SPATIAL ASPECTS OF LABOUR SUPPLY IN THE U.K.

Ian Molho

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ABSTRACT

This thesis sets out to examine the main sources of variation in labour supply, and the interaction with demand conditions. The spatial dimension is taken to be of intrinsic interest (in addition to its importance in disaggregating the national picture), reflecting not only transportation costs to movement, but also problems of information diffusion. Space is therefore seen as an important dimension to issues of labour market disequilibrium and segmentation, conditioning the opportunity sets of labour market participants, and affecting outcomes.

The first section of the thesis examines the determination of male migration patterns, both at the individual and aggregate levels, along lines suggested by search theory. Two main sets of conclusions emerged. Firstly, important differences were found in the behaviour of migrants across search fields, corresponding roughly with housing and employment related motivations for moving. Secondly, some support was found for the notion suggested by search theory that the spatial pattern of flows of opportunities (such as employment growth or house-building rates) were likely to be important in determining migration flows. As such, it was suggested that job creation schemes induce substantial migration adjustments, moderating the impact on local unemployment.

The second portion of the thesis investigates spatial variations in married female labour force participation rates. Initially, a time series analysis was performed at the regional level, which attributed much of the regional convergence in participation to convergence in unemployment and wages. A simultaneous labour market model for the London region was then constructed. This analysis suggested that whereas male labour supply adjusted to changes in local demand conditions via induced migration or commuting, women (particularly married women) appeared to be relatively constrained in this respect, placing much of the burden of adjustment on participation rates instead.

CHAPTER 1 INTRODUCTION: SPATIAL PERSPECTIVES ON LABOUR MARKET BEHAVIOUR

1. Introduction

The purpose of this thesis is to examine the main sources of variability in local labour supply in the U.K., the relationship between supply and demand in a spatial context, and the implications for local labour markets. The selection of this particular range of topics reflects a personal conviction of the importance of labour market issues in general, given the current economic climate, and the spatial dimension in particular as a physical setting within which these labour market phenomena take place, conditioning the opportunity sets facing labour market participants.

Despite growing interest in the analysis of local labour supply, there are still important gaps in our understanding of the determinants of labour supply at a local level, the interface between supply and demand, and the nature of spatial equilibrium across local labour markets.

One of the main aims of local labour market analysis must be to uncover the causes, dynamics, and cures for spatial concentrations of unemployment, and this must involve examination of both demand and supply side processes. Traditionally spatial economic analysis in the UK has emphasized demand-side factors, given the general post-war climate of Keynesian economics within which regional economics developed. Not unnaturally, therefore, the sorts of regional policies that have evolved over this period have also been essentially demand based in their attempts to alleviate spatial economic imbalance.

One aim of this thesis, however, is to show that, within a spatial context, supply-side processes take on renewed significance which needs to be more clearly recognised in the formulation of regional policy. The spatial distribution of labour supply is clearly more elastic than its overall level, implying that job creation at a local level is likely not only to affect unemployment as policy-makers might intend, but also to induce supply side adjustments which may thwart at least in part the objectives of such policies.

In the next section of this introductory chapter, traditional approaches to spatial labour market behaviour will be critically discussed, and a personal view of local labour markets sketched out. In section 3, certain specific themes of the thesis will be addressed, whilst section 4 provides the broad organisational layout of the thesis.

2. The Analysis of Spatial Labour Markets

The purpose of this section is firstly to outline a general perspective on labour market processes, secondly to discuss and evaluate traditional approaches to the treatment of space as a factor in labour market behaviour, and thirdly to suggest ways forward in developing the treatment of spatial factors and integrating them within a more general perspective.

As our point of departure, we shall discuss two contributions that are taken to be of major importance in developing the understanding of general labour market processes, beyond standard neo-classical theory. These are firstly the emergence of disequilibrium theory and associated developments in the treatment of information, and secondly the development of models of labour market segmentation.

The former contribution relates to explicit attempts to analyse the behaviour of markets that fail to clear, how such disequilibria may arise, and how market failure might be re-inforced and sustained (Clower (1965), Leijonhufvud (1967)). This literature focusses on the role played by the Walrasian auctioneer of classical economic theory, i.e. that individual who costlessly conveys information back and forth between buyers and sellers in every market about notional demands and supplies at different prices. This process is assumed to continue in classical models until a (unique) equilibrium price vector is found which clears all markets simultaneously. Only then does trading actually take place.

The <u>removal</u> of the Walrasian auctioneer implies that, to begin with at least, trading is most likely to take place at 'false' prices, such that excesses of notional demand or supply are likely to emerge in different markets. As a result, agents can only signal their <u>effective</u> demands and supplies in any particular market, as opposed to their <u>notional</u> or desired quantities which are planned on the basis of prevailing prices in the absence of quantity constraints.

Thus, for example, a household that is constrained in the labour market by being unable to sell their notional labour supply at the current real wage will then have to form consumption plans for the purchase of goods based on income derived from their effective labour supply. Symmetrically, firms that are unable to sell their full notional output levels at the current product price will then have to decide on levels of labour demand on the basis of effective sales. The issue, therefore, is not simply one of flexibility in prices, but also concerns the transmission of information about notional demand and supplies in order that an appropriate price configuration is obtained so as to clear all markets; not only must prices be sufficiently flexible in order to attain their required values, but a means of amassing the relevant information and calculating these values is also necessary.

In this context it is at least conceivable that disequilibrium may be sustained for some period, as binding constraints on one side of the market feed into and reinforce constraints on the other side. an obvious example (akin to the paradox of thrift) might be where firms' notional production levels exceed actual sales, leading to cutbacks in labour demand. This imposes quantity constraints on households' labour supply, the gap between notional and effective labour supply curtailing consumption plans, and thus reinforcing low levels of demand for the firms' products. Given the relative inefficiency of price signals under such circumstances, a pattern of quantity-quantity type relationships emerge, where, for example, effective labour supply is determined not so much by the real wage as by the level of effective labour demand which is available to absorb existing notional labour supplies.

Whilst one might expect some adjustment in prices to take place eventually, such adjustment is likely to be slower the poorer the available information, and the greater the costs involved. The length of time spans involved is difficult to predict from static theory, but given the ever changing nature of the economic climate, and the pervasiveness of stochastic shocks that are unforeseen by economic agents, one might expect disequilibrium to be the general rule, rather than the exception; the long run is made up of a series of (sequentially dependent) short runs, where constantly changing conditions are likely to imply that full equilibrium is rarely, if ever, attained. And, 'in the long run', as Keynes argued, 'we are all dead'.

Such disequilibrium models have clarified and extended the micro-economic foundations of Keynesian theory, going <u>beyond</u> traditional arguments about the influence of institutions such as Trade Unions, issues of price inflexibility in general, and wage rigidity in particular. In more recent years, the literature on the economics of information (eg. see Stiglitz (1985) for a review) has uncovered a growing catalogue of circumstances where the removal of the perfect information assumptions of standard theory has led to fundamental breakdowns in its predictions. Some of these have even attempted to provide an economic <u>rationale</u> for observations such as the prevalence of downwardly rigid wages.

The 'efficiency wage hypothesis' (eg. see Malcolmson (1981)) for example, posits a lack of information on the part of employers regarding the productivity of a heterogenous pool of potential workers. Employers are aware, however, that the productivity of job applicants increases with the offered wage, either through self-selection of high productivity workers, or incentive effects. Thus, in a situation of excess labour supply, employers might be <u>unwilling</u>

to reduce the offered wage, for fear of hiring low grade workers at the lower wage. Thus wages may remain rigid in periods of unemployment.

Implicit contract theory focusses on differential attitudes to risk as between workers and employers (eg. see Azariadis (1975)). Workers are seen to be more risk averse than employers, who generally have a larger capital base to help them cope with unforeseen random events. The contract of employment guarantees a fixed income to the worker for a specified period, thus shifting the burden of risk away from the worker, and onto the employer. In such circumstances, however, periods of low product demand will manifest themselves _not_ through changes in wages, since the wage is contractually agreed (another argument for wage rigidity) but through fluctuations in _employment_, eg. lower hiring rates, non-renewal of contracts, etc. Once again, quantity-quantity relationships (as between levels of demand and employment) rather than traditional price-quantity relationships emerge from such a scenario.

In general, it may be noted that the _response_ of neoclassical economics to such theoretical developments has been to resort to some surrogate for perfect information and the services of the Walrasian auctioneer, most notably in the form of the rational expectations hypothesis (eg. see Minford et al (1983)). Whilst a full discussion of this literature would extend well beyond the scope of this thesis, the following points may be noted. Firstly, although rational expectations has been defined in many different ways (eg. from perfect foresight to the optimal use of existing information sets), it may be seen to be fundamentally at odds with disequilibrium models in the sense that the distinction between notional and effective quantities makes no sense in such a framework. Secondly, whilst it may be seen to be inappropriate in certain markets (such as the labour market), it may not provide an altogether invalid working assumption in other areas such as the market for foreign exchange. Introduction of rational expectations mechanisms into such markets clearly does not however guarantee that the labour market also will clear continuously (Buiter and Miller (1981)).

The second, closely related, development in labour market theory which is taken to be of major importance in this thesis relates to issues of labour market segmentation (eg. see Reich, Gordon and Edwards (1980)). This literature is closely allied to some of the work discussed above in relation to disequilibrium and the economics of information. The labour market is seen to consist of heterogeneous groups of workers and types of job, and the labour market process as one which attempts to allocate workers to jobs. Broadly, to take the extreme form of such models (i.e. dual labour market theory) for the purposes of exposition, jobs fall into two categories. These are secondary sector jobs characterised by low pay, poor prospects, job instability and vulnerability to unemployment or sub-employment, and primary sector jobs which are relatively stable, well paid, and with good promotion prospects. This structure reflects the interests of employers in keeping a low paid sector of their workforce with little job specific training that may be hired or fired without incurring substantial adjustment costs, at the same time as they maintain clear internal promotion ladders for (what are seen to be) higher grade workers whom they wish to retain.

Workers are allocated to jobs on the basis of imperfect selection criteria. In part selection may be administered on the basis quite simply of discrimination, eg. on grounds of sex or race. Up to a point this might be seen as reflecting employers' 'tastes' along the lines suggested by Becker (1971), i.e. a 'willingness to pay' in terms of lower profits, for a particular composition of workforce. More generally, perhaps, screening criteria may be used in recruitment, in the form of simple rules of thumb such as levels of educational attainment, previous work histories, or indeed characteristics such as sex or race (Spence (1973)). On the basis of such more-or-less directly observable screening criteria, an employer may make inferences about job applicants' productivity at low cost. So long as there exists a significant correlation between observed productivity after hiring takes place, and that predicted by the screening devices, then one might expect employers to continue in their use of these devices and a form of 'informational equilibrium' is attained. In such circumstances, not only does the possibility of multiple equilibria emerge, but some equilibria are clearly Pareto inferior to others.

The distinguishing feature in such labour markets therefore, becomes not actual productivity, but rather the screening criteria themselves. Workers filling secondary sector jobs are not necessarily low-grade workers (at least in terms of potential), but simply those who send adverse signals in the screening process.

Finally, it may be noted that once workers are allocated to secondary sector jobs, there are likely to be barriers to restrict opportunities for movement to the primary sector. Partly, this is because certain of the screening devices that employers might use such as sex or race are unalterable, so that workers with adverse characteristics are always likely to face the same treatment in the recruitment process. More importantly, however, work histories are liable to be used also as a screening device; thus, once a worker is assigned to a secondary sector job, such unfavourable work history is likely to disadvantage that worker in any subsequent attempt to enter or re-enter the primary sector (see eg. Norris (1978b)).

These two developments in labour market theory, i.e. the disequilibrium approach and models of labour market segmentation, may be seen to have a number of common themes. Both may be seen as attempting to break down the 'ideal' properties of neoclassical theory, in terms of the underlying assumptions and also the final outcomes. Both involve the introduction of imperfections and rigidities into the system in order to be able to explain, or at least come to terms with, 'real world' phenomena of persistent unemployment or sub-employment, and labour market disadvantage in general, all involving substantial welfare losses. Both models attempt to analyse economic systems in the absence of perfect information. The disequilibrium approach and models of labour market segmentation may be seen to be essentially in harmony with each other, in as much as the latter represent a specific kind of disequilibrium (in relation to neoclassical models) which is of particular import in the analysis of labour markets.

In both these areas of labour market analysis, spatial factors may be seen to play a potentially important role. Clearly, there is a spatial dimension to labour market disequilibrium, as witnessed by the occurrence of geographical mismatch between workers and jobs, and general patterns of spatial dislocation in labour market processes. There are also distinctive spatial aspects to the issue of the relative importance of price or quantity signals, e.g. the question of whether workers respond to wages or to unemployment differentials in the decision to migrate. More specifically, space plays an important role in labour market segmentation, with the emergence of stigmatised areas, the spatial concentration of groups highly prone to unemployment such as blacks and unskilled manual workers in areas such as the inner cities, the restrictions that spatial factors are likely to place on occupational choice and advancement, and the relative geographical immobility of disadvantaged sections of the workforce such as women.

Potentially, therefore, spatial factors are likely to be of great interest in developing general perspectives in labour market behaviour, and it is in the treatment of this dimension that one would expect spatial economic analysis to provide its major contribution. It is paradoxical, then, to find that traditional approaches to spatial labour market analysis contribute little in this respect, and in general attempt to abstract from or simply to ignore space as a substantive causal factor affecting economic decisions.

There are two traditional approaches to the treatment of space which may be identified, both of which handle space by effectively ignoring it. These are firstly neoclassical models of local labour markets (and extensions thereof), and secondly, what might for the sake of exposition be called closed labour market models. We shall proceed to discuss these in turn.

2.1 Neoclassical Models

A number of variants of neoclassical models of local labour markets may be discerned in the literature (eg. see Armstrong and Taylor (1985) especially chapter 6; Hart (1975a)). For our purposes the following simple model will suffice. Consider a general environment of perfect information and risk neutrality, market clearing, the absence of distortions due to market power, with no rigidities or adjustment costs. From this starting basis, a simple pattern of short run spatial labour market equilibrium may be derived, along with standard comparative static results.

Assume for simplicity that capital is immobile in the short run, but that labour is free to move, without cost. Assume also, again for simplicity, that labour is homogeneous in character. Workers' utility functions are specified such that their locational decisions are determined by prevailing wage rate differentials across areas, plus some other composite index of factors, measuring for example the environmental attractiveness of an area.

Wage rates respond immediately to any excess supply or demand for labour and each local labour market is itself in equilibrium when local labour supply equals local labour demand. Short run spatial equilibrium across local labour markets is attained in the presence of a stationary work force with no migration flows. Should there exist no variation in environmental factors across areas, then such an equilibrium would be consistent with uniform wage rates, resulting in zero migration flows. Should one area be more attractive than the remainder then this will produce inward migration into that area, increasing the labour supply and forcing the wage rate down. This process will continue until the lower wage exactly offsets the environmental attractiveness of the area, in affecting workers' locational decisions. In general, therefore, such a model generates a pattern of compensating variation across areas in those characteristics which appear as arguments in workers' utility functions, the endogenous wage rate responding to migration flows, and serving to equilibrate between spatial labour markets. Any differences in areal attractiveness are exactly compensated for by differences in the wage, such as to remove any incentive for migration.

A number of features of this simple model are worthy of comment. Firstly, specific labour market areas are characterised by internal equilibrium when supply equals demand at the prevailing real wage. In this context, unemployment does not arise as a quantity constraint deriving from insufficient demand; the price signal of the wage is able to clear the market. External equilibrium, i.e. the bringing of labour market conditions in different areas into harmony with each other, is achieved by induced migration flows acting to remove real wage differentials between areas via its impact on local labour supply conditions. Migration does not respond to the quantity of excess labour supply in each area in this model, but to differences in the real price of labour. Finally, it is notable that in full equilibrium, no further migration between labour markets takes place.

Clearly, even with the introduction of environmental factors, this is still a highly simplified formulation. The model may clearly be extended to introduce capital mobility, and developed to address questions of long-term growth (eg. see Borts and Stein (1964)). From the point of view of this thesis, however, it is the issue of market clearing which is the most controversial, and the earlier discussion of imperfect information and price rigidities might lead one to expect at least short run deviations from market clearing. Thus local unemployment differences are likely to emerge, and the degree of excess supply/demand to feed in as a further argument in the migration function. This simple model therefore serves to highlight some of the main differences between disequilibrium and neoclassical models, the latter depending on the existence of imperfections of some form or other which prevent the continuous attainment of full market equilibrium, and the introduction of quantity-quantity type relationships into the model.

The Harris and Todaro (1971) model of urban-rural shift provides an illustrative case in point, which has been important in the development of local labour market theory. Perhaps the most interesting feature of their model is that the introduction of <u>one</u> simple imperfection into an otherwise purely neoclassical model enables them to generate a pattern of rural to urban migration, in conjunction with the co-existence of high wages and unemployment in the urban areas. The imperfection built into their model concerns institutional factors which serve to maintain wage rates at artificially high levels in urban areas. The differential in wages between urban and rural areas induces migrants to enter the urban centres, as in neoclassical models. Wage rigidities prevent the urban wage from being forced down, however. With the prevention of internal market clearing, stocks of unemployed workers therefore accumulate in the cities, generating a form of quantity-quantity relationship as such unemployment feeds back into the decision-making of prospective migrants. Specifically, Harris and Todaro adopt a formulation where prospective migrants respond to <u>expected</u> earnings, constructed as the prevailing wage, <u>weighted</u> by the probability of finding employment.

This probability falls as unemployment rises, so that growing urban unemployment serves to deter further rural to urban migration. In equilibrium, the accumulated stock of unemployed in urban areas serve exactly to offset the higher prevailing wage rate, in order to equalise expected earnings between urban and rural areas. The probability of finding employment acts, in this model in a fashion similar to the role of areal attractiveness in the simple neo-classical model sketched out earlier, in that in equilibrium high unemployment exactly compensates for the high wages, leading to a stationary labour force with no further incentives to move. The main differences are, firstly that it is the level of urban unemployment which is endogenous in this model, rather than the wage which is exogenous, and secondly that the existence of urban unemployment formally introduces a quantity-quantity type relationship into the model.

In sum, therefore, we have seen in this section how some of the divides between neoclassical and Keynesian economics have their parallel in spatial economic analysis. Perhaps the main issue that needs to be addressed at this stage relates to whether spatial economic analysis provides just another manifestation of these arguments, or whether the introduction of space yields any new insights which might deepen our understanding of labour market processes. Is the spatial case merely another version of the national case, at a lower level of aggregation?

The view adopted in this thesis is that the spatial dimension is of itself an important source of market imperfections, conditioning agents' opportunity sets by providing a physical barrier to movement which is costly to overcome, and inhibiting the diffusion of information. The neoclassical and Harris-Todaro models, by casting space as something which is fluid and costless to overcome, lose precisely that element which is characteristic of sub-national labour markets; the direct transfer of spaceless models to the spatial case abstracts from any intrinsic interest in the spatial dimension.

2.2 Closed Labour Market Models

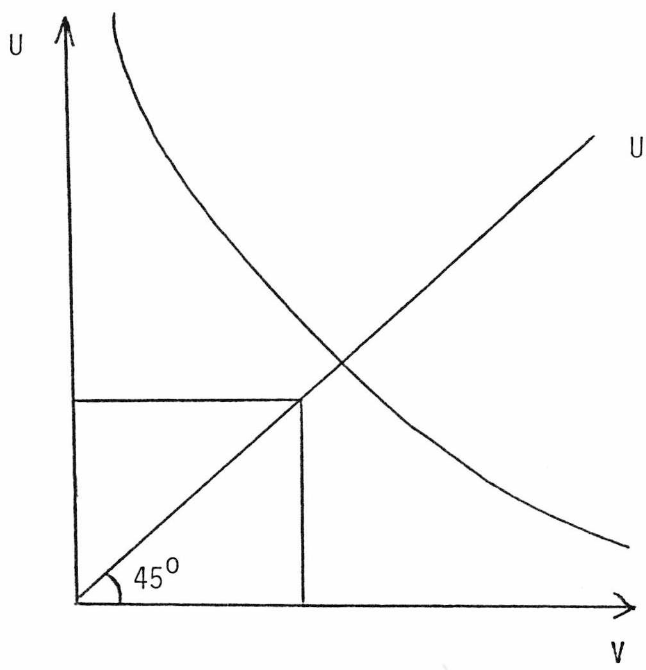
In contrast to the world of perfect mobility characterised above there exists a class of models which, either explicitly or implicitly, treat spatial units as independent point economies which operate and develop in isolation from each other, without scope for mobility or interaction. In this approach, areas are treated purely as subscripts, i.e. unconnected mini-versions of a national or international economy.

Analyses of many labour market phenomena take this form, some more justifiably than others (see for example studies of participation rates discussed in chapter 6), but it is perhaps in keeping with the previous discussion to concentrate on models of local unemployment differentials. Two main approaches to the analysis of unemployment may be discerned in the literature, the unemployment/vacancies (UV) approach which is traditionally interpreted as being demand based and generally applied at the level of broad regions, and the 'personal characteristics' approach, which is supply based, and tends to be applied more at the inter and intra urban level of aggregation.

Historically, the UV approach developed from basic Keynesian arguments about the possibility of involuntary unemployment, and represents an attempt to classify unemployment into distinct components, i.e. structural, frictional and demand deficient unemployment. In standard Keynesian theory, it is important from a policy point of view to separate these categories, since it is essentially the demand deficient category which is likely to respond to aggregate demand management policies, whilst more micro oriented supply side strategies are likely to be appropriate in dealing with the other types of unemployment, eg. Government re-training schemes.

The traditional argument runs as follows. Both unemployment and vacancies are seen to be functions of aggregate demand and supply. As aggregate demand rises (relative to supply) so unemployment falls and vacancies increase. This leads one to expect in general a negative reduced form relationship between the two (i.e. when unemployment is high vacancies will be low, and vice versa). This sort of relationship is depicted in Figure 1.1.

Figure 1.1



If it is the case that U = V, then there are enough jobs available to eliminate unemployment, therefore what unemployment does exist must be due to mismatch, i.e. structural or frictional factors. The extent to which U exceeds V may therefore be used as a criterion with which to extract demand deficient unemployment from the data.(1)

Whilst the model is essentially spaceless in character, it has frequently been applied to regional economies, in order to derive estimates of regional demand deficient unemployment (eg. see Cheshire (1973), Thirlwall (1969)). Clearly, such analyses neglect the possibility of inter-dependence between regional labour markets, and particularly the scope for movement between regions. It is paradoxical in a sense to discuss regional demand deficiency, therefore, when regional imbalance in unemployment is itself in part a structural problem, one solution to which would be the relocation of resources. Indeed, Gordon (1977) argues that it is impossible to define the demand deficient element of unemployment in one region without reference to conditions in other regions.

The 'personal characteristics' approach to unemployment relates more directly to structural and frictional types of unemployment, rather than demand deficiency. In essence, it is argued that there are certain individual characteristics that affect the probability that the person in question is or will become unemployed. Examples of such 'exogenous personal characteristics' that are frequently used empirically are skill, race, and marital status. Geographical unemployment rates depend therefore on the characteristics of the population living in each area, eg. an area with a substantial concentration of black unskilled manual workers is likely to have a high unemployment rate.

This approach has mainly been applied at the urban level (eg. see Metcalf (1975), Metcalf and Richardson (1976)), in contrast to the UV models discussed above which tend to be applied at the broad regional level. The model treats factors such as skill as reflecting something intrinsic about the individual rather than dependent on wider labour market processes. The locational decisions of individuals are disregarded in this approach as well, i.e. rather than asking why individuals who are highly prone to unemployment live in particular areas, the model merely predicts the unemployment rate that is likely to prevail given the observed distribution of the population.

The two models discussed in this section may be seen in certain respects to be opposites, in that the UV approach (at least in the way it is traditionally interpreted) concentrates on demand side factors and treats supply as exogenous, whilst the personal characteristics approach concentrates on supply side explanations and treats demand as exogenous. Both models ignore the potential for movement, and simply accept disequilibrium. As such, they are no more successful in handling the spatial dimension than neoclassical approaches, since they both implicitly abstract from the possibility of spatial linkages.

2.3 A Perspective on Spatial Labour Market Behaviour

One central aspect of this thesis concerns the analytical and empirical treatment of physical space. In particular, it is argued that, regardless of methodological convenience, it makes no sense to analyse spatial phenomena in a framework devoid of spatial content, treating geographical units as a series of independent point economies or unconnected sub-sets of the aggregate national picture. Questions of relative location, accessibility, distance, and inter-dependence clearly affect the functioning of local labour markets.

Whilst standard, spaceless, labour market models may yield insights into the processes operating <u>within</u> local labour markets, they are seen here as inappropriate for the understanding of the development and inter-dependencies <u>between</u> these markets. As in neoclassical models or indeed the models of urban/rural shifts in less developed countries, migration is seen here as the central mechanism whereby spatial labour market equilibrium (i.e. equilibrium <u>between</u> areas as opposed to <u>within</u> them) may be reached. Migration is seen, however, as a much more complex process than the neo-classical or Harris/Todaro type models might suggest, particularly in terms of the treatment of the spatial dimension.

Neoclassical models disregard space by treating it as something which can costlessly be overcome; aspatial models abstract from it by effectively assuming that movement is infinitely costly, so that local labour markets can be analysed in isolation from each other. The view adopted in this thesis lies somewhere between these extremes. A national labour market is seen as the sum of its geo-graphical parts, but these are imperfectly linked together by the potential for movement, particularly of labour. Space is seen as a substantive physical barrier which is costly to overcome and inhibits movement. In contrast to neoclassical models, <u>information</u> about opportunities for movement is also seen as costly to acquire, and these costs increase with distance. As a consequence, movement is seen as the outcome of a <u>search</u> process, in which agents seek infor-mation about migration opportunities, and search more intensively in nearby areas. Whilst local labour markets are seen as interdependent therefore, both direct and information related spatial costs dictate a pattern of distance decay in the strength of labour market ties.

More specifically, geographical unemployment rates are held together by these spatial linkages, such that an increase in unemployment in one area will lead to a process of labour diffusion to surrounding areas, but this diffusion will be hampered by distance, and will not be complete. The resulting equilibrium describes a pattern of spatial autocorrelation in labour market behaviour, as the behaviour of each local labour market reflects and is affected by processes occurring in other geographical areas, the significance of these interdependencies declining with distance. Within this context it is possible to derive an alternative categorisation of 'demand deficient' and 'non-demand-deficient' unemployment to that provided by the standard UV model, which explicitly incorporates the potential for mobility (Burridge and Gordon (1981)).

In terms of standard labour market theory, therefore, space acts as a constraint on geographical movement, providing another potentially important dimension to the notion of labour market segmentation. Whilst distance is clearly not an insurmountable barrier to mobility in this context, it does inhibit movement, partly through direct transportation costs, but also as a spatial filter on patterns of information diffusion. The resulting spatial labour market equilibrium will not be a simple market clearing solution in the neoclassical tradition.

All these issues will be dealt with more precisely and in greater depth at various points in the thesis; the purpose of this section is to serve as an introduction to the main issues, and to provide a general labour market perspective within which the detailed analysis of local labour supply presented here may be considered. In the next section, certain specific underlying analytical themes of the thesis are identified and discussed.

3. Underlying Themes of the Thesis

The analysis of local labour markets in this thesis is pitched at a range of different levels, using a number of different data sources, in order to draw inferences from as broad a body of evidence as possible and to uncover phenomena that might remain obscured if a single perspective were rigidly adhered to. Variations in labour supply are examined not only at the level of the broad Standard Planning Regions, but also within the context of the small areal units of a specific metropolitan labour market, (i.e. the London Boroughs and surrounding counties of the Outer Metropolitan Area), where housing market effects, and commuting patterns take on much greater significance. Single equation models focusing on specific questions pertaining to local labour supply are contrasted with large scale simultaneous systems, and evidence based on aggregate data compared with the results of disaggregate choice modelling. Detailed cross-sectional analysis is coupled with the study of time series behaviour.

One important theme that will be addressed within this context in the analysis of mobility patterns lies in the identification and separation of migrant streams across different distance ranges

(Harris and Clausen (1967), Hyman and Gleave (1977), Gordon (1982)). Put crudely, it is argued that individuals moving for job-related reasons tend to differ in their patterns of behaviour, particularly across distance ranges, from those moving for essentially residential reasons, and that the two respond to different sets of factors, the former more closely associated with labour market processes, and the latter related to housing market conditions.

Temporal factors in the analysis of migration are also considered in terms of distributed lags in migration responses, and fluctuations over time in the overall volume of migration in response to changing national economic conditions. These factors are seen as playing a critical role in affecting the efficiency of migration as an equilibrating mechanism across local labour markets, leading to widening variances in local unemployment rates in times of low mobility (Gordon (1985)).

The discussion of the <u>effects</u> of labour supply adjustments is largely concerned with the inter-relationships between unemployment, employment change, and labour supply. Several interesting issues emerge when these are considered in a spatial context. Two important questions that arise from the previous discussion of spatial labour markets concerns the properties of the underlying spatial equilibrium and the final outcome of stochastic shocks to the system for the pattern of local unemployment rates. From a policy point of view, it is particularly important to be able to quantify the effects of local job creation schemes on local unemployment rates. The question is the extent to which gains in local employment are taken up by reductions in local unemployment rates, rather than by adjustments on local labour supply via changes in mobility patterns (i.e. migration, and at lower levels commuting changes), and labour force participation adjustments.

At a less aggregated level, it is also important to consider migration as an essentially selective process, particularly in terms of age and skill structure, since after a number of years of population dispersal, declining areas may be left with a residual labour force of mainly old and unskilled workers with a high vulnerability to unemployment. The question of cumulative causation in population and employment dispersal, and the dynamic properties of the resulting equilibrium may also be seen to be of great interest. This process results on the one hand from the net effect of employment change on migration, and on the other from the possibility that net migration acts itself as a source of demand, which generates extra jobs.

At a highly localised level, the housing market is seen to play an important inter-mediary role in the relationship between migration and local unemployment. Thus, when dealing with parts of a labour market, it is arguable that the observed distribution of unemployment reveals more about the location decisions of particular sections of the workforce that are highly vulnerable to unemployment, rather than explaining why people in an area have a particular propensity to be unemployed. The availability of different kinds of housing may be seen to play a central role in this process. Thus, for example, the concentration of large housing estates with low rents in certain districts may serve as a residential site attracting sections of the work force that are highly prone to unemployment.

A further issue addressed in the thesis lies in the examination of potential asymmetries between men and women in terms of their local labour supply adjustment processes. Women tend to be relatively immobile geographically (especially married women), whilst exhibiting substantial spatial variation in their labour force participation (eg. see Greenhalgh (1977), Layard and Barton and Zabalza (1980)). By contrast, males are clearly quite mobile geographically (eg. see Gordon and Lamont (1982)), whilst their participation rates are evidently fairly stable across space, exhibiting general invariance with respect to local labour market conditions, and reflecting differences for the most part due to age structure effects (eg. see Bowers (1970), Greenhalgh (1979)). The analysis is therefore concerned not only with the determination of those aspects of local labour supply that clearly matter (i.e. male migration, and female labour force participation), but also in unravelling the processes which produce such fundamental asymmetries bewteen the sexes in their patterns of adjustment in local labour supply.

4. Thesis Organization

The organisation of the thesis may briefly be outlined as follows. The first part of the thesis, comprising the next four chapters, is devoted exclusively to the modelling of the determinants of male migration patterns. The second part, comprising chapters six and seven has the twin aims of incorporating variations in female local labour supply into the model, and extending the analysis to the investigation of the effects of changes in local labour supply (including both migration and participation responses), within the context of a simultaneous labour market system.

The first chapter on male migration patterns (chapter 2) is devoted to a discussion of some of the previous literature and historical developments in migration theory, with a view to formulating a basic micro-economic theoretical perspective on the issue. In this chapter, it is argued that there is a role for migration modelling at both the aggregate and disaggregate levels, and both these approaches will be adopted at various stages of the thesis. The main point is that, whilst disaggregate studies of individual behaviour are obviously of interest, the complexity of migration behaviour renders impractical a comprehensive analysis of all aspects of migration decisions at this level. Aggregate models of spatial interaction are therefore derived on the basis of micro-economic theory.

In chapter 3, a simplified form of discrete choice model, amenable to empirical analysis at the individual level, is constructed and tested on a sample of young men in Great Britain drawn from the 1979 European Commission Labour Force Surveys. Various aspects of their migration decisions are analysed, focusing on the individual characteristics of migrants over different distance ranges.

Chapter 4 returns to the level of aggregate spatial interaction, and is devoted essentially to the question of model estimation. A simple cross-section analysis of male inter-regional migration from the 1971 Census of Population is presented, focusing on methods of empirically identifying different motivational streams of migrants, and presenting estimates of the relative size of these streams in the British regional system. In chapter 5 the analysis is extended to a temporal context, using a quarterly time-series for the latter half of the 1970's extracted from the National Health Service Central

Register, and focusing on the estimation of short run dynamic responses.

Chapter 6 presents an account of previous work on female labour force participation, and the insights that can be drawn from this literature in terms of understanding spatial variations, leading into an analysis of regional variations over time in married female participation rates, using information derived from the Family Expenditure Surveys.

The analysis of female participation rates is then incorporated in chapter 7 into a simultaneous labour market system for the Greater London region, which also treats the migration, commuting change, employment change, and unemployment of men and women as endogenous. Despite recent trends in labour economics towards the analysis of the female labour market, no parallel shift of emphasis may be observed in the study of women in local labour markets, even though consideration of women's labour market experience within an explicitly spatial context is potentially of great interest. As a move in this direction, the analysis attempts to extend and adapt a model of male local labour market processes to the female case and to model the inter-dependencies between the gender-based submarkets. The analysis focusses on the identification of various forms of specifically spatial constraint experienced by women in their labour market histories, and traces through the influence of these constraints on the spatial patterns of female labour market behaviour, and the consequent asymmetries in the labour supply adjustment processes of men and women in a spatial context.

Chapter 8 is devoted to a summary and conclusion of the main aspects of the research presented here, and presents proposals for future research to follow up some of the issues which have been only partially resolved within the context of the thesis.

CHAPTER 2 THEORIES OF MIGRATION: A SURVEY

1. Introduction

A longstanding and deeply rooted problem in assimilating and evaluating research on migration theory lies in the diverse and fragmented nature of the field. This literature derives from a number of different disciplines the various strands of which are rarely bound together into an integrated treatment, and often proceed with little or no exchange of reference. As a result, reliance on any one single approach is likely to lead to a highly specific and incomplete view of the complex processes affecting individuals' locational decisions in the space economy.

Given this diversity of research, there is an obvious need for a fairly wide-ranging review of the literature in the area. As such, Greenwood's (1975) review has become something of a landmark, and a standard reference in the field. Greenwood's (1975) review referred more or less exclusively to the American rather than the British literature in this field, however.(1) Further, a great deal has been published in the area since Greenwood's (1975) review, which is worthy of attention. Most importantly however, Greenwood (1975) confined his attention largely to empirical studies without undertaking a systematic evaluation of underlying theories of migration, and this provides the primary motivation for this chapter.

Whilst the great majority of migration studies do tend to be essentially empirical in content, it is argued here that (contrary to received opinion) the variety of existing theoretical perspectives on migration are nevertheless remarkably rich. Clearly, whilst theory and evidence cannot develop in isolation from each other, all too frequently applied studies tend to proceed on the basis of some hazy theoretical notions which are rarely given more than passing attention. This chapter attempts to redress the balance, considering applied studies only in so far as they are able to shed light on the sign and strength of particular relationships. The theoretical discussion is also concerned virtually exclusively with models of the causes rather than the effects of migration. In later chapters of this thesis, the specification and estimation of simultaneous models will be considered, and the nature of equilibrium across local labour markets discussed.

In the next section of this chapter, several important concepts and themes in migration analysis are identified in order to provide a frame of reference for the consideration of various theoretical perspectives in the remainder of the chapter.(2) In section 3, early economic perspectives on the determination of migration decisions are outlined, whilst section 4 is devoted to a discussion of the human capital approach. In section 5 the issues of rationality and information are addressed, particularly within the context of psychologists' models of migration as a response to 'stress'. This leads into a discussion of random utility theory in section 6, whilst a search theory perspective on migration is suggested in section 7 as a way of handling the problem of information. In section 8, the general problem of implementing models of individual migration behaviour directly at the micro level are discussed, and the possibility of using microeconomic theory as a basis for the derivation of operational models of aggregate behaviour is considered. Section 9 discusses in greater depth certain basic properties of aggregate gravity models, whist section 10 focusses specifically on the relationship between search theory and the gravity model, attempting to elucidate behavioural predictions from that theory which are testable at the aggregate level. In section 11 the process of search is considered in greater depth in relation to the structure of information networks in the space economy. Section 12 is devoted to a discussion of temporal dimensions in migration analysis, and their implications for the specification of aggregate spatial interaction models. The interdependence between housing and labour markets is considered in section 13, in terms of joint residence/workplace choice, and the interaction between migration and commuting decisions. Section 14 provides a summary and conclusion.

2. Some Underlying Themes of Migration Analysis

Within the framework of this thesis, the following sets of issues in migration analysis are seen to be of central significance:-

1. The notion of optimality in agents' decision making, and if agents' decisions are not optimal, the extent to which this is due to lack of information. If information is imperfect, how do individuals go about search to acquire it?

2. The distinction between 'speculative migration' undertaken in the hope of finding a suitable opportunity, and 'contracted migration' undertaken after having already secured such an opportunity at the point of destination.

3. The treatment of space as affecting migration decisions in terms of the geographical distribution of opportunities, distance costs related to movement and transportation, and spatial elements inherent in the search process necessary for the acquisition of information.

4. The relationship between firstly demand-side processes affecting the number and type of opportunities for movement and the choice set faced by individuals; and secondly supply-side processes as regards individual decisions made in the face of such demand conditions and reflecting individual preferences and sets of constraints; and the interaction between these demand and supply side processes.

5. The underlying motivation for moving, the interaction between workplace and residence place decisions, heterogeneity in migration streams, the modelling of labour market and housing market related moves, and the interaction between the two.

6. The temporal dimension, in terms of the time spans involved in migration decision making and enaction, lags related to expectations formation and adjustment costs, the relationship between previous and current migration decisions, and the influence of changes in the national economic climate on individual migration decisions and overall levels of mobility.

7. The question of aggregation in terms of the relationship between models of individual behaviour and the analysis of aggregate patterns of movement.

The various different disciplinary approaches to migration analysis may be regarded in terms of the degree to which they emphasize one or more of these issues, whilst tending to neglect or in some cases question the validity of others. As a result, whilst there is no logical reason why these different elements of migration theory need not be integrated within a more unified perspective, in practice different disciplines tend to focus on different specific influences in the formulation of migration models. Some of these are considered below.

3. Early Economic Perspectives on Migration Analysis

Early economic approaches to migration analysis provide a useful point of departure (eg. Ravenstein's (1889) 'Laws of Migration',(3) Hicks (1932)). Within this framework, demand and supply are seen as being mediated essentially by fluctuations in wages, in the classical tradition. Wages provide the principal argument in individuals' preference functions, whilst the distribution of opportunities for movement as reflected by the pressure of demand are also conditioned by prevailing wages. Wages themselves responded to any excess of demand or supply. On this basis, Hicks (1932) was able to arrive at his well-worn dictum that '... differences in net economic advantage, chiefly differences in wages, are the main cause of migration' (p.76).

A related branch in economic theories of migration came with the development of models of urban/rural shift in less developed countries (eg. Todaro (1969), Harris and Todaro (1970) or see Todaro (1976) for a review). Without going into detail in relation to their approach to local labour market equilibrium (see chapter 1), the main point as regards their model of migration lay in the extension of arguments in prospective migrants' utility functions to include not only wages but also the probability of being able to find employment. As a result migration came to be determined in their model by earnings differentials weighted by relative unemployment rates. In all other respects, however, the Harris and Todaro model tended to broadly follow the traditional economic formulation in migration analysis.

4. The Human Capital Approach

The contribution of Sjaastad (1962) was to suggest a new perspective on migration as a process which might reasonably be modelled as an investment in human capital, and this view has come to form the foundation of the prevailing economic orthodoxy in the area. In essence, potential migrants base their decision within this framework on an assessment of the anticipated future stream of benefits and costs (both monetary and psychic) as a consequence of migration. The basic model may briefly be outlined as follows (Hart (1975)). The potential migrant living in area i evaluates the expected utility, E(U), derived from the discounted present value of expected returns from residence in any one of j = 1... N areas (including the original location i):-

$$E\ \{U[R_j(0)]\} = \int_0^T \exp\ (-rt)\ U\ [R_j(t)]\ dt \qquad (2.1)$$

Where T defines the time horizon (eg. up to retirement) over which the individual calculates net returns, which are assumed to accrue continuously at a rate R(t) from the current time period (t = 0), and r is a subjective discount rate. The expected discounted costs (C) of moving to j may be calculated as:

$$E\,[C_{ij}(0)] = \int_0^T \exp\,(-rt)\,[C_{ij}(t)]\,dt \qquad (2.2)$$

These costs are likely to be a positive function of the distance between i and j, but will of course be zero if i = j, i.e. if the individual does not move. The individual evaluates the expected utility less the movement costs for each of the j = 1... N areas, and selects to live in that area with the highest net outcome. Migration takes place when the favoured area of residence is not the original area i.

The model may be extended into a risk-theoretic framework by introducing uncertainty and attitudes to risk in the formation of expectations and also in the evaluation of discount rates (see for example Langley (1974), Hart (1975)). This sort of model would suggest a whole variety of economic, social and environmental factors as affecting migration decisions, thus breaking with the early emphasis on wage differentials and purely labour market related influences (see Greenwood (1975) for a review of empirical research in the U.S. on various such factors affecting migration, within a human capital framework). The approach also suggests that mobility rates are likely to vary across different population groups, eg. according to age, since older individuals have a shorter time horizon over which to enjoy the benefits from migration, and this theoretical expectation conforms with observed behaviour. The model explicitly incorporates a <u>spatial</u> dimension in the specification of the cost function to moving, and permits a formal introduction of temporal factors in terms of the time horizon over which individuals evaluate expected costs and benefits, and the rate at which they are prepared to exchange expected future gains for current loss of utility in terms of the discount rate. Uncertainty and attitudes to risk are also formally introduced into the analysis.

Perhaps the main defect of the approach lies, however, in the treatment of information. In general, individuals do not have information on all available opportunities immediately at their disposal in order to appropriately calculate the relevant costs and returns, nor is the acquisition of such information without incumbent costs. The human capital approach fails to focus, therefore, on the process whereby individuals acquire information, which is fundamental to migration behaviour.

5. Rationality, Stress, and the Treatment of Information

The general issue of information in migration modelling has led certain investigators (particularly psychologists) to implicitly or explicitly question the assumption of optimality in migration decision—making which underpins all the models outlined above. Simon (1957) argued that, when faced with complex sets of alternatives, individuals do not (or cannot) globally maximise over all the possible alternatives. Rather, they construct simplified models of reality in which only a subset of alternatives are perceived, and they evaluate pay-offs in terms of whether they are satisfactory or not. In this sense, therefore, individuals are seen as satisficing rather than maximising agents.

Wolpert (1966) and Speare (1974) have adopted this sort of perspective in the analysis of migration, by arguing that migration may be seen as a response to 'stress' (see Speare, Goldstein, and Frey (1974) for a general account). They conceive of some threshold in the degree of stress experienced by the individual, up to which point no action is taken, but beyond which the individual deems his or her current state unsatisfactory and seeks some opportunity to move elsewhere. In this context, stress arises out of a tension between individuals' aspirations on the one hand, and expectations about the current situation on the other, prompting the individual to search for opportunities elsewhere. Such a decision criterion may bear very little resemblance to economists' notion of utility maximisation, and may even be regarded in some sense as 'irrational'.

In evaluating this sort of approach to migration it is important to note that the debate about whether individuals are maximising or satisficing agents is largely a semantic one, reflecting the way in which information is treated in setting up the model. Thus, a satisficing individual may just as well be seen as a maximising agent who is subject to powerful constraints on the cost and availability of information. Nevertheless, the recognition of information as a problem and the appeal to some sort of search-theoretic perspective are important ideas, which we shall retain and develop in later sections of this chapter.

The issue of 'stress' as a decision criterion in migration decisions is a slightly thornier subject, since it depends ultimately on how 'stress' is determined and in what sense it differs from utility (or, more correctly, disutility). Arguably, stress is a direct function of those factors that affect individuals' utility, and acts in a similar fashion to a reservation criterion in a utility maximising model, in which case the psychologists' model may easily be recast into an economic framework (this is certainly the interpretation that certain authors have adopted eg. Amrhein and MacKinnon (1985)). For the stress model to contribute anything further towards our understanding of migration decision making, therefore, it must reflect a degree of irrationality in agents' behaviour which goes beyond the problems of information gathering, and which is systematic in nature. As such, the model calls into question the fundamental principles of expected utility theory. Unfortunately, not only is it difficult to conceive of an appropriate practical test of such a model, but it is also as a consequence unclear what important practical implications would arise from it, in the formulation of an operational model.

6. Random Utility Models and the Treatment of the Error Term

A further development of micro-economic models of migration came with the application of random utility theory, developed originally in relation to studies of transport (Domencich and McFadden (1975)). The essential notion of random utility theory is that whilst individuals are assumed to maximise well-behaved utility functions in the conventional manner, the utility function is partitioned into two components, one of which reflects the behaviour of representative individuals and the other of which is a random variable reflecting (unobserved) individual idiosyncracies etc. and situational factors which cause them to deviate in their behaviour from the representative individual. Conventional economic models tend often to add an arbitrary error term on an *ad hoc* basis at the end of a utility maximising exercise in the specification of an empirical model. The random utility approach attempts to integrate an explicit treatment of the error term into the initial formulation of individuals' decision making. By making appropriate assumptions about the distribution of the random element in the utility function across individuals, it is possible to derive a whole family of discrete choice models of individual behaviour, the most well-known of which are the logit and probit models. Not only does the random utility approach effectively integrate theory and estimation, however, but it relates explicitly to situations where the alternatives faced by individuals are discrete, as opposed to conventional utility theory which assumes infinite divisibility between alternatives.

Several studies have attempted to adapt this theoretical approach to migration analysis (eg. see Sheppard (1978), Van Est (1980), Gordon and Vickerman (1982)). In this context, the random utility function over a homogenous population group may initially be specified as:-

$$U_{kin} = V_{in} + \varepsilon_{kn} \qquad (2.3)$$

Where U_{kin} = the expected utility of individual k living in i as a result of moving to (or staying in) n.

V_{in} = the non-random element of this utility, reflecting the preferences of representative individuals

ε_{kn} = a random variable reflecting differences in preferences due to individual idiosyncracies etc.

Specifically, the strict utility component V_{in} of the utility function incorporates the characteristics of individuals which systematically influence mobility; the attributes of areas which attract or repel migrants; and some negative distance decay function reflecting the degree of spatial separation between origins and destinations, affecting the psychic and monetary costs to moving. Assuming that the stochastic component ε_{kn} has a Weibull distribution (double exponential) across individuals and locations, the probability P_{kij} that individual k living in i will choose to move to j (out of the set of possible locations n, including the current location) may be derived as (see Domencich and McFadden (1975)):-

$$P_{kij} = \frac{\exp(V_{ij})}{\sum_n \exp(V_{in})} \tag{2.4}$$

Perhaps the major contribution of the random utility approach in relation to migration analysis, lies in its recognition (implicit in the specification of the stochastic component of the utility function) of heterogeneity across individuals as a fact of life, and a starting point for analysis. This perspective goes a long way toward explaining the apparent complexity in observed migration behaviour. The naive neoclassical model outlined earlier would suggest that all migrants move in the same direction, from low wage to high wage areas. The human capital model would suggest that other individual and areal characteristics should also be taken into account, but still predicts broadly uni-directional moves for any identifiable homogenous population group. The fact that not all migrants do move in the same direction even within broadly homogenous sections of the population is captured within the random utility framework via the presence of a stochastic component in each individual's utility function which reflects unobserved factors specific to each individual. This approach also integrates the probabilistic approach of Wilson (1971), with utility maximising models.(4)

Whilst such discrete choice models may in principle be applied directly at the individual level, this does raise a number of theoretical and computational problems when the set of possible choices is potentially very large, as in migration analysis. The computational problems do not simply reflect our ability as investigators to adequately characterise the behaviour of individuals, however; once again they reflect the very real constraints on time and availability of information which the individuals themselves face. The standard response to this problem in the random utility approach would be to specify a 'nested model', involving some form of postulated decision tree for the individual, where different choices in that tree may be seen to be essentially separable (Domencich and McFadden (1975)). In the next section we shall investigate this possibility when we come to consider search strategy more explicitly.(5)

7. Information and Search

One point that emerges from the discussion so far is that it is clearly important to break down migration decision making into a series of stages in order both to adequately characterise individual behaviour, and also to make the model more tractable. Various forms of decision tree have been proposed in the literature eg. Rossi (1980), for example, suggests three broad stages where agents first decide to leave their old home, secondly search for a new home, and finally choose amongst alternative destinations. Evers and Van der Veen (1985) suggest a somewhat more complex framework where, broadly speaking, individuals living in one area may choose to work in an external area, in which case they may decide either to commute to the workplace zone, or migrate, depending on the distance between residence and workplace. There is a tendency in both these accounts to concentrate on observable outcomes, however, rather than considering in depth how individuals themselves are likely to structure their decision-making process. It is argued here that in order to construct a decision tree which is likely to be broadly representative of individuals' decision making process, it is necessary to focus explicitly on the underlying search strategy in the decision to migrate.

There is by now a substantial literature on the economics of search behaviour (eg. see Lippman and McCall (1976) for a survey), although the specific case of migration has received comparatively slight attention. Much of the literature is concerned with deriving 'optimal stopping rules' for search, usually in the form of a 'reservation wage' which the searcher uses as a basis for accepting or rejecting opportunities as they arise. In the simplest model, a number of key assumptions are made, in particular that searchers face an exogenous wage distribution, the parameters of which are known, but the order in which they receive offers is not known. Searchers conduct search while unemployed, and receive offers at a constant rate over time. The optimal reservation wage is then calculated in order to equate the marginal cost of searching for an extra time period with the marginal expected benefit of the offer (Lippman and McCall (1976)). Much of the literature on search is concerned with relaxing various of these assumptions (particularly the assumption that searchers know the parameters of the wage distribution), and examining the implications for the reservation wage.

In adapting this framework to migration analysis, an important distinction arises between what may be termed 'speculative migration', undertaken in the hope of finding a suitable opportunity at the point of destination (the 'get on yer bike' syndrome), and 'contracted migration' undertaken after having already secured such an opportunity (Silvers (1977)). In the former case migration is an integral part of the search process, in the latter it is the outcome. Much of the literature on search and migration implicitly deals with one or other of these cases.

Rogerson (1982) dealt initially with the case of speculative migration, and extended the standard search model to the spatial case by specifying a set of (known) independent wage distributions for each region, in addition to a matrix of distance related costs. In the simplest case the individual selects to search in the region with the highest reservation wage net of distance costs, and then chooses the first offer in that region which exceeds the reservation wage.

David (1974) also analysed the case of speculative migration, although he used a rather different framework, which concentrated on the expected variance of the offer distribution which confronted job searchers, relative to the average offer. Assume that (risk neutral) potential migrants have a fixed budget allocated to search activities, which they must divide between an initial move and the subsequent extraction of offers at the point of destination. Having exhausted the predetermined budget allowance, the searcher selects the highest valued offer extracted over the course of the search process. Under these conditions, David (1974) showed that the potential returns to job search are greatest in the labour market with the widest dispersion of wages, relative to the average offer. This result, coupled with the assumption that (perceived) relative wage dispersion is greatest in the large urban areas (and indeed, David (1974) advances a number of plausible reasons why this is likely to be the case), suggests that job searchers are likely to be drawn to the big cities as suitable sites for search activity - a sort of Dick Whittington syndrome, as Burridge and Gordon (1981) put it.

Maier (1985) explicitly considers the case where individuals do not know the parameters of the wage distribution (although they might know its general form), but use the information from each offer to update their estimate of the regional wage distributions and correspondingly revise their reservation wage. Explicit consideration of this possibility yields two valuable insights. Firstly, there is likely to be a powerful distance deterrence function implicit in the process of acquiring information (particularly in the presence of risk aversion) above and beyond the simple costs of moving. This point also comes through strongly in the work of Smith and Slater (1981) and Pickles and Rogerson (1984). Secondly, Maier (1985) recognised that uncertainty about regional offer distributions may deter individuals from undertaking immediate speculative migration, but may cause them to invest in further information before moving, or indeed inhibit movement altogether until they have actually secured a suitable opportunity at the point of destination.

Rogerson (1982), on the other hand, considered the case where although individuals may be aware of the parameters of regional wage distributions, they are uncertain as to whether or not they will receive an offer over a specified period. Both these sources of uncertainty, therefore, firstly about the parameters of regional wage distribution, and secondly about the probability of receiving an offer, would suggest that for large sections of the population contracted migration is likely to be the more prevalent form of movement. Indeed, there are relatively few sections of the population that spring to mind for whom speculative migration and ensuing search is likely to be an optimal policy (eg. the low paid or unemployed), since for the bulk of the community such a policy would involve sacrificing current labour income for the uncertain prospect of gaining a better job after an indefinite period of search. Whilst the relative size of such groups might expand during a recession, this effect is likely to be offset to the extent that the remainder of the community is likely to be even less willing to engage in such risky activities when the national labour market is slack (see section 12).

Gordon and Vickerman (1982) focus specifically on the case of contracted migration, and construct a general decision making framework in which the probability of migration taking place is expressed in essence as the product of three main conditional probabilities, forming a hierarchical decision tree:-

1. The probability of being in search during a specific period.
2. The probability, conditional on search, of receiving an opportunity of a specific type, from a specific area.
3. The probability, conditional on receiving such an opportunity, of accepting it.

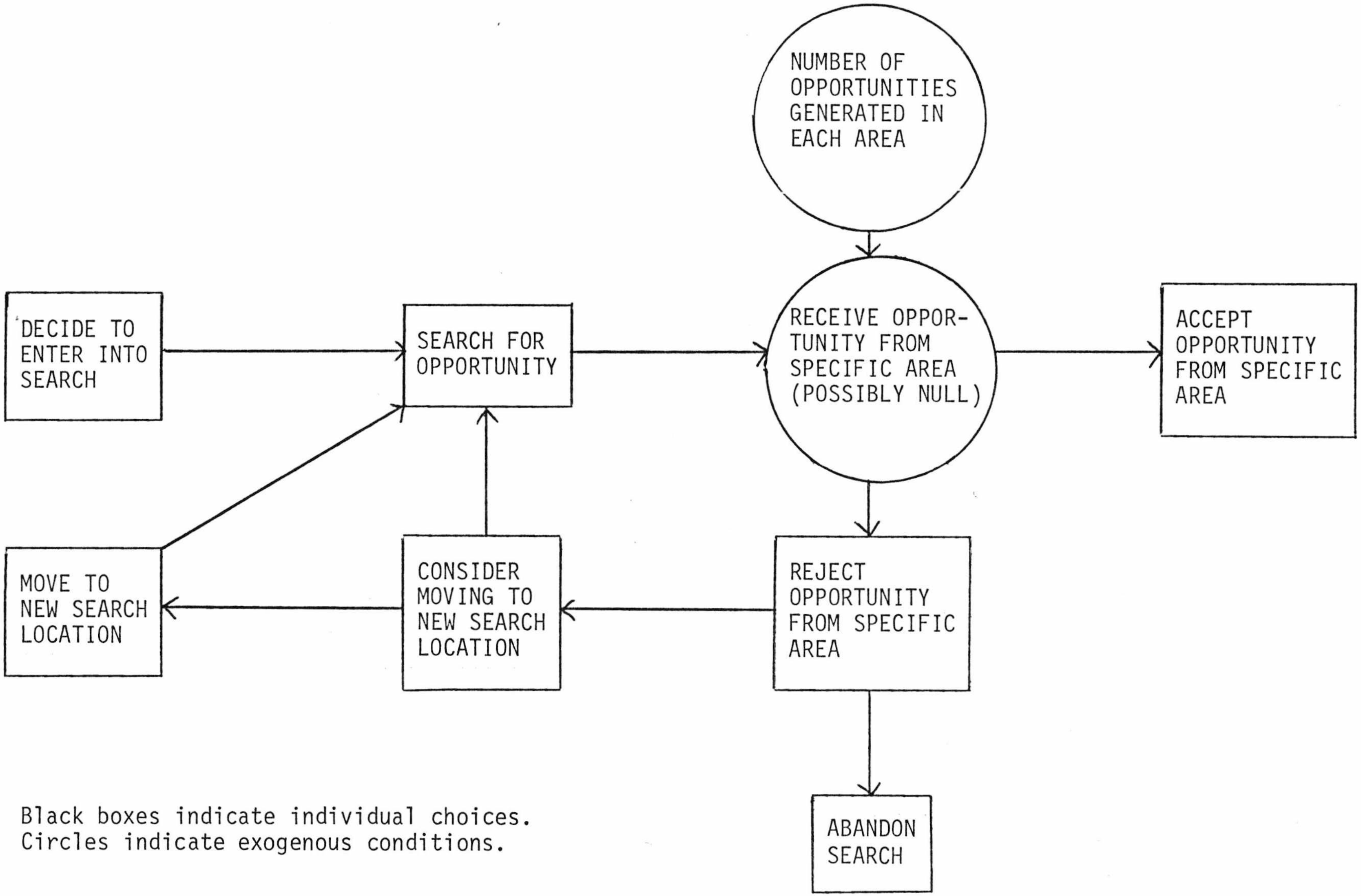
The first and third probabilities are strictly choice probabilities, i.e. they reflect the decisions of the individual. Gordon and Vickerman (1982) argue that on standard random utility assumptions of the kind outlined earlier, these may be represented as logit functions of the expected utilities of the alternatives. The first probability essentially involves comparing search as an activity with all other possible non-search activities, and opens up the possibility that unfruitful search might eventually be abandoned, i.e. there is no definite commitment to move, in contrast to the Rossi (1980) framework, for example.(6) An interesting extension suggested by Pickles and Rogerson (1984) in this context is to treat search itself as a continuous rather than a discrete variable, and thus allow for varying degrees of search intensity. The third probability in the above scheme involves the evaluation of specific migration opportunities as they arise (i.e. the possibility of retaining opportunities for a period before reaching a decision is ruled out).(7) Questions of attitudes to risk and rates of time preference may be incorporated into the determination of these two choice probabilities.

The second probability on the above decision tree is inherently different from the other two, however, and essentially reflects (perceptions of) exogenous demand conditions in terms of the spatial distribution of opportunities at any point in time, determined not only by differential rates of growth, but also by varying degrees of spatial concentration in terms of sheer areal size or 'mass'.(8) Partitioning migration decisions in this way, therefore, not only allows for a more explicit treatment of search and information in the model but also clearly demonstrates the importance of exogenous demand side factors in determining the pattern of migration flows, and integrates demand side influences into the individual decision making process. This feature has important implications as regards the empirical specification of variables that are likely to affect migration, as we shall see later.

The main problem with the Gordon and Vickerman framework, however, is that it specifically relates to the determination of contracted migration and does not encompass the issue of speculative migration taking place as part of the search process rather than its outcome. A modified framework is therefore offered in figure 2.1, to incorporate the possibility of speculative moves. In this revised framework, potential migrants have the (continuous) option of conducting job search elsewhere should search from the original location prove unfruitful (i.e. only null or unacceptable offers are received). The probability of undertaking speculative migration may be modelled in a standard search theoretic framework in terms of the expected relative pay-offs to search in the different areas, and is likely to vary according to current income and employment status (empirical evidence which is consistent with this view is presented in Gordon and Lamont (1982)), as well as the perceived variance of opportunities at the point of destination, according to David's (1974) theoretical analysis. Thenceforward, migration may once again be seen as the outcome of receiving and evaluating particular opportunities as they arise. There is no reason, of course, why an individual who has already moved once to assist in the search process may not undertake further migration, should the final selected opportunity lie outside of the immediate vicinity designated as a suitable basis for search.

To summarise, therefore, the micro-economic decision making framework adopted here involves an initial decision to undertake search, followed by a decision as to choice of location from which that search is likely to be best rewarded. Having selected a suitable base for search, the probability of undertaking contracted migration may be seen as the product firstly of the probability of

Figure 2.1 The Migration Decision Making Framework



Black boxes indicate individual choices.
Circles indicate exogenous conditions.

receiving an opportunity from a specific area, and secondly the decision as to whether to accept or reject each opportunity that arises. In later sections we shall discuss in greater depth the specific factors that are likely to influence each of these probabilities. For the time being however, we turn to the question of aggregation.

8. Gravity Models and the Aggregation Problem

All the models discussed so far relate to the behaviour of the individual. As noted earlier in the discussion of random utility models, however, there are substantial theoretical and computational problems involved in empirical modelling directly at this level. We have discussed how potential migrants may cut down their potential choice sets to manageable proportions, by engaging in a sequential series of search decisions in the face of an (exogenously determined) spatial distribution of opportunities. Unfortunately, not only are demand conditions determining the flow of opportunities a difficult quantity for the investigator to handle at the micro level, but typically information is also unavailable as to potential migrants' underlying search strategy - all that is generally observed is the final outcome.

Frequently therefore, empirical studies at the micro-level have attempted to restrict the choice set by analysing in isolation some aspect of migration behaviour, eg. the movement/non-movement decision, implicitly assuming (with some justification - see chapter 3) that this decision is separable from the choice of destination. The movement/non-movement decision may be straightforwardly modelled empirically within the standard dichotomous framework of discrete choice analysis (eg. using the binary logit model) and yields information on the distinguishing characteristics of movers (eg. see Hughes and McCormick (1981), DaVanzo (1978), Bartel (1979), and chapter 3 of this thesis) and of their home areas and situations.

Mueller (1982) adopted a slightly different approach by dividing the choice set into a subset of 'feasible' and 'unfeasible' alternatives. This division was calculated on the basis of the observed pattern of diffusion from each origin area taken from aggregated Census data ('the distance radius approach'), adjusted on the basis of the choices observed in the survey sample under analysis, i.e. if a sampled migrant from a specific location was observed to move to a location not captured in the 'distance radius approach' then the set of feasible alternatives was augmented to include that location ('the sample-choice approach'). Neither of these approaches may be deemed satisfactory since they avoid the essential problem of modelling how migrants come to select particular destinations in favour of other possible locations. Furthermore, they do not take account of the virtually inevitable heterogeneity in observed destinations, since some 'feasible' destinations from specified origins must be clearly preferred and selected more frequently than others, yet they are all lumped together into one 'feasible set'.

Micro level studies are clearly of great interest, and in chapter 3 this avenue of research will be explored further. Analysis of tractable aspects of migration such as the movement/non-movement decision does not, however, provide a complete picture of migration, and its role in mediating developments between local labour market processes in terms of the structure and dynamics of the underlying equilibrium. One possible solution to these problems lies in aggregation in order to facilitate a wider ranging analysis of migration behaviour and it is in the analysis of aggregate data that 'spatial interaction' or 'gravity' models have their role.

Gravity models originated in the study of human geography, and just as economists have tended in the past to emphasize purely monetary influences on migration, and psychologists have been concerned with rationality, so human geographers have emphasized space as a determinant of migration. This emphasis is clearly apparent in the formulation of 'spatial interaction models'. The gravity model in its most general form posits gross migration flows within a regional network to be a function of origin and destination specific push and pull factors (embodying, for example, the size of the regional populations, relative housing and labour market conditions etc.), combined multiplicatively with some form of distance deterrence function reflecting the degree of spatial separation between origin and destination. Formally, the model may be written:-

$$M_{ij} = A_i \, B_j \, f(D_{ij}) \qquad (2.5)$$

Where subscripts i and j are the areas of origin and destination respectively, M is the number of migrants, D is the distance between i and j which affects migration according to some monotonic inverse function f( ), and A_i and B_j are origin and destination specific factors, pushing or pulling migrants to or from the corresponding areas.

The gravity model was initially conceived of from an analogy between spatial behaviour and Newtonian physics (Stewart (1948)), and was found in practice to be remarkably successful in explaining a wide variety of different forms of spatial interaction in the field of human geography, from migration to commuting, shopping, trade flows, etc. The empirical success of this type of model has led analysts to consider in greater depth the sort of theoretical structures that would give rise to such patterns of behaviour, and thus provide the model with some form of behavioural underpinnings which might even assist in the interpretation of empirical results.

On the one hand, statisticians have developed a whole family of probabilistic models of spatial interaction in the gravity mould, based on the principle of maximum entropy (eg. Wilson (1971)). From a different point of view, many economists and geographers have attempted to rationalise the model in terms of standard microeconomic theory (eg. see Neidercorn and Bechdolt (1969), Smith (1975) (1978), Choukroun (1975), Sheppard (1978), Anderson (1979)).

The prevailing wisdom to emerge from the literature, however, is that the fundamental issue in relating the gravity model to economic theory is, quite simply, one of aggregation. Whilst microeconomic theories of migration start at the level of the individual, most such models will clearly generate some form of gravity formulation, when aggregated over homogenous population groups. Thus, for example, the standard classical view of migration as responding to wage differentials is consistent with an aggregate gravity type model which omits the distance function and includes as its principal push and pull factor the wage rate in the region of origin and destination, with the signs on coefficients dictating a pattern of movement from the low to the high wage areas. The human capital approach would suggest a rather broader variety of social, economic and environmental push and pull factors, as well as explicitly incorporating some form of distance deterrence function to take account of transportation and psychic costs to moving (eg. see Lowry (1966)). The relative importance of such variables raises empirical questions which may be tested within a gravity model formulation. The great virtue of the gravity model lies, therefore, not in any intrinsic contribution to migration theory, but rather in its generality, i.e. its ability to encompass different theoretical perspectives within a readily estimable empirical framework, and thus provide evidence for or against various alternative underlying theories.

Critics of the gravity model have suggested that the underlying micro-economic relationships may not aggregate linearly (eg. Lucas (1985)), leading to distortion on the estimated parameters.(9) As Gordon (1985a) has argued, however, an obvious criterion for aggregation (assuming a homogenous population group) is simply that alternatives be grouped in such a way that the axiom of Independence of Irrelevant Alternatives underpinning the micro-economic model be preserved. Assuming that grouping proceeds on this basis, then the main danger that is likely to arise in aggregation is simply that of lumping together heterogenous groups of migrants. We shall return to this issue in section 11 of this chapter.

9. Some Basic Properties of the Gravity Model

Whilst the purpose of the gravity model is merely to provide an operational form with which to implement the theory, there are certain properties embedded in the gravity formulation which are not necessarily immediately obvious, and which it would be as well to outline here, before continuing the theoretical account. In chapter

4 we shall go on to discuss appropriate functional forms for the distance function in the model, in conjunction with suitable estimation techniques.

Firstly, for all conventional forms of the model, employing for example negative exponential or power distance functions, the gravity model is incapable of predicting negative migration flows, over any distance range. Secondly, the interactive form of (2.5) implies that the influence of local push and pull factors on migration is to an extent conditioned by distance. Thus, for example, an expansion of job opportunities in an area (as reflected in the B_j factor) will, in this formulation, attract more migrants from nearby areas, than from areas some distance away, *ceteris paribus*.

A third point that arises from the multiplicative form of equation 2.5 is that it yields no simple analytical solution for the implicit net migration function, from this gross flows model. As a result, simulation techniques are required to deduce the effects on the pattern of net migration of an exogenous shock applied to the gross flows model. Alternatively, several authors have sought to focus directly on net flows by resorting to linearised approximations to the gravity model which yield more tractable formulations for the implicit outward, inward, and net migration equations, whilst retaining many of the desirable properties of the standard gravity model, eg. see Alperovich, Bergsman and Ehemann (1977) or Burridge and Gordon (1981). A simple example of this method will suffice for expositional purposes. Taking local unemployment rates as the only (representative) push and pull factors, one may specify a gross migration equation of the form:-

$$\frac{M_{ij}}{P_i\, P_j} = (k_1\, U_i + k_2\, U_j)\ f(D_{ij}) \qquad (2.6)$$

By summing over inflows and outflows and substracting one from the other this yields a net migration (NM_i) function of the form:-

$$\frac{\sum_{j \neq i} (M_{ji} - M_{ij})}{P_i} = NM_i = \sum_{j \neq i} P_j\ f(D_{ij})\ [(k_2 - k_1)\ (U_i - U_j)] \qquad (2.7)$$

suggesting that net migration is likely not only to be a (negative) function of <u>local</u> unemployment rates, but also a (positive) function of unemployment elsewhere, spatially weighted by the size of the area (P_j) and an inverse function of distance ($f(D_{ij})$). Clearly, the form and strength of the distance function must be established prior to estimation of the net migration function, or at best, estimated by some grid search technique.

Weeden (1973) has shown that a purely <u>additive</u> gross migration function generates a convenient linear net migration function in which the distance variable nets out. The problem with this formulation, however, is not only that is it inconsistent with the underlying micro-economic theory, but also that many of the desirable properties of the multiplicative model are lost eg. the model is no longer constrained from predicting negative gross migration flows, and the influence of local push and pull effects are no longer conditioned by distance in affecting migration.

Those studies which abstract from spatial effects when attempting to directly model the behaviour of 'net migrants' (eg. see Pissarides and McMaster (1984)) would appear implicitly to make the heroic assumption of an additive underlying gross flows model, therefore. Further problems involved in modelling net migration arise in relation to the existence of heterogenous migration streams. All these problems are less severe in time series than in cross-section, however, suggesting that analyses of net migration trends over time are likely to remain of some interest, given the dearth of accurate time-series data on gross migrant flows in Britain (although see chapter 5 for an exception).

A fourth observation relating to the form of equation (2.5) concerns the fact that it constrains the form of the distance deterrence function ($f(D_{ij})$) to be everywhere the same. A number of studies (eg. see Fotheringham (1981) for a review) have suggested that this constraint is empirically invalid when applied to a variety of different forms of spatial interaction (eg. trade flows, shopping, etc.), and that its removal results in a general pattern of steeper distance decay in more remote areas. At a theoretical level, Gordon (1985a) has advanced a number of hypotheses to explain these empirical findings. In essence, these relate firstly to the possibility of spatial variations in the marginal utility of money and the consequent effect on the distance cost function, and secondly the potential for economies of scale bearing on costs of overcoming distances, both of which are likely to produce a pattern of steeper distance decay in less accessible areas. A third possible empirical explanation relates to the use of data sets based on the inappropriate aggregation of heterogeneous flows, each exhibiting different patterns of spatial diffusion. Thus, for example, if migrant streams differ in their responsiveness to distance, then remote areas containing (in relative terms) significant concentrations of local short distance migrants are likely to attract steeper distance decay parameters (see section 11). This sort of effect does not imply a fundamental misspecification of the basic gravity model, but merely demonstrates the need to identify reasonably homogeneous migrant streams, when fitting this sort of model.

A closely related feature noted by Smith and Clayton (1978) is that as long as a symmetrical distance function is chosen (i.e. $f(D_{ij}) = f(D_{ji})$), then the gravity model is 'transitive' in the sense that if $M_{ij} > M_{ji}$ and $M_{jk} > M_{kj}$ then the model predicts $M_{ik} > M_{ki}$. Whilst this would not, on the face of it, seem an implausible property, Smith and Clayton (1978) observed that it was inconsistent with data on US migration over four periods and three different levels of spatial resolution. This finding may to some extent also reflect aggregation problems, since there is no reason why several heterogenous migrant streams, each conforming to different transitive gravity processes, need produce a transitive pattern of flows when aggregated. Goodchild and Smith (1980) investigated this hypothesis along with several other possible explanations (relating essentially to the structure of the error term) using US data, but rejected it as an explanation of the observed intransitivities. Unfortunately, their ability to disaggregate was limited to the race and gender dimensions. Their analysis was also marred by the fact that they employed a form of gravity model which omitted origin specific influences on migration, whilst in a simulation exercise they further neglected to allow the distance parameter to vary between streams. At this stage therefore, the empirical debate on this issue must be deemed largely unresolved.

10. Search Theory and the Gravity Model

The purpose of this section is to outline specifically how the search theory framework of individual behaviour developed so far might be integrated with gravity models of aggregate behaviour, providing an empirically operational form for the search model. In addition, various predictions of the search theory which might be tested at the aggregate level are examined, with a view to formulating hypotheses which enable us to distinguish the model from alternative theories, within the framework of an aggregate gravity model.

To recap briefly, the search model outlined earlier (from Gordon and Vickerman (1982)) partitioned contracted migration decisions into three main conditional probabilities, the probability of being in search, the probability of receiving an opportunity, and the probability of accepting it. The third probability clearly embodies an implicit distance decay function, since the utility derived from accepting a given opportunity will decline, the more distant that opportunity, and the greater the corresponding costs of the move, as outlined earlier. The second probability may be represented at the aggregate level by two (interactive) components; firstly the spatial distribution over which new opportunities are generated, reflecting a set of purely destination specific influences on migration; and secondly the location of the individual in relation to these opportunities, and the friction in information flows between the two, which may be represented by a (further) standard distance deterrence function (cf. Maier (1985), Smith and Slater (1981), Pickles and Rogerson (1984)).(10)

The first choice probability relates to the evaluation of migration as an activity with all other possible activities, and will thus depend on the characteristics of the individuals and the corresponding alternatives they face in the region of origin. As such this probability incorporates firstly a set of origin specific factors, reflecting the mobility mix of the origin population and the attributes of the area they reside in, and secondly a set of destination specific factors (weighted by an inverse function of distance) representing the attractiveness of these alternatives compared to continued residence in the same area.(11)

Whilst this approach may be represented more formally (Gordon (1985a)), the descriptive account presented here contains the logical elements necessary to demonstrate how the gravity equation may be used to provide an empirically operational formulation of the search model at the aggregate level. It remains for us to investigate the implications of this theory as regards the determination of the specific push and pull factors, A_i and B_j and contrast the predictions of this approach with those of alternative theories. Clearly, the theoretical discussion so far would suggest that these factors are likely to reflect, in part at least, the size of the population 'at risk' of moving at the point of origin (P_i), and the size of population at the destination (P_j) as it affects the supply of 'opportunities'. In addition, however, two further sets of influences may be identified, relating to the characteristics of individuals, and the attributes of areas. Individual characteristics affect the 'mobility mix' of the population, and are therefore likely to enter the model only at the point of origin. Examples of such variables are skill and age structure, marital condition, labour force status, race, etc. denoted by a vector H_m (see Greenwood (1975) for a discussion of the empirical significance of such influences). Areal attributes are likely to incorporate both the rate of opportunities being generated in each zone (eg. the rate of employment growth, or turnover in housing), as well as the desirability of residing in each area, eg. in terms of environment, local amenities etc. In addition, factors causing forcible displacement (eg. eviction, see Lee and Hodge (1984)), may be incorporated within this class of variables. A further potential areal attribute suggested by David's (1974) theoretical analysis lies in the variance of opportunities (or some suitable surrogate), affecting relative pay-offs to search in different areas. These areal attributes may be amalgamated into a second vector of variables X_k, and each of these variables are likely to affect migration both at the point of origin and destination. Combining these sets of influences therefore, and assuming an exponential form for the relationships yields a pair of equations (compare Gordon and Lamont (1982)), determining the push and pull factors derived from the gravity model:-(12)

$$\ln \left(\frac{A}{P}\right)_i = \alpha_o + \sum_m \alpha_m H_{mi} + \sum_k \beta_k X_{ki} \qquad (2.8)$$

$$\ln \left(\frac{B}{P}\right)_i = \gamma_o + \sum_k \gamma_k X_{ki} \qquad (2.9)$$

Where α_m, β_k, and γ_k are parameters. Clearly, if the vectors H_m and X_k were mutually exclusive then one would expect the effect of the areal attributes X_k to be equal and opposite in the two equations. Almost certainly, however, this theoretical expectation is likely to be obscured in practice by an (unknown) degree of overlap in the two sets of variables, so that at the point of origin variables act both as areal and as individual characteristics.(13)

It is important to consider at this point to what extent this particular model of migration leads to different testable behavioural predictions as compared to alternative models. From this point of view, perhaps the clearest innovations lie firstly in the specification of a set of turnover and growth variables as areal attributes affecting contracted migration, and secondly the variables measuring the relative variance in opportunities (again specified as areal attributes) which affect speculative migration. Neither of these factors affect migration directly as arguments in individuals' utility functions, but rather they enter the model as essentially external influences affecting the distribution of opportunities faced by potential migrants, with given preferences.

Compare this model to that developed by Harris and Todaro (1971) to explain migration patterns in less developed countries, where migration decisions depend only on arguments originally specified in potential migrants' utility functions i.e. essentially wages and unemployment. Variations in demand conditions only affect migration in so far as they affect wages and also the spatial distribution of the stock of unemployed, rather than the flow of new opportunities, or their relative variance.

These differences in theoretical approach as between the search model and the Harris/Todaro framework are highlighted in the study by Lucas (1985), which sought to quantify some of the relationships advanced by Harris and Todaro. Lucas estimates micro level wage and employment functions for different locations in Botswana, and uses these equations to predict earnings and employment probabilities in all locations for each individual. These predictions are then used to explain individuals migration probabilities, on the hypothesis that individuals will move if their expected earnings (weighted by the employment probability) are greater elsewhere than in their current location. Thus, potential migrants effectively form expectations of their probability of finding a well-paid job on the basis of the experience of similar individuals living in the different areas, regardless of whether any such vacancies really exist in those areas. This clearly represents a form of speculative migration, and such a strategy may arguably be fairly characteristic of movements in less developed countries, given the poorer quality of information networks. It is not clear, however, why potential migrants should have better information on the experience of similar individuals to themselves than on the flow of new job opportunities, within this context. In addition, David's (1974) analysis would suggest that, as well as being interested in the mean of the wage distribution in alternative locations, the returns to speculative migration will also increase with the variance around that mean.(14) Thus, the search model outlined here may be distinguished from the Harris-Todaro approach (as exemplified by Lucas (1985)) in that it predicts a pattern of migration that is affected by the spatial distribution of job generation as well as the relative variances in pay-offs to migration in different areas, in addition to variables such as wages and unemployment that emerge from the Harris-Todaro framework.

It is of course, notable that many aggregate level studies based on traditional theories of migration also include variables such as employment growth in their migration equations (eg. see Hart (1975)). Ostensibly, such variables are included either as alternatives or as additional proxies (alongside the unemployment rate) for the degree of excess demand in a local labour market. This does not explain, however, why a flow measure should provide an appropriate proxy for what in theory constitutes a stock variable (i.e. the level of excess demand). The only other school of thought apart from the search model which might suggest a plausible role for the flow of opportunities in influencing migration decisions is the human capital approach, outlined earlier (eg. see Fields (1976), who explicitly considers the role of turnover within a human capital model of migration). Ultimately, the difference between the search and human capital models in this respect must be one of emphasis - the search model explicitly predicts that such variables should be relevant (and may be seen to 'sink or swim' on that basis), whereas the human capital model merely provides a possible interpretation for such variables, should they happen to prove significant empirically.

Whilst in principle the variables reflecting the variance in opportunities could be used to identify the search model, in practice only indirect measures such as city size are available, and these might be open to alternative interpretations. At this stage therefore, we must conclude that whilst it is possible to undermine the search model empirically (should variables such as employment growth and turnover prove insignificant), the search model does not generate any additional predictions which cannot be readily interpreted within the human capital framework. Put crudely, whilst the search model can be proved 'wrong' it cannot be proved 'right', vis a vis the human capital model. In the following section, further predictions of the search model will be considered in the light of more detailed discussion of search strategy which might help us to identify the model at the aggregate level.

11. Heterogeneity and the Process of Search in Migration Decisions

As the discussion so far suggests, a major problem involved with operationalising the form of model discussed above lies in the potential heterogeneity of the migrant streams composing the aggregate flow matrix. Various studies have analysed migration flows disaggregated by personal characteristics eg. by age (see eg. Stillwell (1978)), by income-occupational categories (eg. see Weinstein (1975), or between employed and unemployed groups (Creedy (1974)). The emerging wisdom from research in recent years, however, suggests that the principal source of distortion stems from the existence of different levels or fields of search, and related differences in the underlying motives for moving.

Analysts have long been aware of the existence of sharp disjunctures in migration patterns across different distance ranges, and attributed these to different motives for moving, arguing that there are inherent differences between migrants who merely relocate residentially, and those who also change their workplace (see for example Harris and Clausen (1967), Hyman and Gleave (1977), Roseman (1983), Brown (1983), Krumm (1983)). Such considerations lead to a useful if somewhat heuristic classification of migration streams into employment and housing related categories. It is arguable, however, that the defining characteristic identifying migration streams cannot in general be reduced to any single associated motive or constraint. Rather, as Gordon and Vickerman (1982) argue, the literature on search and information in a spatial context would suggest that the fundamental division in migration streams stems from differences in the fields of search that individuals operate within, which arise from the hierarchical nature of information networks in the space economy.

The spatial structure of information networks is potentially quite complex, and various mechanisms for the dissemination of information may be identified. These range from the famous 'friends and relatives effects' advanced by Greenwood (1969), to many forms of impersonal communication such as advertising in national and local press, labelled by Amrhein (1985) as 'source information'. Different motives for moving often involve specialised information sources, eg. much of the literature on residential search quote such specific information sources as estate agents, signs, builders and contractors and the like (Clark and Smith (1979), Talarchek (1982)). In general, however, Gordon and Vickerman (1982) have argued that spatial information networks tend to be targetted over specific areal scales (see also Saunders and Flowerdew (1986)), some corresponding to local level search, others geared to progressively wider spatial fields, and in an analysis of migration in and around the London metropolitan area they identify three broad areal levels of search corresponding to national, regional and local networks of information diffusion.(15)

Clearly, therefore, if information webs may be seen to be spatially differentiated in relation to the distance horizon selected for search, then individuals seeking migration opportunities must initially choose from a range of possible fields of search, and on the basis of this choice select the appropriate combination of corresponding information channels with which to conduct search. The choice of search field (and associated spatial level of information diffusion) is itself likely to reflect the overall combination of motives and constraints underlying the original decision to search; hence the association between search field and migrant motivation, in the labelling of migration streams discussed above. In the search process that ensues, potential migrants compare actual opportunities received with some prior reservation criterion (in general given by the expected utility of continued search) and accept or reject them on that basis. If no suitable opportunity is found over a specified period then the potential migrant may either revise the reservation criterion, switch search field (eg. look further afield through some wider information network), or abandon search altogether (Gordon and Lamont (1982)).

Disaggregating by migrant search field yields an extended multi-stream gravity model (eg. see Gordon and Vickerman (1982)) of the form:(16)

$$M_{ij} = \sum_{s=1}^{S} A_i^s B_j^s f^s (D_{ij}) \qquad (2.10)$$

where $$M_{ij} = \sum_{s=1}^{S} M_{ij}^s \qquad (2.11)$$

where s defines the particular search field that the migrant operates within. This disaggregation by search field represents perhaps the most distinctive feature of the search model in terms of empirical specification, and provides the greatest scope for model identification at the level of aggregate modelling.

An important point to note within this formulation, and one that is easily lost sight of, is that it does <u>not</u> constrain all movers over a particular distance range to belong to a particular stream. In any one distance range, <u>all</u> the migrant streams are likely to be present, in varying proportions. The point is simply that in general, one would expect the distance decay functions to become steeper for the more localised migrant streams, so that certain streams of movers are likely to dominate over specific distance ranges. In addition, there is good reason to expect migrants in the different streams to respond to different sets of push and pull factors, the national streams relating more closely to labour market related factors, as compared to the local streams which are likely to respond to housing variables. Whilst this extended form of gravity model does raise some practical problems at the estimation stage (see chapter 4), in principle the push and pull factors specific to each stream may, therefore, be analysed in much the same way as for the single stream model discussed above.

12. Temporal Aspects of Migration Behaviour

So far very little has been said about migration and time. In the theoretical account of micro-economic decision making the time period was left unspecified, whilst in the formulation of the aggregate spatial interaction models the relationships were taken for the most part to be essentially contemporaneous. In fact, temporal factors are likely to be of great interest in migration analysis, relating to the length of response lags, life cycle effects and the possibility of 'state dependence', and the cyclical nature of the overall volume of migration. These issues will be considered in terms of the aggregate spatial interaction models outlined above, whereby migration is taken to follow some kind of Markov process(17) (eg. see Rogers (1975), Cordey-Hayes and Gleave (1974) or for a more general account Blumen, Kogan and McCarthy (1955)).

Response Lags: The possibility of response lags arises for three inter-related reasons. Firstly there are likely to be delays involved in the diffusion of information, eg. about employment opportunities. Secondly, individuals expectations of future benefit streams involved in the decision to accept or reject an opportunity are likely to depend in part on some weighted average of past trends. Thirdly, significant adjustment lags are likely to arise between the decision to migrate and the final enaction. These considerations would suggest that equations (2.8) and (2.9) relating regional push/pull factors to various locational attributes ought to be specified in some general distributed lag formulation (see chapter 5).

Mobility Mix, Life Cycle Effects, and 'State Dependence': The term 'state dependence' refers to the situation where individuals' migration decisions are explicitly affected by previous locational decisions in their life history. Clearly, migration probabilities are likely to vary over the life cycle, and these effects may be reasonably adequately controlled for by the inclusion of age structure, marital status variables etc. in the vector of variables measuring the 'mobility mix' of the population at the point of origin.

A slightly thornier problem lies in the existence of groups of highly mobile workers who enter and leave regions in rapid succession. The 'outward' migration decisions of such workers may be seen to depend in part on the earlier 'inward' migration decision, and at the aggregate level such behaviour tends to contribute to the well-documented empirical associations between rates of inward and outward movement (eg. see Cordey-Hayes and Gleave (1974)). In addition to these 'mover/stayer' effects there is the issue of 'cumulative inertia', whereby the opportunity costs to the individual of moving may be seen to be a function of the duration of residence, reflecting the progressive accumulation of social and economic ties to an area over time. Both these considerations would lead one to expect a degree of interaction between 'push and pull' factors in the gravity model, where an area's 'push factor' comes to causally depend on the degree to which that area is able to 'pull in' such migrants in the first place (Gordon and Lamont (1982)).

Various other forms of 'state dependence' have already been alluded to in passing. Thus, inward moving national stream migrants may engage in a sequence of successive approximations in their locational decisions, where, for example a series of adjustments in residential location may follow an initial long distance move as migrants become more familiar with residential opportunities in their new neighbourhood (Michelson (1977)). Similarly, 'speculative migrants' who move in the national stream in order to facilitate search may also ultimately re-migrate once they have secured a suitable employment opportunity. A proper empirical analysis of such behavioural patterns inevitably requires longitudinal data, but for the time being we may note that such processes (particularly the former) are likely to produce a degree of interaction between the push and pull factors of different streams, eg. as inward national stream migration affects outward local stream movement (Gordon and Lamont (1982)).

Another form of repeat migration which has attracted some attention in the literature is the phenomenon of the 'return migrant', i.e. migrants who, for whatever reason, decide to go back to their original location (eg. see Vanderkamp (1972a), Vanderkamp (1972b), DaVanzo (1976), Da Vanzo and Morrison (1981)). There is some evidence to suggest that return migrants tend to be less sensitive to distance and relative economic advantage between areas than other forms of migrants (Da Vanzo (1976), Kau and Sirmans (1977)). Kau and Sirmans (1977) interpret this as evidence of the effects of differential information between migrant types, and certainly this interpretation would be consistent with the disaggregation by search field in relation to information networks discussed earlier. Arguably, however, return migrants differ from new migrants in many other respects also, apart from their information endowment. The importance of separately identifying return migrants from the other migrant streams must depend therefore on the relative prevalence of such migration in observed flows, and we shall address this issue in the next subsection.

The Cyclical Nature of Migration: Migration depends not only on the 'repulsiveness', 'attractiveness', and distance between regions at a point in time, but also on changes in the general economic climate nationally over time. For each cross-section gravity model, therefore, there is an implicit constant measuring the aggregate volume of movement for that period, and from which the regional push and pull factors simply measures deviations in inward and outward migration for each area (see chapter 5). This implicit constant is likely to vary over time as the aggregate volume of migration varies with the business cycle. In particular, Hart (1975b) and Gordon (1985b) argue that the volume of migration is likely in general to vary counter-cyclically, since in times of recession liquidity constraints restrict such investment activities, uncertain prospects are discounted more heavily, and employment opportunities are fewer. In general the evidence for Great Britain supports this view (eg. see Gordon (1985b), and chapter 5 of this thesis.)

On the other hand, Vanderkamp (1972a) argues that return migration is likely to vary pro-cyclically, i.e. in times of high national unemployment, return migrants go home whilst the remainder of the population stay home. As such the balance and composition of migration flows may adjust during national downswings in favour of return migrants. It is notable, however, that the likely net direction of such return migration is not necessarily against the general current, particularly if return migration is itself responsive (albeit less so than new migration) to relative prosperity in the regions, as well as national prosperity (Gordon (1985b)). In practice, Vanderkamp's (1972b) empirical analysis of Canadian data attributed to return migration a relatively minor role in the overall flux of population movement, adding a degree of stability to the pattern of movement over time, with return migrant flows tending to be more-or-less in balance between pairs of regions.

13. Migration, Commuting, and the Interaction Between Local Labour and Housing Markets

Housing factors are likely to affect migration in a number of important respects. In terms of the push and pull equations specified in (2.8) and (2.9), housing tenure may enter as a residential constraint on movement, and thus affect the mobility mix of the population at the point of origin, eg. Gleave and Palmer (1978) and Hughes and McCormick (1981) argue that council house tenants tend to be relatively constrained in undertaking long distance migration. Secondly, housing quality (eg. in terms of age, price, tenure mix) is likely to affect the residential desirability of an area, and thus enter as a valued areal attribute in the migration equations at both the point of origin and destination. Thirdly, and finally, housing availability (eg. as affected by the construction rates of new dwellings) is likely to affect opportunities for moving at the point of destination.

Undoubtedly, however, migration is also likely to exert an independent effect on local housing conditions. Thus, it is clear for example that sustained net inward migration is likely eventually to lead to housing congestion, higher prices, and pressure for new housing development. Both of these sets of relationships would lead one to expect a degree of inter-dependence between local housing and labour market conditions. A local labour market characterized by falling demand for labour is likely to experience problems as regards the speed of labour diffusion if a large proportion of the workforce live in council owned accommodation which they cannot easily leave, leading to high levels of local unemployment (McCormick (1983)). Conversely, a buoyant and expanding local labour market is likely to attract in migrants, leading to an increased demand for accommodation.

Both these arguments depend, of course, on an unchanged distribution of commuting, yet commuting decisions are clearly not independent of migration. The interaction between migration and commuting is therefore likely to be of central significance in the analysis of local housing and labour market inter-dependencies, in an urban context. The choice of workplace and the choice of residence are patently joint decisions, which involve some combination of migration and commuting adjustments. Various permutations of residence and workplace, commuting and migration decisions may be envisaged, with changes in commuting providing the shorter term transition mechanism, and migration the longer run adjustment process (Vickerman (1984)).

The dynamics of workplace/residence choice are likely to be complex, and it is not at all obvious which of these choices is likely to dominate the other. In the previous section of this chapter the importance of disaggregating migration models by search field was noted. These different migration streams are likely to involve inherently different adjustments in commuting patterns. Clearly, the national migration stream is likely to involve a transfer of both residence and workplace, and is thus unlikely to have a substantial systematic effect on the net balance of commuting either at the point of origin or destination. As a consequence, the migration process will not be offset by induced commuting in terms of its labour and housing market implications. Local migration streams, on the other hand, are likely to involve residential relocation without an associated movement in workplace. Net inward movement of residential migrants is therefore likely to directly reduce the net balance of commuting in that area, partly because migrants who previously worked in the area will no longer have to commute in, but also because those previously working elsewhere will (as a consequence of moving) now have to commute out. Whilst such residential moves will clearly affect the local demand for housing, therefore, the labour market implications will tend to be offset to some extent by induced adjustments in commuting. After some time, of course, migrants who moved initially for residential reasons may also subsequently move their place of work, so that the long run difference between the two migration streams in terms of their effects on commuting is likely to be less marked. In the short run, however, the point is that local stream migrants are more likely to retain an existing workplace and therefore have a greater impact on net commuting than national stream migrants who may well shift their workplace into their new area of residence. Chapter 7 of this thesis presents empirical evidence to confirm this view.

14. Summary

Migration analysis is an important but complex area. The multidisciplinary nature of the field has produced a diversity of theoretical approaches which have tended to develop historically more-or-less in isolation from one another with little exchange of reference. Several themes were identified from this literature at the outset of this chapter, and various theories of migration were subsequently considered in this light. Building from these traditional approaches a search theoretic perspective on migration behaviour was adopted, which incorporated earlier insights due to human capital and random utility theory. Migration could arise in this framework either as part of the search process (speculative moves) or its outcome (contracted moves). A sequential decision tree was postulated whereby contracted migration decisions were partitioned into three main conditional probabilities involving the probability of being in search, the probability of receiving an opportunity, and the probability of accepting it (Gordon and Vickerman (1982)). The first and last of these were seen as choice probabilities, reflecting supply side processes in terms of individual preferences and constraints. The second probability was seen as being conditioned essentially by demand side processes affecting the spatial distribution of opportunities.

Unfortunately, from the point of view of estimation and testing, it was argued that practical considerations concerning the complexity of migration behaviour precluded an empirical analysis of the full range of migration decisions directly at the micro level. Whilst it is clearly feasible and useful to analyse migration as a zero/one probability at this level, reflecting the decision to move or not, over any realistic set of possible origins and destinations, the choices facing the potential migrant become so numerous that it not only becomes computationally unfeasible to model them at the individual level, but it also requires a much more exhaustive data set than that currently available on individual migration decisions in the UK. Nevertheless, micro-based theory could, it was argued, still provide a useful basis from which to derive models of aggregate behaviour.

The role of the gravity model was considered in this context, not so much in terms of any theoretical contribution to the understanding of migration, but rather as a useful operational model with which to implement micro-economic theories at the aggregate level. The gravity model, it was argued, provides a general empirical discipline which encompasses different micro-based theories of migration, and may be used to provide empirical evidence for or against competing hypotheses.

The relationship between search theory and the gravity model was outlined with a view towards elucidating predictions which might serve to identify the search model at the aggregate level. The process of search in migration behaviour was discussed in terms of the identification of distance horizons in fields of search, and a disaggregated form of gravity model suggested which took account of heterogeneity in migration streams across different search fields.

Finally, the interaction between housing and labour market processes was considered, and migration and commuting decisions characterised as the twin elements in the joint choice of residence and workplace. Various permutations of residence and workplace choice were envisaged, involving different combinations of migration and commuting decisions, the nature and extent of the interaction between the two depending upon the form of migration i.e. whether it was of a local residentially motivated character, or national stream and related primarily to employment considerations.

CHAPTER 3 A DISAGGREGATE CHOICE MODEL OF THE MIGRATION DECISIONS OF YOUNG MEN IN GREAT BRITAIN

I. Introduction

One of the conclusions to emerge from the previous chapter was that whilst theoretical modelling at the micro level was essential for a proper understanding of migration decision making, nevertheless a number of difficulties arise which make it difficult to empirically implement migration models directly at this level. As a consequence, it was argued that aggregate models of migration behaviour which were explicitly founded on micro-economic theory clearly provided a valuable additional analytical tool.

In this chapter we investigate more closely the particular difficulties that arise in empirically modelling migration decisions at the micro level, and construct a simplified form of disaggregate choice model which is amenable to estimation at the micro level. The model is implemented using data from the 1979 European Commission Labour Force Survey, a largely untapped micro data set on migration decisions over a one year interval. The study is devoted to the analysis of males aged between 16 and 24 in Great Britain, partly because these young men tend to be amongst the most mobile geographically, but also because they are clearly amongst the most prone to unemployment.

In the next section a simplified model of migration behaviour is outlined, whilst in section 3 the main features of the data are discussed. The empirical results are presented in section 4, whilst the final section provides a summary and conclusion.

2. Model Specification

Picking up the threads from the previous chapter, a number of problems were identified in applying standard multinomial techniques in the estimation of disaggregate level discrete choice models of migration behaviour. These may be summarised as follows:-

i) The range of alternatives facing the potential migrant is too large to be at all tractable in any realistic analysis of migration behaviour.

ii) Potential migrants are themselves unlikely to continuously evaluate all possible migration opportunities over a complete range of potential destinations, as such models would imply.

iii) Standard multinomial logit models assume equal substitutability of alternatives, due to the underlying axiom of Independence of Irrelevant Alternatives. This axiom is likely to be violated if expected returns from alternative destinations are not appropriately discounted according to distance from origin, yet there is no obvious way of ascertaining the form and strength of the underlying distance deterrence function directly at the micro-level.

iv) A further practical problem arises in relation to the quality of available data, since typically the information contained in sample surveys (which provide the main source of micro level data on migration) is inadequate for the analysis of migration decisions over a realistic set of possible origins and destinations.

At the same time, however, the sort of search-theoretic perspective outlined earlier, in which migration decisions were broken down into a sequence of sub-decisions relating to migrant search strategy, is equally difficult to implement directly at the micro level. Two main problems arise in this context:-

i) Typically data is not available about migrant search decisions, but only on migration outcomes, i.e. whether or not an individual moved over a specified period.

ii) Modelling demand side effects in terms of the flow of opportunities facing migrants is particularly difficult at the micro level. Thus, whilst one might be able to model the individual decisions to accept or reject given opportunities, it is almost impossible to adequately model the differential probability across individuals of receiving that opportunity. (This problem also appears, implicitly at least, in the more conventional random utility formulation).

Despite the obvious advantages of modelling migration decisions directly at the individual level, therefore, we are forced to shift our attention to the analysis of aggregate data in order to get a reasonably complete picture of migration linkages within a spatial system. Whilst this avenue will be explored in later chapters of this thesis, the purpose of this chapter is to see how much can realistically be achieved at the micro-level, by constructing a simplified form of disaggregate choice model that is not inconsistent with the more general perspective outlined earlier, but which is amenable to estimation directly at the individual level.

Clearly, whilst the search model may not provide a suitable basis for empirical modelling of individual migration decisions, the notion of partitioning migration decisions within a sequential hierarchy is a valuable one, which is likely to be of great help in overcoming some of the problems outlined earlier in the study of micro-data. In the analysis of realised migration decisions (as opposed to search) there is an intuitive case for arguing that the initial movement/non-movement decision may be treated separately from the choice of destination, since the former decision involves comparing migration as an activity valued against all other possible activities, whilst the latter represents a choice amongst alternative competing destinations. This question is, of course, open to empirical investigation, and in the next section of this chapter some attempt will be made to resolve the issue, although it is an assumption which does underly many previous micro-level analyses of migration behaviour (eg. Evers and Van der Veen (1984), Hughes and McCormick (1981)). For the moment, therefore, we shall continue the simplified theoretical account under this assumption and attempt to formalise the approach to the analysis of the movement/non-movement decision before going on to consider approaches to modelling choice amongst competing destinations. Using the same notation as in the previous chapter, the random utility function for the decision to move may be written:-

$$U_{kim} = V_{im} + \varepsilon_{km} \tag{3.1}$$

Where U_m is the expected gain in utility as a result of moving (m). The probability that individual k living in area i will move, denoted M_{ki}, may be derived as:-(1)

$$M_{ki} = \frac{\exp (V_{im})}{1 + \exp (V_{im})} \tag{3.2}$$

The non-random component of the utility function (V_{im}) is likely to reflect both the characteristics of the alternatives (i.e. movement or non-movement) and of the identified population group. Clearly, the characteristics of the alternatives will depend largely on the attributes of the area where the individual originally resides. Thus, for example, individuals from a given homogenous population group may be more likely to move if they live in an unattractive area (eg. one characterised by low pay or high unemployment). On the other hand, individuals living in the same area but of different socio-economic position and background may also display varying migration probabilities. The set of locational influences on migration may be captured in the model by a vector of region-specific dummy variables R_k , whilst individual characteristics may be incorporated within a further vector of variables X_k, yielding:-

$$M_k = \frac{\exp\ (\alpha\ R_k + \beta\ X_k)}{1 + \exp\ (\alpha\ R_k + \beta\ X_k)} \qquad (3.3)$$

where α and β are vectors of parameters to be estimated and M takes the value 1 if migration takes place, 0 otherwise. Not only is the dependent variable now in a form which may be handled relatively straightfowardly as compared to the general random utility formulation of equation (2.4) in the previous chapter, but implicit distance related effects may also be relatively safely left to one side here, in the analysis of the movement/non-movement decision. In more familiar form, the model may be re-written:-

$$\ln \left(\frac{M_k}{1 - M_k} \right) = \alpha\ R_k + \beta\ X_k \qquad (3.4)$$

in which the dependent variable is the logit of the probability, or the natural logarithm of the relative odds of migrating.

The second stage of the decision tree relates to the choice of destination. Although the problem is greatly simplified by prior analysis of the decision to move, there are still substantial problems involved in analysing the choice of destination over a realistic number of alternatives, whilst still preserving the axiom of Independence of Irrelevant Alternatives, particularly in a situation where the alternatives are not nested within any obvious prior ordering. Given the presence of an implicit distance deterrence function in individual preferences over alternative destinations, therefore, one possible strategy would be to group moves into more-or-less homogenous distance ranges, and then model migrant choices between these ranges of movement.

A number of interesting precedents may be noted from the literature which support this approach, at the level of disaggregate choice modelling. DaVanzo (1978) in her study of longitudinal data for the U.S. found substantial changes in parameter estimates resulted from using progressively less (spatially) restrictive definitions of migration, implying interesting differences in migrant behaviour across distance ranges. In effect, a similar exercise was performed for the U.K. by Hughes and McCormick (1981) who compared the determination of inter-regional migration with factors affecting the probability of moving house in general, using the 1973 General Household Survey.

In this vein, therefore, a random utility function may be constructed for migrants, relating to their choice of distance horizon:-

$$U_{kid} = V_{id} + \varepsilon_{kd} \tag{3.5}$$

Where U_d is the expected utility of moving in distance range d. The strict utility component V_{id} in equation (3.5) is clearly likely to reflect an implicit distance deterrence function across alternative distance ranges. In addition, since different population groups may be characterised by varying patterns of distance decay, the differing characteristics of individuals at the point of origin are also likely to feature in V_{id}. Finally, proximity of the origin location to attractive destinations is also clearly likely to be reflected in V_{id}. Thus, for example, a particular homogenous population group characterised by a given distance decay function is likely to trade-off distance of move against areal attractiveness in order to maximise utility. Such individuals originally located in a peripheral fringe zone may therefore be willing to migrate further in order to gain access to a particular destination, than similar individuals more fortunately located (at start of period) in close proximity to that area of attraction.

Individual characteristics embedded in the strict utility component of (3.5) may be directly incorporated as arguments in an operational model determining distance range moved. The effect of varying proximity of origin locations to attractive destinations may be approximated by a vector of origin specific dummy variables. As regards the distance deterrence function however, there is no obvious way of directly measuring these effects a priori and building them into the model, nor even proxying them via some surrogate arguments in the utility function. Rather, the approach adopted here is to model the distance effects via the treatment of the stochastic term ε_{kd}.

Essentially, this issue reduces to one of selecting a multinomial discrete choice model which makes appropriate assumptions about the distribution of the stochastic term across alternatives. The standard multinomial logit model assumes a Weibull distribution, with the implicit assumption that the alternatives under consideration be equally substitutable. Such a distribution is clearly inappropriate here, given that we know a priori that a negative distance function is likely to be present across distance ranges. The multinomial (ordered) probit model provides a more suitable alternative specification under such circumstances. The main problem with this model, however, is that it generally requires that the interval limits between alternatives be specified as data input prior to estimation, and these must crucially depend on the shape and strength of the unknown underlying distance deterrence function.(2)

The approach adopted in this study, therefore, was to undertake a form of discriminant analysis of the choice of distance range moved (see Klecka (1980) for an introduction). The object of discriminant analysis is to form canonical functions from the explanatory variables in order to maximise some criterion of 'discriminating power' between alternatives in the dependent variable. These canonical discriminant functions may also be interpreted as axes or dimensions in some form of discriminant space, and the relative location of group centroids in this space may be taken as indicative of the degree of substitutability between the alternatives (as opposed to imposing equal substitutability beforehand, as in the multi-nomial logit model). Discriminant analysis may also be used as a method of classification of course, i.e. it may be used to predict group membership on the basis of the observed values of the explanatory variables. In the particular case of migrants' choice of distance range, the (posterior) probability of individual k choosing a particular distance range n may be denoted:

$$P_{kn} = \text{Prob } (D_k = n) = \frac{g_n \, (X_k, R_k) \, q_n}{\sum_{j=1}^{N} g_j \, (X_k, R_k) \, q_j} \tag{3.6}$$

Where D_k denotes the distance range moved by individual k, which may take on a number of different values j = 1... N, q_n is the prior probability of belonging to group n, and g_j is the density from a normal distribution for each of the j alternatives. The vectors X and R again describe the individual's characteristics and original location. Whilst the main assumption underlying this formulation is that of normality in the density functions g_j, a number of studies have shown that the discriminant analysis model is in fact reasonably robust, and compares well with standard logit specifications in its ability to classify cases (see Amemiya (1981)).

One important problem that arises with this approach lies in potential heterogeneity in migration behaviour (particularly in the pattern of distance deterrence) across migration streams. In chapter 2 it was argued that migrant streams related to fields of search, and that these search fields tended to be associated with corresponding dominant migrant motivations. The clearest distinction in this context lies between employment related migration, and residentially motivated moves without an associated change of workplace. A possible approach to this problem at the micro level, therefore lies in splitting the sample into job changers and non-job changers, and this was the strategy adopted here, both in the analysis of the movement/non-movement decision, and in the choice of distance range. A further sub-sample was also selected of individuals that were not economically active at start of period.

3 The Data

The 1979 LFS provides a broad range of information on a total sample of 228,569 individuals, and as such constitutes one of the largest sources of individual data available in the U.K.(3) In this study, a sub-sample of males aged 16-24 in 1978 was extracted. The sample was also restricted to civilian men living in Great Britain at the beginning and end of period, yielding data on 12,573 individuals, including 571 inter-regional migrants. This group included 20% of working age men in the sample for Great Britain, but 37% of those moving between regions or metropolitan counties.

Most of these young men are recent entrants to the labour market, and most of them still live with their parents. As such, their migration decisions often involve their first move from home, rather than movements with the parental family, and are likely to be the outcome largely of the interaction between educational attainment, family circumstances, and their degree of success in the labour market (e.g. see Kiernan (1977)).

One quite fundamental issue is whether migration decisions should be modelled at the individual or household level. Although the LFS is organised by individual, enough information is retained to be able to re-organise the information into households, if desired. However, this information is only available at end of period and its usefulness is questionable. In the particular case of young men, there are good reasons for keeping to the individual data. As suggested above, this period in men's lives tends to be associated with fairly unstable household structures, involving the formation of new households as these individuals leave their parental homes, or marry. Conceptually, therefore, rather than looking at moving households as the unit of analysis, it is better in this case to examine the influence of household structure as a factor affecting individuals' decisions.

The LFS provides information on usual place of residence at the time of interview and one year ago. Whilst for reasons of confidentiality these addresses are not released at below the level of Standard Region or Metropolitan county, a classification of migrants by distance range moved does contain information on all migrants in the sample, not just those crossing regional boundaries. The distance ranges identified in the survey are intra-district, intra-regional, and inter-regional moves. In addition, since the origins and destinations of inter-regional moves are explicitly identified, it is possible to separate moves between non-contiguous regions from the remainder. (4) A total of 2,186 young men were classified as moving on this basis, and a breakdown of their patterns of movement by distance range, and labour force status is given in Table 3.1. (job changers were defined as those individuals moving between jobs over the period, and non-job changers as the remainder of the economically active population at start of period).(5)

An obvious disadvantage of the LFS for any kind of labour market analysis is that although it contains a wide range of data on housing, education, family structure, race, occupation, labour force status etc., there is no measure of earnings. This omission may not be too serious, however, in the analysis of migration patterns, since a wide variety of studies have shown that earnings exert only a slight influence on male migration in the U.K., either as an areal characteristic influencing overall patterns of movement, or an

Table 3.1 Types of Move By Labour Force Status

Movement Category	Economically Active		Economically Inactive	Total
	Non Job Changers	Job Changers		
0 Non-Movement	6956	1371	2060	10387
1 Intra-District	804	233	194	1231
2 Intra-Region	260	110	107	477
3 Inter-Region (Contiguous)	107	75	57	239
4 Inter-Region (Non-Contiguous)	65	62	112	239
Total	8192	1851	2530	12573

Source: ECLFS 1979

Notes: Metropolitan Areas counted as Regions in identifying movement categories 2, 3 and 4.

individual one acting as a potential constraint on individuals' ability to move (e.g. see Hughes and McCormick (1981), and chapter 5 of this thesis).

A more serious omission lies in the absence of historical information on individual migration decisions, their interaction with labour market behaviour, and bearing on current locational decisions. Implicitly, therefore, a Markov type model is assumed in this study, in which the probability of movement is contingent on current situation, ignoring the possibility of complex life cycle locational decisions (e.g. return migration), as well as the interaction between moves over different search fields. Unfortunately, very little longitudinal information is available in Britain which might form the basis of a more complete analysis of migration decisions in this respect, with the exception of small sample surveys such as the National Survey of Health and Development, discussed by Kiernan (1977), or the historical recall information presented in Gordon et al's (1983) interview survey.

Another important limitation of the data was that most of the variables were defined at end of period (i.e. when the survey was actually carried out), and only a subset of these variables could also be obtained at beginning of period as well (i.e. one year earlier). To some extent this feature is quite natural and would be common to most such surveys, since the object is to learn something about individuals' current position. Nevertheless it does imply that in migration analysis, origin and destination specific effects are likely to be somewhat confused, and in particular migration causes are likely to be confused with the consequences. This problem was felt to be particularly severe in the case of two classes of variables used in the empirical analysis, housing tenure and family circumstance. An instrumental variables approach was therefore adopted, where these variables were each regressed against a vector of variables that were taken to be genuinely exogenous in the determination of migration, combined with a second class of variables that were deemed to be relevant to the determination of the dependent variable in question but excluded from the migration analysis, plus a final vector of variables which were available at both start and end of period. These explanatory variables were all defined uniformly at end of period, at this stage, in line with the dependent variables. A set of predictions were then generated using lagged values of all the variables where such information was available, and these predictions were used as explanatory variables in the explanation of migration decisions. (See Appendix for further details).

4 Estimation and Results

The first stage in estimation was to investigate the appropriateness of treating the movement/non-movement decision separately from the choice of distance range, as outlined in section 2. In order to retrieve as far as possible this aspect of the potential migrant's decision-tree, a discriminant analysis was undertaken to explain both these aspects of migration decision making. Whilst this strategy cannot be seen as a formal test of separability, nevertheless it was hoped that the extracted discriminant functions from such an analysis would provide some suggestive (if not conclusive) evidence on the extent to which the decision to move differed from the choice of distance range.

The maximum number of dimensions or discriminant functions that may be extracted is one less than the number of categories in the dependent variable (i.e. in this case 5-1 = 4). By definition each additional discriminant function adds progressively less than the previous one to the explanatory power of the model. Whilst several criteria have been suggested in order to evaluate the ability of explanatory variables to discriminate between alternatives in the formation of the canonical discriminant functions, the statistic adopted in this study was WilkS λ (the likelihood ratio criterion), which is equivalent to a multi-variate F test for the differences amongst group centroids. (6) This Wilks λ statistic may also be used to assess the number of significant discriminant functions in the data.

At this stage of the analysis, all the available independent variables were used (see later for details), and as Table 3.2 shows, the first discriminant function extracted from the data accounted for the bulk of the explained variance, ranging from 68% in the job changers sample to 78% in the sample of economically active non-job changers. The predicted group centroids indicate the relative location of each of the categories in the discriminant function space, and examination of these group centroids for the first discriminant function shows a stark separation between movers and stayers. The explanation of the choice of distance ranges appears to be largely swamped in this analysis, therefore, by the need to explain the decision to move in the first place, to which the bulk of the variation in the independent variables is devoted. These results suggest, therefore, that it would be more appropriate to model these decisions sequentially, in line with the model specified in section 2.

Table 3.2 Discriminant Analysis

		Economically Active		Economically
		Non Job Changers	Job Changers	Inactive
GROUP CENTROIDS (First Discriminant Function)	0	-0.221	-0.356	-0.369
	1	1.167	0.956	1.320
	2	1.301	1.023	1.567
	3	1.394	1.083	1.899
	4	1.758	1.227	2.189
Proportion of Variance Explained by Function 1		0.775	0.676	0.720
Wilks' λ		0.722	0.618	0.491
n		8192	1851	2530

Source: 1979 ECLFS.

Notes: The Group Centroids are defined as follows:-

0 = Non-movement
1 = Intra-district movement
2 = Intra-region movement
3 = Inter-region (contiguous) movement
4 = Inter-region (non-contiguous) movement.

4.1 Explaining Movement/Non-movement Decisions

The LFS provides a wide choice of variables potentially relevant to this decision, and fairly general specifications of the model were therefore examined initially using Ordinary Least Squares estimates of a simple linear probability model. Various constraints which involved the minimum of distortion and were not rejected by the data, were then sequentially imposed and the model re-estimated using a standard logit formulation.(7) Model selection then proceeded on the basis of this technique, and the final maximum likelihood estimates are presented in Table 3.3. In interpreting these results, it is important to bear in mind that they relate only to whether individuals move or not, and not to the type of move they might undertake.

Despite the fact that the family circumstance and housing tenure variables have been predicted using an essentially instrumental variables approach, they still contribute substantially to the explanatory power of the results. In general, and all other things being equal, heads of household appear to have the highest movement probabilities (all other things being equal), particularly if they are on their own, as one might expect. Married heads of households appear not to be particularly mobile, except in the economically inactive category. Child dependents tend generally to be immobile, again as one might expect.

The results for the housing tenure variables suggest public housing tenants tend generally to be the least mobile amongst economically active young men. It is interesting to compare these results with the results of Hughes and McCormick (1981) who found

Table 3.3 Logit Model of Movement/Non-Movement Decision

	Economically Active				Inactive	
	Non Job Changers		Job Changers			
Family Circumstance*						
Married	4.231	**(6.23)**	-		-	
Head of Household	2.133	**(2.90)**	3.757	**(4.72)**	-	
Married Head of Household	-3.993	**(-6.23)**	-2.598	**(-3.97)**	3.149	**(1.73)**
Single Person Household	3.585	**(3.95)**	-		2.412	**(1.50)**
Child Dependent	-		-		-3.054	**(-2.72)**
Housing Tenure*						
Furnished	-		1.947	**(2.62)**	-3.558	**(-2.78)**
Public Housing Tenant	-0.972	**(-3.08)**	-1.928	**(-3.96)**	-	
Rented (Metropolitan Area)	-		-		0.648	**(1.65)**
Public Housing Tenant (Metropolitan Area)	0.715	**(2.09)**	1.996	**(3.49)**	-1.225	**(-1.90)**
Age (Spline)						
16-19	-		-		0.405	**(4.48)**
20-24	-0.270	**(-4.68)**	-		-0.343	**(-3.55)**
16-24	-		-0.054	**(-0.89)**	-	
Highest Qualification						
Degree (or higher)	-		-0.453	**(-1.35)**	1.088	**(4.70)**
Graduate Member of Professional Institution	0.282	**(0.92)**	-0.544	**(-0.90)**	-	
HNC/HND	-0.383	**(-1.34)**	-		-	
Teaching Qualification (Secondary)	-		-		1.550	**(1.78)**
Trade Apprenticeship (completed)	-0.079	**(0.82)**	-		-0.680	**(-0.97)**

	Economically Active		Inactive
	Non Job Changers	Job Changers	
Trade Apprenticeship (not completed)	-	-0.757 **(-1.88)**	-
City and Guilds	-0.147 **(-1.06)**	-0.468 **(-1.72)**	-
A level	-	-	0.349 **(1.92)**
O level	-	-0.256 **(-1.53)**	-
CSE (other grades)	-	-0.480 **(-2.09)**	-
Still Studying	-	-	1.909 **(1.52)**
Region			
Metropolitan Area	-0.202 **(-1.29)**	-0.907 **(-3.68)**	-
Tyne and Wear Met.		-	-
South Yorkshire Met.	-	0.568 **(1.61)**	-0.754 **(-1.38)**
West Yorkshire Met.	-0.441 **(-2.45)**	-	-
Merseyside Met.	-	0.446 **(1.11)**	-
West Midlands Met.	-	-	-0.357 **(-1.31)**
Inner London	-0.163 **(-0.86)**	-	-0.404 **(-1.36)**
Outer London	0.176 **(1.25)**	-	0.225 **(0.91)**
Outer Met. Area	-	-	0.216 **(0.99)**
Central Clydeside Met.	-0.269 **(-1.25)**	-	-
Regional Remainders (excluding Metropolitan Areas)			
North	-	-	0.584 **(1.77)**
Yorkshire and Humberside	-0.191 **(-1.06)**	-	-
North West	-0.189 **(-1.10)**	-	-
East Midlands	-	0.504 **(1.88)**	-
West Midlands	-0.371 **(-2.40)**	-0.365 **(-1.22)**	-
East Anglia	-0.334 **(-1.43)**	-	-
South West	-	-0.329 **(-1.48)**	-

	Economically Active				Inactive	
	Non Job Changers		Job Changers			
Scotland	0.374	**(2.67)**	0.665	**(2.88)**	-	
Race						
Black (African, West Indian or Guyanese)	0.421	**(1.60)**	1.003	**(1.89)**	1.391	**(4.25)**
Occupation						
SEG (1-6) Non Manual	-		-0.630	**(-2.18)**	-	
SEG (7-11) Manual	-		-0.296	**(-1.08)**	-	
SEG (12-15) Agricultural and Own Account	-0.291	**(-1.28)**	-		-	
Changed Occupation	-		-0.364	**(-2.34)**	-	
Entered SEG's 1-6	-		0.349	**(1.73)**	-	
Labour Force Status						
Unemployed	0.438	**(2.60)**	-		-	
Left Labour Force	0.454	**(2.25)**	-		-	
Constant	-2.483	**(-16.41)**	0.259	**(0.23)**	-6.392	**(-3.02)**
Likelihood Ratio Test	339.89		199.47		468.23	
Number of Parameters (excluding constant)	25		24		20	
Number of observations	8192		1851		2530	
Percentage of Migrants in the Sample	15.1		25.9		18.6	
Mean Standardised Movement Probabilities of Economically Active Non-job Changers	15.1		18.4		17.1	

Source: ECLFS 1979.

Notes: Figures in Parentheses are t ratios. Likelihood Ratio Test is constructed as -2 log (likelihood ratio), and compares the performance of the estimated model against one which only includes a constant term. This statistic is distributed as χ^2 with degrees of freedom given by the number of parameters in the model, less the constant.

* Refers to predicted variables (see Appendix). All other variables defined at start of period, except qualifications.

Omitted Categories:

Region: Wales (also omitted due to general insignificance from Wales was a variable for the Outer South East, (excluding London and the OMA) and a variable for Greater Manchester).

Qualifications: None (also omitted due to insignificance were: Primary School teaching qualifications, nursing qualifications, ONC/OND, and Other Professional/Vocational qualifications).

Housing Tenure: Owner Occupier (also omitted due to insignificance was a variable for all renters).

Occupation: Inadequately described.

that council house tenants had a lower probability of moving between regions, but a higher probability of moving in general. Our results suggest that young men are less likely to move at all from publicly owned housing accommodation. Clearly, however since these young men are unlikely to be tenants in their own right, these results are unlikely to be direct effects of tenure *per se*, but rather they probably reflect associations between housing tenure and general background and upbringing which are likely to affect the locational decisions of young men at this early stage of their housing and labour market experience.

Interestingly, these effects tend to be strongest in the job changers sample, suggesting that (for these individuals) housing tenure may also act as something of a residential constraint on those changing their place of work. (8) Spatially, the effects tend to be most pronounced in non-metropolitan areas, in line with the view that the problem of finding public housing residential destinations is less severe in large urban areas.(9) Whilst no significant differences were found between owner occupiers and renters in general, the results for the job changers sample suggest a higher level of mobility for those living in furnished rented accommodation (c.f. Gordon and Lamont (1982)). In the economically inactive sample the picture seems to be somewhat different, with the distinction between public and private housing tenure appearing not to matter except in metropolitan areas, whilst those living in furnished rented accommodation display the highest movement probabilities.

The age profiles of movement probabilities indicated by the age spline functions suggest something of a tendency for mobility to decline with age, although the effect is insignificant for job changers, and only affects economically active non job changers after the age of 20. Amongst the economically inactive, there is an initial increase in movement probabilities up to the age of 20, and from then on mobility declines significantly.

Movement probabilities also appear to vary with levels of educational attainment, although these effects are generally rather small. Thus, for example, job changers still undergoing trade apprenticeship are (at the mean) 25% less likely to move than those with no qualification at all, although this effect is not particularly well determined. Perhaps the strongest educational effects come through amongst economically inactive young men, particularly those with a degree or teaching qualification, who are over 25% more likely to move than those with no qualifications, evaluating partial derivatives at the mean.

Some interesting locational effects are also in evidence, with a tendency for movement probabilities to be lowest in metropolitan areas, particularly amongst job changers (holding housing tenure constant). This result suggests that a change of job is less likely to involve any residential relocation in areas of high employment density. Certain specific areas also come through as somewhat exceptional, for example Scotland outside of Central Clydeside has generally higher mobility rates (also perhaps reflecting the effects of (low) employment density), whilst the West Midlands (outside the Metropolitan area) has generally lower movement probabilities, amongst the economically active samples.

Ethnic origin also appears to affect mobility, with African, West Indian, or Guyanese young men tending to have higher movement probabilities, holding all other factors constant. This effect is strongest statistically amongst the economically inactive sample.

Whilst previous investigations have tended to find higher movement probabilities in certain sections of industry, particularly services (e.g. see Hughes and McCormick (1981)), no significant effects were detected for the sample of young men analysed here. Some variation across Socio-Economic Groups (SEG's) is in evidence however, particularly amongst job changers who were least mobile in the upper non-manual SEG categories.

Job changing is defined in this sample as any change of firm, industry or occupation, so the relationship between residential movement probabilities and these different types of job change was therefore explored. In general, the findings suggest that residential moves are less common amongst those changing occupation, reflecting perhaps the prevalence of internal occupational moves, at the same place of work. For those changing occupation and, in the process, moving into the upper strata of the SEG categories, however, higher residential movement probabilities are observed, suggesting that 'upward' moves in the occupational hierarchy tend also to involve residential adjustments. It is, of course, hard to say whether this reflects some sort of income effect as promotion enables individuals to move to residentially more desirable areas, for example, or whether it reflects a necessity for residential relocation in order to promote occupational advancement, given an unequal spatial distribution of such opportunities. It is interesting to note however, that occupational moves in the opposite direction did not incur commensurately lower movement probabilities.

The results for the class of variables relating to labour force status are most interesting. In particular, the unemployment variable attracts a significant positive coefficient, suggesting that (at the mean) unemployed individuals are nearly 8% more likely to move than those in employment, all other things being equal.(10) This finding has important implications for the analysis of local labour markets, suggesting that unemployed young individuals are in fact relatively mobile, and presumably willing to move to gain employment.

The results also suggest that movement out of the labour force altogether tends to be associated with higher residential mobility rates, although the causality of this relationship is perhaps questionable. Interestingly, equivalent variables were tried in the inactive sample for movements into the labour force (or out of student status) but yielded no significant effects. Two further variables identifying firstly students and secondly disabled persons from other economically inactive individuals also yielded no significant effects in this equation.

In general, the results suggest a great deal of variation in effects across samples, and an inspection of the proportion of migrants in the raw data suggests that the sample of job changers are the most likely to move. Obviously, in some measure this variation in the raw data reflects the differing characteristics of individuals across samples, and they do not necessarily accurately reflect (for example) the higher movement probability associated with job changing per se. Standardised movement probabilities were therefore generated by predicting how non-job changers would have behaved had they possessed in all other respects the same characteristics as individuals in the other samples, and these are reported at the end of Table

3.3. These figures are derived by inserting the characteristics of individuals in the other two samples into the estimated non job changers equation, and calculating predicted sample means. The results suggest that whilst controlling for differences in other personal characteristics did reduce the degree of variation in the proportion of migrants across samples, nevertheless substantial differences still remained. Thus, for example, of the 11 more individuals per 100 who moved house in the job changers sample as compared to non-job changers, roughly 3 moved as a result of other differing personal characteristics, whilst 8 moved as a consequence of changing their jobs.

4.2 Explaining the Choice of Distance Range

Tables 3.4, 3.5 and 3.6 present the results of a discriminant analysis of the distance range moved by migrants along the lines discussed in section 2, for each of the samples identified in this paper.(11) Variables were selected for inclusion into the models on the basis of the reported F test for discriminating power, having partialled out the other effects in the model. The maximum number of dimensions or discriminant functions that may be extracted in these analyses is three, one less than the number of categories in the dependent variable, as outlined earlier. Some summary statistics are provided in each table on the statistical performance of these discriminant functions. In general, all three functions contributed significantly to the explanatory power of the model, and the classification functions presented here are therefore those based on the three dimensional results.

Table 3.4 Discriminant Analysis - Active Non Job Changers
Classification Function Coefficients

Type of Move	(1)	(2)	(3)	(4)	F
Family circumstance*					
Married	-117.45	-118.94	-118.81	-115.34	(1.62)
Single Person Household	-116.65	-117.76	-115.39	-104.37	(4.37)
Housing Tenure*					
Public Housing Tenant	48.96	47.73	49.89	46.94	(3.52)
Age					
Age (squared)	0.367	0.369	0.371	0.355	(3.35)
Highest Qualification					
Degree	23.56	24.37	25.28	22.07	(2.89)
Professional Institution	23.97	24.49	25.26	22.26	(1.56)
Teaching Qualification (Primary)	11.22	12.15	14.96	9.94	(3.17)
Trade Apprenticeship (completed)	6.49	6.49	7.31	6.15	(2.25)
Trade Apprenticeship (not completed)	9.19	9.03	10.40	7.94	(3.74)
ONC/OND	8.98	9.30	10.85	10.69	(2.52)
City and Guilds	9.81	10.88	11.11	9.81	(4.70)
O level	7.15	7.48	8.22	7.01	(3.21)
CSE	7.09	7.35	7.24	6.30	(1.05)
Region (Metropolitan Areas)					
Tyne and Wear	-4.00	-3.96	-5.04	-3.58	(1.08)
Greater Manchester	1.28	1.85	2.15	2.03	(1.84)
Inner London	-8.31	-6.09	-7.37	-7.36	(8.98)
Outer London	-5.67	-4.25	-3.70	-3.22	(15.05)
Outer Metropolitan Area	1.16	2.26	2.81	2.05	(8.16)
Central Clydeside	-9.26	-7.99	-9.96	-8.39	(3.05)
Regional Remainders					
North	8.93	9.23	9.41	10.04	(1.09)
North West	2.36	3.15	3.30	2.19	(1.75)
East Midlands	5.54	6.74	6.38	6.47	(5.68)
South West	6.44	7.46	6.79	6.99	(3.78)
Scotland	-6.76	-5.83	-5.24	-5.73	(5.41)
Industry					
Service Industry	3.42	3.65	4.01	3.25	(2.42)
Labour Force Status and Changes					
Become Student	21.58	22.60	22.56	27.76	(11.46)
Constant	-71.41	-72.65	-74.99	-68.58	

(Table 3.4 Continued)

Statistical Performance of Canonical Discriminant Functions

Discriminant Function	Eigenvalue	Per Cent of Variance Explained by Function	Canonical Correlation	Functions Derived	Wilks λ	χ^2	DF
1	0.186	60.7	0.396	0	0.751	350.1	78
2	0.091	29.7	0.289	1	0.890	141.7	50
3	0.029	9.6	0.169	2	0.971	35.3	24

Canonical Discriminant Functions - Group Centroids

	Function 1	Function 2	Function 3
1	-0.288	-0.086	0.017
2	0.365	0.312	-0.240
3	0.529	0.461	0.443
4	1.229	-0.946	0.020

Classification Results

			Predicted Group Membership			
		n	1	2	3	4
Actual Group Membership	1	804	496	149	131	28
	2	260	73	107	60	20
	3	107	27	21	53	6
	4	65	20	11	13	21

Percent of 'Grouped' cases correctly classified: 54.8

Sources and Notes: See Table 3.3.

Regional Remainders refers to those areas outside the Metropolitan Counties.

Table 3.5 Discriminant Analysis - Job Changers
Classification Function Coefficients

Type of Move	(1)	(2)	(3)	(4)	F
Family Circumstance*					
Single Person Household	47.79	50.56	53.50	54.08	(7.07)
Child Dependent	290.09	293.11	294.85	293.94	(5.59)
Age					
Age	787.15	788.18	790.14	786.73	(2.29)
Age (Squared)	-18.28	-18.30	-18.34	-18.26	(1.89)
Highest Qualification					
Teaching Qualification (Primary)	34.51	35.48	32.63	31.51	(1.36)
Trade Apprenticeship (completed)	0.82	1.67	1.29	1.01	(2.12)
Trade Apprenticeship (not completed)	-22.94	-24.09	-25.38	-25.07	(1.93)
O level	-4.00	-3.84	-3.39	-3.38	(1.09)
Region (Metropolitan Area)					
Inner London	2.49	4.45	1.67	4.13	(6.63)
Outer London	-19.66	-18.47	-20.24	-17.76	(5.64)
Outer Metropolitan Area	13.93	14.21	15.33	14.65	(2.88)
Regional Remainders					
North	1.04	1.13	2.09	2.13	(1.10)
East Midlands	32.35	34.01	33.85	33.63	(3.60)
South West	14.76	15.38	14.01	15.81	(2.76)
Scotland	40.46	41.60	41.03	41.07	(2.06)
Occupation					
Manual	-8.15	-9.07	-9.54	-9.22	(6.37)
Labour Force Status and Change					
Changed Occupation	13.15	12.88	13.58	14.00	(2.39)
Entered SEG's 1-6	-2.56	-1.31	-1.69	-2.55	(3.57)
Left SEG's 1-6	-21.41	-21.54	-21.36	-22.80	(1.45)
Constant	-4257.01	-4272.39	-4295.17	-4259.51	

(Table 3.5 Continued)

Statistical Performance of Canonical Discriminant Functions

Discriminant Function	Eigenvalue	Per Cent of Variance Explained by Function	of Canonical Correlation	Functions Derived	Wilks λ	χ^2	DF
1	.219	56.0	0.424	0	.696	169.5	57
2	.107	27.4	0.311	1	.848	77.0	36
3	.065	16.7	0.247	2	.939	29.5	17

Canonical Discriminant Functions - Group Centroids

	Function 1	Function 2	Function 3
1	-0.464	-0.062	-0.044
2	0.258	0.419	0.301
3	0.584	-0.608	0.150
4	0.581	0.224	-0.551

Classification Results

			Predicted Group Membership			
		n	1	2	3	4
	1	233	138	40	34	21
Actual Group	2	110	31	35	24	20
Membership	3	75	17	10	43	5
	4	62	11	7	18	26

Percent of 'Grouped' cases correctly classified: 50.4.

Sources and Notes: See Table 3.4.

Table 3.6 Discriminant Analysis - Economically Inactive

Classification Function Coefficients

Type of Move	(1)	(2)	(3)	(4)	F
Housing Tenure*					
Public Housing Tenant	25.17	23.97	20.48	20.90	(5.11)
Rented (Metropolitan Area)	-0.29	3.46	-0.29	1.84	(4.18)
Public Housing Tenant (Met. Area)	-16.54	-20.03	-14.51	-16.10	(2.67)
Highest Qualification					
Degree	-0.77	-0.24	-0.33	2.08	(8.76)
Professional Institution	1.31	-1.66	-1.39	0.11	(1.10)
Teaching Qualification (Secondary)	-3.68	-2.69	-2.80	2.57	(1.42)
Trade Apprenticeship (completed)	6.89	4.91	10.09	4.71	(2.23)
Trade Apprenticeship (not completed)	0.56	-0.19	-2.01	-0.91	(2.69)
A level	0.60	1.07	0.67	1.67	(1.73)
O level	3.17	2.67	1.61	1.63	(2.14)
Region (Metropolitan Area)					
Metropolitan Area	8.32	6.12	6.65	6.16	(3.64)
Tyne and Wear	-0.03	0.26	-0.05	1.92	(2.07)
Merseyside	7.88	9.86	8.41	9.08	(1.70)
Inner London	-1.38	1.36	-0.85	-1.34	(6.44)
Outer London	-0.35	3.92	0.79	2.10	(22.16)
Outer Metropolitan Area	4.64	5.05	6.17	5.57	(1.86)
Regional Remainders					
East Midlands	5.36	5.76	7.10	7.40	(2.95)
West Midlands	5.18	4.78	6.42	4.56	(1.16)
East Anglia	10.48	11.36	10.21	12.49	(1.80)
South West	5.72	5.83	4.84	4.58	(1.63)
Scotland	1.51	3.61	2.14	2.01	(3.16)
Labour Force Status and Change					
Permanently Sick/Disabled	18.15	20.82	17.12	17.33	(2.52)
Student	26.56	26.36	25.12	24.73	(2.68)
Joined Labour Force	-0.23	0.57	1.65	1.46	(5.38)
Constant	-19.05	-19.77	-17.36	-17.99	

(Table 3.6 Continued)

Statistical Performance of Canonical Discriminant Functions

Discriminant Function	Eigenvalue	Per Cent of Variance Explained by Function	Canonical Correlation	Functions Derived	Wilks λ	χ^2	DF
1	.459	56.12	.561	0	.496	319.2	72
2	.271	33.10	.461	1	.723	147.4	46
3	.088	10.78	.285	2	.919	38.4	22

Canonical Discriminant Functions - Group Centroids

	Function 1	Function 2	Function 3
1	-0.672	-0.271	0.117
2	-0.058	0.935	-0.105
3	0.385	-0.521	-0.718
4	1.024	-0.158	0.264

Classification Results

			Predicted Group Membership			
		n	1	2	3	4
	1	194	128	26	29	11
Actual Group	2	107	26	58	9	14
Membership	3	57	16	6	24	11
	4	112	20	10	23	59

Percent of 'Grouped' cases correctly classified: 57.2.

Sources and Notes: See Table 3.4.

The group centroids suggest that the discriminant functions tend in large part to differentiate the different categories on the basis of the length of move, in line with the notion of an implicit distance deterrence function in the data. This feature tends to be most apparent in the first (and most important) of the discriminant functions, where the group centroids tend to be generally arranged more or less monotonically in relation to distance.

Turning to the detailed results for the classification functions, the coefficients may be interpreted as follows. For each individual, classification scores for each of the possible migration groups may be derived on the basis of their observed characteristics and the individual allocated to the group with the highest score. Clearly, all the explanatory variables in the analysis are essentially binary in form, apart from those relating to age. Thus, the <u>order of magnitude</u> of the coefficients on each variable (with the exception of age) indicate the relative <u>weight</u> placed on that variable in the classification procedure, whilst the variation across the different migrant types tells us which distance ranges such an individual is most likely to move in, all other things being equal.

Table 3.4 suggests, therefore, that family circumstance plays a substantial role in affecting distance range moved amongst economically active individuals that did not change jobs, with married individuals and those living in single person households being most likely to move in the longest distance range (inter-regional/non-contiguous). Age appears to have the opposite effect, however, tending to reduce the probability of long distance movement, holding other factors constant (including family circumstance). Public housing also appears to substantially reduce the probability of long distance movement, in line with the findings of Hughes and McCormick (1981). In addition, certain educational attainment variables come through, these tending in general to display something of an inverse U-shaped pattern, with the highest probabilities generally in the middle distance categories.

Given that this sample consists of individuals who were economically active at the beginning of period and did not change their job, it is perhaps not surprising to find also that those moving in the longest distance category tend often to be individuals who left economic activity to become students. Other labour force status variables such as unemployment at beginning of period appeared to contain no significant discriminating power between the different distance categories, however (inclusion of this variable attracted an F statistic of 0.67).

The regional variables are somewhat harder to interpret, since estimated coefficients on these variables are likely to reflect something both about the characteristics of that zone within the regional network, and also something about the way the different categories have been defined, e.g. a region may contain a great many internal moves purely by virtue of its size relative to the other regions.(12) These variables are best regarded as controls therefore, both for systematic spatial effects, and any vagaries in the areal definitions.

The results for the sample of job changers, reported in Table 3.5, suggest once again that family circumstance plays a substantial role, with child dependents and individuals living in single person households being the most likely to move in the long distance ranges.

The age structure effects tend to follow a broadly similar pattern across the different groups, reaching a peak at around 21.5 years of age, although differences in the group profiles suggest that ageing appears to be biased in general toward favouring movement in the (contiguous) regional category.

Housing tenure appears to exert no significant effect, whilst the educational variables tend also to attract statistically rather weaker effects, in this sample. Interestingly, however, the occupational variables suggest that (job changing) manual workers tend to move rather short distances as compared to those in non-manual SEG categories. Those changing occupation over the year (rather than simply changing firm or industry) appear more likely to move in the longer distance ranges, although this result appears to depend partly on the direction of movement, and tends to be offset somewhat in cases where movement is out of the higher SEG categories.

The results for the economically inactive sample, reported in Table 3.6, suggest that whilst age and family circumstance appear to be unimportant in this sample, housing tenure plays a substantial role. In particular, public housing tenants appear to be substantially less likely to move in the longer distance ranges, particularly those living in metropolitan areas who are markedly more likely to move only in the intra district range. Disabled persons and full time students tend not to move in the longer distance ranges, whilst the possession of a degree dramatically increases the probability of moving in the longest distance range. The process of joining the labour force over this 1 year interval is apparently also associated with longer distance movement.

The explanatory power of the models presented in Tables 3.4, 3.5 and 3.6 is encouragingly high, with in each case over 50% of the observations being correctly classified to the appropriate distance category out of four possible alternatives. The χ^2 tests on the Wilks λ coefficients for each of the canonical discriminant functions indicate that the statistical contribution of successive discriminant functions tends to decline markedly, as one might expect, but that in general they retain their significance at standard probability levels.

It is interesting to note (e.g. from Table 3.1) that the sample of job changing migrants tend to be relatively more heavily concentrated in the longer distance migration ranges than other economically active young men, as one might expect. In order to ascertain roughly to what extent this pattern is due to the differing <u>characteristics</u> of individuals in the two samples, the classification functions presented in Table 3.5 for job changers were used to predict the migration patterns of those economically active individuals who did not change jobs over the period. The results suggested that, out of 13 more migrants per hundred in the job changing sample that were <u>predicted</u> to move inter-regionally (as opposed to intra-regional moves) 6 did so as a result of other differing personal characteristics, whilst the remaining 7 reflected the effects of changing jobs <u>per se</u>.(13) These results suggest, therefore, that after controlling for other differing characteristics, non-job changers tended to exhibit a rather steeper distance deterrence function than those changing jobs as well as residence, confirming prior theoretical expecations (see Chapter 2) and the findings of several studies based at the <u>aggregate</u> level (e.g. Gordon and Vickerman (1982), and Chapters 4 and 5 of this thesis), as regards the comparative distance decay patterns of employment related and residentially motivated migration streams.

5. Summary and Conclusions

The purpose of this chapter was to construct a model of individual migration decisions which goes beyond the analysis of the standard movement/non-movement decision and yet is amenable to estimation at the micro level, in order to explore distinctive spatial dimensions to migration in terms of the choice of distance range moved directly at that level. A simplified two stage decision tree was constructed, in which the decision to move was initially modelled using a standard binary logit formulation, and then the choice of distance range analysed using a form of multinomial discriminant analysis.

The model was implemented using data on the migration decisions of young men over a 1 year interval from the 1979 European Commission Labour Force Survey. The results suggested that the migration decisions of these young men were significantly affected by their family circumstance, housing tenure, educational attainment, labour force status, and occupation. In addition, substantial differences were found in the behaviour of economically active job changers and the remainder of economically active young men, as well as the sample of economically inactive individuals. Job changers were not only the most likely to move *per se*, but also the most likely to move over long distances, suggesting the presence of a rather flatter distance decay function for individuals changing jobs and moving house, as compared to essentially residentially motivated moves without an associated change of job.

Appendix

Predicting Family Circumstance and Housing Tenure

Each of the variables in these categories was regressed on three blocks of independent variables:-

$$X_{it} = f(A_{it}, B_{it}, C_{it}, \varepsilon_{it})$$

A_{it} = a vector of variables that were taken to be genuinely exogenous to the determination of migration.

B_{it} = a vector of variables relevant to the explanation of the variable in question, but which were excluded in the explanation of migration e.g. transition between full time education and working life, terminal education age, professional status (e.g. part-time/full-time, self-employed, manual/non-manual).

C_{it} = a vector of variables for which information was available at both start and end of period e.g. region industry and occupation. (The exogeneity of these variables in the determination of migration is irrelevant, since start of period values for these variables are clearly pre-determined).

ε_{it} = a residual term.

These regressions were performed using Ordinary Least Squares methods based on a linear probability model. Given the potentially large number of independent variables involved, a stepwise method was instituted, with a cut off t value of $|1.0|$. Summary statistics on the performance of these equations are given in Table A1.

Predictions of house tenure and family circumstance were then generated using lagged values of C_i and (where possible B_i), together with current values of A_i, for which corresponding lagged variables were unavailable:-

$$\hat{X}_{it-1} = f(A_{it}, B_{it-1}, C_{it-1})$$

These predictions were then used as input into the migration model.

Table A1

Explaining Family Structure and Housing Tenure: Summary Statistics

		JOB CHANGERS	NON-JOB CHANGERS	INACTIVE
Child Dependent	R^2	.329	.281	.439
	F	[19.26]	[48.20]	[54.08]
	k	(46)	(66)	(36)
Married	R^2	.343	.272	.249
	F	[18.81]	[46.78]	[27.69]
	k	(50)	(65)	(30)
Head of Household	R^2	.359	0.292	.437
	F	[21.01]	[55.86]	[57.02]
	k	(48)	(60)	(34)
Single Person Household	R^2	.131	.079	.304
	F	[6.82]	[12.64]	[24.69]
	k	(40)	(55)	(44)
Rented	R^2	.168	.134	.195
	F	[6.98]	[20.04]	[12.79]
	k	(52)	(63)	(47)
Furnished	R^2	.126	.064	.318
	F	[6.85]	[9.76]	[29.79]
	k	(38)	(57)	(39)
Public Housing Tenant	R^2	.196	.141	.169
	F	[9.77]	[21.23]	[11.21]
	k	(45)	(63)	(45)

k = number of variables

CHAPTER 4 THE ESTIMATION OF AGGREGATE SPATIAL INTERACTION MODELS: A STUDY OF MALE INTER-REGIONAL MIGRATION IN 1971

1. Introduction

In this chapter we return to the level of aggregate spatial interaction modelling discussed in chapter 2, and attempt to incorporate some of the empirical insights drawn from the previous chapter on micro level migration decisions into models of aggregate migration flows. In particular, the purpose of this chapter is to outline a method of estimating aggregate spatial interaction models of the kind developed in chapter 2, and to provide a simple example of how this methodology may be implemented using a one year inter-regional migration matrix for males of working age from the 1971 Census. The chapter is divided into three main sections. In section 2, the estimation of single stream gravity models such as that specified in equation (2.3) in Chapter 2 will be considered. A number of different techniques have been suggested in the literature for this purpose, and their various properties have been contrasted from the point of view both of statistical theory, and comparative empirical performance. In this section, two widely adopted research strategies for the economic interpretation of origin and destination specific effects on migration are also identified and contrasted. In section 3 various methods of extending these techniques to the multi-stream case will be discussed and an iterative distance cut-off algorithm proposed for this purpose. Section 4 presents the results of the empirical analysis, whilst section 5 presents a brief summary and conclusion.

2. Calibrating Conventional Spatial Interaction Models

From the point of view of estimation it will be useful to rewrite the simple single stream gravity model developed in chapter 2 in a manner which identifies regional 'mass' effects, in the form of population size, from other potential influences embedded within the origin and destination specific factors:

$$\left(\frac{M_{ij}}{P_i \, P_j}\right) = A_i \, B_j \, f(D_{ij}) \qquad (4.1)$$

One of the first issues that needs to be addressed, before proceeding to discuss methods of estimation lies in specifying the form of the distance deterrence function. A number of monotonic functional forms have been suggested in the literature, the most popular of which have tended to be the power and the exponential functions. A priori, the latter would seem to be preferable, since the power function formulation predicts migrant flows which approach infinity as distances tend to zero, a feature which is clearly inappropriate when dealing with highly localised flows. In fact, a number of theoretical derivations of the gravity model specifically suggest an exponential form for the distance function (eg. see Wilson (1971), Gordon (1985a)), whilst a comparison of the empirical performance of the two models in an analysis of inter-county migration flows in 1971 (Gordon (1982)) showed the exponential function to be clearly preferable. Adopting this formulation therefore, we may write:-

$$\left(\frac{M_{ij}}{P_i \, P_j}\right) = A_i \, B_j \, \exp\,(-\eta \, D_{ij}) \qquad (4.2)$$

Whilst in principle it should be possible to derive some form of implied stochastic structure by aggregating the error distributions from the individual random utility functions, this sort of approach does raise problems in the specification of error structures for the essentially autonomous components representing the spatial distribution of opportunities, friction in information flows, etc., and no attempt has been made to date to deal with these problems in the literature. In fact, much of the literature on the estimation of models of this form has grown out of the entropy maximising derivations of the late '60's and early '70's (eg. Hyman (1969)). The assumptions made in this approach for the purposes of model calibration may be seen to be entirely in keeping with the random utility perspective adopted here, however, suggesting that it would be worthwhile pursuing this avenue to the problem of estimation.

The basic approach adopted in this literature is to specify a set of constraints which uniquely identify the model parameters. These constraints may be written:-

$$\sum_{j \neq i} M_{ij} = \sum_{j \neq i} \hat{M}_{ij} \tag{4.3}$$

$$\sum_{i \neq j} M_{ij} = \sum_{i \neq j} \hat{M}_{ij} \tag{4.4}$$

$$\sum_{i \neq j} \sum_{j \neq i} M_{ij} \; c_{ij} = C \tag{4.5}$$

where a ^ indicates <u>fitted</u> as opposed to actual values, c_{ij} is the cost of moving and C is a constraint on total expenditure. The first two constraints identify the push and pull factors A_i and B_j, by ensuring that the row and column sums of the migration matrix equal the number of migrants originating from each area and the number of migrants attracted, respectively. It is notable, however, that these 'adding up' constraints merely identify uniquely the product $A_i\ B_j$ not the individual components, so that the relative scaling of the factors becomes arbitrary. The last restriction is a form of budget constraint on total moving expenditures, and assuming that moving costs c_{ij} are a positive function of distance (D_{ij}) this restriction may be used to identify the distance parameter. Imposition of these constraints generates a sufficient number of restrictions, therefore, to ensure that (apart from the relative scaling of the push and pull factors) there exists only one set of model parameters capable of satisfying all the constraints. Hyman (1969) suggests an iterative procedure to solve the model, and shows that this solution generates maximum likelihood estimates of the model parameters.

Before going on to consider alternative estimation techniques, it is worth noting that by removing various combinations of the constraints specified in (4.3) and (4.4), it is possible to generate a number of 'special cases' of the gravity model which are widely used in the literature (Wilson (1971)), and which may be seen to impose empirically testable restrictions on the general form. These special cases are:-

1. The unconstrained model, where neither (4.3) nor (4.4) are imposed. The early formulations of the gravity model, which expressed spatial flows as a function simply of regional mass (usually population) and distance, were of this kind:

$$\left(\frac{M_{ij}}{P_i\ P_j}\right) = k \exp\ (-\eta\ D_{ij})$$

this formulation omits any other influences which might be embedded in the A_i and B_j factors.

2. The <u>production</u> constrained model in which only (4.3) is imposed and spatial flows are expressed as a function of regional mass and distance, as well as <u>origin</u> specific factors:-

$$\left(\frac{M_{ij}}{P_i\, P_j}\right) = A_i \exp\,(-\eta\, D_{ij})$$

In this model the constant k in the unconstrained case is allowed to vary for different origins.

3. The <u>attraction</u> constrained gravity model in which only (4.4) is imposed, and spatial flows are expressed as a function of regional mass and distance, as well as <u>destination</u> specific factors, by permitting k to vary across destinations:-

$$\left(\frac{M_{ij}}{P_i\, P_j}\right) = B_j \exp\,(-\eta\, D_{ij})$$

The form of model employed here, therefore, has earned the description of being 'doubly constrained' in that it imposes <u>both</u> sets of adding up constraints to generate estimates of origin and destination specific factors, as well as the distance parameter, η.

Returning to the question of estimation techniques, a number of more convenient alternatives to Hyman's (1969) maximum likelihood method have also been suggested in the literature, based on standard regression techniques. Thus, for example, ordinary least squares (OLS) may be applied using dummy variables to capture origin and destination specific effects, after linearizing the model specified in (4.2) into logarithms, and introducing explicitly an error term which is assumed to enter exponentially:-

$$\ln \left(\frac{M_{ij}}{P_i \, P_j} \right) = \ln A_i \, X_i + \ln B_j \, X_j - \eta \, D_{ij} + \varepsilon_{ij} \tag{4.6}$$

where X_i is a vector of dummy variables taking the value 1 if i is the area of origin and zero otherwise, whilst X_j is a similarly defined vector of destination specific dummy variables. A_i and B_j are estimated as parameters on these dummy variables, and ε_{ij} is an error term.(1)

Various other regression based approaches have also been suggested, for example, using non-linear estimation techniques. The basic difference between all these techniques lies in the treatment of the disturbance term, eg. by using non-linear techniques it is possible to estimate the model with an additive error term included alongside the original multiplicative form of the model. Various extensions to these approaches to estimation have also been suggested in the literature, eg. Baxter (1979) has suggested a form of logit regression analysis to estimate the parameters of a production constrained gravity model, whilst Flowerdew and Aitkin (1982) suggest an approach based on the Poisson distribution rather than the lognormal which underpins the OLS approach, on the grounds that the Poisson distribution is more appropriate when dealing with positive valued integers as in migration analysis. In addition, the OLS approach suffers from the deficiency (not present in the Poisson or maximum likelihood approaches) that it cannot handle zero values in the migration matrix, and requires that arbitrarily low values be substituted into the data to facilitate estimation.

In most cases, however, any empirical attempts to test the relative performance of different estimation techniques have been within the context of models which have not been fully constrained, (often neglecting the possibility of using dummy variables to capture origin and destination specific effects, using standard OLS techniques) (eg. Stetzer (1976), Baxter and Ewing (1979), Flowerdew and Aitkin (1982)). The omission of these dummy variables may be seen to underly the inability of least squares to yield unbiased estimates since the model is prevented from capturing any systematic spatial structures in the data. As such, any inaccuracies that arise are more likely to be due to specification error rather than any significant bias in the estimation procedure.

To some extent the general view taken in this chapter is in accordance with that taken by Sheppard (1979) who argued that model mis-specification often caused OLS to yield biased estimates of gravity parameters, and led to the common empirical suggestion (erronously in this case) of spatial variations in distance deterrence. Sheppard (1979) also took the view, however, that spatial autocorrelation in the 'mass' terms of the gravity model produced non-linear relationships between the independent variables of a log-linearized gravity model which led to genuine biasses in application of least squares. This problem clearly disappears, however, once the *a priori* restriction of unit exponents on these mass terms is imposed, in order to overcome inherent areal aggregation problems. (See footnote 5 chapter 2).

Some experiments were therefore performed to examine the differences between OLS and maximum likelihood techniques using a small inter-regional migration matrix for men taken from the 1971 census (and absent of any zero values), and these results are reported in Table 4.1. The estimates must, of course, be treated with some circumspection since the basic data matrix may easily be shown to comprise at least two heterogenous groups (see section 3 of this chapter). These experiments should at least give some idea of the extent of the biases involved using OLS compared to maximum likelihood, however. Inspection of the results reported in Table 4.1 suggests broad similarity, both in terms of the pattern of push and pull effects, the estimated distance parameter, and the explanatory power of the model.

If the push and pull terms, A_i and B_j are removed, however, and replaced with a simple constant, estimation by OLS yields(2):-

$$\ln\left(\frac{\hat{M}_{ij}}{P_i\ P_j}\right) = \underset{(-81.48)}{-8.506} - \underset{(-5.53)}{0.00311}\ D_{ij}$$

$$R^2 = 0.258 \qquad F = 30.57 \qquad n = 90$$

with an estimated distance parameter which is much closer to zero than with the full model and obviously biassed as a result of the omission of the push-pull terms.

These findings indicate that whilst maximum likelihood may be the more appropriate estimator, OLS can provide a convenient and reasonably accurate approximation, so long as the original gravity model has been properly specified. The convenience of OLS declines as the size of the flow matrix increases however, since large numbers of areas would require an inordinate number of dummy variables. In addition, the finer the degree of areal disaggregation, the greater the probability of zero elements in the original flow matrix being present, preventing the logarithmic transformation of the dependent variable necessary for application of OLS. In this thesis therefore, both techniques have been applied at various different stages of the analysis.

Table 4.1 A Comparison of Estimation Procedures

Model: $M_{ij} = A_i B_j \exp(-\eta D_{ij})$

Correlation coefficients of push and pull factors: maximum likelihood and OLS.	A_i/P_i	B_i/P_i
	0.973	0.989

	OLS		Maximum Likelihood (Hyman)	
	(A_i/P_i)	(B_i/P_i)	(A_i/P_i)	(B_i/P_i)
North	0.289	0.000972	0.298	0.001062
Yorkshire & Humberside	0.251	0.000748	0.246	0.000779
North West	0.213	0.000649	0.209	0.000699
East Midlands	0.276	0.000993	0.247	0.001045
West Midlands	0.212	0.000720	0.197	0.000697
East Anglia	0.334	0.001486	0.338	0.001835
South East	0.315	0.001154	0.298	0.001184
South West	0.430	0.001837	0.439	0.002097
Wales	0.248	0.000850	0.250	0.000969
Scotland	0.351	0.001008	0.400	0.001176
Distance Parameter	-0.005118		-.005265	
(t value)	(-6.98)		-	
R^2	0.894		0.927	
F	31.2		-	
n	90		90	

Notes: Estimated push and pull factors have been deflated by the regional population (P_i) to facilitate interpretation, and to conform with the form of equation (1). Since it is only the product of push and pull factors which can uniquely be identified, and since OLS and maximum likelihood implicitly scale the component element A_i and B_i differently, these have been rescaled onto a common basis for ease of comparison.

F statistics and the t value on the distance parameter were unavailable using maximum likelihood. The R^2 and F values refer to the log of migration, in the OLS case, whilst in the maximum likelihood case R^2 refers to the original (unlogged) values.

Sources: See Appendix.

Before going on to consider appropriate ways of extending these techniques to the multi-stream case, however, it would be of interest to make a further comparison of estimation strategies as regards the interpretation of area specific push and pull factors.

2.1 Interpreting Origin and Destination Specific Factors

In chapter 2 it was shown that the push and pull factors A_i and B_j may be given an economic interpretation by relating them to various measures of local attractiveness, turnover, and population characteristics. In this section, this approach is contrasted with another widely adopted strategy of including such variables directly into the migration function, and dispensing with the interim stage of deriving indices of local push and pull effects (e.g. see Weeden (1973)). Amassing all the relevant variables (eg. wage rates, unemployment rates etc.) into a vector (Y_k), and adding an error term ν_{ij} this sort of model may be written:-

$$\ln\left(\frac{M_{ij}}{P_i\ P_j}\right) = \delta_o + \sum_{k=1}^{n} \delta_k Y_{ik} + \sum_{k=1}^{n} \lambda_k Y_{jk} - \eta D_{ij} + \nu_{ij} \qquad (4.7)$$

This procedure may be directly contrasted with the 'two step' methodology outlined earlier using OLS techniques. A_i and B_j factors are derived by estimating a model of the form specified in (4.6), and these factors are subsequently related to the variables specified in Y_k thus:-

$$\ln A_i = \alpha_o + \sum_{k=1}^{n} \alpha_k Y_{ik} + U_i \qquad (4.8)$$

$$\ln B_j = \beta_o + \sum_{k=1}^{n} \beta_k Y_{jk} + V_j \tag{4.9}$$

where U_i and V_j are error terms.

On substitution back into (4.6) this yields:-

$$\ln \left(\frac{M_{ij}}{P_i \, P_j} \right) = (\alpha_o + \beta_o) + \sum_{k=1}^{n} \alpha_k Y_{ik} + \sum_{k=1}^{n} \beta_k Y_{jk}$$

$$- \eta \, D_{ij} + (\varepsilon_{ij} + U_i + V_j) \tag{4.10}$$

The difference between the two estimation strategies lies in the treatment of the error term. In (4.7) all the sources of error are amalgamated into the single error term ν_{ij}, whereas in (4.10) the disturbance is partitioned into three components, one arising from errors in fitting the basic gravity model, and the other two resulting from an inability to explain perfectly the push and pull factors A_i and B_j.

In a sense, this difference is reminiscent of that between constrained and unconstrained gravity models discussed earlier. The 'one-step' method of including explanatory variables directly into the migration function implies that a <u>complete</u> set of origin and destination specific factors is unlikely to be extracted from the migration matrix, except in the limiting case where the number of variables specified in Y_k is equal to the number of areas minus one, in which case the two approaches are identical (i.e. the number of explanatory variables Y_k equals the number of dummy variables in the two-step procedure). The 'one step' approach is valid insofar as it imposes restrictions which are accepted by the data, i.e. there are no further origin and destination specific factors of any significance which are excluded from the vector Y_k. Should this not be the case, however, then systematic residual autocorrelation along rows and columns of the migration matrix will be introduced, which are likely to result in biased OLS estimates of the distance parameter (cf. Sheppard's (1979) discussion of potential biasses arising from the use of least squares techniques, in the presence of systematic spatial structures). Significance tests are also less reliable using the 'one step' procedure, partly because autocorrelation is likely to bias estimated standard errors, and partly because the number of degrees of freedom is inflated, since repeating observations on the Y_k suggests there are $(n^2 - n)$ observations when in fact there are only n independent values.

Whilst the 'two-step' approach provides an insurance against bias in the estimation of the distance parameter, by explicitly controlling for all origin and destination specific influences, however, neither approach yields unbiased estimates of the coefficients on the Y_k variables in the situation where some important explanatory variables have been omitted from this vector. (See Molho (1984) for a fuller discussion of these issues).

Finally, it may be noted that in the estimation of multi-stream gravity models, iterative techniques are often required (see section 3). The fact that the two-step procedure captures all origin and destination specific influences at each iteration between streams before deriving a final set of push/pull parameters for each stream which may then be given economic interpretation, provides this extended procedure with a potentially substantial advantage.

In summary, therefore, the direct approach of including explanatory variables measuring origin and destination specific effects explicitly into the migration equation is valid insofar as these factors are known to be correctly specified. In situations where they are incorrectly specified, the two-step procedure will yield biased estimates of the influence of these factors on migration, but not of the distance parameter, which is estimated separately. The one-step procedure produces biased estimates of all the coefficients in this situation, including the distance parameter, since all the coefficients are amalgamated within a single regression equation. The greater the mis-specification in terms of loss of explanatory power, the greater the difference between the two procedures in the resulting parameter estimates.

3. The Estimation of Multi-Stream Spatial Interaction Models

At the end of chapter 2 it was suggested that an important source of heterogeneity in migrant streams composing an aggregate flow matrix lay in the existence of different migrant search fields, and associated motives for moving and evidence from micro data in Chapter 3 supported this contention. Migration data from official sources are, in general, not disaggregated along these lines, and this poses serious problems in identifying homogenous migrant streams when it comes to estimating migration equations.

Two main solutions to the problem have been suggested in the literature. The first of these is to attempt to define a set of geographical areas in such a way as to purify the migrant flow matrix between these areas, and some investigators have attempted to use the Standard Metropolitan Labour Areas (SMLA) for this purpose (eg. see

Flowerdew and Salt (1979)). The argument here is that defining a set of functional labour market areas, enables one to remove intra-labour market flows from the data (eg. residential flows), and thus identify a reasonably homogenous flow matrix of inter-labour market moves.

There are three main problems with this strategy. Firstly, it is clear that local labour markets are not discrete in a spatial sense, but are in practice likely to overlap to some degree, whilst important interdependencies are also likely to exist between housing and labour markets (Gordon and Lamont (1982)). Both these factors suggest that the problem of migrant heterogeneity cannot adequately be circumvented by a simple redrawing of areal boundaries, and in fact Hyman and Gleave (1976) quote an average of 1 in 4 of inter-SMLA migrants as moving for housing-related reasons. The second point is that, even if one could adequately surmount the problem in this manner, it is not clear that such a procedure would be desirable, since in a sense it simply removes from the data one of the more interesting sources of complexity in migration behaviour. A much more satisfactory approach would clearly be to explicitly model the different processes present in the data, rather than remove one or more of them. The third and final problem is that often the areas of interest do not constitute functional labour markets. Thus, for example, at one level it would obviously be of interest from a policy point of view to analyse migrant flows between the Standard Planning Regions, yet these regions have not been defined on economic criteria, but for the purposes of administrative convenience. At another level, it would also be of interest to analyse migration as a central process in the development of a particular metropolitan labour market such as London for example, where it is clear that housing-related flows from the central urban area to the peripheral residential suburbs are of great importance.

For all these reasons, therefore, it would appear preferable to construct a model to explain the various aspects of migration behaviour, and to devise a methodology capable of explicitly identifying the various migrant streams. The purpose of this section is to design such a methodology, with a view to implementing it in the next section using a matrix of male inter-regional moves from the 1971 Census.

3.1 The Multi-Stream Methodology

Perhaps the first point to address in constructing a multi-stream gravity model of migration behaviour lies in the choice of the number of streams specified in the model, and this decision essentially depends upon the level of areal aggregation employed in the basic data set. In Gordon and Vickerman's (1982) analysis of migrant flows between a set of relatively small areal units (i.e. a district level analysis in and around London) three migration streams were recovered from the data, related to national, regional and local fields of search. At higher levels of aggregation only two of these streams are clearly in evidence (eg. see Gordon's (1982) analysis at the county level), and these are generally called, for ease of exposition, 'housing' and 'employment' related streams. At this stage of the thesis, therefore, since we are dealing with a matrix of inter-regional moves, this two stream specification will be adopted, although in later sections where the analysis is pitched at a lower level of areal aggregation, more complex three stream models will also be used.

The most promising approach in recent years to the estimation of multi-stream gravity models using a single aggregate flow matrix has involved the use of some sort of distance cut-off to split the migrant streams (Gordon (1982), Molho (1982)). Beyond this distance cut-off, migrant streams are assumed to consist virtually purely of employment related migrants, and to be generally free of housing streams. Short distance flows up to this threshold are assumed to comprise both sets of migrant streams, in varying proportions. Deleting all short distance cells from the matrix therefore, and estimating a model purely on the long distance migration streams, yields unbiased estimates of the gravity model parameters for the employment stream. These estimates may then be used to predict the volume of employment migration over the short distance cells in the matrix, projecting backwards along the distance decay function and incorporating variations in regional push/pull factors for these streams. These (unbiased) predictions may then be subtracted from the original migration flow data, and the remainder used as the basis for estimating a model of housing migration streams.

This procedure yields unbiased parameter estimates for both streams, providing the distance cut off originally selected and incorporated into the estimation procedure has been appropriately identified. The choice of cut off is therefore an important one, which clearly can (and in practice does) affect the final parameter estimates. In Molho (1982) a contiguity/non-contiguity sample split was used for this purpose in a study of inter-regional moves, whilst in Gordon's (1982) analysis of inter-county migration the distance cut off was varied experimentally, and finally fixed at 100 miles.

In this chapter, a somewhat different avenue is explored. In particular, different forms of the housing-related migration model are experimented with in such a way as to be able to predict endogenously the appropriate distance cut-off, and thereby allow the data to generate the sample split necessary to estimate the two-stream model. As such, this approach involves the specification of forms of the housing stream migration model which admit the possibility of genuine distance cut-offs in the data, and then suggests estimation methods capable of locating these threshold points.

Clearly there are important theoretical issues which underly this strategy. Essentially, the presence of a genuine distance cut-off in the model implies the existence of some point where the elasticity of substitution between distance and attractiveness/emissiveness reaches zero, i.e. no matter how attractive (repulsive) an area might be, migrants will not enter (leave) that area beyond distances in excess of a certain threshold. Whilst such a feature might be rather implausible in general, there are reasons to suggest that it might prove not unreasonable in the analysis of housing migration. In this particular case, the attractiveness of an area is likely to depend on housing market conditions, as well as general environmental factors. Clearly, such residential moves involve an element of substitution between long distance commuting back to the original place of work, in exchange for a more pleasant residential environment, for example. It is at least conceivable, however, that beyond a certain distance, commuting no longer provides a viable long term option, and some change of workplace will be called for. As such, housing related migration will be translated into employment stream movement, for which a more traditional probablistic tailing off in the distance function may be specified.

Clearly, the form of the housing stream model is open to empirical testing, and one may compare the 'distance cut-off' model against standard power or exponential type functions. It has already been noted that Gordon's (1982) study of inter-county migration suggested that an exponential form for the distance decay function was statistically the most appropriate. However, the statistical tests employed related more directly to the employment stream than the housing stream model, and there appears to be no obvious <u>a priori</u> reason why the same form should apply to both migrant streams.(3) Various functional forms were therefore tried for the housing stream model in this analysis, and in particular the possibility of approximating the housing stream model with forms capable of predicting zero migrant flows were experimented with, for example:-

$$\left(\frac{M^H_{ij}}{P_i\ P_j}\right) = A^H_i + B^H_j - \eta^H\ D_{ij} \qquad (4.11)$$

$$\left(\frac{M^H_{ij}}{P_i\ P_j}\right) = \ln A^H_i + \ln B^H_j - \eta^H \ln D_{ij} \qquad (4.12)$$

where the H superscript indicate housing related movers. For the purely additive model, the distance cut off D^*_{ij} may be calculated as:-

$$D^*_{ij} = [A^H_i + B^H_j]/|\eta^H| \qquad (4.13)$$

and in the semi logarithmic case:

$$\ln D^*_{ij} = [\ln A^H_i + \ln B^H_j]/|\eta^H| \qquad (4.14)$$

One interesting feature that emerges from equations (4.13) and (4.14) is that these distance cut-offs depend both upon the strength of the distance deterrence relationship (η^H), and also the size of the regional push and pull factors. As a result, the appropriate distance cut-off is unlikely to be a single number taking on a uniform value across all cells in the matrix, but will in fact vary with the relative attractiveness and emissiveness of the region pairs involved. Specifically, the cut-off will be the greater for flows from emissive regions to attractive ones, a result which seems intuitively plausible. The importance of the push and pull factors in evaluating the appropriate distance cut-off is brought home more forcibly when a further alternative which has been suggested in the literature (eg. see Gordon (1975)) for the migration model is considered:-

$$\left(\frac{M_{ij}}{P_i\ P_j}\right) = (A_i + B_j)\ f(D_{ij})$$

The choice of f( ) is irrelevant in this case to the prediction of the distance cut-off, since the model predicts zero migrant flows independently of distance, if and when $(A_i + B_j) = 0$. This formulation is less useful for the purposes of estimation, however, since we have a much clearer impression of the relative distance patterns of the two streams (i.e. that housing streams are likely to be much more localised than employment streams), than we have about relative push and pull effects between the streams.

This leads us on to the question of model estimation. Returning to the functional forms specified in (4.11) and (4.12) therefore, suppose we adopt as a set of starting values an arbitrary matrix of distance cut-offs (eg. a contiguity/non-contiguity sample split) in order to estimate the employment and housing stream models: The implied distance cut-offs (D^*_{ij}) may then be calculated as in equation (4.13) or (4.14), and compared to the initial set of starting values which were applied originally in order to estimate the model. This procedure not only provides an important diagnostic check on the internal consistency of the model, but may also be used as the first round of an iterative algorithm capable of generating a unique set of distance cut-offs corresponding exactly to the model parameters. This algorithm is depicted graphically in Figure 4.1.(4)

At the end of the first iteration described above, the matrix of predicted distance cut-offs may be used as input to the estimation procedure in order to calibrate a revised set of model parameters. This procedure may then be continually repeated until the system converges, the sample split stabilizes, and the predicted set of distance cut-offs matches up with the cut-off matrix used to estimate the model. At a solution, the constraint is imposed that predicted housing migrant flows cannot be negative, i.e.:-

$$\hat{M}^H_{ij} = 0 \qquad \text{If } D_{ij} \geq D^*_{ij} \tag{4.15}$$

At a practical level, it is notable that empirical measures of the distance variable D_{ij} cannot vary continuously, implying that an exact solution to the algorithm may be unobtainable, in which case the results most closely approximating this solution may be selected.

A number of questions remain to be resolved at this stage, relating to the exact form of the housing migration function specified (i.e. either (4.11) or (4.12)); the theoretical and empirical appropriateness of such a form as compared to more traditional formulations; the stability and uniqueness of the solution to the estimation algorithm; and the efficiency and unbiasedness or otherwise of the resulting parameter estimates.

Both (4.11) and (4.12) may be criticised on the grounds that they do not constrain housing migrant flows to be non-negative. However, as equation (4.15) demonstrates, the estimation algorithm adopted here imposes this constraint, even if the functional forms do not. The model specified in (4.12) has the theoretical advantage of incorporating some interaction in push, pull, and distance factors, unlike the additive specification in (4.11).(5) In practice, however, a comparison of statistical fit achieved using these models on inter-regional migration data indicated that the linear specification clearly and consistently out-performed the semi-logarithmic model.

Testing the linear model against the exponential and power function formulations is, unfortunately, more difficult since these more traditional specifications involve a logarithmic transformation of the dependent variable to permit estimation to proceed by OLS. Comparison of the log-likelihood values in the manner outlined by Sargan (1964), however, using several different sample splits, indicated that, although there was generally very little to choose between the specifications, the linear model generally outperformed the exponential model, and that the power function formulation was inferior to both of these. This result suggests therefore that at a regional level of aggregation the simple additive model may be regarded (statistically at least) as a reasonable approximation in the analysis of housing-related migration streams.

The model constructed so far may therefore be summarised as follows:-

$$\left(\frac{M_{ij}}{P_i\ P_j}\right) = A_i^E\ B_j^E\ \exp\ (-\eta^E\ D_{ij})\ \exp\ (\varepsilon_{ij}^E) + A_i^H + B_j^H$$

$$- \eta^H\ D_{ij} + \varepsilon_{ij}^H \qquad (4.16)$$

$$M_{ij} = M_{ij}^E + M_{ij}^H \text{ and } \hat{M}_{ij}^H = 0 \text{ If } D_{ij} \geq [A_i^H + B_j^H]/|\eta^H| \qquad (4.17)$$

where superscripts E and H indicate employment or housing streams respectively, and the ε's are disturbance terms.

In order to determine whether or not the estimation algorithm is able to generate an unbiased solution in calibrating this model, let us make two assumptions:-

i) The model is correctly specified

ii) Housing streams are more responsive to distance than employment streams over all distances, below the cut off.

$$\text{(i.e. } \frac{\partial M_{ij}^H}{\partial D_{ij}} > \frac{\partial M_{ij}^E}{\partial D_{ij}} \text{ If } D_{ij} < [A_i^H + B_j^H]/|\eta^H|).$$

Much of the discussion so far has been concerned with the appropriateness of assumption (i), whilst assumption (ii) may be considered eminently reasonable, given the essentially short distance nature of housing-related moves. Under these assumptions, let us consider the unbiasedness of OLS estimates in two possible situations:-

I) Where all the distance cut-offs selected are too high i.e. many of the flows which are originally assumed to contain elements of both housing and employment migrants in fact only contain the latter streams. Under these circumstances, although the employment stream estimates will be inefficient insofar as they do not incorporate all the available data, there is no reason to expect any systematic bias in the estimates. As a result, the corresponding back predictions of employment streams over the shorter distances are also not likely to be systematically biassed, and therefore the housing stream estimates also. This result would also hold in the limiting case where no housing streams exist at all, in which case the migration model collapses to a single stream formulation.

II) Where one or more of the distance cut-offs selected are too low. In this case the employment stream model will be contaminated by the presence of housing stream migrants, leading to an upward bias in the estimated distance parameter of the employment stream model (i.e. it will have a steeper negative slope). Back projections of employment streams based on these estimates will also incorporate housing migrants leading to an exagerration of the predicted number of employment stream migrants over short distances. This situation is depicted in figure 2 where the dotted line represents the estimated employment stream model and the continuous lines the 'true model'. As this diagram clearly demonstrates however, this situation cannot represent a solution to the estimation algorithm, since the estimated housing stream model based on distance cut-off (a) will necessarily predict a new cut-off further out at point (b). Continued iteration will therefore direct the model to the cut-off at point (c) which is of course the 'true' cut-off.

Figure 4.1: A Graphical Representation of the Distance Cutoff Algorithm

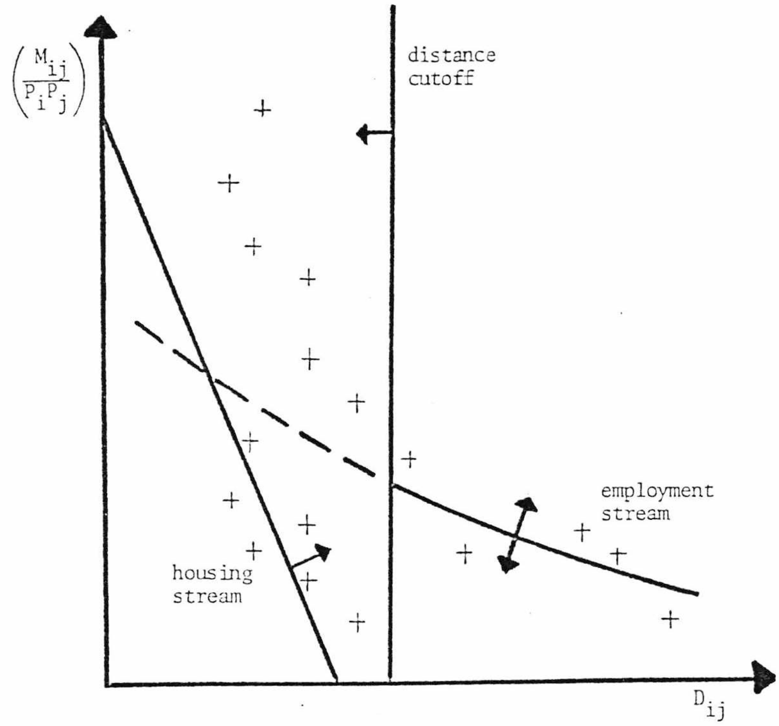
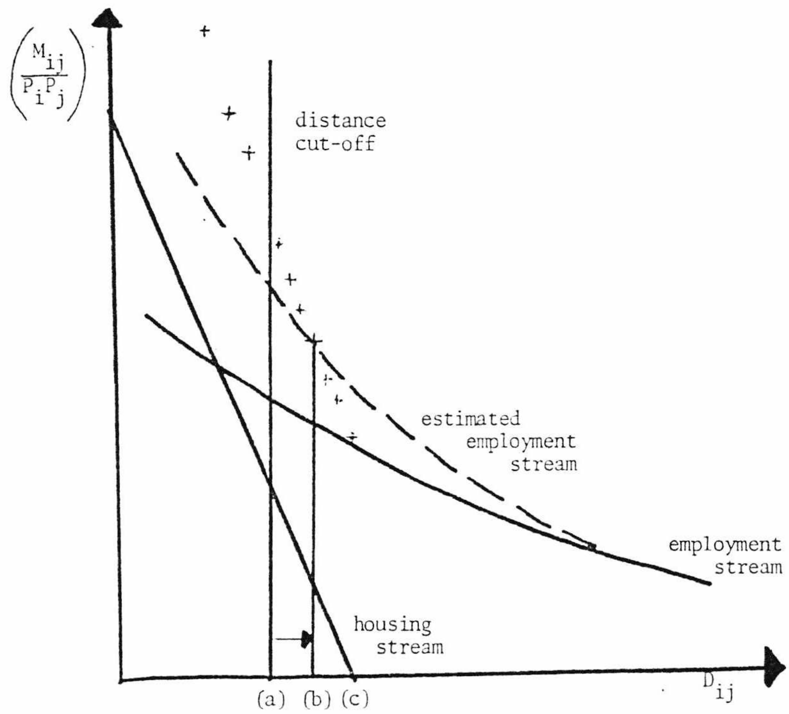


Figure 4.2: Choosing Too Low a Cut-off



These conclusions were confirmed in a simulation exercise using pre-selected values of push, pull, and distance parameters for both migrant streams in order to generate an artificial migration flow matrix. An arbitrary set of distance cut-offs were initially selected and the estimation algorithm set in train. In all cases the estimates always converged on the initial set of pre-selected model parameters.

Two limiting cases may be identified where the algorithm does not converge onto point (c). The first case arises where the initial cut-off is imposed at a distance of zero (or any distance below that observed in the data) in which case a single stream model is assumed to begin with. The second case arises at the other extreme when an initial cut-off is selected which is beyond the range of distances observed in the data, in which it becomes altogether impossible to estimate the employment stream model. This situation may arise in practise if the data used consists entirely of short distance moves, and excludes any migration flows which consist of purely employment streams. Whilst these are extreme limiting cases, of course, they do serve to demonstrate the importance of starting from a reasonable set of initial values of the distance cut-offs, such as, for example, a contiguity/non-contiguity sample split.

A further problem arises as regards the <u>measurement</u> of distance in the analysis of migration. The empirical section of this chapter relates to the modelling of inter-regional flows, and it is apparent that measures of distance at this level of aggregation are extremely coarse. In particular, standard road distance measures between regional centroids are likely to substantially over-state the length of movements made by housing related migrants, many of whom only accidentally cross regional boundaries in undertaking essentially short distance moves.

Two types of distance measures were therefore tried, and their performance contrasted. The first was a standard road distance measure taken from Weeden (1973), and the alternative was taken from a simulation of flows between 68 sub-regions.(6) A simple gravity model of the form:-

$$\hat{M}^{s}_{AB} = P_A \, P_B \, \exp\,(-\beta^{s} \, D_{AB})$$

was used to predict flows between sub-regions (A and B) using prior estimates of the β values. These flows were then aggregated to produce an inter-regional migration matrix, and the model inverted to produce estimates of inter-regional distances by migration stream:

$$\hat{D}^{s}_{ij} = \frac{1}{-\beta^{s}} \ln \left(\frac{\hat{M}^{s}_{ij}}{P_i \, P_j} \right)$$

where i and j denote regions. The main advantage of this approach is that it yields rather shorter estimates of distance for the housing migration streams, although they are still likely to be subject to an upward bias, since the sub-regional matrix is still likely to exagerate to some extent the distances travelled by housing stream migrants. These simulated distances nevertheless outperformed the standard road distance measure in the explanation of male inter-regional migration, and also produced much more plausible estimates of the housing stream distance cut-offs. The results presented in this chapter are therefore based on these simulated distances.

In concluding this section, two final observations may be made.

Firstly, one would expect the estimation procedure suggested here to yield more reliable estimates of the employment stream rather than the housing stream model, since estimates of the latter are based on subtracting employment predictions from the raw data. These estimates are therefore contingent on the employment stream estimates being accurate whilst the employment stream model is based purely on the raw data. Furthermore, since the total housing stream is likely in general to be the smaller of the two streams, the errors for that stream are likely to be proportionately larger, given that the sum of the errors is zero.

The second observation concerns the interpretation of the results. It is important to note that the model cannot tell us if individual migrants are moving for employment or housing related reasons below the distance cut-off; it merely predicts for each cell in the migration matrix the number of migrants moving for housing or employment related reasons.

4. Results

In this section, the results of an empirical analysis of male inter-regional migrants of working age within Great Britain over a 1 year interval from the 1971 Census are presented. The results of fitting equation (4.16) in the manner outlined in the previous section are reported in Table 4.2 (see Molho (1984) for a disaggregation by age band).

The estimated distance parameters are negative and significant, being stronger for the housing related migrants in terms of the mean

Table 4.2 Two Stream Gravity Model Estimates, Inter-Regional Migration, 1971

	Yorkshire & Humberside	North West	East Midlands	West Midlands	East Anglia	South East	South West	Wales	Scotland
PUSH FACTOR (A_i)									
Employment Stream	-0.436 (-2.63)	-0.370 (-2.46)	-0.067 (-0.38)	-0.414 (-2.38)	0.202 (1.64)	0.155 (1.28)	0.401 (3.50)	-0.215 (-1.72)	0.094 (0.77)
Housing Stream	-0.351 (-1.28)	-1.206 (-4.24)	-0.660 (-2.49)	-0.996 (-3.71)	-0.024 (-0.07)	-0.647 (-2.05)	-0.959 (-2.80)	-0.412 (-1.38)	-0.818 (-1.83)
PULL FACTORS (B_j)									
Employment Stream	-0.304 (-2.14)	-0.467 (-3.13)	0.003 (0.02)	-0.262 (-1.49)	0.403 (3.14)	0.377 (3.28)	0.613 (4.80)	-0.315 (-2.20)	-0.010 (-0.08)
Housing Stream	-0.820 (-2.86)	-1.255 (-4.51)	-0.654 (-2.43)	-1.083 (-4.15)	0.257 (0.91)	-1.971 (-4.36)	-0.275 (-0.94)	0.007 (0.03)	-1.023 (-2.29)

	Constant	Distance Parameter (η)	Mean Distance Elasticity	R^2	F	Mean of Dependent Variable	n
Employment Stream	0.444 (1.70)	-0.00258 (-3.15)	-0.431	0.839	8.79	-0.0557	52
Housing Stream	4.700 (10.04)	-0.03631 (-10.01)	-3.364	0.897	8.26	0.799	38

Sources: See Appendix.

Notes: t statistics in brackets. The omitted region is the North.

For the employment stream, the push and pull factors are the logged coefficients on the appropriate dummy variables; for the housing stream they are unlogged. R^2 and F refer to the logged dependent variable for the employment stream, and the unlogged dependent variable for the housing stream. Mean distance elasticities are calculated as:

$\eta^E \times \bar{D}^E_{ij}$ for the employment streams ($\bar{D}^E_{ij}$ = 167)

$\eta^H \times \bar{D}^H_{ij} \times \frac{\bar{M}^H_{ij}}{P_i \; P_j}$ for the housing streams ($\bar{D}^H_{ij}$ = 74).

elasticity and t value, as expected, and in line with the findings of Chapter 3. The final solution of the algorithm suggested that over half (52) of the 90 observations could be treated as containing only employment stream migrants, whilst the remaining 38 observations contained both streams, in varying proportions. Summing the housing and employment stream model predictions, and correlating these with the raw aggregate migration data suggested that the two stream model captured 97% of the variance in the original migration data. Housing migration accounted for 19% (i.e. just under a fifth) of inter-regional migrants in the model predictions, an estimate which seems much more plausible than Gordon's (1975) estimate of more than 50%. The division between streams in predicted net migration flows are given in Table 4.3, and the results suggest that actual net migration flows are often a poor indicator of net employment related moves between regions. (The predicted gross flows by stream are reported in Appendix 1). This finding suggests that straightforward analyses of net inter-regional migration are likely to be confounded by the presence in varying proportions of housing related migrants, particularly as regards uncovering the relationships between migration and local labour market conditions (eg. see Pissarides and McMaster (1982)).

Table 4.4 reports the distance cut-off matrix predicted by the housing stream model. A high degree of variability is found in the predicted distance cut-offs, resulting from variations in the regional push and pull factors, for housing migrants, with a mean cut-off of around 94 miles, as compared to a mean distance travelled by housing stream migrants of 74 miles. Whilst these estimates are still no doubt subject to an upward bias for the reasons outlined earlier, they do not appear implausible.

Table 4.3 Net Inter-Regional Migration, Males 16-64

(10s)

	Predicted Net Employment Stream	Predicted Net Housing Stream	Total Net Predicted Streams	Actual Net Migrant Streams
N	-179	101	-78	-50
YH	32	-470	-438	-530
NW	-548	40	-508	-412
EM	-125	401	276	265
WM	61	-183	-122	-270
EA	86	549	635	621
SE	1125	-1290	-165	35
SW	248	680	928	836
Wales	-269	191	-78	10
SC	-431	-19	-450	-505

Table 4.4 The Distance Cut-off Matrix

(Miles)

	N	YH	NW	EM	WM	EA	SE	SW	W	SC
N	-	107	95	111*	100*	137*	75*	122*	130*	101
YH	120	-	85	102	90	127	65*	112*	120	92*
NW	96	74	-	78	66	103*	42*	89*	96	68*
EM	111*	89	77	-	82	119	57*	104	112	83*
WM	102*	80	68	84	-	110	48*	95	103	74*
EA	129*	106*	94*	110	99	-	74	121*	129*	100*
SE	112*	89*	77*	93	82*	119	-	104	112*	83*
SW	103*	81*	69*	85*	73	111*	49*	-	104	75*
W	118*	96*	84	100*	89	126*	64*	111	-	90*
SC	107	84*	72*	89*	77*	114*	52*	99*	107*	-

Notes: Estimates derived from Table 4.2 using the formula:

$$D^*_{ij} = [a_i + b_j] / |\eta|$$

* indicates $D_{ij} > D^*_{ij}$

$\bar{D}^*_{ij} = 94$

$\bar{D}^H_{ij} = 74$

The next stage lies in interpreting the regional push and pull factors presented in Table 4.2. These factors should be interpreted in relation to the omitted region, the North, which is embedded in the constant term. The push and pull factors are clearly highly correlated with each other. For the employment stream the weakest values are those for the North West, Yorkshire and Humberside, the West Midlands and Wales, whilst the strongest values are found in the South West, East Anglia, and the South East. For the housing streams the pattern is rather different, with the weakest effects being detected in the West Midlands and North West, whilst the strongest effects are those for East Anglia, and the North.

Detailed statistical analysis of these patterns is obviously rather hazardous, since there are only ten observations for each factor. Nevertheless, by way of an example of what can be done in interpreting these factors, Table 4.5 presents the results of an Ordinary Least Squares regression analysis of these factors. These equations must, of course, be regarded only as a form of 'pilot analysis' for the more extensive studies presented later in this thesis. Nevertheless, some of the results that emerge do appear to be reasonably sensible. Thus, for example, employment related migrants appear to be attracted into regions of high employment growth and pleasing environment in accordance with the search theory arguments outlined in Chapter 2. Income has the expected effect of reducing outward movement of employment streams, whilst house prices have the opposite effect of increasing it, acting perhaps as a proxy for regional cost of living differences. The absence of an unemployment rate effect in these equations probably reflects the very slight statistical leverage afforded by these ten observations, rather than accurately reflecting the behaviour of employment related inter-

Table 4.5 Regression Analysis of Push and Pull Factors

	Employment Stream Pushes	Employment Stream Pulls	Housing Stream Pushes	Housing Stream Pulls
Unemployment Rate	-	-	0.178* (1.65)	-
Employment Growth	-	0.065** (1.97)	-	-
Income	-4.262** (-3.35)	-	-	-
Environmental Preference	-	0.010** (2.85)	0.008 (1.17)	-
House Prices	0.380** (4.17)	-	-	-0.385** (-1.95)
House Construction Rates (Private)	-	-	-	0.270* (1.74)
East	-	-	0.594** (2.92)	-
Constant	3.456** (2.61)	-6.815** (-2.18)	-2.087** (-2.75)	0.346 (0.30)
R^2	0.716	0.735	0.635	0.500
F	8.81	9.71	3.48	3.51
n	10	10	10	10
Mean of Dependent Distances	-.065	.004	-.607	-.681
Standard Deviation	0.287	.359	.407	.689

Sources: See Appendix 2.

Notes: t statistics in parentheses. Pushes and pulls are calculated as differences from the North, with the value for the North set at zero. Pushes and pulls for the employment stream are logged, and for the housing stream, unlogged.

** indicates significance at the 95% level.
* indicates significance at the 90% level.

regional migrants.

The results for the housing streams (which exhibited rather lower variances), suggest that housing migrants tend to be attracted into areas with high private housing construction rates and low house prices, as one might expect, although neither of these effects appear to be particularly strong. Outward housing migration appeared to be rather harder to explain; the results suggest an apparent tendency for outward housing migration to be higher in eastern regions, although the possible causes are unclear. The unemployment variable attracts a small positive coefficient, although the effect is not well determined, whilst the environmental preference variable attracts an insiginficant positive coefficient.

The results appear somewhat mixed. They confirm some prior hypotheses from the search theory model such as the attractiveness of regions with high employment growth to employment-related migrants, and extensive house construction to housing related migrants, as well as providing support for the existence of different migrant streams in line with the search theory model set out in Chapter 2. The results also present us with some intriguing conundrums, however, for example the absence of a significant unemployment rate effect on employment related migration. However, further statistical investigation with this data set is likely to be a rather unreliable guide given the small number of observations available. We shall defer more detailed analysis of this kind to the next chapter, where use of time-series data provides rather more degrees of freedom, and to chapter 7 where a detailed analysis of migration in and around the London Metropolitan area will be undertaken.

5. Summary

The main points of this chapter may be summarised as follows: Firstly, two main methods of estimating single stream gravity models were identified, one based on a maximum likelihood criteria, the other on Ordinary Least Squares techniques incorporating appropriately defined dummy variables. The two methods were constrasted in an empirical application and found to yield similar results.

Secondly, two methods of incorporating origin and destination specific effects into the gravity model were contrasted, and a number of arguments advanced in favour of the strategy of using dummy variables first, then explaining the pattern of coefficients on these variables at a later stage. These arguments were particularly cogent when estimating two stream gravity models.

Thirdly, an iterative algorithm was suggested for the estimation of a particular two stream model, and its properties examined. Finally, an example of an empirical application was provided, using data on male inter-regional migration from the 1971 Census. This analysis suggested that 97% of the variance in male inter-regional migration could be accounted for using a two stream gravity model. Housing migrants were found to constitute roughly a fifth of all male inter-regional migrants, whilst the geographical pattern of housing migration exhibited sufficient variation across regions to imply that the aggregate <u>net</u> pattern of employment related moves was very different from that suggested by a casual inspection of the raw net migration data. A preliminary analysis of regional push and pull factors demonstrated how in practice one might attempt to make sense of the pattern of variation in regional attractiveness/emissiveness, and suggested some reasonably plausible results.

In the next chapter we turn to the analysis of migration behaviour over time, an extension which not only affords greater degrees of freedom but also permits an examination of the possibility of distributed lags in migration responses, and of fluctuations in the volume of migration over time in response to changing national economic conditions.

Appendix 1

Predicted Gross Migration Flows by Stream

Predicted Employment Streams (10s)

	N	YH	NW	EM	WM	EA	SE	SW	W	SC
N	-	142	160	120	135	64	678	163	57	175
YH	125	-	168	138	153	82	783	189	62	138
NW	177	211	-	193	231	116	1112	278	99	209
EM	112	147	163	-	175	100	952	228	69	124
WM	116	150	180	161	-	99	1016	258	84	132
EA	53	77	86	88	94	-	643	136	38	66
SE	543	715	808	818	947	630	-	1549	408	603
SW	132	175	204	198	243	134	1564	-	110	153
W	63	79	99	82	108	52	563	150	-	75
SC	194	174	210	147	171	90	835	210	75	-

Predicted Housing Streams (10s)

	N	YH	NW	EM	WM	EA	SE	SW	W	SC
N	-	221	85	-	-	-	-	-	-	0
YH	293	-	432	289	140	39	-	-	57	-
NW	95	301	-	42	76	-	-	-	217	-
EM	-	212	30	-	242	110	-	27	8	-
WM	-	46	89	258	-	36	-	195	151	-
EA	-	-	-	94	4	-	132	-	-	-
SE	-	-	-	347	-	594	-	481	-	-
SW	-	-	-	-	49	-	-	-	91	-
W	-	-	135	-	81	-	-	117	-	-
SC	19	-	-	-	-	-	-	-	-	-

Residual (10s)

	N	YH	NW	EM	WM	EA	SE	SW	W	SC
N	-	-15	21	12	16	15	-63	-12	-12	0
YH	12	-	-82	36	-66	25	35	4	-11	-9
NW	-17	-112	-	-13	55	-7	15	46	59	-21
EM	53	66	1	-	-41	-3	-211	-26	8	-16
WM	6	12	87	43	-	-19	-5	-42	-14	-6
EA	-6	22	-18	-1	1	-	0	3	8	-7
SE	-53	-96	74	-227	-108	-11	-	267	61	91
SW	-11	-17	-7	-56	45	1	309	-	-23	69
W	-8	6	-16	16	12	-2	-22	1	-	-3
SC	0	-14	42	10	1	-10	139	-23	-6	-

Note: Predictions Derived on Basis of Estimated Equations, Reported in the Text.

Appendix 2

Data Sources

Migration	-	1971 Census Table 2A Migration Tables Part 1 (10% Sample). Male migrants within one year of Census (16-24).
Population	-	Registrar Generals Statistical Review for England and Wales 1971. Estimated male home population at June 1971.
Employment Growth	-	Ratio of employees in employment 1971, to employees in employment 1966 (%). DE Gazette, June 72, Table 8, and British Labour Statistics Historical Abstract Table 131. Employees in employment, all males, mid year estimates.
Income	-	Abstract of Regional Statistics (1973), personal incomes before tax for 1970/71. Table 71. Employment Income Schedule E.
Unemployment	-	Department of Employment Gazette (Various issues). Male Registered Unemployment Rate - average of monthly rates May 1970 to April 1971.
House Prices	-	Average Dwelling Prices, all dwellings, 5% Sample, advances completed. Table 105 Housing and Construction Statistics 1969-1979. Standardised using unpublished data from Department of Environment on regional mix of dwelling types (see Fleming and Nellis (1981) for a discussion).
Environmental Preference	-	A manually interpolated estimate taken from the 'national perception surface' of Gould and White (1968, p. 172). Based on a study of the environmental preferences of school leavers.
House Construction	-	1970 Permanent Private Dwellings completed per 1000 populations, Table 77, p. 84, Housing and Construction Statistics 1970-80.

CHAPTER 5 THE SHORT RUN DYNAMICS OF MALE INTER-REGIONAL MIGRATION

1. Introduction

Temporal factors clearly play an important role both in individuals' decisions to migrate, and the subsequent enaction. Thus, migration may be seen essentially as a dynamic process involving potentially significant response lags, and liable to fluctuations over time, both in terms of overall volume and also patterns of movement. Unfortunately, most previous studies of internal migration in Great Britain have tended to be essentially static in their approach. This feature has been largely attributable to the dearth of time-series information on migration restricting investigators to the estimation of 'snapshot' cross-section models based chiefly on evidence from the Censuses of Population.

The purpose of this chapter is to devise and implement a methodology for the analysis of temporal fluctuations in gross migration flows, within the context of the theoretical and statistical framework set out in the previous chapters. The analysis is based on time-series data derived from the records of the National Health Service Central Register (NHSCR) on male inter-regional migrants of working age between 1975 quarter 2 and 1979 quarter 2. Whilst the use of such a data source necessarily engenders problems of its own, it is hoped that the construction of a dynamic model based on this information will yield interesting new insights into the migration process.

The next section is devoted to extending the analysis of the previous chapters into a temporal context, and in particular developing an appropriate distributed lag model with which to analyse the NHSCR information. In section 3 the discussion turns more explicitly to the data sources used in this study, and in particular the derivation, virtues, and defects of the NHSCR migration series. This section also addresses regional labour market trends over the estimation period. The fourth section is devoted to the presentation of the empirical results, whilst section 5 provides a brief summary and conclusion.

2. Modelling Migration Decisions Over Time

Since the objective of this chapter is to examine the determination of migration within a dynamic setting, it is important that the model specification adopted is suitable for the examination of the nature and significance of lags in migration responses. Initially, three potential sources of lagged response may be identified:-

I Expectations Effects: Migration decisions may be based not so much on contemporaneous values of the explanatory variables as on expectations of the future, and these expectations are likely to be formed not only on the basis of current values but also past trends.

II Adjustment Lags: After the decision to migrate has been made, considerable time lags may be involved before migration actually takes place. These lags may be due to the securing of accommodation and employment in the region of destination, for example, transportation arrangements, the fulfillment of commitments in the region of origin, and so on. In practice, such adjustment lags are likely to be closely related to expectation 'lags', and the decision to migrate will not be independent of the expected adjustment costs.

III Re-registration Lags: This lag is peculiar to the NHSCR data, since typically migrants do not re-register immediately with a new doctor. The nature of the lag, and general problems involved in the use of the NHSCR data will be more fully discussed later.

The most common methodology adopted in the literature for the modelling of a time-series of aggregate gross migration matrices is to relate migration to the size of the regional populations, the distance between regions of origin and destination and a vector of variables measuring the attractiveness of the regions of origin and destination such as regional unemployment rates, wage rates etc., along the lines of the 'one step' procedure discussed in chapter 4 section 1.1. Typically, dynamics are handled either through the specification of a simple partial adjustment (or adaptive expectations) model, or by the incorporation of an autoregressive error process in the estimation technique, or both (see for example Elias and Molho (1982), Salvatore (1977)).(1) Whilst such studies yield valuable insights into the determination of migration, this approach to the analysis of migration dynamics is fairly limited. The specification of a simple geometric decline in migration responses (common to all the explanatory variables in the model) which is implicit in the adaptive expectations or partial adjustment models is highly restrictive and often quite implausible. The presence of serial correlation in the residuals is further evidence of dynamic mis-specification, whilst the adoption of a serial correlation adjustment in the estimation technique imposes untested and often invalid restrictions on the dynamic structure of the model (Hendry and Mizon (1978)). Whilst in principle the model may be further developed in order to remove these problems by the adoption of more general distributed lag specifications, experiments in this direction indicated that the general framework does not lend itself very readily to the analysis of migration dynamics, since the resulting model becomes too cumbersome and unwieldly with severe and rather intractable residual serial correlation problems. A further, closely related option is to fit a cross-section model of this type to each time point. However, whilst this facilitates an examination of the stability of the relationship between migration and its various determinants over time, it does not permit an analysis of the dynamics of the relationships.

2.1 A Two-Stream Model of Migration Dynamics

An alternative approach to the modelling of migration dynamics is therefore offered in this chapter. Rather than relating migration directly to the regional characteristics, a gravity model is specified of the kind set out in chapter 4 which relates gross migrant flows to generalised push and pull factors as well as distance and population. Such a gravity model may be fitted to each time point in the data set. Movements in the generalised parameters over time indicate trends in the relative attractiveness of the regions. Subsequent to the initial calibration of these factors, the dynamics of migration may be analysed by relating these generalised parameters to the regional characteristics such as unemployment rates etc., in some form of general distributed lag model. In this approach therefore, the relative attractiveness of the regions is inferred from the revealed behaviour of migrants, which may be directly observed from the original migration matrices. The determination of movements over time in regional attractiveness are then seen as the outcome of a general dynamic process in which regional characteristics such as labour market conditions play an important part.

Formally, the model may be presented as follows. Initially, the two stream gravity model specified in chapter 4 may be extended by adding time subscripts to all the appropriate parameters and variables:

$$\left(\frac{M_{ij}}{P_i \; P_j}\right)_t = \left(a^E_{i_t} \; b^E_{j_t} \; \exp\,(-\eta^E_t \; D_{ij}) \; \exp\,(\varepsilon_{ij_t})\right)$$
$$+ \left(a^H_{i_t} + b^H_{j_t} - \eta^H_t \; D_{ij} + \nu_{ij_t}\right) \qquad (5.1)$$

$$M_{ij} \equiv M^E_{ij} + M^H_{ij} \qquad (5.2)$$

$$\hat{M}^H_{ij_t} = 0 \quad \text{If } D_{ij} \geq [a^H_{i_t} + b^H_{j_t}]/|\eta^H| \qquad (5.3)$$

Whilst in chapter 4 an iterative algorithm was devised to endogenise the sample split using this specification, in this chapter a contiguity/ non-contiguity split was adopted as a first approximation, in order to ease the computational burden involved when modelling a time-series of migration matrices, and also to ensure consistency in the sample split over time.

Having derived the locational push/pull factors for each stream over time using this sample split, the generalised indices of regional attractiveness may be related in some form of distributed lag model to the regional characteristics:-

$$a^k_{i_t} = \sum_{n=1}^{N} \sum_{h=0}^{H} \alpha^k_{nh} \left(Y_i \, n_{t-h} \right) + U^k_{i_t} \tag{5.4}$$

$$b^k_{j_t} = \sum_{n=1}^{N} \sum_{h=0}^{H} \beta^k_{nh} \left(Y_j \, n_{t-h} \right) + V^k_{j_t} \tag{5.5}$$

where Y is a vector of n = 1....N regional attributes which affect migration with a lag of up to H periods, k denotes either employment or housing streams, α and β describe the form of the functions and U_i and V_j are error terms.

Since the number of time points available from the NHSCR is fairly restricted, the analysis of regional push and pull factors was conducted by pooling the time series of cross-section observations measuring regional attractiveness yielded by estimation of equation (5.1). Factors influencing the aggregate level of migration over time, independent of origin and destination, were separated out by the inclusion of a vector of time-specific dummy variables. The coefficients on these variables reflect national trends in migration which are uniform across regions, and may be explained in terms of the general economic climate. Thus, the coefficients on these variables may be subsequently related to national unemployment rates, as well as a vector of seasonal dummies, reflecting seasonality not only in migration patterns, but also re-registration propensities. In general, one would expect high national unemployment to reduce aggregate migration rates, since in times of general recession liquidity constraints tend to restrict such investment activities, uncertain prospects are discounted more heavily, and employment opportunities are fewer (Gordon (1985c)).

As regards the specification of the Y_n variables in equations (5.4) and (5.5), regional push and pull factors for both housing and employment streams were explained in terms of local registered unemployment rates, wage rates, and employment growth, reflecting local labour market influences on the direction of migration. Housing market influences were represented by regional house prices and private housing construction rates, whilst general environmental conditions were proxied by an environmental preference index derived from the study by Gould and White (1968) of the locational preferences of a sample of school leavers.

An interesting and rather unusual feature of the approach adopted here is that the estimation of equation (5.1) also yields a time-series of estimated distance parameters for the employment and housing streams. This feature not only facilitates an examination of the overall stability of the migration/distance relationship, but also an investigation of the determination of this relationship over time, i.e. one may estimate:-

$$\eta_t^k = \sum_{n=1}^{N} \sum_{h=0}^{H} \psi_{nh}^k \left(X_{n_{t-h}} \right) + e_t^k \qquad (5.6)$$

where the X's are potential determinants of η, ψ describes the form of the relationships and e is an error term. In the specification of this equation, temporal movements in distance sensitivity were related to a vector of seasonal dummy variables, transportation costs relative to general retail prices, and national unemployment rates which are likely to affect the degree of friction in information flows.

2.2 The Distributed Lag Model

In equations (5.4) to (5.6) the form of the distributed lag model has not been specified and it is to this issue that we now turn. Given the importance of these lags and the focus of this chapter on the dynamic aspects of migration, the choice of an appropriate lag structure is by no means trivial. The basic problem is to select a distributed lag model which extracts the maximum information available in the data regarding the dynamics of the migration process. The lags involved are likely to be long and are unlikely to decline geometrically.

The distributed lag model adopted in this study, therefore, will be Jorgenson's rational lag (Jorgenson (1966)), which contains the Koyck, Pascal and Almon lags as special cases. The rational lag model does not impose the severe restrictions on the shape of the lag structure which are implicit in the Koyck model, nor the constraints across parameters which make the Pascal lag so difficult to estimate. The model permits the estimation of lengthy time lags with the loss of relatively few time points as compared to an Almon lag. Complex lag structures may be incorporated by the adoption of high order polynomials in the lag operator.

The bare bones of the model may be sketched out using a single explanatory variable (x) and dropping any intercept constant terms for expositional ease. Expectations and adjustment lags may be lumped together and called 'economic lags', in order to distinguish them from 're-registration lags'. Regional subscripts will be dropped for convenience, and a single 'push-factor' equation may be taken as representative of the essential methodology. Call 'Ra' the attractiveness parameter derived from registered migration and 'Ma' that from (unobserved) actual migration. Using lag operator notation, the 'true model' may be written:-

$$Ma_t = \frac{A(L)}{B(L)} x_t \qquad (5.7)$$

Whilst the lag between migration and registration may take the following form:-

$$Ra_t = \frac{(1 - \theta_1)}{(1 - \theta_1 L)} Ma_t \qquad (5.8)$$

The form of this lag is assumed to be independent of the cause of migration, and imposes a long run multiplier of $\left(\frac{1 - \theta_1}{1 - \theta_1}\right) = 1,$ which implies that eventually all migrants re-register with a new doctor. This functional form is also consistent with independent information regarding the structure of the re-registration lag (see section 4). Combining (5.7) and (5.8) yields:-

$$Ra_t = \frac{(1 - \theta_1)}{(1 - \theta_1 L)} \cdot \frac{A(L)}{B(L)} x_t \qquad (5.9)$$

Assume B(L) is a first order polynomial of the form:

$$B(L) = 1 - \theta_2 L$$

Whilst the form of A(L) may be empirically determined without too much difficulty, for ease of exposition a first order polynomial will be assumed.(2)

$$A(L) = \phi_0 + \phi_1 L$$

$$\text{Thus } Ra_t = \frac{(1 - \theta_1)}{(1 - \theta_1 L)} \cdot \frac{(\phi_0 + \phi_1 L)}{(1 - \theta_2 L)} x_t \qquad (5.10)$$

$$= \frac{(\gamma_0 + \gamma_1 L)}{(1 - \lambda_1 L - \lambda_2 L^2)} x_t$$

$$Ra_t (1 - \lambda_1 L - \lambda_2 L^2) = (\gamma_0 + \gamma_1 L) x_t$$

$$Ra_t - \lambda_1 Ra_{t-1} - \lambda_2 Ra_{t-2} = \gamma_0 x_t + \gamma_1 x_{t-1}$$

$$Ra_t = \gamma_0 x_t + \gamma_1 x_{t-1} + \lambda_1 Ra_{t-1} + \lambda_2 Ra_{t-2} \quad (5.11)$$

where $\gamma_0 = \phi_0 (1 - \theta_1)$

$\gamma_1 = \phi_1 (1 - \theta_1)$

$\lambda_1 = \theta_1 + \theta_2$

$\lambda_2 = - (\theta_1 . \theta_2)$

and the absolute values of θ_1 and θ_2 are less than unity, to ensure dynamic stability. Thus, in the estimation of equation (5.11) one may interpret the lag function as the convolution of two lags, the initial 'economic lag' where the first two (or more) lag coefficients are determined freely and an infinite geometric decline imposed thereafter, and the secondary 're-registration lag', which follows a straightforward geometric decline. Any change in x must pass through this 'cascade' of lag distributions in affecting migration registrations, and any re-registration lags may thus be identified and 'filtered out'.

Although the time series available from the NHSCR is rather limited, some mention must also be made about the long-run properties of the model. The long-run dynamics of migration are crucial, especially with regard to the labour market, since migration is often regarded by economists as a long-run equilibriating mechanism between spatially separated labour markets.(3) Whilst in later chapters we shall examine more closely the role of migration in this context, and the character of the spatial equilibrium that is likely to result, for the time being this would appear a useful point of departure as regards considering the long run properties of the model. If the predictions of orthodox theory are correct, therefore, then ceteris paribus one would expect migration patterns to compensate in the long run for movements in relative wage and unemployment differentials, with migration tending to zero as the system tends towards equilibrium. The efficacy of migration within this context is far from clear, and depends in part on the direction and size of the associated multiplier effects. However, if migration were effective as a long run equilibriating mechanism, then long term regional economic imbalance may still be explained as the result of other compensating influences on migration, such as environmental factors (ENV) (cf. Chapter 1). This point may be illustrated with reference to a highly simplified migration model of the form:-

$$M_{ij} = a(U_i - U_j) + b(ENV_j - ENV_i)$$

which in an orthodox model would yield the following long run equilibrium, where $M_{ij} = M_{ji} = 0$:-

$$U_i - U_j = \frac{b}{a} (ENV_i - ENV_j)$$

If environmental factors were negligible (b = 0), then this would reduce to $U_i = U_j$. If b > 0, then long run regional unemployment differentials would simply reflect variations in environmental attractiveness.

If migration were ineffective as an equilibriating mechanism, however, then within the model specified here, there would be no in-built mechanism to ensure long-run equilibrium with a stationary labour force. Thus, for example, whilst the effect of an increase in unemployment differentials on migration will be finite, the effect will be renewed in each period as long as the differential persists.

Finally, as regards estimation techniques, the main problem with the rational lag is that, if the residuals are serially correlated, Ordinary Least Squares (OLS) estimates are biassed and inconsistent. Moreover, many standard tests for serial correlation are invalid using such a lag structure. The approach adopted in this chapter follows recent advances made in the field (Hendry and Mizon (1978)). Serial correlation is treated as reflecting some form of misspecification. Conventional solutions to the problem such as applying the Cochrane-Orcutt iterative technique assume the misspecification lies in the dynamics of the error term and adjust the dynamic specification in order to generate a white noise error term. However, such a transformation imposes several untested restrictions across parameters. The alternative approach and that adopted in this study is to estimate the more general rational lag model without any such restrictions, and then impose any restrictions that are admitted by the data. Once the final form of the equation is reached, if the errors are still autocorrelated, then this may be treated as a convenient simplification and not a nuisance, since it allows a reduction in the number of parameters required by permitting the imposition of further restrictions.

3. The Data and Regional Labour Market Trends in the 1970's

The NHSCR provides one of the few sources of time-series data on inter-regional migration available in GB(4) and is used by OPCS in the development of their regional population projections. The data is derived from a 10% sample of personal registration with Family Practitioner Committees and is available by sex and age on a quarterly basis over the period 1975 II to 1979 II. This study refers only to re-registrations of males aged 16-64, between the Standard Planning Regions of Great Britain yielding a time-series of seventeen 10 x 10 quarterly matrices.

By tracing a small sample of migrants from the General Household Survey through on the NHSCR, OPCS were able to estimate an average re-registration lag implicit in the data of around 3 months with over 90% of migrants re-registering within a year. Thus one would expect an estimated value for θ_1, the re-registration lag coefficient, of around 0.5, yielding an average lag of $[\theta_1/(1 - \theta_1)] = 1$ quarter, with nearly 94% of the effect complete after a year.

Ogilvy (1982) has compared NHSCR data with information derived from the EC Labour Force Surveys, and the 1971 Census of Population. Using a 3 month lag to approximate the re-registration lag, he found a high degree of comparibility between all three sources.

In general, one would expect the migration data to provide more reliable estimates for the employment rather than the housing streams, partly because of the high level of areal aggregation employed, but also because the NHSCR information is likely to be particularly weak in picking up short-distance moves, for obvious reasons. In addition, the estimation procedure is likely to project any inaccuracies in the employment stream estimates, and incorporate them in the estimation of the housing stream model, along the lines discussed in chapter 4. Further problems arise in the measurement of the explanatory variables (details given in Appendix 1), and in particular the wage rate, house price and housing construction data had to be interpolated to yield quarterly estimates. These problems should be borne in mind in interpreting the empirical results.

As regards labour market trends over the period, there is a clear tendency for national unemployment rates to rise, and an associated trend for regional unemployment rates to diverge from the national average at least when measured in absolute terms. This tendency has generally been attributed to demand side factors in terms of regional variations in industrial structure and the degree of labour hoarding in the hiring and firing practices of firms across regions (see for example Bell and Hart (1980)). In fact, an analysis of regional employment trends revealed no corresponding relationships to those detected in the analysis of regional unemployment, casting doubt on these demand side explanations (Gordon (1985d)). An alternative explanation lies in temporal fluctuations in migration behaviour, however, since if migration is at all significant as a spatial equilibriating mechanism across local labour markets, then one would expect its efficiency to decline in periods of high national unemployment, leading to greater divergence in regional unemployment, and longer lags in adjustment to some sort of equilibrium in local unemployment rates. In fact, previous descriptive discussions of the NHSCR migration series' (Ogilvy (1982)) do indeed reveal substantial reductions in the volume of migration over this period, against the backcloth of rising national unemployment, and

Gordon's (1985c) time-series study of net migration rates between Scotland and England and Wales between 1952 and 1981 also found evidence to support this view.

4. Results

The results of fitting equation (5.1) to the NHSCR data are reported in Appendix 2, Tables A1 and A2. The employment stream estimates are based on the sample of non-contiguous region flows, whilst the housing stream estimates are derived from the contiguous region sample, after having substracted predicted employment streams from the original data. The estimated parameters reported in Appendix 2 indicate the push/pull factor of the regions relative to the omitted region, the South East, reflected in the constant term. Trends in the parameter estimates indicate movements in attractiveness or repulsiveness over time, as compared to the South East. Trends in the constant term reflect in part relative trends in the South East, as well as aggregate national trends in the level of migration.

Pure cross-section studies of migration generally concentrate on relative variation in locational push and pull factors and, therefore, implicitly normalise these factors around unity prior to any behavioural analysis, by setting the constant term to zero. Within a time-series context, however, it is important to capture movements in the overall level of migration over time, which are in part embedded in this 'constant term'. The inclusion of a complete vector of time-specific dummy variables in the model implies that the estimated equation will remain essentially unaffected by the incorporation of this constant term, since any movement over time which is common to all the regions will simply result in a corresponding adjustment to the estimated coefficient on the dummy variable for the time point in question. Thus, in this chapter the constant term for each time point was added to the corresponding relative push/pull parameter, and variations in the 'constant term' over time were incorporated in the analysis of the estimated coefficients on the time specific dummy variables.

Because of the limited number of time points available in the analysis of the a_i and b_j factors, the lagged dependent variables were restricted to a maximum of a two quarter lag, in keeping with the model outlined in section 1.2. Degrees of freedom were more plentiful for the independent variables, however, and lags of up to four quarters were permitted. On the basis of statistical tests, progressively more restrictive models were selected, finally yielding the preferred equations.

4.1 The Employment Streams

The results for the employment stream are presented in Table 5.1, where:

ENV = environmental preference

HCR = housing construction rates(5)

HP = house prices(5)

W = wage rates

ΔE = employment growth

U = unemployment rates

Table 5.1 The Employment Stream Model

$$\ln\hat{a}^E_{i_t} = \underset{(-2.51)}{-7.443} + \underset{(0.93)}{0.073ENV_i^2} + \underset{(2.57)}{0.526HCR_{i_t}} + \underset{(3.16)}{0.284HP_{i_t}} + \underset{(0.67)}{0.355\ln W_{i_{t-4}}} + \underset{(1.24)}{3.806\Delta\ln E_{i_t}} + \underset{(1.98)}{0.130U_{i_t}}$$

$$\underset{(-3.03)}{-\ 0.308U_{i_{t-1}}} + \underset{(3.61)}{0.337U_{i_{t-2}}} \underset{(-2.36)}{-\ 0.221U_{i_{t-3}}} + \underset{(1.17)}{0.067U_{i_{t-4}}} + \underset{(4.40)}{0.387\ln a^E_{i_{t-1}}}$$

$$+ \underset{(0.76)}{0.068\ln a^E_{i_{t-2}}} + \sum_{t=4}^{17} \sigma^E_t D_t$$

$R^2 = .852 \quad F = 27.29 \quad n = 150$

$$\ln\hat{b}^E_{j_t} = \underset{(-2.75)}{-10.730} + \underset{(1.36)}{0.144ENV_j^2} + \underset{(3.47)}{0.924HCR_{j_t}} + \underset{(3.27)}{1.093HP_{j_t}} \underset{(-2.37)}{-\ 0.864HP_{j_{t-4}}} + \underset{(1.38)}{0.958\ln W_{j_t}}$$

$$+ \underset{(3.67)}{11.775\Delta\ln E_{j_t}} \underset{(-4.42)}{-\ 0.300U_{j_{t-1}}} + \underset{(4.83)}{0.476U_{j_{t-2}}} \underset{(-2.60)}{-\ 0.174U_{j_{t-3}}} + \underset{(3.27)}{0.375\ln b^E_{j_{t-1}}}$$

$$+ \underset{(0.93)}{0.076\ln b^E_{j_{t-2}}} + \sum_{t=4}^{17} \xi^E_t D_t$$

$R^2 = 0.865 \quad F = 31.73 \quad n = 150$

$$\hat{\sigma}^E_t = \underset{(-8.52)}{-3.596} \underset{(-11.01)}{-\ 0.544S_1} \underset{(-3.56)}{-\ 1.749} (\ln\bar{U}_t - \ln\bar{U}_{t-1}) \underset{(-11.24)}{-\ 4.657\ln\bar{U}_{t-2}} + \underset{(9.03)}{5.828\ln\bar{U}_{t-4}} \underset{(-7.42)}{-\ 3.374\ln\bar{U}_{t-5}}$$

$R^2 = .957 \quad F = 40.19 \quad n = 15 \quad d = 1.88$

$$\hat{\xi}^E_t = \underset{(-9.30)}{-8.911} \underset{(-7.90)}{-\ 0.700S_1} + \underset{(4.09)}{3.434\ln\bar{U}_{t-1}} \underset{(-8.69)}{-\ 7.658} (\ln\bar{U}_{t-2} - \ln\bar{U}_{t-4}) \underset{(-9.14)}{-\ 4.751\ln\bar{U}_{t-5}}$$

$R^2 = .934 \quad F = 35.497 \quad n = 15 \quad d = 1.17$

$$\hat{\eta}^E_t = \underset{(1.94)}{0.002} \underset{(-0.76)}{-\ 0.0003S_2} \underset{(-3.63)}{-\ 0.0008S_3} + \underset{(3.25)}{0.008} (\ln\bar{U}_t - \ln\bar{U}_{t-1}) \underset{(-2.43)}{-\ 0.028\ln DP_{t-1}} \underset{(-2.57)}{-\ 0.028\ln DP_{t-2}}$$

$$+ \underset{(3.96)}{0.766\eta^E_{t-1}}$$

$R^2 = 0.826 \quad F = 7.13 \quad n = 16 \quad d = 1.85$

Sources: see Appendix

Notes: t statistics in parentheses

D_t = a vector of time specific dummy variables

(σ and ξ are the corresponding parameter estimates)

$\bar{U}$ = national unemployment rates

DP = (transport prices - retail prices)

Functional forms were selected on statistical goodness of fit criteria. The results indicate an insignificant role for environmental preference in affecting migration, whilst housing construction rates appear to raise both inward and outward movement, although the former effect comes through as the stronger. House prices also raise both outward and inward movement, although the latter effect is largely eroded over time. The wage rate variable attracts insignificant coefficients in both push and pull equations, a result which is consistent with most previous studies based on British data, although not with evidence from the U.S. Although unemployment rates initially affect both inward and outward migration in the expected direction, the effects appear to be essentially short run. These results were found to be remarkably robust to changes in specification. In selecting the appropriate definition of the employment variables, statistical tests supported the widespread usage in cross-section studies of an employment growth term, with a one quarter rate of change appearing to provide the most appropriate definition. Whilst employment growth appears not to significantly affect outward movement, a strong positive effect is observed on inward migration, as expected.

The characteristic roots of the push and pull equations were (.518, -.131), and (.521, -.146) respectively. Since these roots are less than unity in absolute value, the equations may be deemed dynamically stable. The first root in both equations may be interpreted as the re-registration lag coefficient, and the estimates of around .5 agree with the independent estimate from OPCS discussed earlier. The implied lag structures derived from the estimated push and pull factor equations are presented in Table 5.2, and the component 'economic' lag identified, on the assumption that these roots may be taken as estimates for a geometrically declining re-registration lag. By filtering out the re-registration lags on this basis, the economic lags tend to converge much more rapidly to zero than the total lags, as one would expect. The long-run multipliers for the 'economic' and 'total' effects are identical, since all migrants are assumed to re-register in the long run. As Griliches (1967) has observed, the implied lag structures derived using rational lag functions tend to be quite sensitive to slight changes in the coefficients, so that the results should only be considered as broadly indicative of the general shape of the lag distribution.

The estimates indicate that for the period in question, whilst unemployment rates significantly affected the short-run dynamics of employment related migration, the most significant labour market influence in the long-run was the rate of employment growth. In particular the estimates indicate that, <u>ceteris paribus</u>, a sustained 1% increase in the rate of employment growth, for example from 1.00 per cent to 1.01, will increase the rate of in-migration by around 20% in the long run. This result confirms the findings of Gordon and Lamont (1982) that it is the existence of employment <u>opportunities</u>, particularly in the region of destination, which represents the main economic influence on employment related migration streams.

Turning back to table 5.1, aggregate inward and outward employment related migration rates (reflected in the estimated coefficients

Table 5.2 The Implied Lag Distribution: The Employment Stream

a) a_i Equation

	Unemployment Total	Unemployment Economic	Wages Total	Wages Economic	Employment Growth Total	Employment Growth Economic	House Prices Total	House Prices Economic	House Construction Total	House Construction Economic	Environmental Preference
0	0.130	0.270	-	-	3.808	7.900	0.284	0.589	0.526	1.091	-
1	-0.258	-0.674	-	-	1.474	-1.035	0.110	-0.077	0.204	-0.143	-
2	0.246	0.788	-	-	0.829	0.136	0.062	0.010	0.115	0.019	-
3	-0.143	-0.562	-	-	0.421	-0.018	0.031	-0.001	0.058	-0.002	-
4	0.028	0.213	0.355	0.737	0.219	0.002	0.016	-	0.030	-	-
5	0.001	-0.028	0.137	-0.096	0.114	-	0.008	-	0.016	-	-
6	0.002	0.004	0.077	0.013	0.059	-	0.004	-	0.008	-	-
7	0.001	-	0.039	-0.002	0.031	-	0.002	-	0.004	-	-
8	0.001	-	0.020	-	0.016	-	0.001	-	0.002	-	-
Σ	0.009	0.009	0.651	0.651	6.987	6.987	0.521	0.521	0.965	0.965	0.134

b) b_j Equation

	Unemployment Total	Unemployment Economic	Wages Total	Wages Economic	Employment Growth Total	Employment Growth Economic	House Prices Total	House Prices Economic	House Construction Total	House Construction Economic	Environmental Preference
0	-	-	0.958	2.000	11.775	24.582	1.093	2.282	0.924	1.929	-
1	-0.300	-0.626	0.359	-0.292	4.416	-3.589	0.410	-0.333	0.347	-0.282	-
2	0.364	1.085	0.208	0.043	2.551	0.524	0.237	0.049	0.200	0.041	-
3	-0.060	-0.522	0.105	-0.006	1.292	-0.077	0.120	-0.007	0.101	-0.006	-
4	0.005	0.076	0.055	0.001	0.678	0.011	-0.801	-1.803	0.053	0.001	-
5	-0.003	-0 011	0.029	-	0.353	-0.002	-0.291	0.263	0.028	-	-
6	-0.001	0.002	0.015	-	0.184	-	-0.170	-0.038	0.014	-	-
7	-	-	0.008	-	0.096	-	-0.086	0.006	0.008	-	-
8	-	-	0.004	-	0.050	-	-0.045	-0.001	0.004	-	-
Σ	0.004	0.004	1.745	1.745	21.448	21.448	0.417	0.417	1.683	1.683	0.262

Notes: Estimates derived from results in Table 1. Functional forms as in Table 1.

on the time specific dummy variables) display a strong short-run relationship with national unemployment rates ($\bar{U}$), the long-run effect being somewhat smaller but negative as expected. In addition, a seasonal pattern is detected, with migration rates being lower in the first quarter of the year than at other times. Distance sensitivity appears to be closely related to national unemployment rates, as well as transportation costs relative to retail prices. However, whilst rising transportation costs do raise distance sensitivity in the long run by generating a lower (negative) value for η_t^E, the long-run unemployment rate effect is zero. A seasonal pattern is also detected in distance sensitivity.

An examination of the residuals from the estimated equations in table 5.1 was undertaken, for the presence of serial correlation orders 1 to 4 inclusive. Conventional tests are, of course, invalid in the presence of lagged dependent variables, whilst the small number of time points available renders any appeal to the asymptotic properties of the Durbin h-test or the general Lagrange Multiplier test somewhat dubious. In the absence of any valid rigorously derived test statistic, therefore, a more ad hoc approach was taken by extracting the residuals from the a_i and b_j equations for each region, examining residual correlograms, and regressing residuals on their past values. This exercise indicated the absence of autocorrelation.(6) In addition, the possibility that the residual variances might be related to the standard errors around the a_i, b_j, σ, ξ, and η estimates was investigated using various forms of Glejser tests. These tests indicated the general absence of heteroscedasticity.

4.2 The Housing Streams

The results for the housing streams (based on the estimates in table A2) are given in table 5.3, using the same statistical methodology as that described for the employment streams. (7) The environmental preference variable again attracts insignificant coefficients, whilst housing construction rates show a significant positive relationship with both inward and outward housing migration, as was the case for the employment stream. However, whilst house prices appeared to raise employment related migration, a significant depressing effect is observed on both inward and outward housing migration. In addition, whilst wage rates appeared not to affect employment-related migration, a significant positive effect is observed on the short distance housing streams. Thus, whilst high wage rates in the region of destination appear to encourage in-migration as expected, high local wage rates would seem also to enable the local population to re-locate residentially, without changing their place of work. The employment growth variables attract the expected signs on estimated coefficients, but the effects border on insignificance. The unemployment rate variables attract coefficients which display the same oscillatory pattern over time as was detected for the employment stream, with long run multipliers close to zero.

The characteristic roots for the push and pull equations were (.652, -.387), and (.768, -.374) respectively, indicating dynamic stability in the relationships. However, the estimated re-registration lag coefficient, which corresponds to the former root in each equation, is substantially greater than the expected value of around .5. This result may simply reflect rather longer lags in re-

Table 5.3 The Housing Stream Model

$$\hat{a}^H_{i_t} = \underset{(-2.05)}{-36.066} + \underset{(1.30)}{0.628}ENV_i + \underset{(3.03)}{3.424}HCR_{i_{t-4}} - \underset{(-1.93)}{0.902}HP_{i_t} + \underset{(2.09)}{7.095}\ln W_{i_t} - \underset{(-1.71)}{23.847}\Delta\ln E_{i_t}$$

$$+ \underset{(2.74)}{0.819}U_{i_{t-1}} - \underset{(-2.74)}{1.158}U_{i_{t-2}} + \underset{(2.14)}{0.609}U_{i_{t-3}} + \underset{(3.02)}{0.265}a^H_{i_{t-1}} + \underset{(3.01)}{0.252}a^H_{i_{t-2}}$$

$$+ \sum_{t=4}^{17} \sigma^H_t D_t$$

$R^2 = .892 \quad F = 42.92 \quad n = 150$

$$\hat{b}^H_{j_t} = \underset{(-1.99)}{-30.502} + \underset{(1.07)}{0.464}ENV_j + \underset{(2.72)}{3.352}HCR_{j_{t-4}} - \underset{(-2.30)}{0.985}HP_{j_t} + \underset{(2.01)}{6.060}\ln W_{j_{t-4}} + \underset{(1.19)}{15.645}\Delta\ln E_{j_{t-3}}$$

$$+ \underset{(3.96)}{7.464}\ln U_{j_t} - \underset{(-1.18)}{3.470}\ln U_{j_{t-1}} - \underset{(-2.91)}{9.366}\ln U_{j_{t-2}} + \underset{(3.57)}{6.791}\ln U_{j_{t-3}} + \underset{(4.85)}{0.394}b^H_{j_{t-1}}$$

$$+ \underset{(3.78)}{0.289}b^H_{j_{t-2}} + \sum_{t=4}^{17} \xi^H_t D_t$$

$R^2 = .951 \quad F = 96.05 \quad n = 150$

$$\hat{\sigma}^H_{j_t} = \underset{(-6.96)}{-5.884} - \underset{(-4.13)}{0.385}S_2 - \underset{(-5.59)}{0.548}S_3 + \underset{(3.18)}{2.219}\ln\bar{U}_t - \underset{(-3.62)}{3.564}\ln\bar{U}_{t-1} + \underset{(5.53)}{4.913}(\ln\bar{U}_{t-2} - \ln\bar{U}_{t-4})$$

$$+ \underset{(3.81)}{3.453}\ln\bar{U}_{t-5} - \underset{(-1.94)}{0.985}\ln\bar{U}_{t-6}$$

$R^2 = 0.947 \quad F = 18.00 \quad n = 15 \quad d = 2.56$

$$\hat{\xi}^H_t = \underset{(-3.57)}{-3.898} - \underset{(-6.15)}{0.649}S_2 - \underset{(-5.52)}{0.759}S_3 - \underset{(-2.56)}{2.566}\ln\bar{U}_{t-1} + \underset{(4.91)}{6.069}(\ln\bar{U}_{t-2} - \ln\bar{U}_{t-4}) + \underset{(3.24)}{4.036}\ln\bar{U}_{t-5}$$

$$- \underset{(-1.47)}{1.049}\ln\bar{U}_{t-6}$$

$n^2 = .892 \quad F = 10.98 \quad n = 15 \quad d = 2.84$

$$\hat{n}^H_t = \underset{(-2.93)}{-0.025} + \underset{(3.55)}{0.012}S_2 + \underset{(4.73)}{0.018}S_3 - \underset{(-2.73)}{0.066}(\ln\bar{U}_{t-3} - \ln\bar{U}_{t-4}) - \underset{(-0.98)}{0.153}\ln DP_{t-2}$$

$R^2 = 0.738 \quad F = 8.43 \quad n = 17 \quad d = 1.92$

Sources: See Appendix

Notes: t statistics in parentheses.
The push, pull, and distance equations are based on the re-scaled parameter estimates from Table A2. The time dummy parameters were divided by 10, prior to the estimation of the σ and ξ equations

registration for short distance moves, as migrants may, for example, continue to consult their previous doctor for a while before formally re-registering with a new doctor. However, the appropriateness of interpreting this coefficient as reflecting re-registration lags must be regarded with suspicion for these housing streams, and resulting estimates of implied economic lags treated as tentative. The rather implausible pronounced oscillations observed in the implied 'economic lag' presented in Table 5.4, resulting from the relatively large negative second characteristic root, support this view.

The coefficients on the time specific dummy variables (σ and ξ) show a marked relationship with national unemployment rates, but the long run effects are quite small as was the case for the employment stream. Distance sensitivity is negatively related to the rate of growth of national unemployment, with a lag of three quarters, but relative transportation costs appear to have an insignificant effect on the distance sensitivity of housing migrants.

An analysis of the residuals for autocorrelation and heteroscedasticity of the kind described for the employment stream again indicated the absence of any such statistical problems. The Durbin Watson statistics for the σ and ξ equations are substantially above 2, but, nevertheless, remain in the inconclusive region.

5. Summary

The purpose of this chapter was to construct a dynamic model of inter-regional migration based upon time-series data for the regions of Great Britain developed from the records of the NHSCR. A method-

Table 5.4 The Implied Lag Distribution: The Housing Stream

a) a_i Equation

	Unemployment Total	Unemployment Economic	Wages Total	Wages Economic	Employment Growth Total	Employment Growth Economic	House Prices Total	House Prices Economic	House Construction Total	House Construction Economic	Environmental Preference
0	-	-	7.095	20.388	-23.847	-68.526	-0.902	-2.592	-	-	-
1	0.819	2.353	1.880	-7.890	-6.319	26.520	-0.239	1.003	-	-	-
2	-0.941	-4.238	2.286	3.053	-7.684	-10.263	-0.291	-0.388	-	-	-
3	0.566	3.390	1.080	-1.182	-3.629	3.972	-0.137	0.150	-	-	-
4	-0.087	-1.312	0.862	0.457	-2.898	-1.537	-0.110	-0.058	3.424	9.839	-
5	0.120	0.508	0.501	-0.177	-1.682	0.595	-0.064	0.023	0.907	-3.808	-
6	0.010	-0.197	0.350	0.068	-1.176	-0.230	-0.044	-0.009	1.103	1.474	-
7	0.033	0.076	0.219	-0.027	-0.736	0.089	-0.028	0.003	0.521	-0.570	-
8	0.011	-0.029	0.146	0.010	-0.491	-0.034	-0.019	-0.001	0.416	0.221	-
Σ	0.559	0.559	14.689	14.689	-49.373	-49.373	-1.867	-1.867	7.089	7.089	1.300

b) b_j Equation

	Unemployment Total	Unemployment Economic	Wages Total	Wages Economic	Employment Growth Total	Employment Growth Economic	House Prices Total	House Prices Economic	House Construction Total	House Construction Economic	Environmental Preference
0	7.464	32.172	-	-	-	-	-0.985	-4.246	-	-	-
1	-0.529	-26.989	-	-	-	-	-0.388	1.588	-	-	-
2	-7.417	-30.277	-	-	-	-	-0.438	-0.594	-	-	-
3	3.716	40.596	-	-	15.645	67.435	-0.285	0.222	-	-	-
4	-0.680	-15.183	6.060	26.121	6.164	-25.221	-0.239	-0.083	3.352	14.448	-
5	0.806	5.678	2.388	-9.769	6.950	9.433	-0.176	0.031	1.321	-5.404	-
6	0.121	-2.124	2.692	3.654	4.520	-3.528	-0.138	-0.012	1.489	2.021	-
7	0.281	0.794	1.751	-1.366	3.789	1.319	-0.105	0.004	0.968	-0.756	-
8	0.146	-0.297	1.468	0.511	2.799	-0.493	-0.082	-0.002	0.812	0.283	-
Σ	4.476	4.476	19.117	19.117	49.353	49.353	-3.107	-3.107	10.574	10.574	1.464

Notes: Estimates derived from results in Table 3. Functional forms as in Table 3.

ology was developed for the analysis of temporal variations in regional gross migration flows which differed in many important respects from the techniques adopted in previous studies of time-series migration flows. Regional push and pull factors were derived on the basis of the revealed preferences of migrants, using a two-stream gravity model, and then subsequently related to vectors of regional characteristics, within a general dynamic setting. Factors affecting the overall volume of migration nationally were separated out from those determining the internal direction of migration flows, and factors affecting distance sensitivity. Despite weaknesses in the available data set, the results achieved on this basis suggested many interesting dynamic responses, implying lengthy and important lags in the estimated relationships. In particular, the results suggested that whilst national unemployment reduced the volume of migration and affected distance sensitivity over time, the main lasting labour market influence on the direction of job-related moves was the rate of employment growth.

This chapter concludes the portion of the thesis concerned principally with the determination of migration. The main points to emerge from the discussion may briefly be summarised. Firstly, the importance of integrating different approaches to migration was emphasized, and in particular the relationship between aggregate and disaggregate models examined. At an empirical level both these approaches to migration may be seen to be of interest, and to provide complementary insights into migration modelling. At a theoretical level, however, the importance of explicitly setting out the under-pinnings of aggregate models in micro-economic theory were stressed. Secondly, the role of search in the process of migration was empha-sized, and the interface between supply and demand side effects examined, within a search theoretic context. The state of demand was seen as determining the flow of opportunities facing potential migrants in the process of search, where individuals may accept or reject these opportunities as they arise, by comparing them with some reservation criterion. Thirdly, the existence and empirical identification of different streams of migration were investigated. These streams were seen as being related to the existence of a hierarchy of spatially differentiated search fields and associated motives for moving, leading to sharp disjunctures in migration patterns over different distance ranges. Finally, the importance of dynamic considerations in the migration process were investigated, focussing on the identification of lags in migration responses, and temporal fluctuations in the overall volume of movement.

Appendix 1

Data Sources

M - NHSCR Re-registrations, males aged 16-64 1975 Q2 - 1979 Q2.

P - PP1 and annual reports for Northern Ireland and Scotland. June estimates, linearly interpolated.

U - DE Gazette. Monthly statistics used to calculate quarterly averages.

W - New Earnings Survey Part E. April estimates linearly interpolated.

E - DE Gazette (various issues).

D - Weeden (1973).

ENV - Gould and White (1968).

HP - Housing and construction statistics 1969-1979 standardised for regional variation in dwelling mix using unpublished data from the Department of the Environment. Annual data linearly interpolated.

HCR - Permanent private dwellings completed per 1,000 of population p. 73, Table 61, Housing and Construction Statistics 1969-1979.

Appendix 2 Table A1

Gravity Model Estimates for the Employment Stream

(1) ln a_{i_t} - The Push Factors

	East Anglia	South West	West Midlands	East Midlands	Yorkshire & Humberside	North	North West	Wales	Scotland
1975 2	0.0945	-0.0554	-0.5612	-0.2180	-0.4231	-0.3065	-0.3680	-0.4121	-0.7703
3	-0.0545	-0.1492	-0.6212	-0.1407	-0.4681	-0.5240	-0.4029	-0.7648	-0.5300
4	0.1063	0.0038	-0.4158	-0.1132	-0.3389	-0.2407	-0.3758	-0.4128	-0.6102
1976 1	-0.0234	0.0087	-0.5406	-0.1796	-0.3871	-0.3922	-0.4721	-0.5444	-0.2127
2	0.0410	-0.0341	-0.4827	-0.1714	-0.2311	-0.2845	-0.5340	-0.5377	-0.2249
3	-0.1536	-0.0793	-0.3545	-0.1753	-0.3729	-0.2199	-0.3642	-0.4292	-0.2771
4	0.2138	-0.0235	-0.4448	-0.3061	-0.5459	-0.3777	-0.5189	-0.3661	-0.4546
1977 1	-0.1010	-0.0042	-0.4277	-0.2197	-0.4280	-0.2379	-0.4804	-0.5549	-0.1460
2	-0.3528	-0.1011	-0.5097	-0.3726	-0.4233	-0.2364	-0.3947	-0.4928	-0.0935
3	-0.2223	0.1332	-0.4023	-0.3190	-0.4009	-0.2730	-0.3628	-0.4880	-0.1497
4	-0.0170	0.0073	-0.4651	-0.2170	-0.4671	-0.3407	-0.4338	-0.5038	-0.5442
1978 1	0.1397	0.0889	-0.1062	0.0329	-0.2666	-0.1533	-0.1887	-0.4513	-0.2192
2	-0.0952	0.1402	-0.4109	-0.1023	-0.4526	-0.2407	-0.2842	-0.1901	-0.2756
3	0.0413	-0.0949	-0.5257	-0.1701	-0.3708	-0.0982	-0.4050	-0.4952	-0.2160
4	0.1891	-0.0105	-0.5683	-0.1612	-0.3520	-0.2316	-0.4526	-0.5691	-0.4266
1979 1	0.0859	-0.1160	-0.4727	-0.0969	-0.4574	-0.2867	-0.3138	-0.2168	-0.3315
2	-0.2437	-0.0978	-0.7414	-0.6169	-0.6242	-0.4756	-0.5625	-0.5224	-0.2647

(2) ln b_{j_t} - The Pull Factors

	East Anglia	South West	West Midlands	East Midlands	Yorkshire & Humberside	North	North West	Wales	Scotland
1975 2	0.0192	-0.0015	-0.6561	-0.4067	-0.4409	-0.3322	-0.5441	-0.5653	-0.4218
3	-0.2083	-0.1039	-0.9287	-0.4605	-0.6771	-0.5490	-0.5950	-0.6407	-0.4595
4	0.2666	-0.0418	-0.6197	-0.2388	-0.4547	-0.2861	-0.6034	-0.5919	-0.6020
1976 1	-0.0055	0.0256	-0.6407	-0.1018	-0.4699	-0.1873	-0.5345	-0.3475	-0.0196
2	-0.1299	0.1039	-0.8200	-0.2853	-0.5368	-0.4518	-0.6318	-0.4097	-0.2015
3	0.1648	0.0638	-0.6512	-0.2216	-0.4974	-0.2399	-0.4839	-0.5253	-0.2595
4	0.4276	0.0793	-0.4846	-0.2382	-0.3936	-0.1723	-0.6070	-0.4554	-0.5452
1977 1	-0.0950	-0.0943	-0.6360	-0.1984	-0.6891	-0.3848	-0.5541	-0.8069	-0.4117
2	-0.3101	0.0984	-0.5958	-0.3191	-0.5038	-0.4966	-0.6611	-0.7769	-0.0218
3	-0.1888	0.1818	-0.7170	-0.4552	-0.5199	-0.4888	-0.7103	-0.3684	-0.2595
4	0.4429	0.0327	-0.4253	-0.2121	-0.3425	-0.3482	-0.6493	-0.5879	-0.7529
1978 1	-0.1479	-0.0768	-0.4792	-0.0885	-0.4615	-0.4760	-0.4650	-0.5283	-0.5332
2	-0.1245	0.2366	-0.4623	-0.2021	-0.6054	-0.7475	-0.4843	-0.4603	-0.4976
3	-0.1171	-0.0526	-0.7641	-0.4941	-0.7638	-0.5916	-0.6150	-0.7441	-0.3717
4	0.1105	0.0117	-0.7346	-0.2507	-0.3427	-0.2671	-0.7189	-0.6776	-0.5870
1979 1	0.0242	-0.1759	-0.7735	-0.3805	-0.7990	-0.6806	-0.6918	-0.6770	-0.6368
2	-0.1749	0.0752	-1.0473	-0.5825	-0.8914	-0.6708	-0.9442	-0.8651	-0.5445

	CONSTANT	η_t	(t)	R^2	F
1975 2	-9.5012	-0.002788	(-2.40)	.771	7.10
3	-9.4141	-0.003224	(-3.02)	.787	7.79
4	-9.2019	-0.002758	(-3.00)	.858	12.75
1976 1	-9.5660	-0.002770	(-3.14)	.683	4.53
2	-9.6478	-0.003151	(-3.12)	.701	4.94
3	-9.5927	-0.003673	(-3.41)	.732	5.76
4	-9.2903	-0.003248	(-3.09)	.822	9.74
1977 1	-9.3558	-0.003512	(-3.31)	.734	5.81
2	-9.5058	-0.004038	(-2.56)	.526	2.33
3	-9.5278	-0.003789	(-3.12)	.631	3.61
4	-9.2326	-0.003001	(-2.97)	.862	13.13
1978 1	-9.8147	-0.001864	(-1.69)	.671	4.29
2	-9.7245	-0.002630	(-2.28)	.721	5.44
3	-9.3670	-0.003792	(-2.63)	.611	3.30
4	-9.1669	-0.003506	(-3.74)	.854	12.32
1979 1	-9.3883	-0.002938	(-3.45)	.840	11.06
2	-9.0843	-0.004572	(-3.52)	.721	5.43

Appendix 2 Table A2

Gravity Model Estimates for the Housing Stream

(1) a_{i_t} - The Push Factors

	East Anglia	South West	West Midlands	East Midlands	Yorkshire & Humberside	North	North West	Wales	Scotland
1975 2	-0.3979	0.1800	-1.2278	-1.9442	-1.4894	0.1096	-2.3825	0.5307	-2.3301
3	1.5646	2.3937	0.0669	0.7727	0.0776	2.4397	0.0151	1.9169	-0.5941
4	1.7809	2.0997	-1.2295	-1.6542	-0.3899	1.7944	-0.7320	1.6507	-0.0228
1976 1	2.9559	2.6249	-0.0324	0.1871	0.1975	1.6939	0.2717	2.6992	-0.0554
2	1.6746	2.0565	-0.5859	0.3547	-0.6388	1.5887	0.4410	1.5835	-2.0002
3	3.5414	2.0602	0.4560	0.8404	0.2953	2.1108	-0.2939	1.5320	0.4190
4	-0.1862	1.5539	-0.8957	-0.5578	-0.4452	2.2534	-1.0467	1.4728	-2.4942
1977 1	2.4250	2.2641	-0.4052	0.4862	0.6782	1.9597	0.6683	1.6068	-1.4336
2	1.5876	0.9917	-0.9353	0.3220	-0.1602	1.1368	-0.5119	1.4987	-0.7199
3	2.7400	0.6567	-0.1918	0.1648	0.8132	1.7293	-0.3304	1.0773	-0.3389
4	2.7423	1.9245	-0.7252	0.3860	1.2424	2.3338	0.5162	1.8580	-0.4379
1978 1	1.2016	0.6502	-1.6140	-1.3540	-0.4638	1.7634	-1.3799	1.3000	-2.0292
2	1.3115	1.7538	0.3129	0.4309	0.8071	1.8568	0.4158	1.9967	0.6374
3	1.3451	1.1716	0.1983	-0.3576	1.2638	1.3583	0.0000	1.6727	0.2268
4	0.2467	2.6813	0.0808	-0.0657	0.2620	2.3096	0.4804	1.9434	-0.5462
1979 1	0.9235	2.3129	-0.2140	-0.0134	0.7068	2.0114	0.0399	1.0839	0.0921
2	2.7835	1.4718	1.4356	1.2563	2.3680	1.8059	1.1924	2.5210	0.4201

(2) b_{j_t} - The Pull Factors

	East Anglia	South West	West Midlands	East Midlands	Yorkshire & Humberside	North	North West	Wales	Scotland
1975 2	4.0534	2.8902	0.5297	1.1024	1.5424	2.8814	0.1042	2.9290	-0.1143
3	5.2673	4.1617	0.7953	1.7115	0.8691	2.3698	0.6829	3.3287	-0.4402
4	6.3339	4.4776	0.1161	1.6069	1.6811	3.4056	0.1769	4.6710	-0.1554
1976 1	6.8538	3.9156	-0.3224	1.5759	1.2529	1.6345	0.5552	3.5042	0.1215
2	4.5901	3.7751	-0.0025	1.4065	0.1854	3.2830	0.6179	3.4072	0.6382
3	3.2964	2.9862	0.9034	1.3587	1.2274	2.3652	0.4483	3.4413	-0.8690
4	3.2967	3.3004	0.4596	0.3775	1.2542	3.5232	0.2671	3.0005	-1.0239
1977 1	5.0191	3.1435	-0.1274	1.0998	0.6535	2.2907	0.4342	3.8710	-0.5600
2	3.5055	2.4170	0.1074	0.4942	0.8877	1.6485	0.3228	3.1900	-0.4595
3	4.2840	2.0664	0.7991	1.4314	1.1001	1.9925	0.4912	2.4583	-0.1939
4	3.3168	3.9256	0.7927	1.4911	2.1427	2.7152	1.0118	3.1968	-0.3051
1978 1	4.2358	3.2290	-0.3925	-0.0622	-0.2164	2.1405	-0.7436	2.8989	-1.2103
2	4.6743	1.6489	-0.5011	0.7741	0.9942	1.3018	-0.4273	2.7328	-0.0102
3	3.4400	2.6386	0.9017	1.5223	1.6160	1.4704	0.3943	3.1544	-0.7480
4	4.2811	3.1675	0.9971	1.4098	1.8998	2.8661	1.3802	4.2524	0.2509
1979 1	3.6412	3.9209	0.3299	1.6957	1.3071	2.4464	0.4249	3.2105	-0.3746
2	3.4562	2.1637	1.3335	1.9890	1.9020	1.5727	0.9141	3.4406	0.6994

	CONSTANT	η_t	(t)	R^2	F
1975 2	4.6195	-.027751	(-1.96)	.869	3.50
3	2.8412	-.031028	(-2.25)	.876	3.73
4	5.2330	-.043026	(-2.44)	.884	4.02
1976 1	3.1579	-.032129	(-2.12)	.909	5.26
2	3.5068	-.035219	(-3.25)	.905	5.03
3	1.2626	-.017930	(-1.13)	.798	2.08
4	5.1919	-.040272	(-2.63)	.852	3.03
1977 1	2.6989	-.028392	(-1.86)	.868	3.46
2	2.5693	-.022188	(-1.69)	.841	2.79
3	1.4599	-.014824	(-1.24)	.871	3.56
4	2.8711	-.030312	(-1.55)	.756	1.65
1978 1	5.3247	-.034236	(-1.87)	.820	2.40
2	2.3033	-.021174	(-1.36)	.830	2.57
3	0.8607	-.011409	(-0.77)	.811	2.26
4	3.1731	-.038597	(-2.94)	.902	4.87
1979 1	3.1451	-.030487	(-1.54)	.729	1.42
2	-1.1479	-.006201	(-0.54)	.878	3.79

Notes: (t) refers to the t statistic on the distance parameter. t statistics on the push/pull parameter estimates are not reported to save space. These statistics indicate significance only in relative rather than absolute terms. The estimates for the housing stream have been multiplied by 10^6. The housing stream equations were also re-estimated omitting insignificant dummies in order to ease the degrees of freedom problem, and to raise the significance of the equations overall. Such a procedure implicitly sets the corresponding region's push/pull factor equal to the south east. The results of this exercise were very similar to those reported here. In order to avoid problems of comparability of the estimates over time in the a_i, b_i and η equations, the estimates using the full complement of dummy variables were adopted throughout.

CHAPTER 6 THE ANALYSIS OF SPATIAL VARIATION IN LABOUR FORCE PARTICIPATION

1. Introduction

In this latter portion of the thesis, we address a further potential source of variation in local labour supply arising through spatial variations in participation (chapter 6), and attempt to incorporate such aspects of local labour supply into a simultaneous model of the London labour market (chapter 7).

The analysis of labour force participation is already a highly developed area of labour economics, particularly in relation to the explanation of variations across individuals and over time, although our understanding of spatial variation is still somewhat limited. One theme that emerges from this chapter, as well as chapter 7, is that locating labour force participation decisions in an explicitly spatial context does raise rather more general issues and problems which are relevant to, if not immediately apparent in, standard approaches to the field. The next section discusses previous studies of geographical variations in participation rates within the context of conventional (spaceless) theories of labour supply, and sketches a more complete, if informal, theoretical perspective, in terms of the treatment of space. The remainder of this chapter is then devoted to an empirical analysis of regional trends in the labour force participation of married women in the UK, using quarterly data from the Family Expenditure Surveys of the period 1968-77. Section 4 is devoted to a discussion of the Family Expenditure Survey data used in this chapter. Section 5 discusses the specification of the particular variables which are taken to be potentially relevant to the determination of the participation decision in this study. Section 6 presents an econometric framework for implementing the model, and section 7 is devoted to a presentation of the empirical results. Section 8 examines the sources of regional convergence in married female participation over time in the UK. Section 9 presents a summary and conclusion.

2. Orthodox Theory, and Previous Empirical Work

Taking as our point of departure the standard neoclassical model of labour supply, the simplest static textbook model may be sketched out as follows.

The individual derives utility from leisure time L, and a composite bundle of consumption goods C, receives R per period in real non-labour income, and is paid a real wage W per period. Individuals divide their time per period between H (work time) and L, where H + L = 1. Static models generally assume no uncertainty and perfect information, with neither saving nor borrowing, so that utility is maximised subject to C = WH + R, yielding a standard labour supply function of the form H = H(W,R). The model may be extended to the household unit, essentially by the assumption that household utility is maximised, and the incorporation of cross-substitution effects between household members (Ashenfelter and Heckman (1974)). Taxes and overtime rates may be incorporated by altering the definition of the budget constraint.

Individual preferences, as captured by the utility function, are likely to vary according to personal circumstances, thus leading to the inclusion of a battery of such variables in the final estimated labour supply function. Life cycle influences would appear to be important here, particularly for women, as marriage and child rearing are likely to substantially affect their marginal valuation of time spent in the home as compared to earnings from employment.

The participation decision relates essentially to a corner solution in this framework, i.e. to seek work or not to seek work, rather than deciding on how much time to devote to work. Such models may be estimated either on individual data using a zero/one dependent variable using a standard discrete choice framework such as the logit formulation, (e.g. Stern (1981)), or (under certain aggregation assumptions) using grouped data, in which case the dependent variable reflects the proportion of the sample who participate and may vary within the limits of zero to 100% (e.g. Greenhalgh (1977))(1)

Since the seminal work of Mincer (1962, 1966), this sort of model (and developments thereof) has been applied with some success to the explanation of participation decisions, generally using cross-sectional data for individuals (see Bowers (1975) and Greenhalgh and Mayhew (1981) for reviews of the British literature, and Heckman, Killingsworth and McCurdy (1981) for a review of the American literature). Most frequently, the focus of attention has been on the participation of married women, since it is within this section of the potential workforce that participation rates are seen to be the most volatile both temporally and spatially.(2) Research into the participation of married women has also been stimulated by interest in the general area of women and work, which has its roots in various contemporary social movements.

The differences between men and women (especially married women) in the determination of labour force participation rates is an interesting one, since the few existing empirical studies of male participation suggest substantially lower sensitivity to labour market conditions (principally wages and unemployment) than that exhibited by married women. What variations do exist in male participation, across regions for example, tend to be largely explicable in terms of demographic characteristics such as age structure (Bowers (1970)).

For the time being however, we shall concentrate on the analysis of married female participation, in line with the large body of literature in this general area. Much of this literature has, implicitly or explicitly, attempted to pinpoint the sources of growth in married female participation since the early 1950's (and more recently the tailing off in the rate of increase, which became evident towards the end of the 1970's). Thus, for example, Greenhalgh (1977) quotes the rapidly rising married female participation rates over the period 1951 to 1971 (see Table 6.1) whilst the Family Expenditure Survey data for the UK shows an average increase in married female participation from 44.4% in 1968 to 58.1% in 1980. Several factors have been highlighted in the literature as having contributed to this increase, in particular the rising relative real wages of women, and falling birth rates. However, typical elasticities derived in cross-section models still underpredict the temporal changes that have been observed (Greenhalgh (1977)), suggesting that other influences more generally associated with the 'social' as opposed to the purely 'economic' environment may also have played a part, for example in terms of the social acceptability of married women taking up paid employment.

Table 6.1 Postwar Trends in Participation Rates of Married Women

(%)

Age	1951	1961	1971
16-19	38.1	41.1	42.4
20-24	36.6	41.4	46.7
25-34	24.4	29.5	38.4
35-44	25.7	36.4	54.5
45-54	23.7	35.3	57.0
55-59	15.6	26.0	45.5
60-64	7.2	12.7	25.2
65+	2.7	3.4	6.5

Source: Department of Employment Gazette (January 1974), 10; derived from Census of Population. (Figures relate to Great Britain). Greenhalgh (1977) p. 249.

Table 6.2 Female Labour Force Participation Rates by Standard Planning Region 1961 to 1975

(%)

	1961	1971	1975
South East	39.4	45.2	47.2
	(1.06)	(1.05)	(1.03)
East Anglia	29.5	38.7	44.5
	(0.80)	(0.90)	(0.97)
South West	30.3	37.6	40.8
	(0.82)	(0.86)	(0.89)
West Midlands	41.3	45.6	47.8
	(1.11)	(1.06)	(1.04)
East Midlands	36.6	43.0	46.0
	(0.99)	(1.00)	(1.00)
Yorkshire and Humberside	37.4	41.8	45.7
	(1.01)	(0.97)	(1.00)
North West	41.9	44.8	48.0
	(1.13)	(1.04)	(1.05)
North	31.4	40.4	43.6
	(0.85)	(0.94)	(0.95)
Wales	27.5	35.9	39.8
	(0.74)	(0.84)	(0.87)
Scotland	35.4	42.6	45.8
	(0.95)	(0.99)	(1.00)
Great Britain	37.1	43.0	45.8
	(1.00)	(1.00)	(1.00)

Source: D E Gazette (September 1978)

Note: Figures in Parentheses show ratio of regional rates to national rate.

If our understanding of the sources of temporal change in married women's participation is somewhat limited, however, then the sources of spatial variation are even less well understood. This gap in the research literature is perhaps more attributable to deficiencies in the underlying theory than anything else, since as we have seen the theoretical model upon which most empirical research has been based to date is essentially spaceless in character. At a fairly simple theoretical level it would, of course, not be too difficult to introduce space as a further dimension in the neo-classical model by inserting appropriate cost functions for travel or migration in the determination of the participation decision, given an exogenous spatial distribution of residential and employment opportunities. Participation decisions would then depend on the wage attached to each job, discounted by the corresponding travel costs necessary to access that job, making more distant opportunities less attractive all other things being equal. However, as we shall see, such a framework would not do justice to the complexity of the underlying issues involved.

Turning to previous empirical studies in the area, these may be roughly classified into two broad categories:-

i) Early work, which attempted to explain variations in aggregate participation rates over a cross-section of geographical areas (eg. Gordon (1970), Greenhalgh (1977), Taylor (1971)).

ii) More recent work, based on individual data, incorporating spatial variations through the inclusion of a vector of locational dummy variables (eg. Layard, Barton and Zabalza (1980), Greenhalgh (1980)).

Whilst the latter approach relating to the analysis of participation at the individual level may be seen to be superior to the aggregate models in a number of respects, such studies are perhaps less illuminating in the analysis of spatial variations in participation. Thus, the inclusion of vectors of locational dummy variables in such models merely serve to demonstrate the significance of spatial variations (even controlling for implied spatial variation in the other explanatory variables such as wages etc.) without providing any real insights into the underlying causes. As such, analyses of this kind may be seen to be essentially descriptive rather than behavioural in their treatment of the spatial dimension. In addition, the areal units identified in such analyses tend to be highly aggregated for computational reasons and thus hide substantial internal variation.

The former class of model identified above attempts to explain local variations in terms of the attributes of the areas under observation, notably local labour market conditions and the personal characteristics of individuals resident in the area. Little concern was given to explicitly spatial factors in such analyses, however, for example questions of relative location, commuting distances, the accessibility of employment opportunities, and the endogeneity of location of residence due to the potential for migration. The structure of the local population must reflect, in the long run at least, the cumulative effects of successive waves of population movement, leading to an element of self-selection in the spatial distribution of the population, whilst favourable labour market conditions may induce workers into an area over a relatively short period of time. Thus, spatial variations in rates of labour force participation may depend just as much on where the economically active population choose to live as on the reasons why people in a certain area have a particular probability of participating in the labour force. This problem is particularly relevant in the detailed areal analysis of variations within a particular labour market (see chapter 7).

A number of the results of previous studies can plausibly be reinterpreted in terms of such spatial effects. Thus, for example, Greenhalgh (1977, 1979) in her studies of variations in the participation of married women and men respectively across 106 towns and cities in Britain included two forms of unemployment variable in her model. One variable related to male unemployment rates at the local level, the other related to the regional pressure of demand, measured as the difference between the current regional unemployment rate and that which would occur at full employment. The former variable attracted a significant negative coefficient and the latter a positive one. Whilst Greenhalgh interpreted these effects in terms of discouraged and added worker effects, it is also quite plausible to view them as the result of migration. Thus, high local unemployment may lead to net out-migration, whilst high regional 'demand deficient' unemployment (with a given local unemployment rate) may induce net in-migration from the surrounding areas, as a result of the differential between the local and regional unemployment rate. Assuming that migrants responding to these labour market stimuli are more likely to be economically active, then the former effect is likely to reduce participation whilst the latter effect is likely to increase participation, in accordance with the estimated coefficients for these two variables.(3)

The issues which are involved here are potentially complex. Nevertheless, if the spatial dimension is of intrinsic interest (as opposed to analyses which simply seek to control for spatial factors in attempting to identify some other influence) then these important issues need to be addressed. Clearly, this interpretation of participation functions in terms of migrational responses is likely to be more relevant to the case of men than married women, since the former tend to be the more mobile spatially. One of the most interesting issues in relation to married women concerns the potential dependence of their migration decisions on the choices of their husbands. Such constraints on the mobility of married females, coupled with their more restricted commuting fields (eg. see Andrews (1978), Madden (1977)) suggests that their employment status is likely to depend on circumstances within specific areal labour markets, whilst a greater degree of fragmentation between local female labour markets is likely to emerge, as compared to men. In particular, if married females are dependent on their husbands in the determination of their location, then one might also expect pools of potential married female labour supply to accumulate at sites of growing opportunities for men - married men move to areas of growing male employment opportunities and bring their wives and families with them. The resulting net increase in local levels of demand for retailing and services may, of course, serve to generate employment opportunities for women, also, via a local multiplier process. In this regard employment growth is itself likely to be endogenous with respect to migration, although it is doubtful that all the available female labour supply could be absorbed in this way, implying that some adjustment in unemployment or participation is likely to be necessary, following such a move.

In this way, migration and participation are likely to be contingent and accommodating decisions for married women - for example, in situations where a married woman gives up her job to move with her husband and family, and ends up withdrawing from the labour force at her new place of residence (see Mincer (1978) for a theoreticl discussion of some of the issues involved, within a neoclassical framework).(4) Viewed within this context, the asymmetries between men and women in their local labour supply begin to make some sense, reflecting a pattern of dependence of married women on the locational decisions of their husbands and spatial constraints on mobility. No attempt, however, is made in this thesis to sketch out a formal theoretical model. The potential interdependencies between male and female labour market decisions, the interaction between supply side and demand side effects, and the relationship between housing and labour market processes are likely to be too complex to yield a simple tractable theoretical model. Of greater interest, perhaps, would be an empirical study to evaluate the importance of some of these processes, and their impact on local labour market patterns. Chapter 7 attempts such an analysis, specifying a simultaneous housing and labour market system for men and women in the London region at the time of the 1971 Census of Population. The approach is essentially aggregative in character, attempting to trace through consistent causal chains and sequences of behaviour, and attempts to interpret these in terms of the sorts of theoretical issues outlined above. At some later date, it would also be of interest to attempt a more micro level analysis of the decisions of individual households and household members in relation to their labour market decisions over time.

3. Regional Trends in the Labour Force Participation of Married Women

For the time being, having noted the problems, we shall confine ourselves to the specific analysis of trends in the labour force participation of married women across the Standard Planning Regions of the U.K. There are a number of reasons why a regional analysis is likely to be of interest.

The rapid increase in married female participation rates over the last 30 or so years has already been mentioned, but it is also important to note that this growth has taken a highly unbalanced form across the regions. Specifically, the evidence suggests higher growth in areas where participation tended initially to be below average, thus producing an overall trend toward convergence in regional married female participation rates (eg. see Bowers (1970), D E Gazette (1978), Stern (1981)). This pattern is clearly exhibited in Table 6.2, which portrays the general pattern of female participation rates across the regions from 1961-75. Thus, for example, whilst in 1961 the female participation rate was 14.4 percentage points higher in the North West than in Wales, by 1975 this differential had fallen to only 8.2 percentage points.

The only previous published work on temporal trends in regional participation in the UK are the studies undertaken by Corry and Roberts (1970, 1974). These studies focused on the relationship between participation and unemployment, and were based on national insurance card count data and registered unemployment statistics. Their studies show a strong inverse relationship between female participation and unemployment, although the cyclical sensitivity of male rates was more doubtful. However, their study was hampered by a number of serious problems. Firstly the data excluded the unregistered unemployed, and thus neglected potential cyclical variability in registration propensities (i.e. the possibility that the propensity to register as unemployed might itself be a function of the unemployment rate). Secondly, their analysis was not disaggregated by marital status, when all the evidence suggests that it is married female participation rates which are the most volatile element in female labour supply. Thirdly, by focusing on the unemployment/ participation relationship they neglect a wide variety of other potential influences on participation which theory and cross-section evidence indicate are likely to be of great importance such as wage rates, non-labour income, family formation effects etc.

In the remaining sections of this chapter, therefore, an analysis of regional trends in married female participation rates is presented, using quarterly data constructed from the Family Expenditure Surveys (FES) for 1968-1977. The next section is devoted to a discussion of this data, whilst section 5 attempts to set out in theoretical terms a model for the analysis of areal participation rates. The remainder of the chapter is concerned with the econometric implementation of this model.

4. The Data

The FES is a continuous sample survey, collecting information from households within the Standard Planning Regions on income and expenditure by means of a rotating stratified random sampling technique. Roughly 11,000 addresses are sampled annually, with a response rate of around 70%. Sampling is spread evenly through the year, and information is also retained as to the week of interview. Using this information it is possible to build quarterly averages of certain variables for the period 1968-1977, yielding 40 time series observations. 12 regions are used in this analysis (the South East is split into Greater London and the Rest of South East) yielding a total of 480 observations when the data is pooled. In some of the regions the quarterly sample sizes are typically quite small, producing substantial sampling variation in the estimates. The sample used here is restricted to households where both husband and wife are present, yielding an average national quarterly sample size of around 1,250 households. The smallest quarterly samples were generally in Northern Ireland and East Anglia, where the sample sizes were around 30 and 50 households respectively, whilst the largest regional sample was in the Rest of the South East (excluding London) with an average of around 230. (For the whole of the South East, the average was around 370).

In an investigation of the validity of the FES data in this context, Molho and Elias (1984) correlated the FES regional information with data from larger samples and surveys, and found a reasonably close correspondence. Nevertheless, this sampling variation is likely to exaggerate the significance of variables measuring household characteristics, since they essentially explain variations between the small samples rather than the populations. However, by the same token, the significance of variables relating to conditions in the regional labour markets may be underestimated. Under such conditions the construction of moving averages for these latter variables may be warranted. This issue is discussed further in the next section.

One potential estimation problem that arises out of the use of such small sample survey data is that the residual variances are likely to be related to the sample sizes. Glejser's (1969) tests for heteroscedasticity generally proved insignificant, however (see Molho and Elias (1984)).

One important advantage of the FES data as compared to that used in previous studies such as that of Corry and Roberts (1970) is that its definition of unemployment includes the unregistered unemployed, thus removing question marks about the cyclical sensitivity of registration propensities, changes in benefit regimes, etc.

Finally, it should be noted that, following the 1972 Local Government Act, changes in the definition of certain of the standard regions occurred on 1st April 1974. Specifically, the definitions of the North, the North West, Yorkshire and Humberside, the East Midlands, the South East and the South West were altered. With the exceptions of the South West and East Midlands these changes were fairly small, and in the rest of the regions no change took place at all. The boundary changes affected the FES data set from 1975 onwards. Experiments with regional dummy variables for this period added little to the explanatory power of the model, however, and these variables have, therefore, been excluded from the final model.

5. Model Specification

This section presents a broad schematic account of the factors affecting married female participation rates at an areal level. Following on from the general discussion of female labour markets in section 2, it would appear fruitful to place the analysis in a life cycle context, where labour force participation, child rearing, and migration may be seen as interdependent decisions. Involvement in the labour force may be seen as the outcome of an accumulation of the effects of a history of earlier labour market decisions impinging on the current position, together with some limited scope for altering that position as a result of current decisions. Evidence for this kind of 'state dependency' has been presented by Heckman (1980) using American data, and also within the framework of cohort models based on British data (Joshi, Layard and Owen (1981), Elias and Main (1982)).

Periods of labour force activity and inactivity must be timed in conjunction with decisions to relocate, settle, and bring up a family, with current decisions contingent on the background of previous decisions made in the life cycle. This perspective would suggest a 'components of change' type approach might be appropriate to the analysis of participation (Gordon and Molho (1985)),where the current participation rate may be seen in terms of surviving participants from an earlier date, less exits plus new entrants. Different sets of factors are likely to operate at different points in this scheme.

The probability of entry (or re-entry) into labour force participation may be cast in a similar framework to that applied to migration decision making in chapter 2. The decision to enter economic activity may be seen as the outcome of a (subjective) assessment of the likely costs and benefits to search, reflecting primarily the size and quality of the flow of opportunities faced by married women resident in a particular area, as well as the likely cost of acquiring information about these. Introducing search into the decision making framework in this way constitutes a clear break with the orthodox neo-classical 'full information' model outlined in section 2, and tends to shift the emphasis away from purely wage related considerations to the question of flows of opportunities faced by individuals, and the process by which such opportunities are discovered and accepted or rejected. Once again, as in the discussion of migration behaviour in chapter 2, the issue of 'quantity constraints' becomes more apparent in this search perspective, in that the choice sets faced by individuals are clearly to some degree determined by the state of demand in generating opportunities across areas and over time. Such a perspective also provides a much wider role for the spatial dimension, in terms of search costs over distance, and friction on the dissemination of information about job opportunities between areas.

The relevant variables affecting the decision to enter the labour force are in this context likely to be rates of employment growth, vacancies, and unemployment (affecting the perceived probability of receiving a job offer), and accessibility and search costs (affecting the flow of information about job opportunities). Earnings play a more subsidiary role, here, in so far as they affect the quality of job offers (see Greenhalgh (1977, 1980) for previous empirical evidence of the influence of earnings on married female participation). (5) In this small sample regional analysis, factors affecting the perceived probability of receiving an offer are extremely hard to proxy, and whilst aggregate regional unemployment/ vacancies type variables (drawn from DE sources) were tried, the best measure in the statistical analysis was found to be the (FES measure of) unemployment rate of married males. In the next chapter, where aggregate census data at the detailed district level are used, more explicitly 'search' oriented variables such as the rate of employment growth prove to play an important role. For the time being, however, it may be noted for the purposes of this analysis that previous work by Corry and Roberts (1970) on aggregate time series regional participation rates found evidence of a significant negative relationship between female participation rates and unemployment.

As regards information flows, very little previous evidence is available on the effects of employment accessibility on local participation rates,(6) and indeed such an effect would be hard to proxy with the small sample data used here, defined over such broad areal units as the Standard Planning Regions. Once again in the analysis presented in the following chapter there was greater scope to experiment with such variables as local employment density as influences on married female participation. Variables affecting the costs of job search such as the proportion of households with a car or a telephone were tried in this analysis, but proved insignificant in the empirical work.

Returning to the components of change in labour force participation, the rate of exits from the labour force over a period are likely to be determined by the proportion at risk of withdrawing at any one time (i.e. the lagged participation rate), and by demographic factors such as age structure. Evidence as to the importance of these variables is available in a host of different sources (Heckman (1980), Joshi, Layard and Owen (1981) etc.).

A further set of factors is likely to affect participation decisions both at the point of entry, and exit. Thus, child-bearing is likely to induce married women to leave the labour force (Martin and Roberts (1984), but may also constrain the timing of re-entry until some future date. To some extent this effect will depend upon the financial implications of bringing up a family, and also the cost and availability of alternative child care arrangements. Previous empirical work (Greenhalgh (1977) (1980), Elias (1981), Layard *et al* (1980), Joshi, Layard and Owen (1981)) confirms the view that the presence of young children is associated with a marked reduction in the participation of married women, but that this effect diminishes for older children, and may possibly even change sign as the financial burden of bringing up teenage children induces re-entry into the labour force. Interestingly, Moss (1980) has shown that the upward trend in the labour force participation of married women between 1966-71 was in part due to the increased participation of mothers with very young children. In this analysis, the presence of young children was captured using three variables representing the proportion of households in which there were children in the age ranges 0-1, 2-4, and 5-16.(7)

A second factor which is likely to affect married female participation both at the point of entry and exit, but one which proved generally insignificant in the empirical analysis relates to household non-labour income. Husbands' earnings are also likely in theory to operate in a similar way to non-labour income in affecting married female participation, but in practice this variable proved too highly correlated to married female earnings to produce a significant additional contribution to the statistical model.

Finally, very little has been said about migration in this scheme. Clearly, from the point of view of the household, migration may act either as a pre-requisite for labour market entry (i.e.

movement to find work) or, and perhaps more likely in the case of married women, a factor inducing dis-attachment from the labour force, as movement forces the married woman to surrender her old job. From the point of view of the area however, what matters is whether net migrants into the area are any more or less likely to be economically active. This is a difficult question, since whilst some married women may have given up their jobs to move into the area, there might still be a higher proportion that are economically active than in the indigenous population. It is also a question about which the FES provides no information, however, and therefore one which we will have to put aside for the time being, although in the following chapter we shall return briefly to this issue.

6. The Framework of Analysis

This section presents an econometric framework within which regional participation rates may be analysed. Regional variation in the labour force participation rate may be defined in terms of the value of (p_r/P) where p_r = labour force participation rate in region r (r = 1 ...R), and P = national labour force participation rate. Deviations in participation rates in region r from the national rate (at time t (t = 1 ...T)), are determined by regional deviations in a vector of explanatory variables of the kind discussed in the previous section $(x_{ir}/X_i)_t$ where x_i refer to regional values of the explanatory variables, and X_i their national counterpart, and i = 1 ...k, thus:-

$$(p_r/P)_t = \alpha_r + \sum_{i=1}^{k} \beta_{ir} (x_{ir}/X_i)_t + U_{rt} \qquad (6.1)$$

where U is an error term.

Thus, using the national values of the variables (P, X_i) provides a benchmark against which to discuss regional variation.(8) Within this framework, regional variation in participation may be due either to regional variation in the explanatory variables ($x_{ir}/X_i \neq 1$), or regional variation in the relationship between (p_r/P) and (x_{ir}/X_i) i.e. regional variation in the β_i. Note that if all $x_{ir} = X_i$, then $(\hat{p_r/P}) = \alpha_r + \sum_{i=1}^{k} \beta_{ir}$.

Equation (6.1) provides the basic model adopted here, and is essentially equivalent to estimating a set of $r = 1 \ldots R$ single regional equations. The validity of imposing various restrictions on estimated coefficients across regions shall also be considered. If the restriction that all the parameters in equation (6.1) are the same across regions (i.e. $\beta_{i1} = \beta_{i2} = \ldots = \beta_{iR}$(for all $i=1\ldots k$)) is accepted by the data then the regional distribution of participation rates may be determined purely in terms of the variation in the explanatory <u>variables</u> rather than regional variation in the estimated <u>coefficients</u>. The estimated β_i will also be more reliable, since they will be based on a considerably larger sample, incorporating information in all the other regions which is ignored when single regional equations are estimated. Of course, the proposed restriction on coefficients across regions must be validated and this amounts to testing the validity of pooling the data. However, it may be noted that this sort of restriction is implicitly imposed in pure cross-section studies of regional participation rates, without being testable in such a cross-section framework.

The properties of this model may briefly be outlined. In essence, within the framework set out here, the regional distribution of participation rates may be affected by the independent variables only in so far as regional trends in these variables diverge from national ones. Thus, for example, if a variable changes over time in a uniform manner across regions, then although that variable may affect participation both regionally and nationally, it will leave the regional distribution around the national average unaffected, within the context of the model set out here. In addition, provided that the restriction proposed above is validated by the data, then any regional divergence in the explanatory variables will affect the relative regional participation rate in the same way, independently of the particular region under consideration. Finally, it would perhaps be as well to note here that the expected sign of the effect of a variable on participation (eg. as discussed in the previous section) is unlikely to be affected by the fact that the model is set up in ratio form, since if:-

$$\frac{\partial p_r}{\partial x_{ir}} > 0, \frac{\partial P}{\partial X_i} > 0, \frac{x_{ir}}{X_i} > 0, \frac{p_r}{P} > 0, \qquad \text{then}$$

$$\frac{\partial\ (p_r/P)}{\partial\ (x_{ir}/X)} > 0.$$

7. Results

Estimation proceeded in two stages. Initially a static model of the kind presented in equation (6.1) was adopted, and used to test the validity of restricting coefficients across regions. An examination was then made of the dynamic specification of the model, and a distributed lag structure adopted, allowing a more general distributed lag pattern than if only a single lagged dependent variable were allowed in the model.(9)

The results of estimating the static model are presented in Table 6.3. In equation (1) the whole sample of 480 observations is used and all the coefficients (including the constant term) are restricted from varying across the regions. Signs on all the estimated coefficients agree with expectations, but the Lagrange Multiplier test (LM) indicates severe autocorrelation problems.(10) (see Godfrey (1978)). An F test was applied to test the validity of restricting all the coefficients to be the same across the regions and the test statistic of 2.734 indicated that the restriction was rejected by the data.(11) In equation (2) intercept dummies are included (12) to allow the constant term to vary across the regions but the restriction that all the slope coefficients are the same across regions is retained. The problem of autocorrelation is considerably reduced and the F statistic to test the validity of the restrictions on the slope coefficients yielded a value 0.886 which is clearly insignificant and indicates that the restriction is accepted by the data.(13) Obviously, whilst this result may hold in total, it does not necessarily hold for each of the explanatory variables. Tests were therefore also performed on each variable in turn, and the F statistics were in each case insignificant.

These results indicate that without much loss of generality we can determine variation in regional participation rates purely in terms of variation in the explanatory variables across regions, and treat the relationship between the explanatory variables and the dependent variable as being essentially the same in all the regions. Essentially, the results suggest a positive but small and insignificant real wage effect, a negative and significant unemployment rate coefficient, whilst the influence of the presence of young children is to reduce participation as expected, although, a little surpris-

Table 6.3 Regression Results

	(1)	(2)	(3)
CONSTANT	1.111	0.472	0.580
	(2.62)	(1.30)	(1.62)
W_W (Wage)	0.324	0.089	0.071
	(5.45)	(1.44)	(1.16)
U_h (Unemployment)	-0.032	-0.014	-0.013
	(-6.28)	(-2.94)	(-2.78)
K_1 Children (0-1)	-0.151	-0.099	-0.095
	(-7.62)	(-5.78)	(-5.64)
K_2 Children (2-4)	0.050	-0.010	-0.007
	(1.17)	(-0.61)	(-0.46)
K_3 Children (5-6)	-0.257	-0.091	-0.107
	(-5.32)	(-2.14)	(-2.52)
A_2 Age 20-24	0.078	0.099	0.090
	(2.01)	(3.06)	(2.83)
A_3 Age 25-34	0.055	0.177	0.160
	(0.51)	(1.94)	(1.78)
A_4 Age 35-44	0.062	0.184	0.172
	(0.68)	(2.38)	(2.29)
A_5 Age 45-54	0.026	0.173	0.154
	(0.30)	(2.38)	(2.15)
A_6 Age 55-59	-0.017	0.024	0.017
	(-0.45)	(0.75)	(0.55)
A_7 Age 60-64	-0.090	-0.021	-0.026
	(-2.58)	(-0.72)	(-0.87)
A_8 Age 65+	-0.131	-0.048	-0.062
	(-2.77)	(-1.22)	(-1.58)
YH	-	0.065	0.065
		(2.85)	(2.49)
EM	-	0.133	0.132
		(1.62)	(1.58)
EA	-	0.085	0.078
		(3.56)	(2.92)
GL	-	0.132	0.131
		(4.83)	(4.39)
RoSE	-	0.081	0.088
		(3.33)	(3.26)
SW	-	0.042	0.045
		(1.78)	(1.70)
WA	-	-0.086	-0.074
		(-3.68)	(-2.83)
WM	-	0.105	0.110
		(4.50)	(4.20)
NW	-	0.116	0.120
		(5.03)	(4.61)
SC	-	0.020	0.019
		(0.87)	(0.73)
NI	-	-0.183	-0.176
		(-7.20)	(-6.26)
R^2	0.393	0.598	0.562
F	25.23	29.53	24.103
LM	95.47	13.44	7.34
n	480	480	456

Sources: FES (1968-1977)
t Statistics in Parentheses.

ingly, the anticipated reduction on the effect for older children is not confirmed in this analysis. Controlling for these other influences, the pattern of age effects shows a profile of increasing participation up to the 35-44 age band, declining steadily thereafter, whilst the regional pattern indicates that, all other things being equal, participation tended to be highest in the East Midlands and lowest in Northern Ireland.

Turning to the regional pattern implied by the coefficients on the dummy variables, the results suggest that all other things being equal, participation rates tend to be highest in the East Midlands and Greater London, and lowest in Northern Ireland. Clearly, it would be more satisfactory to be able to explain this pattern of regional variation than to take it as given, and the large drops in the coefficient and significance of the wage and unemployment variables that occur between equations (1) and (2) do suggest that inclusion of the regional dummy variables is transferring some of the explanation away from these variables of interest. Nevertheless, the large jump in R^2 of 20% does suggest that the regional dummies are adding substantially to the fit of the model, beyond that provided by the variables in equation (1).

There is still some evidence of autocorrelation, however, and regressions of residuals on their own past values indicated that autocorrelation was of orders 1 and 2. Initially a version of the Cochrane-Orcutt iterative routine extended to include second order autocorrelation was applied, and the results are presented as equation (3) in Table 6.3 ($\hat{\rho}_1$ = .043, $\hat{\rho}_2$ = .075). The basic texture of the results is unaffected by this procedure. The problem with this technique, however, is that it imposes unnecessary and untested restrictions across parameters in the dynamic specification of the model. The equation was therefore re-estimated using a general rational lag function of the kind proposed earlier, using lags of up to 2 quarters on the dependent and independent variables. Various restrictions that were not rejected by the data were then imposed sequentially, yielding the following final equation:

$$\begin{aligned}
\widehat{(p_r/P)}_t = &\underset{(-0.37)}{-0.065} + \underset{(2.00)}{0.071} \sum_{j=0}^{2} W_{wt-j} \underset{(-2.97)}{-0.014U_{ht}} + \underset{(2.31)}{0.010U_{ht-1}} - \underset{(-5.76)}{0.094K_{1t}} \\
&- \underset{(-1.95)}{0.021\Delta K_{2t}} - \underset{(-2.77)}{0.113K_{3t}} + \underset{(7.28)}{0.118A_{2t}} + \underset{(3.86)}{0.051A_{2t-1}} + \underset{(5.50)}{0.238A_{3t}} + \underset{(6.34)}{0.229A_{4t}} \\
&+ \underset{(6.43)}{0.208A_{5t}} + \underset{(2.23)}{0.047A_{5t-1}} + \underset{(2.61)}{0.044A_{6t}} - \underset{(-1.17)}{0.014A_{7t-1}} - \underset{(-1.65)}{0.031A_{8t}} \\
&+ \underset{(3.18)}{0.070YH} + \underset{(3.91)}{0.090EM} + \underset{(3.70)}{0.086EA} + \underset{(2.68)}{0.087GL} + \underset{(3.05)}{0.079ROSE} + \underset{(2.27)}{0.052SW} \\
&- \underset{(-2.05)}{0.048Wa} + \underset{(4.41)}{0.104WM} + \underset{(4.71)}{0.107NW} + \underset{(0.88)}{0.019Sc} - \underset{(-5.24)}{0.141NI} + \underset{(2.02)}{0.056} \sum_{j=1}^{2} (p_r/P)_{t-j}
\end{aligned}$$

$R^2 = 0.642$ $F = 28.38$ $LM = 9.12$ $n = 456$

The LM statistic indicates the absence of autocorrelation, and the characteristic roots of the equation took the values 0.267 and -0.211. Both these roots are less than unity in absolute value, indicating that the equation is dynamically stable. It is interesting to note that by effectively averaging the wage rate variable over three quarters, a significant positive coefficient is attracted. This result may perhaps reflect the sampling variation in the FES data mentioned in the previous section. All the remaining estimated coefficients agree in sign with prior expectations.

In Table 6.4 the implied lag structures and long-run effects are presented.(14) The results indicate a fairly rapid decay in the implied lag structures, due to the small coefficients on the lagged

Table 6.4 The Implied Lag Structures

LAG	W_W	U_L	K_1	K_2	K_3	A_2	A_3	A_4	A_5	A_6	A_7	A_8
D	0.071	-0.137	-0.094	-0.021	-0.113	0.118	0.238	0.229	0.208	0.044	0	-0.031
1	0.075	0.097	-0.005	0.020	-0.006	0.058	0.013	0.013	0.059	0.002	-0.014	-0.002
2	0.079	-0.002	-0.006	0	-0.007	0.010	0.014	0.014	0.015	0.002	-0.001	-0.002
3	0.009	0.005	-0.001	0.001	-0.001	0.004	0.002	0.002	0.004	0.	-0.001	0.
4	0.005	0	0	0	0	0	0.001	0	0.001	0	0	0
TOTAL	0.240	-0.037	-0.106	0	-0.127	0.190	0.268	0.258	0.287	0.050	-0.016	-0.035

Notes: Lag structures derived from estimated coefficients.

dependent variables. It is interesting to note that whilst the unemployment rate of married males exerts a sizeable negative short-run effect, the long run effect is negligible. Thus, a sustained increase is required before any substantial long run effect may be observed.

8. Regional Convergence in Participation Rates

Purely as an aid to interpretation, it is perhaps useful to calculate some benchmark for the regional pattern of participation rates implied by the estimated model. It may be noted that if (for a lengthy period of time) no regional variation existed in the explanatory variables then $W_{wrt} = U_{hrt} \ldots = A_{8rt} = 1$, in which case the model predicts a value for the dependent variable given by the formula:

$$(\hat{p_r/P})_t = \alpha_r + \sum_i \sum_j \beta_{ij}$$

where k is the number of slope coefficients, and j the length of the lag. Calculations of this formula are given in Table 6.5.

Table 6.5 $(\hat{p_r/P})_t = \alpha_r + \sum_i \sum_j \beta_{ij}$

N	YH	EM	EA	GL	RoSE	SW	Wa	WM	NW	Sc	NI
0.90	0.98	1.00	1.00	1.00	0.99	0.96	0.84	1.02	1.02	0.92	0.74

This initial pattern we may take for the purposes of interpretation to be broadly given, and one upon which we can build, by incorporating further information on variation in wages etc. Thus, if no regional variation existed in the explanatory variables, then the model would predict participation rates in the North 10% below the national average, whilst in the West Midlands they would lie 2% above. Having established the initial starting points we may now examine the effect of regional variation in the explanatory variables on this distribution. If, for example, wage rates rose in the North to 10% above the national average, then participation would rise in the long run by 2.4% to 92.4% of the national average, with the lag structure presented in Table 6.4.

Table 6.6 presents average actual and predicted values generated by the model for 1968_{III} - 1969_{II}, and 1977_{I} - 1977_{IV} (the first two time points are lost due to the inclusion of lagged variables in the regression equation). The predicted values indicate how much the regional variation in the explanatory variables has caused the regional distribution of participation rates to vary from the initial starting point in Table 6.5. Thus, in Northern Ireland for example the model indicates that unemployment, wage rates and family and age structure reduced participation from 74% of the national average to 64.1% in 1968/69. Predicted values correspond well to the actual values, although much sampling variation is in evidence, especially in East Anglia and the South West. Inspection of both the actual and predicted values reveals a general trend toward regional convergence along the lines discussed in section 3, despite the sampling variation. The means of both the actual and predicted values move closer towards unity over the period and there is a fall in the standard deviation around the mean.

Formally, this trend implies that the regional variance of (p_r/P) had been collapsing around unity over the estimation period.

Table 6.6

Actual and Predicted (Pr/P)

	1968/69			1977		
	ACTUAL	PREDICTED	ERROR	ACTUAL	PREDICTED	ERROR
N	0.902	0.899	-0.003	0.939	1.002	0.063
YH	0.999	0.967	-0.032	0.964	1.023	0.059
EM	0.981	0.980	-0.001	1.007	1.043	0.036
EA	1.168	1.026	-0.142	0.866	0.921	0.055
GL	1.122	1.114	-0.008	1.096	1.060	-0.036
ROSE	1.114	1.073	-0.041	1.054	1.069	0.015
SW	0.809	0.951	0.142	1.141	0.945	-0.196
Wa	0.808	0.829	0.021	0.916	0.897	-0.019
WM	0.988	1.008	0.020	0.991	1.029	0.038
NW	1.050	1.078	0.028	0.982	1.026	0.044
Sc	0.924	0.927	0.003	0.919	0.882	-0.037
NI	0.674	0.641	-0.033	0.731	0.681	-0.050
MEAN	0.962	0.958		0.967	0.964	
STANDARD DEVIATION	0.410	0.123		0.103	0.105	

UK Participation Rate 1968/69 = 45.0

UK Participation Rate 1977 = 55.2

Sources: FES base tapes

Regional variances in (p_r/P) can be calculated for each time point. Regressing the logarithm of the regional variance of (p_r/P) on time yielded(15):-

$$\ln [\sigma^2 (p_r/P)]_t = \underset{(-25.71)}{-3.687} - \underset{(-1.90)}{0.011t} + error_t \qquad R^2 = 0.096$$

$$d = 2.00 \qquad LM = 0.06$$

In order to test the ability of the model to capture these time series trends, the following regression was also estimated:-

$$\ln [\sigma^2 (\hat{p_r/P})]_t = \underset{(-23.56)}{- 4.014} - \underset{(-2.04)}{0.014t} + error_t \qquad R^2 = .104$$

$$d = 1.66 \qquad LM = 4.76$$

where $(\hat{p_r/P})$ indicates predicted values, taken from the regressions presented in the previous section, rather than actual values. The results indicate that the trend is in fact present in both actual and predicted values, with a rate of decline of between 1.1% and 1.4% per quarter respectively. Thus, over 40 quarters the variance is predicted to decline by over 40%.

In principle it is, of course, possible to decompose $\sigma^2 (\hat{p_r/P})_t$ into the variances of the $(x_{ir}/X_i)_t$ and therefore determine the causes of regional convergence in terms of the explanatory variables. The problem with this approach is that the (x_{ir}/X_i) are typically not independent, however, and the covariances must therefore also be considered. A pragmatic solution to this problem is to estimate the relationship in a regression framework(16):-

$$\ln [\sigma^2 (\hat{p_r/P})]_t = A + \sum_i \sum_j B_{ij} \quad \ln [\sigma^2 (x_{ir}/X_i)]_{t-j} + e_t \quad (6.2)$$

The following (i=1....k) relationships may also be estimated:

$$\ln [\sigma^2 (x_{ir}/X_i)]_t = a_i + b_i t + V_{i_t} \qquad (6.3)$$

where e and V are error terms.

Substituting these relationships into equation (6.2) and differentiating with respect to time yields:-

$$\frac{d \ln [\sigma^2 (p_r/\hat{P})]}{dt} t = \sum_i \sum_j B_{ij} b_i$$

The results of estimating (6.2) and (6.3) are given in the appendix. The calculated $\Sigma B_{ij} b_i$ are given in Table 6.7. These results indicate that within the context of the model developed here, convergence in regional participation is largely attributable to regional convergence (in proportional terms) in unemployment rates, and to a lesser extent wage rates.

As regards convergence in regional unemployment rates, one substantive issue which perhaps requires further thought relates to whether relative or absolute differences are the appropriate measure of dispersion in regional unemployment rates. Clearly, as an arithmetic property it is the case with constant <u>absolute</u> differences, any increase in the national <u>average</u> unemployment rate will cause <u>relative</u> regional unemployment rates to converge. Thus over the latter half of the period under consideration it is likely that converging relative regional unemployment rates reflected the rising national average, whilst a measure constructed in terms of absolute differences would have presented a picture of divergence rather than convergence.(17) To the extent, however, that there exists, <u>ceteris-</u>

Table 6.7

The calculated $\sum_j B_{ij} b_i$

Variable	$\sum_j B_{ij} b_i$
W_w	-.003
U_h	-.010
K_1	.000
K_2	.000
K_3	.000
A_2	.000
A_3	.000
A_4	.000
A_5	.002
A_6	.001
A_7	.000
A_8	.000
$\sum_i \sum_j B_{ij} b_i$	-.010

paribus, some uniform upper limit to the depth of hidden labour reserves that might be generated by such discouraged worker effects, the property that relative regional unemployment rates (and therefore, participation rates) will tend to converge as a result of rising national unemployment (given a constant pattern of absolute regional unemployment differences) would not appear, a priori, to be an undesirable feature of constructing the unemployment variable in ratio form rather than absolute differences. Clearly, however, more theoretical (as opposed to empirical) work is required on this issue.

9. Summary

In this chapter, the analysis of spatial variation in labour force participation was considered in terms of orthodox theory and previous empirical evidence. The general stability over time and space in male participation was contrasted with the relative volatility in married female participation in both these dimensions. Previous studies of geographical variations in participation rates were characterised as essentially aspatial in their approach, and a number of problems were identified in relating standard theory to the analysis of spatial variation. These problems were seen to be less severe at the fairly aggregate level of the Standard Planning Regions for example, as opposed to the analysis of variations within a particular labour market. At this rather aggregate level, a number of interesting trends were identified, quite apart from the general rise in married female participation which has, by now, been well documented in the literature. In particular, recent historical experience suggested a trend toward regional convergence in female participation.

A regional analysis of married female participation rates between 1968 and 1977 was undertaken, therefore, based on small sample survey data from the FES. The results of this analysis indicated that both age and family structure played a significant explanatory role in the determination of married female participation across regions and over time, whilst both wage and unemployment effects were also in evidence. An analysis of the causes of regional convergence in married female participation suggested that regional convergence in (proportional) wage and unemployment rates played a significant explanatory role.

Appendix

$$\ln \sigma^2[(x_{ir}/X_i)]_t = a_i + b_i t + e_{i_t}$$

	a_i	b_i	R^2	d	LM
$\ln[\sigma^2(W_w)]_t$	-4.472 (-66.14)	-.013 (-4.47)	.370	2.07	2.09*
$\ln[\sigma^2(U_h)]_t$	0.315 (1.50)	-.022 (-2.50)	.145	1.80	1.31*
$\ln[\sigma^2(K_1)]_t$	-2.846 (-14.82)	.017 (2.14)	.113	1.62	1.09
$\ln[\sigma^2(K_2)]_t$	0.152 (2.40)	.019 (7.07)	.581	2.01	5.51
$\ln[\sigma^2(K_3)]_t$	-3.896 (-24.66)	.001 (0.13)	.001	2.04	1.22*
$\ln[\sigma^2(A_2)]_t$	-2.234 (-31.57)	.008 (2.81)	.180	2.13	2.83*
$\ln[\sigma^2(A_3)]_t$	-3.421 (-21.63)	.001 (0.19)	.001	2.01	2.79
$\ln[\sigma^2(A_4)]_t$	-3.484 (-21.01)	.021 (3.11)	.211	1.98	3.55
$\ln[\sigma^2(A_5)]_t$	-3.599 (-15.48)	0.023 (2.57)	.163	1.76	1.25*
$\ln[\sigma^2(A_6)]_t$	-2.049 (-11.24)	-.001 (-0.10)	.000	2.17	2.11
$\ln[\sigma^2(A_7)]_t$	-2.063 (-14.30)	.004 (0.66)	.012	1.74	5.49
$\ln[\sigma^2(A_8)]_t$	-1.947 (-10.08)	-.013 (-1.63)	.069	1.89	4.26

Continued .....

Appendix continued

$$\ln[\sigma^2(\hat{p_r/P})]_t = \underset{(-4.94)}{-5.612} + \underset{(1.72)}{0.292}\ \ln[\sigma^2(\bar{W}_w)]_t - \underset{(-0.78)}{0.101}\ \ln[\sigma^2(W_w)]_{t-1}$$

$$+\underset{(5.34)}{0.447}\ \ln[\sigma^2(U_h)]_{t-2} \underset{(-1.34)}{-0.103}\ \Delta\ln[\sigma^2(K_1)]_{t-1}$$

$$+\underset{(0.05)}{0.015}\ \ln[\sigma^2(K_2)]_t \underset{(-2.64)}{-0.195} \sum_{j=1}^{2} \ln[\sigma^2(K_3)]_{t-j}$$

$$+\underset{(2.28)}{0.179}\Delta\ln[\sigma^2(A_2)]_t \underset{(-0.05)}{-0.006}\ \ln[\sigma^2(A_3)]_t$$

$$\underset{(-4.32)}{-0.478}\ \Delta\ln[\sigma^2(A_4)]_t \underset{(0.80)}{+0.097}\ \ln[\sigma^2(A_5)]_t$$

$$\underset{(-4.48)}{-0.514}\ \ln[\sigma^2(A_6)]_{t-2} \underset{(-3.55)}{-0.355}\ \Delta\ln[\sigma^2(A_7)]_t$$

$$+\underset{(1.37)}{0.103}\ \Delta\ln[\sigma^2(A_8)]_t \underset{(5.14)}{+0.502}\ \Delta\ln[\sigma^2(p_r/P)]_{t-1}$$

$R^2 = 0.822$ $F = 6.93$ $d = 1.90$ $n = 36$ $LM = 5.19$

SOURCE = FES (1968-1977)

Notes: σ^2 refers to the variance of each variable across regions at time t. All variables are the ratios of regional to national rates. Equations marked * have been adjusted for autocorrelation.

CHAPTER 7 GENDER DIVISIONS IN LOCAL LABOUR SUPPLY: A MODEL OF THE LONDON LABOUR MARKET*

1. Introduction

The purpose of this chapter is to attempt to integrate a number of the strands of thought outlined so far within the context of a simultaneous labour markets system for Greater London, and to explore the different labour market positions of men and women within a specifically spatial context. Both demand and supply sides of the labour market will be treated as endogenous, and the implications of the analysis for the understanding of spatial unemployment differentials explored. In the previous chapter, important differences were noted between men and women in terms of their patterns of local labour supply. In this chapter we shall consider these differences in a wider context, and also attempt to unravel the processes which generate such asymmetries.

Clearly, gender divisions exist in local labour markets not only on the supply side, with unequal constraints on the timing and location of economic activity, but also on the demand side, as reflected in the persistent forms of occupational segregation. Both sets of divisions are deeply embedded and of great significance, but it is mainly on the supply side that spatial factors are likely to be of greatest import. Of particular importance in this regard are issues

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* This chapter is a revised version of a paper written with Ian Gordon (Gordon and Molho (1985b)).

such as the potential dependence of married female migration decisions on the locational choices of their husbands (as touched upon in chapter 6), restricted commuting fields, and limited access to employment opportunities. The main objective of this chapter, therefore, is to locate models of female labour supply in an explicitly spatial context, and to examine the contribution that spatial factors can make to our understanding of female labour supply. By examining the broad range of local supply-side adjustment processes of men and women (in terms of migration, participation, and also commuting change) in the face of endogenously determined distributions of labour demand and earnings, the different causal processes which underly the asymmetry between the sexes in terms of their local labour supply may be traced through.

Ironically, the position of women in local labour markets has been less extensively studied than that of men, and there has been a particular lack of econometric work on such issues as spatial variation in female employment and unemployment, as well as migration. To a large extent this bias stems from a taken-for-granted view of males as the dominant agents in the labour market, combined with the anticipated analytical complexities of introducing an adequate model of female labour markets. A growing body of work has pointed to the importance of women in the restructuring of employment and the changing regional division of labour (Massey, 1983) and to some of the distinctive problems faced by women in local labour markets (Vipond (1980); Lewis and Foord (1984)). Most of this work has been qualitative in character - focussing particularly on issues of segmentation, labour process and the relation between women's roles in production and in reproduction - and has carried with it a critique of the atheoretical character of urban modelling and of the tendency simply to transfer to the female case, models developed for the analysis of male labour markets.

The approach adopted here involves the elaboration and estimation of a simultaneous equations model which seeks to account for variations between districts in male and female migrational flows (of various types), employment change, unemployment rates, commuting changes and participation rates, together with house prices and construction rates. It is a comparatively large system, including some 31 equations (excluding identities) with the potential to simulate the impact of exogenous local changes in, for example, land availability, job creation or the mix of housing tenures. By intent, however, it is neither a planning nor a forecasting tool but rather a disciplined framework for developing and testing hypotheses about the operation of adjustment processes in the labour markets of the region. The concern is as much with qualitative as with quantitative conclusions and the rationale for specifying a fairly full system of relationships and for analysing several population groups simultaneously has been particularly to allow more checks on the substantive consistency and interpretability of results during the process of model development.

The remainder of this chapter is in three main sections: the first of these outlines the structure of the model and the main sets of relationships embodied in it; the second describes the basic data set, and the third discusses the main results to emerge from estimation of the model.

2. The Model

2.1 General Structure

In starting to develop a model of female labour markets in the London region the approach adopted here was to extend an existing model estimated originally for males by Gordon and Lamont (1982) to incorporate factors specific to the labour market for women and to model the interdependences between the gender based markets, rather than starting from first principles in the theoretical literature on women and employment. A limitation of this approach is that the model treats employment in a rather aggregated fashion, making no distinctions between primary and secondary jobs or other segments of the labour market which may offer distinctive conditions of employment and different forms of competition between males and females. On the other hand, the very explicit treatment of spatial interdependences, in terms of commuting flows and different types of migration, and of the relationship between housing and labour markets offered a strong basis for the investigation of the form and effects of locational constraints on women in the labour market.

Thus, the methodology adopted here is to identify certain features specific to female labour markets, and explore their implications within a spatial context, rather than attempting to embody a comprehensive understanding of these processes in a model of local female labour markets. The relative predominance of part-time work, generally lower rates of pay, fragmented career profiles and discrimination in terms of wages and job opportunities in female labour markets will be taken as given, rather than explained, as will the distinctive patterns of industrial and occupational segregation.

Forms of vertical and horizontal separation of men and women at work have changed little over the last eighty years and female employment has remained concentrated in a minority of occupations (Hakim (1981)).

The general structure of the model is sketched in Figure 7.1 which shows the principal links between sets of equations and exogenous variables. As the diagram suggests, a block of migration equations is at the hub of the model linking developments in the female labour market with both the housing market and the market for male labour. Two-way relationships with migration are postulated for house construction, employment change and unemployment: in the first two cases the link is expected to amplify changes, while the unemployment-migration link should be equilibrating. It can be seen that most of the central relationships in the model are quantity-quantity relationships and that price variables (notably earnings) play a more peripheral role. This accords with the general view adopted in this thesis of the crucial importance of the number and distribution of opportunities, and of individuals exposed to those opportunities, in determining patterns of change in metropolitan housing and labour markets, with variations in actual or reservation prices playing a more limited role. The salience of earnings variables was not ruled out *a priori*, however, and they have been included in the estimated version of more equations than are indicated in this diagram but generally proved insignificant.

2.2 Migration

Following the approaches set out in the earlier part of this thesis, a multi-stream gravity model of migration behaviour is

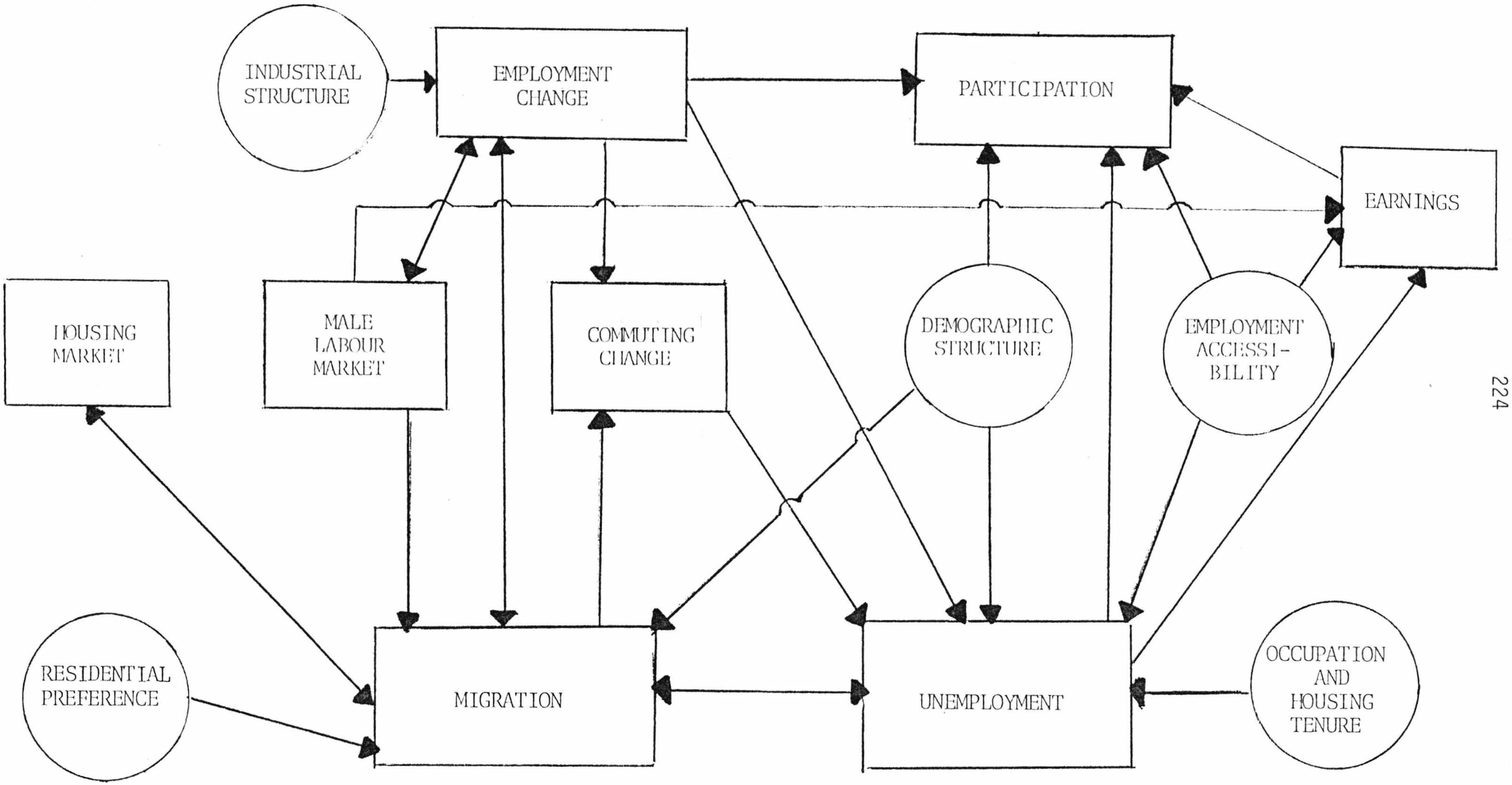


Figure 7.1 The Female Labour Market

specified. At this very detailed level of areal aggregation however, the simple two-stream gravity model formulation adopted earlier may be seen to be inadequate due to the presence of a significant middle distance stream (Gordon and Vickerman (1982)). The distinction between purely 'employment related' and 'housing related' migration (adopted earlier for expositional ease) will therefore be replaced in this chapter by the following hierarchy of migration streams:-

(1) A national movement stream, principally involving flows to and from other regions, includes moves for which employment considerations for at least one member of a household are liable to be important factors, and which are likely to require changes of workplace for all working members of the household.

(2) A regional stream incorporates mostly middle-distance moves undertaken in search of better areas, and which in the London region are predominantly outward from Greater London to the Outer Metropolitan Area or beyond. For males, such moves tend not to be influenced by employment considerations and are associated (at least initially) with longer distance commuting back to an existing workplace (Gordon et al. (1983)). For females with lower pay, shorter hours and more constraints on commuting, the employment consequences of such moves are more likely to be significant, however.

(3) The local stream includes the majority of short distance moves undertaken essentially for housing reasons, particularly for larger housing. Most such moves are within districts but an outward bias, particularly among new

entrants to owner-occupation, makes this the largest component in population loss for Inner London. Even for males such moves may lead to workplace changes in the longer run: for females there could be more immediate effects on employment for part-timers, the lowest paid or those in a secondary labour market dependent on localised sources of job information (Gordon et al. (1983)).

Using standard notation, the model may formally be expressed as:-

$$M_{ij} = \sum_{s=1}^{3} A_i^s B_j^s \exp(-\beta_s D_{ij}) \qquad (7.1)$$

Calibration of this interaction model on the relevant inter-area migration matrices yields estimates of the sets of push and pull factors for each stream to be used as the dependent variables for the migration equations in the econometric model, together with estimates of the breakdown of net migration between the three streams which are used as independent variables in other equations. (See section 4 for a discussion of estimation methods.) The migration equations are specified in exponential form along the lines described in chapter 2, with the dependent variables constructed as:-

$$\ln\left(\frac{A_{ip}^s}{P_{ip}}\right) \quad \text{and} \quad \ln\left(\frac{B_{jp}^s}{P_{jp}}\right)$$

where P = population and the subscript p denotes a particular population sub-group

The specific sets of variables included in the equations for particular streams reflect the particular motives associated with each as well as factors (such as housing tenure) serving as constraints on all types of movement. Some interdependence between migration streams was also allowed for, with national stream immigration as a possible influence on shorter distance emigration, reflecting a postulated strategy of successive approximation in residential movement. Mover-stayer effects within particular streams were also tested for by including pull factors (B_j) values in the push factor (A_i) equation. In general independent variables were defined directly in relation to the situation of the resident population: in the case of employment growth rates, however, the estimates were weighted averages of changes in the relevant workplace areas, thus implicitly assuming similar commuting patterns for migrants and other residents.

In a labour market model the main concern is with migration of the economically active population. For married women in particular, however, labour force status may be significantly affected by residential movement as discussed in the previous chapter. In the empirical analysis, however, practical considerations inhibited a direct treatment of this interaction and the dependent variables for the migration equations have been defined simply in terms of those who were economically active at the end of the period. In other respects also the formal treatment of migration by non-married women was similar to that for males although explanatory variables were defined in terms, respectively, of female or male labour market indicators and commuting patterns, and differences were anticipated in the relative strength of particular relationships. For married women, however it was supposed that male labour market conditions and employment opportunities were likely to be the more important influence on movement. After experimenting with alternative formulations, the simplest form of treatment of this dependence was found to be the inclusion of the male migration variables (A_i, B_j) in the corresponding equations for married females. Because marital status changes are strongly associated with some types of movement, estimates of in-migration by non-married females were also included in the push factor equations for married women.

Disaggregation of the migration model to distinguish the influences on movements of economically active men, married and non-married women involves little that is fundamentally different and few relationships which are not intuitively obvious. By making the dependences and constraints more explicit, however, it becomes possible to trace through their implications for the forms of adjustment process operating within and between local labour markets and the differential outcomes for particular groups.

2.3 Commuting Change

Because commuting is a repeated activity in which the individual returns to base at the end of each daily or weekly cycle, (in contrast to migration) it is commuting change which is the significant labour market adjustment process. Much less attention has been paid to modelling changes in the balance of flows than to the simulation of origin and destination matrices (but c.f. Congdon (1983); van der Veen and Evers (1983)). However, conventional gravity-type models of commuting suggest that changes in net gains or losses during a particular time period should largely be explicable in terms of net migration on the one hand and intra-labour market differences in rates of employment growth or decline on the other. Some distinction would clearly need to be drawn between the different migration streams since if the shorter distance movers retain an existing workplace they will necessarily affect commuting more than longer distance movers who may well shift their workplace into their new district of residence. For those who do not move their residence, we assume that changes in the pattern of commuting are likely to reflect firstly a desire to reduce commuting distances, as and when opportunities become available, and secondly any differences in rates of employment growth between districts within a travel-to-work area. Ignoring the factors which might affect the intensity of interaction between specific pairs of areas, this accounting approach suggests a net commuting change equation of the form:-

$$\Delta c_i = \lambda_o (r_i - \bar{r}_{ttw}) + \sum_{s=1}^{3} \lambda_s m_i^s - \lambda_4 c_{i(t-1)} \qquad (7.2)$$

where c = net commuting as a proportion of employment

r = rate of employment change

$\bar{r}_{ttw}$ = average rate of employment change in areas of workplace of residents of area i

m^s = net migration in stream s as a proportion of employment

The same form of equation should be applicable equally to both males and females. Since both lower earnings and specific time constraints tend to limit women's travel to work (Madden (1977); Pickup (1984)), values of both the variables and parameters are likely to be significantly different, however. In particular, commuting changes for women should be less affected by each of the factors included in equation (7.2).

2.4 Labour Force Participation

Following on from chapter 6, female labour force participation rates (disaggregated by marital status) are incorporated into the model as an alternative to mobility in the labour supply adjustment of women. Given the highly integrated nature of the London Metropolitan region as a geographical network, in comparison to the Standard Planning Regions analysed earlier, explicitly spatial influences are likely to be of some importance. In an attempt to capture such effects, a number of variables relating to residential and employment density, distance from the main employment centres etc. were included in the model, in addition to net female migration rates (disaggregated by stream) predicted by the migration model, in order to control for adjustments in local population structure arising through such movements.

The other variables included in the model are fairly standard and reasons for their inclusion have already been discussed at length in chapter 6, eg. the rate of unemployment, earnings, the presence of young children, age structure, lagged values of the participation rate etc. The only other variable worthy of particular comment which was included in the model was the rate of employment growth, which in terms of the framework of the previous chapter is likely to affect the flow of new opportunities faced by potential re-entrants in the labour market. This variable is rather unconventional as compared to standard formulations of participation equations (which tend to concentrate on wages and unemployment as the relevant labour market conditions), but fits in well with the perspective of entry into participation as the outcome of a search process, analogous to the search model of migration set out in chapter 2.

2.5 Unemployment

Much of the work discussed so far in relation to labour supply and demand is aimed ultimately towards gaining a better understanding of the determination of local unemployment rates differentials, and indeed much of the introductory chapter of this thesis focussed on this issue. In this final analytical chapter, therefore, we attempt to draw together some of the strands of thought developed so far in order to examine their implications for the understanding of local unemployment patterns. As it was argued in the introductory chapter, most analyses of urban and regional unemployment have sought to apply essentially aspatial models developed for the analysis of more-or-less closed labour markets in the national economy. In particular, they have tended to ignore the implications of induced migration and commuting as adjustment mechanisms at the sub-national level.

So long as net labour migration into an area is influenced by the difference between its unemployment rate and that in other areas, it can be shown that differences in unemployment rates across areas will tend to an equilibrium pattern determined by relative rates of employment growth, natural change in labour supply and labour force characteristics such as age, race or skill (Brown (1973); Burridge and Gordon (1981)). The logical elements of this argument may briefly be described as follows. By taking a linear approximation to the gross flows model of employment related migration, one may derive a net migration function in terms of the potentialised explanatory variables, including the unemployment rate. This behavioural net migration function may then be substituted into an identity comprising the components of change in local unemployment rate differentials i.e. natural growth in labour supply, employment growth, net migration, and net commuting change. In equilibrium, changes in local unemployment rate differentials should tend to zero. Imposing this condition onto the system, therefore, one can solve for the equilibrium level of unemployment (as opposed to the change), appearing as an argument in the net migration function, in terms of all the other variables affecting net migration, plus the remaining components of change in local unemployment differentials appearing in the original identity.

In periods of reasonably full employment, when mobility rates are high, convergence on this pattern is likely to be quite rapid and the equilibrium unemployment rate model provides a good approximation to cross-sectional differences in unemployment rates. At times of high national unemployment when mobility is constrained by uncertainty, lack of liquidity or poor information (as in the 1980's) (eg. see chapter 5), the spread of unemployment rates tends to widen, adaption to equilibrium is slower and differentials embody the lagged effects of employment changes over more protracted periods (Gordon (1985c)). This would tend to be the case also for labour market groups with more restricted mobility as well as for areas which are less open to migration or commuting.

This line of analysis has been applied with some success to the modelling of male unemployment rate differentials, both in time series and in cross-section (Gordon and Lamont (1982); Gordon (1985b)). Its extension to females raises a number of additional issues, however - principally the interaction with male labour market trends and the endogeneity of participation rates. To consider these we should first set out the basic form of the equilibrium unemployment rate model, which involves an identity:-

$$\Delta u \equiv s - r + m + \Delta c + \dot{p} \tag{7.3}$$

where u = unemployment

s = natural change in labour supply

r = employment change

m = net labour migration

c = net commuting

$\dot{p}$ = labour supply changes resulting from variations in participation rates

and all variables are expressed as proportions of employment.

And three behavioural equations:-

$$m = f_1 (\hat{u}, \hat{r}, \tilde{X}) \tag{7.4}$$

$$\Delta c = f_2 (\hat{\hat{r}}, \tilde{Y}) \tag{7.5}$$

and

$$\dot{p} = f_3 (r, u, \tilde{Z}) \tag{7.6}$$

where the hatted variables are differentials between travel to work areas and the doubly hatted variable is the differential within a travel to work area.

$\tilde{X}$, $\tilde{Y}$, $\tilde{Z}$ are vectors of additional variables.

The equilibrium condition is that equation (7.3) be set at zero, when the corresponding equilibrium unemployment rate may be derived by substituting equations (7.4), (7.5) and (7.6) in (7.3) and solving for u. In this formulation, therefore, all other variables appearing in the migration, participation or commuting change equations ($\tilde{X}$, $\tilde{Y}$, $\tilde{Z}$) would thus be influences on the equilibrium unemployment rate. Specifically, in the case of women, if male labour market variables affect migration, they will also affect female unemployment. Thus, for example, if male employment growth draws in more married women as well as men to an area without affecting the female employment growth rate, it should raise female unemployment in the area.

3. The Data

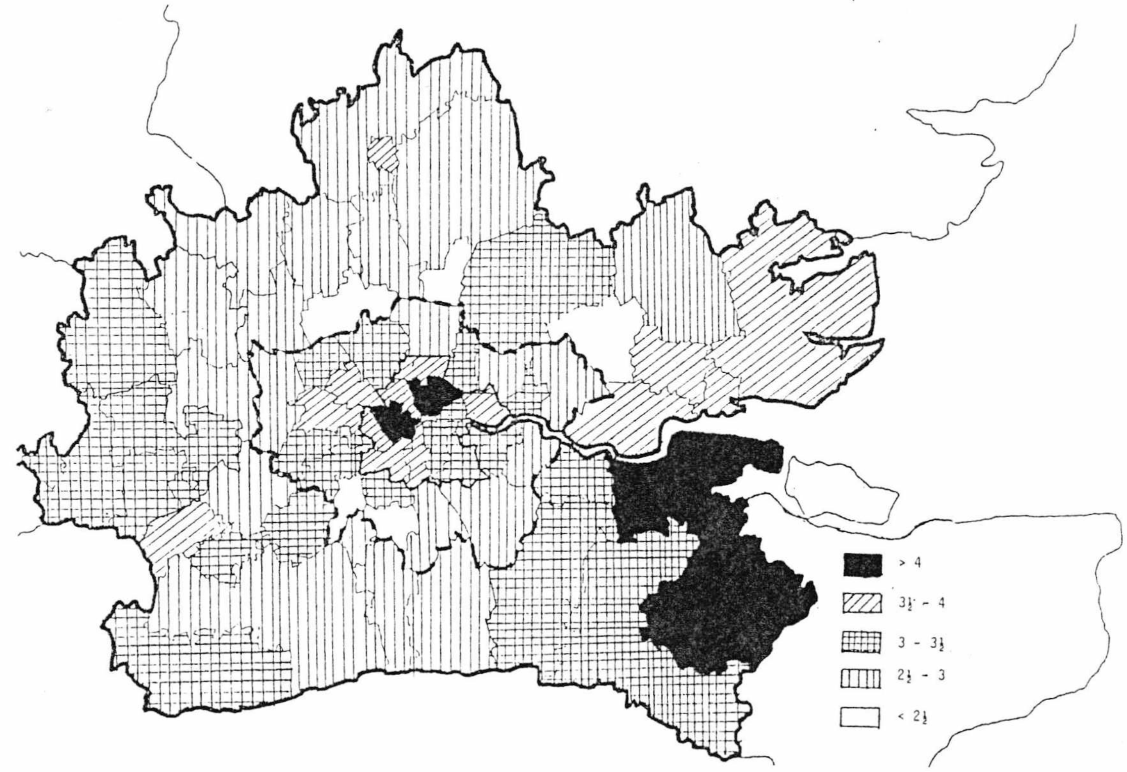
The main data base for estimation of the model outlined in the previous section consists of 71 boroughs, districts or pairs of districts in the London metropolitan region, drawn primarily from the Census of Population and relating to conditions in 1971 and changes between 1966-1971. A list and map of the 71 areas is provided in Appendix 1. Full data from the 1981 Census were not available at the time of writing (Summer 1984), and would not in any event allow the same direct matching between recorded 5 year migration and intercensal employment changes. This period is also of particular interest as one in which population and employment decentralization within the London region were at their height.

The broad features of some of the key variables are exhibited in maps 7.1 to 7.8. The maps of female and male unemployment in 7.1 and 7.2 (measured on a census definition and including the unregistered unemployed) display some striking differences; female unemployment is clearly much more evenly distributed spatially as compared to male unemployment which is densely concentrated in the inner city and to a lesser extent outer London and along the Thames estuary. Employment changes by contrast (maps 7.3 and 7.4) display a more similar distribution across space as between men and women, with the major losses being concentrated (perhaps predictably) in the inner city and also parts of outer North West London.

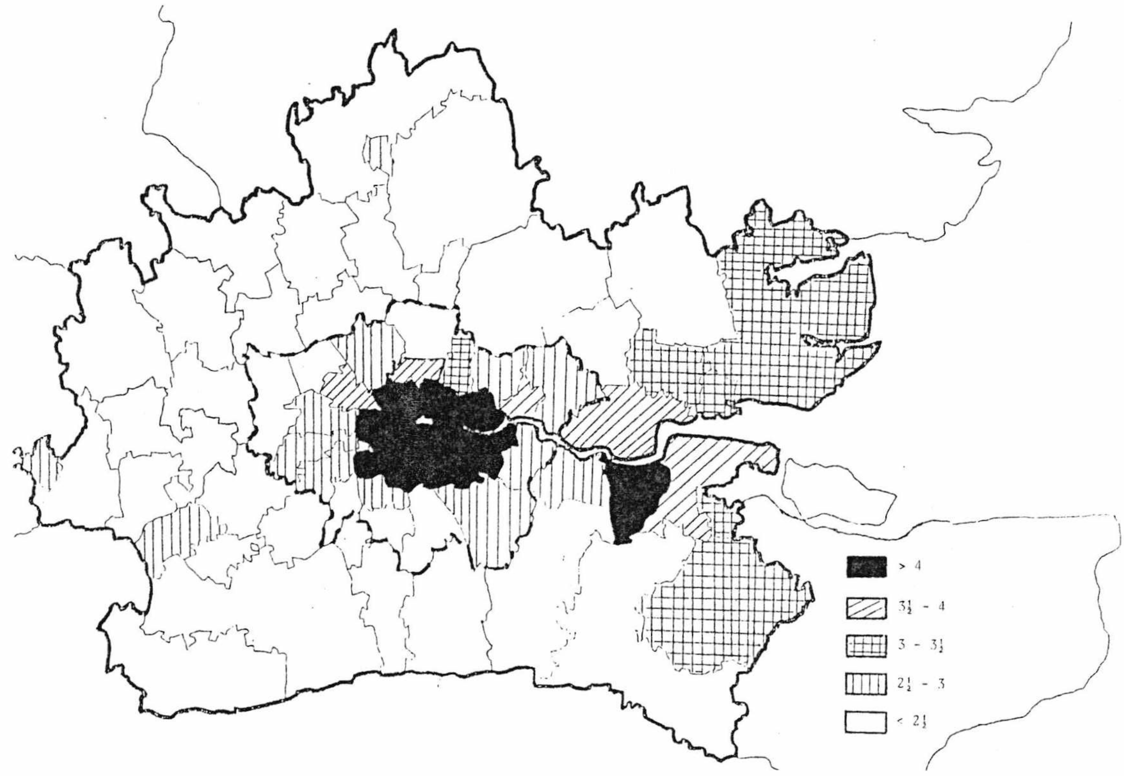
Net migration rates of movers in the national migration stream (see section 4 for a discussion of the method of identifying these migrants) suggest that much of the population decentralisation evident in the raw data may be attributed to environmental and housing related moves. Nevertheless, a certain amount of population dispersal is still in evidence in male national stream migration, and clearly more so than for women, where the main gaining areas appear to lie in pockets of North and West London.

The maps of female participation (7.7 and 7.8) reveal substantial concentrations of economically active women in inner and West London, and also (in the case of married women) in parts of Hertfordshire, most obviously Stevenage New Town, and Welwyn Hatfield, containing Welwyn Garden City.

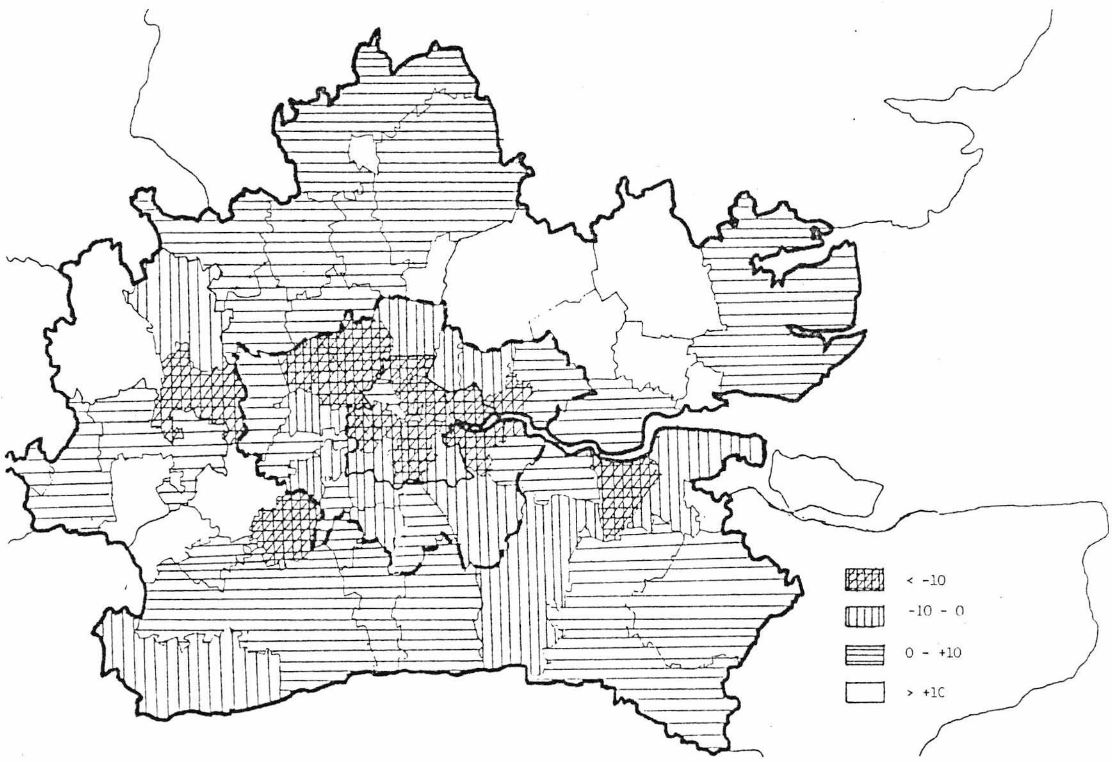
In general, therefore, these maps indicate some interesting differences between men and women in the spatial pattern of some of the key labour market variables and suggest marked contrasts between the 'urban core' and the associated hinterland. In the next section we shall attempt to explain these patterns in terms of some of the differences in labour market behaviour of men and women, along the lines set out in section 2.



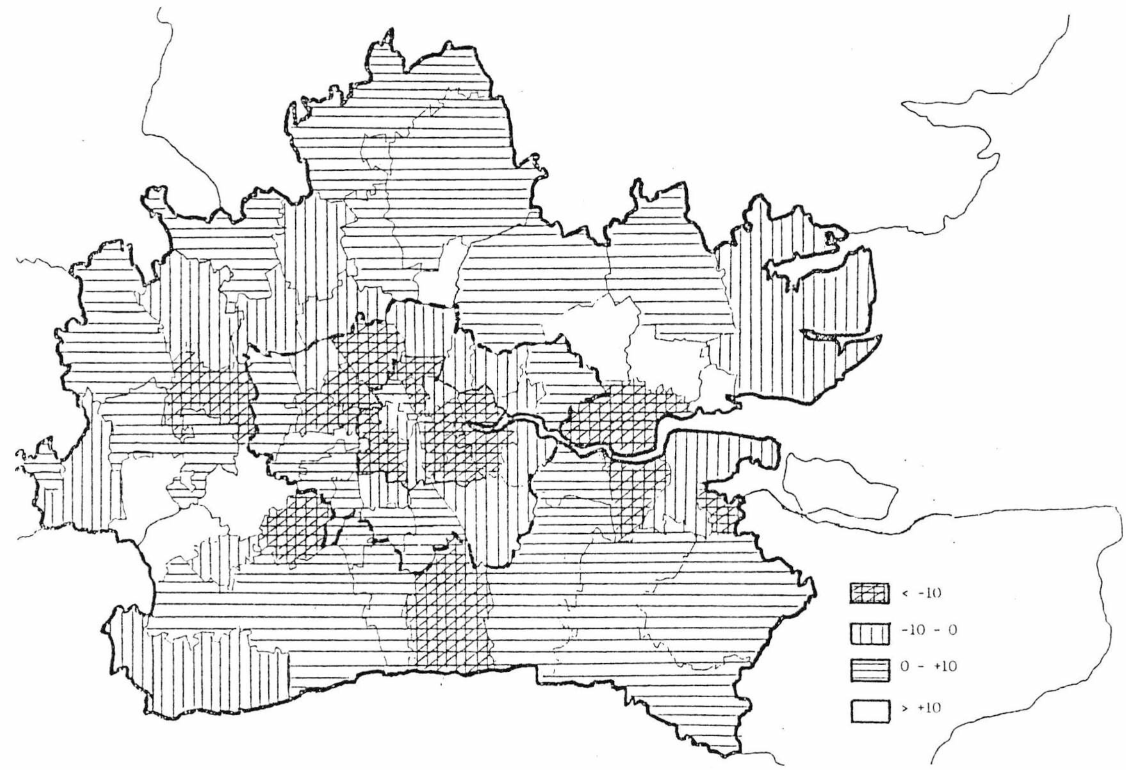
Map 7.1 Female Unemployment 1971 (%)



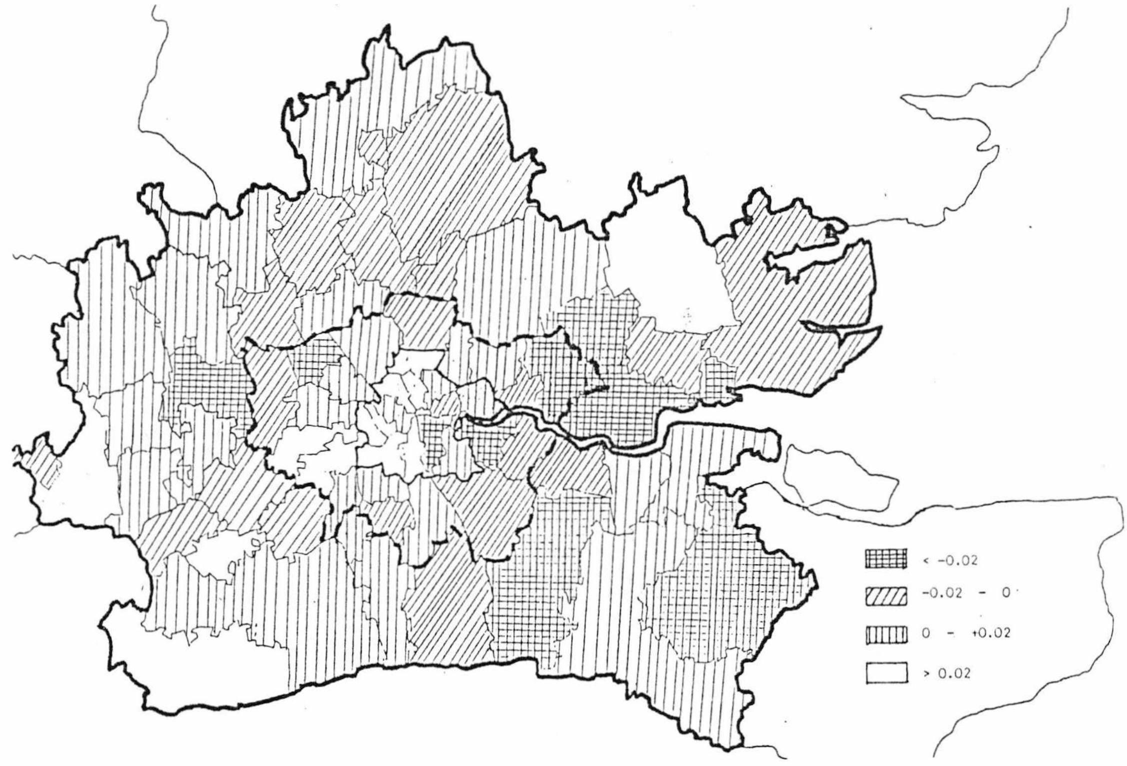
Map 7.2 Male Unemployment 1971 (%)



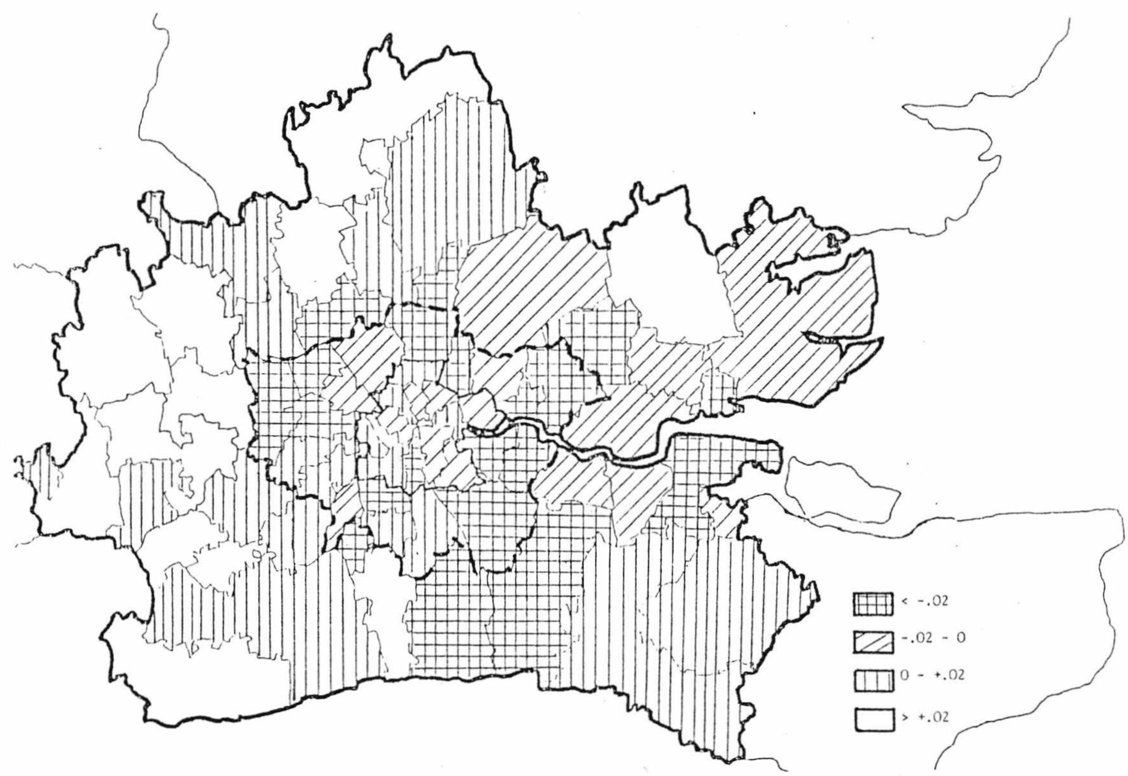
Map 7.3 Female Employment Growth 1966-1971 (%)



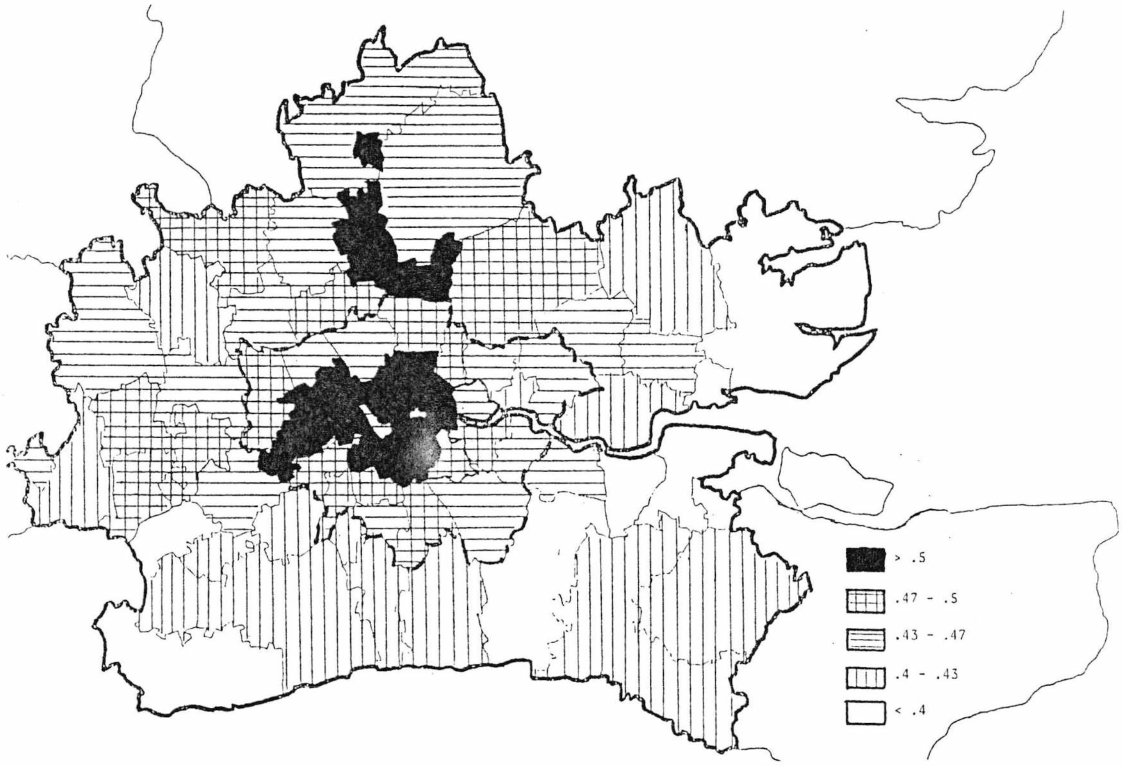
Map 7.4 Male Employment Growth 1966-1971 (%)



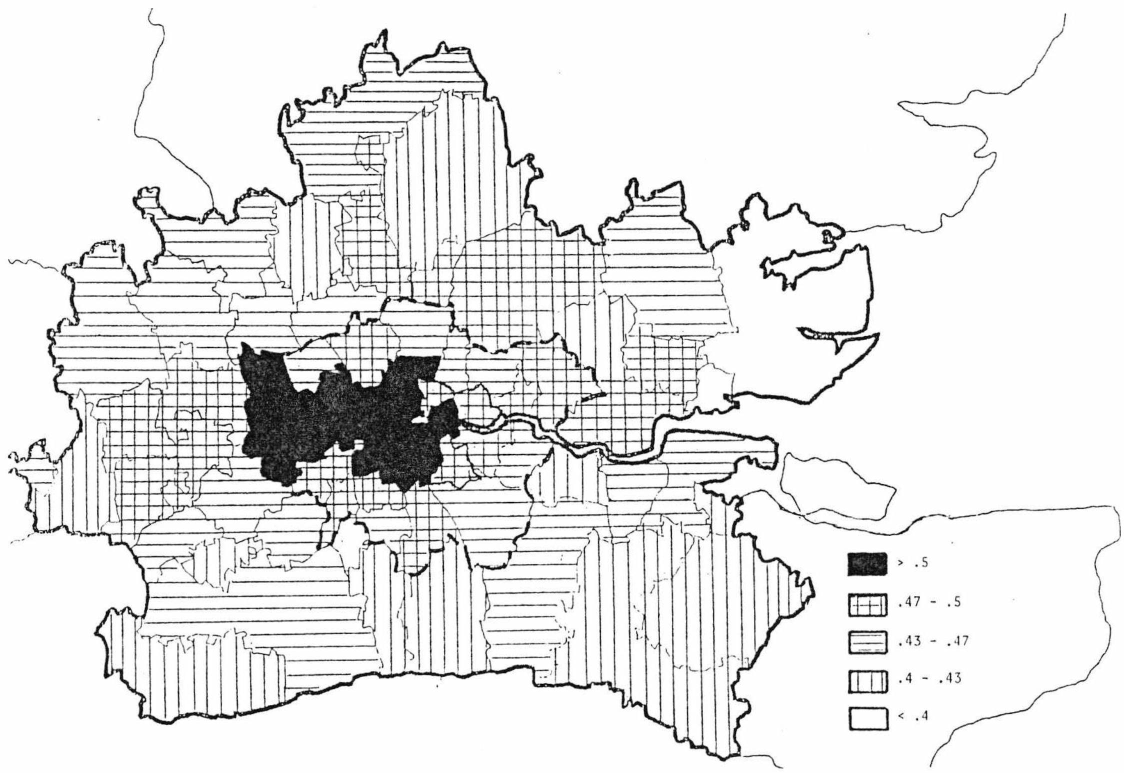
Map 7.5 Net Migration Rates, National Stream
Economically Active Females 1966-1971



Map 7.6 Net Migration Rate, National Stream
Economically Active Males 1966-1971



Map 7.7 Married Female Participation Rate 1971



Map 7.8 Non-Married Female Participation Rate 1971

4. Estimation and Results

Estimation of the model proceeded in two main stages. First the interaction models for migration were calibrated on flow matrices incorporating flows between the 71 internal zones and with 41 external zones covering (almost all) the rest of Great Britain. Secondly the estimates of push, pull, and net migration by stream derived on this basis were included in the simultaneous econometric model of male and female labour markets in the London region. This latter stage proceeded using Two Stage Least Squares techniques, coupled with a series of weights based on the square root of population in each area.

In this section, the major points emerging from the estimation of the model outlined earlier will be discussed. The large volume of results generated in estimation is too great for detailed reporting in the main text of this chapter. However, the housing market system is essentially the same as that reported in Gordon and Lamont (1982), which also includes male versions of many of the labour market equations. For the most part, therefore, the main text of this chapter will be devoted to a discussion of new results relating to participation and commuting, and female labour market variables.

The complete system also involved equations for male and female earnings and employment changes. Since these also do not constitute the main focus of this chapter (which is more concerned with supply side processes), we shall limit our discussion here to a broad outline of the main features of the results (see Gordon and Molho (1985) for a more complete account). In essence, employment changes (Table 7.1) were found broadly to reflect local industry mix,

Table 7.1 Employment Growth

	Female	Male
Net Migration, Females Stream 1	0.071 (0.14)	-
Net Migration, Females Stream 2	-0.117 (-0.27)	-
Net Migration Females Stream 3	-0.431 (-0.86)	-
Net Migration, Males Stream 1	0.795 (1.97)	0.360 (0.91)
Net Migration, Males Stream 2	0.741 (2.12)	0.451 (1.67)
Net Migration, Males Stream 3	0.698 (1.85)	0.442 (1.40)
Wage Rates^{F}	0.102 (1.15)	-
Wage Rates^{M}	-0.127 (-3.16)	-0.024 (-0.54)
Male 'Structural' Employment* Change	-0.357 (-0.89)	0.741 (1.53)
Female 'Structural' Employment* Change	1.039 (2.67)	-
Participation Rate^{SF}_{t-1}	0.186 (0.81)	-
Participation Rate^{MF}_{t-1}	-0.337 (-1.09)	-
Natural Growth in Male Labour Supply	0.0888 (1.79)	0.028 (0.44)
House Construction	-0.050 (-0.12)	0.413 (0.89)
House Demolitions	-2.380 (-2.60)	-1.800 (-1.64)
Industrial Development Certificate Refusals	-0.010 (-0.04)	0.373 (1.01)
Land Free of Development Constraint (logged)	0.014 (0.54)	0.659 (0.02)

Table 7.1 Continued

	Female	Male
Married Female Unemployment Rate	-	-2.561 (-1.14)
Constant	-0.542 (-0.85)	0.055 (0.50)
R^2	0.770	0.483
F	10.42	5.02

Notes and Sources: See Table 7.5.

* These 'structural' variables are derived by applying national employment growth rates to base year employment in each industrial MLH in an area.

particularly for women, as well as growth in local pools of labour. The latter effect appeared predominantly to be caused by induced growth in local demand since inward migration tended to contribute more to local job creation than natural growth in the labour supply. Little evidence was found to support the notion of direct substitution between men and women in response to wage differentials - differences in wages between areas did affect female employment change, with faster growth in lower wage areas, but lower earnings for females relative to males had no detectable effect.

As regards the earnings equations (Table 7.2), areal variations in male earnings appeared largely to be explained by the socio-economic composition of the resident population, rather than by local pressure of demand. In addition, male earnings appeared to increase with distance from the city centre. For women these patterns were reversed, with socio-economic composition explaining little of the variation in (full-time equivalent) earnings, variations in excess demand figuring much more prominently, and earnings falling with distance from the city centre. Taken together, therefore, the results suggested that female earnings were substantially dependent upon place of residence, reflecting the varying pressure of demand for labour, whereas for males earnings capacity influenced the area of residence.

In the remainder of this section we shall examine in detail the results pertaining to the supply side adjustment processes, and the implications regarding unemployment.

<u>**Table 7.2 Earnings**</u>

	Women	Men
Average Employment Growth Across Travel to Work Area (by Sex)	0.003 (0.02)	-0.139 (-0.66)
Employment Growth (by Sex)	0.212 (1.21)	-
Unemployment^{SF}	-0.105 (-0.03)	-
Unemployment^{MF}	-12.876 (-2.85)	-
Male Unemployment	-	3.296 (2.02)
Male Earnings	0.441 (3.28)	-
Female Earnings	-	0.132 (1.63)
Distance from Westminster	-1.428 (-2.15)	1.763 (3.65)
Distance (squared)	1.706 (1.80)	-2.238 (-3.46)
Children 0-4	0.532 (0.71)	-
Children 5-14	-0.132 (-0.31)	-
House Construction	-0.830 (-1.50)	-
House Prices	-0.319 (-1.08)	0.175 (0.92)
Aged 16-19* (by Sex)	-0.661 (-0.31)	-
Young Economically Active Men	-	-0.703 (-0.05)
Proportion of Economically Active Women that are Married	-0.298 (-0.64)	-
SEG1	-	-0.57 (-0.03)

Table 7.2 Continued

	Women	Men
SEG2	-	0.459 (0.33)
SEG3	-	15.937 (2.96)
SEG4	-	3.016 (1.97)
SEG5	-	-0.507 (-0.46)
SEG6	-	0.927 (1.36)
SEG7	-	3.092 (2.73)
SEG8	-	3.492 (1.12)
SEG9	-	0.296 (0.34)
SEG10	-	0.126 (0.16)
SEG11	-	-1.669 (-1.75)
SEG15	-	-3.538 (-1.82)
Constant	6.123 (4.60)	4.953 (4.79)
R^2	0.535	0.895
F	5.04	22.80

Note: Dependent variable is logged.

Female earnings adjusted for variations in the proportion of part time workers.

Futher notes and sources: See Table 7.5.

4.1 Migration

The calibration method outlined in chapter 4 for the migration model was unworkable in this context, for two main reasons. Firstly, the specification of a series of exponential distance deterrence functions in equation (7.1) prevents the prediction of distance cut-offs, and secondly, the presence of a third migration stream cannot easily be handled within the two-stream migration framework outlined in chapter 4. Instead (as in Gordon and Lamont (1982)), a series of approximations to the distance cut-offs were tried, using Hyman's (1969) maximum likelihood method at each stage of estimation. These cut-offs were varied experimentally, and finally fixed at 100 miles and 15 miles. The furthest cut-off of 100 miles was used to estimate the national stream model, and generate predictions of this stream over the full range of shorter distances. The second cut-off of 15 miles was then used to separate regional from local stream movers, along similar lines. To ensure consistency between the three streams, an iterative procedure was then set in train. The regional migration stream model was revised in the light of the estimated local stream model by generating predictions of the latter over the longer distance ranges. The national stream model was then revised in the light of the estimated local and middle distance stream models. Iteration continued until the estimates stabilized in each stream.

Summary results for the migration model are presented in Table 7.3 (below) while Table 7.4 expresses the estimates of inter-area flows in each stream as a proportion of the population at risk of moving. For economically active married women these show, as one might expect, a pattern of movement very similar to that of econo-

Table 7.3
Coefficient Estimates for the Three Stream Migration Model

Population Group	R^2	Distance Parameters			Inter-Area Flows (000's)		
		β_N	β_R	β_L	National Stream	Regional Stream	Local Stream
Economically Active:							
Males	0.77	-.005	-.130	-.515	59	26	32
SWD Females	0.67	-.017	-.061	-.249	15	2½	4
Married Females	0.75	-.004	-.102	-.463	18	11	13

Note: the β values relate to distances measured in miles.

Table 7.4
Inter-Area Mobility Rates 1966-71 by Mover Stream

Percentages

	National Stream	Regional Stream	Local Stream
Economically Active:			
Males	8.9	5.9	8.6
SWD Females	9.1	2.3	4.3
Married Females	7.3	6.8	9.4

Note: this table includes only moves originating in the London metropolitan region.

mically active males. Small differences in mobility rates between these two groups essentially reflect age and life-cycle effects, in as much as long distance mobility for employment is at a peak among young workers while regional and local stream moves tend to be associated with family formation. Economically active non-married women appear to be as mobile as the average male (i.e. less mobile than single males) in the national stream but show much lower rates of inter-area mobility in the local, or particularly, the regional movement stream. Again this may reflect life-cycle influences and a lack of need to move for many single women, but the pattern is also consistent with the view set out earlier about the constraining effects of smaller travel to work areas and dependence on rented accommodation. For all economically active women, combining the married and the non-married, rates of inter-area mobility were between 10% (in the national stream) and 16% (in the regional stream) lower than those for their male counterparts.

For non-married women, the pattern of distance deterrence also appears to be significantly different from that found for economically active males. The much stronger distance effect indicated in the national stream might imply a greater reluctance to accept additional movement costs on the part of women with expectations of lower pay and more limited careers. Comparison with distance parameters estimated for different social class groups of males, however, suggests a need for caution in interpretation since a similar set of values to that for non-married women was obtained both for unskilled manual workers and for professionals and managers.

The qualitative results of estimating equations for the push and pull factors in the econometric model may be briefly summarised. For males the strongest influences on the direction of migration in the national stream were the rate of employment growth and the availability of furnished rented accommodation in potential destination areas. The principal factors affecting the generation of moves from particular areas were the social class composition of the resident population and the rate of in-migration in this stream. For non-married females moving in the national stream (see Table 7.6) furnished rented accommodation and residential preferences for destination areas were the principal influences. Employment growth rates had no significant effect on movement and the main labour market factor was unemployment, both at the origin and the destination. In this respect, and in the lack of influence of in-migration on out-migration, the behaviour of single women is very much like that of semi and unskilled male manual workers. In both cases it seems to reflect a relative lack of direct information about employment opportunities in potential destination areas. In this respect, single women and low skill men appear to correspond to the speculative model of migration outlined in chapter 2, where migrants 'move then search', rather than 'search then move'. Social class appears to be a weaker influence on long-distance mobility among single women, but a significant negative effect from the proportion of unfurnished rented accommodation at the point of origin suggests that housing tenure factors may be a significant constraint.

For married females, however, national stream migration patterns reflected not so much female labour market conditions as those prevailing for men, particularly the attraction of growth in male employment opportunities (see Table 7.5). When male 'pushes' and 'pulls' were included in the married women's equations, not surprisingly they were the most significant explanatory variables. A

Table 7.5 National Stream Migration Model
Married Women

	PUSH	PULL
Average Female Employment Growth Across Travel to Work Area	0.198 (0.43)	1.037 (2.18)
Wages^{F} (logged)	0.061 (0.19)	0.315 (1.08)
Unemployment^{MF}	4.274 (0.38)	-
$\text{Unemployment}^{F}_{t-1}$	-7.919 (-1.14)	-
$\text{Unskilled Manual}^{MF}$	2.541 (2.06)	-
Aged 16-29^{MF}	5.297 (2.50)	-
Aged 60+^{MF}	-3.657 (-2.18)	-
Children 0-4	-5.812 (-2.71)	-
Residential Preference	0.045 (1.08)	0.058 (1.17)
Private Furnished Rented Housing	0.086 (0.06)	3.611 (2.64)
Private Unfurnished Rented Housing	-	-1.413 (-1.90)
Rented from Local Authority or New Town	-	-0.944 (-3.68)
House Prices	-	-1.039 (-1.54)
$\text{Participation Rate}^{MF}_{t-1}$	-1.764 (-2.34)	-
Ratio of Economically Active Married to Non-Married Women	0.340 (0.98)	-3.263 (-5.27)
Pull Factor (Married Women, Stream 1)	0.319 (3.20)	-

Table 7.5 Continued

	PUSH	PULL
Push Factor (Men, Stream 1)	1.310 (4.65)	-
Pull Factor (Men, Stream 1)	-	3.350 (5.84)
(Pull Factor, Men Stream 1) x (Ratio of Economically Active Married to Non-Married Women)	-	-3.590 (-3.24)
Average Male Employment Growth Across Travel to Work Area	-	0.901 (1.02)
Constant	-3.501 (-1.24)	-3.119 (-1.01)
R^2	0.784	0.819
F	14.51	24.21

Note: The dependent variables are logged. t statistics reported in parentheses. Superscripts SF, MF indicate non-married females, and married females respectively. Subscript (t-1) indicates a variable taken from the 1966 Census. All equations estimated over the 71 areas described in Appendix 1. Two stage least squares estimates.

Sources: See Appendix 2.

Table 7.6 National Stream Migration Model
Non-Married Women

	PUSH	PULL
Average Female Employment Growth Across Travel to Work Area	1.085 (1.60)	-
Unemployment Rate^{SF}	35.638 (4.40)	-14.906 (-2.54)
Wage Rate^{F}	0.399 (0.84)	-
Unskilled Manual^{SF}	6.580 (1.49)	-
Personal Service Workers^{SF}	3.178 (1.40)	-
Aged 16-19^{SF}	-5.847 (-2.19)	-
Student	10.892 (3.43)	-
Residential Preference	0.035 (0.44)	0.198 (5.46)
Private Furnished Rented Housing	-	7.046 (11.48)
Private Unfurnished Rented Housing	-2.448 (-2.39)	-
Rented from Local Authority or New Town Development Corporation	-0.425 (-0.95)	-
Participation Rate$^{SF}_{t-1}$	-1.035 (-1.05)	-
Pull Factor, Non-Married Women (Stream 1)	0.136 (1.19)	-
Constant	-9.243 (-2.46)	-7.650 (-39.05)
R^2	0.625	0.671
F	8.04	45.64

Note: The dependent variables are logged.
Further notes and sources: See Table 7.5.

number of additional influences may also be observed in the equations for married women moving in the national stream. Thus, the results suggested higher outward mobility rates amongst unskilled married women, in contrast to the case for males where unskilled men tend to be less mobile. This result suggests that the presence of a second earner in a family who occupies a fairly high level job tends to raise the opportunity cost to the family of moving, whilst perhaps making it also more difficult to find a destination location to suit both earners, in line with Mincer's (1978) theoretical perspective on family migration decisions. The presence of young children also appears to be a significant constraint on the outward movement of married women. Housing factors appear to play a significant role at the point of destination, with married women being attracted into areas with high concentrations of private rented furnished accommodation.

In the regional and local streams the movement of economically active married females followed that of males, being influenced particularly by the distribution of new private house-building. Even among non-married women, as among men, there was no indication that movement in either of these streams was influenced by local employment opportunities. (1) However, whereas for males (or the married population) regional or local migration was strongly associated with, respectively, owner-occupation or entry into owner-occupation, there were no such associations for non-married females. In the regional stream, in particular, movement was less likely from areas of furnished rented accommodation and more likely to areas of unfurnished renting and, particularly, new towns. The strongest single link by far was between in-movement in the national stream and out-movement in the regional stream, suggesting a process of successive approximation may account for much of the regional stream migration among single, widowed and divorced females.

4.2 Commuting Change

Although there are some obvious differences in travel to work between married and non-married females (or part-timers and full-timers) the commuting change equations could only be estimated for all females, and for all males. The results, for the period 1966-71 are shown in Table 7.7.

The basic hypotheses are confirmed for both sexes. Net inward migration serves to increase the net commuting outflow from an area, or reduce the net inflow, particularly if it involves movements (in the regional or local streams) over a distance such that migrants do not have to switch their place of work. Also, rates of employment growth in an area which exceed those in its hinterland serve significantly to increase the net commuting inflow, and vice versa. In the absence of either change, net commuting volumes tend to shrink - by about 1% per year on these estimates - as residents succeed in finding nearer workplaces.

Comparison of the results for males and for females shows two significant differences. Firstly, there is no significant effect on commuting as a result of national stream migration by females, almost all of whom would appear to work in their area of residence. Secondly, whereas for males the effect on net commuting is shown as absorbing all of the differential in employment growth between an area and its commuting field(2) within the five year period, for females only

Table 7.7
Commuting Change

	Males	Females
Employment Growth Differential	1.202 (12.04)	0.321 (4.74)
Net migration of economically active:		
National Stream	-0.374 (-3.45)	-0.101 (-0.48)
Regional Stream	-0.719 (-15.40)	-0.638 (-5.93)
Local Stream	-0.659 (-8.18)	-0.682 (-4.64)
Lagged Net Commuting	-0.046 (-4.09)	-0.052 (-2.57)
R^2	0.836	0.459
F	67.48	11.18

Notes: 1. All variables are defined as proportions of employment in 1971.

2. The employment growth differential is constructed as the difference between employment growth in the immediate locality, and in the overall travel to work area. (See Appendix 2 for further details).

Further Notes and Sources: See Table 7.5.

a third of the effect appears to be absorbed in this way. This contrast is not simply a reflection of differences in commuting ranges, since these have already been incorporated in the construction of the differential employment growth term. Rather, it would seem to reflect a combination of three inter-related factors. Firstly, many additional female jobs are likely to be part-time, or otherwise more suitable for those women with stronger constraints on travel-to-work. Secondly, the generation of such local job opportunities is likely to draw previously inactive females within the area into the labour force, as well as diverting commuters from elsewhere. Finally, the process of adjustment in commuting is likely to be somewhat slower for female workers, reflecting in part the greater reliance on localised sources of information about employment.

One might have expected that females moving in the regional and local streams would be more likely than their male counterparts to change their place of work to somewhere nearer their own residence. The coefficients on regional and local stream moves in the estimated equations do not reflect this hypothesis, however, having similar values for both males and females. In both cases the values suggest that about one in three of these economically active migrants during this five year period switched their area of workplace to the new area of residence. A higher proportion would have been expected for women but this estimate may reflect the fact that in many cases 'housing' moves of this sort are associated with child bearing, in which case some of the expected switches of workplace could be delayed a few years.

Although all the expected coefficients are clearly significant in the female equation, the proportion of the variance explained is disappointingly low and much worse than for males although this may partially be explained by a lower variance in the dependent variable to begin with. The implication is that the commuting behaviour of women is more heterogeneous than its specification recognises. Any substantial improvement is likely to require a separation in terms of hours of work and/or marital status.

4.3 Participation Rates

The estimated participation rate equations for married and non-married women are presented in Table 7.8. The results suggest that the principal difference between married and non-married women lies in the relative importance of labour market influences. For non-married women earnings levels (on a full-time equivalent basis), employment growth and current unemployment all attract insignificant coefficients. The strongest influences are age structure(3) and the proportion of students. Accessibility to central places - an indicator of employment opportunities - is also a very significant influence, but with the unemployment and participation rates five years previously also figuring significantly, it seems that expectations about opportunities may have had more effect than actual experience of the labour market. In the case of the accessibility relationship, it is possible also that there is an element of self-selection in the resident population with those non-married women who are seeking work living closer to centres of female employment. In any event, net in-migration of economically active non-married women also tends to raise participation rates.

Table 7.8

Estimates of Participation Rate Equations

Married Women			Non-Married Women		
Constant	-0.294	(-0.66)	Constant	0.040	(0.30)
$Wages_1^F$ (logged)	0.132	(2.23)	$Wages^F$ (logged)	-0.004	(-0.27)
$Wages_2^F$ (logged)	0.001	(0.05)	$Unemployment^{SF}$	-0.184	(-0.55)
$Unemployment^{MF}$	-2.076	(-3.41)	$Unemployment_{t-1}^F$	-0.971	(-2.45)
Employment $Growth^F$	0.064	(2.38)	Employment $Growth^F$	0.001	(0.04)
$Wages^M$ (logged)	-0.078	(-4.01)	First Stream Net $Migration^{SF}$	0.226	(2.38)
$Unemployment^M$	-0.433	(-1.24)	Second Stream Net $Migration^{SF}$	0.224	(1.55)
Children (0-4)	-0.258	(-2.15)	Students	-0.490	(-4.28)
$Immigrants^{MF}$	0.134	(2.74)	$Immigrants^{SF}$	0.087	(2.44)
Age $Structure^{MF}$	0.804	(4.65)	Age $Structure^{SF}$	0.803	(10.81)
Owner Occupier	-0.083	(-4.64)	Over 1 person per room	0.138	(1.48)
Distance from Westminster	-0.285	(-2.90)	Accessibility to Service Centres	0.338	(4.06)
$Distance^2$	0.275	(2.04)			
$Participation_{t-1}^{MF}$	0.251	(4.56)	$Participation_{t-1}^{SF}$	0.119	(3.09)
R^2	0.938		R^2	0.954	
F	65.95		F	100.18	

Notes and Sources: See Table 7.5.

For married women by contrast, current economic variables are important. One of the strongest single variables is again the age structure measure, based in this case on national average participation rates by age group for married women without children, while the incidence of young children is also significant. But so too are earnings levels, unemployment among married women and the female employment growth rate in the area of residence.

A series of spline functions were used to investigate the effects of female earnings levels in an area on participation. The form finally chosen shows a strong positive effect of earnings ($WAGES_1^F$) up to a threshold level of £1535 p.a. (about 90% of the average for these areas), with a virtually flat relationship thereafter ($WAGES_2^F$). Earnings are important therefore, but only in a minority of low paying areas, including several New Towns, docklands and areas along the Thames estuary. Once the threshold is passed, further increases in earnings may affect hours worked but not participation, apparently. In most areas therefore it is lower unemployment and faster employment growth rates which elicits additional labour supply from married women when demand increases, rather than the level of wage offers. This result is consistent with the emphasis (in section 2) on the importance of the perceived flow of opportunities in influencing the timing of re-entry by married women. The unemployment rate variable exhibits a strong 'discouraged worker' effect, with 1% on the married female unemployment rate apparently inducing a long run reduction of 2.8% in the participation rate. With participation rates of around 50% this would imply that about 85% of married female unemployment (i.e. about two thirds of all female unemployment) was disguised as inactivity, even on Census measures of unemployment. The responsiveness of participation rates to employment change would also slightly damp the effects of employment fluctuations on female unemployment: the estimated coefficient implies that in an average area, growth or decline by 1000 in female jobs would have altered the number of economically active married women by about 100 in the long run.

The restricted search and commuting fields of married women also suggest that the accessibility of employment opportunities may well affect their ability to participate in the labour force (c.f. Andrews (1978)), in line with the discussion in chapter 6, and in section 2 of this chapter. Various indicators of accessibility of employment opportunities were tried, including employment density, rurality etc. The main effects were captured, however, with a quadratic function of distance from the CBD, identified with Westminster: the coefficients indicated a pattern of significantly falling participation rates with increasing distance from Central London with a predicted minimum about 51 kms out around the edge of the O.M.A. (c.f. Wabe (1969)). All else being equal, therefore, decentralisation of households in the region is likely to be associated with falling participation rates for married women.

A number of effects on participation rates arising from household circumstances were also found. As expected, male wage rates exerted a strong negative influence, suggesting powerful cross-substitution effects in family labour supply (Ashenfelter and Heckman (1974)).(4) Male unemployment, which because of benefit structures can be a disincentive to wive's participation, showed only a slight negative effect. However, owner-occupation proved to have a significant effect, which might be attributed either to the increased requirement for domestic labour in larger properties or the influence of household non-labour income. The presence of young children (under 5) also significantly reduced participation, although variables relating to older children had no such effect. Beyond this age, the demands of child-care appear increasingly to be balanced by the financial requirements of raising a family (Greenhalgh (1977)), in line with the discussion in chapter 6.

Seen simply in stock-adjustment terms, the estimated coefficient on the lagged participation rate suggests that, for married women, nearly 75% of responses are complete after 5 years, with a mean lag of roughly 20 months. This compares with a much shorter mean lag for non-married women of around 8 months. Perhaps the central result to emerge from this analysis, however, lies in the extent to which married women's participation rates in a particular area can be varied when labour demand warrants it, without necessarily affecting wage rates or producing large fluctuations in unemployment.

4.4 Unemployment

The derivation of the equilibrium unemployment rate model in section 2.5 of this chapter showed how each of the relationships discussed above should affect local unemployment levels, with the implication that virtually all the exogenous variables should be included in the specification of an unemployment equation. In practice, a more parsimonious approach is required and the estimated equations omit many of the variables from the participation equations which may not greatly affect temporal adjustments.

For males the results showed that rates of employment growth, personal characteristics such as age or skill, the stock of private rented accommodation and net migration in the regional and local migration streams were all important in accounting for differences in unemployment rates between areas (see Gordon and Lamont (1982)). The size of the coefficients on employment change variables, however, showed that induced migration and commuting had absorbed most of the original effects of employment growth or decline.

For females, the complex interactions between employment growth, migration, participation, and commuting changes tend to produce a pattern of unemployment which is harder to interpret, and the results need to be considered in terms of the full labour market system, in order to trace through the relevant sequences of causation, and construct a coherent overall picture. The detailed results are reported in the Table 7.9. One important (and in some senses counter-intuitive) finding which emerged from the analysis of female unemployment was that the effect of employment growth was <u>even weaker</u> for females than for males. This result may be interpreted in terms of the different labour supply adjustment processes for married and non-married women (although, once set in train, both these sequences of causation tend to interact to affect unemployment rates for both groups because of the overlap in the two markets). In particular, whilst the migration patterns of married women exhibited general insensitivity to labour market conditions, their participation rates were clearly responsive to changes in demand conditions for female labour. Thus the impact of employment growth tends to be partially offset by participation rate adjustments, as additional labour demand in a sense creates its own supply. For non-married women, although their labour force attachment appeared in essence to be unresponsive

Table 7.9 Female Unemployment

	Married	Non-Married
Average Male Employment Growth Across Travel to Work Area	0.006 (0.47)	-
Average Female Employment Growth Across Travel to Work Area	0.004 (0.62)	-0.005 (-0.71)
Female Employment Growth	-0.012 (-1.43)	-0.006 (-0.85)
Male Unemployment$_{t-1}$	-0.058 (-0.44)	-
Unemployment^{SF}	0.350 (3.06)	-
Unemployment^{MF}	-	0.700 (4.77)
Female Unemployment$_{t-1}$	0.146 (1.37)	0.242 (2.22)
Growth in Female Participation*	-	-0.010 (-0.08)
Female Participation$^{*}_{t-1}$	-0.017 (-1.44)	-
Female Net Migration (Second Stream)*	0.015 (0.74)	0.062 (1.59)
Female Net Migration (Third Stream)*	0.016 (0.62)	-0.036 (-0.88)
(Female) Junior Non-Manual*	0.010 (0.76)	0.006 (0.52)
(Female) Personal Service Workers*	-0.001 (-0.02)	-0.005 (-0.17)
(Female) Unskilled Manual*	0.007 (0.34)	0.019 (0.44)
Private Furnished Rented Housing	0.068 (3.92)	0.048 (1.79)
Private Unfurnished Rented Housing	0.005 (0.39)	0.013 (0.94)
Rented from Local Authority or New Town	0.010 (1.79)	0.005 (0.88)

Table 7.9 Continued

	Married	Non-Married
Residential Density	-0.173 (-1.57)	0.176 (1.26)
Residential Preference	-0.001 (-1.01)	-
Aged 16-19 SF	-	0.118 (4.70)
Aged 16-29 MF	-0.017 (-0.25)	-
Aged 60+*	0.036 (1.04)	0.116 (3.71)
Children 0-4	0.058 (0.99)	-
Children 5-14	-0.010 (-0.40)	-
African*	-0.083 (-0.50)	0.166 (1.37)
Asian*	0.036 (0.95)	-0.062 (-1.06)
Americas*	0.003 (0.05)	-0.050 (-1.15)
Constant	-0.001 (-0.05)	-0.061 (-4.35)
R^2	0.844	0.829
F	10.38	13.01

Notes: * indicates variable is disaggregated by marital condition.

Unemployment rates calculated on a Census definition, which includes the unregistered unemployed.

Further notes and sources: See Table 7.5.

to labour market factors, their migration patterns were strikingly sensitive to local unemployment conditions, so that the impact of employment growth on unemployment was rapidly dispersed by the consequent effect on patterns of movement.

The reasons for this pattern deserve further investigation: possibly the relative lack of career prospects for women encourages a more direct response to immediate economic circumstances; or possibly unemployment amongst non-married women is a more general risk than it is for men, among whom experience of unemployment tends to be concentrated in a small minority. In any case, the consequence is to make labour migration among single females a much stronger equilibriating mechanism than originally anticipated.

Among the personal characteristics included in the equations, age structure proved very significant among non-married women, with higher rates where there were more in the youngest and oldest working age groups, as for men. For neither married nor non-married women, however, were indicators of social class or skill at all important, in marked contrast to the results obtained for males. In this respect women workers appear to be more homogeneous, or to be treated more homogeneously by employers, than men are.

A more important variable for women is the proportion of furnished rented accommodation in an area, which is positively associated with unemployment levels both for the married and non-married, suggesting that as a valued attribute, the presence of such accommodation is traded off against the risk of unemployment. This interpretation is consistent with the fact that such accommodation acts as a major influence on long-distance migration among the non-married, and consequently on overall rates of net migration by economically active women. As such it appears to be the major constraint on the tendency of non-married women to move to areas of lower unemployment, and its effects also spill over into the sub-labour markets for married women.

Two further sets of variables in the married female equation are worthy of comment although neither is statistically significant in this set of observations. The first relates to the rate of male employment growth which appears as a positive influence on married women's unemployment through its effects on net inward migration. The second involves the consequences of net migration in the regional and local streams for local labour supply and thus for unemployment: as for males there is evidence of such an effect, but for both the female groups its significance is obscured by covariance with female employment growth rates.

5. Summary

The purpose of this chapter has been to construct a simultaneous equation model of labour market relationships in the London metropolitan region, and attempt within the context of this system to explore some of the specific characteristics of women's labour markets, especially those concerning supply-side adjustment mechanisms, and the interaction between men and married women in their local labour supply. The emphasis has been on modelling as a tool for explaining complex patterns of dependence and constraint, rather than as an end in itself.

A particular concern has been with assessing the significance of various forms of constraint on the mobility of married and non-married women, and their consequences for employment status and the incidence of unemployment. In addition to the well documented limitations on travel-to-work fields, particularly for married women, two significant sets of constraints were identified. First is the fact that the residential location of married women tends to be dependent on access to male, not female, labour market opportunities. Thus, local variations in the demand for married female labour tended to be equilibriated less by migration and commuting (as compared to men), but rather by large fluctuations in labour force participation. Secondly, limited access to owner-occupation tends to restrict the residential mobility of non-married women, making them particularly dependent on private rented accommodation, concentrated in parts of inner London. The findings suggested that the responsiveness to local demand conditions of married women's participation on the one hand, and non-married women's migration on the other made female unemployment much less sensitive to employment change. An important question which emerges therefore, particularly in relation to married women, is whether exploiting pools of local labour reserves is a more fruitful outcome of local job creation than simply attracting migrants from elsewhere, as tends to be the case for males and non-married women. The results also suggested that residential moves which take married women away from existing centres of female employment might have very little effect on their risk of unemployment because of the effect of such moves on demand for women in local service activities. Of course, it remains an open question whether the particular jobs available in outer areas are qualitatively comparable as employment opportunities.

Appendix 1

Districts Used in Statistical Analysis

London Boroughs

1. Barking
2. Barnet
3. Brent
5. Bromley
6. Camden
7. Croydon
8. Ealing
9. Enfield
10. Greenwich
11. Hackney
12. Hammersmith & Fulham
13. Haringey
14. Harrow
15. Havering
16. Hillingdon
17. Hounslow
18. Islington
19. Kensington & Chelsea
20. Kingston-upon-Thames
21. Lambeth
22. Lewisham
23. Merton
24. Newham
25. Redbridge
26. Richmond-upon-Thames
27. Southwark
28. Sutton
29. Tower Hamlets
30. Waltham Forest
31. Wandsworth
32. Westminster

Districts in the Outer Metropolitan Area

Berkshire

33. Bracknell
34. Reading
35. Slough + Windsor & Maidenhead
36. Wokingham

Buckinghamshire

37. Beaconsfield
38. Chiltern
39. Wycombe

Essex

40. Basildon
41. Brentwood
42. Castle Point
43. Chelmsford
44. Epping Forest + Harlow
45. Rochford, Southend-on-Sea + Maldon*
46. Thurrock

Hertfordshire

47. Broxbourne
48. Dacorum
49. East Hertfordshire
50. Hertsmere
51. North Hertfordshire
52. St. Albans
53. Stevenage
54. Three Rivers + Watford
55. Welwyn Hatfield

Kent

56. Dartford
57. Gillingham
58. Gravesham
59. Maidstone
60. Medway
61. Sevenoaks
62. Tonbridge & Malling + Tunbridge Wells

Surrey

63. Elmbridge
64. Epsom & Ewell
65. Guildford + Mole Valley
66. Reigate & Banstead
67. Runnymede + Spelthorne
68. Surrey Heath
69. Tandridge
70. Waverley
71. Woking

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* Maldon is in the Outer South East.

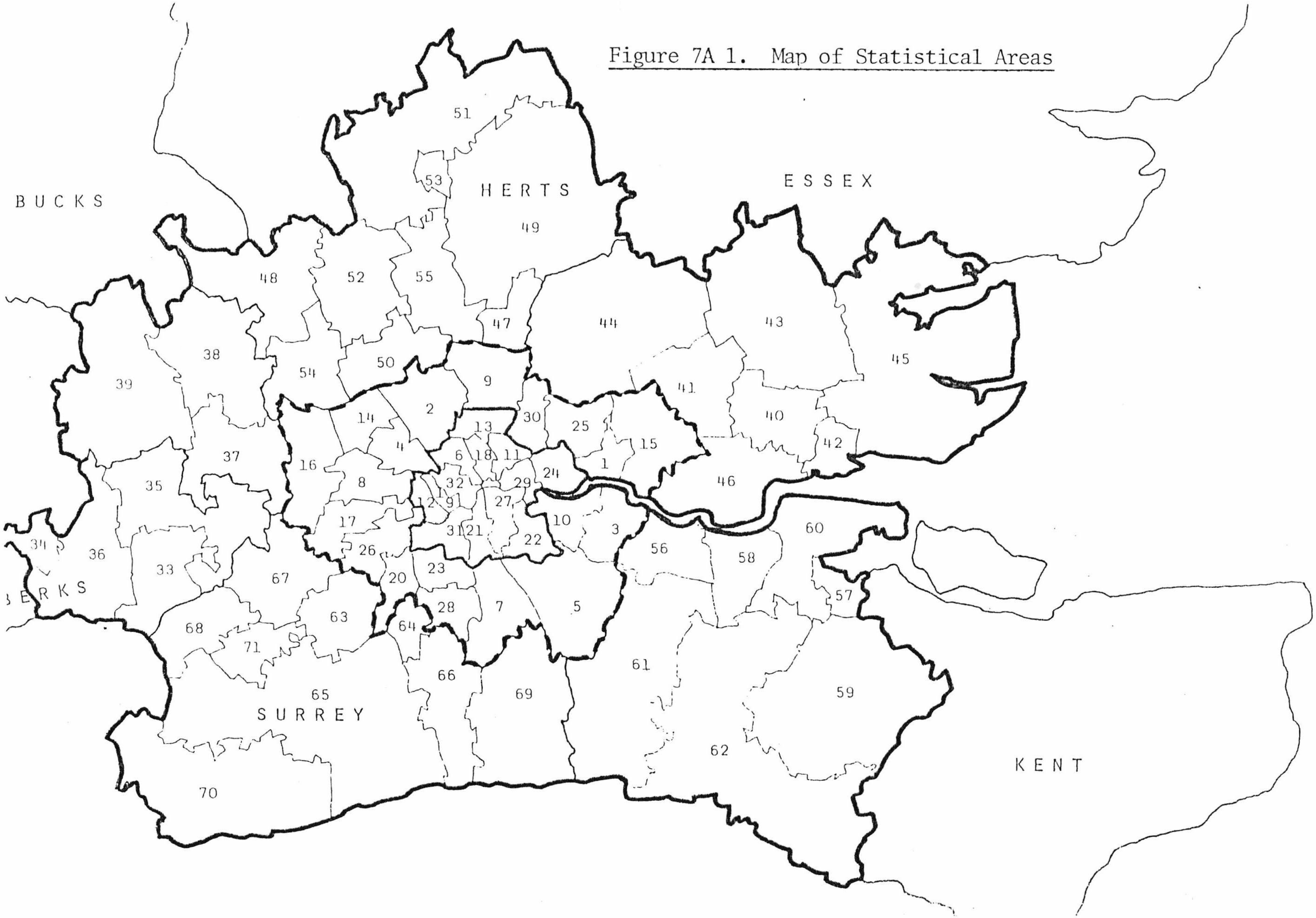


Figure 7A 1. Map of Statistical Areas

Appendix 2

The construction of variables used in quoted results (source is 1971 Census of Population, unless otherwise stated).

Employment Growth - Employment change 1966-1971, as proportion of those employed, disaggregated by sex.

Travel to Work Area Employment Growth - Average proportional employment change 1966-1971 by area of workplace in the journey to work area of each zone, weighted by the proportion of local residents working in each area, disaggregated by sex.

Unemployment - Proportion of economically active persons unemployed seeking work, disaggregated for males, married females, and non-married females (lagged unemployment derived from 1966 Census). Includes the unregistered unemployed.

Migration - Gross migrant flows of economically active persons 1966-1971, disaggregated for males, married females, and non-married females. Net migrant streams derived from calibration of gravity model outlined in section 2.

Participation - Proportion of economically active females, disaggregated by marital condition (lagged values derived from 1966 Census).

Net Commuting Change - Change in net balance of commuting 1966-1971 as a proportion of employment, disaggregated by sex (lagged commuting taken from 1966 Census).

Female Earnings - Average female earnings (£'s) per employed female 1971. Adjusted onto a full-time basis by regressing:-

$$\ell n\, W_i^F = \alpha_0 + \alpha_1\, \ell n\, W_i^M + \alpha_2\, PT1_i + \alpha_3\, PT2_i + E_i$$

$$\ell n\, \hat{W}_{i(FT)}^F = \ell n\, W_i^F - (\alpha_2\, PT1_i + \alpha_3\, PT2_i)$$

where $\ell n\, W_i^F$ = log of average female earnings

$\ell n\, W_{i(FT)}^F$ = (adjusted) log of average female earnings

$\ell n\, W_i^M$ = average male earnings (£'s) per employed male (logged)

PT1 = % females working $<$ 8 hours per week

PT2 = % females working 8 $<$ PT2 $<$ 30 hours per week

$\hat{\alpha}_0 = 5.138$; $\hat{\alpha}_1 = 0.308$; $\hat{\alpha}_3 = -0.0188$

$R^2 = 0.544$; $F = 26.6$

Male Earnings - Average male earnings per employed male.

Students - Number of female students as a proportion of total non-married female population.

Age Structure - National age profile of female participation rates, disaggregated by marital condition. Constructed as:-

$$\sum_{i=1}^{n} \alpha_i \, AGE_i$$

where AGE_i = proportion of population in age group i

α_i = national activity rate in age group i

(excluding married females with children, including students).

Children (0-4) - Number of children under 5 as a proportion of married females.

Children (5-14) - Number of children aged between 5 and 14 as a proportion of married females.

Owner Occupation - Proportion of owner occupiers in private households.

Distance from Westminster (and distance^2) - In hundreds of kilometers.

Over 1 Person Per Room - Proportion of private households with over 1 person per room (1971).

Accessibility to Service Sectors - Defined as in Gordon and Whittaker, Regional Studies, 1972.

Residential Preference - Average area attractiveness scores of social work trainees in 1977 (Bebbington (1979)).

Residential Density - Density of persons in private households (persons per acre).

House Construction - Public sector house construction in new towns and London overspill schemes 1966-1970, as a proportion of 1971 occupied dwelling stock (MHLG Local Housing Statistics).

House Demolitions - Dwellings removed from stock by demolition or closing order 1966-1970, as a proportion of those occupied 1971 (MHLG Local Housing Statistics).

Industrial Development Certificate Refusals - Refusal rate for Industrial Development Certificates as a proportion of sustained applications 1970-1974 (estimated from data for thirty four planning areas in the region in Galagan et al (1976)).

Land Free of Development Constraint - Land free of constraint for development per head of resident population (spliced together from two variables available for different areas in the region, both from DSPSE (1976). For London boroughs the variable is vacant land; for districts in the OMA it is a (transformed) estimate of land free of specified planning constraint).

Private Furnished Rented Housing - Proportion of persons in private households living in privately rented furnished accommodation.

Private Unfurnished Rented Housing - Proportion of persons in private households living in privately rented unfurnished accommodation.

Rented from Local Authority or New Town - Proportion of persons in private households renting from a local authority or a new town development corporation.

House Prices - Inland Revenue based price estimates for 3 bedroom semi-detached houses in 1970.

'Structural' Employment Change - Expected change in employment by workplace, 1966-1971, based on 1966 employment structure, and national employment change by MLH, expressed as a proportion, and disaggregated by sex.

National Growth in Male Labour Supply - Estimated over the period 1966-1971 from populations in 15-19 and 65-69 age groups in 1971, expressed as a proportion of economically active males.

Skill Structure - Variables for married and non-married women refer to respective proportions in SEG's 6, 7, and 11. Variables included in male earnings equation refer to proportions of persons either economically active or retired in each SEG.

Race - Variables in participation rate equations refer to the proportion of female residents born outside UK, disaggregated by marital status. Variables in unemployment equations refer to respective proportions of females born in Africa, Asia and Oceania, and the Americas, disaggregated by marital condition.

CHAPTER 8 SUMMARY, SUGGESTIONS FOR FUTURE RESEARCH, AND CONCLUSIONS

1. Summary

The purpose of this thesis has been to examine labour supply in a specifically spatial context, the interaction between supply and demand at the local level, and the implications for our understanding of spatial variations in unemployment. The importance of supply side adjustments at the local level has been emphasized, both in terms of migration (and commuting at very low levels of aggregation) and labour force participation.

A general perspective on local labour markets was set out in the introductory chapter, serving as a basis for the analysis presented in the remainder of the thesis. Much of the argument focussed on the treatment of space in relation to local labour markets, on the basis that it is this feature which critically distinguishes local level analysis from national studies, rather than being simply another dimension along which to *disaggregate* any particular model. It is in the treatment of this issue, it was argued, that one might reasonably expect urban and regional economics to be able to contribute to economic analysis and the understanding of economic problems. In fact, previous research on local labour markets has tended frequently to *abstract* from the influence of space, either by treating it as a quantity which may be *costlessly* overcome (so that labour markets may be regarded as being perfectly integrated), or by assuming that space is infinitely costly to overcome (so that local labour markets may be modelled in isolation). A middle road was suggested as being more appropriate, which would allow some scope for mobility, but would incorporate costs to such movement, re-inforced by distance friction in patterns of information diffusion. In this framework, local labour markets may still be seen to be inter-dependent, but not perfectly so, the strength of ties depending on relative location.

The remainder of the thesis concentrated on the analysis of local labour supply, from the point of view set out in the Introductory chapter. The second chapter set out to investigate theories of migration decision making. A number of key themes were identified in the analysis, relating to imperfect information and search; contracted versus speculative migration; the treatment of space and distance deterrence; the impact of demand side processes on the choice sets faced by individuals; the interaction between preferences and constraints on the supply side; differing underlying motivations for movement; temporal dimensions to migration; and problems of aggregation. With these themes in mind, the development of migration theory and modelling was traced through from the early emphasis on wage differentials to the Harris-Todaro model, the human capital approach, stress models, random utility perspectives, and search theory.

The next three chapters dealt with the empirical estimation of migration functions. Chapter 3 approached the issue from the micro level, in an analysis of individual migration decisions based on a sample of young men taken from the 1979 European Community Labour Force Survey. Initially the movement/non-movement decision was analysed within a dichotomous logit framework, then the choice of distance range moved was modelled using a form of mult-nomial discriminant analysis. The results suggested that the migration decisions of young men in the sample depended upon family circumstance, housing tenure, educational attainment, labour force status, and occupation. In addition, substantial differences were found in the behaviour of those economically active young men who changed jobs over the period as compared to the remainder of economically active young men, as well as those not economically active. Job changers were not only the most likely to move, but also more likely to move over long distances, suggesting the presence of a somewhat flatter distance deterrence function for individuals who change jobs as well as moving house, as compared to purely residential moves without an associated change of job. This finding was consistent with the distinction made in the theoretical section of the thesis on search fields of migration, and their association with the underlying motive for moving.

Chapter 4 dealt with the estimation of aggregate migration functions in terms of standard spatial interaction models, which may (as discussed in Chapter 2) be formally derived from micro-economic decision making models. Various estimation methods were discussed, and the distinction between what we might (for simplicity) call job-related and housing-related moves was considered at greater length. An algorithm was suggested for splitting the two streams based on the view that migration over long distances is likely to be predominantly job-related in nature. This methodology was then successfully applied to a matrix of 1 year male inter-regional migration taken from the 1971 Census, yielding plausible estimates of the size of the two streams in the regional network (in inter-regional migration on the matrix). The uneven distribution of housing migrants in the matrix made the interpretation of the raw gross flows, as well as the raw net migration figures rather hazardous, it was argued. In general, housing-related moves appeared to be significantly influenced by housing market conditions in terms of rates of housebuilding and house prices, whilst job-related migrants appeared to be affected by labour market conditions as one might expect.

Chapter 5 attempted to extend this analysis in a temporal dimension, showing how a time series of migration matrices might be analysed using the gravity model framework (whilst retaining the distinction between housing and job-related moves), and how the estimated push and pull factors derived from such gravity models may be analysed in a general distributed lag setting. This technique was applied to a time series of quarterly inter-regional migration matrices derived from the National Health Service Central Register over the latter half of the 1970s. A number of interesting features emerged from this analysis. Firstly, significant lags were detected in the relationships suggesting that standard cross-sectional models are rather too simple in their treatment of time. Secondly, distance deterrence parameters which tend generally to be thought of as broadly fixed at least in the short term, were found to exhibit considerable variability over the period, the degree of distance friction depending partly on variations in relative transport costs as well as on national levels of unemployment. Finally, it was shown that embedded in the set of attraction/repulsion parameters yielded by the estimation of standard cross-section doubly-constrained gravity models there is an implicit parameter which reflects the overall volume of moves over the period. There was some evidence to suggest that this parameter varied inversely with national unemployment conditions, suggesting that in times of national economic recession the general slackness of the labour market in all areas leads to significant curtailment in the level of migration activity.

Chapter 6 examined a further source of variability in local labour supply, apart from male migration behaviour, in terms of the labour force participation rate of married women. The variability of married female participation across areas is well documented, as has been the marked rise in married female participation nationally over the post-war period up to the mid 1970's. This increase has taken on a rather unbalanced form across areas, being concentrated more heavily in the regions where participation was originally lowest, thus producing a trend toward convergence in the regional pattern of married female participation. These trends were analysed using small survey sample quarterly time-series data taken from the Family Expenditure Surveys over the period from the late 'sixties to the late 'seventies. Regional married female participation rates were found in this analysis to depend upon wage and unemployment rates, the presence of young children in the family, and age structure. Convergence in the regional participation rates of married women over time was found to be related to convergence in (proportional) regional unemployment and wage rates.

Chapter 7 attempted to integrate a number of the emergent theories from the previous chapter within the context of a simultaneous model of the London labour market, based on data from the 1971 Census. In particular, the asymmetry between the supply-side adjustment processes of men and women were investigated, in terms of labour force participation and migration decisions. An analysis of the employment-related migration patterns of non-married women suggested affinities with semi and unskilled manual men, in that these groups appeared to respond not so much to job opportunities (in terms of rates of job generation) as to relative unemployment patterns. These findings suggested that a model of speculative migration (as discussed in Chapter 2) might be reasonably appropriate for these groups - they have less direct information about job opportunities in other areas, and less to lose by relocating in order to facilitate search (as opposed to contracted migration where movement is undertaken as the outcome of search) than other groups.

Married women appeared to respond very largely to male job opportunities in terms of their employment related migration, however, rather than the female labour market conditions (as measured by rates of employment growth, unemployment, or wages), suggesting a pattern of dependency of married female labour market activity on the decisions of their husbands (or any males with whom they live). The pattern appeared, therefore, for married women to be one of relative constraint in terms of choice of residence location, in conjunction with accommodating adjustments in labour force participation; to take a stylised view, men who are faced with a general reduction in demand for labour in their area of residence are more likely to move elsewhere, whereas married women, who are relatively constrained in this respect, are more likely simply to withdraw from the labour force.

2. Future Research

Clearly there is a great deal of scope for further work in all the areas discussed so far, as well as related fields suggested by the material covered in this thesis. Some more concrete proposals for future research are presented in this section.

From a theoretical point of view, some of the issues raised in the final chapter in connection with married female participation decisions would seem to be worth further investigation. The distinction between factors affecting entry probabilities into the labour force, and those affecting exit probabilities would appear to be quite fruitful, suggesting that over the life cycle perhaps the main decisions made by married women relate to the timing of their periods of labour force activity and inactivity. In addition, there was some evidence that married female participation responded to the flow of employment opportunities as well as the stock of unemployment. This finding suggests that it might well prove fruitful to recast the analysis in a search theoretic framework, as in the models of migration discussed in Chapter 2, where migration behaviour was broken up into decisions to search, the receipt of opportunities, and the decision to accept or reject those opportunities. Extending the analysis in this way might well prove useful for national level studies, as well as for analyses at the local level.

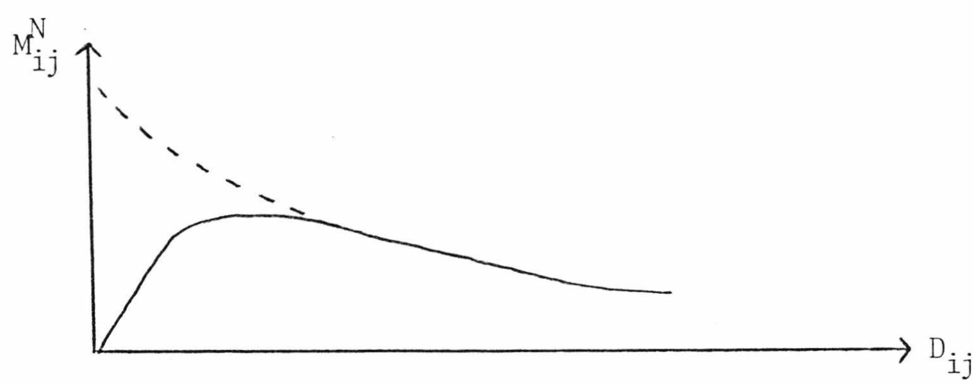
Empirically, it would also clearly be of interest to examine at a micro-level some of the processes identified in the final chapter relating to the interaction between migration and labour force participation of married men and women. As it stands much of the more interesting material is based on inference from aggregate patterns, and a more disaggregate approach is required to test more rigorously some of the ideas which emerged.

There is clearly also a need to develop empirical migration modelling at the micro-level, in general. This is particularly true in relation to the longitudinal data sets currently becoming available, which are likely to yield interesting insights into individuals' migration behaviour over time. Temporal dimensions to migration behaviour were touched upon in chapter 2 of the thesis, eg. as regards life cycle effects, return migration, mover/stayer distinctions, the importance of cumulative inertia, and state dependence in migration behaviour generally. Such issues are not at all well handled at the aggregate level, where the most that can really be done is to attempt to control for such effects as best as possible in order to minimise distortion in the estimation of relationships which can be properly handled at this level. In order to address these issues properly, micro-level longitudinal data is required. Thus, for example, in relation to the issue of cumulative inertia, one might attempt to capture the effects of growing social and economic ties to an area over time, by specifying some form of hazard function, where the hazard (i.e. the probability of migration out of an area) falls off with the duration of stay (cf. Murphy (1986)). The possibility of successive approximation in the selection of residential location (i.e. where a series of housing related moves succeed an initial long distance employment motivated move) may also be investigated in such a framework.

The distinction between speculative and contracted migration might be worth exploring further at the micro-level. To what extent are speculative moves successful in turning up 'acceptable' job opportunities? To what extent does this involve the revision of agents' reservation criterion for accepting opportunities, as opposed to genuine improvements in the quality and/or rate of job offers, as a result of undertaking the speculative move? What are the time spans involved? To what extent is the achievement of 'successes' dependent on the time period involved and the climate of demand? Finally, the issue of whether initial speculative moves are succeeded by subsequent contracted migration would appear worthy of further investigation.

As far as aggregate migration modelling is concerned, one interesting extension of the framework outlined in this thesis would be to incorporate a choice in the theoretical model between national stream 'employment-related' migration and commuting. Some work along these lines is currently proceeding, jointly with Ian Gordon. If search in this stream turns up an opportunity which is relatively near to the original place of residence, then individuals may well choose <u>not</u> to migrate to the new area but simply to adjust their commuting patterns. Thus one might expect a non-monotonic distance decay function for migration in this stream of the kind depicted in figure 8.1, where for near opportunities an increasing fraction of the individuals switch to commuting, and at the limit of zero distance <u>all</u> individuals commute rather than migrate.

Figure 8.1



By progressively shaving off more of the national stream migrants as one approaches zero distance, a 'wedge' is formed constituting those individuals who elect to commute rather than migrate to the new opportunity.

In terms of the original theory therefore one might attach a further conditional probability to the framework, whereby those who have decided to search in the national stream, have received an opportunity, and having accepted it, then have to decide whether migration is the best route via which to access that opportunity. Experiments with an extended form of gravity model incorporating this trade-off for national stream migrants has yielded promising results, so far.

A further avenue along which research is currently proceeding is to attempt a rather more sophisticated treatment of space in the analysis. Distances have generally been measured in this thesis in terms of pure physical separation - road distances, or straight line distances, for example, between areas. Individual perceptions of distance are arguably rather more complex, however, varying from physical distance not just because of differences in the quality and cost of transport links between pairs of areas, but also reflecting psychological factors or institutional barriers. Work with Ian Gordon suggests that it is possible to construct plausible 'behavioural maps' using a revealed preference approach which extracts implied distances from matrices of commuting patterns. These distances were found to yield clearly superior fits in the explanation of migration patterns than standard measures of physical distance.

Further research is also currently being conducted into the issue of decentralisation of population and employment. The sort of simultaneous model outlined in Gordon and Lamont (1982) and in chapter 7 of this thesis has implications for the process of dispersal from London, whereby the population movements in the form of the three migrant streams are affected by, and in turn themselves affect, the growth of employment opportunities in the suburbs, as well as housing opportunities in terms of the rate of private house-building. Clearly these processes are inter-dependent and self-reinforcing, possibly leading to a pattern of cumulative causation over time. The properties of the model in this respect may therefore be investigated by simulation of the system, solving the set of equations for each area as well as the equations for interactions between the areas. The effects of government policy may then be investigated, e.g. in terms of job creation at the level of single boroughs, blocks of areas such as the inner city London boroughs, or for the London and OMA area as a whole. Such an exercise could yield important insights into the effectiveness of job creation schemes in alleviating inner city unemployment, for example, after having taken account of ripple effects in other areas as a result of induced migration, housing market adjustments etc.

Finally, there is clearly a pressing need to examine the more recent data now made available from the 1981 Census, to assess what principal features of urban and regional labour markets have changed since the 1971 Census, and why. Work on analysing an inter-district migration matrix for the whole of Great Britain taken from the 1981 Census is currently being undertaken jointly with Ian Gordon.

3. Conclusions

The general emphasis of this thesis has been about the importance of constraints on individual decision-making; constraints imposed by local markets characterised by imperfect information and quantity-quantity relationships rather than by price adjustment to market clearing. Choice sets facing individuals are defined largely by the broad climate of demand both over time and across areas, and such restrictions on choice play a substantial role in dictating behaviour - arguably more so than the influence individuals themselves can exercise in selecting from the range of potential choices. Prices play a more peripheral role in this scheme, in so far as they represent one dimension (and not necessarily the over-riding one) of the choices which individuals select from.

This view contrasts markedly with that of neoclassical economics, where information problems are either not addressed or are assumed away (eg. via the rational expectations assumption), and prices are taken to adjust in order to restore supply/demand equilibrium. In this neoclassical world, choice sets are defined by competitive market forces, where all possibilities of Pareto improvement are uncovered and accommodated by the market, individuals select voluntarily (and therefore optimally) from this choice set, and the only question marks that remain relate to the distribution of welfare and opportunities across individuals.

The view adopted here of individual decision making is more in keeping with Keynesian perspectives than with the neoclassical paradigm, in that it accords a substantial role to quantity constraints and the influence of demand. Nevertheless, the broad tenor of the conclusions that emerge is in line with neither of these perspectives. On the one hand, the neoclassical view of spatial economic imbalance stemming from labour immobility and contributing in the aggregate to the 'natural rate' of unemployment is seen here to be fundamentally incorrect in its view of individual behaviour, and of the operation of spatial markets. On the other hand, orthodox Keynesian policies of demand management are seen here to disregard questions of supply side adjustment, both in terms of the open-ness of areas with regard to movement, and the scope of individuals to vary their degree of labour force attachment in response to market conditions. The supply side does matter, but it does not operate in the way neoclassical theory suggests.

Within the broad perspective adopted in this thesis, appropriate policy responses to help alleviate spatial economic imbalance in general, and local unemployment problems in particular, are not easy to formulate. The general problem that emerges is one of successfully targetting policies at particular groups or areas, due to the scope for supply side adjustment to demand side policies. The emphasis in this thesis has been on the inter-dependence of areas - policies aimed at one specific area will induce adjustments which will then have 'ripple effects', differentially affecting other areas depending on the degree of spatial separation. Other forms of inter-dependence are likely to be equally important however, eg. as between occupational groups, and the scope for interaction between these, in terms of occupational movement.

Keynesian demand management policies, and more supply oriented policies in the spirit of neoclassical economics, may be seen to operate in contradiction to each other, in so far as they aim to alleviate the problem of spatial concentrations of unemployment. If the labour market is made more open with respect to movement, then demand side policies are likely to be less effective, given the greater scope for supply side adjustment in the face of demand changes.

Ironically, the emergent picture of the 1980s has been one of slackness in the labour market, which has contributed to a growing rigidity on the supply side, despite popular appeals to workers to intensify search. In such circumstances, job creation schemes are likely to be more effective in relieving local unemployment problems than they were in the early 1970's, at least at the broad regional level, and to a lesser degree at the urban level also.

FOOTNOTES

Chapter 1

1. It is notable however, that it is also possible to derive UV type relationships from alternative perspectives, such as the Holt (1971) model, based on the inter-relationships between hiring and quit rates, and unemployment and vacancies.

Chapter 2

1. Examples of empirical work on migration in Britain prior to Greenwood's review are Hart (1970), (1972), Oliver (1964), Jack (1970), (1971), and Weeden (1973).

2. Whilst the discussion is couched generally in terms of individual rather than household behaviour, there is no reason why the theoretical structures should not be directly transferable to the household case. See Gordon and Molho (1985), Mincer (1978) for a discussion of the interaction between household members in reaching decisions about migration.

3. The essence of Ravenstein's laws are:- migration falls with distance; long-distance migrants go to the cities; migration takes place by stages; each migration stream is associated with a compensating counter-stream; there is an urban/rural distinction in migration propensities; females predominate amongst short distance migrants; technological improvements (in transport especially) increase the volume of migration; and that 'economic motives' (i.e. higher income) dominate in most migration decisions.

4. It is interesting to note in this context that the algebriac manipulations required to translate micro-economic theory to reach a statement of the aggregate gravity model parallel in many respects the earlier derivation of spatial interaction models based on purely probablistic considerations relating to the maximisation of entropy functions (Wilson (1971)).

5. One practical problem that may be noted with the random utility approach is that the presence of an implicit distance deterrence function in the strict utility component V_{in} requires that the attractiveness of different areas be discounted according to distance from point of region. Without prior knowledge of the form and strength of this distance function, the random utility model would be very difficult to implement at the individual level. Disregarding the distance function, on the other hand, necessarily implies a violation of 'Independence of Irrelevant Alternatives' (implicit in the specification of the Weibull distribution) since alternatives may no longer be seen as equally substitutable.

6. Standard search models either disregard or make some fairly simplistic assumption about the determination of the decision to enter or abandon search, eg. that the number of searchers in each region is exogonously fixed (Maier (1985), Amrhein and

MacKinnon (1985)), or that only the unemployed are in search, although the model may of course be extended to the analysis of 'on-the-job' search (Lippman and McCall (1976)). Within the Gordon and Vickerman framework, however, employment status may simply be seen as one of several possible arguments influencing the decision to undertake search, which reflects the balance between the expected utility of search (acting like a reservation criterion) and non-search. The 'stress' model outlined earlier also focusses on this decision, but questions the validity of treating it as the outcome of a utility maximising exercise.

7. It is notable that Gordon and Vickerman (1982) do not concentrate so heavily on wages as the single over-riding characteristic in the searcher's decision to accept or reject an opportunity, but permit other attributes of specific opportunities to enter into the individual's decision. As we shall see later, this generalisation is also consistent with the view that there are a number of different possible motivations for moving, apart from those related to the labour market.

8. The determination of the probability of receiving an offer is also dealt with in the standard search model by assuming a fixed rate at which offers are generated (eg. once a day), from a given wage distribution rather than looking at the demand side conditions which influence this probability. In this respect standard search models may, once again, be generalised to allow for a variable rate of offers over time (Lippman and McCall (1976)), or across space (Rogerson (1982), Pickles and Rogerson (1984)). Rather than looking at the effects of changing these specific assumptions, however, Gordon and Vickerman seek to model directly those processes which affect the rate of generation of new opportunities.

9. A closely related point is that the summation of migration data may involve substantial loss of information. In practice however, the choice facing the investigator is generally between aggregated Census data and small sample survey micro data. On this basis it is not self evident that small sample data on several thousand individuals contains indisputably more information than, say, an inter-district census drawn matrix consisting of over 450 x 450 cells. The problem of information loss clearly depends in part on the level of areal aggregation which is chosen to fit the gravity model.

10. Friction in information therefore provides a further avenue, over and above pure costs of movement, whereby distance may affect migration decisions in the search model, and it is a channel which is notably absent in the human capital model.

11. Speculative migration may also be seen to vary with the characteristics of the origin population (eg. such speculative moves are likely to be more rewarding for those who are unemployed or employed in unskilled low paid jobs), and the relative variance in the type of opportunities at the point of destination (David (1974)). An implicit distance deterrence function is also likely to be present, reflecting costs to movement which have to be set against the relative expected pay-

off, as well as friction in information flows about the relative dispersion of opportunities in different areas.

12. The population terms are used as left hand side deflators, since it can be shown that attaching exponents to these other than unity is likely to lead to spatial aggregation problems, unless the areal units have been uniquely defined. The otherwise exponential formulation is adopted since the distribution of push and pull factors is likely to be strongly skewed without ever being negative (since this would imply negative migration flows).

13. Unemployment, for example, is likely to affect <u>both</u> the mobility mix of an area (if the unemployed have different propensities to move), and its valued attributes in terms of the perceived effect on the probability of being able to find work. As a further example, wages are likely to act on one hand as an areal characteristic in affecting the desirability of moving to or from a region, but on the other as an individual one affecting the <u>ability</u> to move in its role as a potential financial constraint.

14. Indeed, the strong correlation between city size and relative variances, suggested by David (1974), might conceivably have contributed to the observed pattern of rural/urban shift in less developed countries.

15. Each of these national, regional, and local streams were associated with a variety of motivational factors, the clearest of these associations being with employment-related, environmental, and housing-related reasons for moving, respectively.

16. It is interesting to note that <u>speculative</u> migration is likely to occur only in the <u>national</u> migration stream, since it would make little sense to relocate locally in order to facilitate search, or to move in order to search for better housing.

17. Within this framework one can apply matrices of transition probabilities to vectors of local populations and simulate expected future profiles of regional population distributions depending on the differential mobility rates of different population groups.

<u>Chapter 3</u>

1. The alternative in this case is non-movement, which is assigned the value of unity in this formulation, calculated as the exponential of zero.

2. Some experiments were nevertheless performed with this model varying the interval limits between alternatives in experimental fashion. This exercise suggested that the power of the ordered probit model to distinguish <u>between</u> alternatives using this data set was very poor, since it generally allocated virtually <u>all</u> its predictions simply to the largest alternative grouping (in this case short distance moves).

3. The timing of the survey is also noteworthy. Although the recession had not yet begun to bite particularly severely by this time, nevertheless national unemployment rates were substantially higher than they had been over the Sixties and early Seventies, and the overall volume of migration was depressed as a result (see e.g. Ogilvy (1979)), in comparison to the GHS migration data for 1973 analysed by Hughes and McCormick (1981), for example.

4. Metropolitan areas were treated as separate regions in the definition of contiguity.

5. Clearly, there is no reason to expect these figures to decline monotonically with distance, since they also reflect the relative size of each distance range. Job changers were identified in this analysis on the basis of having either changed firm, industry (by MLH), or occupation (including occupational moves within the KOS definitions), or any combination of these, over the one year interval.

6. This test also takes into account the degree of homogeneity within groups.

7. In general, the logit estimates did not differ substantially from those obtained using the linear probability model, in terms of signs and significance of variables.

8. Partial derivatives may be calculated as $\frac{\delta M}{\delta X} = \beta \left(\frac{M}{1-M}\right)$ and since the population migration means are higher for job-changers, this implies an even greater contrast in the size of the housing tenure effects across samples.

9. Hughes and McCormick (1981) in an analysis of individual inter-regional moves come to broadly the same conclusions for the London region, the only metropolitan area identified separately in their sample. Separating out London from the other metropolitan areas in the sample used here produced no significant effects.

10. This variable is based on an ECLFS definition of those unemployed and seeking work one year ago, rather than registered unemployment. The variable only applies (by definition) to the economically active non job changing sample, and is defined at start of period.

11. Only the classification functions are reported in detail to save space, although the coefficients of the canonical discriminant functions themselves are available from the author on request. These functions may be used to locate individuals in the underlying three dimensional discriminant space on the basis of their observed characteristics.

12. Although problem is obviously less severe when comparing non-contiguous inter-regional moves against the rest.

13. Deleting those individuals who left the labour force from the economically active non-job-changing sample further accentuated

these results. Thus, out of 15 more inter-regionl migrants per hundred amongst job changers, 8 moved as a result of changing their jobs, rather than any other differing personal characteristics.

Chapter 4

1. Obviously, one region must be deleted either from the push or pull dummy variables (or both if a constant term is included in the model) in order to prevent the model from becoming singular. The problem of selecting a particular region for this purpose is essentially equivalent to the arbitrariness that arises with the Hyman (1969) methodology in relation to the relative scaling of the push and pull factors.

2. Including a set of origin specific parameters into this model generated an estimated distance parameter of -0.00356, whilst an equivalent model with destination specific effects yielded an estimated distance parameter of -.00350.

3. It is notable that statistical tests based on the inter-regional migration matrix used here confirmed Gordon's (1982) finding that the exponential formulation is the most appropriate for the employment stream model.

4. Variations in the distance cut-off due to differences in the regional push and pull factors may be handled in this figure by adjustments in the vertical intercept of the housing stream function, whilst keeping the slope unchanged.

5. See chapter 2 for a detailed discussion of the weaknesses of the additive model. It may be noted, however, that these weaknesses are likely to be less serious when dealing with housing migrants where distances travelled are much more uniformly short, as compared to employment stream movers.

6. These estimates taken from Gordon and Molho (1985a).

Chapter 5

1. In addition to these studies of gross migration flows over time, several time-series studies of net migration have also been conducted for Great Britain (see for example Pissarides and McMaster (1984)), generally using data constructed from information on regional populations, births and deaths. Apart from the obvious data problems involved in calculating migration as a residual in this manner, as well as the inability of the investigator to properly identify employment and housing related moves, however, there are serious theoretical problems in modelling directly net as opposed to gross flows, regardless of distance and spatial location.

2. In the multi-variate case, the form of A(L) may be allowed to vary across explanatory variables.

3. Thus the validity of treating labour market variables as exogenous in the long run must be called into question. This issue presents a potentially serious problem with the estimates presented in this chapter, although similar drawbacks also apply to conventional single equation pure cross-section models. However, OLS may still provide consistent estimates on the assumption that the system may reasonably be regarded as recursive.

4. The EC Labour Force Surveys have also provided information once every two years since 1973.

5. House prices were standardised for regional variation in dwelling mix in the manner outlined by Fleming and Nellis (1981) using unpublished information from the Department of the Environment. Since house prices and construction rates are likely to be influenced by migration flows, these variables were regressed on their own past values, and the regression predictions used in estimation.

6. Whilst the Durbin-Watson statistic (d) is substantially less than 2 for the ξ equation, the test is still inconclusive due to the limited number of degrees of freedom.

7. Since the dependent variables for the push/pull equations are in this case linear (due to the functional form chosen for equation (4.1)), the estimated coefficients are, of course, not directly comparable with those presented in Table 1 for the employment stream.

Chapter 6

1. The binary nature of the dependent variable at the individual level, and the limited nature at the aggregate level, suggest that a logit formulation would be appropriate in both these cases. Cogan (1980) has shown that there is generally little difference between such logistic and linear models, however, except at low or high probability levels for the dependent variable.

2. Various studies may be identified which also deal with male participation, however, eg. Bowers (1970), Gordon (1970), Corry and Roberts (1970), Greenhalgh (1979).

3. There would, of course, be strong grounds for differentiating between movement of housing and employment related migrants within this context, since it is mainly the latter that are likely to respond to local labour market conditions, and to contribute to the local stock of economically active individuals in the population (see Molho (1982b) for a more detailed discussion of these issues).

4. An interesting but perhaps less prevalent possibility involves households moving in essentially <u>residential</u> streams, since a move to a more desirable place of residence for the family might entail the loss of work for the married woman, given the likelihood of greater constraints on commuting back to the original workplace, as compared to the husband.

5. The absence of regional price data meant that a national price deflator had to be used. This omission is a potentially serious one, but one which is common to previous work on regional participation. At a national level, Berg and Dalton (1977) found that female rates responded negatively to long run movements in prices but positively to short run deviations.

   It is quite possible that the relative sizes of the income and substitution effects may vary across socio-economic groups. Thus a more disaggregated study may be warranted at some later date.

6. Simpson's (1982) search model of married female participation in London ultimately related it only to the stock of different types of job.

7. The results of Easterlin (1978) and Ermisch (1982) would suggest a causality problem here, in so far as birth rates may well be endogenous with respect to the level of labour force participation. Cramer's (1980) analysis of longitudinal survey data for the US showed, however, that the dominant effects were from fertility to employment in the short run, and from employment to fertility in the long run, suggesting that family structure variables may reasonably be treated as exogenous in this short run quarterly analysis. Also, to the extent that the variables used here may also reflect sampling variation between different households, it would also seem reasonable to treat them as predetermined.

8. For example, participation in region r may be termed 'high' (i.e. above the national average), because unemployment, say, is low (i.e. below the national average). An alternative formulation would have been the use of absolute differences rather than ratios as measures of regional variation, in which case the variables would have been distributed around zero rather than unity. This issue is discussed later in connection with trends in regional unemployment.

9. Thus the model selection procedure was considerably simplified by the assumption of a uniform dynamic structure across regions, in all stages of estimation.

10. The LM test was for autocorrelation orders 1 to 4 inclusive.

11. The F test compares the sum of squared residuals of the restricted and unrestricted equations in the usual way. The sum of squared residuals for the unrestricted case was derived by adding together all the sums of squared residuals yielded by estimating the same equation for each region. These equations are not reported to save space.

12. The excluded dummy is for the North region. As regards the remaining dummies, YH = Yorkshire and Humberside, EM = East Midlands, EA = East Anglia, GL = Greater London, RoSE = Rest of South East, SW = South West, Wa = Wales, WM = West Midlands, NW = North West, Sc = Scotland and NI = Northern Ireland.

13. The restriction of a constant intercept over time was also tested, the calculated F statistic yielding a value of 0.220, which clearly indicates that the restriction is valid.

14. These may be calculated from the regression coefficients (see Wallis (1973)).

15. Adjusted for autocorrelation orders 1-4 inclusive. The semi-log transformation is used, partly because it imposes the desirable property that $\sigma^2\ (p_r/P)$ can never be negative, so that (p_r/P) will collapse (asymptotically with t) around unity, and partly because it conveniently allows the calculation of rates of growth. Linear formulations yielded very similar results in terms of signs and significance. Note that $\ln [\sigma^2\ (pr/P)] = 2 \ln [\sigma\ (p_r/P)]$, so that the estimates will be essentially unaffected by whether the variance or the standard deviation is used as the dependent variable.

16. Linear and semi-log formulations yielded very similar results. Since the relationship is likely to be dynamic rather than static, a rational (infinite) distributed lag model was used in the estimation of equation (6.2).

17. Clearly, there are behavioural factors at work here, as well - the reversal of sign regarding the cyclical sensitivity of regional unemployment rates depending on whether absolute or proportionate measures are used, has long been noted, eg. see Thirlwall (1966), Brechling (1967). Gordon (1985b) has argued that the tendency for <u>absolute differences</u> to diverge in times of recession reflects the reduced volume of migration over such periods, in contrast to the traditional <u>demand</u> side explanations which have been suggested in the past.

Chapter 7

1. Using a similar data set, Congdon (1983) suggests that differences in employment growth rates did affect shorter distance migration. This result, however, seems to reflect the omission of <u>private</u> house-building as a distinct influence in Congdon's model.

2. The regression estimate actually implies that more than 100% of the effect is absorbed in this way. This obvious over-statement is thought to be attributable to the implicit assumption of fixed commuting patterns in the definition of the differential growth variable, which is only strictly justifiable for marginal employment changes.

3. This variable was constructed in terms of the <u>national</u> age profile of participation rates, and the estimated coefficient on this variable indicates the extent to which London diverges from this national average.

4. The absence of such effects in chapter 6 largely reflected the strong collinearity between male and female earnings over time.

REFERENCES

Alperovich, G., J. Bergsman, and C. Ehemann (1977) "An Econometric Model of Migration Between US Metropolitan Areas", Urban Studies, 14, pp.135-145.

Amemiya, T. (1981) "Qualitative Response Models: A Survey", Journal of Economic Literature, Vol. XIX, pp. 1483-1536.

Amrhein, C. (1985) "Interregional Labour Migration and Information Flows", Environment and Planning A, 17, pp.1111-1126.

Amrhein, C., and R. MacKinnon (1985) "An Elementary Simulation Model of the Job Matching Process within an Interregional Setting", Regional Studies, pp. 193-202, 19.

Anderson, J. (1979) "A Theoretical Foundation for the Gravity Equation", American Economic Review, 69, pp. 106-116.

Andrews, H. (1978) "Journey to Work Considerations in the Labour Force Participation of Married Women", Regional Studies, Vol. 12, pp. 11-20.

Armstrong, H., and J. Taylor (1985) Regional Economics and Policy, Oxford, Philip Allan (2nd ed.).

Ashenfelter, O. and J. Heckman (1974) "The Estimation of Income and Substitution Effects in a Model of Family Labor Supply", Econometrics, Vol. 42, No. 1, pp. 73-85.

Azariadis, C. (1975) "Implicit Contracts and Underemployment Equilibria", Journal of Political Economy, vol. 83, pp.1183-1202.

Bartel, A. (1979) "The Migration Decision: What Role Does Job Mobility Play?", The American Economic Review, 69, pp. 775-786.

Baxter, M. (1979) "The Application of Logit Regression Analysis to Production Constrained Gravity Models", Journal of Regional Science, vol. 19, no. 2, pp. 171-177.

Baxter, M. and G. Ewing (1979) "Calibration of Production Constrained Trip Distribution Models and the Effects of Intervening Opportunities", Journal of Regional Science, Vol. 19, pp. 319-330.

Bebbington, A. C. (1979) "Priorities in Job Choice - An Analysis of the Social Work Trainees Survey" DP-97, Personal Social Services Research Unit, University of Kent at Canterbury.

Becker, G. (1971) The Economics of Discrimination, University of Chicago Press, Chicago.

Bell, D. and R. Hart (1980) "The Regional Demand for Labour Services", Scottish Journal of Political Economy, 27, pp. 140-151.

Berg, S. V. and T. R. Dalton (1977) "United Kingdom Labour Force Activity Rates: Unemployment and Real Wages", Applied Economics, 9, No. 3, pp. 265-70.

Blumen, I., M. Kogan and P. McCarthy (1955) Industrial Mobility of Labour as a Probability Process, Ithaca, Cornell University Press.

Borts, G. and J. Stein (1964) Economic Growth in a Free Market, Columbia University Press.

Bowers, J. (1970) "The Anatomy of Regional Activity Rates", NIESR Regional Papers 1, CUP.

Bowers, J. (1975) "British Activity Rates: A Survey of Research", Scottish Journal of Political Economy, XXII, I, pp. 57-90.

Brechling, F. (1967) "Trends and Cycles in British Regional Unemployment", Oxford Economic Papers, 19, pp.1-21.

Brown, J. (1983) "The Structure of Motives for Moving: A Multi-Dimensional Model of Residential Mobility", Environment and Planning, A, vol. 15, pp. 1531-1544.

Buiter, W. and M. Miller (1981) "Monetary Policy and International Competitiveness: The Problems of Adjustment", Oxford Economic Papers.

Burridge, P. and I. Gordon (1981) "Unemployment in the British Metropolitan Labour Areas", Oxford Economic Papers, vol. 33, no. 2, pp. 274-297.

Cheshire, P. (1973) "Regional Unemployment Differences in Great Britain", in NIESR Regional Papers II, Cambridge University Press.

Choukroun, J. M. (1975) "A General Framework for the Development of Gravity-Type Trip Distribution Models", Regional Science and Urban Economics, vol. 5, no. 2, pp. 177-202.

Clark, W. and T. Smith (1979) "Modelling Information Use in a Spatial Context", Annals of the Association of American Geographers, 69, pp.575-588.

Clower, R. (1965) "The Keynesian Counter-Revolution: A Theoretical Appraisal", in F. Halm and F. Brechling (eds.), The Theory of Interest Rates, ch. 5, pp. 103-125, Macmillan.

Cogan, J. (1980) "Married Women's Labour Supply: A Comparison of Alternative Estimation Procedures" in Smith, J. P. (ed.), Female Labor Supply: Theory and Estimation, Princeton: Princeton University Press.

Congdon, P. (1983) "A Model for the Interaction of Migration and Commuting", Urban Studies, Vol. 20, pp. 185-195.

Cordey-Hayes, M., and D. Gleave (1974) "Migration Movements and the Differential Growth of City Regions in England and Wales", Thirteenth European Congress of the Regional Science Association, Papers and Proceedings, pp. 99-123.

Corry, B. A. and J. R. Roberts (1970) "Activity Rates and Unemployment: The Experience of the United Kingdom 1951-1966", Applied Economics, Vol. 2, No. 3, pp. 179-201.

Corry, B. A. and J. R. Roberts (1974) "Activity Rates and Unemploy ment: Some Further Results", Applied Economics, Vol. 6, No. 1, pp. 1-21.

Cramer, J. C. (1980) "Fertility and Female Employment: Problems of Causal Direction", American Sociological Review, Vol. 45, No. 2, pp. 167-190.

Creedy, J. (1974) "Inter-regional Mobility: a Cross-Section Analysis", Scottish Journal of Political Economy, vol. 21, pp. 41-53.

Da Vanzo, J. (1976) "Differences Between Return and Non-Return Migration: An Econometric Analysis", International Migration Review, 10, pp.13-27.

Da Vanzo, J. (1978) "Does Unemployment Affect Migration? - Evidence from Micro Data", Review of Economics and Statistics, 60, pp. 504-514.

Da Vanzo, J. and P. Morrison (1981) "Return and Other Sequences of Migration in the United States", Demography, 10, pp.85-101.

David, P. (1974) "Fortune, Risk, and the Microeconomics of Migration", in P. David and M. Reder (eds.) Nations and Households in Economic Growth, Academic Press.

Deaton, A. and J. Muellbauer (1980) Economics and Consumer Behaviour, Cambridge University Press.

D E Gazette (1978) "Regional Civilian Labour Force Projections", September, pp. 1040-1043.

Domencich, T. and D. McFadden (1975) Urban Travel Demand: A Behavioural Analysis, North Holland, Amsterdam.

DSPSE (1976) "Strategy for the South East: 1976 Review, Report of the Land Group", Department of the Environment, London.

Easterlin, R. A., M. L. Wachter and S. M. Wachter (1978) "Demographic Influences on Economic Stability: The United States Experience", Population and Development Review, Vol. 4, No. 1, pp. 1-22.

Elias, P. and B. Main (1982) Womens Working Lives: Evidence from the National Training Survey, Institute for Employment Research Report, University of Warwick.

Elias, P. and I. Molho (1982) "Regional Labour Supply: An Economic/Demographic Model", Population Change and Regional Labour Markets. OPCS Occasional Paper 28, London: HMSO, pp. 55-65.

Ermisch, J. (1982) "Economic Models of Period Fertility in Britain", Policy Studies Institute, London, (mimeographed).

Evers, G. and A. van der Veen (1985) "A Simultaneous Non-linear Model for Labour Migration and Commuting", Regional Studies, pp. 217-230, 19.

Fields, G. (1976) "Labour Force Migration, Unemployment and Job Turnover", Review of Economics and Statistics, pp. 407-415, 58.

Fleming, M. and J. Nellis (1981) "The Interpretation of House Price Statistics for the United Kingdom", Environment and Planning A, 13, pp. 1109-1124.

Flowerdew, R. and M. Aitkin (1982) "A Method of Fitting the Gravity Model Based on the Poisson Distribution", Journal of Regional Science, vol. 22, no. 2, pp. 191-202.

Flowerdew, R. and J. Salt (1979) "Migration Between Labour Market Areas in Great Britain, 1970-1971", Regional Studies, vol. 13. pp. 211-231.

Fotheringham, A. S. (1981) "Spatial Structure and the Parameters of Spatial Interaction Models", Annals of the Association of American Geographers, 71, 425-436.

Gahagan, M., and A. Bishop, J. May, A. Ryan (1976) "Strategy for the South East: 1976 Review, Report of the Economy Group", Department of the Environment, London.

Gleave, D. and D. Palmer (1978) "Mobility of Labour: Are Council Tenants Really Handicapped?", CES Review, No.3, pp.74-77.

Godfrey, L. G. (1978) "Testing for Higher Order Serial Correlation in Regression Equations when the Regressors Include Lagged Dependent Variables", Econometrica, 46, No. 6, pp. 1303-1310.

Goodchild, M. and T. Smith (1980) "Intransitivity, the Spatial Interaction Model, and US Migration Streams", Environment and Planning A, 12, pp.1131-1144.

Gordon, I. (1970) "Activity Rates: Regional and Sub-Regional Differentials", Regional Studies, 4, pp. 411-424.

Gordon, I. (1975) "Employment and Housing Streams in British Inter-Regional Migration", Scottish Journal of Political Economy, vol 22, no. 2, pp. 161-177.

Gordon, I. (1977) "Regional Interdependence in the U.K. Economy", in W. Leontief (ed.), Structure, System, and Economic Policy, Cambridge University Press.

Gordon, I. (1982) "The Analysis of Motivation Specific Migration Streams", Environment and Planning, A, 14, pp. 5-20.

Gordon, I. (1985a) "Economic Explanations of Spatial Variations in Distance Deterrence", Environment and Planning, A, Vol. 17, pp. 59-72.

Gordon, I. (1985b) "The Cyclical Interaction Between Regional Migration, Employment, and Unemployment: A Time-Series Analysis for Scotland", Scottish Journal of Political Economy, forthcoming.

Gordon, I. (1985c) "The Cyclical Sensitivity of Regional Employment and Unemployment Differentials", Regional Studies, forthcoming.

Gordon, I. and D. Lamont (1982) "A Model of Labour Market Interdependencies in the London Region", Evironment and Planning, A, 14, pp. 237-264.

Gordon, I. and R. Vickerman (1982) "Opportunity, Preference and Constraint: An Approach to the Analysis of Metropolitan Migration", Urban Studies, 19, pp. 247-261.

Gordon, I., R. Vickerman, D. Lamont, and A. Thomas (1983) "Opportunities, Preferences, and Constraints on Population Movement in the London Region", Final Report to the Department of the Environment, Urban and Regional Studies Unit, University of Kent at Canterbury.

Gordon, I. and I. Molho (1985a) "A Study of Regional Trends in Migration 1960-81", Urban and Regional Studies Unit discussion paper (forthcoming).

Gordon, I. and I. Molho (1985b) "Women in the Labour Markets of the London Region: A Model of Dependence and Constraint", Urban Studies, forthcoming.

Gould, P. and R. White (1968) "The Mental Maps of British School Leavers", Regional Studies, 2, pp. 161-182.

Greenhalgh, C. (1977) "A Labour Supply Function for Married Women in Great Britain", Economica, 44, 175, pp. 249-265.

Greenhalgh, C. (1979) "Male Labour Force Participation in Great Britain", Scottish Journal of Political Economy, 26, pp. 275-286.

Greenhalgh, C. A. (1980) "Participation and Hours of Work for Married Women in Great Britain", Oxford Economic Papers, 32, No. 2, pp. 296-318.

Greenhalgh, C. A., and K. Mayhew (1981) "Labour Supply in Great Britain: Theory and Evidence", in The Economics of the Labour Market, Z. Hornstein (ed.), London: HMSO.

Greenwood, M. (1969) "An Analysis of the Determinants of Geographic Labour Mobility in the United States", Review of Economics and Statistis, 51, pp.189-194.

Greenwood, M. (1975) "Research on Internal Migration in the United States: A Survey", Journal of Economic Literature, 13, pp. 397-433.

Griliches, Z. (1967) "Distributed Lags: A Survey", Econometrica, 35, pp. 16-49.

Hakim, C. (1981) "Job Segregation Trends in the 1970's, Employment Gazette.

Harris, A. and R. Clausen (1967) Labour Mobility in Great Britain, 1953-63 HMSO, London.

Harris, J. and M. Todaro (1970) "Migration, Unemployment, and Development: A Two-Sector Analysis", American Economic Review, 60, pp. 126-142.

Hart, R. (1970) "A Model of Inter-Regional Migration in England and Wales", Regional Studies, 4, pp.279-296.

Hart, R. (1972) "The Economic Influences on Internal Labour Force Migration", Scottish Journal of Political Economy, 19, pp.151-173.

Hart, R. (1975a) "Inter-regional Economic Migration: Some Theoretical Considerations Part 1", Journal of Regional Science, vol. 15, no. 2, pp. 127-138.

Hart, R. (1975b) "Inter-Regional Migration: Some Theoretical Considerations (Part 2)", Journal of Regional Science, 15, 3, pp. 289-305.

Heckman, J. (1980) "Sample Selection Bias as a Specification Error", in Smith, J. P. (ed.), Female Labor Supply: Theory and Estimation, Princeton: Princeton University Press.

Heckman, J., M. Killingsworth, and T. McCurdy (1981) "Empirical Evidence on Static Labour Supply Models: A Survey of Recent Developments" in The Economics of the Labour Market, Z. Hornstein, J. Grice, and A. Webb (eds.), London: HMSO.

Hendry, D. and G. Mizon (1978) "Serial Correlation as a Convenient Simplification, Not a Nuisance: A Comment on a Study of the Demand for Money by the Bank of England", The Economic Journal, September, 88, pp. 549-563.

Hicks, J. (1932) The Theory of Wages, London: Macmillan.

Holt, C. (1971) "How can the Phillips Curve be Moved to Reduce both Inflation and Unemployment"?, in E. S. Phelps (ed.), Microeconomic Foundations of Employment and Inflation Theory, London, Macmillan.

Hughes, G. and B. McCormick (1981) "Do Council House Policies Reduce Migration Between Regions?", The Economic Journal, 91, pp. 549-563.

Hughes, G. and B. McCormick (1985) "Migration Intentions in the UK. Which Households Want to Migrate and Which Succeed", Economic Journal, Vol. 95.

Hyman, G. (1969) "The Calibration of Trip Distribution Models", Environment and Planning, vol. 1, no. 1, pp. 105-112.

Hyman, G. and D. Gleave (1977) "A Reasonable Theory of Migration", Transactions of the Institute of British Geographers, New Series, 3, pp. 179-201.

Jack, A (1970) "A Short Run Model of Inter-Regional Migration", The Manchester School, 38, pp.15-28.

Jack, A. (1971) "Inter-Regional Migration in Great Britain: Some Cross-Sectional Evidence", Scottish Journal of Political Economy, 18, pp.141-160.

Jorgenson, D. (1966) "Rational Distributed Lag Functions", Econometrica, January, 32, 1, pp. 125-149.

Joshi, H. and S. Owen (1981) "Demographic Predictors of Women's Work Participation in Post-War Britain", Centre for Population Studies Working Paper No. 81-3, (mimeographed).

Joshi, H., R. Layard and S. Owen (1981) "Female Labour Supply in Post-War Britain: A Cohort Approach", L.S.E. Discussion Paper No. 79.

Kau, J. and C. Sirmans (1977) "The Influence of Information Cost and Uncertainty on Migration: A Comparison of Migrant Types", Journal of Regional Science, 17, pp.89-96.

Kemsley, W. F. F. (1969) "Family Expenditure Survey: Handbook on the Sample, Fieldwork and Coding Procedures", London: HMSO.

Kiernan, K. (1977) "Characteristics of Young People who Move Inter-Regionally: A Longitudinal Study", in Regional Demographic Development, J. Hobcraft and P. Rees (eds.), ch. 9, pp. 211-227.

Klecka, W. (1980) Discriminant Analysis, SAGE University Paper Series on Quantitative Applications in the Social Sciences No. 19, SAGE Publications, Beverly Hills and London.

Krumm, R. (1983) "Regional Labour Markets and the Household Migration Decision", Journal of Regional Science, vol. 23, pp. 361-376.

Langley, P. (1974) "The Spatial Allocation of Migrants in England and Wales: 1961-1966", Scottish Journal of Political Economy, 21, pp. 259-277.

Layard, R., M. Barton, and A. Zabalza (1980) "Married Women's Participation and Hours", Economica, pp. 31-52.

Lee, B. and D. Hodge (1984) "Social Differentials in Metropolitan Residential Displacement", in Palen and London (eds.), Gentrification, Displacement and Neighbourhood Revitalisation, State University of New York Press, Albany.

Leijonhufvud, A. (1967) "Keynes and the Keynesians: A Suggested Interpretation", American Economic Review, 57, no. 2, pp. 401-410.

Lippman, S. A. and J. J. McCall (1976) "The Economics of Job Search: A Survey. Part I: Optimal Job Search Policies", Economic Inquiry, vol. XIV, pp. 155-189.

Lowry, I. (1966) "Migration and Metropolitan Growth", Chandler, San Francisco.

Lucas, R. (1985) "Migration Amongst the Botswana", Economic Journal, pp. 358-382, 95.

McCormick, B. (1983) "Housing and Unemployment in Great Britain", Oxford Economic Papers, Vol. 35, pp. 283-305.

Madden, J. F. (1977) "An Empirical Analysis of the Spatial Elasticity of Labor Supply", Papers of the Regional Science Association, 39, 157-171.

Maier, G. (1985) "Cumulative Causation and Selectivity in Labour Market Oriented Migration caused by Imperfect Information", Regional Studies, Vol. 19, pp. 231-241.

Main, B. and P. Elias (1982) "Patterns of Work", Chapter 2 of Elias, P. and B. Main, Women's Working Lives: Evidence from the National Training Survey, Research Report, Institute for Employment Research, University of Warwick.

Malcolmson, J. (1981) "Unemployment and the Efficiency Wage Hypothesis", Economic Journal, vol. 91, pp. 848-866.

Martin, J. and C. Roberts (1984) Women and Employment: A Lifetime Perspective, H.M.S.O.

Massey, D. (1983) "Industrial Restructuring as Class Restructuring: Production Decentralization and Local Uniqueness", Regional Studies, 17, 2, 73-89.

Massey, D. and R. Meegan (1982) The Anatomy of Job Loss, Methuen.

Metcalf, D. (1975) "Urban Unemployment in England", Economic Journal, 85, pp. 578-589.

Metcalf, D. and R. Richardson (1976) "Unemployment in London", in G. Worswick (ed.), The Concept and Measurement of Involuntary Unemployment, Allen and Unwin, Herts.

Michelson, W. (1977) Environmental Choice, Human Behaviour and Residential Satisfaction, Oxford University Press.

Mincer, J. (1962) "Labour Force Participation of Married Women: A Study of Labour Supply", in NBER Aspects of Labour Economics, A Conference: Princeton.

Mincer, J. (1966) "Labour Force Participation and Unemployment: A Review of Recent Evidence", in Prosperity and Unemployment, R. A. and M. S. Gordon (eds.), John Wiley and Sons: New York.

Mincer, J. (1978) "Family Migration Decisions", Journal of Political Economy, 86, pp. 749-773.

Minford, P., D. Davies, M. Peel, and A. Sprague (1983) Unemployment: Cause and Cure, Martin Robertson, Oxford.

Molho, I. (1982a) "Contiguity and Inter-regional Migration Flows in Great Britain", Scottish Journal of Political Economy, vol. 29, no. 3, pp. 283-297.

Molho, I. (1982b) "Labour Force Participation and Migration: Some Theoretical Considerations", Institute for Employment Research, Research Paper No. 72.

Molho, I. (1984) "Distance Deterrence Relationships in Multi-Stream Migration Models", The Manchester School, vol. LII, pp. 49-69.

Molho, I. and P. Elias (1984) "A Study of Regional Trends in the Labour Force Participation of Married Women in the UK, 1968-77", Applied Economics, Vol. 16, No. 2, pp. 163-173.

Moss, P. (1980) "Work, Family and Equal Opportunities", London: Maurice Temple-Smith.

Mueller, C. (1982) The Economics of Labour Migration: A Behavioural Analysis, Academic Press.

Murphy, M. (1986) "Mobility by Age and Life Cycle Stage", paper presented to Regional Science Association (British Section) Conference, Bristol.

Narendranathan, W., S. Nickell, and J. Stern (1985) "Unemployment Benefits Revisited", The Economic Journal, 95, pp.307-329.

Niedercorn, J. H. and B. V. Bechdolt (1969) "An Economic Derivation of the "Gravity Law" of Spatial Interaction", Journal of Regional Science, 9, pp. 273-282.

Norris, G. M. (1978a) "Unemployment, Subemployment and Personal Characteristics (A): The Inadequacies of Traditional Approaches to Unemployment", Sociological Review, pp. 89-108.

Norris, G. M. (1978b) "Unemployment, Subemployment and Personal Characteristics (B): Job Separation and Work Histories: the Alternative Approach", Sociological Review, pp. 327-347.

Ogilvy, A. (1979) "Migration - the Influence of Economic Change", Futures, pp. 383-394.

Ogilvy, A. (1982) "Population Migration Between the Regions of Great Britain, 1971-79", Regional Studies, 16, 1, pp. 65-73.

Oliver, F. (1964) "Inter-Regional Migration and Unemployment, 1951-61", Journal of the Royal Statistical Society, 127, Part 1, Series A, pp.42-69.

Pickles, A. and P. Rogerson (1984) "Wage Distributions and Spatial Preferences in Competitive Job Search and Migration", Regional Studies, vol. 18, pp. 131-142.

Pickup, L. (1984) "Women's Gender Role and its Influence on Their Travel Behaviour", Built Environment, 10, 1, 61-68.

Pissarides, C. and I. McMaster (1984) "Regional Migration, Wages, and Unemployment: Empirical Evidence and Implications for Policy", Discussion Paper No. 204, Centre for Labour Economics, LSE.

Ravenstein, E. (1889) "The Laws of Migration", Journal of the Statistical Society, No. 52, pp. 214-301.

Rogers, A. (1975) Introduction to Multiregional Mathematical Demography, John Wiley, New York.

Rogerson, P. (1982) "Spatial Models of Search", Geographical Analysis Vol. 14, pp. 217-228.

Roseman, C. (1983) "Labour Force Migration, Non-Labour Force Migration, and Non-Employment Reasons for Moving", Socio-Economic Planning Science, vol. 17, pp. 303-312.

Rossi, P. (1980) Why Families Move, Sage Publications Ltd., London, California.

Salvatore, D. (1977) "An Econometric Analysis of Internal Migration in Italy", Journal of Regional Science, 17, 3, pp. 395-408.

Sargan, J. D. (1964) "Wages and Prices in the United Kingdom Economy: A Study in Econometric Methodology", in Econometric Analysis for National Economic Planning, P. E. Hart et al., London: Butterworth.

Saunders, M. and R. Flowerdew (1986) "Spatial Aspects of the Provision of Job Information", Conference Paper from the Symposium on Urban and Regional Labour Markets: Problems, Perspectives and Politics, 20-22 February, 1985, Vienna.

Schroeder, L. (1976) "Interrelatedness of Occupational and Geographical Labour Mobility", Industrial and Labour Relations Review, pp. 405-411.

Sheppard, E. S. (1978) "Theoretical Underpinnings of the Gravity Hypothesis", Geographical Analysis, vol. 10, pp. 386-401.

Sheppard, E. (1979) "Gravity Parameter Estimation", Geographical Analysis, vol. 11, no. 1, pp. 120-132.

Silvers, A. (1977) "Probablistic Income Maximising Behaviour in Regional Migration", International Regional Science Review, 2, pp. 29-40.

Simon, H. (1957) Models of Man, John Wiley, New York.

Simpson, W. (1982) "Job Search and the Effect of Urban Structures on Unemployment and Married Female Participation Rates", Applied Economics, Vol. 14, pp. 153-165.

Sjaastad, L. (1962) "The Costs and Returns of Human Migration", Journal of Political Economy, 70, pp. 80-93.

Smith, T. (1975) "A Choice Theory of Spatial Interaction", Regional Science and Urban Economics, 5, pp. 137-176.

Smith, T. (1978) "A Cost Efficiency Principle of Spatial Interaction Behaviour", Regional Science and Urban Economics, pp. 313-337.

Smith, T. and C. Clayton (1978) "Transitivity, Spatially Seperable Utility Functions, and United States Migration Streams, 1935-70", Environment and Planning A, 10, pp.399-414.

Smith, T. and P. Slater (1981) "A Family of Spatial Interaction Models Incorporating Information Flows and Choice Set Constraints Applied to US Interstate Labor Flows", International Regional Science Review, 6, pp. 15-32.

Speare, A. (1974) "Residential Satisfaction as an Interviewing Variable in Residential Mobility", Demography, 11, pp. 173-188.

Speare, A., S. Goldstein, and W. Frey (1974) Residential Mobility, Migration, and Metropolitan Change, Ballinger, Camb. Mass.

Spence, M. (1973) "Job Market Signalling", Quarterly Journal of Economics, Vol. 87, pp. 355-374.

Stern, N. (1981) "The Participation of Married Women in Paid Work in the UK in the 1970's", (mimeograph).

Stetzer, F. (1976) "Parameter Estimation for the Constrained Gravity Model: A Comparison of Six Methods", Environment and Planning, A, 8, pp. 673-683.

Stewart, J. (1948) "Demographic Gravitation: Evidence and Applications", Sociometry, 11, pp. 31-58.

Stiglitz, J. (1985) "Information and Economic Analysis: A Perspective", Economic Journal, Vol. 95, (supplement), pp. 21-41.

Stillwell, J. (1978) "Interzonal Migration: Some Historical Tests of Spatial Interaction Models", Environment and Planning, A, 10, pp. 1187-1200.

Talarchek, G. (1982) "Sequential Aspects of Residential Search and Selection", Urban Geography, 1, pp.34-57.

Taylor, J. (1971) "A Regional Analysis of Hidden Unemployment in GB, 1951-66", Applied Economics, 3, pp. 291-303.

Thirlwall, A. P. (1966) "Regional Unemployment as a Cyclical Phenomenon", Scottish Journal of Political Economy, 13, pp. 205-219.

Thirlwall, A. P. (1969) "Types of Unemployment: With Special Reference To "Non Demand-Deficient" Unemployment in Great Britain", Scottish Journal of Political Economy, pp. 20-50.

Thirlwall, A. P. (1975) "Forecasting Regional Unemployment in Great Britain", Regional Science and Urban Economics, Vol. 5, pp. 357-374.

Todaro, M. (1969) "A Model of Labour Migration and Urban Unemployment in Less Developed Countries", American Economic Review, 59, pp. 138-148.

Todaro, M. (1976) "Internal Migration in Developing Countries: A Review of Theory, Evidence, Methodology, and Research Priorities", International Labour Office, Geneva.

Vanderkamp, J. (1972a) "Migration Flows, Their Determinants and the Effects of Return Migration", Journal of Political Economy, 80, pp.1012-1031.

Vanderkamp, J. (1972b) "Return Migration: Its Significance and Behaviour", Western Economic Journal, 10, pp.460-465.

Van Der Veen, A. and G. Evers (1983) "A Simultaneous Model for Regional Labor Supply, Incorporating Labor Force Participation, Commuting and Migration", Socio-Econ. Plan. Sci., Vol. 17, No. 5-6.

Van Est, J. (1980) "An Inter-Regional Migration Model: A Disaggregate Approach", paper presented at the 20th European Congress of the Regional Science Association, Munich, West Germany.

Vickerman, R. (1984) "Urban and Regional Change, Migration and Commuting - The Dynamics of Workplace, Residence and Transport Choice", Urban Studies, Vol. 21, pp. 15-29.

Vipond, J. (1980) "Intra-Urban Unemployment Differentials in Sydney, 1971" Urban Studies, Vol. 17, pp. 131-38.

Wabe, J. S. (1969) "Labour Force Participation Rates in the London Metropolitan Region", Journal of the Royal Statistical Society, Series A, pp. 245-264.

Wallis, K. (1973) Topics in Applied Econometrics, Gray Mills, London.

Weeden, R. (1973) "Inter-regional Migration Models and their Application to Great Britain", NIESR, Regional Papers 11, Cambridge University Press.

Weinstein, E. (1975) "Some Characteristics of Owner Occupier Migrant Households - A Study Based on Building Society Data", Regional Studies, 9, pp. 147-156.

Wilson, A. (1971) "A Family of Spatial Interaction Models, and Associated Developments", Environment and Planning, 3, pp. 1-32.

Wolpert, J. (1966) "Migration as an Adjustment to Environmental Stress", Journal of Social Issues, 22, pp. 92-102.