CHAPTER 4

Multiregional population projection in the Netherlands (1)

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I. — Earlier approaches

The history of regional population projections in the Netherlands since the Second World War can be divided into three periods (Eichperger, 1984).

First of all, the period 1947 to 1959, in which economic-demographic models were used. In these models, migration is assumed to be triggered by supply and demand of employment, as well as by social and economic factors. The models were not very suitable as an instrument for regional population projection: the results were not consistent with the national forecast because forecasts were made for each region.

During the second period, 1960 to 1971, population distribution models allowed us to distribute the projected national population across the regions, the so-called top-down approach. However, such models are generally very mechanical. Migration is not, or barely, taken into account, and problems arise if the national population increases while the regional population decreases within a given period of analysis. Hybrid models do away with a number of these drawbacks. From 1971 onwards, until very recently, these models were used for provincial population forecasts by the National Physical Planning agency. In hybrid models, the components of regional population trends (fertility, mortality, and migration) are modelled separately. For fertility and mortality, the approach is purely demographic. With the aid of a regression equation, net migration is made subject to regional labour market trends, the regional housing situation, interregional distances and the quality of the living environment.

(1) This is a revised version of a paper prepared for the Workshop Multiscale Demography, Zeist, November 1988. The revision consists of:
— an extension of the analysis period with two years, 1985 and 1986 in order to revise (if necessary) the hypotheses of regional fertility, regional mortality, internal migration and the regional distribution of external migrants.
— basing the regional population projections on the recent NCBS population forecast of 1988.
The hybrid model has a number of drawbacks, however, the most important of which is that net migration figures are used instead of migration flows. The interaction between the various regions is therefore not explicitly modelled.

The multiregional approach to regional population projections does not have the major drawbacks of the hybrid approach. The method was developed by Rogers and others in the mid-1970's (Rogers, 1975, 1981; Willekens and Rogers, 1978).

**The MUDEA-project**

In 1982, the National Physical Planning agency commissioned the Netherlands Interuniversity Demographic Institute and the Department for Urban Planning of the Technical University of Delft to apply the multiregional approach to the Dutch situation. During the course of this project, a new multiregional projection model was developed: MUDEA (Multiregional Demographic Analysis). MUDEA was an improvement on the model described by Willekens and Rogers in 1978 (Willekens, 1984). The relationship between the model's parameters and the Lexis-diagram was made explicit, which meant that the model structure could be considerably simplified. Moreover, the results of the multiregional model and of the national model were tested for consistency, and algorithms were developed to ensure consistency.

II. – The MUDEA-model

1) **General**

An extensive description of the MUDEA-model is given in Willekens (1984) and Willekens and Drewe (1984). We should state first of all that the model:

--- is purely demographic: it contains only definition equations, and no behavioural equations;

--- analyses men and women separately, whereas fertility has been modelled in a female-dominant manner;

--- is deterministic and time-discrete;

--- has age intervals and time intervals of the same length (generally 1 year or 5 years);

--- has demographic rates (central rates, occurrence-exposure rates) as the parameters for fertility, mortality, internal migration and emigration, and absolute figures as the parameters for immigration;

--- results at the level of 44 regions (for an overview see figures 1 to 4)

Compared with the models developed by Rogers and others in the 1970's, the MUDEA-model is an improvement in several respects:

--- international migration is explicitly included in the model;
Figure 1. — Population growth 1988-2015 (1988 = 100) based on the national population forecast 1988.

Figure 2. — Growth of the 0-14 years age group in the 44 regions.
Figure 3. – Growth of the 15-64 years age group.

Figure 4. – Growth of the 65 and more years age group.
— when describing the demographic events experienced by an individual, the model uses a period-cohort criterion instead of a cohort criterion only. Unnecessary complications (for example, the derivation of survivorship proportions from transition probabilities, Rogers, 1975) are thus avoided.

2) The equations of the multiregional model

The model construction begins with the identification of stock variables and flow variables. The stock variables are the numbers of people in every population category (defined as a given combination of the dimensions age, sex, and region of residence).

They are written as $K_i(x, t)$ which indicates the number of people living in region $i$ at time $t$, aged $x$ years old. The number of people aged $x$ years old at time $t$ can be brought together in a column vector

$$K(x, t) = (K_1(x, t), K_2(x, t), \ldots, K_N(x, t))^T,$$

where $N$ is the number of regions distinguished.

The flow variables describe the number of demographic events in the projection interval, i.e. between time $t$ and time $t + h$. These events lead to a change in one of the dimensions; e.g. in the region of residence (migration from region $i$ to region $j$); from living in region $i$ to deceased (death). The following flow variables have been distinguished:

- $O_{ij}(x, t)$ the number of migrations from region $i$ to region $j$ in the period $(t, t + h)$ for persons aged $x$ at time $t$;
- $O_{id}(x, t)$ the number of people aged $x$ at time $t$ dying in region $i$ in the period $(t, t + h)$;
- $O_{io}(x, t)$ the number of emigrants aged $x$ at time $t$ who migrate from region $i$ in the period $(t, t + h)$ and who go abroad;
- $O_{oi}(x, t)$ the number of immigrants aged $x$ at time $t$ who come to live in region $i$ in period $(t, t + h)$;
- $B_i(x, t)$ the number of children born in region $i$ in period $(t, t + h)$ to mothers aged $x$ at time $t$.

All flow variables have been defined with the aid of a period-cohort criterion. Thus, the following balance equation between stock variables and flow variables applies in region $i$

$$K_i(x + h, t + h) = K_i(x, t) - \sum_{j \neq i} O_{ij}(x, t) + \sum_{k \neq i} O_{ki}(x, t) - O_{id}(x, t) - O_{io}(x, t) - O_{oi}(x, t) + O_{oi}(x, t), \ 0 \leq x \leq z - h$$

(2.1)

(2) "Aged $x$ at time $t$" means that the exact ages at time $t$ lie between $x$ and $x + h$. 

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Equation (2.1) applies to all age groups, with the exception of the lowest (children born between \( t \) and \( t + h \)) and the highest age group, which is open-ended. For children born in \((t, t + h)\) the balance equation is:

\[
K(0, t+h) = B_i(t) - \sum_{j \neq i} O_{ij}(0, t) - \sum_{k \neq i} O_{ki}(0, t) - O_{id}(0, t) - O_{io}(0, t) + O_{oi}(0, t) \quad (2.2)
\]

where \( O_{ij}(0, t) \) is the number of children born in period \((t, t + h)\) and who move from region \( i \) to region \( j \) before the end of the period. \( O_{id}(0, t) \), \( O_{io}(0, t) \) and \( O_{oi}(0, t) \) have analogous meanings. \( B_i(t) \) is the total number of births \( x \) between \( t \) and \( t + h \).

The number of people in the highest age group, i.e. aged \( z \) or higher, is given by \( K_i(z, t) \) for region \( i \) at time \( t \). This definition entails that the highest age group is open-ended. The balance equation is therefore:

\[
K_i(z, t+h) = K_i(z-h, t) - \sum_{j \neq i} O_{ij}(z-h, t) + \sum_{k \neq i} O_{ki}(z-h, t) - O_{id}(z-h, t) - O_{io}(z-h, t) + O_{oi}(z-h, t)
+ O_{oi}(z, t) - K_i(z, t) - \sum_{j \neq i} O_{ij}(z, t)
+ \sum_{k \neq i} O_{ki}(z, t) - O_{id}(z, t) - O_{io}(z, t) + O_{oi}(z, t) \quad (2.3)
\]

A demographic rate (occurrence-exposure rate) expresses the ratio between the number of events and the number of person-years in the initial state (see Keyfitz, 1968, 9, for example, for a definition). The migration rate \( m_{ij}(x, t) \), the mortality rate \( m_{id}(x, t) \) and the emigration rate \( m_{io}(x, t) \) are, respectively, defined as:

\[
m_{ij}(x, t) = \frac{O_{ij}(x, t)}{L_i(x, t)}, \quad (2.4)
\]

\[
m_{id}(x, t) = \frac{O_{id}(x, t)}{L_i(x, t)} \quad (2.5)
\]

\[
m_{io}(x, t) = \frac{O_{io}(x, t)}{L_i(x, t)} \quad (2.6)
\]

where \( L_i(x, t) \) is the number of person-years which a population aged \( x \) at time \( t \) spends in region \( i \) during period \((t, t + h)\). Immigration rates are not defined for immigrants. The population at risk lives outside the Netherlands; this population therefore does not feature in the model. The absolute number of immigrants
\( O_{al}(x, t) \) will thus remain in the final model equations as an exogenous variable (parameter). In general, the number of person-years is equal to the length of all life lines in the observation interval. Thus, if the interval is \( h \) years, the following applies:

\[
L_i(x, t) = \int_0^h K_i(x + s, t + s) \, ds
\]  

(2.7)

If all events \( O \) in equation (2.1) are uniformly distributed over \((t, t + \Delta t)\), then population \( K_i(x + s, t + s) \) will develop linearly between \( s = 0 \) and \( s = h \), such that (2.7) can be written as:

\[
L_i(x, t) = 1/2 \, h \, [K_i(x, t) + K_i(x + h, t + h)]
\]  

(2.8)

Substituting expression (2.4)-(2.6) in equation (2.1) gives

\[
K_i(x + h, t + h) = K_i(x, t) - [m_{ii}(x, t) + \sum_{i \neq j} m_{ij}(x, t) L_i(x, t) + \sum_{k = 1}^i m_{ii}(x, t) L_k(x, t) + O_{al}(x, t)]
\]

(2.9)

The above equation applies for region \( i \). Repeating this equation for each of the other regions, yields a set of \( N \) equations. These can then, taking into account expression (2.8), be easily expressed in matrix notation:

\[
[I + 1/2 \, hM(x, t)] \, K(x + h, t + h) = [I - 1/2 \, hM(x, t)] \, K(x, t) + O_o(x, t)
\]

or

\[
K(x + h, t + h) = [I + 1/2 \, hM(x, t)]^{-1} [I - 1/2 \, hM(x, t)] \, K(x, t)
\]  

\[
+ [I + 1/2 \, hM(x, t)]^{-1} O_o(x, t)
\]

(2.9)

vector \( K(x, t) \) was defined as the vector with the number of \( x \)-years-old at time \( t \) distributed by region. \( I \) is the \( N \times N \) identity matrix. Vector \( O_o(x, t) \) contains the number of immigrants during \((t, t + h)\), distributed by region of destination. These immigrants are \( x \)-year-old at time \( t \). Matrix \( M(x, t) \) can be interpreted as the multidimensional generalisation of the one-dimensional figures defined in (2.4)-(2.6).

The model equation for the highest open-ended age group is:

\[
K(z, t + h) = [I + 1/2 \, hM(z - h, t)]^{-1} [I - 1/2 \, hM(z - h, t)] \, K(z - h, t)
\]

\[
+ [I + 1/2 \, hM(z, t)]^{-1} [I - 1/2 \, hM(z, t)] \, K(z, t)
\]

\[
+ [I + 1/2 \, hM(z - h, t)]^{-1} O_o(z - h, t)
\]

\[
+ [I + 1/2 \, hM(z, t)]^{-1} O_o(z, t)
\]

(2.11)

The model equation for the lowest age group is:

\[
K(00, t + h) = [I + 1/2 \, hM(00, t)]^{-1} [B(t) + O_o(00, t)]
\]

(2.12)
The entire multiregional projection model consists of the expressions (2.9), (2.11), and (2.12).

The multiregional model described in the foregoing is fairly general. However, the operationalisation of internal migration deserves further attention. In MUDEA II (follow-up), the age-specific internal migration figures \( m_{ij}(x, t) \) for men and women have not been taken as parameters. Instead, the total departure rate \( m_i(x, t) = \sum_{j \neq i} m_{ij}(x, t) \), and the total arrival rate, \( a_j(x, t) = \sum_{i \neq j} o_{ij}(x, t)/L_j(x, t) \) have been used. The calculations of internal migration with the aid of total departure rates and total arrival rates can be divided into three steps:

1. Per region, the initial number of emigrants \( o_i^a(x, t) \) is determined as \( o_i^a(x, t) = m_i(x, t) \cdot L_i(x, t) \), and the initial number of immigrants as \( o_j^a(x, t) = a_j(x, t) \cdot L_j(x, t) \).

2. The total number of emigrants per age and sex for all 44 regions \( \sum_i o_i^a(x, t) \) is compared with the total number of immigrants \( \sum_j o_j^a(x, t) \) at the national level (for men and women and for every age group) the total departure rate should be exactly equal to the total arrival rate.

3. The difference between total initial departures \( \sum_j o_j^a(x, t_0) \) and the total initial arrivals \( \sum_j o_j^a(x, t) \) is proportionally distributed across the regions of departure.

Thus, for each region, the initial number of emigrants is exactly equal to the sum of immigrants calculated earlier. The number of immigrants \( o_j^a(x, t) \) therefore remains unchanged.

3) Consistency algorithms

In section I, we mentioned that one of the criteria for the model was that the results, after summing over all regions, had to be entirely consistent with the national numbers calculated. This requirement refers not only to stock variables (the population decomposed by sex, age and region of residence), but also to flow variables: results for regional fertility, regional mortality and international migration, per region, should coincide with the national results. This criterion entails that the regional forecast is subordinate to the national forecast. What are the advantages of such a top-down approach? For various reasons, a large population is often easier to forecast than a relatively small population (Schwarz, 1975; Pittenger, 1976, 79; Baxter and Williams, 1978, 61). First of all, the behaviour of an aggregate population is usually fairly stable. Secondly, statistical data for sophisticated calculations for small regions are often lacking. Lastly, internal migration is not relevant to the national population statistics; international migration on the other
hand is usually more important than birth and deaths. Regional forecasts often strongly depend on internal migration, which is very difficult to extrapolate.

The consistency problem is solved in the following way.

For the first projection interval, the regional initial population — for each age group and for both men and women alike — is consistent with the national population at the start of the interval. If we then adjust the regional numbers of deaths, live births and cases of international migration for each age and for both men and women during that interval, such that they become consistent with the corresponding national variables, then the regional population will automatically be consistent with the national population at the end of the projection interval. The consistency algorithm designed for MUDEA thus concentrates on the flow variables.

III. — Trends and hypotheses

Hypotheses concerning the future development of regional fertility, regional mortality, internal migration and the regional pattern of external migration were based on thorough analysis of recent trends in these variables. For each of these variables an overview is given of the main elements of the process of analysis and formulation of hypotheses.

1) Regional mortality

Analyses have been carried out of mortality trends by age and by sex in the periods 1972-1976, 1976-1980, 1980-1984 and 1982-1986. Regional life tables formed the basis for such analyses. However, the pattern of regional life tables is often irregular due to the small size of the population. Parametrisation could offer a solution to this problem (van Poppel, 1987). Parametrisation is also useful when comparing mortality between regions and for comparison over time; when inter-regional differences in mortality can be summarised in 1 or 2 parameters which adequately describe the entire mortality curve, the comparison can be much more precise.

We have used the relational model designed by Brass (1971; 1975). This model assumes that if the \( l(x) \) values of two life tables — the probability of survival from birth to age \( x \), expressed as a proportion — are transformed in a particular manner, they are linearly related. If \( \lambda(x) \) and \( \lambda'(x) \) are transformations of values from two different life tables, if \( \alpha \) and \( \beta \) are constants and is defined as

\[
\lambda(x) = \lambda(l(x)) = \text{logit}(1 - l(x))
\]

\[
= 0.5 \ln \left( (1 - l(x))/l(x) \right)
\]

(3.1)

then

\[
\lambda(x) = \alpha + \beta \lambda'(x)
\]

(3.2)
The transformation of each life table can be expressed as a linear function of the transformed of a particular "standard" life table. This implies that all life tables can be derived from one single life table by varying the values of alpha and beta. Here, the relationship between the national life table and the regional life tables is determined. The life table for the Netherlands in the period 1980-1984 has been taken as the standard.

Ordinary least squares has been applied in order to estimate the parameters in the regression \( \lambda(x) = \alpha + \beta \lambda^x(x) \).

Quantitative hypotheses for the different regions were derived in the following way.

First of all, the life table drawn by the NCBS for the year 2000 for the Netherlands as a whole was related, according to the Brass-model, to the life table in the base period: alpha and beta compare the mortality level and the age pattern of the life table from 1996-2000 with the standard life table of 1980-1984. This procedure was applied for all 3 variants of the mortality forecast.

For the majority of regions, we then assumed that the absolute difference with the national alpha and beta values found for the period 1980-1986 will apply in the period 1996-2000.

Given the values of alpha and beta in the period 1996-2000 for the Netherlands as a whole and given the differences between national and regional alpha and beta values, the values for each region in the year 1998 can be derived for each variant. The values of alpha and beta in the years between 1986 and 1996-2000 have been derived with the aid of (two-point Hermite) interpolation.

Next, annual life tables can be calculated for each region which belongs to a regional cluster by applying the values of alpha and beta to the standard life table of 1980-1984.

2) Regional fertility

Various studies have shown that the Gamma-fertility curve is very useful for summarizing a series of age-specific fertility rates in a small number of parameters (Duchêne and Gillet-De Stefano, 1974; Hoem et al., 1981; Eichberger, 1981; Janssen, 1984). With the aid of a Gamma-curve, a fertility rate for age \( y = x - 15 \) for a given period and region is written as:

\[
m_b(y) = K \lambda, p_y, p - 1, \exp(-y)/\Gamma(p), \quad p > 0.
\]  

(3.3)

where \( m_b(y) \) is the fertility rate for the shifted ages \( 0 < y < 35 \). The minimum age has thus been fixed at \( x = 15 \). \( \Gamma(\cdot) \) is the gamma function (Abramowitz and Stegun, 1970), defined by

\[
\Gamma(p) = \int_0^\infty \exp(-x)x^{p-1}dx,
\]

with the characteristic \( \Gamma(p + 1) = p \Gamma(p), \quad p > 0 \).
In the expression (3.3), \( K, \lambda \) and \( p \) act as parameters; they are not easy to interpret. These parameters have therefore been transformed into other parameters, namely the total fertility rate \( (D) \), the average age of the mother at childbirth \( (\mu_y) \), and the deviation of that distribution \( (\sigma_y) \). The transformation is then (Keilman and Manting, 1987, 61):

\[
D = K \\
\mu_y = p/\lambda \\
\sigma_y = p/\lambda.
\]

From 1972 onwards, age-specific fertility rates were available for 5-year age groups of the mother for each of the 44 COROP-regions.

Period-cohort rates have been calculated for the periods 1972-1976, 1976-1980, 1980-1984 and 1982-1986. With the aid of these observed fertility rates, regression was used to estimate the parameters of the Gamma-curves.

When extrapolating regional developments, the regional trends had to be more or less the same as the national trend (albeit at a higher or lower level). For this reason a constant ratio between regional and the national parameters was used in the extrapolations. The national parameters had been extrapolated by the NCBS for the national forecast, i.e. independently of the MUDEA-project. Next, a visual inspection was carried out in order to detect unrealistic developments in the regional parameters, given the trends since 1972 and the interpretations thereof.

From 1995 onwards the parameters were kept constant. Between 1986 (the last observation year) and 1995 a smooth interpolation was carried out. (Hermite interpolation). In view of the importance of the total fertility rate \( D \) for the age-specific figures \( m_b(x) \), and in view of the uncertainty in the NCBS forecast with respect to the future national fertility, two hypotheses for total fertility — a high one and a low one—were formulated per region. The difference in the total fertility rate between these two variants amounts to 0.4 children per woman. This uncertainty margin coincides with the margin which the NCBS applies to its national fertility hypotheses.

The three parameter values which have been assumed for each year in the period 1986-1995, have yielded regional age-specific fertility rates, via the Gamma curve.

3) Internal migration

On the basis of 44 COROP-regions, 2 sexes and 96 age groups, we can distinguish 8 448 categories of migrants. However, if we also take into account the region of origin and the region of destination of the migrant, the number of possibilities will be as much as 363,264. It goes without saying that for the analysis of migration trends in the recent past as well as for the formulation of hypotheses regarding future trends, the number of categories must be restricted. Such a reduction in the number of data has been pursued by:
1. expressing the mobility level by a single index number;
2. working with a model representation of the regularities by age found in the migration pattern;
3. working with age profiles which are representative of large number of regions.

1. The GMR (OBS), the observed gross migration rate, was used to calculate the level of internal migration. GMR (OBS) - hereafter to be called GMR or mobility level - gives the sum of the observed age-specific migration rates.

The mobility level of the 44 regions in the period 1973-1979 is fairly uniform. However, after 1979 large regional differences occur. In order to throw light on the background of this development we analysed the influence of a number of potentially important factors. On the basis of this analysis, we may assume that 3 factors will play an important role in future mobility trends, namely demographic, housing, and economic factors. Of these three factors, the development of the Dutch economy is the most uncertain one. The real net national income could be either low or high, depending on the development of world trade (Central Planning Bureau, 1985). This uncertainty calls for drawing up scenarios. For the Netherlands, we can distinguish a CONSTANT and a HIGH scenario.

The CONSTANT scenario does not appear to stimulate the mobility level to a great extent. The GMR remains constant to the average level of the GMR in the period 1984-1986. The HIGH scenario on the other hand allows for an increase in mobility, according to the economic growth as forecasted by the Central Planning Bureau. The growth of the GMR in this scenario is mainly concentrated in the period 1988-2000. After the year 2000 the GMR are considered to remain constant on the level reached in the year 2000.

2. Age profiles. Irrespective of the level of mobility, we can distinguish similarities in the course of migration by age. They can be modelled with the aid of model migration schedules (Rogers and Castro, 1981a, 1981b). Observed migration curves (age and sex-specific) are reduced to a limited number of parameters.

The parameters of the model curve are estimated on the basis of migration rates for departure and arrival for each sex over the years 1973, 1979 and 1980-1984. Since we could not detect a clear trend of deviations, and other studies (Scherbov and Golubkov, 1986) showed that the age profiles tended to be stable over time, the parameters estimated for 1984 were taken as the basis for the regional population forecast.

3. Regional preferences. The index for region of preference, which expresses the specific migration relationship between region $i$ and region $j$, gives the ratio between the number of persons who actually migrate from $i$ to $j$ and the number of migrants one would expect if there were no regional preferences. Between 1979 and 1986 overall regional preferences were not stable. Because of the existence of unstable regional preferences, a large number of region-specific hypotheses had to be formulated. For practical reasons and as an easy alternative, the regional preference – as observed in 1984 – is assumed to remain constant in the future.

On the basis of the hypotheses formulated with respect to the level of mobility, with respect to the age profile of settlement and departure and with respect to
regional preference by age, the number of arrivals and departures, by region of origin and region of destination, can be derived for each COROP-region.

4) **International migration at the regional level**

Schakenraad (1987) has extensively described the manner in which the analysis of international migration at COROP-level and the subsequent formulation of hypotheses was carried out. The approach consisted of:

2. an analysis of these trends at the COROP-level, 1980-1985;
3. formulation of hypotheses for the period 1986 onwards.

The hypotheses for emigration were based on the following assumptions: The emigration decline observed in the early 1980's, at the national level, will change into a slight increase in the very short term. Emigration will subsequently stabilise. Regional stable trends are expected to continue, whereas migration by the population aged 50+ from urban regions is expected to rise.

Declining trends will level off in the short term, or even temporarily increase.

Analysis of the external migration in the years 1985 and 1986 did not give rise to change the original hypotheses as formulated above. When formulating the hypotheses for immigration, we chose to keep the regional figures constant at the levels observed during 1986.

**IV. – Results**

We will here briefly deal with a number of results calculated with the aid of the MUDEA model. The description is mainly based on the medium variant of the national population forecast (NCBS 1989) with the scenario for high internal migration.

The results expressed as indices (1988 = 100) are given in figure 1. For the entire projection period (1988-2015) the population in the northern part of the country is declining. This decline can be attributed primarily to the strong internal migration deficit in those regions.

A decline of population is also expected in two regions in the western part of the country. This decline is caused by a mortality surplus. Note the strong growth of the four big cities (Utrecht, Amsterdam, Rotterdam, Den Haag) in the period 1988-2015. This growth (10 to 36%) may be attributed in the first instance to the considerable international net migration surplus expected by the NCBS for the years to come. Population growth is also considerable in the regions in the middle part of the country. The strongest population increase will take place in the new province Flevoland.

As for the trends in the age structure, we refer to the figures 2 to 4. The growth of the 0-14 years-old is considerable in the regions in the middle part of
the country. This growth can be attributed to the strong internal migration surplus expected in most of these regions, as well as to high fertility. An explanation for this high fertility is that the population in most of these regions accrue to the group of orthodox protestants (Keilman and Manting, 1987).

The growth of population in the working ages (15 to 65) is considerable in most regions of the country (see figure 3). Note the decline of population in this age group in the regions in the north, the east, and the south of the country. This decline can be attributed to the internal migration deficit for this age group in these regions. The increase of the number of people aged over 65 years is significant in the regions in the north, and the south-west of the country.

A comparison of the two internal migration scenarios shows that, due to the lower level of internal migration, population growth in a number of regions will be stronger than the variant with the high level of internal migration, because of the smaller net migration deficit.

As was the case in the national population forecast, the high and the low variants give the margins within which regional population developments will take place. This means that the regional population size as calculated by the medium variant, can be between 6% lower and 5% higher. The distribution pattern of the regional population in the high and in the low variant yields the same as in the medium variant.

From the results of the calculations the conclusion can be drawn that the regional population distribution pattern is determined more by internal migration and the uneven distribution of foreign migrants than by regional differences in mortality and fertility.

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SUMMARY

The paper presents a new method for regional population projection and its application in the Netherlands. The method is an extension of the multiregional cohort-survival model, developed by Rogers and associates. For projection purpose, the age profiles of transition rates are parametrized and the geographical units are clustered in demographically homogeneous regions.

Associated with the new method is a software package for multiregional demographic analysis (MUDEA). Both the methodological research and the software development were commissioned by the National Physical Planning Agency.