HALF A CENTURY OF POPULATION FORECASTING IN THE NETHERLANDS

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HALF A CENTURY OF POPULATION FORECASTING IN THE NETHERLANDS

1.- Introduction

The first Dutch population forecast was published in 1921 when Prof. Dr. C. A. Verrijn Stuart predicted a population of 27.5 million for the year 2020. After a few unpublished forecasts, Statistics Netherlands (CBS) published its first projections ´Berekeninig omtrent de toekomstige loop der Nederlandse bevolking´ (Calculations of future paths of the population of the Netherlands), Forecast 1950 (CBS, 1951). Since then over twenty-five regular forecasts have been made. From the mid-eighties they were produced annually and from 1997 every other year a long-term forecast and short-term forecast. The last forecast, Forecast 2001, predicts a population of 17.5 million for the year 2020, 10 million less than in the forecast of 1921. Other (regular) national population forecasts have not been published by other institutes than the CBS.

Beside regular population forecasts, some experimental calculations, high and low varieties and scenarios, and other exercises were made. These are not treated here.

As is common practice, the forecasts will be named after the first year for which assumptions were made and not according to the year of publication (although these could coincide) . For example, Forecast 1950 was published in 1951, but the starting population was that of the first of January of 1950 and therefore this forecast will be addressed as Forecast 1950. No detailed information is available for Forecast 1951 and Forecast 1959, therefore these will be omitted from some tables and graphs.

An overview of forecasts made before 1950 can be found in CBS (1951). Population Forecasts made after 1950 were also discussed in De Beer (1990), Cruijsen and Zakee (1991), De Jong (1995) and Gjaltema and Broekman (2001a, 2001b, 2002a, 2002b).

In the next chapter a more detailed description will be given of the official forecasts made in the Netherlands. It will concentrate on the changes in assumptions and in methodology compared to the previous forecast. Chapter three discusses the assumption levels, methodological changes, the advice groups used in making the forecasts, and the

variable level. The forecast performance in terms of forecast error is subject to chapter 4. Finally, conclusions are drawn in chapter 5.

2.- Overview of the Forecasts

In the following section the forecasts made in the second half of the twentieth century will be described. The main changes in the three components and the effect on the total population will be discussed. A discussion of the forecast errors can be found in chapter four. *Table 1* gives an overview of the main assumptions of the forecasts made in the past fifty years. In *Table 2* the situation as forecasted for the year 2000 can be found (more information can also be found in graphs 1, 2, 8, 14, and 20 of chapter four).

Table 1 Main indicators population forecast: end values

Forecast					life-expectancies	
Start-year	end-year	total population x1000	TFR	net-migration	male	female
1950	1980	13036	2.28	0	69.4	71.5
1951	1981	14270		-50000	69.4	71.5
1959	1981	14649		-20000	69.4	71.5
1965	2000	20977	3.22	0	72.3	79.4
1967	2000	17895		0	72.3	79.4
1970	2000	17058	2.24	0	69.5	76.6
1972	2000	15727		0	69.5	76.6
1975	2010	15007	1.69	0	71.4	77.8
1980	2025	15573	1.73	6000	73.3	79.5
1984	2035	13361	1.50	0	74.5	81.5
1985	2020	13394	1.50	0	74.5	81.0
1986	2035	14599	1.65	0	74.5	80.5
1987	2035	15777	1.65	20000	74.5	80.5
1988	2050	14857	1.65	20000	75.0	81.5
1989	2050	14879	1.65	20000	75.0	81.5
1990	2050	15326	1.65	25000	75.0	81.5
1991	2050	16430	1.80	25000	75.0	81.5
1992	2050	16668	1.80	25000	76.0	81.5
1993	2050	17293	1.80	35000	76.0	81.5
1994	2050	17152	1.80	35000	76.0	81.5
1995	2050	16991	1.80	35000	76.0	81.5
1996	2050	16874	1.70	35000	80.0	83.0
1997	2003	16149	1.60	34377	75.7	80.7
1998	2050	17230	1.70	22316	80.0	83.0
1999	2004	16339	1.67	44150	75.9	80.8
2000	2050	18005	1.75	29725	79.5	83.0

2.1.- The first thirty years

The first forecast was made in a period in which family formation nearly solely took place within marriage. Therefore, Forecast 1950 was based upon marital fertility. Despite a peak in the number of births in 1946, a result of an increase of young couples, a decline in the fertility was assumed from an average of three children to just over two children per woman. Two variants were made for marital fertility, a maximum keeping developments after 1952 at the 1937 level (the lowest level registered till then) and a low scenario with a continuation of the decline as had already been observed for the years since 1875. Together with two assumptions for the percentage of woman married, this lead to four fertility-forecasts. The base-line scenario consisted of the average of the two extremes of these four scenarios.

In the first part of the twentieth century, the volume of immigration and emigration tended to fluctuate extensively from year to year; years of net-inflow were followed by years of net loss of population. Direction and content also varied from year to year. After the Second World War, an active emigration policy was proceeded by the Dutch government. The state of the world economy was also assumed to stimulate emigration. Despite this, no explicit assumptions about migration were made in the final population forecast. Implicitly it was therefore assumed that in the long-term emigration and immigration would balance each other out. Possible direct and indirect (less births) effects of migration on population growth were studied, however. The government's strife was a net-emigration of 20 to 25 thousand workers (together with their family this would mount to a net departure of 50 thousand migrants). This exercise resulted in an expected lowering of the population size of two million by the year 1980.

Assumptions for the mortality forecast were based upon observations from the previous years. Levels of the 1947-1949 period were kept constant. Lack of epidemics and selective mortality during the war had caused relative low mortality during this period and it was assumed that these relatively low levels could be maintained. If necessary, further downward adjustments could be made in the future. Due to population ageing, the number of deaths would increase despite lower mortality levels.

In the foreword of Forecast 1950 it was stated that, if necessary, the forecast would be revised. Only one year later a revision was thought to be necessary. The percentage of married woman turned out to be higher than expected. Furthermore, the decline of the

marital fertility turned out to be less than assumed. Because of this a revision was felt to be necessary. Forecast 1951, therefore, predicted more births.

It neither seemed that assumptions on mortality could be maintained. In Forecast 1951 the mortality levels of the previous forecast were chosen as the highest scenario. A logarithmic extrapolation of values observed between 1900-1909 and 1947-1949 delivered the low scenario. The base-line scenario was the average of the two extreme values.

Forecast 1951 was made with and without explicit assumptions on migration. The effects of two different scenarios for migration were calculated (yearly emigration of 20 and 50 thousand). It was not clarified which of the two should be considered the most likely forecast. As in the previous forecast, immigration was assumed to be negligible. Because emigrants were mainly young people, these assumptions increased the average age of the population. Compared to Forecast 1951 the variant without emigration would see the total population increase with one million by 1980.

The net result of these changes would mean an extra one million inhabitants in the year 1980 (in the version without explicit migration assumptions). More births, and to a lesser extent, less deaths would lead to these changes.

Forecast 1959 was produced in 1959, the starting population was that of 1956 but the population up to 1959 were observed ones (the forecast was made for the OECD which asked for forecasts from the period 1956). Compared to the previous predictions, no changes were made for fertility. In accordance with observed trends, mortality levels were, again, lowered a little bit.

For migration, again estimations with and without migration were made. In the ultimate population projections the migration component was not included though. The overall effect on the population forecast was an increase in the total population.

A further increase in the percentage of married persons was expected in Forecast 1965. Observations from the U.S. census were taken as maximum values for the proportion of the population that would marry. Younger age at marriage and a concentration of first-motherhood in the first years of marriage would lead to an increase in fertility of women below age 30. At higher ages a decline in fertility was predicted.

Emigration had become less important in the previous years. Each time less people moved to overseas emigration countries and more and more people were settling in the

Netherlands. They came mainly from Suriname and the Dutch Antilles. Labour immigrants came from Southern-Europe and Turkey (the official recruitment countries). The uncertainty of future developments was considered large and in Forecast 1965 therefore no explicit assumptions were made for migration.

The decline in mortality was again extrapolated logarithmically, now using observations from the years 1951-1955 and 1961-1963. The only exception was made for men between the ages 47 and 71. Mortality had risen for these ages. Because of this, more deaths were excepted than in the pervious forecast.

Forecast 1965 became known for its large error. It was not considered unlikely that the population for the year 2000 would increase to 21 million. No assumptions were made for the years beyond 2000, however, in an evaluation a population of 50 million was not considered impossible for the year 2050. The main causes of error were erroneous assumptions of the fertility component.

Forecast 1967 was a revision of Forecast 1965. The decline in marital fertility made an adjustment necessary. The decline from 1964 to 1965 was the fastest ever observed till then. Current Amsterdam levels (lowest of the Netherlands) were taken as the minimum for the longer term. No changes were made in the assumptions for the other two components (migration and mortality). However, due to a change in the age-structure, the number of deaths would decline slightly.

In Forecast 1970 a methodological change took place. Marital duration specific fertility rates were introduced a shift to a more longitudinal approach. A decline in marital fertility was expected, though there would be a compensating effect because the percentage of persons married would increase. Together with an increase in the number of woman at marital age, this would lead to an increase in the number of births. First signs of postponement were noticed which was reflected in the assumptions.

After 1964, there was a continuation of labour migration. Nevertheless, again no assumptions were made for migration. Some global calculations were made for the years 1970-1975, though. It was assumed that immigration from the Mediterranean countries was only a temporary affair; migrants would return after some years. More attention was paid to migration streams from now onward.

Total mortality was predicted more or less accurately in Forecast 1965. However, age-specific figures corresponded less to ex-ante observations. A new methodology was

introduced for mortality. Four causes of death were distinguished. For each category, the proportional change between 1961-1965 and 1966-1968 in the non-weighted probabilities of death were extrapolated linearly. The sum gave the total age-specific probabilities of dying. These would increase for nearly all ages for men. Woman would see an increase below age 55 and a decrease in mortality above these ages. The total effect would mean a decline in the life expectancy for men (-1.4 on the long-term), while that of woman would increase slightly (+0.3 years). The overall number of deaths would increase.

The lowering of survival probabilities for men resulted in a decline of the forecasted population. More births would not outbalance this but would lead to more people in the younger age groups.

Two years later the number of births again appeared to be forecasted too high. Across all ages and duration of marriage a decline had taken place. It mainly concerned a decline in parity three and higher. The decline in the ultimate number of children seemed to have increased while the postponement in the first years of marriage had continued. Forecast 1972 therefore predicted fewer births.

In Forecast 1972, no changes were made for migration and mortality. These changes meant a decline in the size of the younger age groups and in the total population.

The decline in marital fertility was larger than expected and the number of marriages less than foreseen. Forecast 1975 assumed a continuation of the decline in the percentage of married woman. Contrary to the previous two forecasts, the age of the woman at marriage was no longer included in the forecast model. In its place, birth order was introduced as part of the calculation model. More general assumptions were that there would be a further acceptance of childlessness and of the use of contraceptives. An increase in the mean age at birth was also assumed. On the long-term however, only slightly lower fertility rates were expected. It was further stated that the uncertainty about the future had increased. To express this, only a high and a low scenario were published. The choice of the most likely developments was left to the forecast users.

The ‘Wetenschappelijke Raad voor het Regerings beleid’ (scientific council for government policy) had advised to pay more attention to migration in the next forecast. Beside a scenario without explicit assumptions for migration, two alternative

calculations were made with assumptions about migration. Again no base-line migration forecast was made; only the extremes were given. Assumptions were only made for the first ten years. After the tenth year migration was again set to zero. As a result of this expected downward trend, only a limited total number of immigrants was foreseen. For the first time the possibility was stated that migration could be more permanent than previously expected.

Short-term forecasts of mortality had been quite accurate in the past two forecasts. Only female mortality above age 65 was overestimated. Mortality rates as observed in the period 1971-1974 were applied for the whole forecast period with the only exception of infant mortality and of female mortality above age 55. Linear extrapolation of female rates led to an increase in life expectancy of 0.8 year in Forecast 1975. Life expectancies for men only increased slightly (0.2 year) from the previous forecast.

Table 2 Main indicators population forecast for the year 2000

Forecast	Total population x1000	TFR	births	net-migration	life expectancies		Deaths
					males	females	
1965	20977	.	.	0	.	.	.
1967	17895	.	*335200**	0	.	.	*142700**
1970	17058	.	*293300**	0	*69.5**	*76.6**	*161500**
1972	15727	.	217150	0	69.5	76.6	162700
1975	15099	1.66	168200	0	71.4	77.8	159950
1980	15643	1.75	189166	6000	73.3	79.5	154141
1984	15147	1.50	164138	0	74.5	81.5	143825
1985	15213	1.50	166050	0	74.5	81.0	144769
1986	15588	1.65	184794	9000	74.5	80.5	146140
1987	15718	1.65	191415	20000	74.5	80.5	146332
1988	15717	1.65	191983	20000	74.8	81.3	142658
1989	15696	1.65	192995	20000	74.8	81.3	142606
1990	15860	1.65	195403	25000	74.8	81.2	142754
1991	16015	1.73	206971	25000	74.8	81.2	142902
1992	16007	1.73	207614	25000	75.4	81.0	139774
1993	16079	1.73	209325	41000	75.4	81.0	139876
1994	15983	1.72	206866	36000	75.4	81.0	139426
1995	15881	1.72	205343	35765	75.4	81.0	139355
1996	15801	1.56	187983	33773	75.3	80.6	141176
1997	15832	1.59	192153	33773	75.3	80.6	141126
1998	15848	1.64	197836	37945	75.3	80.6	141234
1999	15862	1.64	198243	45171	75.3	80.6	140979
2000	15864	1.72	206598	52206	75.3	80.6	140991

* 1999

As no base-line scenario was given, the average between the high and low will be used in the evaluation. Unpublished data on migration unto 2010 are used in the comparison of the population and age structure. Compared to the pervious forecast, all changes in the demographic components combined would mean a lowering of the forecasted population for the middle and long-term. Remarkable is also that for the first time an ultimate decline of the population was forecasted. The turning point would be 2003 (see *Table 3*).

2.2.-The Eighties

Forecast 1980 had some changes. The marital duration specific approach was dropped and for the first time migration became an integrated part of the forecast. Forecasts were also made by marital status.

An expected increase of extra-marital births and childless cohabitation reflected the new ideas about marriage no longer being the sole institution for family formation. The Dutch Fertility Survey (‘Onderzoek Gezindsvorming’) provided information about the expected number of children. The end result of a thorough analysis of observed trends in fertility and attitudes was that the total fertility rates were adjusted upwardly.

The uncertainty surrounding future paths of migration was expressed by a large margin between the high and the low scenario of the migration forecast. Migrant streams were divided into groups on the basis of their juridical status, sensibility to change in government policy, stability of past developments and the availability of data. Migration experts were consulted to support the assumptions. It was assumed that the Netherlands was an immigration country and that it would remain being so. Restrictive government policies were seen as the main check on migration. Migration from Surinam and the Dutch Antilles was assumed to be temporary and in the longer run it would be replaced by labour migration from the Mediterranean recruitment countries. Furthermore, migration related to family formation was expected to end before 1990 and marital migration would increase up till 1985.

Mortality assumptions were only made for the period 1980-1990. Mortality rates were kept constant for the years after 1990.

Negative influences on life expectancy, caused mainly by social-economic and cultural-technological developments, would not outpace the effects of medical improvements,

better hygiene and feeding practices, and preventive medical health care. Mortality rates would decline slightly, and sex differentials would decrease somewhat. First, life expectancies were fixed for 1990 after which mortality rates were deduced from interpolated figures.

The changes to the previous forecast of a little bit more births, net immigration (instead of zero), and slightly lower mortality, would result in a larger population size.

A few years later it appeared that Forecast 1980 took far less account of postponement of births. Fertility rates were taken too high for young woman. In Forecast 1984 expected total fertility rates were lowered from 1.75 to 1.50 children per woman. Continuing emancipation and change of economic value of children would lead to a preference for fewer children. Childlessness was also expected to increase. As the makers were less sure about the path of fertility, they increased the margin between the high and the low scenario. Because it was felt that the relation between marriage and childbirth would become less strict, the distinction between marital and non-marital fertility was dropped.

For the migration component, predicted net-migration was lowered from six thousand in the previous to three thousand per year in Forecast 1984. For the first time the administrative corrections were also forecasted. These are mainly corrections for emigration; migrants that did not gave notice to the municipal population registration about their departure. In later forecasts administrative corrections were included in migration. As these corrections were forecasted to be the same in size as the net-migration, the expected inflow of people was therefor zero.

Extensive research also led to a change in mortality assumptions. Improvements across all ages were expected for both sexes. In contrary to the previous forecast, no decline in the difference between male and female life expectancy at birth was predicted. Medical developments, more security, further improvements in preventive healthcare and more free time would improve survival chances. Negative effects would come from environmental pollution, unemployment, individualisation, and stress. After fixing life expectancies for 1995, age-specific mortality rates were deduced. Because it was considered to be impossible to make assumptions for the longer run, rates were kept constant for the years after 1995.

The changes would mean less population growth. Fore example, for the year 2000 the forecasted total population was nearly half a million lower than in the previous forecast. The year in which the population would start to decline changed to 2008 (from 2003).

Because of an increased demand for recent population projections it was decided to launch a new forecast every year. The main changes in Forecast 1985 were a slight increase in the median age at childbirth and an increase of female life expectancy.

For the short-term more migrants were expected. On the longer term however, the increase would be balanced by a similar increase in predicted administrative corrections.

The total population would increase more because of these changes than as predicted in Forecast 1984. Population decline was now expected to start in 2004, four years earlier than in the previous forecast (*Table 3*).

The last two forecasts had not assumed enough children for woman at higher ages. Total fertility rates were therefore increased from 1.50 to 1.65 in Forecast 1986. The decline in fertility levels at younger ages was maintained.

In Forecast 1986 it was explicitly stated that the Netherlands was, and would remain so for the time being, an immigration country. For the longer-term the number of migrants was fixed at nine thousand (including administrative corrections).

For mortality, a high and a low forecast were added, life expectancies at birth deviated from the base-line scenario with 0.5 years in the final year. Long-term female life expectancies were lowered with 0.5 years. No changes were made for males.

Again the forecast of the total population was adjusted upwardly. Larger younger age groups because of more births, and less at higher ages because of less old-aged woman, made some changes to the age structure.

Short-term fertility forecasts were lowered slightly in Forecast 1987. The main change from the previous forecast was an increase of the expected net-migration. Long-term forecasts were now set at 20 thousand. This was, still a decline in comparison to observations of the previous years. The mortality forecast saw no change.

These changes would lead to a slightly different age-structure and to a higher total population. The year in which the population would start to decline was put three years further into the future, from 2007 to 2010.

In Forecast 1988, again only small downward adjustments were made for the short-term fertility. Short-term migration was set a bit higher.

Observed mortality was again lower than previously forecasted. The relative high mortality registered in 1985 and 1986 was caused by the extreme cold winters. Life expectancies at birth were increased with 0.5 years for men and 1.0 years for women. Increased uncertainty was expressed in larger margins in the low and high scenarios. The number of forecasted deaths had never been as low as in Forecast 1988.

Changes in size and age-structure of the population were very small.

In Forecast 1989, for the third year in a row, short-term fertility forecasts were lowered slightly. The average age of mother at childbirth was increased.

The number of net-migrants was increased slightly for the short-term, but remained unchanged for the middle and longer-term. Administrative corrections are now included in the migration assumptions and are no longer forecasted separately. To express the increased uncertainty of the forecasters, the margins between high and low forecast were made larger.

Mortality assumptions only changed for the short-term for females.

As with the previous forecast, changes in the age-breakdown and size of the total population would be small.

Table 3 Forecast year with highest population size

Forecast	maximum mln	Year	Forecast	maximum mln	year
1950	13.0	*1980*	1988	16.2	2010
1951	12.2	*1981*	1989	16.2	2010
1959	14.6	*1981*	1990	16.5	2023
1965	21.0	*2000*	1991	17.1	2030
1967	17.9	*2000*	1992	17.3	2031
1970	17.1	*2000*	1993	17.7	2033
1972	15.7	*2000*	1994	17.6	2033
1975	15.1	2003	1995	17.4	2033
1980	15.8	2008	1996	17.2	2034
1984	15.2	2004	1997	16.1	2003
1985	15.3	2004	1998	17.4	2036
1986	15.8	2007	1999	16.3	2004
1987	16.1	2010	2000	18.1	2040

2.3.- The Nineties

After lowering short-term assumptions in the previous three forecasts, Forecast 1990 saw an increase in the short-term fertility expectations.

Observed net-(im)migration had been higher than forecasted earlier. Assumptions were subsequently adjusted. In the preparation of Forecast 1990, more attention was given to time-series analysis in order to support qualitative assumptions. The Schengen Agreement and the asylum treaty were signed. It was thought that the number of asylum seekers would be stable. For the first time the presence of illegal immigrants was mentioned. With the increase of the Turkish and Moroccan population at marital ages, an increase in family formative migration was expected. Remigration was perceived as a minor phenomenon.

It was thought that the fluctuations in mortality at the end of the 1980s were caused by flue epidemics. Therefore, no changes were made for the mortality component in Forecast 1990.

The total population would increase because of higher net-migration. The peak of the total population would now be reached in 2023, thirteen years later than in the previous forecast. Higher age groups would be least effected by these changes.

For the first time since Forecast 1986, long-term fertility assumptions were put higher in Forecast 1991. More children per woman and less childlessness would lead to more births. The number of births would further increase because of higher assumed migration levels for the short-term.

Only short-term migration forecasts were changed in Forecast 1991. Again assumptions were formulated for the various sub-categories. Immigration and emigration with other countries of the European Union was suppose to increase, however, net-migration levels would hardly be affected. Labour migration from eastern-European countries was not expected to be of much importance. Migration resulting from family reunification was assumed to continue its decline, while family formative migration would increase for the short-term (though it would decline on the long-term). Although the number of asylum seekers would increase, more restrictive government police would lead to less permanent settlement. Preliminary figures for 1991 showed the highest increase in the number of immigrants since 1975. These observations were included in the short-term migration forecast.

As in the previous forecast, no changes were made in the mortality forecast.

The young age groups would be larger than in the previous forecast (more births). Working-age age groups were predicted to increase more because of higher net-migration. Again the year in which the population would start to decline was put further away in the future: 2030.

In Forecast 1992, only minor changes were made in the short-term assumptions of fertility.

Because the influx of migrants in the second half of 1991 declined, and continued to decline in the first observations for 1992, the forecast was lowered. The uncertainty about the outcome increased however; margins between the low and high variant were higher. The largest part of the Yugoslavian refugees was not registered as immigration (´ontheemdenstatus´).

Life expectancies at birth for males were increased with one year for the long-term. Most gain was reached between ages 50 and 70. Females did not show the same progression and did worse than forecasted earlier. Their expectancies were therefore lowered for the short-term. The loss for females would not offset the gain of males and the total number of deaths would decline.

These adjustments would lead to changes in the age and sex structure of the population. On the short-term the total population would be slightly lower than previously forecasted. On the long-term, however, there would be some increase.

Again, only small adjustments to fertility assumptions for the short-term were made in the next forecast. Changes in the migration forecast for the short-term would lead to more life births.

Forecast 1993 saw again an upward adjustment. This time also long-term assumptions were increased. Current levels would continue until 2010. Compared to the previous forecast this would mean more than 200 thousand extra migrants until the year 2010. For the longer-term migration levels would still decline, however, less than in previous forecasts was assumed. A small shift, from a decrease in immigration from Turkey and Morocco to an increase in immigration from countries of the European Union, was foreseen.

No changes were made to the mortality assumptions, though the number of deaths increased because of a larger inflow of migrants.

With 17.7 million, the maximum population size would be reached in 2033. Compared to the previous forecast, short-term increases were small but over time the differences would increase (to 625 thousand in 2050).

Forecast 1994, for the third time in a row, saw no real changes in the predictions of the fertility component.

First observations suggested that immigration would be far lower than assumed in the last forecast. This was mainly because of delayed mobility of asylum seekers from refugee centres to ordinary homes. Only in the last case they would be inscribed in the population registers. Forecast 1994 thus had lower short-term migration levels than the previous.

Again the mortality observations were in line with the forecast and except for the first year, no adjustments were made.

The changes for the first years would only lead to minor changes in population structure and size.

In Forecast 1995, no further decline of fertility at younger ages was assumed. Postponement would however lead to an increase of fertility at higher ages. This small increase in fertility would be offset by an increase in childlessness. The total effect would be a small decline in fertility.

Economic trends were considered to influence decisions on fertility and ideas about future economic changes were subsequently used in the projections. No further decline of fertility at younger ages and but a continuing fertility increase at higher ages was put in the forecast model.

It turned out that the decline in the number of migrants was under-estimated. It seemed difficult to predict the number of asylum seekers that would ultimately be inscribed in the population registers. Government policy had also been tightened and short-term migration forecasts were adjusted. Long-term assumptions remained unchanged.

For the third forecast in a row, no changes were made to mortality assumptions. Indirect effects (less births and immigrants) slightly lowered the number of deaths.

Less inflow at age zero because of a little bit less children and less net-migration on the short-term would slightly affect the age-structure. The maximum population size was lowered slightly as well, though the year in which the decline would start remained 2033.

An increase in childlessness is the main change in Forecast 1996. Although, forecasted long-term fertility levels were lowered accordingly, an future increase in the total fertility rate was still foreseen. Larger margins between the high and the low scenario depict the increase in uncertainty about the future.

The decline in migration appeared to have stalled. Only small adjustments were made for the short-term.

Concerning the main indicators, assumptions have always been made onto a certain limit-year (in the last forecast 2010) For later years the assumptions were kept constant. From Forecast 1996 onward, explicit assumptions are made for all years. Beside these methodological changes, changes were also made to the assumptions. Male life-expectancies were lowered for the short-term. However, now that explicit assumptions were made for the whole forecast period, life-expectancies for the long-term were increased with four years to 80 years. Female life-expectancies at birth were now incremented with 1.5 years to 83.0 years. It was the first time since Forecast 1988 that changes where made assumptions on female mortality for the long-term. Margins between the high and low scenario were increased to express the higher uncertainty.

Forecast 1997 is a short-term forecast only. The forecasted number of births increased. No changes were made for the migration and mortality component.

With the introduction of stochastic forecasting, a new methodology was introduced with Forecast 1998. Instead of high and low scenarios representing the uncertainty and boundaries of possible outcomes (with a certain subjective probability), now an error density has to indicate the uncertainty of the forecast. Error functions are based on observed deviation and on subjective functions.

In Forecast 1998 long-term fertility levels remained unchanged but it was expected that these levels would be reached earlier than assumed before. After earlier upward adjustments, childlessness was readjusted to lower levels for the long-term. Less third and higher births would counterbalance the change.

Increased migration would also increase the number of births in later years.

For the migration component, emigration probabilities were introduced (instead of number of emigrants). A distinction is made across age, sex and country of birth. In the model, immigration effects emigration in later years. Those born outside the Netherlands have higher probabilities of emigration. Further, older immigrants have higher probabilities of emigration than younger. The distinction between non-nationals and nationals was dropped. Because assumptions on emigration probabilities are specified according to the country of birth of the individual and not of his parents, it was implicitly assumed that second-generation immigrants (born in the Netherlands but one or more parents born outside) show the same tendencies as the non-migrant population. These changes lead to an increase in net-migration on the short-term. In contrary, long-term forecasts were lower than the previous five forecasts. The later was because of an increase in the number of emigrants. The emigration probabilities would decline, but because of a larger stock of foreign-born population, the number of emigrants would increase.

Mortality assumptions were the same as in the previous two forecast (only the first year was adjusted).

After four times in a row a decline (if we do not count the short-term forecast of 1997), the effect of the changes in the components now meant an increase in the predicted maximum population size. The maximum size of 17.4 million would be reached in the year 2036, a few years later than predicted in the previous (long-term) forecast.

Again higher fertility levels were assumed in Forecast 1999 for the short-term. Small changes were also made for emigration probabilities and for the number of immigrants.

The mortality component only changed for the first forecast year.

Because the number of woman that ultimately would have two children increased in Forecast 2000 (and the number with only one child decreased), the number of births would increase again.

Again short-term adjustments more in line with recent trends were made. The long-term forecast of the net-migration was increased, though not to the levels of the forecasts from the mid-90s.

Assumptions for the short and middle-term changed slightly. For both males as females the life-expectancy at birth was increased. Long-term expectancies for males, however, were lowered with 0.5 year. For the first time a trend-model was used describing the

mortality trends since 1900. Influences from smoking behaviour and other life-style effects were taken into account (Van Hoorn & De Beer, 2001).

Since Forecast 1965, Forecast 2000 forecasted the highest maximum population. The population would grow to 18.1 million in 2040 before declining to 18.0 in 2050. This is more than 750 thousand more than in the previous forecast but still about 3 million below the maximum of Forecast 1965.

Above, twenty-six forecasts have been described into more detail. This has been done mainly in relation to the changes made in comparison to the previous forecast. An overview of the changes made to the forecast in relation to the previous forecast can be found in *Table 4*.

Table 4 Main changes from previous population forecast

forecast	short-term (0-4 years after start)				middle-term (5-14 years after start			
	Births	migration	deaths	total	births	migration	deaths	total
1951	+ + +	* (- - -)	*	+ +	+ + +	* (- - -)	+	+ + +
1959	*	* (+ + +)	+ + +	-	*	* (+ + +)	+ + +	+
1965	+ + +	* (+ +)	- -	+ +	+ + +	* (+ +)	- - -	+ + +
1967	- - -	*	+	- - -	- - -	*	+	- - -
1970	+	*	- -	+	*	*	- - -	*
1972	- - -	*	*	- -	- - -	*	*	- - -
1975	- - -	* (+ + +)	+	*	- - -	* (+ +)	+	- - -
1980	+	+	+ +	+ + +	+	+	+ +	+ + +
1984	- - -	-	+	- - -	- - -	-	+ +	- - -
1985	+	+	-	+	+	*	-	+
1986	+ +	+ +	-	+	+ + +	+ +	-	+ + +
1987	-	+	+	+	+	+ +	*	+ +
1988	-	*	+	*	*	*	+	*
1989	-	+	*	*	*	*	*	-
1990	+	+ +	*	+ +	+	+	*	+ + +
1991	*	+ +	*	+	+ +	+	*	+ + +
1992	*	-	*	*	*	*	+	*
1993	*	+	*	*	*	+ +	*	+ +
1994	*	- -	*	-	-	-	*	- -
1995	-	- -	*	- -	*	*	*	- -
1996	- -	-	-	-	- -	*	*	- - -
1997	+	*	*	+	*	*	*	*
1998	+	+	*	+	+	*	*	+ +
1999	*	+	*	+	*	*	*	*
2000	+	+	+	+	+ +	+	+	+ + +
	>10%	>25000	>10%	>1%	>10%	>25000	>10%	>1%
+ + / - -	5 – 10%	10-25000	5 - 10%	0,5 - 1%	5 - 10%	10-25000	5 - 10%	0,5 - 1%
+ / -	1 – 5%	1-10000	1 - 5%	0,1 - 0,5%	1 - 5%	1-10000	1 - 5%	0,1 - 0,5%
*	< 1%	<1000	< 1%	< 0,1%	< 1%	<1000	< 1%	< 0,1%

In brackets () the variants with non-zero migration assumption

3.- Forecast Methods

In this chapter we will first discuss the assumption levels that can be distinguished. Next, a short overview of the methodological changes is given (a review of information also hidden in chapter two). The third section is about the commissions of experts that are involved in the making of the forecasts. Finally, the variable levels chosen for further analysis are being discussed.

3.1.- Assumption Levels

We can distinguish three assumption levels (CBS 1984). These are: detailed assumptions (model parameters like age-specific mortality rates), main assumptions (such as life-expectancy at birth or total fertility rates), and general hypotheses (for example, expectations about changes in family formation, life extending techniques, government policy). For each demographic component in the forecast model assumptions can be made at the three levels. General hypotheses give a general insight in the expected developments in the demographic components. They function as the overall framework for the expected trends.

Next, for the long-term values for the main assumptions are chosen. In general this are total fertility rates for fertility, net-migration levels for migration, and life-expectancies at birth for both sexes for the mortality component. Additional indicators can be chosen for these components (like mean-age at first birth) or other components can be added (like marital status and the percentage of extra-marital birth). With assumptions for the short and middle term, observations are being extrapolated towards and connected to the main assumptions for the long-term.

3.2.- Methodological Changes

For each component we see more or less gradual changes in methodology. From marital-fertility rates, followed by fertility rates according to duration of marriage, to parity and age-specific fertility rates. Other changes were from a more period approach towards a cohort approach. From Forecast 1980 onward, results from the Dutch family

and fertility survey (‘Onderzoek Gezinsvorming’) are used to support the assumption making. General hypotheses became especially important after 1975.

Migration has often been left out of the forecast. Only since Forecast 1980 migration became an integral part of the forecast. Before only some calculations with the effect of migration were done. Implicitly these forecast without migration assumed zero net-migration. In contrary to fertility and mortality, the population at risk is difficult to define for immigration. The population of the countries from which the migrants move to the Netherlands could be defined as the population at risk, but this is not a workable concept. In practice, main assumptions are formulated for the number of net-migrants. The population at risk for emigrants is better to define. Since Forecast 1998 emigration probabilities are used. Another characteristic of migration is that, unlike birth and death, it is a reversible and repeatable process. The number of sub-divisions into countries of origin and destination and into migration motive also changed over time. First, national and non-nationals were distinguished. As the Netherlands moved from an emigration to an immigration country, destinations like North-America and Australia changed into countries of origin like Morocco and Turkey. At the end of the 1980s the influence of asylum seekers increases and subsequently more attention is given to these groups.

The so called Administrative Corrections are corrections on the population registration made by the municipality offices. In general these relate to persons that have left the municipality (and country) but have not de-registered from the municipality records. At first they were treated and forecasted separately, but since Forecast 1989 they are included in the migration assumptions.

Because male and female mortality rates are rather different, mortality is distinguished by sex. Assumptions about increasing or decreasing differences between the sexes are often made in the forecasts.

First only simple (logarithmic) extrapolations were made for the short-term. For the long-term mortality rates were kept constant. The period for which explicit assumptions were made increased step by step, but only from Forecast 1996 onward assumptions were made for the whole forecast period (instead of keeping them constant for example after the year 2010). In Forecast 1970, mortality causes of death were included in the forecast model. As it did not give the expected improvement they were dropped in the next forecasts. They are studied, however, in order to formulate general assumptions

about mortality. Smoking behaviour was found to be one of the strongest factors linked to the level and change of mortality and it could explain a large part of the difference between males and females.

3.3.- Advice Group

In making the forecasts, the statistical office is advised by external experts. In 1967 the first working-group on population forecasting methodology was formed with members of the Dutch planning agencies and of academic institutes. The main expert-group is the Commission of Advice for Population forecasts ("Commissie van Advies voor de Bevolkingsprognose") which was installed in 1975 by the Central Commission for Statistics ("Centrale Commissie voor de Statistiek", CCS). Various ministries and planning agencies are represented in this commission. Experts in the field of fertility, mortality, migration, and household demography resort under the auspices of this working-group. Next to these experts-groups, the appraisal of acknowledged experts is used on a more ad-hoc basis. For example, the introduction of the chort-approach in 1970 was stimulated by a working-group. Another example was that as a result of a note of advice by the Scientific Council for Government Policy ("Wetenschapelijke Raad voor het Regeringsbeleid") and further stimulated by the OECD and the EEC, more attention was given to migration. International consultation between forecasters is co-ordinated by Eurostat.

3.4.- Variable levels

Main assumptions on future developments of fertility are generally formulated on the level of the total fertility rates. However, what we want to predict is the total number of births. These form the natural inflow of the population and therefore determine the error in the forecast of the population caused by the fertility component. Because of this the concentration in the qualitative comparison will be on number of births. A more result oriented approach therefore. Another reason for not focusing on fertility rates is that these are not published is that for all forecasts.

If explicit assumptions on migration were made, it was in terms of total numbers. These subsequently had to be divided across age and sex. Only recently other methods were introduced. In the next chapter net-migration will therefore be used to evaluated the

error in the migration assumptions. The accuracy of the various sub-groups (country of origin and/or by reason) of migrants will not be discussed.

In line with fertility and migration, the errors in number of deaths will mainly be used in the evaluation of the mortality component. They determine the natural ‘outflow’ of the population. Like total fertility rates, life-expectancies at births (by sex) are not always available.

A clear relation exists between changes in the total fertility rate and number of life births. If the female population by age does not change, a percentage change in fertility rates will lead to an equal change in the number of life births. This does not mean that a one-to-one relation exists between the error in the number of births and the total fertility rate. Because the age groups are not equal in size, age-specific fertility rates are multiplied by the number of woman in those age groups. This means that forecast errors in the various age-specific rates can have a different effect on the number of births. The other way around, forecast errors in the number of woman by age caused by errors in the forecast of migration and mortality or as a result of echo-effects (births by mothers that were earlier forecasted as births) can lead to a discrepancy in the errors of rates compared to numbers of births.

Main assumptions on migration have mainly been made on the number of net-migrants. No other main-indicator has been used and using net-migration to evaluate the forecast error seems a logic choice. Indirect effects of the other demographic components are less strong (more births could lead to more emigrants for example). More immigrants could lead to more emigrants because.

For mortality, main assumptions are formulated in terms of life-expectancies at birth. Mutations on the population structure, however, are in number of deaths (by age). Unlike with fertility, no direct relation exists between life-expectancies and number of deaths. As reasoned with fertility, we will mainly look at the error in the number of deaths and less to life-expectancies. Changes in the age-structure will again influence the number of deaths (but not the life-expectancies). Indirect effects of errors in births, and especially, migrants will influence the error in deaths. This does not have to increase the error, because of balancing effects, the relative errors in the number of deaths can be smaller than the relative errors in the life-expectancies.

With births the error is concentrated in the age group zero. From year to year this groups, and the error it causes in the age-structure, moves up in the age-pyramid. The error in the number of migrants is spread across the age groups and will lead to less abrupt errors in the age-structure than births. Deaths also take place across all ages but the effect of the errors will be largest for the oldest age groups.

4.- Forecast errors

Various error measures can be used to evaluate the forecast to ex-post observations. They each measure (slightly) different things. Here error measures are used that give a direct and imaginable indication of the error. More complex indicators or simple but difficult to visualise indicators are not used as these give similar results but make interpretation less easy. In the text only graphs are used, tables with the data behind the graphs and more detailed information can be find in Appendices. Furthermore, indicators are used that can be accumulated across calendar or forecast time or across components in order to prevent from having to use too many graphs.

For the evaluation of births and deaths the same indicators are used, because of the different nature of net-migration slightly different error measures are used. The part discussing the population structure and the contribution of the different indicators have for similar reasons, and in order to present the graphs more concisely other (similar) indicators. Definitions of the error measures and the motivations for using them can be found in the subsequent chapters.

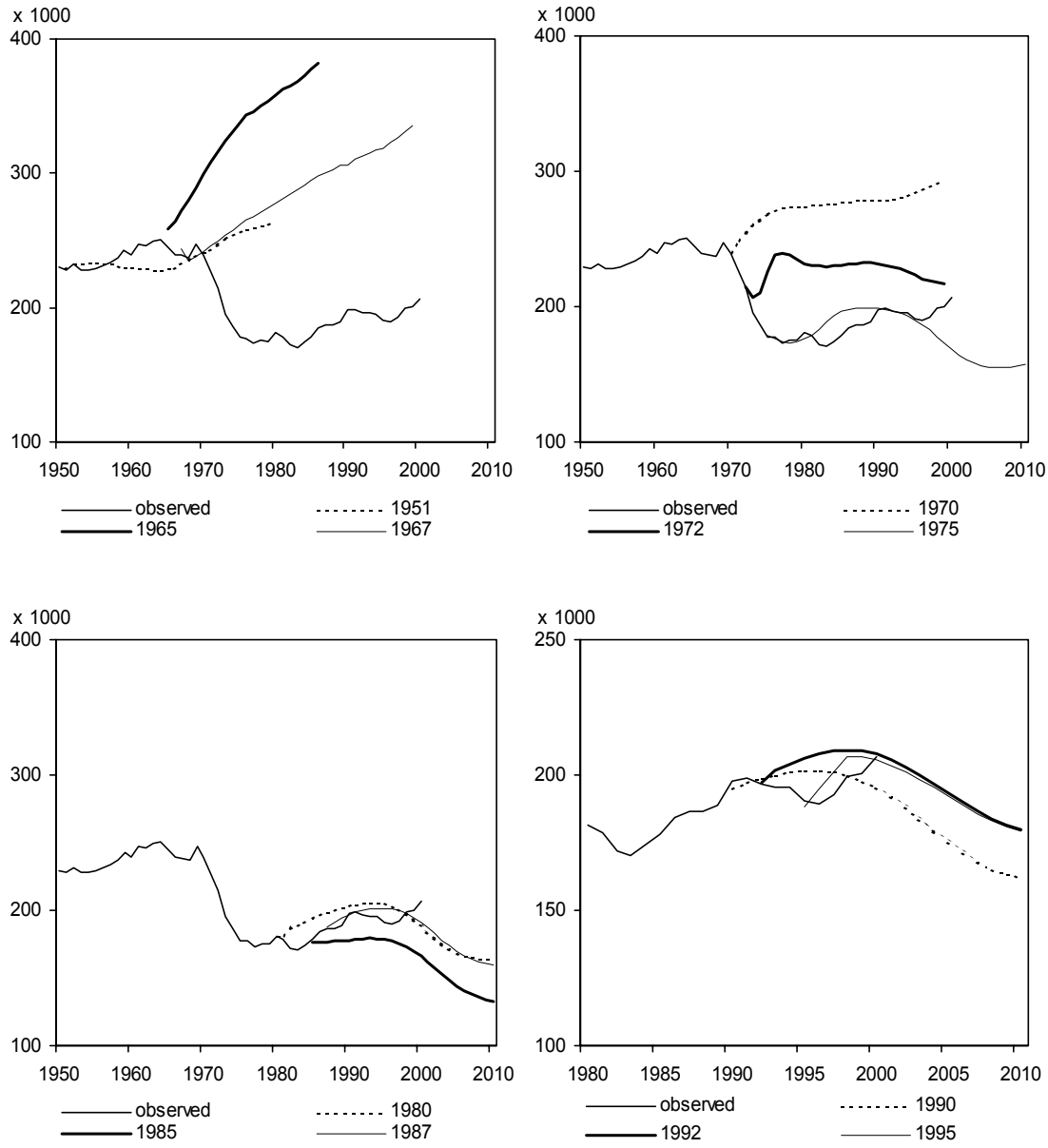
The forecasts are mainly evaluated in terms of forecast time. This we define as the time that passed since the start year of the forecast. In case of Forecast 1950, the forecast time of 0-4 years refers to the yearly forecast error for the calendar period 1950 to 1954 and in case of Forecast 1970 it refers to the calendar period 1970 to 1974. Less attention will be given to the comparison of different forecast for the same calendar period.

4.1.- Births

The Dutch population forecasts predict between twenty and fifty years ahead. End values of the total fertility rate give the long-term expectations (see *Table 1*). The highest assumptions were those of forecast 1965, which forecasted an average of more than three children per women. Downward adjustments were made in subsequent

forecasts. The lowest predictions were in Forecast 1984 and 1985 with only 1.50 children per woman. Thereafter, long-term forecast increase the value to 1.65 and 1.80 in the mid-nineties after which they are again lowered for some years in order to rise again in Forecast 2000 to 1.75 (note that Forecast 1997 and 1999 are short-term forecasts only). In *Table 2*, the forecasts for the year 2000 are given for the various forecasts. The observed total fertility rate became ultimately 1.72 children per woman (206 619 live births).

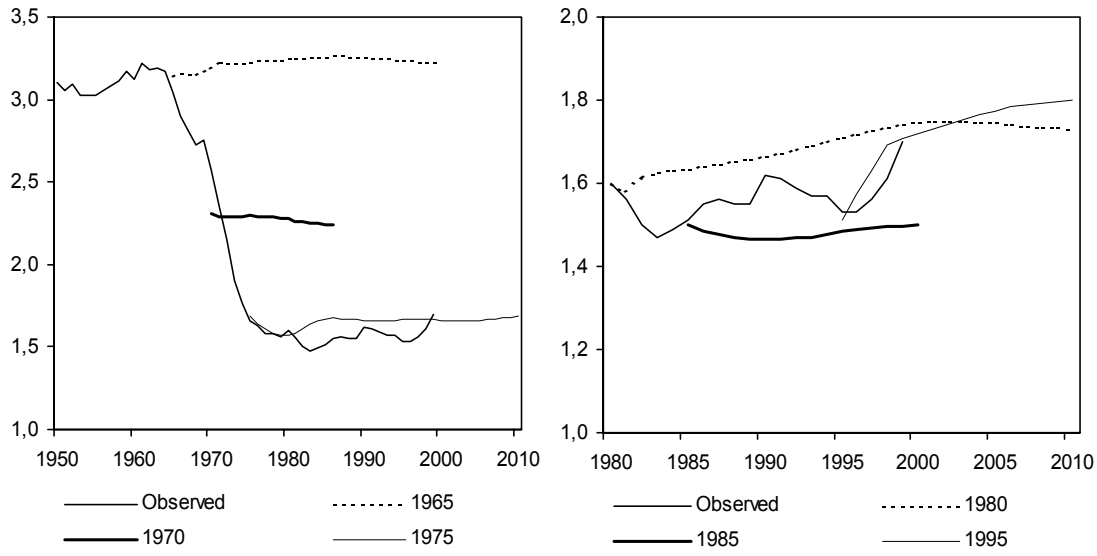
Graph 1 Live births: observed and forecasted



Graphs 1 give the absolute number of births as observed and as projected. Forecasts that are not given show similar levels and patterns as others that are listed (Forecast 1959 is

the same as Forecast 1951; Forecast 1984 similar to Forecast 1985; Forecast 1986 as Forecast 1987, Forecast 1988 and 1989 as Forecast 1987 and as Forecast 1990; Forecast 1991, 1993 and 1994 are nearly the same as Forecast 1992 and 1995). The error of the forecast compared to the ex-post observed values of the total fertility rate can be seen in *Graph 2*. Because the age-structure does not has an influence, patterns are in general more smooth than with numbers of births. The fact that because of the inflow of large cohorts in the fertile age groups the number of births can increase despite a lowering of fertility rates is exemplified by comparing number of births and total fertility rates of Forecast 1965 and Forecast 1970.

Graph 2 Total fertility rate: observed and forecasted



Various error measures exist to express the differences between observed and forecasted data. For the error in the number of births, in *Graph 3*, the mean absolute percentage error was chosen. By using the absolute error, over and under-estimations are not compensating each other. If percentage errors are taken, the errors between numbers of births and total fertility rates can be compared. Furthermore, periods with a relative high number of births are better comparable with periods with a low number of births. By relating the error to the observed number of births, a direct imaginable indication of the error, i.e. the percentage yearly deviation from the observed number of births in a given period.

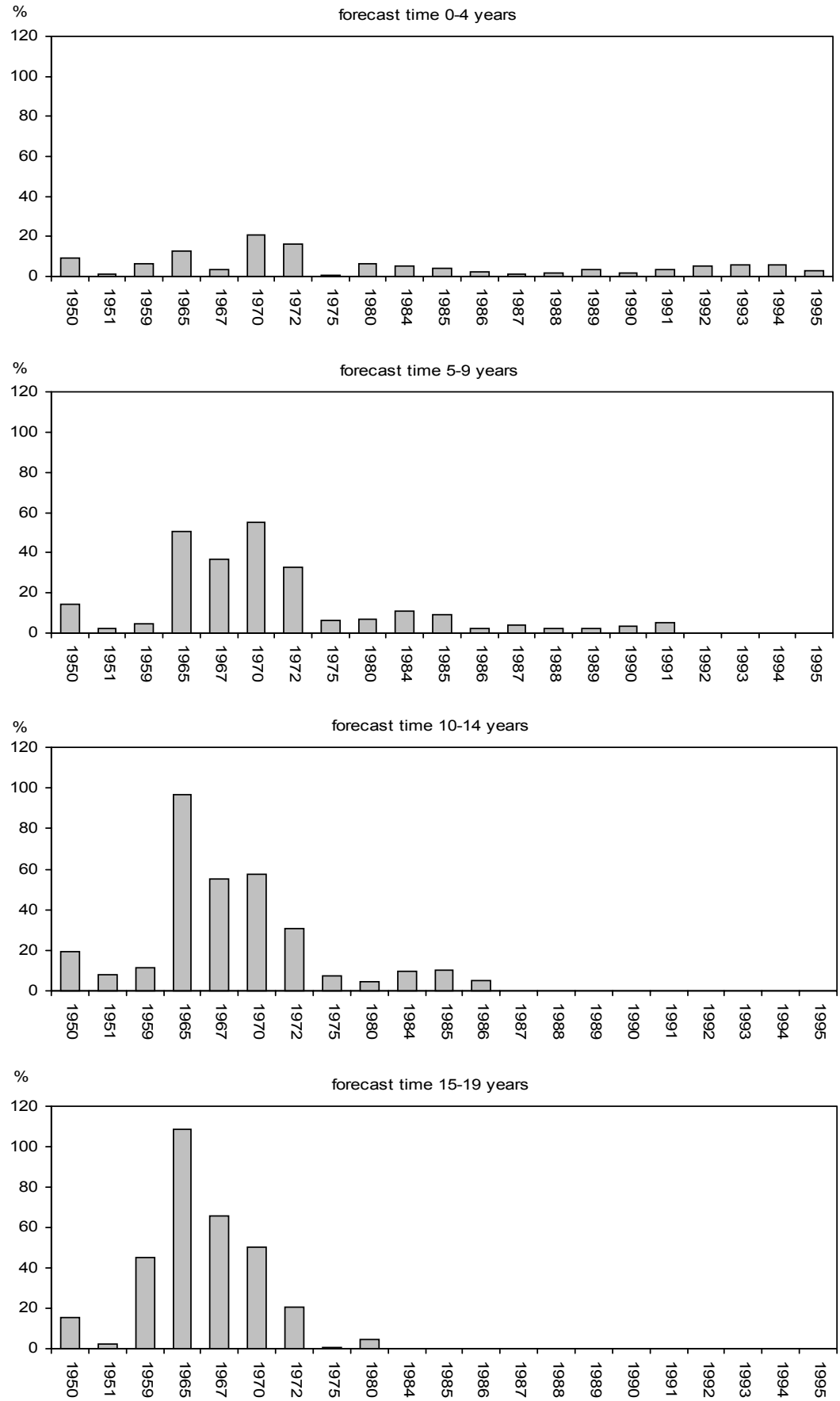
Graph 3 gave the mean absolute percentage error (MAPE) for the first twenty years after the start of the forecast in periods of five years. In general, the errors increase for a

certain forecast if the forecast time increases, this is not a rule, however. The increase in the error decreases for the forecast for which the evaluation period was long enough. Compared to the error in first four years after the start of the forecast, the error increases to the forecast time of 5-9 with an average factor of 2.8 and in the forecast time of 10-14 it increased with a factor of 1.5 compared to 5-9 years after the forecast start (refer to *Appendix C* for more MAPEs). The average error 15-19 years was only 1.1 times larger than the forecast time of 10-14. The differences between observed and forecasted values vary from a few percent till way over ten percent.

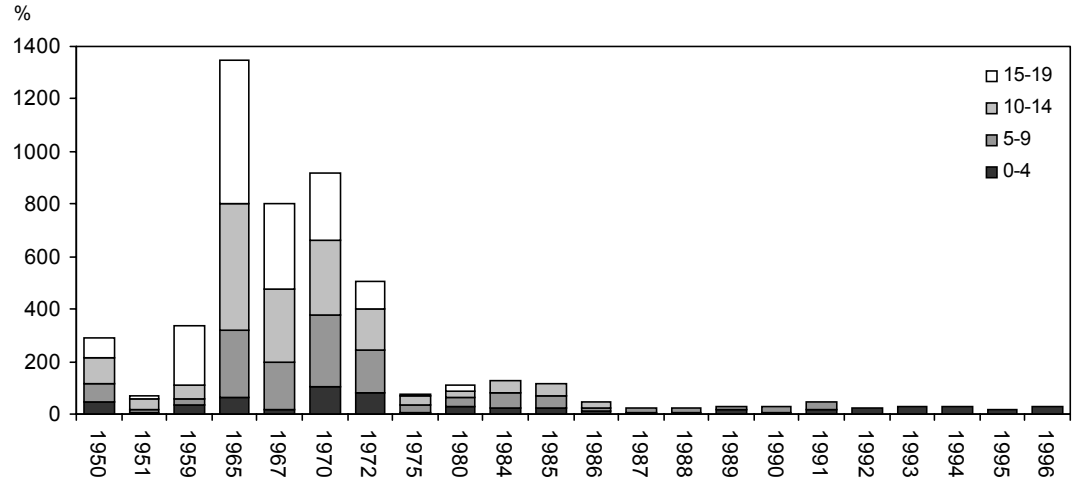
The largest errors are shown for forecasts that were made before or at the beginning of the sudden decline in fertility in the end of the sixties. Errors in the number of births can amount to more than 50% per year (*Graph 3* and *Table A1* in Appendix C). Forecast 1965 even shows an error in the forecast time of fifteen to nineteen years of over 100%. Forecast 1967 and 1970 are other forecasts that give bad results for the first twenty years after the start of the forecast. The forecasts that made predictions for the years before the fertility decline show errors for these years comparable to those made in forecast made in the relative stable period after the end of the decline. Forecasts 1951 and 1975 are examples and give best results.

Because the mean absolute percentage error as shown in *Graph 3* is an average, it can not be cumulated across forecast time. The absolute percentage error can be accumulated. *Graph 4* gives an overview of the error per period of five years in forecast time. Forecasts 1951, 1967, and 1972 were revisions of earlier forecasts and made because observations deviated, according to the forecast makers, too much from observed values. The revisions turned indeed out to be improvements. Forecast 1951 and 1975 give very good results. The error in the first twenty years of Forecast 1951 refers to the period until the beginning of the fertility change from relative high to low fertility. Forecast 1975 is the forecast with the starting point in the period that starts in the first years of the stable period with relative low fertility. Forecast made in the 80s and 90s can only be evaluated for the first five or ten years of the forecast time. Compared to the forecast with start years in the end of the 80s, the forecast in the first half of the 90s do not seem to be improvements.

Graph 3 Births: mean absolute percentage error of forecast

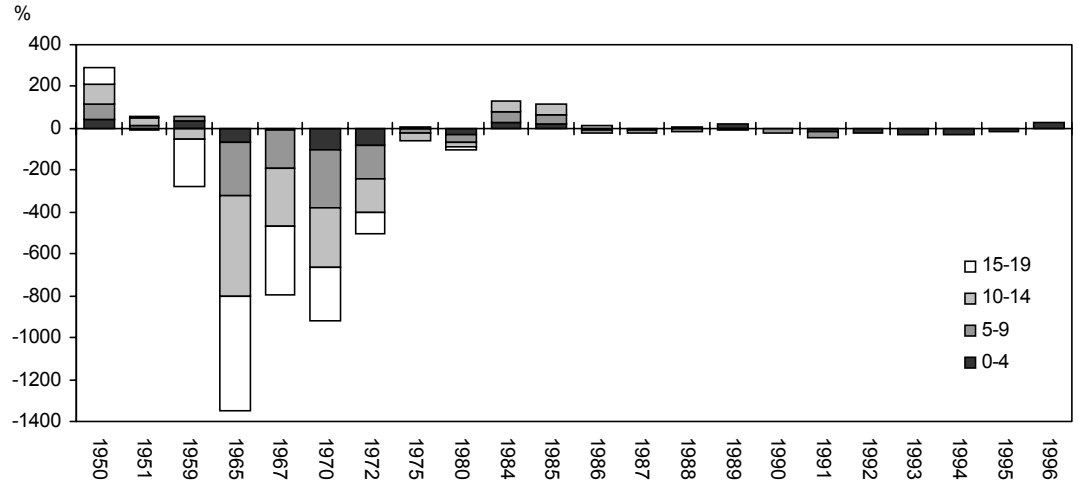


Graph 4 Births: absolute forecast error in forecast time



By taking the percentage error absolute, the direction of the error (under or over-estimation) is not visible anymore. *Graph 5* shows the percentage error. These indicators do give the direction of the error, though within a period of five years positive and negative errors are compensated. If not fluctuations from year to year but the average forecast error for a period are more important, this measure is better used for evaluation.

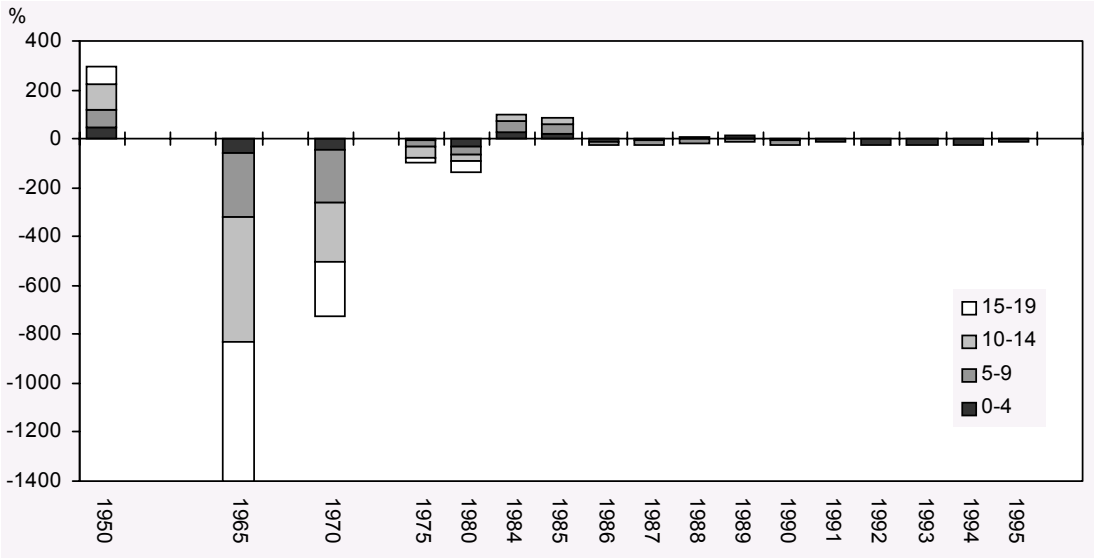
Graph 5 births: percentage forecast error in forecast time



Forecast 1975 seems to have been even more in accordance with observations than with the pervious measures. Forecasts from the end of the 80s and the beginning of the 90s give a better outcome according to this indicator. In general however, differences are

small. Over estimation of the number of births is most common (negative values). The six forecast following Forecast 1990 for example, all have over estimated the number of births.

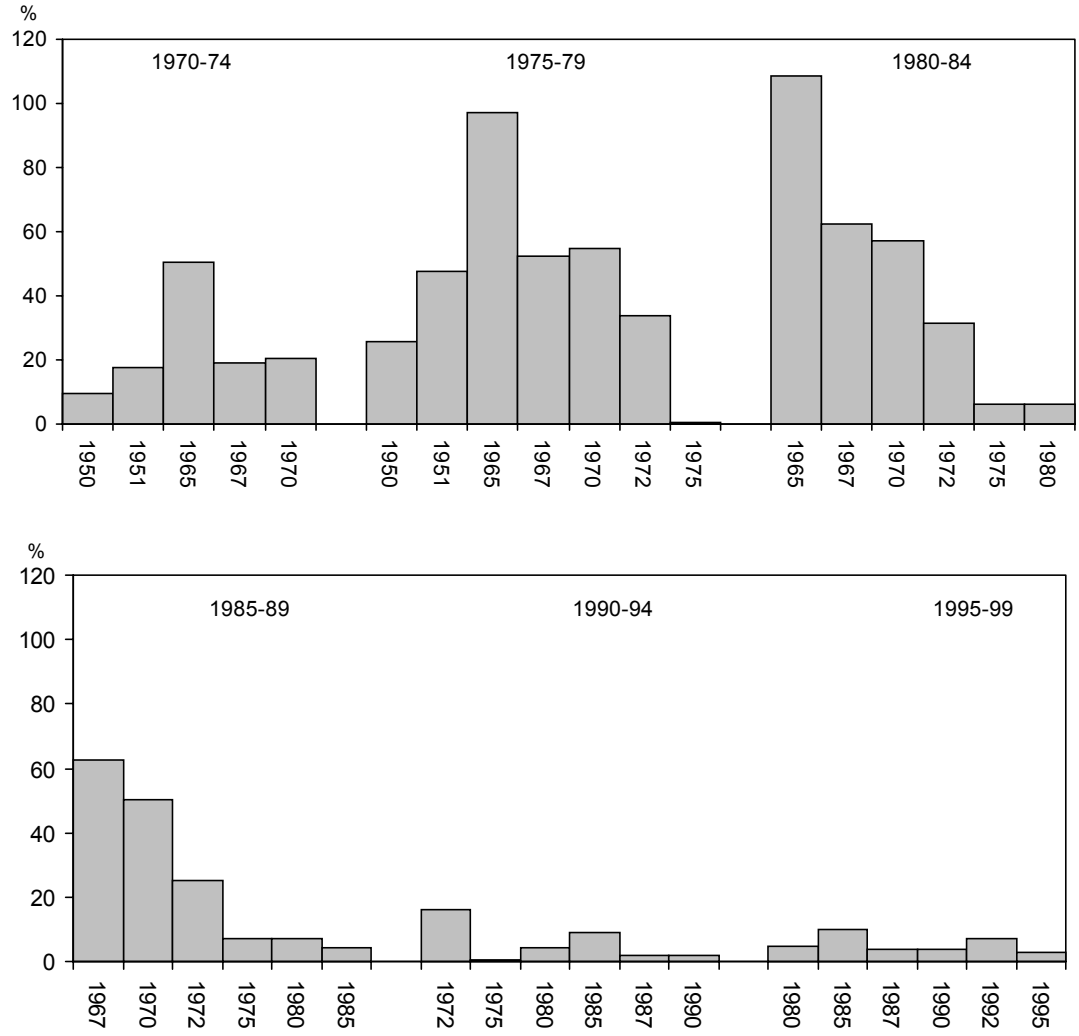
Graph 6 Total Fertility Rate: mean percentage error



Beside a result oriented approach that uses number of births, we could make an evaluation on the level of assumptions, the total fertility rates. *Graph 6* shows the mean percentage error of the total fertility rate. Time-series are not available for all forecasts. Errors in number of births and total fertility rate only differ if the age structure of females in the fertile age-groups (15-44 years) change. As indirect effects are still minor in the first nineteen years of the forecast time, the errors are very similar to *Graph 5*.

Beside a comparison in terms of forecast time, errors can be compared fore a certain calendar period. For calendar periods of five years, *Graph 7* gives the mean absolute percentage error. The first series gives the average relative absolute error for some forecasts for the years 1970 to 1974. For the years 1970-74 and 1975-79, forecasts made closer to these years do not always give better results than those made earlier. Forecast 1950 and 1951 were better than those made fifteen to twenty years later. Again the relative good fit of Forecast 1975 is apparent. The years 1980 till 1989 are more in line with the expectation that more recent forecast could use more observations and information and should therefore be better. Errors for the past ten years, in contrary, give another picture, though errors are relatively small.

Graph 7 Mean absolute percentage forecast error by forecast period



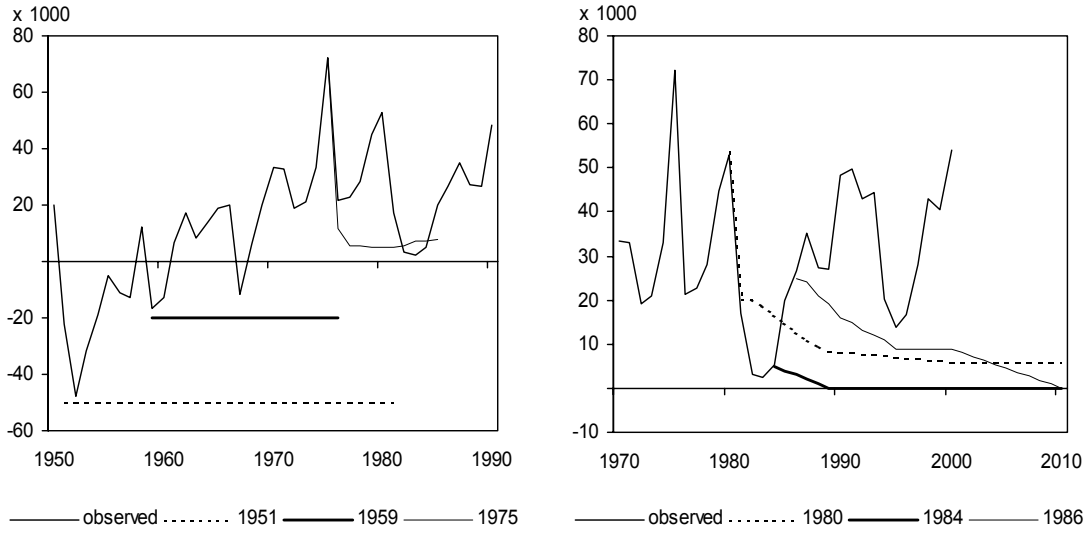
4.2.- Migration

The highest net-migration was measured in 1975 with over 70 thousand. This was mainly the result of a record immigration of over 130 thousand (ten thousand of which were due to regularizations). Net-migration was also high in the years around 1980, 1990 and 2000. Emigration was at its height in 1943 and in the fifties, while war years showed relatively low levels. Emigration as well as immigration saw an increasing trend the last fifty years. Yearly fluctuations were highest for immigration.

Since Forecast 1980, migration forms an integral part of the medium scenario of the population forecast. Forecast 1965, 1967, and 1972 had zero net-migration assumptions. Forecast 1950 and 1970 had each an explorative variant in which the effects of migration were estimated. Of these forecast the version with zero migration are taken in the evaluation. In the other three forecasts made before Forecast 1980 (Forecast 1951,

1959, 1975) it is not clear which should be taken as the most likely base-line forecast. In the evaluation, the versions with migration are used. As appendix a short overview is given about the migration history of the Netherlands. Refer to this *Appendix A* for graphs on observed immigration and emigration in the past 100 years.

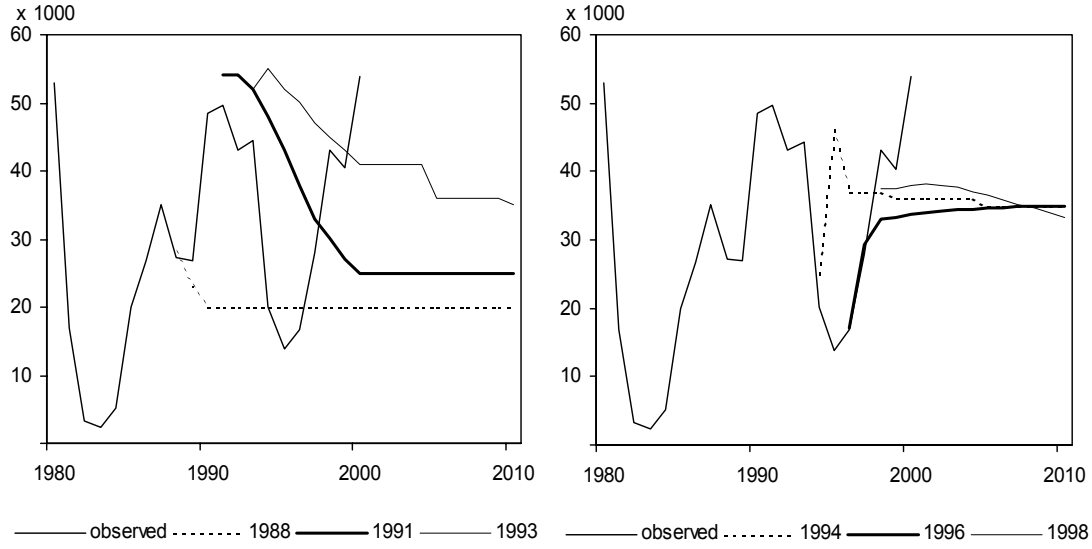
Graph 8a Observed and forecasted net-migration



In *Graphs 8a* and *8b* net-migration assumptions are plotted against observed values for some forecasts. Forecast with explicit and implicit zero net-migration assumptions are not listed, neither are those that do not differ significantly from the previous or the next forecast. Forecast 1987 and 1989 only differ for the short-term from Forecast 1988; Forecast 1990 and 1992 are similar to Forecast 1991; Forecast 1995 does not differ much from Forecast 1994 (Forecast 1997 and 1999 are short-term forecast only).

Numbers of births and deaths are always positive and never zero. The average percentage error and mean absolute percentage error can give an indication of the error for these components. The number of net-migrants can, both in the observations and in the forecast, equal or close to zero. In such situations relative measures give problems.

Graph 8b Observed and forecasted net-migration



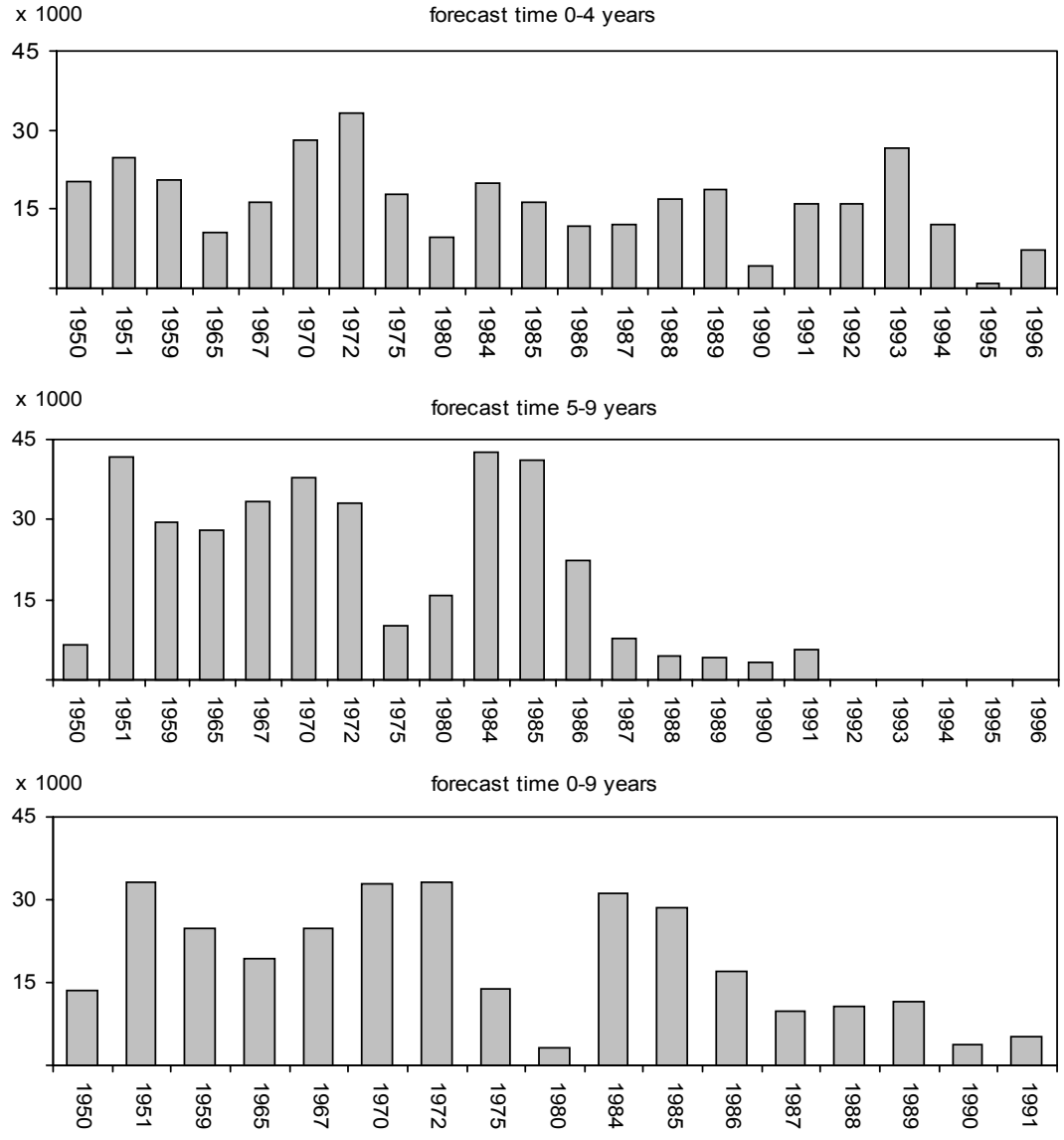
If the forecasted net-migration is zero and the observed not zero, the error will always be 100%, regardless the size of the difference (if taken as percentage of the observations). Additionally, small errors can give large relative errors if net-migration is low. If fore example the observed number of net-migration is one thousand and the forecast expected five thousand, the relative error is 400%. If the observed number was ten thousand and the forecast four thousand, the error is six thousand but the relative error will only be 60%. Fore this reason the use of the mean absolute error is better.

Because the number of net-migration tents to fluctuate from year to year, the main aim of forecasting migration is more to forecast the average of a period accurately and not so much the yearly fluctuations. By not taking the mean absolute error but the mean error, positive and negative errors compensate for each other, which gives a better indication of the error. Another possibility is the absolute difference of the net-migration for a period of some years. Over and under estimations cancel each other out within a period. For migration this absolute mean error will mainly be used. The error is defined as forecast minus observation.

Graph 9, gives the absolute mean error for forecast time 0-4, 5-9 and 0-9 years (refer to *Table A2* in *Appendix C* for more data). For the short-term, a clear improvement in predicting net-migration does not appear from forecast to forecast. For this period, Forecast 1995 and 1990 gave the best fit. The forecasts made from the mid-80s onward seem to improve in predicting the forecast time of 5-9 years; the smallest errors were

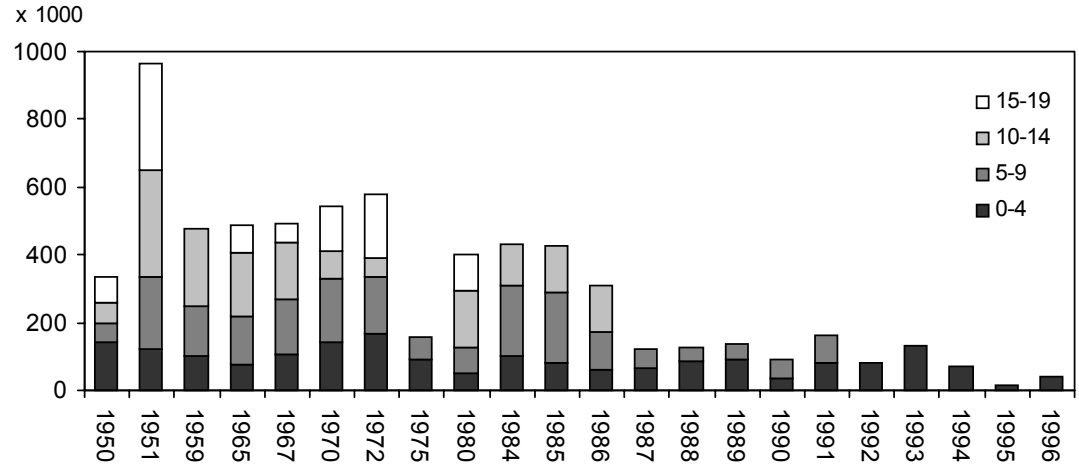
reached by Forecast 1987 and beyond. The implicit assumption of zero migration of Forecast 1950 also gave a relative low error for this forecast time period. Again five years further in forecast time, Forecast 1950 even gave the best results (only forecasts with a start year before 1986 can be evaluated for 10-14 years). For the referring calendar period (1955-64), net-migration fluctuated around zero. In later forecasts that, explicitly or implicitly, used the assumption of zero-migration were much less accurate.

Graph 9 Net-migration: absolute mean forecast error in forecast time

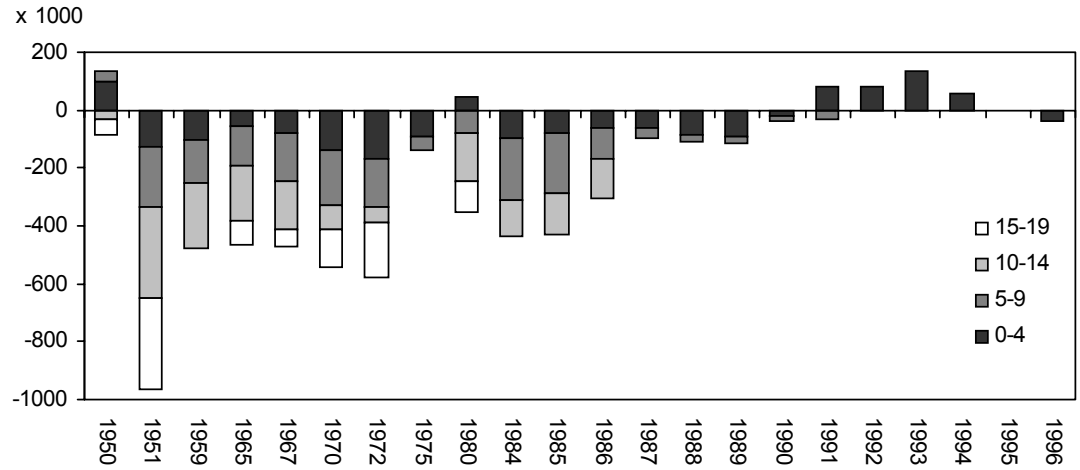


The absolute average forecast error for the first ten years after the start of the forecast gives similar results (lower panel of graph). The compensation for over and under estimation across a period of ten years turned out to work most favourable for Forecast 1980.

Graph 10 Net-migration: sum absolute forecast error in forecast time



Graph 11 Net-migration: summed forecast error in forecast time

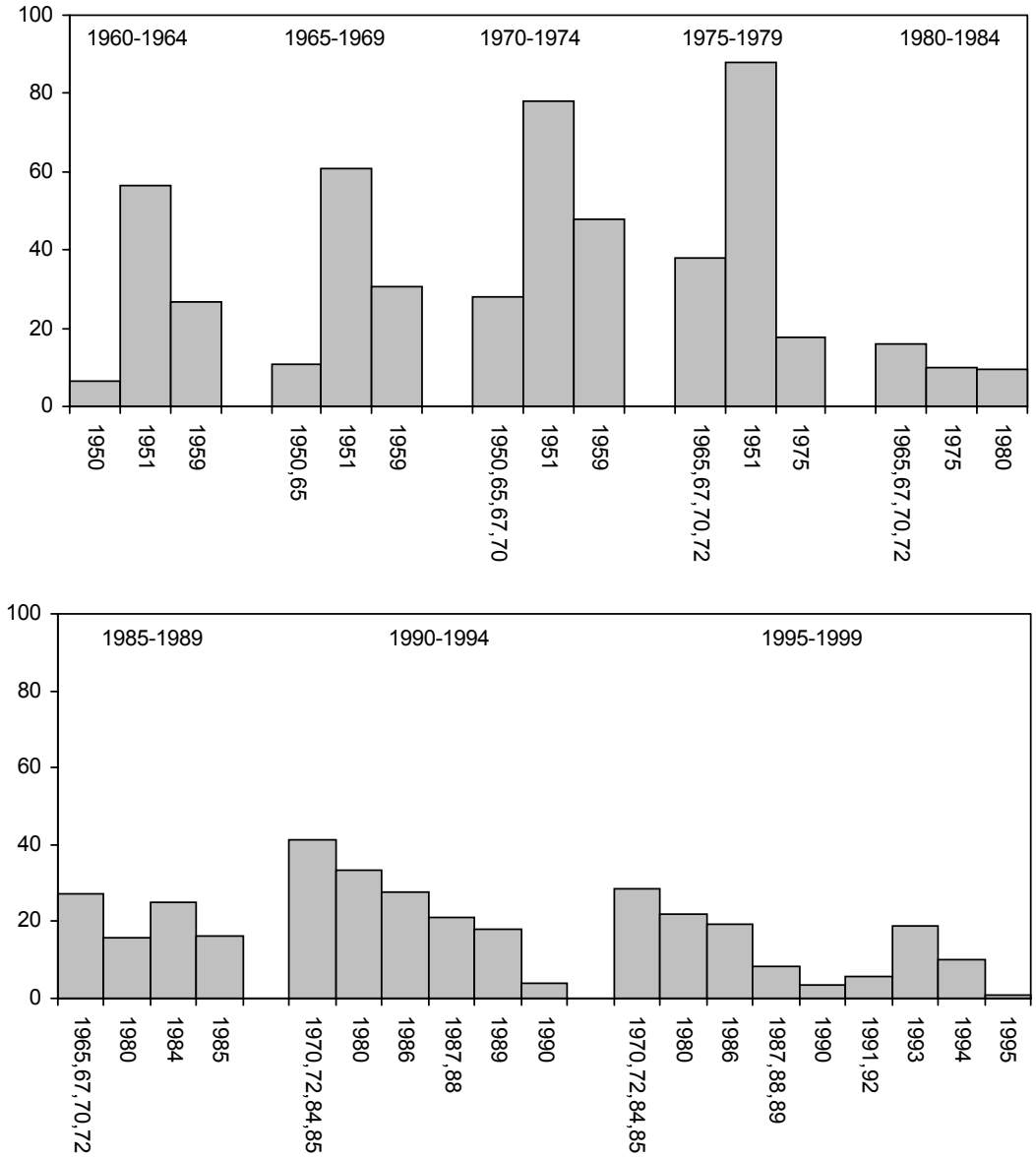


Graph 10 shows the sum of the absolute error for periods of five years in forecast time. The different five-year periods after the start of the forecast can now be cumulated. Negative and positive values within a period do not compensate each other. For forecast time 0-4 years, recent forecasts do not seem to have improved in upon earlier forecasts. As far as evaluations can be made for forecast time 5-9, the last forecast have smaller errors than those made before Forecast 1987.

The direction of the error is nearly always negative (*Graph 11*), meaning that in general net-migration was under-estimated in the migration forecasts. Beside Forecast 1950 (zero migration assumption), only Forecast 1980 and Forecasts 1991 to 1994 had over-estimated the net-migration, and they did so only in the first five years after the start of the respective forecasts.

As with births, we can also evaluate the migration forecasts in terms of (five-year) calendar periods. The absolute mean forecast error are shown in *Graph 12*.

Graph 12 Net-migration: absolute mean forecast error in forecast period



Again forecasts made closer to the period under study do not necessarily give better results than those made further in the past. An improvement in time is neither visible for the past twenty years, errors for calendar years 1980-84 are similar than those for period 1995-99.

As described in chapter 2, some forecast had a version with and without explicit migration assumptions and some explorative forecasts were made. The zero-migration assumption had been better for Forecast 1950 and 1959 than the variant with migration

(refer to *Table A2b* for absolute mean error of these alternative forecasts). The explorative variant of Forecast 1970 would have been better than the base-line forecast with zero-migration. Forecast 1975 did rightfully not chose for the assumption of zero migration.

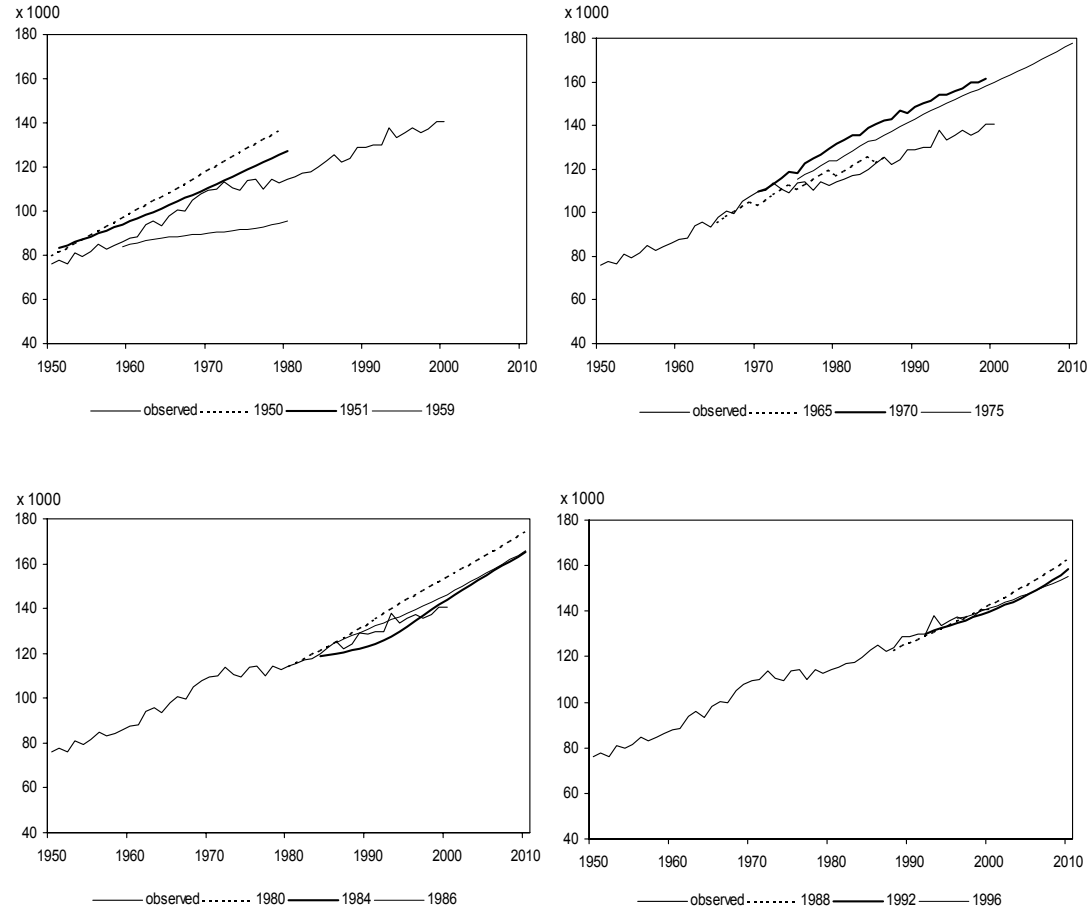
4.3.- Deaths

The number of deaths shows a continuously increasing trend (*Graph 13*). This is a result of a growing population, especially of the older age-groups. The increase of the number of deaths has been offset partly by improved life-expectancies. The trend in female life-expectancies has been going up since 1950, though from year to year some fluctuations could be observed. At the end of the 60s, it seemed as if the increase would come to an end, however, in the 70s the up-ward trend recovered. In the 80s the improvements slowed down again and it is not clear if further improvements will take place.

Fore males developments in life-expectancy at birth are less favourable. After some hesitating increases in the 50s, even a decline followed in the 60s. In the early 70s the trend recovered and life-expectancies have been increasing from then onward. Differences between males and females were 2.3 years in 1950. The gap first widened to 6.7 years before narrowing to 5.0 in 2000. According to Forecast 2000 the difference would further reduce to a difference of about three years in 2050.

For some forecasts the number of deaths are plotted in *Graph 13*. Observed and forecasted life-expectancies are shown in *Graph 14*. Forecasts that are not shown, have predicted values similar to others. Forecast 1965 is nearly the same as 1967; Forecast 1985 as 1984; Forecast 1987 to 1986; Forecast 1989, 1990, and 1991 to Forecast 1988; Forecast 1993, 1994, 1995 to Forecast 1992. In the graph with life-expectancies, years with the same end-values are neither shown.

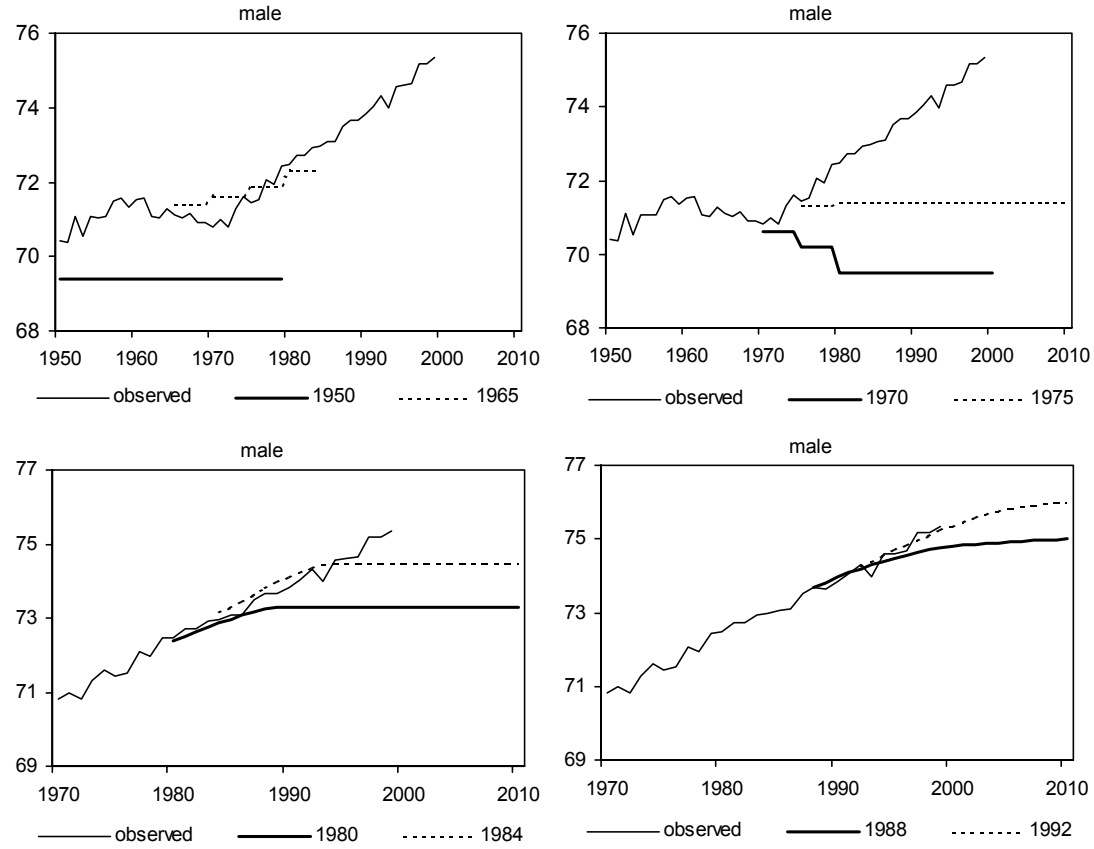
Graph 13 Mortality: observed and forecasted number of deaths



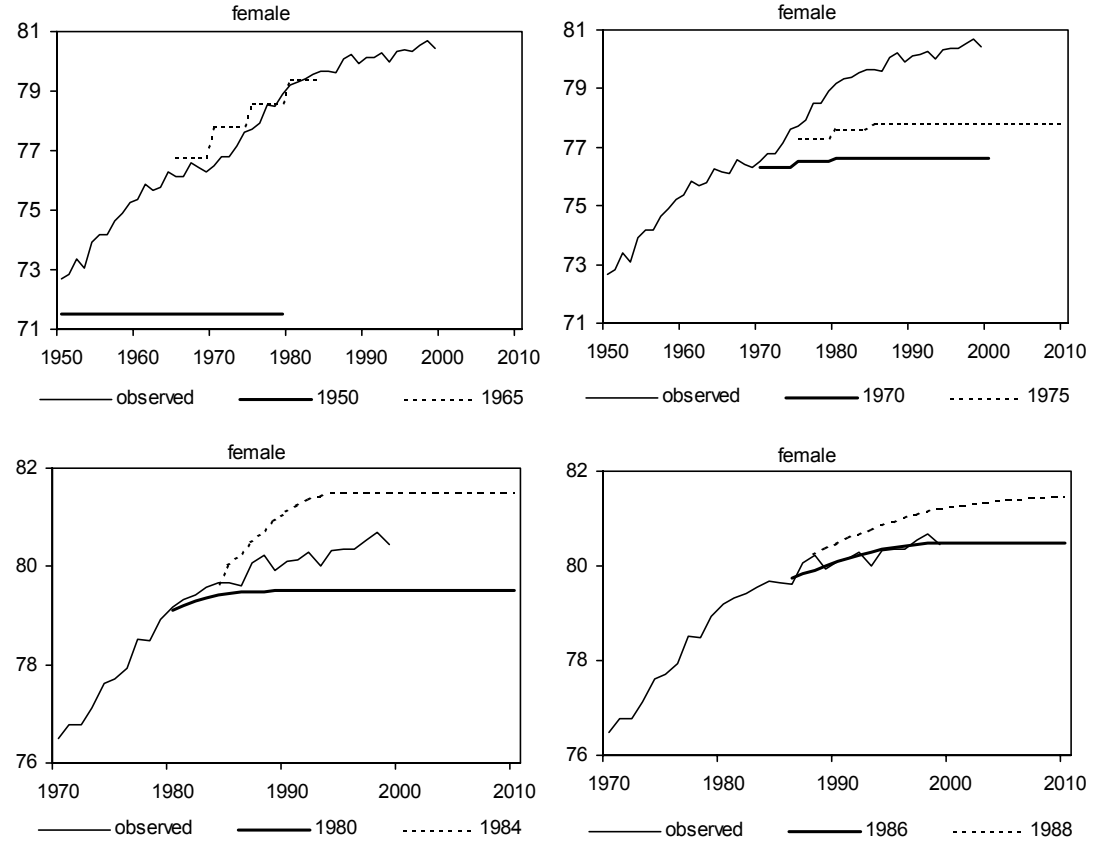
As with total fertility rates for the birth component, the aggregated indicator of life expectancy at birth gives information on the aptness of the main mortality assumptions. The number of deaths also includes indirect errors (wrong age structure) and errors in the translation of life-expectancies into age-specific mortality rates. From a quick scan of these graphs it becomes clear that most forecast before the mid-80s under-estimated improvements in health. Life expectancies improved in general more and for a longer period than forecasted.

For a more quantitative comparison of the forecast we can look at the error measures. In *Graph 15*, the mean absolute percentage error per five year period of forecast time (refer to introduction of this chapter for definition of forecast time) are given for the number of deaths. This measure was earlier used in the discussion on the fertility component and gives the yearly percentage difference between the forecast and the observations.

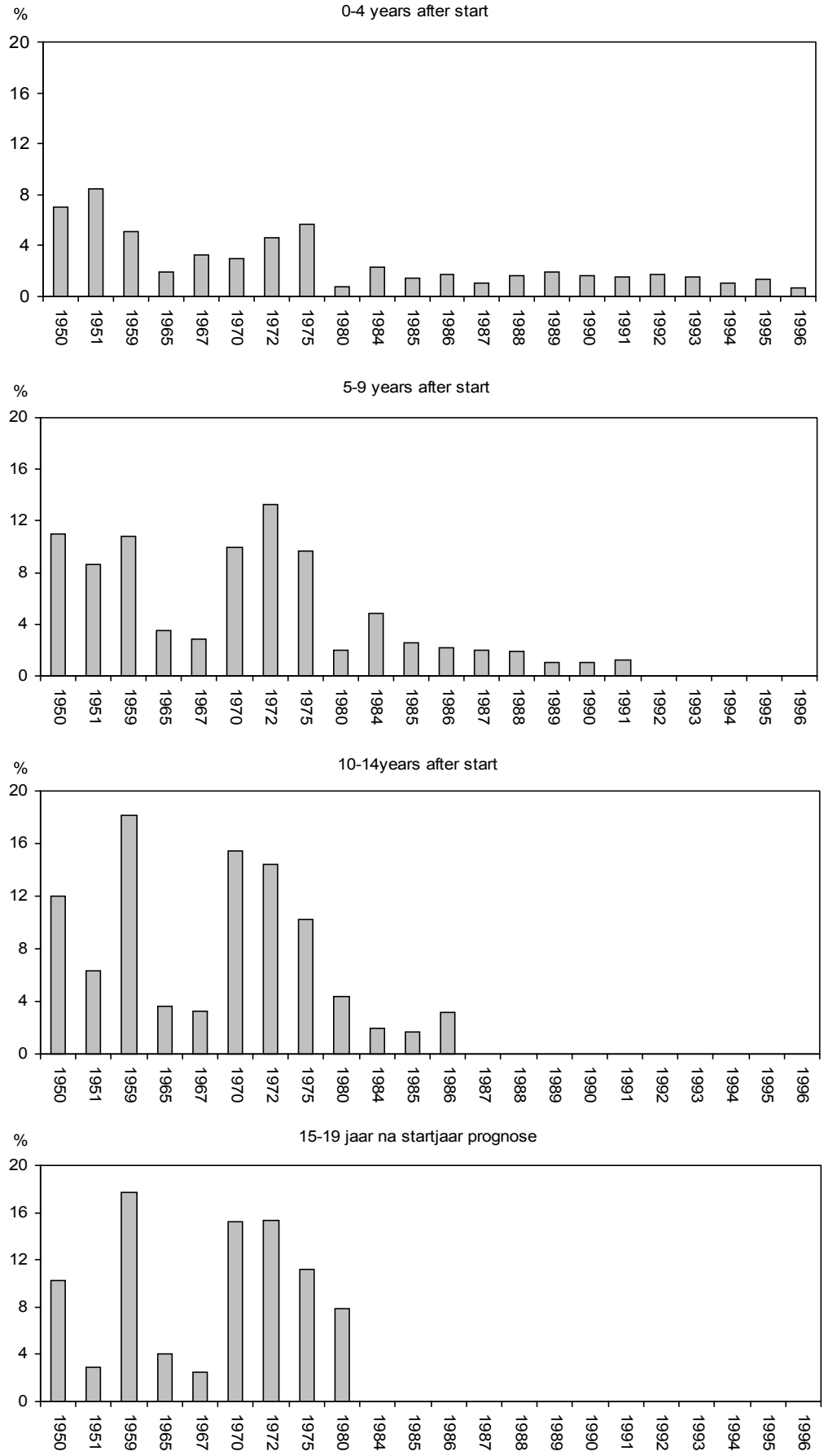
Graph 14a Male Life expectancy: observed and forecast



Graph 14b Female Life expectancy: observed and forecast

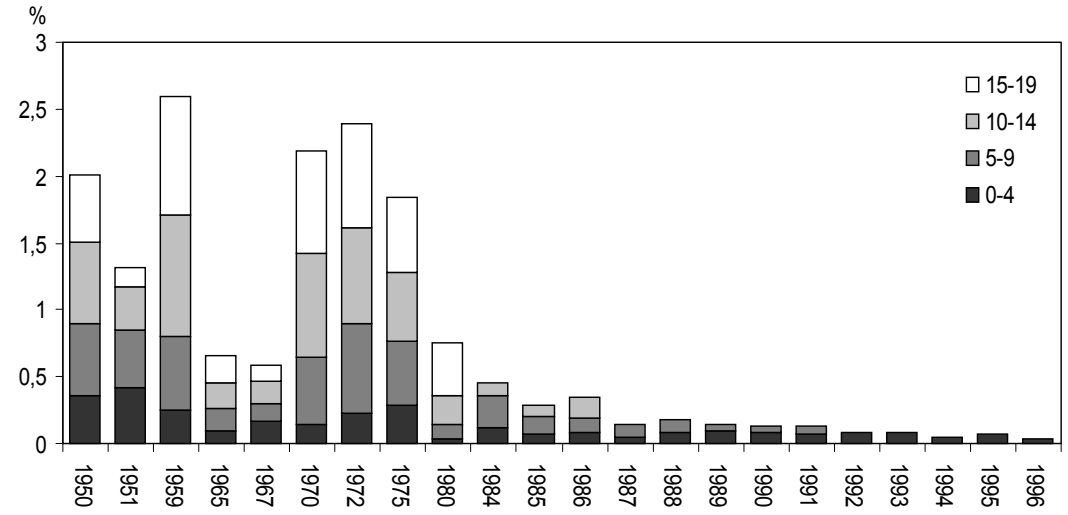


Graph 15 Mortality: mean absolute percentage error

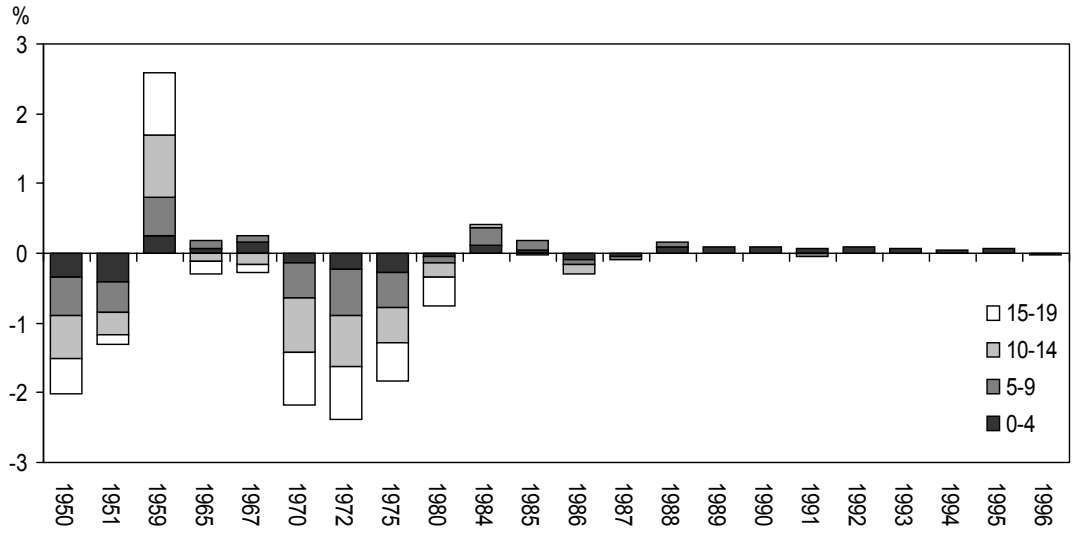


Forecasts with starting years in the fifties and seventies appear to have been the least accurate mortality forecasts. These forecasts had been too pessimistic about improvements in the life expectancy. In the first five years after the start of the forecasts, Forecast 1980 and 1996 have the lowest error. Of all forecasts that could be evaluated for forecast time 5-9 years, the three most recent (Forecast 1989, 1990, and 1991) gave better results for the second than for the first five-year period of forecast time. All other forecast satisfy the expectation that errors increase according as the forecast time passes.

Graph 16 Mortality: absolute percentage error in forecast time

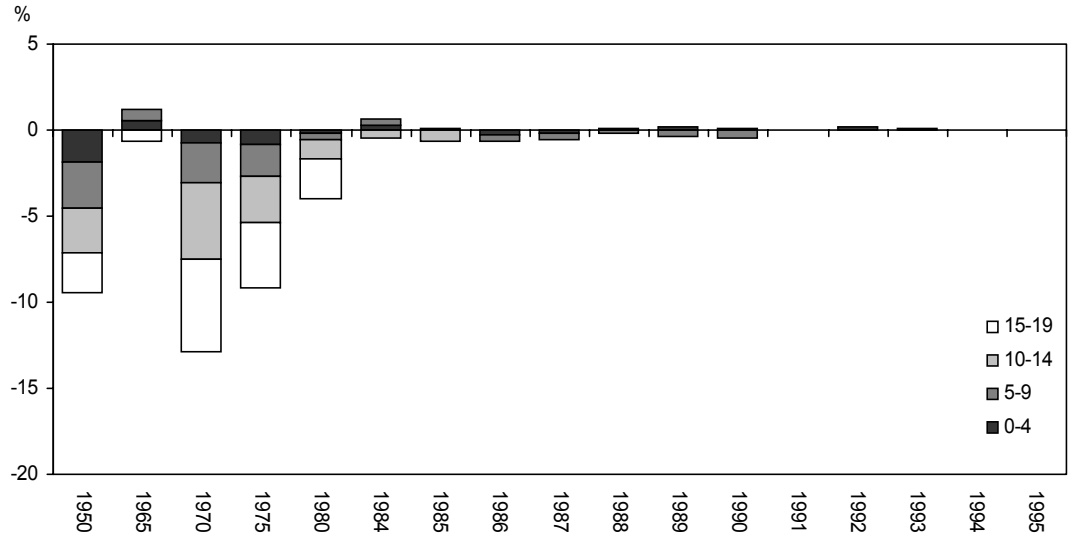


Graph 17 Mortality: percentage error in forecast time

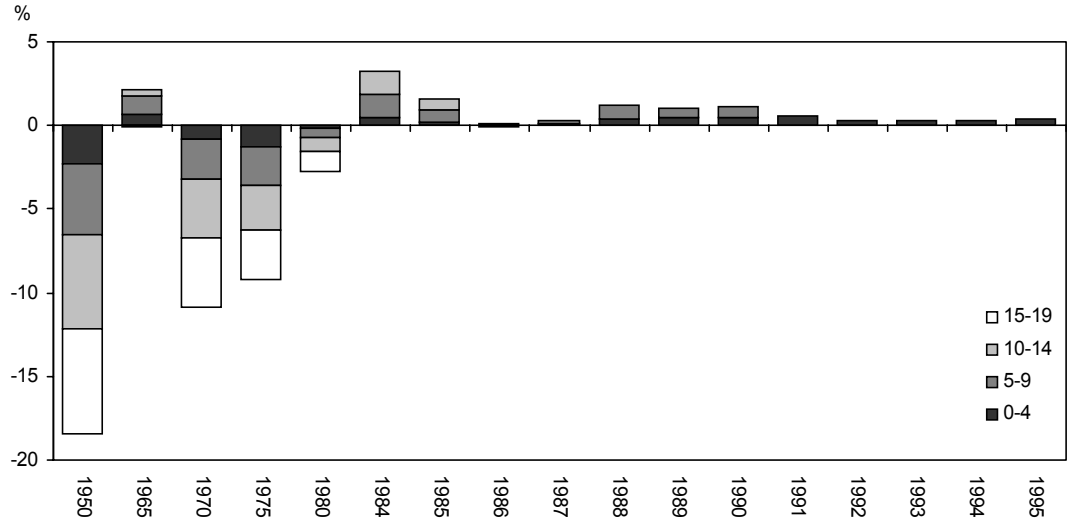


Graph 16 gives the absolute percentage error which can be accumulated. If fluctuations from year to year are not so important but the average across a forecast time of five years is more relevant, this measure can give a better impression. The direction of the error in each period of five years becomes clear in *Graph 17* where the mean percentage error is shown. Negative values mean an over estimation of mortality. For some forecasts the effect of the balancing of over and under estimation in a period of five years improves the score. Fore example, for the forecast time of 5-9 years, the error nearly disappeared for Forecast 1989 and Forecast 1990.

Graph 18a Male life expectancies: Mean percentage error

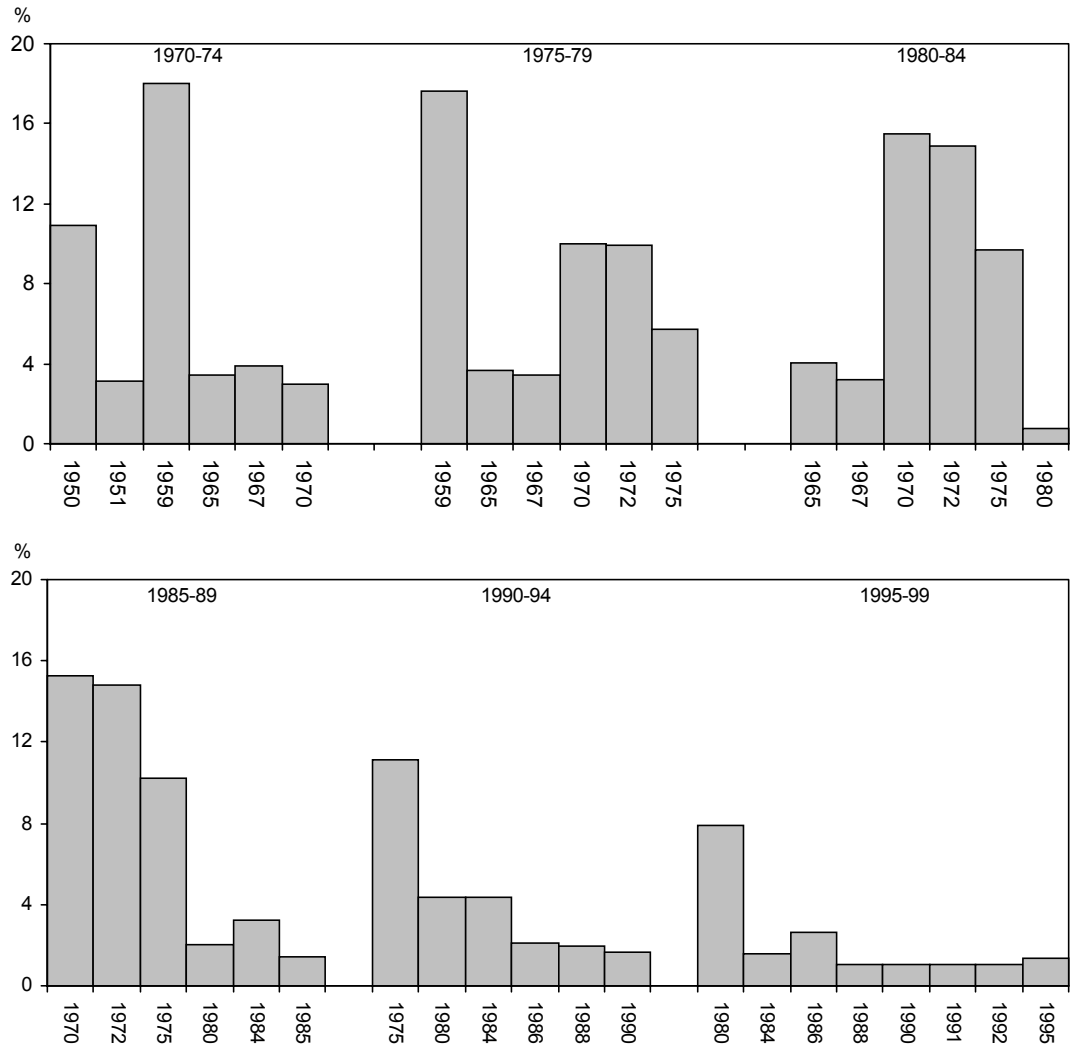


Graph 18b Female life expectancies: Mean percentage error



Beside the above more result oriented approach of the comparison of number of deaths we can evaluate at the assumption level by looking at the life expectancies at birth. Indirect effects on the error caused by error in the number of births, net-migration or base population are now excluded (but errors caused by transformation of life expectancies into probabilities of dying are neglected). *Graphs 18a* and *18b* give for those forecasts for which data were available the mean percentage error (negative values mean that the forecasted life expectancy at was too low). Conclusions are similar as drawn from comparing forecasts by number of deaths. Errors are in general larger for assumptions made for female than for male life expectancies. The error in the first five years after the start of the forecast are small, especially since the 80s; the average for forecasts 1980 till 1995 was 0.12% for male and 0.33% for female life expectancies at birth.

Graph 19 Number of Deaths: mean absolute forecast error in forecast period



Compared to number of deaths, errors in life expectancies at birth are much smaller. Indirect effects can have a negative influence on error of the number of birth, however, the reason for the difference is mainly caused by the method of calculation of the life expectancy.

As with births and migration we can compare the mortality forecasts for calendar periods. *Graph 19* gives the mean absolute percentage error for calendar periods of five years. As seen with the other components, nearness to the calendar period under study is no guarantee for smaller errors. This is mainly the result of the relative bad forecasts in the 50s and 70s. Although later years satisfy more the expectation that more recent forecasts predict better than more distant forecast for a certain calendar period, it does not seem to be a real clear benefit.

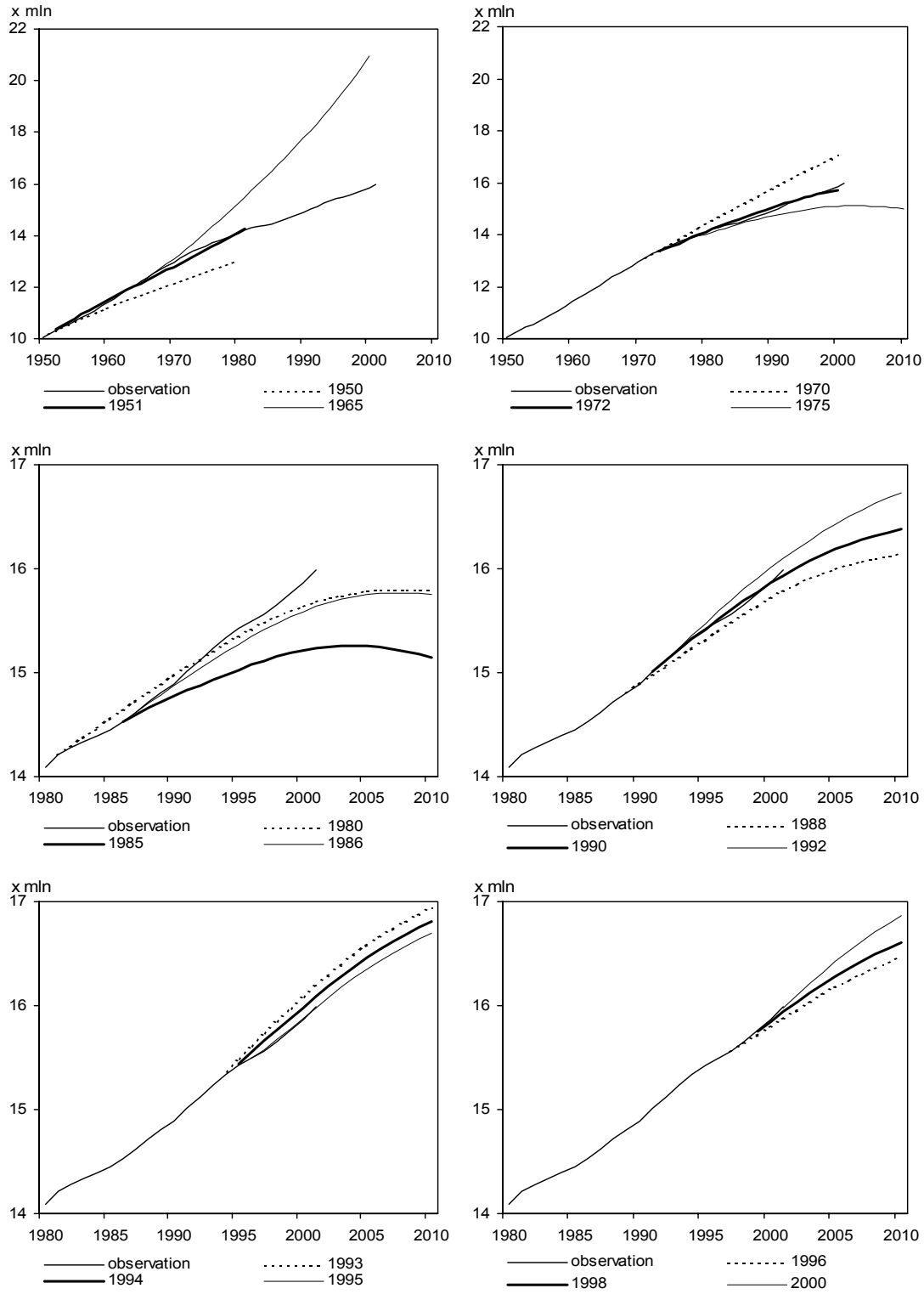
4.4.- Population structure

From 1950 to the beginning of 70s the annual population growth was over one percent (*Graph 20*). Afterwards the growth rate fluctuated around 0.6 percent. As births and deaths show a relative stable pattern, it is mainly the strong fluctuating migration component that causes most of the changes in the yearly population growth.

From Forecast 1975 onward, all forecasts predict an ultimate decline of the total population (refer to table *tp01*). From forecast to forecast, each time the turning point has been put further in the future (from 2003 in Forecast 1975 to 2040 in Forecast 2000).

The maximum population size (of 21 million) for the year 2000 was assumed in Forecast 1965. Forecast 1975 and 1984 expected the lowest total population, only 15.1 million. In the end, the population registers gave 15.68 million for the first of January 2000. In Forecast 1990 this had been foreseen correctly, while Forecast 1972 came close.

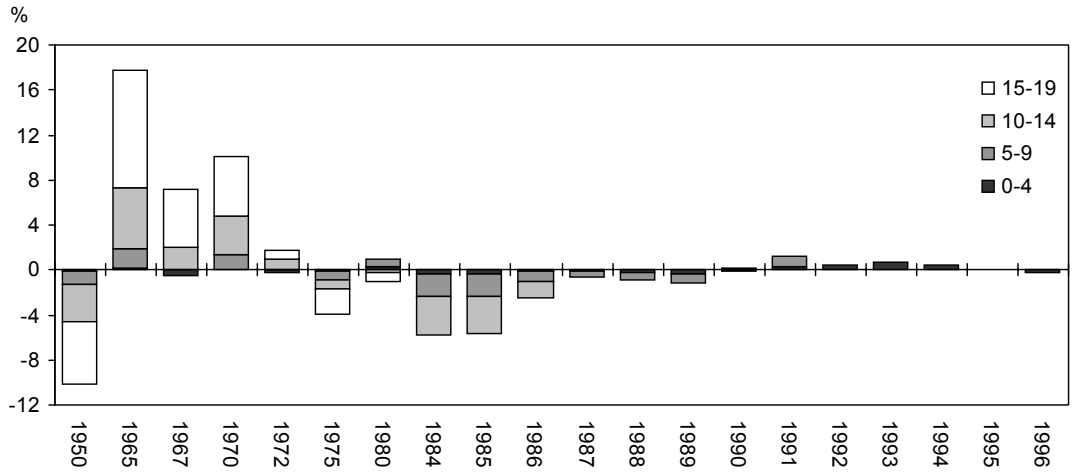
Graph 20 Total population: forecasted and observed



The mean yearly percentage forecast error of the total population in forecast time are given in *Graph 21*. Since the first forecast, no improvement seems visible for the first five years after the start of the respective forecasts. The smallest error had Forecast 1970, 1990 and 1995 while Forecast 1993, 1994, and 1967 showed the biggest forecast error. Five to ten years after the start of the forecast, errors are in general larger; on

average 0.9 against 0.28 in the first five years. Errors do not always point in the same direction. Because of this forecast that score relatively bad in the first five forecast years do not necessarily have the largest in the second period of five years. Fore example, Forecast 1967 gave in the period five to nine years after the start of the forecast the smallest error (while it was one of the worst in the forecast time 0-4 years). Ten to fifteen years after the start of the forecast the average error of the forecast for which a comparison can be made, increased to 2.42 percent. Again five years further in forecast time the errors have increased to 4.34. Note that errors can only be calculated up till Forecast 1980.

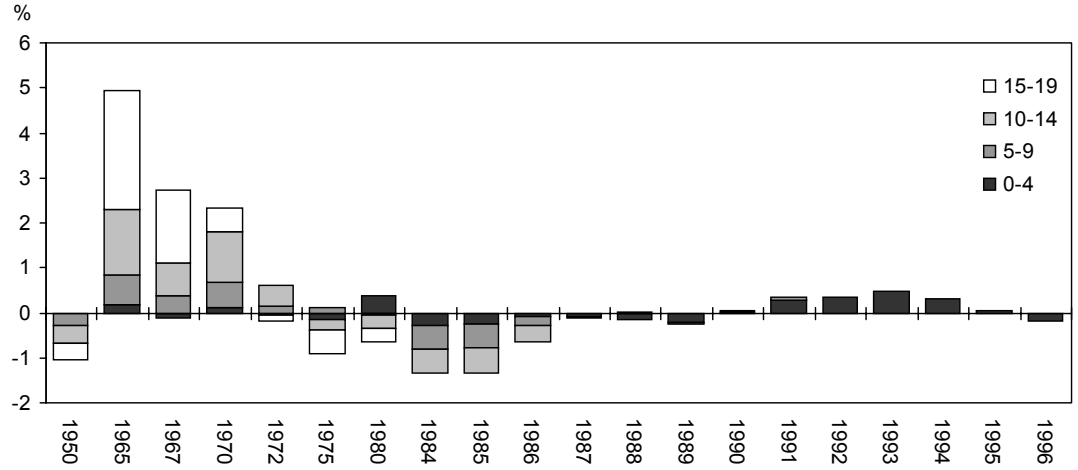
Graph 21 Total population: mean percentage forecast error in forecast time



The goal of a population forecast is the prediction of the future population and population structure. Because of this we mainly evaluate the forecasts against errors between observed and forecasted population. The problem with the error in the total population, however, is that an accumulation of errors can occur. If the population growth was forecasted wrongly for the first year but correctly in all subsequent years, the total population will show an error for all these years. An evaluation of the error in the population growth does not suffer from this problem. *Graph 22* gives the mean percentage forecast error of the population growth. The picture is more or less the same, though in detail some differences can be observed. Forecast 1990 gives the smallest error and Forecast 1950 improves compares relatively better. Errors between observed and forecasted population can not only accumulate, levelling of errors is also possible. For some forecasts score better in the inter-forecast comparison for population growth. Especially Forecast 1967 and 1980 and forecasts made in the beginning of the 90s show

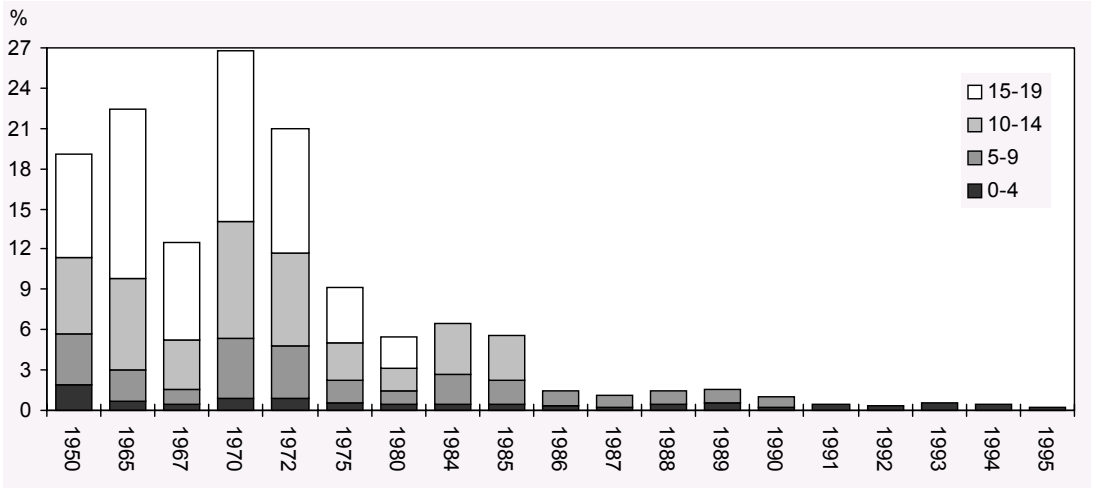
larger errors in the comparison of the population growth than in the comparison of the error in the total population.

Graph 22 Population growth: mean percentage forecast error in forecast time



Forecasts are not (only) made for predicting the total population. Forecasting the population structure is often more important. Predicting the total population accurately does not necessarily mean that the underlying population structure was forecasted correctly as well. Over estimations at certain ages can compensate for under estimations at other ages. By aggregating the errors made for each age group of five year, we can get a better picture of the error in the population structure. Graph 23 shows the mean absolute percentage forecast error for the population in five year age groups fore forecasts times of five years. Again we can conclude that forecasts for the short-term were relatively good and that errors are comparable from forecast to forecast. Differences in errors become larger after the first five-year period of forecast time. The average error increases from 0.55% in the first five years after the start year of the forecast to 1.9% and 4.8% in the subsequent five-year periods. Especially the forecasts of the 70s and Forecast 1980 performed worse in the error in the age structure than the error in the total population. In these forecasts, over-estimation of the number of births was compensated by under-estimation of migration and of the increase in the life expectancy.

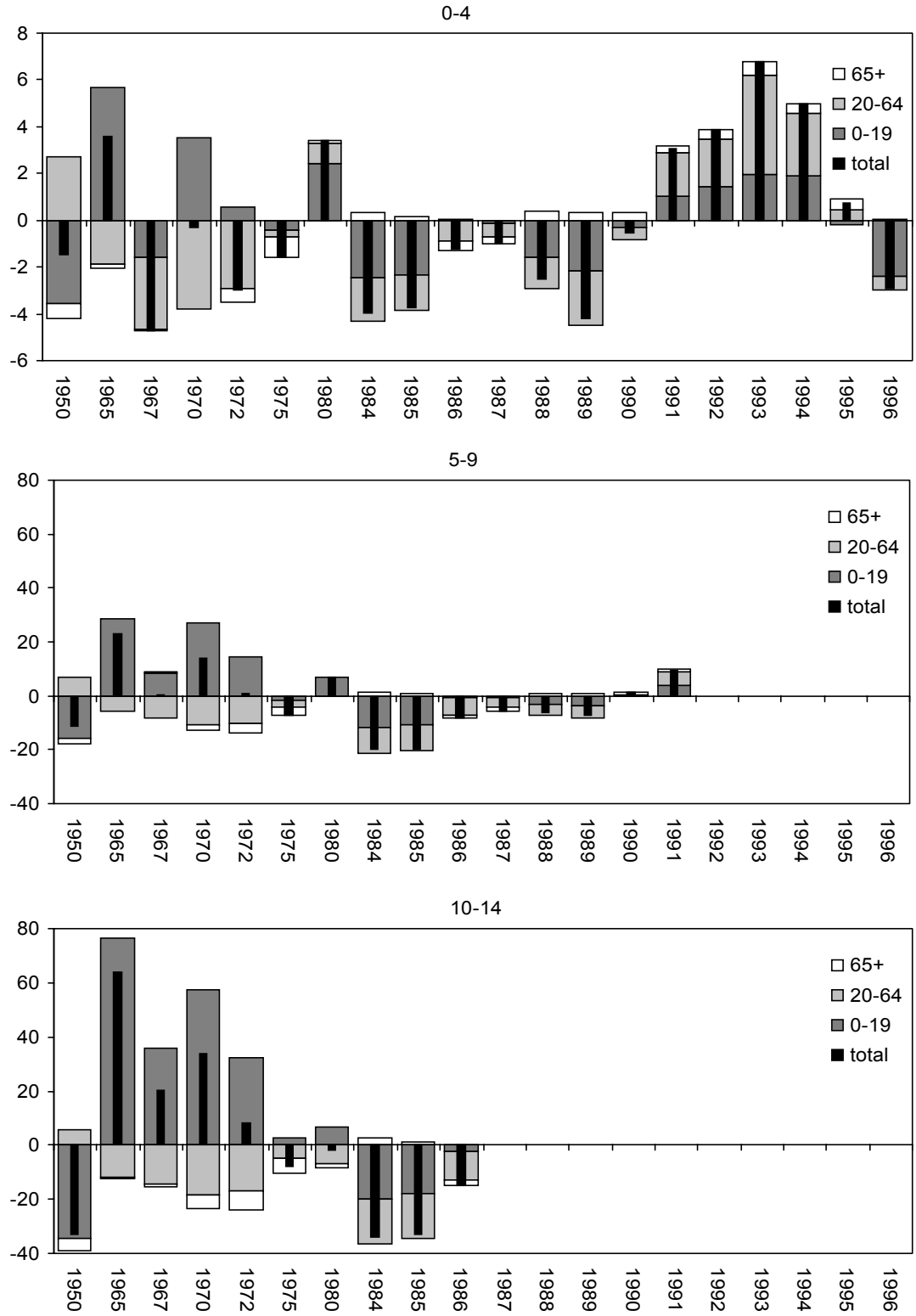
Graph 23 Age pattern: mean absolute percentage forecast error in forecast time



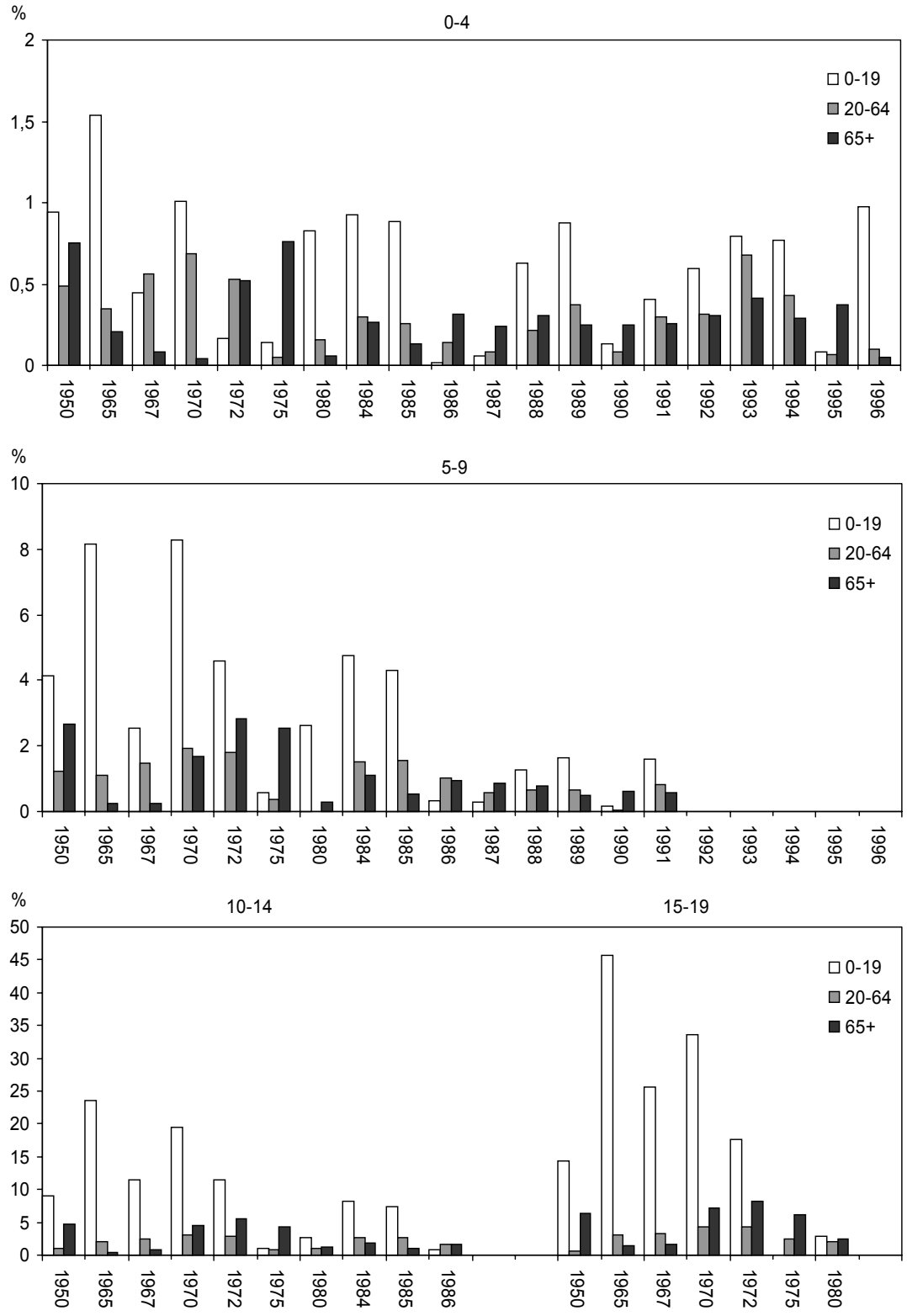
Whereas *Graph 23* gave an overview of the sum error in the age structure, *Graph 24* gives the error for broad age group. In order to keep a convenient arrangement, three broad age groups are chosen that represent more or less the education, work, and pension ages (younger than 20, 20-64 years and 65 and older). Because between 1950 and 2000 the total population increased by 57%, a weighted error measures is more suitable to make e a comparison between forecasts in this time period. As error measure we have chosen for the mean error as a percentage of the average total population in the period under consideration. By taking the total population as divider, the errors of the age groups can be cumulated. Because negative errors in one age group can compensate positive errors in another age group, the error in the total population is also given.

The size of the three broad age groups is no equal. A larger error in age group 20-64 compared to age group 0-19, does not mean that in relative terms the forecast for this age group was worse. *Graphs 25* shows the absolute mean percentage forecast errors in forecast time.

Graph 24 Broad population age groups: mean percentage error (weighted by average total population)



Graph 25 Absolute mean percentage forecast error in forecast time



From *Graphs 24* and *25* it again becomes clear that no improvements have been made from past to present. More experience in making forecasts has not lead to smaller errors.

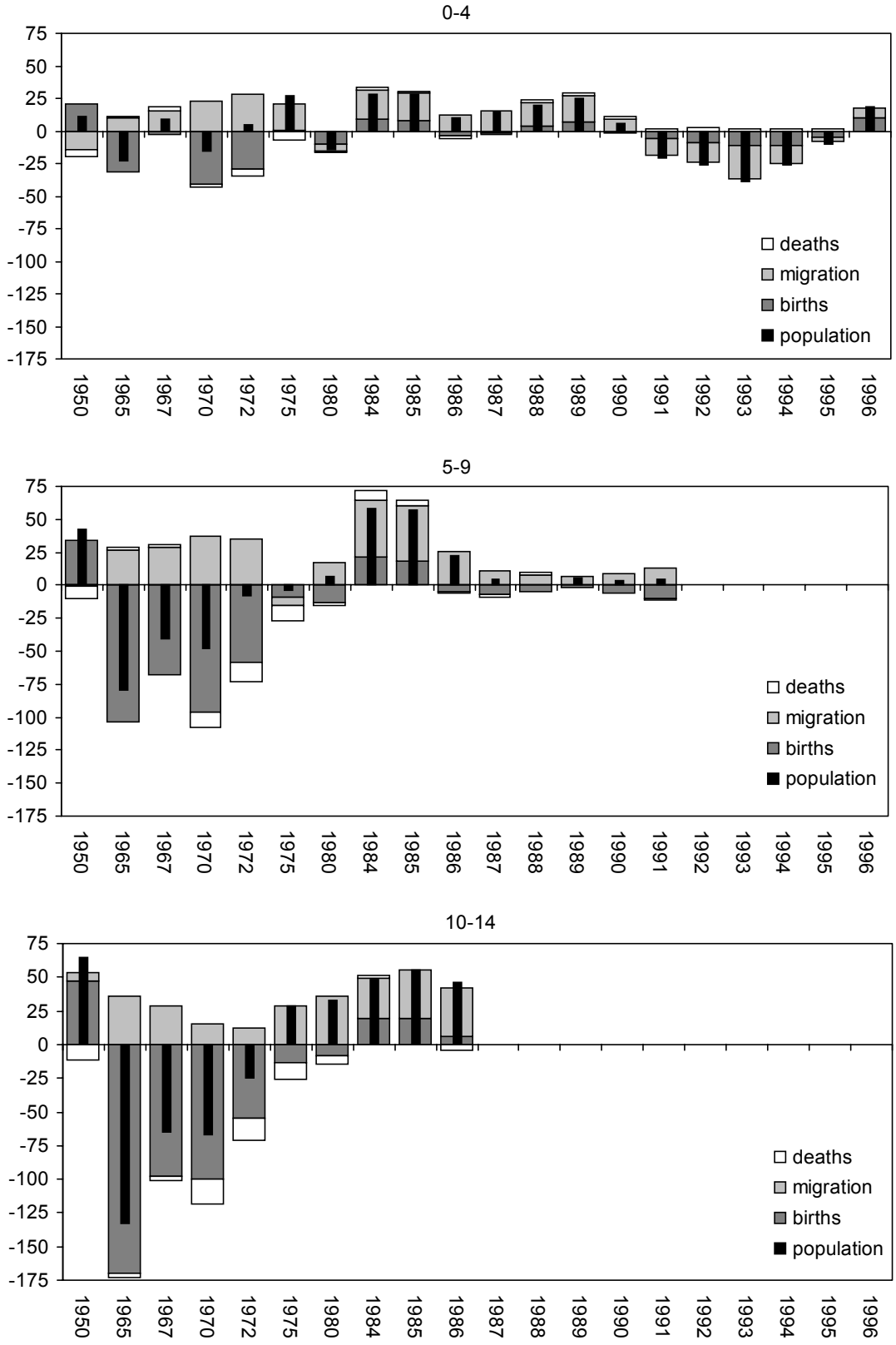
Not that there is much space for improvement, the error is 0.6% for the age group 0-19 and around 0.3% for the age groups 20-64 and 65 and over. In forecast time, errors increase (note that the scale differs for each period of five years of forecast time). The increase in the error in forecast time is largest for the youngest age group. The average error five to nine years after the start of the forecast is about 3% and for the two other age groups around 1%. Another five years further in forecast time, errors again increase. For the age groups 0-19, 20-64, and 65 and over to 9.5%, 2.1%, and 2.6% respectively. For most forecasts the error is relatively largest for the 0-19 year olds. In the first forecast time period of five years, four of the twenty forecasts have a larger error for the broad age group of 20-64 year old (Forecast 1967, 1972, 1986 and 1987). After a forecast time of five to nine years this only counts for two forecasts (1986 and 1987) and after ten to fourteen years only Forecast 1986 shows a larger error for age group 20-64. In this Forecast 1986 the forecast of the youngest age group was most accurate. Because the population size of the age group 65 years and older is relatively small, errors seem small in *Graph 25*. *Graph 25* gives a better picture. The predictions for age group 65 and older is slightly more often larger than that of the 20-59 year olds. The average error however, is more or less the same for both groups.

Errors in the younger age groups are mainly caused by errors in the fertility assumptions. Compared to deaths and migrants, births are unique in the sense that they all enter in one age group, namely age group zero. The two other components influence all age groups. Because of the concentration in one age group, the disturbance in the age structure is larger for the birth component. At higher ages de assumptions about life expectancy at birth and the resulting change in the probabilities of dying at higher ages are most important.

Graph 26 gives the mean percentage forecast error for five year periods of forecast time of the three demographic components. Indirect effects are not taken into account. Examples of such effects are more deaths because of more immigration or more births. On the short and middle-term, these errors will be relatively small.

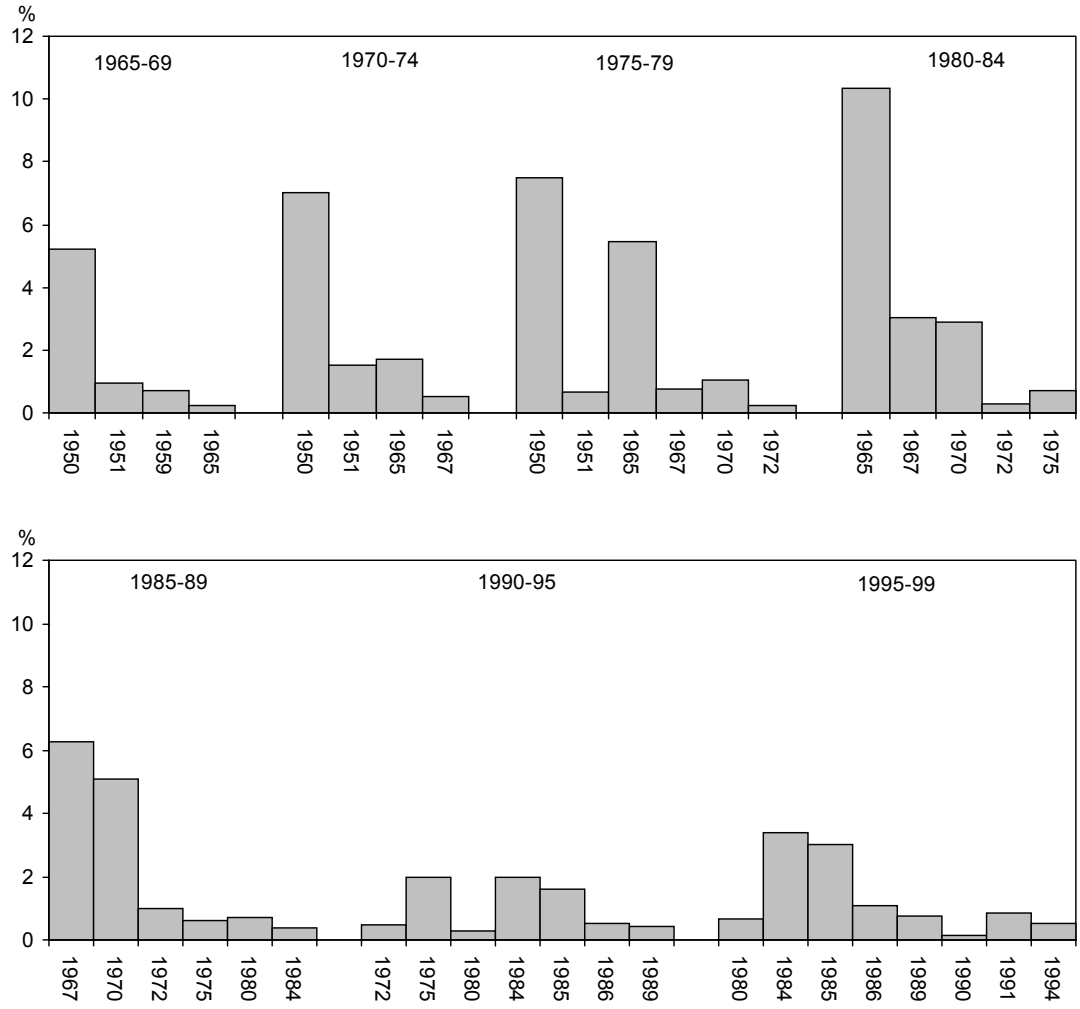
Errors in births correspond with errors in the age-group 0-19 years (compare *Graph 26* and *Graph 24*, where a positive error in the birth assumptions leads to a negative error in the population). Only in the long-term (19 years and beyond) these births move to next broad age group. Deaths have most influence on the population of 65 and older and net-migration is relatively more influential in the age-group of the economic active.

Graph 26 Mean annual error per component in forecast time



In general, the birth component produces the largest error. Also changes in migration do not always seem to be easily predictable. Forecasts with start years in the 70s know a relatively large error in the mortality component. Combined errors in Forecast 1984 and 1985 were relatively large because all three components pointed in the same direction. Compensation caused a reduction in the error in the total population in other forecasts. For example, Forecast 1970 and 1972 seem to be quite accurate when evaluated in terms of total population, the errors underlying structure and in the components were one of the largest. In the first five years after the start of the forecast, the oldest forecasts benefit most from this effect. Five to nine years after the start of the forecast the compensation effect is in general higher. Now more recent forecast also benefit, although errors in the components are relatively small, the error of the total population is a bit a flattered.

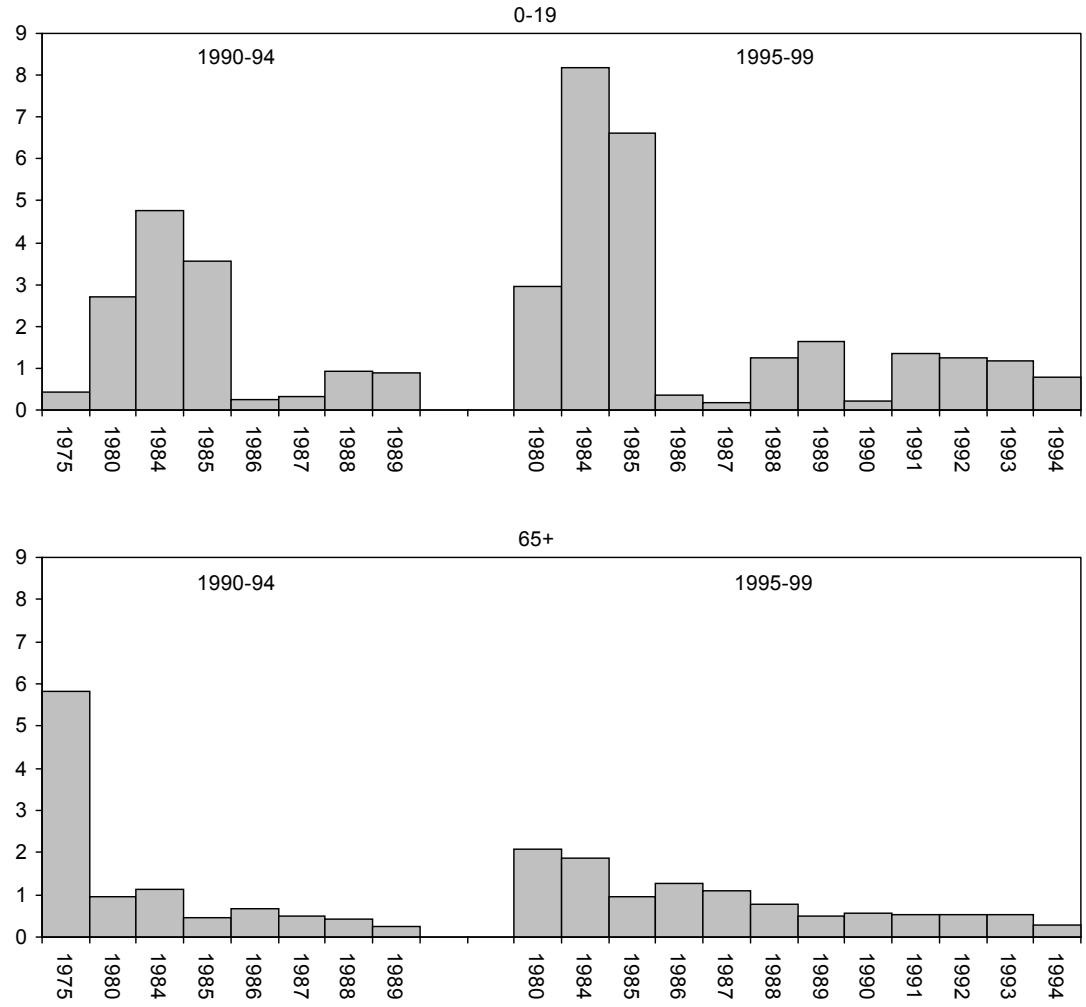
Graph 27 Total Population: mean absolute percentage forecast error in forecast time



Again we can also look at the forecast performance for calendar years. *Graph 27* gives the mean absolute percentage forecast error for the total population for five year forecast time periods. Most often forecast made closer to the calendar period under consideration show a better result. However, as we have seen before with the components, more recent forecast do not always give better results. Examples are Forecast 1980 for the period 1990-1995 and Forecast 1990 for the period 1995-2000.

Graph 28 shows for the 90s an overview of the age groups 0-19 and 65 and older. Changes in mortality are more gradual leading to better results for more recent forecasts. The birth component seems less predictable and adjustments for the short-term were often in the wrong direction or too strong.

Graph 28 Age groups 0-19 & 65+: mean absolute percentage error in forecast time



5.- Conclusion

There are some problems in comparing forecasts' performance. The period in which the forecast was made and period after making the forecast differ. Uncertainty about future trends and variance in recent trends are not the same at the time of making each forecast. Many errors measures exist and each could give a different outcome. Comparisons and evaluation always have to be seen in this perspective. In addition, the goal of a forecast is not to predict the exact changes from year to year. More important than following the yearly fluctuations is the trend across some years.

The fertility forecasts had problems with predicting the developments for the transition period from relative high fertility up till 1965 to low fertility levels after 1975. Crucial was how much of the decline or increase in fertility rates was attributable to change in age pattern and how to decline in ultimate number of children per woman. The total fertility rate is a period measure by changing age patterns of fertility this can lead to biases if we interpret it as a proxy for the ultimate number of children per woman. In the beginning of the sixties woman became mother at younger ages. This lead to an increase in the total fertility rate and to an over estimation of the expected ultimate number of children per woman. In the seventies and eighties the opposite happened; woman started postponing their children and stayed childless until much higher ages. This lead to an under estimation of the ultimate number of children per woman and to an over estimation of childlessness.

Another problem is how fast in the making of a new forecast one should adjust according to new developments. The distinction between temporary fluctuations and changes in trend is crucial. In the 90s, such cyclical fluctuations were, wrongly, partly interpreted as changes in trend.

In the previous century, 6.0 million immigrants were registered against 5.2 million emigrants. After World War II, the Netherlands was at first an emigration country. Since 1967 however, net-migration has not been negative. It took some time before it was realised that the Netherlands had become a permanent immigration country.

The explorative variant of Forecast 1950 and the alternative version of Forecast 1951 and 1959 were rightfully put at negative net-migration for the short-term (net-migration for the 1950s as a whole was –130 thousand). However, the level was too much directed by government policy that assumed a yearly departure of 50 thousand persons. Because

of this, the versions with zero migration assumptions gave after all a better result. For later forecast the assumption of zero migration was not a good choice.

In post war Netherlands, the economic recovery went off faster than had been expected in the first forecasts and less persons left and more came. Labour-migrants were brought to the Netherlands from the so called recruitment countries. Wrongly it was at first assumed that settlement would be temporary. Even with a downward business cycle, and against expectation, only a limited return migration took place. In Forecast 1975 some attention was given to this possibility, but adjustments were not made for the long-term migration forecast. Forecast 1986 stated explicitly that the Netherlands would, for the time being, keep on being an immigration country. Long-term assumptions were nevertheless put at zero net-migration. The next forecast, for the first time long-term net-migration levels were not put at zero and from then onward migration becomes an important component in the population forecasts. Until Forecast 1994, however, all forecasts assumed that in the short-term, migration levels would decline compared to the last observed values. Now and then though, long-term assumptions were raised.

From forecast to forecast each time it seemed that adjustments were too small. Large fluctuations and periodically strong declines of net-migration made interpretation of the trend difficult; the distinction between trend and short-term cyclical changes appeared complicated. From Forecast 1987 onward, term trends were rightfully not adjusted every year to recent observations.

The inflow of asylum seekers and refugees was initially not seen as permanent, or at least not as increasing. Phenomena like family reunion and family formation with foreign partners were noticed and predicted early, but each time it was assumed that restrictive government policy would reduce the flows. These interventions only had a short-term effect. Influences of changes in government policies and the law do have a stronger and more direct effect on migration than on mortality.

The life expectancy at birth has more than doubled in the past 150 years. Life extending factors such as public health system, medical knowledge and technology, hygiene and preventive medicine improved. Traffic regulations, laws regulating working conditions, the quality of housing, and personal life style more directed towards health, all have contributed to the decline in mortality.

In comparison with births and, especially, migration, the pattern of mortality from year to year is stable. With each new forecast, the long-term mortality assumptions have not always been adjusted. Since Forecast 1970, male life expectancies have been raised in small steps at a time. Despite (slightly) larger errors in female life expectancies, adjustments were less frequent.

Male mortality rates increased during the 60s and beginning of the 70s. These developments were wrongly seen as permanent. During the 70s the male mortality rates started to decline again and life expectancies started a continuous increase. Female life expectancies at birth showed a constant rise in the period under investigation. It appeared difficult to predict for how long this trend would prolong. Short-term changes were sometimes wrongly taken as signs of structural changes. From forecast 1984 onward, female life expectancies were underestimated. Long-term male levels were under-estimated. The forecast of the number of births reflects the same. For the middle and long-term they are more often over estimated. In contrary, from the 80s onward numbers of death for the short-term were most often under-estimated. Forecast with start years in the 50s and 70s gave worse results.

Methodology didn't change much. An attempt to include causes of death explicitly in the forecast model didn't give the expected results. Together with medical and technological developments, life-style is an important factor influencing death rates. The effects of life-style will often only influence the death rates after some years. Changes in smoking behaviour appeared to be a very strong predictor of developments in mortality and could also explain to a significant extent the differences between males and female levels of life expectancies.

The main question remains for how long life expectancies continue to rise and to what levels. The last years a stabilisation seems to take place, especially by female life expectancies. Improvements at (very) high ages is limited or absent. Therefore, a continuation of rising trends does not seem obvious.

The total population was forecasted accurately by Forecast 1972 and 1980. But a small error in the forecast of the total population does not mean that the assumptions basic to the forecast were correct. Because of compensating effects between age groups, caused by the three demographic components, the underlying age structure have large errors.

Forecast 1972, fore example, had wrong assumptions but because errors were compensating each other it predicted (by accident) the total population quite accurately.

Errors in the three broad age-groups (0-19, 20-64, and 65 and over) correlate with errors in the three components. The birth component is for the first twenty years exclusively related to the youngest age group. Mortality is especially an important factor for the population at pension ages. Migration has a stronger effect on the population in the economic active age-group (20-64 years). The youngest age-group gave most problems. Errors are mainly related to wrong assumptions on fertility. Changes in age-patterns and ultimate number of children per woman appeared difficult to distinguish (postponement or abandonment). Foreseeing the changes in net-migration was also relatively problematic. The strong fluctuations from year to year tended to increase the error, but also over a longer period changes were difficult to predict. Too often were settlement and the increase in flows seen as temporarily. The forecasting of mortality was the easiest of the three components and lead to the smallest errors. Because of the concentration of the error at higher ages, the percentage error for this age-group is similar to that of the age group 20 to 64 years. The worsening of the mortality trend in the 60s and early 70s was wrongly seen as a permanent change. Since then improvements beyond the short-term have in general been under-estimated, though adjustments did most often mean an improvement.

Significant improvements in short-term forecasts were not made during the fifty years of forecast practice. Hence it seems that methodological changes and more data and surveys has not been of much use. Improvements will also be difficult to achieve as forecast errors are already small. Most gain can therefore be achieved at young age groups by improving fertility forecasts and at the working age group by predicting net-migration more accurately. It is therefore better to concentrate on assumption making of the middle and long-term for these two components.

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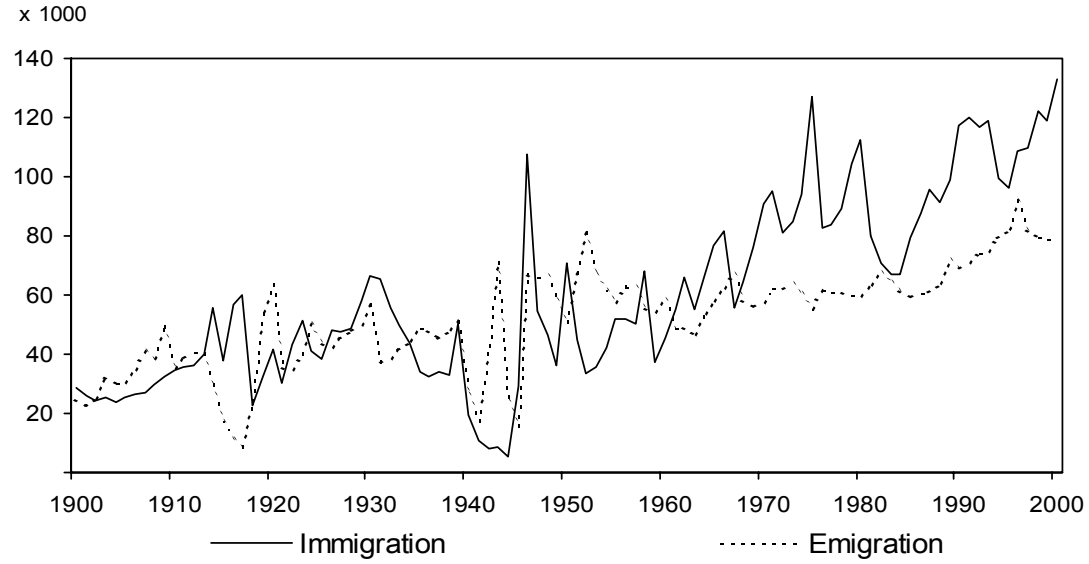
Appendix

Appendix A: Migration in the Netherlands

In the beginning of the 20th century more people were still leaving than coming to the Netherlands (Graph A1). Beside streams between neighbouring countries, migration consisted mainly of emigration to the traditional settlement colonies (North-America, South-Africa, and Australia and New Zealand). World War I changed things drastically; migration stopped and refugees came from Belgium (many of which were not registered). After the First World War most refugees returned. The worsening of the labour-market in the United States and in Germany resulted in immigration from these countries. During the Great Depression immigration slowed down again.

Graph A1: Immigration and Emigration, 1900-2000

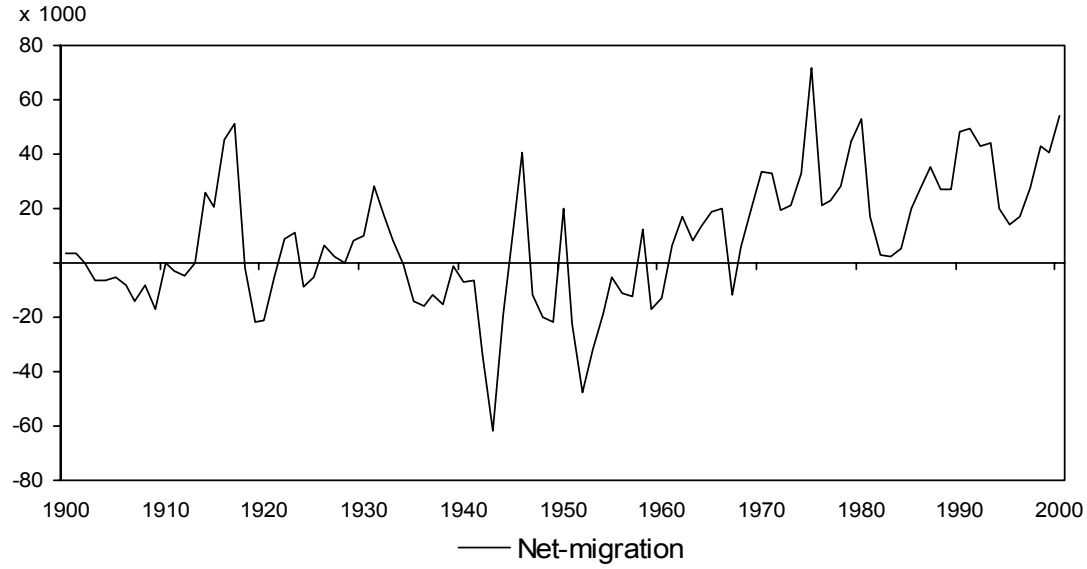


At the end of the 30s many refugees, especially Jewish, came from Germany. During the German occupation migration came to a stand still. The deportation during World War II of mainly Jews lead to a peak in the outflow of people. After the capitulation of Japan, many migrants came back from the Dutch Indies (currently Indonesia). First some Dutch also headed to the former colony but after re-colonisation seemed impossible most returned. After change of sovereignty, again some hoped to make a new start in Indonesia but after the crisis around New Guinea they returned. The group of more than 18 thousand South Moluccans (that had fought alongside the Dutch against the Indonesian freedom fighters) that arrived in 1951 were only registered as immigrants in 1958.

After the World War II, many Dutch sought a future in the traditional settlement colonies (mainly Canada and Australia). This migration flow lasted until the end of the 50s. After the improved economy in the Netherlands, immigration and emigration streams with these countries become more balanced. In the 60s the economic situation in Surname became worse and with the improved Dutch economy more and more immigrants came from Suriname. This increased rapidly once the first negotiations about independence started. In 1975, the year of Suriname's independence, the flow reached it's peak. In the period of transition during which Surinamese could settle reely in the Netherlands many more opted for the Netherlands.

In 1960, the Dutch and Italian government signed the first labour recruitment agreement. Spain, Portugal followed immediately and slightly afterwards Turkey and Greece followed by Morocco, Yugoslavia and Tunisia. The so called guest workers kept on coming during periods of economic downturn, also when the large stream, and potential labour force, came from Suriname. At first the labour migrants came alone but shortly afterwards spouses and children joined and settlement turned out to be less temporary than assumed at first. The assumption that these labour migrants would leave again in periods of economic downturn turned out to be largely unfounded. In 1975, by regularisation programme, over ten thousand illegally present workers were registered.

Graph A2: Net-migration



In 1973 no new working permits were issued to Turks and Moroccans, however, family reunion continued. Later family formative migration emerged, which at the end of the

eighties became an important part of immigration from the former recruitment countries. The determent policy at the end of the 80s (for example visa requirement for Surinamese, Turks and Moroccans, minimum income in case of family formative migration) resulted in a strong temporary decline in migration. Soon, however, immigration started to increase again. After again a tightening up of immigration regulations and an economic downturn, net-migration started to decline again. However, since the low of 1995, again an increase was registered. The high number of emigration in 1996 was mainly the result of administrative corrections.

Beside the Belgium refugees of the WW I and refugees from Germany and eastern-Europe before WW II some thousands refugees came from Hungary in 1956 and from Czechoslovakia in 1968. From the mid-80s the number of asylum seekers increased continuously. New conflicts and wars lead to new groups of refugees and asylum seekers (for example, Somalia in 1989 and especially 1994-95, Sri Lanka around 1990, Yugoslavia from 1991 onward, Rumania until 1994, Iran in and around 1994, Afghanistan and Iraq from 1993, Turkey from 1997, and the former Soviet Union since the political changes of ‘die Wende’.

Step by step the Netherlands had chanted from an emigration country into an immigration country. Various determent policies and tightening of immigration rules could not offset this process. Since 1967, net-migration has not been negative again.

Appendix B: Error measures used

mean absolute percentage error (MAPE): $\frac{1}{n}\sum_{t=1}^{n}\left(\left|\frac{O_t - F_t}{O_t}\right|\right)$

absolute percentage error (APE): $\left|\frac{F_t - O_t}{O_t}\right|$

percentage error (PE): $\frac{F_t - O_t}{O_t}$

mean percentage error (MPE): $\frac{1}{n}\sum_{t=1}^{n}\left(\frac{F_t - O_t}{O_t}\right)$

mean percentage error (MPE) population structure: $\frac{1}{n}\sum_{t=1}^{n}\sum_{x=1}^{x}\left(\frac{F_t - O_t}{O_t}\right)$

mean error (ME): $\frac{1}{n}(F_t - O_t)$

weighted percentage error (wPE): $\frac{\frac{1}{n}\left(\sum_{t=1}^{n}(F_t - O_t)\right)}{\frac{1}{n}\sum_{t=1}^{n}P_t}$ (where P = total population)

absolute average error (AME): $\left|\frac{1}{n}\sum_{t=1}^{n}(O_t - F_t)\right|$

sum absolute error (AE): $\sum_{t=1}^{n}|O_t - F_t|$

sum error (E): $\sum_{t=1}^{n}(F_t - O_t)$

mean absolute error (MAE): $\frac{1}{n}|O_t - F_t|$

Appendix C: Forecast Errors

Table A1 Births: mean absolute percentage error (MAPE)

	forecast time (in years)							
	0-4	5-9	10-14	15-19	20-24	0-9	10-19	0-19
1950	9.1	14.4	19.3	15.6	9.7	11.7	17.5	14.6
1951	1.3	2.5	7.8	2.4	26.4	1.9	5.1	3.5
1959	6.4	4.6	11.2	45.1		5.5	28.2	16.8
1965	13.0	50.6	97.0	108.6		31.8	102.8	67.3
1967	3.3	36.6	55.2	65.7	59.2	19.9	60.5	40.2
1970	20.5	54.9	57.2	50.4	42.2	37.7	53.8	45.8
1972	16.1	32.9	30.9	20.8	16.3	24.5	25.9	25.2
1975	0.7	6.2	7.2	0.5	6.2	3.5	3.9	3.7
1980	6.1	7.2	4.3	4.8		6.6	4.5	5.6
1984	5.1	11.0	9.9			8.0		
1985	4.3	9.2	10.0			6.7		
1986	2.1	2.3	5.1			2.2		
1987	1.3	3.9				2.6		
1988	1.7	2.6				2.1		
1989	3.6	2.1				2.9		
1990	1.7	3.6				2.7		
1991	3.5	5.3				4.4		
1992	5.0							
1993	5.9							
1994	6.0							
1995	3.1							
1996	5.3							

	calendar period							
	1960-64	1965-69	1970-74	1975-79	1980-84	1985-89	1990-94	1995-99
1950	19.3	15.6	9.7	25.8				
1951	7.2	3.6	17.8	47.8				
1959	7.2	3.6	17.8	47.8				
1965		13.0	50.6	97.0	108.6			
1967			19.0	52.5	62.5	62.4	58.6	68.2
1970			20.5	54.9	57.2	50.4	42.2	48.4
1972				33.9	31.4	25.1	16.2	12.9
1975				0.7	6.2	7.2	0.5	6.2
1980					6.1	7.2	4.3	4.8
1984						6.8	11.2	11.1
1985						4.3	9.2	10.0
1986							1.5	3.9
1987							1.7	3.9
1988							1.9	3.1
1989							3.8	2.3
1990							1.7	3.6
1992								7.1
1993								7.4
1994								6.4
1995								3.1

Table A2a Net-Migration: Absolute Mean Error (AME)

	forecast time (in years)							
	0-4	5-9	10-14	15-19	20-24	0-9	10-19	0-19
1950	20.2	6.7	6.5	10.7	28.0	13.4	8.6	2.4
1951	24.8	41.8	62.8	63.6	85.7	33.3	63.2	48.3
1959	20.4	29.4	45.4			24.9		
1965	10.7	28.0	37.8	16.1	27.2	19.3	27.0	23.2
1967	16.2	33.4	33.1	11.5	37.4	24.8	22.3	23.6
1970	28.0	37.8	16.1	27.2	41.1	32.9	21.7	27.3
1972	33.4	33.1	11.5	37.4	27.7	33.3	24.5	28.9
1975	17.8	10.1				13.9		
1980	9.6	15.8	33.2	21.8		3.1	27.5	15.3
1984	19.8	42.5	24.4			31.1		
1985	16.3	41.1	28.4			28.7		
1986	11.9	22.2	27.4			17.0		
1987	11.9	7.7				9.8		
1988	16.8	4.6				10.7		
1989	18.7	4.2				11.4		
1990	4.1	3.4				3.8		
1991	16.0	5.8				5.1		
1992	16.1							
1993	26.6							
1994	12.0							
1995	0.9							
1996	7.1							

	calendar period							
	1960-64	1965-69	1970-74	1975-79	1980-84	1985-89	1990-94	1995-99
1950	6.5	10.7	28.0	37.8				
1951	56.5	60.7	78.0	87.8				
1959	26.5	30.7	48.0					
1965		10.7	28.0	37.8	16.1	27.2	41.1	28.4
1967			28.0	37.8	16.1	27.2	41.1	28.4
1970			28.0	37.8	16.1	27.2	41.1	28.4
1972				37.8	16.1	27.2	41.1	28.4
1975				17.8	10.1			
1980					9.6	15.8	33.2	21.8
1984						25.2	41.1	28.4
1985						16.3	41.1	28.4
1986							27.7	19.4
1987							21.1	8.4
1988							21.1	8.4
1989							18.1	8.4
1990							4.1	3.4
1992								5.8
1993								19.0
1994								10.2
1995								0.9

Table A2b Net-migration: absolute mean error of Alternative Forecasts (x1000)

	forecast time (in years)							
	0-4	5-9	10-14	15-19	20-24	0-9	10-19	0-19
1950	29.8	43.3	56.5	60.7	78.0	36.6	58.6	47.6
1951	25.2	8.2	12.8	13.6	35.7	16.7	13.2	1.7
1959	0.4	9.4	25.4			4.9		
1970	8.3							
1975	37.8	16.1	27.2	41.1	28.4	27.0	34.1	30.6

	calendar period							
	1950-54	1955-59	1960-64	1965-69	1970-74	1975-79	1980-84	1985-89
1950	29.8	43.3	56.5	60.7	78.0	87.8		
1951		6.7	6.5	10.7	28.0	37.8		
1959			6.5	10.7	28.0			
1970	39.8							
1975						37.8	16.1	27.2

Table A3 Deaths: mean absolute percentage error (MAPE)

	forecast time (in years)							
	0-4	5-9	10-14	15-19	20-24	0-9	10-19	0-19
1950	7.1	11.0	12.0	10.2	10.9	9.0	11.1	10.1
1951	8.4	8.6	6.3	2.9	3.8	8.5	4.6	6.6
1959	5.1	10.8	18.1	17.7		8.0	17.9	12.9
1965	1.9	3.5	3.6	4.0		2.7	3.8	3.3
1967	3.3	2.8	3.2	2.5	3.1	3.0	2.9	3.0
1970	3.0	10.0	15.5	15.3	14.9	6.5	15.4	10.9
1972	4.7	13.3	14.4	15.4	14.1	9.0	14.9	11.9
1975	5.7	9.7	10.3	11.2	12.8	7.7	10.7	9.2
1980	0.7	2.0	4.4	7.9		1.4	6.1	3.8
1984	2.3	4.9	2.0			3.6		
1985	1.5	2.6	1.7			2.0		
1986	1.7	2.1	3.1			1.9		
1987	1.0	1.9				1.5		
1988	1.6	1.9				1.8		
1989	1.9	1.0				1.5		
1990	1.6	1.0				1.3		
1991	1.5	1.2				1.4		
1992	1.8							
1993	1.6							
1994	1.1							
1995	1.4							
1996	0.7							

	calendar period							
	1960-64	1965-69	1970-74	1975-79	1980-84	1985-89	1990-94	1995-99
1950	12.0	10.2	10.9	17.4				
1951	7.1	3.7	3.1	8.3				
1959	5.9	12.9	18.1	17.6				
1965		1.9	3.5	3.6	4.0			
1967			3.9	3.4	3.2	2.8	2.1	1.6
1970			3.0	10.0	15.5	15.3	14.9	15.6
1972				9.9	14.9	14.8	14.4	15.2
1975				5.7	9.7	10.3	11.2	12.8
1980					0.7	2.0	4.4	7.9
1984						3.3	4.4	1.6
1985						1.5	2.6	1.7
1986							2.1	2.7
1987							1.9	2.7
1988							2.0	1.0
1989							1.5	1.0
1990							1.6	1.0
1992								1.0
1993								1.0
1994								1.3
1995								1.4

Table A4 Total Population: mean absolute percentage error (MAPE)

	forecast time (in years)							
	0-4	5-9	10-14	15-19	20-24	0-9	10-19	0-19
1950	0.147	1.127	3.302	5.630	7.205	0.637	4.466	2.551
1965	0.387	2.267	6.380	11.501	17.247	1.327	8.941	5.134
1967	0.470	0.342	2.025	5.058	7.728	0.406	3.541	1.974
1970	0.254	1.409	3.361	5.378	6.085	0.832	4.369	2.601
1972	0.295	0.094	0.836	0.793	0.086	0.194	0.814	0.504
1975	0.162	0.706	0.781	2.350	3.899	0.434	1.565	1.000
1980	0.337	0.674	0.277	0.838		0.506	0.557	0.531
1984	0.396	1.970	3.408			1.183		
1985	0.368	1.963	3.315			1.166		
1986	0.125	0.835	1.503			0.480		
1987	0.128	0.557				0.343		
1988	0.257	0.628				0.442		
1989	0.415	0.746				0.580		
1990	0.053	0.149				0.101		
1991	0.303	0.949				0.626		
1992	0.385							
1993	0.673							
1994	0.496							
1995	0.074							
1996	0.292							

	calendar period							
	1960-64	1965-69	1970-74	1975-79	1980-84	1985-89	1990-94	1995-99
1950	2.812	5.233	6.997	7.475				
1965		0.231	1.692	5.467	10.359	16.171	21.330	27.840
1967			0.512	0.774	3.058	6.266	8.554	11.199
1970				1.060	2.902	5.091	5.983	6.988
1972				0.260	0.292	0.986	0.465	0.198
1975					0.715	0.633	1.990	3.532
1980						0.714	0.289	0.655
1984						0.396	1.970	3.408
1985							1.605	3.008
1986							0.538	1.100
1987							0.356	0.567
1988							0.399	0.634
1989							0.415	0.746
1990								0.148
1991								0.848
1992								0.750
1993								0.916
1994								0.496

Table A5 Population 0-19: mean absolute percentage error (MAPE)

	forecast time (in years)							
	0-4	5-9	10-14	15-19	20-24	0-9	10-19	0-19
1950	0.941	4.133	9.076	14.443	16.704	2.537	11.759	7.148
1965	1.540	8.152	23.527	45.687	72.886	4.846	34.607	19.727
1967	0.448	2.530	11.427	25.684	42.333	1.489	18.556	10.022
1970	1.097	8.297	19.425	33.512	43.575	4.697	26.469	15.583
1972	0.474	4.577	11.375	17.725	20.709	2.526	14.550	8.538
1975	0.214	0.773	0.958	0.331	1.506	0.493	0.644	0.569
1980	0.830	2.636	2.689	2.848		1.733	2.769	2.251
1984	0.936	4.755	8.193			2.845		
1985	0.882	4.284	7.288			2.583		
1986	0.070	0.338	0.867			0.204		
1987	0.163	0.314				0.238		
1988	0.625	1.273				0.949		
1989	0.875	1.619				1.247		
1990	0.129	0.223				0.176		
1991	0.421	1.611				1.016		
1992	0.592							
1993	0.796							
1994	0.771							
1995	0.093							
1996	0.973							

	calendar period							
	1960-64	1965-69	1970-74	1975-79	1980-84	1985-89	1990-94	1995-99
1950	7.990	13.470	16.839	13.383				
1965		0.927	6.160	19.883	40.503	67.676	91.539	106.528
1967			0.587	5.654	16.286	32.388	47.987	55.129
1970				6.447	16.797	30.822	42.378	44.403
1972				1.619	6.912	14.205	19.641	19.540
1975					0.803	0.866	0.423	1.016
1980						2.458	2.714	2.951
1984						0.936	4.755	8.193
1985							3.540	6.628
1986							0.245	0.352
1987							0.325	0.174
1988							0.908	1.249
1989							0.875	1.619
1990								0.217
1991								1.336
1992								1.243
1993								1.162
1994								0.771

Table A6 Population 20-64: mean absolute percentage error (MAPE)

	forecast time (in years)							
	0-4	5-9	10-14	15-19	20-24	0-9	10-19	0-19
1950	0.490	1.244	1.119	0.550	1.113	0.867	0.834	0.851
1965	0.347	1.089	2.141	3.059	3.065	0.718	2.600	1.659
1967	0.559	1.495	2.544	3.311	4.574	1.027	2.928	1.977
1970	0.686	1.918	3.120	4.310	5.429	1.302	3.715	2.508
1972	0.526	1.799	2.859	4.379	5.792	1.162	3.619	2.391
1975	0.052	0.387	0.819	2.495	3.954	0.219	1.657	0.938
1980	0.154	0.013	1.091	1.950		0.083	1.521	0.719
1984	0.300	1.502	2.668			0.901		
1985	0.252	1.571	2.684			0.912		
1986	0.144	1.011	1.726			0.578		
1987	0.086	0.594				0.340		
1988	0.216	0.672				0.444		
1989	0.370	0.675				0.523		
1990	0.086	0.027				0.029		
1991	0.297	0.807				0.552		
1992	0.318							
1993	0.681							
1994	0.432							
1995	0.068							
1996	0.099							

	calendar period							
	1960-64	1965-69	1970-74	1975-79	1980-84	1985-89	1990-94	1995-99
1950	1.183	0.665	0.731	3.713				
1965		0.267	0.905	1.908	2.915	3.174	1.859	3.666
1967			0.905	1.908	2.915	3.721	4.939	2.960
1970				1.640	2.915	4.017	5.420	3.604
1972				1.015	2.281	3.372	5.189	5.454
1975					0.367	0.628	2.121	3.641
1980						0.168	0.834	1.758
1984						0.300	1.502	2.668
1985							1.260	2.442
1986							0.643	1.354
1987							0.357	0.625
1988							0.378	0.699
1989							0.377	0.675
1990								0.071
1991								0.763
1992								0.602
1993								0.905
1994								0.432

Table A7 Population 65+: mean absolute percentage error (MAPE)

	forecast time (in years)							
	0-4	5-9	10-14	15-19	20-24	0-9	10-19	0-19
1950	0.753	2.652	4.720	6.288	7.167	1.702	5.504	3.603
1965	0.203	0.263	0.350	1.397	2.157	0.233	0.873	0.553
1967	0.191	0.228	0.804	1.662	2.447	0.210	1.233	0.721
1970	0.168	1.696	4.451	7.235	9.921	0.932	5.843	3.387
1972	0.556	2.833	5.481	8.291	10.756	1.694	6.886	4.290
1975	0.759	2.539	4.280	6.206	7.978	1.649	5.243	3.446
1980	0.077	0.272	1.163	2.366		0.174	1.764	0.969
1984	0.268	1.118	1.854			0.693		
1985	0.132	0.549	0.959			0.341		
1986	0.314	0.924	1.626			0.619		
1987	0.241	0.846				0.544		
1988	0.304	0.758				0.531		
1989	0.248	0.511				0.380		
1990	0.247	0.605				0.426		
1991	0.253	0.573				0.413		
1992	0.317							
1993	0.415							
1994	0.291							
1995	0.368							
1996	0.051							

	calendar period							
	1960-64	1965-69	1970-74	1975-79	1980-84	1985-89	1990-94	1995-99
1950	5.394	7.746	8.143	9.790				
1965		0.218	0.262	0.208	1.210	2.023	2.625	2.837
1967			0.262	0.208	1.210	2.023	2.625	2.837
1970				1.232	3.892	6.686	9.402	11.794
1972				1.301	3.904	6.635	9.319	11.652
1975					2.192	3.927	5.822	7.607
1980						0.170	0.948	2.083
1984						0.268	1.118	1.854
1985							0.444	0.947
1986							0.674	1.282
1987							0.480	1.110
1988							0.420	0.790
1989							0.248	0.511
1990								0.576
1991								0.532
1992								0.541
1993								0.518
1994								0.291