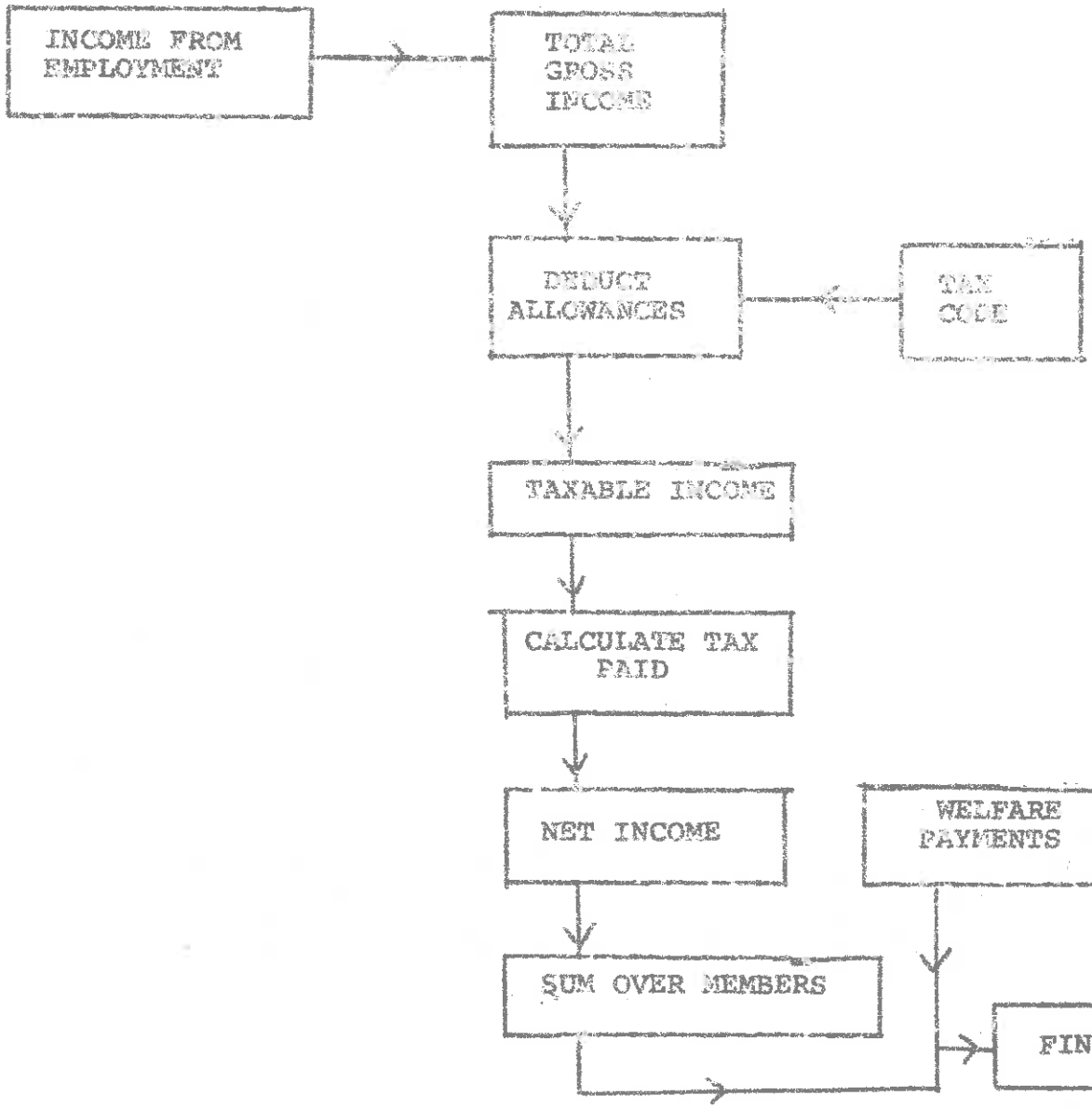
(iv) The second part of the transfer payments section deals with the state benefits. The following benefits are considered:

a) National Insurance - Unemployment Benefit

b) Supplementary Benefit

c) Retirement Pensions

FIG 3 INCOME MODEL



PERSONAL ALLOWANCES

(i) MARRIED MAN'S ALLOWANCE
(ii) SINGLE PERSON'S ALLOWANCE
(iii) WIFE'S EARNED INCOME ALLOWANCE
(iv) AGE ALLOWANCE
(v) CHILD ALLOWANCE 0-11 years
11-15 years
16 +

BENEFITS

(i) NATIONAL INSURANCE UNEMPLOYMENT BENEFIT
(ii) SUPPLEMENTARY BENEFIT
(iii) RETIREMENT PENSIONS
(iv) FAMILY INCOME SUPPLEMENT
(v) CHILD BENEFIT

d) Family Income Supplement

e) Child Benefit

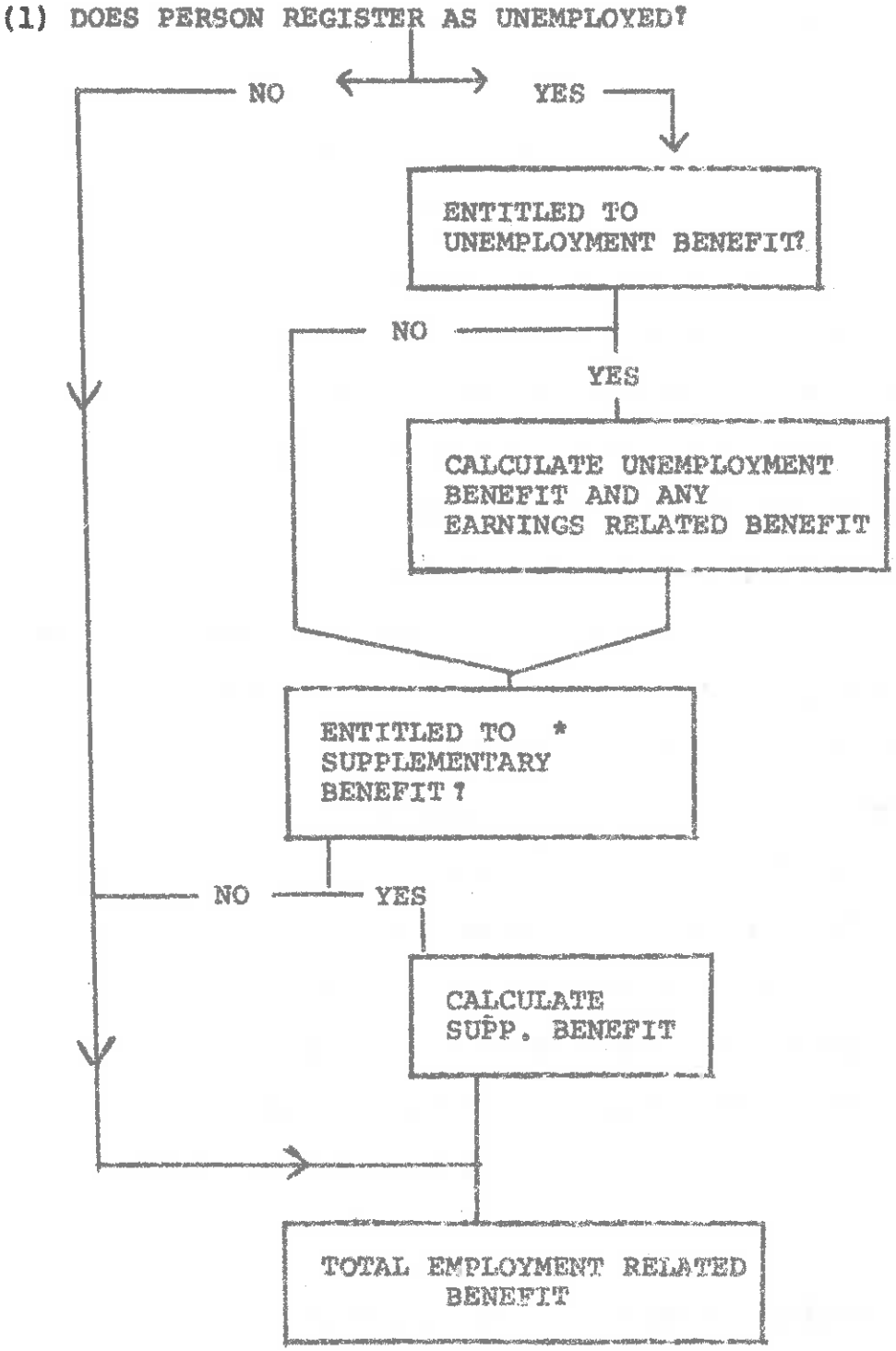
f) Rent and Rate Rebates.

The rules for qualification for these benefits are often complex and in the main we have had to simplify them for our own purposes. Firstly, we assume that if someone is eligible for benefits of any kind they receive them (unfortunately, this is by no means the case in reality). We further assume that recipients receive what they are entitled to. The rules governing receipt are laid down in a series of documents (eg. Social Security Statistics, Supplementary Benefit Commission Report), and these are followed as far as possible in determining benefits. Most of the pertinent information relating to benefit payments is captured within our individual and household attribute lists, such as family size, earned income, age, marital status, etc. An example of the calculations performed if someone is made unemployed is shown in Figure 4. Each year (or iteration of the model) allowances are made for changes in eligibility etc. When all the benefits have been assessed those received are aggregated and the amount is added to the gross income after tax. A further assumption is that there is no relationship between benefits and taxation apart from the fact that, other things being equal the more tax individuals pay, the more they earn and are therefore less likely to qualify for benefits.

6. Exploratory Results from the Micro-simulation model

Previous studies of the characteristics of the unemployed have tended to adopt a retrospective approach, by cross-sectional surveying of a sample of the unemployed at one or two time periods. Daniel and Stilgoe (1977) undertook a follow-up survey of the unemployed in 1976 to examine the

Fig 4. BENEFIT MODEL FOR UNEMPLOYED



* 9% of the unemployed recieved both unemployment and supplementary benefit in 1977. This was due to claimants having very large families or increased housing costs.

fate of those interviewed in an earlier survey (Daniel, 1974). They found that, after discounting those that had retired in the intervening years, only 38 percent of those registered as unemployed in 1973 were in work three years later. In a survey of the unemployed who receive Supplementary Benefit, Clark (1978) focussed on how individuals and households adjusted to changes in income through being made unemployed. She noted that large families often had the greatest difficulty in making ends meet.

Forecasting future employment and unemployment rates has been a preoccupation of econometricians for many years now, and the models they have developed vary in levels of sophistication. However, they are in general more concerned with producing macro-economic indicators than in identifying the socio-economic characteristics of the unemployed. We now proceed to outline results of the simulation exercise for public sector redundancies in the Leeds Metropolitan District that attempts to focus now only on the aggregate statistics involved, but to examine the characteristics of the unemployed.

The micro-specified population generated using the methods outlined earlier consisted of 5000 households containing a total of 13,261 individuals. This represents about a 2.5% sample of the Leeds population at census date, 1971.

We adopted the following method for making public sector workers redundant. As with all other transitions in this model, it was implemented using Monte-Carlo sampling. This required knowledge of the probability of a public sector worker being made redundant. As the employees are characterised by occupation this meant attempting to find firstly, the probability of a worker in occupation i being in the public sector, as we had no occupation breakdown for Leeds M.D. public sector employees. An

estimate of this was obtained from the New Earnings Survey (HMSO, 1978, Table 135). Then it was possible to apply a redundancy rate to these workers. For example, in one policy it was decided to make 25% of the public sector clerical workers redundant. This was done using the following probability string.

Assume that a worker is sampled in the list-processing procedure who is in the clerical occupation group, then,

Prob (being made redundant) =

Prob (made redundant/work in public sector as a clerk)

Both of the probabilities on the right-hand side are available from published data or are model parameters. Thus the chances of a particular individual being made redundant given that they have a specific occupation are found. It is also possible to allow a differential chance of redundancy on the basis of sex, and for age for example. Using this albeit fairly crude method resulted in making some 14.92% of the total local authority labour force redundant. Scaled up to the Leeds population this would amount to some 4,666 workers out of a labour force of 33,000. While this is a large number by any standards, in the context of the present economic climate it is perhaps not totally unrealistic. For example, Humberside County Council shed some 3,027 full and part-time workers from their total labour force of 35,000 between March 1979 and March 1980. (Yorkshire Post, July 10, 1980). In addition, we re-emphasize that the model runs were undertaken as exploratory analysis and not as detailed policy analysis.

Some characteristics of those workers made redundant are shown in Table 6. The most striking feature to note is that 61.3% of this group are females, and this will have further repercussions in terms of employment

TABLE 6 SOME CHARACTERISTICS OF THE REDUNDANT

MALE	38.7%
FEMALE	61.3%
MARRIED FEMALES	52%
HEADS OF HOUSEHOLD	40%
NON-HEADS OF HOUSEHOLD	60%

TENURE CHARACTERISTICS
(individual's head of household)

Public Rented	18.6
Private Rented	11.9
Owner Occupied	53.1
Owner Outright	16.4

AGE DISTRIBUTION

<25	15.0
25-34	22.3
35-44	20.8
45-54	26.9
54-65	15.0

HOUSEHOLD SIZE DISTRIBUTION

1 person	33.3
2 person	22.2
3 person	3.7
4 person	22.2
5 person	14.8
6 person +	3.7

opportunities and benefit payments as we discuss below. Of these women just over half were married, and thus more likely than not to be the second worker in the family. Only 40% of the group were heads of households and this confirms a finding presented in an earlier paper (Clarke *et al.*, 1979). It was found in a forecast of the unemployed in Yorkshire and Humberside in 1982 that a significant number of the unemployed were not heads of households and consequently this had implications when examining the tenure characteristics of the unemployed. For our group over half the members are in the owner occupied sector, though only about half of these are heads of households.

As for the fate of this group, Table 7 shows what the model predicts as happening over a five year period from 1979-80 to 1983-84. 'Not in the population' includes those people who have either died or out-migrated during the period. A note of caution is needed here. We have not as yet built in any behavioural mechanism between employment and migration, although some evidence does exist as to the nature of this relationship (see, for example, Cleave and Palmer, 1978). 'Not in the labour force' refers, firstly, to women who give birth to a child during the period and leave the labour market and also to those women who would leave the labour market for other reasons. The numbers in this category is calculated from a regression equation based on Greenhalgh (1977). All males who reach the age of 65 and females who reach 60 are automatically retired from employment, or if unemployed assumed to be no longer seeking work. These form category three in Table 7. The last two categories are self-explanatory.

Turning to the percentages in each category, 57% of those made redundant were still unemployed at the end of year 5 and a meagre 13% had found alternative employment. Again, this has to be viewed in light of the

Economic Scenario 1

%

	Year				
	1	2	3	4	5
Not in the population	2	6	6	8	10
Not in the Labour Force	3	7	11	15	16
Reached Pensionable Age	0	1	1	3	4
Found Alternative Employment	2	5	8	11	13
Still Unemployed	93	81	74	63	57

TABLE 7. FATE OF THOSE MADE REDUNDANT.

Economic Scenario 2

%

	Year				
	1	2	3	4	5
Not in the population	3.6	7	8.6	8.6	9.2
Not in the Labour Force	8	9.8	12.0	15.5	16.3
Reached Pensionable Age	2.7	3.5	5.0	5.0	6.2
Found Alternative Employment	3.6	6.2	9.0	12.0	14.9
Still Unemployed	81	73	65.4	58.9	53.4

TABLE 8. FATE OF THOSE MADE REDUNDANT.

macro-economic assumptions pertaining to future levels of labour demand in the region. Table 8 repeats the analysis for the same population under a more optimistic assumption* about national and regional levels of labour demand. Recall that in section 2 we argued that the fate of the public sector redundant could be affected by the local labour demand. Although Leeds is close to the national average in terms of unemployment, the unemployment levels in the two models were assumed to reach 10% and 7% of the labour force respectively by 1982.

While interpretation of these figures must be undertaken with some care, due to the relatively small sample size, it appears that only a slightly larger percentage of those made redundant do find alternative employment under the more optimistic policy and the proportion still remains low. Part of the problem obviously lies in the mismatch between the types of skills in demand and the kinds of skills that the unemployed have. Attempts to alleviate this structural problem have been mainly concerned with retraining the unemployed and this analysis suggests that this may be more important in the future.

Moving on to assess the economic effects of making public sector employees redundant recall we argued earlier that the costs involved, including benefits payable and income tax lost, could significantly reduce the savings made in reducing the labour force. Table 9 enumerates some of these for the five year period involved in the simulation under the first economic assumption. Note that all figures are in base year money units, are scaled up from the sample, and that no discounting has been employed.

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* The macro-economic forecasts are taken from the Cambridge Economic Policy Review. The first scenario envisages a national figure of 4.0 million unemployed in 1984, the "optimistic" policy forecasts 1.8 million unemployed in 1984.

TABLE 9. £ millions

	Year 1	2	3	4	5
Salary Savings	11.089	11.089	11.089	11.089	11.089
Lost Inland Revenue	2.770	2.409	2.376	2.043	1.918
Benefit Payments	3.528	2.509	2.072	2.609	2.670

TABLE 10.

	1	2	3	4	5
Salary Savings	12.920	12.920	[illegible]	12.920	12.920
Lost Inland Revenue	3.430	[illegible]	2.772	2.500	2.420
Benefit Payments	5.612	5.182	5.908	5.737	5.521

The initial impression is that the benefit payments for those unemployed are underestimated. In fact, the smaller than expected figure is a consequence of having a large proportion of women who are not heads of household in our redundancy pool. They are typically not eligible for benefits such as unemployment benefit, supplementary benefit, etc. In addition, the rise in the benefit payments in the third year may appear anomalous, but this is the effect of individuals becoming eligible for long-term benefit payments at the correspondingly higher rate. The lost Inland Revenue gradually declines over the period as a consequence of the fall in the proportion still unemployed.

Two important qualifications are necessary at this juncture. Firstly, this analysis is by no means a comprehensive treatment of all the costs and benefits involved. Redundancy payments for example are ignored as is the reduction in final demand and a number of other effects, and it should be added that the costs and benefits are only examined over a medium-scale time span. Secondly, by viewing the consequences of public sector redundancies in this economic way we hide the social realities of long-term unemployment and reduction in income for the individuals and households involved (see, for example Townsend, 1979, for a particularly depressing account). However, by identifying at least some of the flows involved it becomes clear that the real savings involved are by no means close to the absolute savings in salary costs. A further point is that although all these flows are additional from the public purse, it is suggested that it is central government that loses out in terms of benefit payments and lost inland revenue and the local authority which saves in terms of staff costs.

Perhaps one of the most interesting effects we picked up in the above analysis was that *ceteribus paribus*, there seemed to be more savings to be

TABLE 11.

Costs as a percentage of savings

		Year 1	2	3	4	5
Lost Inland Revenue	a	24.98	21.72	21.43	18.42	17.30
	b	26.55	22.96	21.45	19.3[illegible]	18.73
Benefit Payments	a	31.8	22.63	25.[illegible]0	25.[illegible]5	24.68
	b	44.98	40.11	49.[illegible]2	44.56	42.73
Total	a	51.53	44.68	42.89	37.77	36.03
	b	76.78	62.74	71.62	69.89	66.81

a - indiscriminate redundancies

b - male only redundancies

made by making women employees redundant than by making their male counterparts redundant. To examine this hypothesis we repeated the analysis but this time in our redundancy model only made males redundant. (This was achieved by boosting the probabilities of redundancy and restricting the test to males). Table 10 shows the economic consequences of this policy with the same number of persons made redundant. The immediate difference is that savings in salary costs are much higher than in the previous simulation and thus net "savings" higher. This is because males typically receive higher wages than females*. However, as we anticipated, the amount of benefits payed out rose. For a stricter comparison, Table 11 calculates the benefit and tax costs as a percentage of the salary saving for each of the three years. While tax costs are roughly similar the benefit costs are notably higher when only men are made redundant and thus the total costs as a percentage of the savings are much higher.

A number of technical questions remain to be commented on, in particular the sensitivity of the model solution to: a) Monte-Carlo variation, b) sample size. Monte-Carlo variation arises out of repeating the same experiment but using a different random number string. It is related to sample size in that those events that are least common are affected most by Monte-Carlo variability. Thus with a larger sample size both sampling errors and Monte-Carlo variability will be reduced. To obtain an indication of the sensitivity of our model to both these factors we ran the model twenty times for a 1 year period. Table 12 below gives the means of the observed output for a number of selected events together with the standard deviations for the twenty runs and for comparison the expected or actual results for Yorkshire and Humberside. As can be observed,

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* For example, in 1977, the average gross weekly earnings in managerial employment were £88 for males and £52 for females. In the personal services the corresponding figures are £57 for males and £41 for females (N.E.S. 1978).

the standard deviations are consistently small and the correlation between observed and expected results reassuringly high. This information gives us the confidence that the model performs reasonably well for these events and that Monte-Carlo variation is relatively insignificant. Of course, a larger sample would be more desirable from a statistical viewpoint but the inevitable trade off between sample size and computer implementation has to be borne in mind.

	Mean of 20 simulations	Standard Deviation	Expected Results, Yorkshire & Humberside
Deaths/1000	12.31	0.45	12.15
Births/1000	13.46	0.65	13.0
Marriages/1000	16.78	0.58	16.0
Net-Outmigration/1000	-4.3	0.15	-4.1

TABLE 12

Means, Standard Deviations and Expected Results for Selected Events.

The results presented in this section, while only of an exploratory nature, do emphasize the need to consider the attributes of the individuals and households concerned and micro-level interdependence when considering policy issues of this type.

7. Conclusion

The present Government's policy of attempting to reduce public expenditure is bound to have important repercussions in a wide number of areas. It may turn out that the consequences of certain types of policy are often "counterintuitive". In this paper, we have tentatively attempted an analysis of the effects in terms of public sector employment, using a model based approach. It is often claimed that modelling approaches to the analysis of socio-economic problems and related policy issues are irrelevant. We argue strongly against this stance, and believe that only by scientifically assessing the impacts of policy can informed discussion arise. In a sense a major challenge now exists to model based analysts, in that a significant change in direction in public policy has emerged, the outcomes of which remain far from clear. It remains to be seen if this challenge is accepted.

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