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HOW THE DUTCH AND THE ENGLISH  
ADOPTED MULTIREGIONAL MODELS  
FOR SUBNATIONAL POPULATION PROJECTION

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## ABSTRACT

The Netherlands and the United Kingdom have both introduced multiregional models to carry out part of the task of projecting the population of subnational areas. This paper describes and compares these efforts. They are also evaluated in two ways: against the requirements of potential users of forecasts and against the principles that should be applied in sound multiregional population models.

## 1. INTRODUCTION

In both the Netherlands and the United Kingdom national government departments responsible for the production of population projections for both the nation and subnational units have recently sought to improve those projections through the development and implementation of new multiregional models. Researchers and consultants outside of central government were asked to prepare these models (Martin & Voorhees Associates and Bates 1981; Willekens and Drewe 1981, 1984). In this paper these efforts are described and compared in order to assess what has been achieved to date and what improvements could be effected. A particular emphasis is laid on assessment of the outputs available from such models.

In the next section of the paper the needs of users of subnational population projections are assessed. In section three the conceptual bases of multiregional models are briefly reviewed. Section four outlines the nature of the data bases available for use in population projections in the two countries. The fifth section outlines and compares the new population models. The final part of the paper assesses the models and elicits lessons.

## 2. FORECASTING REQUIREMENTS

Here we review the demands of users of population projections rather than the wishes of population modellers. The latter need to assess the requirements of the "market" for their product carefully, and to invest rather more attention than hitherto in the presentation of model outputs. Because of the large number of variables used in multiregional population models, this issue must be the concern of the model designer/systems analyst, and not just a task relegated to a later stage in the development of a projection system.

### 2.1 Population numbers, age disaggregation and time intervals

Users of population projections, be they planners or academics, most usually require knowledge of population numbers at short intervals for varying periods into the future.

The populations are broken down into detailed age groups, not for their own sake, but in order to yield good estimates of target client or service or market populations. Examples are the school populations in various grades, the numbers of potential students qualified to enter higher education, the labour force, or the retired population. The age classification of the population needed to estimate these target populations must be as fine as possible, preferably by single years of age.

Full details of all single year age populations are rarely required but flexible aggregations of these ages are needed. For example, to assess the viability of alternative plans for school reorganization in Leeds, the City Education Committee required projections for the 5-8, 9-13, 14-18 age groups in one scheme, and the 5-10, 11-16, 17-18 age groups in another.

Very often, population numbers themselves are insufficient to define the target population. Further disaggregation may be needed. In the school planning case, an estimate is required of the proportions in any age group entering independent and state supported schools, and within the state sector the proportions or numbers likely to enter Roman Catholic, Anglican or secular schools.

## 2.2 Detailed inputs and outputs

Most population projection models can be designed to yield not only fine detail on the population stocks at regular intervals but also fine detail on the demographic components that link successive population stocks. Users do not normally require, for example, detailed information on mortality or migration rates used in the projections by single years of age, but they probably wish to know what those rates mean in terms of summary measures such as the crude death rate, life expectancy, the crude migration rate or gross migration rate. A detailed account of interregional migration by single years of age is seldom used but a summary of interregion flows by broad age groups would be of interest. But if the number of regions was large, even an interregion matrix would be too detailed, and a summary of the main or total inflows and outflows for each region would be preferable.

To generalize this point, we can say that multiregional population projection models operate with variables at a level of disaggregation much finer than that required by most users and that any implementation of such models should aim to provide relevant summaries of the information generated.

## 2.3 An example of projection outputs

To exemplify these points, we examine the practice adopted by the United Nations (UN) in their latest, very useful set of population estimates and projections as assessed in 1982 (UN, 1985). The results for the Netherlands and the United Kingdom are reproduced in Appendix 1.

Tables A.2 and A.4 show the estimates and projections of the populations of the two countries at 5 year intervals from 1950 to 2025 for

both sexes and for 5 year age groups to 80+ years in a one page format (compressing two pages of computer printout).

Tables A.1 and A.3 summarize the population stock information by broad age groups and provide a set of indicators of the age and sex structure of the population in the first of three sub-tables. The second sub-table provides information on component rates in the 5 year time intervals and summarizes the fertility and mortality levels using nine indicators. The final sub-table gives a selection of the indicators for high fertility and low fertility variants.

The same set of statistics is provided by the UN for all constituent countries and for continental, sub-continental and more/less developed areas, so that comparisons across and between all scales are a simple matter. All the statistics are available to users on magnetic tape for further analysis.

A key feature of the UN projections is the emphasis on presenting statistics over time: time points or intervals are used as the column dimension in all tables. Time series analysis of the results is intended and made easy by such a presentation (e.g. Keyfitz and Vaupel, 1986). The UN projections provide guidelines against which the presentation of subnational projection results can be assessed.

What is less satisfactory about the UN projections, however, is the lack of detail provided about the models and programs used to generate the results. UN(1985, p.3) suggests that 5 year time and age intervals were used throughout to generate tables of the A.2 and A.4 type, but no details are provided on the methods used to produce the annual population figures and other age group numbers contained in the first sub-table of the A.1 and A.3 type.

#### 2.4 A specific or a general model?

Population projection models and their associated software may be specific to the particular system being studied or they may be used more generally with a variety of systems of interest. Academic researchers incline to the latter kind of model because they wish to study many different systems; government researchers prefer the former, both because the model and associated software are easier to design and because their attention is focussed on the current set of subnational units.

This issue is far more serious if a multiregional modelling strategy is adopted. A single region cohort survival model with net migration rates or flows does not require alteration when used with more regions. The same model is simply used more times. However, in multiregional models an expansion from N regions to 2N may require redesign of the

software (because interaction variable dimensions increase in proportion to  $N^2$ ) or redesign of the model (because with very many regions in relation to the size of the population many of the cells in the migration matrix may contain small and unreliable numbers). The model used will vary with the size of the system being modelled.

Although system specific models are easier to design and program, even in governmental use there will be problems occasioned by the frequent re-specification of subnational areas prompted by politicians either because the settlement system has changed or because electoral advantage may be thereby gained. It may be worthwhile, therefore, investing in a more general model for long term use designed to withstand severe "spatial shock".

## 2.5 Issues concerned with the spatial units adopted

The strategies for modelling the populations of a large number of regions have been reviewed in Rogers (1976) and Rees (1979a, 1981b) and may be summarized as follows.

### (1) Fully multiregional

All regions in the system are modelled simultaneously in a multiregional model in full age and sex detail. Problems of small numbers or unreliable data are ignored.

### (2) Partitioned

The system of regions may be partitioned into sub-systems, interregional migrations within which are modelled explicitly while migration between regions in different subsystems is modelled at the subsystem level.

### (3) Aggregated

Some of the variables in the system are aggregated or pooled across the spatial or the age dimension of the model. For example, in the subnational projections for England (OPCS, 1984) migration between 108 subnational units is modelled for three aggregate age groups (see section five for more details). Another popular choice is to divide the migration process into a process of choosing to move and a process of selecting a destination (Frey, 1984).

### (4) Biregional

In this strategy the system is collapsed into  $N$  sets of 2 regions consisting of the area of interest and the rest of the nation (although flows to and from the rest of the world should also be incorporated in the model).

All the strategies listed above can be termed "multiregional" because they retain at least some of the interactions and interdependency between



regions. Solutions (1) and (4) lead to general and portable models. Solutions (2) and (3) result in models specific to the system being studied. Each solution will yield a different set of projections, and the subnational projections will not necessarily add to the figures obtained in projecting the national population. A decision has then to be made about whether to adjust the subnational populations or to accept their sum as the national projections.

## 2.6 Summary of the user's requirements for a subnational population projection model

To summarize, users of population projections for subnational units require:

- (1) future populations classified by single years of age and sex;
- (2) summary measures of the inputs to the projections for each interval;
- (3) summary measures of the components of change in each future period;
- (4) time oriented presentation of the projection results;
- (5) standard presentation of the projection results at all scales;
- (6) a model (or its software) general enough to cope with a redefinition of the spatial units of projection; and
- (7) an effective strategy for projecting the population of a large number of units, either across the country or within a particular region.

Having discussed the needs of users of forecasts and some of the issues that producers of national forecasts face, we review in the next section the main features of multiregional population modelling.

## 3. MULTIREGIONAL POPULATION MODELLING: THE BARE NECESSITIES

### 3.1 The case for multiregional population modelling

A strong case has been made for two decades now that the only proper way to project regional populations is to model explicitly the migration flows between them along with the mortality, fertility and external migration components involved (see Rogers 1985a, 1985b, Willekens 1985b and Rees 1986a for recent surveys). Use of net migration rates or flows can lead in the long run to absurd results. By explicitly modelling interregional migration flows using interregional transition rates, the influence of one region's population dynamics on that of another is captured. The same case can be made for explicitly modelling international migration in a similar way but data difficulties usually mean that a net flow or rate term is used. However, external migration must be included in a regional population projection in order to close the population account (Rees 1986b).

### 3.2 Migration concepts and projection models

For nearly a decade now a clear link has been recognized between the form in which migration activity is recorded and the form which the multiregional population projection model should take (Rees 1977; Ledent 1978, 1979; Ledent and Rees, 1980, 1986; Rees 1985). There are three principal sources of migration data: censuses, population registers and surveys. Survey data on migration are not as yet used much for projection purposes and they are not considered further here.

The national census frequently contains a retrospective question on the place of residence at some date in the past. The date can be fixed, for example, when the place of residence  $n$  years ago is recorded, or variable, for example, when the place of birth or place of residence at a given age is recorded. Alternatively, the census may contain a question on the previous residence, without any information on the time of migration.

Population registers typically contain information on each change of usual address. Cross-classifications of regions of residence at two points of time are referred to as transition data and migrations data based on changes of residence are denoted as movement data. Transition data are used to compute transition probabilities directly which are entered in the multiregional cohort survival model as rates of migration and survival or survivorship rates. Movement data are used to compute occurrence-exposure rates from which probabilities suitable for entry into multiregional cohort survival models can be estimated.

Figure 1 sets out the broad steps involved in using the two different migration data sets in a multiregional population projection model. Two further points emerge from the diagram. The first is that mortality, fertility and external migration data are similar in the transition and movement approaches. The second is that there are two alternatives in the transition approach. If data are available giving the number of persons surviving and staying in the same region, survivorship rates can be estimated without recourse to mortality data. If they are not available or reliable, the number of surviving stayers must be estimated as a residual thus:

$$\begin{array}{lcl} \text{surviving stayers} & = & \text{initial population less internal out-migrants} \\ & & \text{less emigrants} \quad \text{less non-survivors} \end{array} \quad (1)$$

These computations are best organized in a population accounting framework.

Even if surviving stayer information is available it may still be preferable to incorporate mortality information into the projection

process so that the risk of mortality can be separated from that of migration:

$$\begin{array}{l} \text{probability of} \\ \text{migrating and} \\ \text{surviving} \end{array} = \begin{array}{l} \text{probability of} \\ \text{migration given} \\ \text{survival} \end{array} \times \begin{array}{l} \text{probability of} \\ \text{survival} \end{array} \quad (2)$$

and the effect of future trends in mortality monitored.

### 3.3 The role of population accounts

Population accounts are tables which display in a consistent fashion all the inputs from and outputs to a regional population. It is not appropriate here to give a full description (see Rees and Wilson 1977 and Rees 1981a for details of transition accounts and Rees 1984 for details of movement accounts), nor is it necessary to construct accounts before computing the rates that enter multiregional population models. But population accounts do provide yardsticks of the consistency with which population models have been put together, and transition and movement accounts are therefor described here using a British and a Dutch example.

### 3.4 Transition accounts

Table 1 sets out a set of transition accounts for a three region division of Great Britain for one age group transition in a 5 year period, 1966-71 (from Rees 1979b). The number of surviving internal migrants are entered in the table directly: 7578 between East Anglia and the South East, 8141 from East Anglia to the Rest of Britain, 14408 from the South East to East Anglia and so on to the 84510 from the Rest of Britain to the South East. The fourth column contains an estimate of the numbers of surviving emigrants (5296, 101985, 107473) and the fourth row holds the numbers of surviving immigrants (7790, 88045, 70123). The other data entered in the account are the initial regional populations (101007, 1184032, 2284298) and regional deaths (392, 3998, 8353). An accounts based model is then used (Rees 1981) to estimate the non-survivor elements in the table (the block on the right hand side) and the surviving stayers (79620, 984059, 2074448). The survivor columns of the account can then be totalled to yield the end of period populations. There will be such an account for each age group to age group transition, from the first which involves persons born within the time interval to the last which involves survival of the most aged population 5 years into the future.

The bracketed figures in Table 1 associated with selected cells of the account are transition probabilities or immigration or mortality rates that can be used in a regional projection model. Thus, the number of surviving migrants from the South East to East Anglia would be projected

by multiplying the appropriate probability by the population of 20-24 year olds in the South East in 1971 =  $.01217 \times 1,362,256 = 16,579$  migrants in 1971-76.

### 3.5 Movement accounts

Table 2 shows a movement account for a 2 region system in the Netherlands in 1976 for women aged 20 on January 1st 1976 and 21 on January 1st 1977. The account is simpler than that of Table 1 in that total regional deaths no longer appear in the last internal column. The entries in the table are counts of moves between the West Netherlands and the Rest of the Netherlands (1375 and 1739), of emigrations from the two regions (402 and 437), of immigrations to them (759 and 546) or of deaths within them (17 and 23). The diagonal term is computed as a residual (e.g.  $49121 - 50915 - 17 - 402 - 1375$ ) and is not an event count. The bracketed figures in the table are occurrence-exposure rates in which the occurrences (moves) are divided by the populations exposed to the risk of the event weighted by their exposure (approximated by the average population): thus the rate of movement from the Rest of the Netherlands to the West Netherlands is  $.02821 = 1739 / 0.5 \times (61794 + 61516)$ . To project the population forward using these rates an accounts based model can be used (Rees 1984, 1986a, 1986b) which involves a small number of model iterations or a matrix method can be employed to convert the rates shown in the table into transition probabilities (see Willekens and Drewe 1984). Again there are accounts for each age transition from the first, born in the year to age 1, through 20 to 21 shown in Table 2, to the last, 90+ to 91+. Births are generated in the model using fertility rates and populations at risk in the fertile age range before being subjected to migration and mortality risks. Similarly, the flow of immigration is also subjected to migration and mortality processes. Both types of new arrivals (infants and immigrants) are, however, only exposed for half the time interval, on average, to these forces.

### 3.6 Age matters

In constructing any population model care must be exercised in adopting the correct age-time plan (ATP) in which the data are observed or estimated. Four age-time plans may be distinguished (Willekens, 1985a): the age-cohort plan, in which events are classified by the cohort to which a person belongs and the age at the time of the event; the age-period (or just period) plan, in which the age and the calendar period at the time of the event are recorded; the period-cohort plan, in which the cohort is recorded to which a person belongs and the calendar period in which the event occurs; and the age-period-cohort plan in which the age and the calendar period at the event together with the cohort are recorded. The period-cohort plan (see Rees and Woods, Figure 12.2) is the appropriate

one for projection purposes, and the implementation of any regional projection model is considerably simplified if all age classified data are assembled using this ATP or are converted to it through estimation prior to model specification.

A second age matter is the existence of regularities in the profiles of migration rates by age, thoroughly researched by Rogers and Castro (1986) and by many other authors. Figure 2 shows two examples from the Netherlands and the United Kingdom. These schedules can be summarized as being composed of three or more of the five components shown in the inset to Figure 2. For the Greater London profile in Figure 2 we would use a model with a retirement peak. For the West Netherlands only three components would be necessary. The large number of age specific migration rates (16 for Greater London, 92 for West Netherlands) can be reduced to 9, 11 or 13 model parameters. This proves to be of considerable utility in implementing single year of age multiregional population models.

### 3.7 Summary of the modelling requirements for a subnational population projection model

Work in the field of spatial population dynamics over the past decade suggests that the following guidelines be followed in designing a subnational projection model.

- (1) It should incorporate multiregional features.
- (2) Clear cognizance must be taken of the conceptual type of migration data available in designing the projection model. It has proved too easy in the past to muddle model design in this respect.
- (3) Although it is not essential to construct population accounts prior to projection, all the components included in population accounts must be consciously incorporated in the projection, either implicitly or explicitly.
- (4) It is preferable to prepare all input data for the base period and all rate or parameter changes in the projection periods using the period-cohort age-time observation plan. It has also proved very easy in the past to confuse this problem, which is one of estimation, with that of projection model design.
- (5) One useful method for handling the problem of too many variables that occurs in multiregional modelling is to use model parameters rather than rate schedules to represent age-disaggregated migration components (Rogers, 1986).

#### 4. THE DATA BASES

##### 4.1 The data base for the Netherlands

The Netherlands has a rich resource of socioeconomic information about its population. This is extensively reviewed in ter Heide and Willekens (1984), particularly in Part 2: Data in Chapters by van der Erf, by Scheurwater and by Gordijn, Heida and ter Heide. Migration data are also reviewed by Keilman (1986).

In principle, any information required for a regional projection model can be assembled from the migration data of the population register. These data, kept by the municipalities, are assembled by the Central Bureau of Statistics and are accessible through an interactive demographic information system called RUDAP ("Ruimtelijk Demografische Aspecten van Planprocessen") (Scheurwater 1984). Any set of regions can be assembled as long as they are amalgamations of current municipalities (774 from January 1982 van der Erf, 1984, p.52). The data are available for single calendar years up to the year prior to the present.

Migration data are available from the population register of the Netherlands and are counts of moves from one spatial unit to another, rather than transition counts.

One difficulty is that although the Central Bureau of Statistics prepares migrations and births data files using the period-cohort ATP, this isn't the method adopted for regional mortality data. At the regional level, deaths are classified by age at death and year of death (period ATP). The problem is a coding problem, since the year of birth and date of death are recorded on the death certificate. At the national level, mortality data are available by year of birth, year of death and age at death.

From this account of the data base available in the Netherlands for population projection at subnational scales, it is clear that any regional projection model must be based on the movement concept.

##### 4.2 The data base for the United Kingdom

Demographic information available for subnational areas in the United Kingdom has steadily improved over the past two decades. Births and deaths data are now produced by the Office of Population Censuses and Surveys (OPCS) for very small areas (wards within local authority areas OPCS 1983, p.8), and the deaths data are disaggregated by age (0, 1-4, 5-14, 15-24 and 10 year age groups to 85+). Population data are available from the 1981 Census at the enumeration district (England, Wales, Northern Ireland) or postcode (Scotland) scale (circa 130,000 units). Estimates

are made by OPCS of the population at each mid-year following the census at local authority and health district scale. Unofficial estimates have been prepared by the CACI market research firm (OPCS 1985, p.8) at ward level.

Internal migration data are produced in the United Kingdom from two sources: the decennial Census and the National Health Service Central Register (NHSCR) of patient transfers. In the 1981 Census a question about place of residence one year prior to the census data (April 5) was asked and this generated tables of one year transition data for 1980-81 on both a local authority and ward scale. To fill the gap between censuses OPCS have established, in cooperation with the National Health Service, a system for recording changes of Family Practitioner Committee (FPC) areas by patients who re-register with a new FPC as a result of a migration. The FPC areas coincide, for the most part, with local authority areas as currently constituted (except for London boroughs, for which estimates are not available - OPCS, 1985, p.ix). No data are available for intra-area migration, which leads to difficulties when projections are required for finer areas than local authority districts. Prior to 1984 the NHSCR based statistics were published in an aggregate form (in- and out- migrations by age and sex, interarea migrations in total) and estimation methods were used to fill out the full region, age and sex disaggregated array (see Stillwell, 1986). From 1984 the individual migration records have been made available for users to create their own migration counts.

External migration data are generated from the International Passenger Survey (OPCS, 1986) but much careful estimation must be carried out (Rees and Woods 1986) to produce figures for subnational areas. Rather more reliable estimates of immigration for subnational areas are available in the Census but only for the year prior to the census date.

From this account of the data base available in the United Kingdom for population projection at subnational level, it is not clear whether a movement concept or a transition concept population projection model should be designed. In the former case, recourse to census transition data may be necessary to improve initial estimates of migration flows; in the latter case, recourse to NHSCR move data is necessary to update migration patterns for changes since the year prior to the last census.

We now examine what has been accomplished with these data bases.

## 5. THE PROJECTION MODELS

### 5.1 MUDEA: a multiregional model for the Netherlands

Between 1982 and 1984 a multiregional model for subnational population projection was developed at the Netherlands Interuniversity Demographic Institute (NIDI), under the direction of Frans Willekens of NIDI and Paul Drewe of Delft University of Technology under contract to the Physical Planning Agency (RPD) of the Netherlands. The project was overseen by and responded to an inter-ministry Committee for Regional Population Prognoses (CORBEP). The model structure is fully described in Willekens and Drewe (1984) and its intended application is briefly outlined in ter Heide (1984, p.346). Full details of the computer program and applications are available from NIDI.

#### 5.1.1 The model

This model was developed

- (1) for two sexes;
- (2) for a variable number of regions (up to 40; the number is limited by computer memory);
- (3) for flexible age groups (e.g. 1 year or 5 year) and a variable highest age (e.g. 80+ or 90+);
- (4) for a projection interval equal to the age interval (generally 1 or 5 years); and
- (5) for regional projections that are consistent with exogeneously given national projections (optional).

The modelling strategy adopted was the fully multiregional model (section 2.5) in which the complete array of migration variables (migration disaggregated by 2 sexes, N regions of origin, N regions of destination and NA ages) was used.

The original intention (Willekens and Drewe 1981) was to base the projection model on earlier models developed at the International Institute for Applied Systems Analysis (IIASA) (Willekens and Rogers 1978, Willekens 1979, Ramchandran 1980). In the event, the MUDEA model incorporated substantial changes from the IIASA models.

(1) The model deals with two sexes using a female dominant fertility sub-model. That is, male births are a product of the proportion of births that are male multiplied by a set of fertility rates multiplied by a set of female populations at risk (Willekens and Drewe 1984, pp.329-330).

(2) The age-time plan for the input data was changed from ATP I (the period plan) to ATP II (period-cohort plan) because the focus of interest was projection rather than life table analysis. The original intention to



report on multiregional life expectancies was dropped, although Ledent and Rees (1980, 1986) have shown that such expectancies, at birth, can be generated directly from the projection model's survivorship rates and Rees (1986) has suggested that the whole life table could be estimated from ATP 11 data.

(3) The MUDEA model is clearly and unambiguously based on migration data of the movement type (as generated by the Dutch registration system), whereas the original IIASA models were ambiguous in their input requirements (because the issues involved were only resolved in the course of the associated project).

(4) The MUDEA model is clearly linked to an underlying set of population accounts of the movement variety, although the flow accounting equations are used rather than the full accounts based model.

(5) One consequence of this is that the MUDEA model fully and carefully incorporates international migration into its structure. Emigration flows are treated in the model in the same way as internal out-migration flows, namely as the product of migration rates transformed into period-cohort transition probabilities and the base population. Immigration flows are treated as exogenous inputs (which are subjected to survival, fertility and migration rates appropriate to their sojourn after immigration).

Thus, the MUDEA model meets the first four modelling requirements set out at the end of section three of the paper. There was a clear intention in the original specification of the project (Willekens and Drewe 1981) that the fifth requirement, that the user be able to "control" the projection by inputting a limited set of key parameters rather than a large body of age specific rates, be met, but this has yet to be accomplished. There is also the ambition (Willekens and Drewe 1981, ter Heide 1984) that the MUDEA model be linked with explanatory models of migration being developed under other RPD research contracts in a second phase. The goal has been partly achieved (Willekens 1986; Drewe 1986; Willekens and Drewe 1986). An analytical framework has been developed which can be used to integrate stability analysis (temporal stability of migration patterns) and explanatory analysis. Four components of migration are distinguished: a level component, a generation component, an attraction component and a spatial interaction component. The components can be studied and projected separately or simultaneously. The contribution of each component to the future migration pattern is determined by its contribution in the past (stability, inertia) and exogenous factors, such as policy measures, causing the value of a specific component to change.

How general is MUDEA (recalling the discussion of sections 2.4 and 2.5)? It is general in the sense that it can be used with any number of

regions (up to 40) and any number of ages, and can be employed in other countries where the same input information is available or can be estimated. In principle, the number of regions could be expanded given sufficient computer memory for the resulting arrays, but the flow and rate estimates would rapidly become unreliable because of the small number problem. The MUDEA model could not be directly used at the local level in the Netherlands (as ter Heide, 1984 recognizes). Another modelling strategy (partitioning, aggregation, parameterization or biregional modelling) would be required.

### 5.1.2 Inputs

Inputs required for the MUDEA model are:

- (1) the start of base year and end of base year populations by sex and age (e.g. 0,1,2, ..., 89,90+) for each region;
- (2) births in a year by age (of mother) by region;
- (3) births in a year by sex of child;
- (4) deaths in a year by age by region and sex;
- (5) internal migrations by age by origin, sex and destination;
- (6) emigrations by age by region and sex; and
- (7) immigrations by age by region and sex.

All age classifications for flows are of the period-cohort type. The migration data are all published by the Central Bureau of Statistics on this basis, but data on childbearing and mortality are published according to age at time of the event (period data). They were converted to period cohort form before being entered in the MUDEA model.

### 5.1.3 Outputs

Table 3 summarizes the considerable printed output that the MUDEA model produces for each period of analysis. Virtually all the model variables are printed out in full age detail (in most tables the row classification is by age). MUDEA tables 1 and 2 report the start of year populations, tables 3 through 6 report the components of growth (or accounting equation terms) in age detail, tables 8 and 9 report the rates that enter the matrix model, tables 10 to 15 report on internal migration numbers and tables 17 to 18 yield end of period populations. MUDEA tables 7 and 16 provide some summary information.

The outputs of the model are clearly voluminous. In a two region test run there were 169 pages of output for one period. The MUDEA program, however, contains parameters to control table printing (cf. MOVE, Rees 1984, in which the printing of virtually all tables can be suppressed). The presentation of the results of the multiregional model compares rather

unfavourably with that of the UN (Appendix). Time-oriented tables are essential for easy and fruitful use of projection outputs. Tables should be standard for each spatial unit across all spatial scales. The user should be able to suppress difficult to assimilate matrix style multiregional output (really needed only for error diagnosis) and concentrate on the essential results of the multiregional model. All these criticisms apply equally to MOVE.

## 5.2 The OPCS/DOE subnational population projection model for England

Between 1979 and 1981 a model was developed for the projection of the internal migration component of the official subnational population projections for England by Martin and Voorhees Associates and John Bates Services under contract to the Department of the Environment (DOE) of the United Kingdom in close liaison with the Regional Demography Unit of OPCS. Ian Bracken of the University of Wales Institute of Science and Technology (Cardiff) acted as consultant to the project. The model is fully described in Martin & Voorhees Associates and John Bates Services (1981), in associated programmer's guide and user's manual, and in two journal papers, Bates and Bracken (1982) and Bracken and Bates (1983). Results of using this new model are reported in the fifth of the series of subnational population projections for England (OPCS 1984). A new set of projections incorporating data from the 1981 Census as well as NHSCR data from the post-1981 period are in course of preparation.

### 5.2.1 The model

The model is concerned only with internal migration and is designed to supply a pre-existing single region cohort survival model with net migration values by sex and single years of age, values which can be modified in consultation with local authorities, but which were not changed much in the consultation exercise to judge from the comments in OPCS (1984, p.ix). DOE and OPCS were concerned to preserve their existing investment in a subnational projection model. One ironic benefit of using net migration in the projection model is that it doesn't matter whether the net figures are derived from transition or movement data as long as all transition types have been accounted for (Rees 1985).

Since the project brief required that single year of age populations for males, females and persons be projected for 108 local authority areas in England, a fully multiregional strategy was rejected from the outset because of the small number problem. Rather, an approach was developed which used trended gross migration rates, model generated rates of out-migration and in-migration (a "parameterized" strategy) and interregion allocation rates for three broad age groups only.

The model comprises three stages.

(1) The numbers of moves out of each area by age and sex are estimated by applying model migration rates to trended projections of the region-specific Gross Migration Rate (GMR).

(2) These moves are assigned to destinations using a matrix of allocation proportions based on NHSCR migration data for a 5 year period for three broad age groups and two sexes.

(3) The numbers of moves into each area are summed to obtain gross in-migration totals for each area, which are disaggregated by age using model migration rates (as in stage (1) for out-migrants).

It is useful in exposing the structure of the model in full to present it in general equation form (which the authors do not) as this will reveal a number of interesting features. All the variables in the model are disaggregated by sex, but, since the two populations are treated in the same way in the migration model, no notation for the sex classification is introduced in the description below.

#### (1) The total number of out-migrations

The total number of out-migrations from an area  $i$  by age  $a$  for a future period  $t$  is projected by

$$M_a^i(t) = (GMR_a^i(t) \cdot om_a^I(s)) \cdot P_a^i(t) \quad i \in I \quad (3)$$

where

$GMR_a^i(t)$  the gross migration rate of out-migration from area  $i$  in period  $t$ , which is a linear extrapolation of the GMR of the area for a standard period in the past.

$om_a^I(s)$  the proportion of the out-migration GMR accounted for by age group  $a$ . It is derived from model migration rates standardized to a GMR of 1 for area cluster  $I$  for standard period  $s$ .

$P_a^i(t)$  = population of region  $i$  at age  $a$  in period  $t$ .

The authors (Bates and Bracken 1982, Bracken and Bates, 1983) used migration data from the 1971 Census to calibrate model migration rate schedules for the 108 areas for males and females. A cluster analysis was then carried out to combine together similar profiles into 12 groups. New model schedules were then defined using the pooled data for the 12 groups.

## (2) The assignment of out-migrations to destinations

The total of out-migrations from an area is spread across the available destinations by multiplication by an allocation proportion:

$$M_{ij}^A(t) = M_{i.}^A(t) k_{ij}^A(s) \quad (4)$$

where

$M_{ij}^A(t)$  = the number of moves from area  $i$  to area  $j$  in period  $t$  in broad age group  $A$

$$M_{i.}^A(t) = \sum_{a \in A} M_{ia}^A(t)$$

$k_{ij}^A(s)$  = the proportion of origin  $i$  moves in broad age group  $A$  in standard period  $s$  that have destinations in area  $j$ .

In OPCS (1984) NHSCR data for mid-1977 to mid-1982, supplemented with 1971 census data where the spatial disaggregation of the NHSCR data was insufficient, were used. The broad age groups were

- (i) ages 0-16 and 29-59 (family ages)
- (ii) ages 17-28 (labour force ages)
- (iii) ages 60 and over (retirement ages).

The broad age groups were determined by the similarity of their origin-destination patterns.

## (3) In-migration totals

The inter-area migrations by broad age group were summed and then disaggregated to single years of age:

$$M_a^{..J}(t) = \sum_A \sum_j M_{aj}^A(t) \quad (5)$$

where

$M_a^{..J}(t)$  total number of in-migrations to area  $j$  in period  $t$  in age group  $a$

$j$   
 $i_m(s)$  the proportion of the in-migration GMR accounted for  
 $a$  by age group  $a$ . The proportions are derived from  
 model migration rates standardized to a GMR of 1  
 for area cluster  $J$  for standard period  $s$ .

#### (4) Net migration

This is then derived as a residual:

$$\begin{matrix} j \\ N(t) \\ a \end{matrix} = \begin{matrix} \cdot j \\ M(t) \\ a \end{matrix} - \begin{matrix} j \cdot \\ M(t) \\ a \end{matrix} \quad (6)$$

and fed into the single region cohort survival model. Methods were also developed to adjust the migration matrices resulting at stage (2) of the model to exogeneous in-migration totals.

#### 5.2.2 Comments on the OPCS/DOE model

The OPCS/DOE model represents an elegant and thoroughly tested solution to the problem of projecting the internal flows of a large number of subnational areal units, carried out by the consultants in a remarkably short period of 18 months.

However, a number of further comments can be made based on this algebraic reformulation of the model.

Firstly, it is unfortunate that the migration model is decoupled from the population projection model. This means that the indicators of the components of change offered in the projection model output are very limited. Secondly, it would be very easy to carry out this integration and make the combined migration and projection model fully multiregional by merging equations (3) and (4):

$$\begin{matrix} ij \\ M(t) \\ a \end{matrix} = \begin{matrix} i \\ GMR(t) \end{matrix} \begin{matrix} I \\ om(s) \end{matrix} \begin{matrix} ij \\ k(s) \\ A \end{matrix} \begin{matrix} i \\ P(t) \\ a \end{matrix} \quad i \in I, a \in A \quad (7)$$

or in other words the migration rate would be modelled as

$$\begin{matrix} ij \\ m(t) \\ a \end{matrix} = \begin{matrix} i \\ GMR(t) \end{matrix} \begin{matrix} I \\ om(s) \end{matrix} \begin{matrix} ij \\ k(s) \\ A \end{matrix} \quad (8)$$

where  $s$  refers to the standard or base period (which may differ between variables). Stage (3) of the model is then unnecessary. Constraints on

ij  
 M (t) can easily be introduced using multiproportional fitting  
 a  
 techniques, generalizations of the Furness method referred to by Martin & Voorhees Associates and John Bates Services (1981).

When we examine the terms on the right hand side of equation (7), it can be seen that the only statistic that is projected forward in time is the GMR. There is no reason why the age factor and the allocation proportion could not also be projected forward given reliable time series, so a more general model would substitute period label t for the standard or base period label s in equations (7) and (8).

A third point to make about the OPCS/DOE model is that, in exposition, it suffers from a lack of clarity as to age-time plan of observation. The subscript a should refer to a period-cohort ATP throughout. However, the NHSCR data are published using the period ATP and Census migration data are collected using the period-cohort ATP. It is also unclear what populations at risk are being used in rate computation: initial, mid-point, average or final populations.

A related fourth point refers to migration concept being used. Both Census and NHSCR data are used (and have to be used) in the model but it is never made clear which conceptual type of migration (movements or transitions) is being estimated and projected. In the exposition above it is assumed that the model works with the movement concept. OPCS 1984, p.viii states that "the level of migration activity" derives from NHSCR data, whereas in the project report (Martin & Voorhees Associates and John Bates Services 1981) the GMRs reported are from census data. This conceptual ambiguity arises from the aim of the model being to generate age disaggregated net migration vectors for areas.

Fifthly, we need to consider the roles of aggregation and sub-model representation in the overall model. The interarea allocation terms, the k's, involve aggregation of actual migration data into a few broad age groups. The alternative of using gravity models of such interarea migration was rejected after investigation because the predicted matrices were felt to be insufficiently accurate. The out-migration factors or om's, involve both aggregation over area cluster and model representation of rates. A great deal of detailed work is involved in the calibration of model migration schedules and their classification though it needs only to be carried out in the British context every ten years. In other situations the use of pooled, observed data to generate standard rates might provide a short cut since the key features of the out-migration rate schedules that vary from area to area (Bracken and Bates, 1983, p.353), namely presence/absence of a retirement peak and/or slope, the age at which the labour force migration peak occurs and the extent to which migration activity is concentrated around the peak could be determined by

simpler methods.

How general is the OPCS/DOE model (recalling again the discussion of sections 2.4 and 2.5)? It is clearly a very specific model in terms of its implementation and exposition, designed for one set of clients (DOE/OPCS) with particular requirements in terms of area populations to be projected. It is also specific in the sense that the aggregation decisions (pooling of out-migration and in-migration profiles by cluster, use of particular broad age bands in allocating out-migration) are peculiar to the system being studied. It is doubtful whether the underlying software would be portable, and the mixture of census and register sources of migration data characteristic of the United Kingdom seems to be repeated only in Japan (Nanjo, Kawashima and Kuroda 1982). However, the methods employed to solve the problem of handling many regions simultaneously are of general utility and could be applied in other contexts.

### 5.2.3 Outputs

Table 4 summarizes the readily available outputs from the subnational projections. Further detailed data are available from OPCS's Regional Demography Unit. Output tables 1 to 4 appear in OPCS (1984); tables 5 and 6 are the standard detailed projection tables provided on request.

A good feature of these outputs is their time orientation, although the published tables are woefully inadequate in the number of future time points for which data are provided - only two! For any serious use of these projections the user needs to obtain the detailed single years of age and time outputs from the Regional Demography Unit. Output tables 3 and 4 provide some idea of the components in number form but not in rate form. Summary indicators such as GMRS or total fertility rates or life expectancies are not provided.

As with the MUDEA model, the outputs of the OPCS/DOE model are not as well organized and accessible as those of the United Nations' projections (Appendix).

## 6. CONCLUSIONS

The purpose of this review has been to look critically at these two new applications of multiregional methods in order to learn from the experience. Here an attempt is made to summarize what has been learnt.

The theoretical base and mathematical specification of the Dutch MUDEA model are very sound. The projection model is carefully matched with the movement type of migration data used in a period-cohort age-time plan. The English OPCS/DOE model is not as well specified as one set of



equations, and there is a lack of clarity concerning both the migration concept aimed at in the model and the age-time plans employed. However, it has the merit of making fruitful use of both census and register derived migration data, using the former to overcome deficiencies in the latter.

The Dutch MUDEA model is a multiregional model that handles all migration flows in age-sex-origin-destination specificity with a considerable degree of flexibility. So, for example, projections of the 11 provinces or of 15 functional regions or 41 urbanization regions could be carried out. The English OPCS/DOE model involves modelling of pooled profiles of out- and in-migration at a detailed age scale and an age pooled method of assigning out-migration to destinations. It is designed to prepare the migration projections for 108 areas and is capable of handling the other subnational areas of the United Kingdom outside England as well either separately or together with those of England.

Whereas the Dutch model is easily portable to other demographic systems for which the same kinds of data are available, it is difficult to envisage the English model being directly used because of some system specific features. These are the need to arrive at a classification of in- and out-migration profiles and a pooling of the age specific interarea migration matrices into broad age ranges with common interaction features. The classes and age ranges will vary from situation to situation. Nevertheless the ideas behind the English model could well be applied elsewhere because it provides a solution to the problem of using multiregional models with a large number of regions.

In terms of user requirements both models provide the essential projections by single year of age and sex of the populations of subnational units, controlled by sets of time-varying assumptions as to levels of fertility, mortality and migration, and thus represent considerable advances on previous models and software. The organization and presentation of the results of both models, however, fall short of the ideal. The MUDEA model provides voluminous outputs on a single year of age basis for both inputs and results, and it is difficult for users to find the essential statistics amid the haystack of paper. Output tables are provided a year at a time, whereas most users find tabulations of statistics across time points or intervals much easier to contemplate and from which trends can be grasped more easily. A time orientation is employed in the presentation of the results of the English area projections, but the published volume provides very little information at the level of detail on the key statistics input to each time interval. Users must purchase detailed unpublished tabulations and tapes. The outputs of both Dutch and English models contrast unfavourably with the projection statistics published by the UN (Appendix) for countries of the world. Such a volume and associated tapes, with appropriate modifications, for the subnational areas of the Netherlands and the United

Kingdom would be a very valuable planning and research resource.

These efforts in the application of multiregional methods to official subnational population projection represent considerable pioneering achievements. There is ample room, however, for improvement in the "packaging" of both models and outputs: the field awaits its Alan Sugar (the boss of the Amstrad company, who repackaged consumer electronics, word processors and business machines and made a fortune).

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Table 1. Transition accounts and associated rates for Great Britain, 1966-71, age transition 20-24 to 25-29, persons.

Final state Initial state	Survival in: Aged 25-29			Death in: Aged 20-24 or 25-29			Totals
	EA	SE	RB	RW	EA	SE	RW
East Anglia (EA)	79,620 (.78826)	7,578 (.07502)	8,141 (.08060)	5,296 [.05243]	334	13	10
South East (SE)	14,408 (.01217)	984,059 (.83111)	79,740 (.06735)	101,985 [.08596]	26	3,691	175
Rest of Britain (RB)	9,440 (.00413)	84,510 (.03700)	2,074,448 (.90813)	107,473 [.04703]	18	145	208
Rest of World (RW)	7,790 (.07712)	88,045 (.07436)	70,123 (.03070)	0	14	149	0
Totals	111,258	1,164,192	2,232,452	214,554	392 <.00369>	3,998 <.00341>	393 <.00370>

Source: Rees (1979b)

(.78826) internal survivorship rates [ .05243] emigration rates

(.07712) immigration rates <.00370> non-survivorship rates or death rates



Table 2. Movement accounts and associated rates for the Netherlands, 1976, age transition 20 to 21, females.

Final state Initial state	State after move				Totals
	WN	RN	RW	Deaths	
West Netherlands (WN)	49,121	1,375 (.02682)	402 [.00784]	17 (.00033)	50,915
Rest of the Netherlands (RN)	1,739 (.02821)	59,595	437 [.00709]	23 (.00037)	61,794
Rest of world (RW)	759 (.01480)	546 (.00886)	0 -	0 -	1,305
Totals	51,619	61,516	839	40	114,014

#### Notes

1. West Netherlands consists of the provinces of Noord-Holland, Zuid-Holland and Utrecht. The Rest of the Netherlands contains the remaining 8 provinces and IJsselmeerpolder.

#### 2. Rates:-

(0.2682) internal movement rates

[.00784] emigration rates

(.01480) immigration rates

All rates employ an average population at risk.

TABLE 3. Summary of the output tables produced by NUDEA

TABLE	VARIABLES	FORM	MACRO-CLASS	ROW-CLASS	COLUMN-CLASS
1.	population (initial)	numbers percentages	Sex	Age (1)	region
2.	population (initial)	numbers percentages	Sex	Age (5)	region
3.	person/years, births, deaths, interregional migration, external migration	numbers percentages	Sex by region	Age (1)	components (as under variables)
4.	person years, births, deaths interregional migration, external migration	numbers percentages	Sex by region	Age (5)	components (as under variables)
5.	components as in 4 (except person years)	age specific rates per 1000	Sex by region	Age (1)	components (as under variables)
6.	components as in 5	age specific rates per 1000	Sex by region	Age (5)	components (as under variables)
7.	components (summarized)	numbers, percentages years rates per 1000 mid-year population		sex by region	components
8.	birth rates	age-specific rates	Sex by origin region	Age (1)	destination region
9.	survivorship rates	age-specific rates (decimal proportions)	Sex by origin region	Age (1)	destination region
10.	internal migration	numbers	Sex by origin region	Age (1)	destination region
11.	internal migration	numbers	Sex by origin region	Age (5)	destination region
12.	internal migration	percentages	Sex by origin region	Age (1)	destination region
13.	internal migration	percentages	Sex by origin region	Age (5)	destination region
14.	internal migration	rate per 1000 (out-migration)	Sex by origin region	Age (1)	destination region
15.	internal migration	rate per 1000 (out-migration)	Sex by origin region	Age (5)	destination region
16.	internal migration (summarised)	numbers, percentages, rates	Sex	form by origin region	destination region
17.	population (final)	numbers, percentages	Sex	Age (1)	residence region
18.	population (final)	numbers, percentages	Sex	Age (5)	residence region

## Notes to Table 3

1. Percentages = age-specific variable as % of all age total
2. Table 8: the column class in the NUDEA output is incorrectly labelled as "birth region": it is the region of destination of the infant
3. Table 10 includes migration between localities within regions which do not figure in the NUDEA model as such
4. Age (1) = single years of age age (5) = 5 year age groups

TABLE 4 Summary of the output tables produced by the OPCS/DOE model

TABLE	VARIABLES	MACRO-CLASS	ROW-CLASS	COLUMN CLASS
1	populations (mid-year projected)	England regions	age (5) ages (summary)	time by sex
2	populations (mid-year projected)	Areas (see note 3)	time by sex	ages (summary
3	natural components (births, deaths natural change)		Areas (see note 3)	components (as variables), two summary time periods
4	projected in- out and net migration		Areas (as in 3)	migration components (as variables) two summary time periods
5	populations (mid-year projected)	Areas (as in 3)	age (1)	time (years) by sex
6	populations (mid-year projected)	Areas (as in 3)	age (5)	time (years) by sex

Notes

Tables 1 to 4 appear in OPCS (1984) and report on population projections from 1981 to 2001.

Tables 5 and 6 are examples of unpublished tabulations obtained from the Regional Demography Unit (Dept. ARV), Office of Population Censuses and Surveys St. Catherine's House, 10 Kingsway, London WC2B 6JP. Populations to 2011 are provided

Areas: Table 2: Inner London boroughs, Outer London boroughs, Metropolitan Counties and Districts, Non-Metropolitan Counties

Table 3: England, standard regions, and Table 2 areas

Netherlands													
POPULATION													
ANNUAL													
1977 1978 1979 1980 1981 1982 1983 1984 1985 1986 1987 1988 1989 1990													
10000 10000 10000 10000 10000 10000 10000 10000 10000 10000 10000 10000 10000 10000													
MEDIUM VARIANT													
POPULATION BY SEX													
TOTAL (IN 1,000,000)	1011.1	1114.0	1204.2	1277.6	1342.0	1400.6	1452.6	1500.0	1543.9	1584.1	1621.2	1656.0	1689.9
MALE (IN 1,000,000)	504.1	517.0	528.6	539.4	549.7	559.5	568.9	577.9	586.5	594.8	602.9	610.8	618.5
FEMALE (IN 1,000,000)	507.0	597.0	675.6	738.2	792.3	841.1	883.7	922.1	957.4	989.3	1018.3	1045.2	1071.4
SEX RATIO (PER 1000 FEMALES)	99.4	97.2	97.0	97.0	97.0	97.0	97.0	97.0	97.0	97.0	97.0	97.0	97.0
POPULATION BY AGE GROUP													
AGE 0-14 (IN 1,000,000)	294.4	304.3	313.6	322.5	331.0	339.0	346.6	353.9	361.0	367.9	374.6	381.1	387.5
AGE 15-64 (IN 1,000,000)	494.7	504.0	512.7	520.9	528.7	536.1	543.2	550.1	556.8	563.4	569.9	576.4	582.9
AGE 65+ (IN 1,000,000)	76.3	105.7	126.0	144.2	160.3	174.5	186.9	197.6	206.7	215.2	223.1	230.5	237.5
AGE 0-14 (PERCENTAGE)	29.1	27.2	25.9	25.0	24.2	23.9	23.7	23.4	23.1	22.8	22.6	22.4	22.2
AGE 15-64 (PERCENTAGE)	49.4	45.0	42.4	41.4	40.6	40.0	39.5	39.1	38.7	38.4	38.1	37.8	37.5
AGE 65+ (PERCENTAGE)	7.7	10.0	11.7	13.6	15.2	16.1	16.6	17.5	18.5	19.7	20.3	20.8	22.7
AGE INDICATORS													
MEDIAN AGE	29.0	29.7	30.4	31.1	31.8	32.5	33.2	33.9	34.6	35.3	36.0	36.7	37.4
DEPENDENCY RATIO	46.4	45.2	44.0	42.8	41.7	40.6	39.5	38.4	37.3	36.2	35.1	34.0	32.9
DEPENDENCY RATIO 0-14	12.3	11.8	11.2	10.7	10.1	9.6	9.1	8.6	8.1	7.6	7.1	6.6	6.1
DEPENDENCY RATIO 65+	34.1	33.4	32.8	32.1	31.6	31.0	30.4	29.8	29.2	28.6	28.0	27.4	26.8
SPECIFIC AGE GROUPS													
AGE 0-14 (IN 1,000,000)	294.4	304.3	313.6	322.5	331.0	339.0	346.6	353.9	361.0	367.9	374.6	381.1	387.5
AGE 15-24 (IN 1,000,000)	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
AGE 25-34 (IN 1,000,000)	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
AGE 35-44 (IN 1,000,000)	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
AGE 45-54 (IN 1,000,000)	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
AGE 55-64 (IN 1,000,000)	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
AGE 65+ (IN 1,000,000)	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
URBAN POP. (IN 1,000,000)	704.0	704.0	704.0	704.0	704.0	704.0	704.0	704.0	704.0	704.0	704.0	704.0	704.0
RURAL POP. (IN 1,000,000)	307.1	409.7	499.6	568.2	638.0	701.6	753.7	801.1	843.9	882.2	916.3	946.0	971.4
PER CENT URBAN (69.6%)	70.4	70.4	70.4	70.4	70.4	70.4	70.4	70.4	70.4	70.4	70.4	70.4	70.4
PER CENT RURAL (30.4%)	29.6	29.6	29.6	29.6	29.6	29.6	29.6	29.6	29.6	29.6	29.6	29.6	29.6
POP. DENSITY (/SQ. KM.)	241	241	241	241	241	241	241	241	241	241	241	241	241
MEDIUM VARIANT													
1990-95 1995-00 2000-05 2005-10 2010-15 2015-20 2020-25 2025-30 2030-35 2035-40 2040-45 2045-50 2050-55													
AVERAGE ANNUAL CHANGE													
POP. INCREASE (IN 1,000,000)	1.7	1.2	1.0	0.8	0.7	0.6	0.5	0.4	0.3	0.2	0.1	-0.1	-0.2
BIRTHS (IN 1,000,000)	2.1	1.6	1.4	1.2	1.1	1.0	0.9	0.8	0.7	0.6	0.5	0.4	0.3
DEATHS (IN 1,000,000)	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4
NET MIGRATION (IN 1,000,000)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RATE OF ANNUAL CHANGE													
POP. CHANGE TOTAL (%)	1.72	1.27	1.17	1.14	1.01	0.90	0.80	0.73	0.65	0.52	0.42	0.32	0.23
URBAN (%)	1.72	1.27	1.17	1.14	1.01	0.90	0.80	0.73	0.65	0.52	0.42	0.32	0.23
RURAL (%)	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
CRUDE BIRTH RATE (/1000)	22.1	16.9	14.9	12.8	11.6	10.4	9.3	8.3	7.3	6.3	5.3	4.3	3.3
CRUDE DEATH RATE (/1000)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
NATURAL INCREASE (/1000)	18.1	12.9	10.9	8.8	7.6	6.4	5.3	4.3	3.3	2.3	1.3	0.3	-0.3
NET MIGRATION (/1000)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
FERTILITY & MORTALITY													
TOTAL FERTILITY RATE	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
GROSS REPRODUCTION RATE	1.49	1.49	1.49	1.49	1.49	1.49	1.49	1.49	1.49	1.49	1.49	1.49	1.49
NET REPRODUCTION RATE	1.41	1.41	1.41	1.41	1.41	1.41	1.41	1.41	1.41	1.41	1.41	1.41	1.41
GENERAL FERT. RATE/1000	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0
CHILD-MORRAN RATE	47.0	43.2	40.0	36.5	33.2	30.0	26.7	23.4	20.1	16.8	13.5	10.2	6.9
INFANT MORTALITY RATE	14.0	14.0	14.0	14.0	14.0	14.0	14.0	14.0	14.0	14.0	14.0	14.0	14.0
LIFE EXPECTANCY (MALES)	70.9	71.1	71.0	71.1	71.2	71.3	71.4	71.5	71.6	71.7	71.8	71.9	72.0
LIFE EXPECTANCY (FEMALES)	73.4	73.6	73.6	73.6	73.6	73.6	73.6	73.6	73.6	73.6	73.6	73.6	73.6
LIFE EXPECTANCY (TOTAL)	72.1	72.4	72.4	72.4	72.4	72.4	72.4	72.4	72.4	72.4	72.4	72.4	72.4
HIGH VARIANT													
1990-95 1995-00 2000-05 2005-10 2010-15 2015-20 2020-25 2025-30 2030-35 2035-40 2040-45 2045-50 2050-55													
DEMOGRAPHIC INDICATORS													
POPULATION													
TOTAL (IN 1,000,000)	1423.0	1555.5	1688.1	1820.7	1953.3	2085.9	2218.5	2351.1	2483.7	2616.3	2748.9	2881.5	3014.1
AGE 0-14 (IN 1,000,000)	314.0	281.0	248.0	215.0	182.0	149.0	116.0	83.0	50.0	17.0	-16.0	-33.0	-50.0
AGE 15-64 (IN 1,000,000)	601.0	601.0	601.0	601.0	601.0	601.0	601.0	601.0	601.0	601.0	601.0	601.0	601.0
AGE 65+ (IN 1,000,000)	508.0	573.5	639.1	704.7	770.3	835.9	901.5	967.1	1032.7	1098.3	1163.9	1229.5	1295.1
AGE 0-14 (PERCENTAGE)	21.3	17.7	14.7	11.8	9.3	7.2	5.1	3.5	2.0	0.6	-0.6	-1.2	-1.6
AGE 15-64 (PERCENTAGE)	42.2	39.2	35.5	33.5	31.3	29.3	27.2	25.2	23.2	21.2	19.2	17.2	15.2
AGE 65+ (PERCENTAGE)	36.5	43.1	49.8	54.7	59.4	63.5	67.7	71.3	75.8	78.2	80.2	81.6	83.2
AGE INDICATORS													
MEDIAN AGE	31.5	33.4	35.3	37.2	39.1	41.0	42.9	44.8	46.7	48.6	50.5	52.4	54.3
DEMOGRAPHIC INDICATORS													
1990-95 1995-00 2000-05 2005-10 2010-15 2015-20 2020-25 2025-30 2030-35 2035-40 2040-45 2045-50 2050-55													
AVERAGE ANNUAL CHANGE													
POP. INCREASE (IN 1,000,000)	0.9	0.3	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
BIRTHS (IN 1,000,000)	1.7	1.6	1.5	1.4	1.3	1.2	1.1	1.0	0.9	0.8	0.7	0.6	0.5
DEATHS (IN 1,000,000)	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8
NET MIGRATION (IN 1,000,000)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RATE OF ANNUAL CHANGE													
POP. CHANGE TOTAL (%)	0.64	0.21	0.12	0.11	0.10	0.09	0.08	0.07	0.06	0.05	0.04	0.03	0.02
URBAN (%)	0.64	0.21	0.12	0.11	0.10	0.09	0.08	0.07	0.06	0.05	0.04	0.03	0.02
RURAL (%)	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
CRUDE BIRTH RATE (/1000)	12.0	11.0	10.0	9.0	8.0	7.0	6.0	5.0	4.0	3.0	2.0	1.0	0.0

NETHERLANDS

POPULATION (IN THOUSANDS) BY SEX AND AGE, MEDIUM VARIANT

AGE GROUP	1 9 5 0			1 9 5 5			1 9 6 0			1 9 6 5		
	BOTH SEXES	MALES	FEMALES	BOTH SEXES	MALES	FEMALES	BOTH SEXES	MALES	FEMALES	BOTH SEXES	MALES	FEMALES
ALL AGES	18114	10411	19773	16741	9356	9385	15469	9717	5753	12292	6133	6159
0-4	12892	690	587	1110	578	548	11394	5711	5683	12115	622	589
5-9	932	478	454	1106	609	577	1106	568	538	1151	590	561
10-14	885	471	404	911	478	440	1093	607	476	1107	568	539
15-19	811	416	397	817	416	401	913	467	446	1123	466	657
20-24	800	404	396	769	401	369	806	408	398	912	440	464
25-29	796	394	402	761	383	378	771	398	381	896	417	479
30-34	699	361	338	713	368	349	766	378	388	774	373	401
35-39	683	325	358	673	333	342	765	373	390	757	313	444
40-44	608	317	291	676	322	354	687	329	358	761	375	386
45-49	593	298	295	637	310	327	663	271	392	763	415	348
50-54	520	252	268	579	261	298	625	263	362	690	316	374
55-59	440	218	222	509	242	267	561	270	291	603	275	328
60-64	376	183	193	424	204	220	473	223	250	549	277	271
65-69	305	172	137	363	165	178	387	182	205	431	198	233
70-74	231	111	120	259	124	135	293	138	155	331	131	200
75-79	165	67	76	173	82	91	196	91	105	224	104	120
80+	102	46	56	127	58	69	150	72	78	169	66	103

AGE GROUP	1 9 7 0			1 9 7 5			1 9 8 0			1 9 8 5		
	BOTH SEXES	MALES	FEMALES	BOTH SEXES	MALES	FEMALES	BOTH SEXES	MALES	FEMALES	BOTH SEXES	MALES	FEMALES
ALL AGES	13937	6964	6973	13744	6954	6790	14220	7047	7173	14596	7211	7385
0-4	1168	608	560	1038	531	507	1075	644	435	1027	623	404
5-9	1216	623	593	1219	622	597	1067	529	537	1070	601	469
10-14	1191	591	600	1242	636	607	1226	627	599	1092	537	555
15-19	1130	569	561	1186	604	582	1232	648	584	1131	619	512
20-24	1189	606	576	1142	583	559	1199	608	593	1250	641	609
25-29	1077	547	530	1122	567	555	1150	587	563	1196	609	587
30-34	913	427	486	926	437	489	1019	429	590	1101	463	638
35-39	779	397	372	825	429	397	936	449	487	1020	629	591
40-44	706	359	347	762	392	370	828	429	399	936	467	469
45-49	754	367	387	753	373	379	700	376	324	676	426	250
50-54	604	317	287	765	361	404	766	364	402	771	389	382
55-59	567	303	264	631	312	319	729	349	380	803	419	384
60-64	469	266	203	596	274	320	609	284	325	690	328	362
65-69	367	217	150	520	216	304	590	266	324	608	285	323
70-74	366	180	186	420	173	246	433	190	244	460	286	174
75-79	254	109	145	289	120	169	330	129	201	396	141	255
80+	225	96	129	276	106	170	297	111	186	336	119	216

AGE GROUP	2 0 0 0			2 0 0 5			2 0 1 0			2 0 1 5		
	BOTH SEXES	MALES	FEMALES	BOTH SEXES	MALES	FEMALES	BOTH SEXES	MALES	FEMALES	BOTH SEXES	MALES	FEMALES
ALL AGES	14726	7310	7407	14695	7400	7295	15011	7494	7517	15025	7496	7529
0-4	873	422	452	814	416	397	797	408	389	768	403	365
5-9	820	423	406	826	422	404	815	417	406	796	408	390
10-14	880	451	429	820	424	406	828	423	405	816	413	399
15-19	1096	550	546	1082	532	550	1031	476	555	1081	473	608
20-24	1232	629	603	1095	530	517	983	532	451	832	424	408
25-29	1297	640	656	1133	626	507	989	573	416	882	482	400
30-34	1196	600	596	1237	640	617	1233	620	606	1094	537	557
35-39	1199	584	615	1196	606	590	1297	629	610	1233	626	607
40-44	1117	626	591	1131	594	537	1199	604	595	1236	636	618
45-49	922	427	495	1210	619	590	1144	566	578	1187	599	588
50-54	813	417	396	920	473	447	1195	500	695	1121	569	553
55-59	731	375	357	794	422	372	976	437	539	1167	587	580
60-64	676	333	343	720	352	368	761	378	382	861	430	431
65-69	607	296	311	640	297	343	660	317	343	767	381	386
70-74	400	213	187	567	246	321	569	251	318	768	406	361
75-79	280	152	128	387	177	210	452	186	266	646	286	360
80+	272	129	143	406	180	226	431	187	244	608	281	327

AGE GROUP	2 0 2 0			2 0 2 5			2 0 3 0			2 0 3 5		
	BOTH SEXES	MALES	FEMALES	BOTH SEXES	MALES	FEMALES	BOTH SEXES	MALES	FEMALES	BOTH SEXES	MALES	FEMALES
ALL AGES	14972	7412	7560	14608	7366	7242	14766	7264	7502	14609	7162	7447
0-4	719	366	349	721	369	352	760	369	390	766	400	366
5-9	769	383	386	716	366	349	732	370	361	761	390	371
10-14	799	381	418	750	386	364	717	363	356	713	378	335
15-19	810	387	423	681	409	272	701	384	317	716	367	351
20-24	836	423	413	616	417	199	681	400	281	732	384	348
25-29	826	424	402	640	426	214	619	417	201	681	409	272
30-34	666	411	432	623	426	197	630	422	208	614	417	197
35-39	1096	536	560	804	431	373	893	423	470	880	422	458
40-44	1230	626	604	1095	538	557	1032	602	430	1012	612	400
45-49	926	438	487	1223	619	604	990	528	462	879	466	413
50-54	5176	2506	2670	1256	620	636	1812	609	1203	1066	622	444
55-59	1107	590	517	1160	579	579	1209	601	598	1106	591	517
60-64	1121	554	566	1065	519	546	1107	539	568	1166	569	597
65-69	802	399	403	1047	501	546	976	521	455	1017	600	417
70-74	626	308	318	710	329	381	696	425	271	677	401	276
75-79	472	201	271	583	210	373	574	209	364	756	326	430
80+	411	177	234	560	192	368	576	209	366	680	326	354

APPENDIX

TABLE A.2 Population (in 1000s) by age and sex, medium variant (from UN, 1985), Netherlands

INDICATOR	POPULATION										MIGRATION									
	1950	1955	1960	1965	1970	1975	1980	1985	1990	1995	2000	2005	2010	2015	2020	2025	2030	2035	2040	2045
<b>POPULATION BY SEX</b>																				
Total (in 1,000,000)	50,100	52,350	53,600	54,850	56,100	57,350	58,600	59,850	61,100	62,350	63,600	64,850	66,100	67,350	68,600	69,850	71,100	72,350	73,600	74,850
Male (in 1,000,000)	24,550	25,200	25,850	26,500	27,150	27,800	28,450	29,100	29,750	30,400	31,050	31,700	32,350	33,000	33,650	34,300	34,950	35,600	36,250	36,900
Female (in 1,000,000)	25,550	27,150	27,750	28,350	28,950	29,550	30,150	30,750	31,350	31,950	32,550	33,150	33,750	34,350	34,950	35,550	36,150	36,750	37,350	37,950
Sex ratio (per 1,000 males)	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5
<b>POPULATION BY AGE GROUP</b>																				
Age 0-14 (in 1,000,000)	11,100	10,200	9,300	8,400	7,500	6,600	5,700	4,800	3,900	3,000	2,100	1,200	0,300	-0,600	-1,500	-2,400	-3,300	-4,200	-5,100	-6,000
Age 15-64 (in 1,000,000)	28,600	29,700	30,800	31,900	33,000	34,100	35,200	36,300	37,400	38,500	39,600	40,700	41,800	42,900	44,000	45,100	46,200	47,300	48,400	49,500
Age 65+ (in 1,000,000)	10,400	12,450	13,500	14,550	15,600	16,650	17,700	18,750	19,800	20,850	21,900	22,950	24,000	25,050	26,100	27,150	28,200	29,250	30,300	31,350
Age 0-14 (% of total)	22.2	19.5	17.3	15.3	13.4	11.5	9.7	8.0	6.4	4.8	3.3	1.8	0.4	-0.9	-2.2	-3.5	-4.8	-6.1	-7.4	-8.7
Age 15-64 (% of total)	57.1	56.8	57.5	58.2	58.9	59.6	60.3	61.0	61.7	62.4	63.1	63.8	64.5	65.2	65.9	66.6	67.3	68.0	68.7	69.4
Age 65+ (% of total)	20.7	23.7	25.2	26.5	27.7	28.9	30.3	31.3	32.2	33.1	34.0	34.9	35.8	36.7	37.6	38.5	39.4	40.3	41.2	42.1
<b>AGE INDICATORS</b>																				
Median age	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0
Life expectancy at birth	72.0	72.0	72.0	72.0	72.0	72.0	72.0	72.0	72.0	72.0	72.0	72.0	72.0	72.0	72.0	72.0	72.0	72.0	72.0	72.0
Life expectancy at age 65	14.0	14.0	14.0	14.0	14.0	14.0	14.0	14.0	14.0	14.0	14.0	14.0	14.0	14.0	14.0	14.0	14.0	14.0	14.0	14.0
Life expectancy at age 75	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0
<b>SPECIAL AGE GROUPS</b>																				
Age 0-14 (in 1,000,000)	11,100	10,200	9,300	8,400	7,500	6,600	5,700	4,800	3,900	3,000	2,100	1,200	0,300	-0,600	-1,500	-2,400	-3,300	-4,200	-5,100	-6,000
Age 15-64 (in 1,000,000)	28,600	29,700	30,800	31,900	33,000	34,100	35,200	36,300	37,400	38,500	39,600	40,700	41,800	42,900	44,000	45,100	46,200	47,300	48,400	49,500
Age 65+ (in 1,000,000)	10,400	12,450	13,500	14,550	15,600	16,650	17,700	18,750	19,800	20,850	21,900	22,950	24,000	25,050	26,100	27,150	28,200	29,250	30,300	31,350
Age 0-14 (% of total)	22.2	19.5	17.3	15.3	13.4	11.5	9.7	8.0	6.4	4.8	3.3	1.8	0.4	-0.9	-2.2	-3.5	-4.8	-6.1	-7.4	-8.7
Age 15-64 (% of total)	57.1	56.8	57.5	58.2	58.9	59.6	60.3	61.0	61.7	62.4	63.1	63.8	64.5	65.2	65.9	66.6	67.3	68.0	68.7	69.4
Age 65+ (% of total)	20.7	23.7	25.2	26.5	27.7	28.9	30.3	31.3	32.2	33.1	34.0	34.9	35.8	36.7	37.6	38.5	39.4	40.3	41.2	42.1
<b>DEMOGRAPHIC INDICATORS</b>																				
Total fertility rate	2.10	2.10	2.10	2.10	2.10	2.10	2.10	2.10	2.10	2.10	2.10	2.10	2.10	2.10	2.10	2.10	2.10	2.10	2.10	2.10
Gross reproduction rate	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Net reproduction rate	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Crude birth rate	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0
Crude death rate	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0
Net migration	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
<b>DEMOGRAPHIC INDICATORS</b>																				
Total fertility rate	2.10	2.10	2.10	2.10	2.10	2.10	2.10	2.10	2.10	2.10	2.10	2.10	2.10	2.10	2.10	2.10	2.10	2.10	2.10	2.10
Gross reproduction rate	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Net reproduction rate	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Crude birth rate	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0
Crude death rate	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0
Net migration	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

## APPENDIX

TABLE A.3 Demographic indicators, United Kingdom (from UN, 1985)

U.K., G.A., BRITAIN &amp; N.I., IRELAND

AGE GROUP	1 9 5 0			2 0 0 0			2 0 5 0			2 1 0 0		
	BOTH SEXES	MALES	FEMALES	BOTH SEXES	MALES	FEMALES	BOTH SEXES	MALES	FEMALES	BOTH SEXES	MALES	FEMALES
ALL AGES	26656	24173	26641	31190	28726	26478	32599	29490	27109	35520	26536	28984
0-4	4367	2225	2122	2894	1470	1424	4330	2134	2224	4136	2460	2336
5-9	2411	1043	1368	4280	2103	2177	3906	1949	1957	4114	2100	2000
10-14	2346	1702	1644	2330	1823	1507	4263	2120	2143	3791	1940	1895
15-19	2316	1678	1638	2312	1640	1672	3999	1824	1711	4257	2171	2086
20-24	2567	1801	1766	3294	1834	1460	3609	1785	1824	3441	1807	1634
25-29	2679	1752	1926	3441	1730	1711	3303	1672	1631	3632	1767	1869
30-34	2791	1791	1999	3513	1895	1618	3600	1716	1711	4247	1711	2536
35-39	3291	1936	1955	3369	1667	1702	3773	1672	1901	3427	1721	1706
40-44	3057	1861	2196	3704	1827	1877	3704	1647	2057	3647	1879	1768
45-49	2562	1722	1839	3721	1840	1881	3716	1622	1994	3300	1625	1675
50-54	2162	1426	1636	3467	1679	1787	3619	1622	1856	3406	1747	1659
55-59	1761	1234	1527	3204	1563	1641	3192	1568	1624	3192	1609	1583
60-64	1425	1070	1354	2534	1095	1439	2722	1230	1510	2626	1406	1220
65-69	1017	704	1113	2000	850	1150	2221	911	1310	2301	904	1397
70-74	1592	670	924	1667	670	997	1729	670	1049	1809	694	1115
75-79	1032	426	606	1120	441	679	1191	456	733	1250	446	804
80+	768	270	498	860	304	556	1003	336	667	1106	344	762

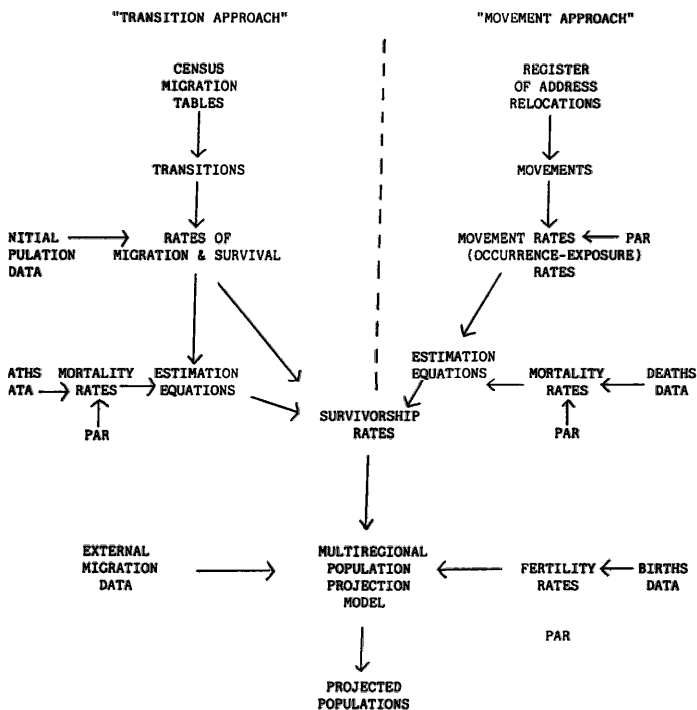
AGE GROUP	1 9 5 0			2 0 0 0			2 0 5 0			2 1 0 0		
	BOTH SEXES	MALES	FEMALES	BOTH SEXES	MALES	FEMALES	BOTH SEXES	MALES	FEMALES	BOTH SEXES	MALES	FEMALES
ALL AGES	26656	24173	26641	31190	28726	26478	32599	29490	27109	35520	26536	28984
0-4	4367	2225	2142	2894	1470	1424	3600	1768	1832	3422	1767	1655
5-9	4699	2409	2290	4494	2309	2185	3903	2000	1903	3362	1827	1535
10-14	2366	1724	1642	2306	1642	1664	4662	2211	2172	3696	2004	1692
15-19	2602	1951	1651	2645	2375	2270	4616	2240	2172	4122	2109	2013
20-24	4779	2165	2614	3070	1922	1148	4442	2126	2316	4422	2266	2156
25-29	4793	2670	2123	3704	1927	1777	3603	1736	1867	4462	2096	2366
30-34	3294	1834	1460	3676	1760	1711	4102	2000	2092	3729	1802	1927
35-39	3197	1992	1205	3232	1653	1579	3606	1710	1896	4095	2021	2074
40-44	3009	1800	1209	3267	1592	1675	3600	1615	1985	3640	1609	1931
45-49	2509	1736	1773	3292	1637	1655	3000	1549	1451	3126	1476	1650
50-54	2266	1592	1674	3231	1722	1509	3177	1503	1672	3000	1409	1591
55-59	1826	1403	1423	2807	1404	1403	3121	1421	1401	2766	1366	1400
60-64	1372	1043	1329	2170	1400	1000	2700	1311	1387	2126	1009	1117
65-69	1142	816	1326	1621	1100	1521	2100	1100	1500	2100	1100	1500
70-74	1904	766	1138	2212	879	1333	1716	766	1250	2216	776	1440
75-79	1270	460	810	1406	466	940	1666	566	1100	1766	476	1290
80+	1253	361	892	1426	379	1047	1666	402	1267	1503	344	1159

AGE GROUP	1 9 5 0			2 0 0 0			2 0 5 0			2 1 0 0		
	BOTH SEXES	MALES	FEMALES	BOTH SEXES	MALES	FEMALES	BOTH SEXES	MALES	FEMALES	BOTH SEXES	MALES	FEMALES
ALL AGES	26656	24173	26641	31190	28726	26478	32599	29490	27109	35520	26536	28984
0-4	4620	1853	2767	3646	1866	1780	3560	1817	1743	3265	1732	1533
5-9	4696	1677	3019	3566	1823	1743	3610	1647	1762	3504	1722	1782
10-14	2366	1724	1642	2306	1642	1664	3575	1831	1743	3600	1809	1791
15-19	2602	2034	1568	2645	2375	2270	3507	1712	1600	3630	1827	1774
20-24	4779	2165	2614	3070	1922	1148	4442	2126	2316	4422	2266	2156
25-29	4793	2670	2123	3704	1927	1777	3603	1736	1867	4462	2096	2366
30-34	3294	1834	1460	3676	1760	1711	4102	2000	2092	3729	1802	1927
35-39	3197	1992	1205	3232	1653	1579	3606	1710	1896	4095	2021	2074
40-44	3009	1800	1209	3267	1592	1675	3600	1615	1985	3640	1609	1931
45-49	2509	1736	1773	3292	1637	1655	3000	1549	1451	3126	1476	1650
50-54	2266	1592	1674	3231	1722	1509	3177	1503	1672	3000	1409	1591
55-59	1826	1403	1423	2807	1404	1403	3121	1421	1401	2766	1366	1400
60-64	1372	1043	1329	2170	1400	1000	2700	1311	1387	2126	1009	1117
65-69	1142	816	1326	1621	1100	1521	2100	1100	1500	2100	1100	1500
70-74	1904	766	1138	2212	879	1333	1716	766	1250	2216	776	1440
75-79	1270	460	810	1406	466	940	1666	566	1100	1766	476	1290
80+	1253	361	892	1426	379	1047	1666	402	1267	1503	344	1159

AGE GROUP	2 0 0 0			2 0 5 0			2 1 0 0			2 1 5 0		
	BOTH SEXES	MALES	FEMALES	BOTH SEXES	MALES	FEMALES	BOTH SEXES	MALES	FEMALES	BOTH SEXES	MALES	FEMALES
ALL AGES	26656	24173	26641	31190	28726	26478	32599	29490	27109	35520	26536	28984
0-4	3900	1696	2204	3409	1706	1703	3522	1606	1716	3596	1616	1780
5-9	3910	1699	2211	3419	1709	1710	3532	1610	1720	3606	1626	1780
10-14	3920	1702	2218	3429	1712	1717	3542	1614	1724	3616	1636	1790
15-19	3930	1705	2225	3439	1715	1724	3552	1617	1733	3626	1646	1800
20-24	3940	1708	2232	3449	1718	1731	3562	1620	1743	3636	1656	1810
25-29	3950	1711	2239	3459	1721	1738	3572	1623	1753	3646	1666	1820
30-34	3960	1714	2246	3469	1724	1744	3582	1626	1763	3656	1676	1830
35-39	3970	1717	2253	3479	1727	1753	3592	1629	1773	3666	1686	1840
40-44	3980	1720	2260	3489	1730	1763	3602	1632	1783	3676	1696	1850
45-49	3990	1723	2267	3499	1733	1773	3612	1635	1793	3686	1706	1860
50-54	4000	1726	2273	3509	1736	1783	3622	1638	1803	3696	1716	1870
55-59	4010	1729	2280	3519	1739	1793	3632	1641	1813	3706	1726	1880
60-64	4020	1732	2287	3529	1742	1803	3642	1644	1823	3716	1736	1890
65-69	4030	1735	2294	3539	1745	1813	3652	1647	1833	3726	1746	1900
70-74	4040	1738	2301	3549	1748	1823	3662	1650	1843	3736	1756	1910
75-79	4050	1741	2308	3559	1751	1833	3672	1653	1853	3746	1766	1920
80+	4060	1744	2315	3569	1754	1843	3682	1656	1863	3756	1776	1930

## APPENDIX

TABLE A.4 Population (in 1000's) by age and sex, medium variant (From UN, 1985), United Kingdom



# KEY

PAR . POPULATION AT RISK (MID-INTERVAL OR AVERAGE POPULATION)

**FIGURE 1** The steps in the incorporation of migration data in regional population projections



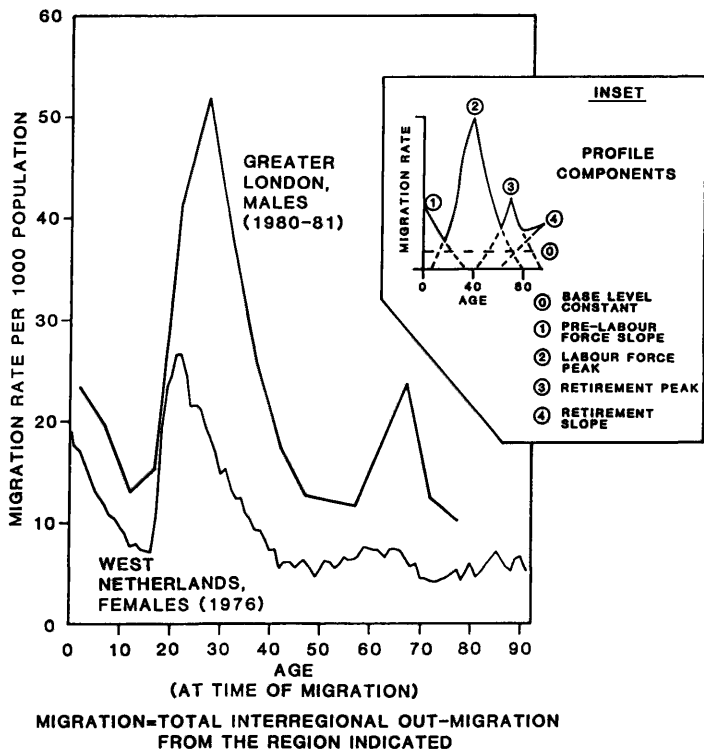


FIGURE 2. Examples of migration rate profiles



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