

# ***WORKING PAPER***

SOME DEMOGRAPHIC ASPECTS OF AGING  
IN THE GERMAN DEMOCRATIC REPUBLIC

Thomas Büttner  
Wolfgang Lutz  
Wulfram Speigner

November 1987  
WP-87-116

**SOME DEMOGRAPHIC ASPECTS OF AGING IN  
THE GERMAN DEMOCRATIC REPUBLIC**

*Thomas Büttner  
Wolfgang Lutz  
Wulfram Speigner*

November 1987  
WP-87-116

*Working Papers* are interim reports on work of the International Institute for Applied Systems Analysis and have received only limited review. Views or opinions expressed herein do not necessarily represent those of the Institute or of its National Member Organizations.

INTERNATIONAL INSTITUTE FOR APPLIED SYSTEMS ANALYSIS  
A-2361 Laxenburg, Austria

## Preface

If people are going to live longer, then the community will have a larger proportion of old people. This is true, but only if other things remain the same, and especially if birth rates remain the same. Rising birth rates could counteract improved survival. In fact birth rates have fallen, in the GDR as in other industrialized countries, so to the survival effect is added a low birth rate effect, and the latter is the major component of aging as it is actually occurring.

What aging has taken place so far, in the GDR as elsewhere in the industrialized world, is slight compared with what is expected to take place before the new century is much advanced. The relatively high births that followed World War II are now adults moving towards the middle working years, and aging will intensify in the future. The people born in the late 1940s and 1950s offer plentiful experienced labor, and that has always been a clear advantage for production. But when technology moves very rapidly experience may become inapplicable, and the question is then whether people at middle ages can unlearn what they know and develop new skills. If they are slow to do so the shortage of young people will seriously handicap production.

This and allied questions are not directly addressed in the present paper, but it does provide the demographic framework for their analysis. The population problem, wherever there is one, shows itself as tendencies that will develop their acutest form in the future. That is why so much of demography is concerned with projections or forecasts. The prospects for industry with its presently aging labor force, the prospects for the overall efficiency of the economy when large numbers start to retire about 2015, the social as well as the economic consequences of an aging society, these are the issues that underly the considerations of this paper. It is an example of fruitful collaboration between IIASA and scholars of a member country.

Nathan Keyfitz  
Leader  
Population Program

## **Contents**

|   | <i>Page</i> |
|---|-------------|
| INTRODUCTION  | 1           |
| 1. CURRENT DEMOGRAPHIC PROFILE OF THE GERMAN<br>DEMOCRATIC REPUBLIC         | 2           |
| 1.1. Population Age Structure and Sex Ratio                                 | 2           |
| 1.2. Reproduction   | 5           |
| 1.3. Mortality  | 6           |
| 1.4. Migration and Regional Structure                                       | 7           |
| 1.5. Nuptiality and Marital Status Distribution                             | 8           |
| 2. COMPONENTS OF THE AGING PROCESS  | 10          |
| 2.1. Age Distributional Changes   | 10          |
| 2.2. Mortality  | 16          |
| 2.3. Fertility  | 20          |
| 2.3.1 Past Trends   | 20          |
| 2.3.2 Sociological Findings: Social Conditions, Value<br>Patterns and Needs | 27          |
| 2.3.3 Further Trends  | 29          |
| 3. SELECTED MULTI-STATE MODEL   | 31          |
| 3.1. Aging and Changes in the Marital Status<br>Distribution                | 31          |
| 3.1.1 Period Multi-State Tables   | 32          |
| 3.1.2 Marital Status Forecasts  | 34          |
| 3.2. Changes in the Spatial Population Distribution                         | 40          |
| CONCLUDING REMARKS  | 45          |
| REFERENCES  | 51          |

## **SOME DEMOGRAPHIC ASPECTS OF AGING IN THE GERMAN DEMOCRATIC REPUBLIC**

*Thomas Büttner, Wolfgang Lutz and Wulfram Speigner*

### **INTRODUCTION**

Like most other European countries the German Democratic Republic experiences fundamental changes in the age composition of its population. This does not only have direct effects on the social security system but also exerts indirect influence on a number of very important social variables ranging from living arrangements to family lifestyles and the structure of the labor force up to socio-cultural values.

Adverse quantitative effects of changes in the population's age structure will not become actually dramatic until the end of this century. However, socio-political measures to counteract some of these problems should already be implemented by the end of the century. For this reason in the German Democratic Republic, as in many other countries, there is noticeable political demand for scientific research in the field of aging.

The present paper grew out of collaborative research between the Institute for Sociology and Social Policy (ISS) of the GDR Academy of Sciences and IIASA's Population Program. This paper is based on two previous studies prepared by the ISS for IIASA, namely

- Major results obtained from the first analyses of causes, course and effects of the shift of age structure in the GDR, the period 1982 to 2010" (December 1984).
- "Demographic processes in the regions of the GDR, 1980 to 2010" (April 1986).

In the current paper we try to highlight some of the major findings of this previous research and add some new aspects to give a concise and relevant picture of demographic factors associated with population aging in the German Democratic Republic.

## **1. CURRENT DEMOGRAPHIC PROFILE OF THE GERMAN DEMOCRATIC REPUBLIC**

### **1.1. Population Age Structure and Sex Ratio**

Population size and age structure as well as the sex ratio are not simply components of current social developments but have also been affected by historical events and social, economic, and demographic settings of the past. Moreover, the current demographic situation will determine to some extent the demographic, social, and economic future. For this reason we choose the current status of the population as our point of departure for this study.

The last census held on 31 December 1981 recorded 16.706 million inhabitants (resident population) in the German Democratic Republic. With 154 persons per square kilometer the GDR is among the most densely populated countries of Europe.

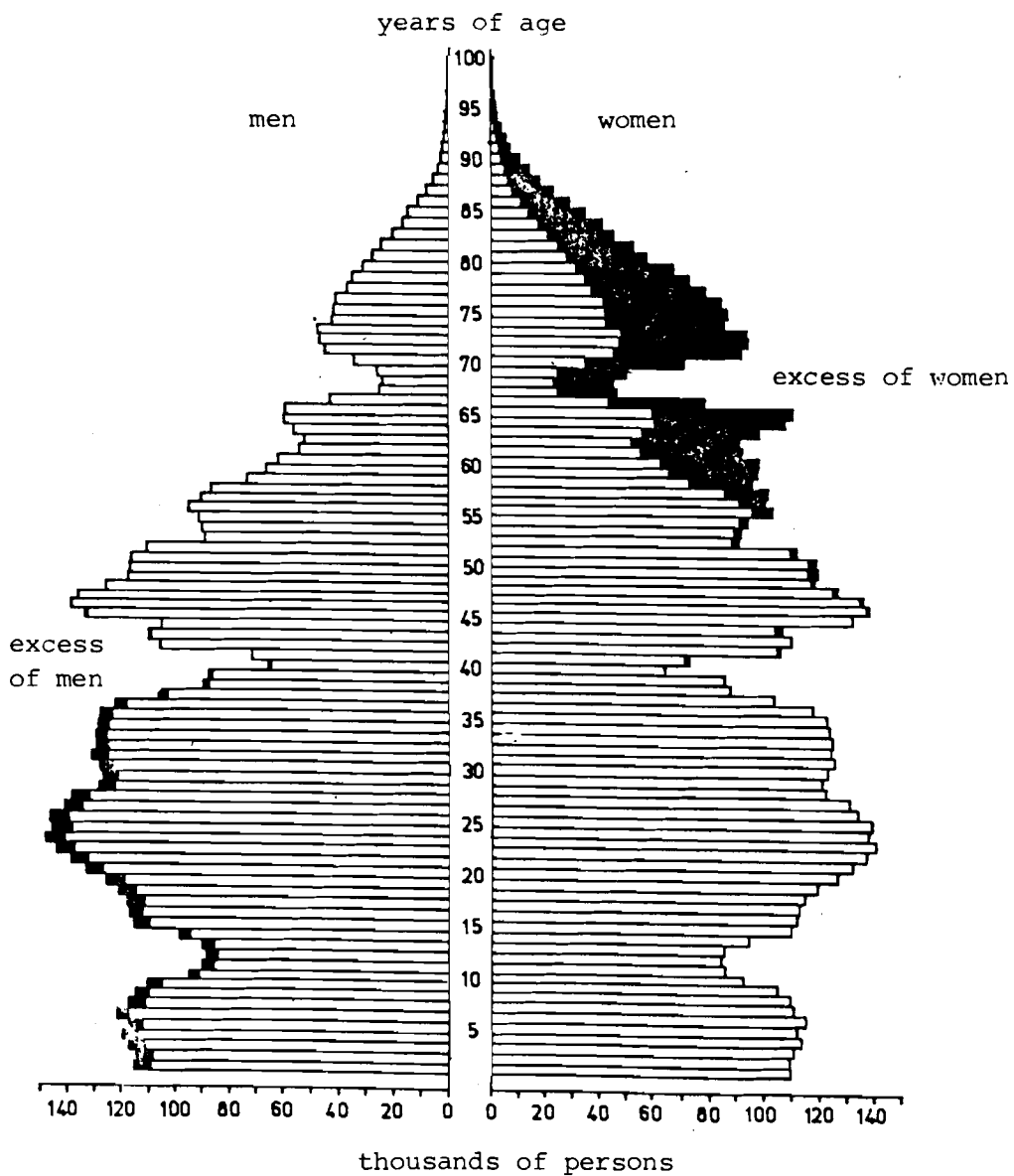
By the end of 1985 the population amounted to 16.640 million inhabitants. The uneven age distribution and the disproportions of sexes within the higher age groups (preponderance of women) have imparted and will impart special dynamics to the population development. It is, to a large extent, for this reason that demographic processes often exhibit great annual fluctuations.

For historical reasons mainly, two world wars and a history of higher life expectancy of females, there is a total excess of women over men beginning at age 40. In 1985 1.092 million females more than males were recorded in the age groups above age 40.

In 1985 the overall sex ratio (defined as the number of females per 100 males) was 111; it is of different size for the main age groups of the population. The sex ratio for the age group of children (0-14) was 95, for people in working age about 100, but for persons in pension age, it deviates with a value of 195 significantly from the average.

With respect to the age composition of the population, different definitions and approaches are possible. Especially in a planned economy great demand exists for detailed information on size, composition and development of a variety of different age groups. Therefore a system of age group definitions was elaborated and introduced into planning mechanisms. These definitions are related to such predefined categories as working age delimitation, but also for smaller and more specific age groups to be applied to the analysis of demand for kindergarten or school

Figure 1. Age structure of the population by age and sex in 1985.



enrollment.

The most important age groups--children, working age, pension age/retirement age--are in the GDR officially defined as follows:

children: from 0 to 13 years, plus 7/12 of persons aged 14;

working age: from 15 to 64 (males) or 59 (females), plus 5/12 of persons aged 14;

retirement age: from 65 for males or 60 for females respectively.

For reasons of international comparability in this study, we use another classification of broad age groups:

children: 0 to 14;  
 working age: 15 to 59;  
 aged persons: 60 and older.

For the total population in 1985 the three main age groups amounted to 3.19 million of children, 10.40 million for people in working age, and 3.04 million in older ages (pension age).

Consequently, the percentage of children was 19.2%, of people in working age 62.5%, and of aged persons 18.3%.<sup>1</sup> Superimposed to this are significant differences between the sexes. The percentage of aged women (23.9%) is remarkably higher than that of aged males (13.1%).

Table 1. Dependency ratios, GDR, 1985.

| Dependency ratios |      |     | Population aged<br>0-14 per 1000<br>of population<br>aged 60+ |
|-------------------|------|-----|---|
| Total             | 0-14 | 60+ |   |
| 599               | 307  | 292 | 1050  |

The dependency ratios which also reflect the population age structure indicate a fairly favorable demo-economic current situation as compared with the past, as well as with mid-term projections of changes in the population age structure (section 2.1). In other words, currently the cohorts born during the high fertility period after World War II (the so-called "baby boom") are in their working

<sup>1</sup>There is, of course, a slight difference between such indicators based on the age breakdown officially used in the GDR and those used here. For instance, the percentages according to national definitions are (for total population): 18.6% children, 64.8% in working age, and 16.6% in pension age.



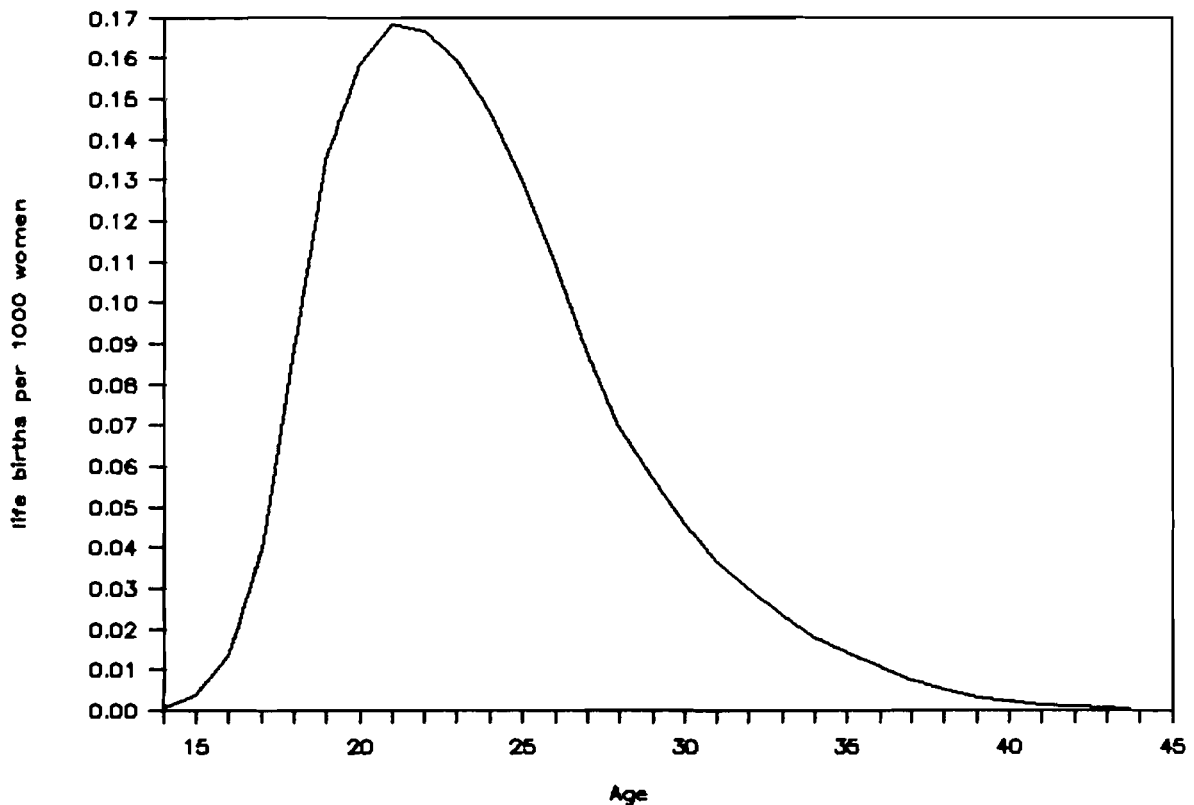
ages. Not before these cohorts reach retirement age, will the situation become critical.

## 1.2. Reproduction

In 1985 227,648 life births had been recorded which makes a crude birth rate of 13.7. At the same time there were 225,353 deaths, implying a crude death rate of 13.5. This setting yielded an excess of 2,295 thousand life births over deaths—or 0.2 per thousand inhabitants.

The Total Fertility Rate (TFR) was 1.73 in 1985 which can be viewed as about 0.83% of replacement. A special feature of fertility in the GDR is its concentration on young age groups.

Figure 2. Age-specific fertility in the GDR, 1985.

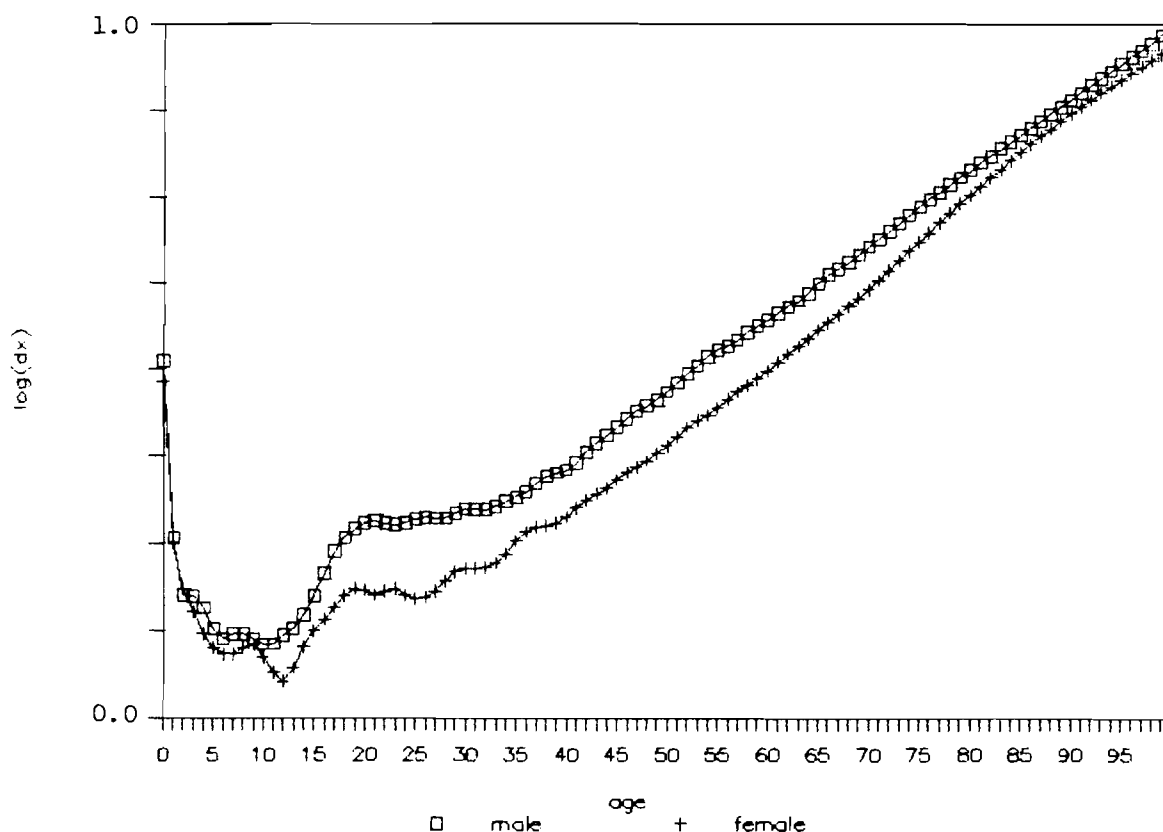


The highest age-specific fertility rate was observed in the age group 22–23 (166.4); already around the age of 35 years the reproductive career of women is almost finished: more than 98% of the TFR happened up to this age. Even up to the

age of 30 more than 91% of period fertility is completed. This special pattern of high age concentration of fertility has also been reflected by the actual parity distribution of births. In 1985 the percentage of first order births was 48.5%; of second order 37.0%, third order 10.6%, and all other orders together amounted to not more than 3.9%.

### 1.3. Mortality

Figure 3. Age-specific death rates (according to life table for 1984/85).



Due to the specific age structure of the GDR population the absolute number of annual deaths has been relatively high during recent years. Already since 1955 the crude death rates have always been somewhat above 12 per thousand (13.5 in 1985).

The latest life table available (for the 1984/85 period) shows a life expectancy for newborn males of 69.45 years and of 75.29 years for newborn females. The infant mortality rate was fairly low (9.4 per thousand in 1985). The age pattern of

mortality follows the well-known J-curve, where at each age male mortality is higher than female mortality with the greatest gap between ages 20 and 25. This difference is mainly due to a higher risk of accidents for males.

#### 1.4. Migration and Regional Structure

There is considerable concentration in the spatial distribution of population between the capital Berlin, the 14 districts, 28 urban and 191 rural counties together with 7550 communities. A remarkable share of the population is living in large cities. 26.4% of the population live in 15 cities with more than 100,000 inhabitants. Only 23.4% of the population is living in communities with less than 2,000 inhabitants. This settlement structure, as well as the total distribution of the population at large, is substantially influenced by past streams of internal migration rather than differentials in natural growth. The total scope of internal migration has, in the long run, declined in its volume.

Table 2. Internal migration flows: number of migrants crossing county-border, 1955-1983 (in thousands).

| Year | Males | Females | Total |
|------|-------|---------|-------|
| 1955 | 453.4 | 318.0   | 771.4 |
| 1960 | 355.1 | 267.3   | 622.4 |
| 1965 | 278.6 | 220.0   | 498.6 |
| 1970 | 136.4 | 134.0   | 270.4 |
| 1975 | 140.8 | 137.7   | 278.5 |
| 1980 | 141.6 | 138.1   | 279.7 |
| 1985 | 139.7 | 136.0   | 275.7 |

Still at the beginning of the 1960s more than 600,000 persons changed their place of residence annually (e.g. internal migration beyond the borders of counties). Within the 1960s the volume of internal migration was reduced to half and in the 1970s it remained unchanged at about 300,000 cases of migration per annum. The internal migration of the GDR is characterized by a well-balanced sex ratio.

Migration in the GDR has, for decades, been done from the small communities into medium-type communities and especially into the largest towns or cities. The biggest migration losses have again been suffered by the smallest communities with a size of below 2000 inhabitants, whereas the big cities with more than 100,000 inhabitants show the greatest gain from migration.

External migration had contributed to changes in the age composition on the national level. In the fifties there had been a population loss of around 2 million people, mainly in working age due to migration into the GFR.

### 1.5. Nuptiality and Marital Status Distributions

Table 3. Marital status: population over 18 years by sex and marital status (in percentages).

| Year           | Total | Never   |         |         |          |
|----------------|-------|---------|---------|---------|----------|
|                |       | Married | Married | Widowed | Divorced |
| <b>MALES</b>   |       |         |         |         |          |
| 1964           | 100   | 13.9    | 79.9    | 4.5     | 1.7      |
| 1970           | 100   | 15.6    | 77.8    | 4.3     | 2.3      |
| 1975           | 100   | 17.3    | 75.3    | 4.1     | 3.3      |
| 1981           | 100   | 19.9    | 71.6    | 4.8     | 4.8      |
| <b>FEMALES</b> |       |         |         |         |          |
| 1964           | 100   | 12.6    | 62.4    | 20.3    | 4.7      |
| 1970           | 100   | 12.6    | 62.2    | 20.0    | 5.2      |
| 1975           | 100   | 12.9    | 61.4    | 19.6    | 6.1      |
| 1981           | 100   | 13.9    | 60.3    | 18.4    | 7.4      |

In 1985 131,514 marriages were contracted. On the other hand, the dissolutions of marriages (by death of spouse and divorce) amounted to 140,143, that is an excess of dissolutions over marriages by 8,629. The death of a spouse contributed with 88,903 and divorce with 51,240 to the total amount of marriage dissolutions. With 30.8 divorces per 10,000 of population, the total level of divorce is fairly high. Under the current nuptiality pattern about every fifth marriage is expected to be divorced.

In the last four decades we may distinguish between two periods. From the early fifties to 1964 one could observe a continuous excess of marriages and remarriages over marriage dissolutions. As a result the number of married couples increased by half a million. From 1964 until now in every year, with the exception of 1977, more dissolutions of marriages occurred than marriages were contracted. This resulted in a decrease of the the number of married couples decreased by some 140 thousand. Consequently, the marital status structure of resident population changed slowly but significantly. The changes relate, in particular, to the ages

between 18 and 40 years.

As a result of decreasing frequencies of marriages as well as increasing frequencies of divorce, the proportion of married population fell in favor of never married and divorced persons. In the explanations of this phenomenon, sex differentials play a major role. The increase in the number of never married persons originates to a large extent from a growing number and proportion of never married males; the percentage of never married females has increased only slightly. At the same time the proportion of married males has decreased.

## **2. COMPONENTS OF THE AGING PROCESS**

The process of population aging is to be viewed as a long-term process. Many of the current phenomena seen as aging-related are outcomes of events in the past. Hence, the current demographic situation will have impacts on the future as well. The generations who will experience a thoroughly aged society are already born today. Assuming the same retirement regulations as today, the newborn generation of 1987 will retire in 2047 if female, and in 2052 if male, a period that is not covered by usual population projections.

Fertility and mortality are the main demographic components of population aging. Because of the overwhelming importance fertility has for the population development, the main attention has been given to fertility. Fertility is the component that has exhibited the most remarkable dynamics of change, in terms of the absolute and relative amount of change within the last four decades. Much more than mortality, fertility is subject to a high amount of individual and societal control, which makes it dependent on a wide variety of non-demographic factors.

For this reason, in the following section we will extend the purely demographic analysis to look at some sociological dimensions of reproductive behavior, that is to ask for the motivations and value patterns behind the demographic events registered in vital statistics.

Less attention is given to mortality as a component of aging. The figures and estimations given in this study seem to support the assumption that current mortality patterns are relatively stable, but they do not provide us with a certain mortality scenario. No doubt, more attention has to be given to the analysis of possible future changes in mortality which seems to be a task of its own.

Before studying the individual components of aging, we will have a close look at past, present, and projected future changes in the population's age structure. Our focus will be the period 1950 to 2010 for more detailed statistics and to 2030 for a long-run prospective.

### **2.1. Age Distributional Changes**

When studying the process of aging it is of certain interest to look at both the absolute changes in the size of certain/broad age groups and the relative shares of these age groups in the total population. For some socio-economic questions the absolute numbers approach is more appropriate, for others the relative approach.

In this study we will consider both.

Besides the quantitative description of age distributional changes by certain indicators, e.g. dependency ratios, it is very instructive to study the development visually. A visual 3-D view helps to identify the major features of the pattern and, on the other hand, includes the complete age-specific information, that is lost in the case of summary indicators.

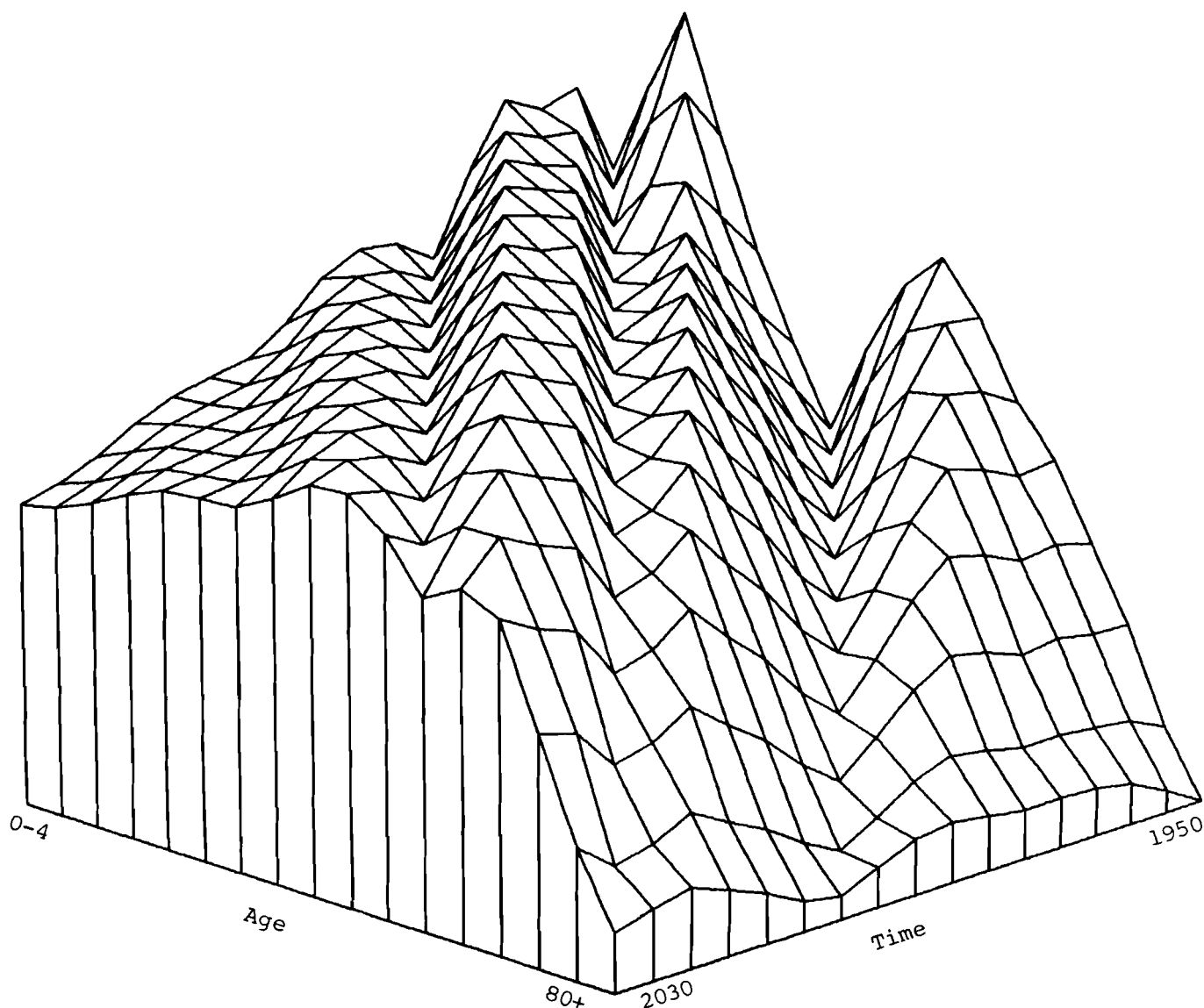
Figures 4 and 5 give an impression of age distributional changes for both the past three decades and the next four decades by using a 3-D plot of population age distribution for male and females, respectively. The plots are based on the population by five-year age groups for every five-year period from 1950 to 2030. For the period 1950 to 1985 data from national statistics had been used, and for the period from 1990 to 2030, the results of *status quo* forecast had been plotted with the initial data of 1985.

Although somewhat smoothed, the plots clearly show the long-term consequences of the irregular age distribution of GDR population, reflecting both population losses during the time after World War I and the effects of World War II. The pictures are characterized by several ridges running along the cohort lines from back to front. To the very right you have great cohorts born before World War I that still were subject to high mortality; for this reason the ridge declines rapidly. After the low cohorts of the war and depression years, fertility reaches another peak right after World War II, followed by the peak of the baby boom that was born at the end of the fifties and during the 1960s. The ridge of the baby boom is expected to decrease much less than previous ridges because of lower mortality (and possibly reduced outmigration). To the very left we see another rather weak ridge, the echo of the baby boom, i.e. the great cohorts of young women will again give birth to a greater absolute number of children when they are in their prime child-bearing ages.

Considering broad age groups the age structure changed from 1950 up to the 1980s as follows (see Table 4). From 1950 to the beginning of the 1970s the percentage of people in economic active ages decreased significantly from 61% to 54.7% and the share of aged persons increased from 16.2% to 22%. In the same period the percentage of children fell and rose again.

A clear trend towards an aging of the population was broken by the influences of a highly disturbed age structure and the effects of the post-war baby boom. Consequently, after 1970 there was a temporary increase of the percentage of people in working age, and a decrease in the share of aged persons. The percen-

Figure 4. Age distributional changes for females in the GDR, 1950-2030.

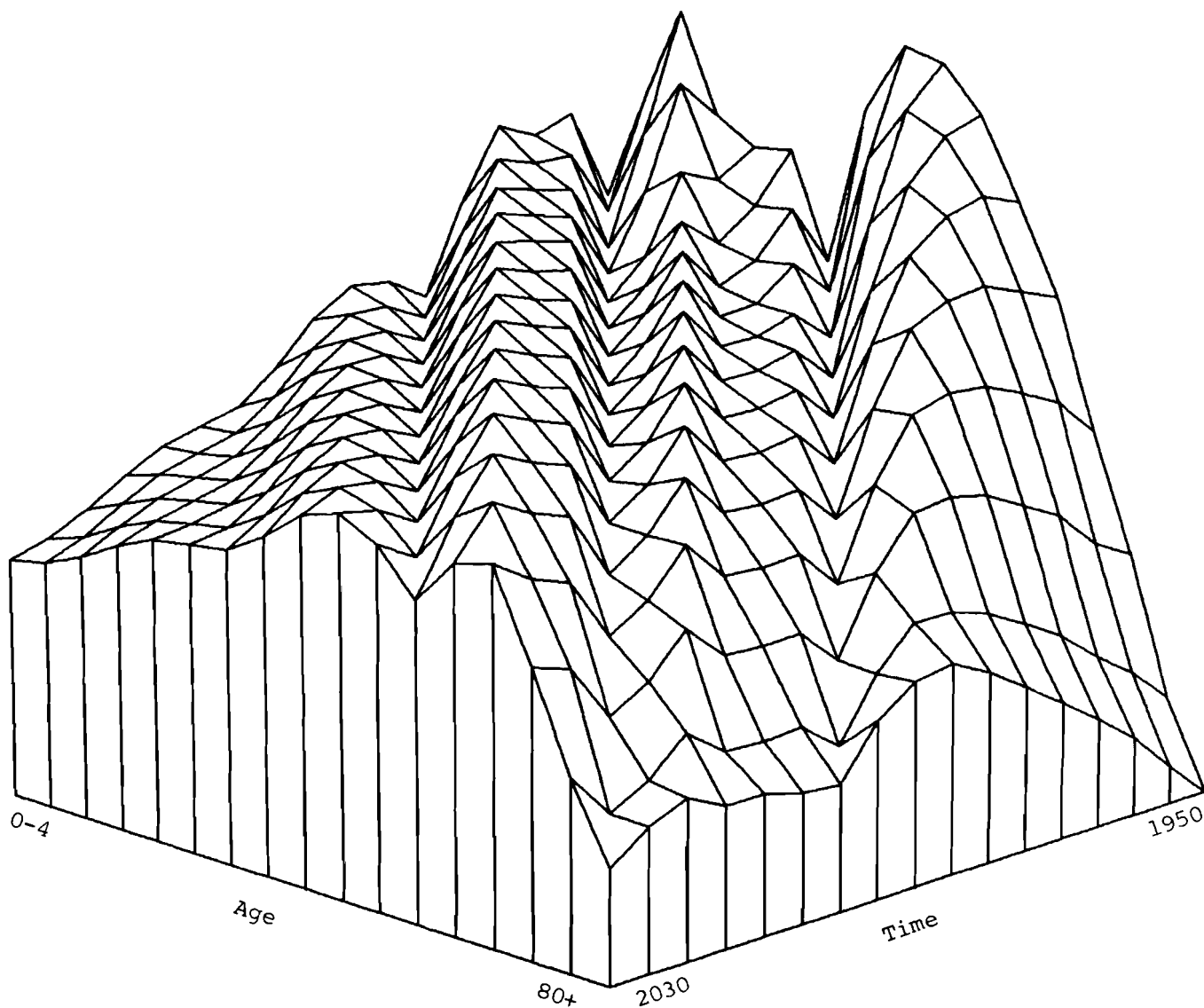


tage of children decreased, due to the low level of birth rates.

As compared to 1950, at the beginning of the 1980s there was a slightly lower Total Dependency Ratio (TDR). This is also true for the Children Dependency Ratio (ChDR) as well as for Old Age Dependency Ratio (OADR). In other words, at the beginning of the period under consideration 1,000 persons in working age were related to 640 people in non-working age, but in 1985 it was only 599. may be expressed through dependency ratios as well. a significant increase in the TDR had occurred, caused by an increase in both the ChDR and OADR.



Figure 5. Age distributional changes for males in the GDR, 1950-2030.



The GDR population continues to age up to the year 2010 at a rate that may be considered acceptable from a social and economic perspective. The total number of population will change only marginally in the time period under consideration. The GDR population will by and large maintain its quantitative level until the middle of the 1990s followed by a decline to about 97% of its current level by the year 2010.

The structure of the broad age groups considered here will be shifted in the direction of increasing shares of people in working age, and especially the aged. While the number of people in working age is expected to remain relatively stable

Table 4. Population by broad age groups, 1950–1980, end of the year.

| Age groups                       | 1950 <sup>1</sup> | 1955   | 1960   | 1964   | 1970   | 1975   | 1980   |
|----------------------------------|-------------------|--------|--------|--------|--------|--------|--------|
| <i>Population in thousands</i>   |                   |        |        |        |        |        |        |
| Total                            | 18,388            | 17,832 | 17,188 | 17,004 | 17,068 | 16,820 | 16,740 |
| 0-14                             | 4,202             | 3,718  | 3,678  | 4,045  | 3,970  | 3,591  | 3,271  |
| 15-59                            | 11,214            | 10,852 | 10,013 | 9,320  | 9,334  | 9,592  | 10,261 |
| 60+                              | 2,972             | 3,262  | 3,497  | 3,639  | 3,764  | 3,637  | 3,208  |
| <i>Population in percentages</i> |                   |        |        |        |        |        |        |
| Total                            | 100.0             | 100.0  | 100.0  | 100.0  | 100.0  | 100.0  | 100.0  |
| 0-14                             | 22.8              | 20.8   | 21.4   | 23.8   | 23.3   | 21.4   | 19.5   |
| 15-59                            | 61.0              | 60.9   | 58.3   | 54.8   | 54.7   | 57.0   | 61.3   |
| 60+                              | 16.2              | 18.3   | 20.3   | 21.4   | 22.0   | 21.6   | 19.2   |

<sup>1</sup> population at 31 August

Table 5. Dependency ratios, 1950–1985.

| Year | Dependency ratios |      |     | Population aged 0-14<br>per 1,000 population<br>aged 60+ |
|------|-------------------|------|-----|--|
|      | Total             | 0-14 | 60+ |  |
| 1950 | 640               | 375  | 265 | 1,414  |
| 1955 | 643               | 343  | 300 | 1,140  |
| 1960 | 716               | 367  | 349 | 1,052  |
| 1965 | 824               | 434  | 390 | 1,112  |
| 1970 | 828               | 425  | 403 | 1,055  |
| 1975 | 735               | 374  | 379 | 987  |
| 1980 | 632               | 319  | 313 | 1,020  |
| 1985 | 599               | 307  | 292 | 1,050  |

in absolute numbers, the number of aged people will increase. Compared with 1980, in 2010 there will be 215 thousand less people in working age (i.e. a decrease by 2%), but 93 thousand aged people more than 1980 (i.e. an increase by about 3%). Both sexes will be affected by this dynamic. There will be a greater decrease in the total number for women than of men.

The share of the male working age population is expected to increase until the mid-1990s approaching the same level as it had in 1980 (64.4%). The respective percentage of women will also increase. Especially the trend in the percentage of aged population indicates significant changes in the age-sex-composition which will happen in the future. The relatively high share of aged females (23.5% in 1980) will not have changed at the end of the projection period (23.3% in 2010). On the other

Table 6. Population by broad age groups 1990–2010, end of the year.

| Age groups                       | 1990   | 1995   | 2000   | 2005   | 2010   |
|----------------------------------|--------|--------|--------|--------|--------|
| <i>Population in thousands</i>   |        |        |        |        |        |
| Total                            | 16,702 | 16,606 | 16,462 | 16,309 | 16,110 |
| 0-14                             | 3,387  | 3,262  | 2,999  | 2,811  | 2,763  |
| 15-59                            | 10,324 | 10,296 | 10,105 | 10,091 | 10,046 |
| 60+                              | 2,991  | 3,048  | 3,358  | 3,407  | 3,301  |
| <i>Population in percentages</i> |        |        |        |        |        |
| Total                            | 100.0  | 100.0  | 100.0  | 100.0  | 100.0  |
| 0-14                             | 20.3   | 19.6   | 18.2   | 17.2   | 17.1   |
| 15-59                            | 61.8   | 62.0   | 61.4   | 61.9   | 62.4   |
| 60+                              | 17.9   | 18.4   | 20.4   | 20.9   | 20.5   |

Table 7. Population by sex and broad age groups 1990–2010, end of the year.

| Age groups                       | 1990  | 1995  | 2000  | 2005  |
|----------------------------------|-------|-------|-------|-------|
| <i>Population in percentages</i> |       |       |       |       |
| Males                            | 100.0 | 100.0 | 100.0 | 100.0 |
| 0-14                             | 21.7  | 20.8  | 19.2  | 18.1  |
| 15-59                            | 65.1  | 67.7  | 63.8  | 64.1  |
| 60+                              | 13.2  | 14.5  | 17.0  | 17.8  |
| Females                          | 100.0 | 100.0 | 100.0 | 100.0 |
| 0-14                             | 19.0  | 18.5  | 17.3  | 16.4  |
| 15-59                            | 58.7  | 59.5  | 59.1  | 59.7  |
| 60+                              | 22.3  | 22.0  | 23.6  | 23.9  |

hand, the percentage of aged males will increase from 14.4% in 1980 to 17.6% in 2010.

Population estimates until 2010 indicate that the dependency ratios are expected to fluctuate further, but not to the same extent as before. In the next few decades until the turn of the century, the TDR will slightly increase due to a significant increase of the OADR. In the same time the ChDR will decrease. After the year 2000 the decrease in ChDR will overcompensate the increasing OADR. Although the TDRs in 1985 and 2010 are by and large equal in a quantitative sense, a turnover in the relation between children and aged people will have happened. Per 1,000 aged people there will then be 837 people aged 0–14.

Table 8. Dependency ratios, 1990–2010.

| Year | Dependency ratios |      |     | Population aged 0-14<br>per 1,000 population<br>aged 60+ |
|------|-------------------|------|-----|--|
|      | Total             | 0-14 | 60+ |  |
| 1990 | 618               | 328  | 290 | 1,132  |
| 2000 | 629               | 297  | 332 | 893  |
| 2010 | 604               | 275  | 329 | 837  |

Summarizing these findings brings us to the conclusion that in the next few decades some important economic conditions as expressed in terms of dependency ratios will remain on a level comparable to the current situation, while at the same time the quantitative relationship between aged people and children will be inverted.

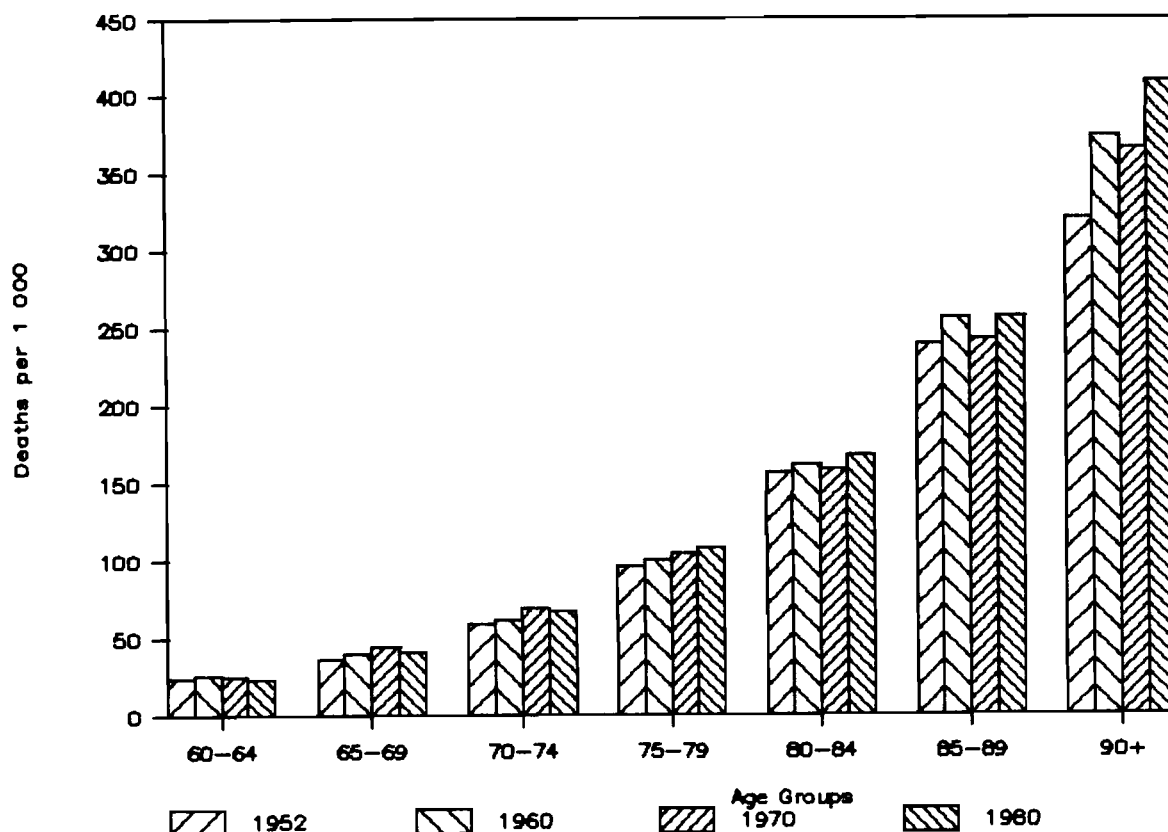
## 2.2. Mortality

Due to late effects of World War II, to changes in morbidity, and to the specific age structure of GDR population, the Crude Death Rate (CDR) is relatively high as compared to other developed countries (Table 9). For males the Crude Death Rate (CDR) is almost 13 (deaths per 1,000), and for females more than 11. Since 1970 a slight tendency towards a decline in the male CDR has been observed. Between 1970 and 1980 the male CDR declined from 14.4 to 13.8, but for females it rose from 13.9 to 14.7. Since 1980 the trend of slightly decreasing CDR can be observed for both male and female rates, as data for 1984 (12.6 for males, 14.4 for females) shows.

Age-specific mortality declined especially in the youngest age groups. Infant mortality has been reduced significantly for both male and female babies; from 68.5 (1952) to 14.2 (1980) for baby boys and from 54.7 to 10.3 for baby girls. In the 1980s a further reduction in infant mortality has been achieved. The middle age groups show different but in most cases falling tendencies. For higher age groups mortality rose temporarily, especially for males. Since 1980 a trend towards a decline has begun (Figures 6 and 7).

One of the most striking features of the mortality pattern is the significant and rising difference between the sexes. In all age groups male mortality is higher than female mortality.

Figure 6. Age-specific mortality in the GDR, males aged 60 and over.



In the age group of 15 to 60 the mortality of men is about twice as high as the mortality of women. Furthermore, there is a trend towards an increasing sex differentiation. The underlying causes are still, to a large extent, unexplored. One known factor contributing to this situation is the observed difference in attitudes towards one's own health and the use of medical care, which results in an advantage for women.

The most obvious difference between male and female mortality is between ages 15 and 20 where the most significant mortality excess is due to accidents (especially motorbikes). Among the aged population (60 years and over) differences between the sexes still exist but they seem not as important as in younger age groups.

The trend in life expectancy, especially those of newborn children, has documented success in the country's health policy. In the past decades it was possible to achieve a marked increase in life expectancy. During the period 1955-1983 the life expectancy of a newborn male rose by 3.68 years and that of a newborn female

Figure 7. Age-specific mortality in the GDR, females aged 60 and over.

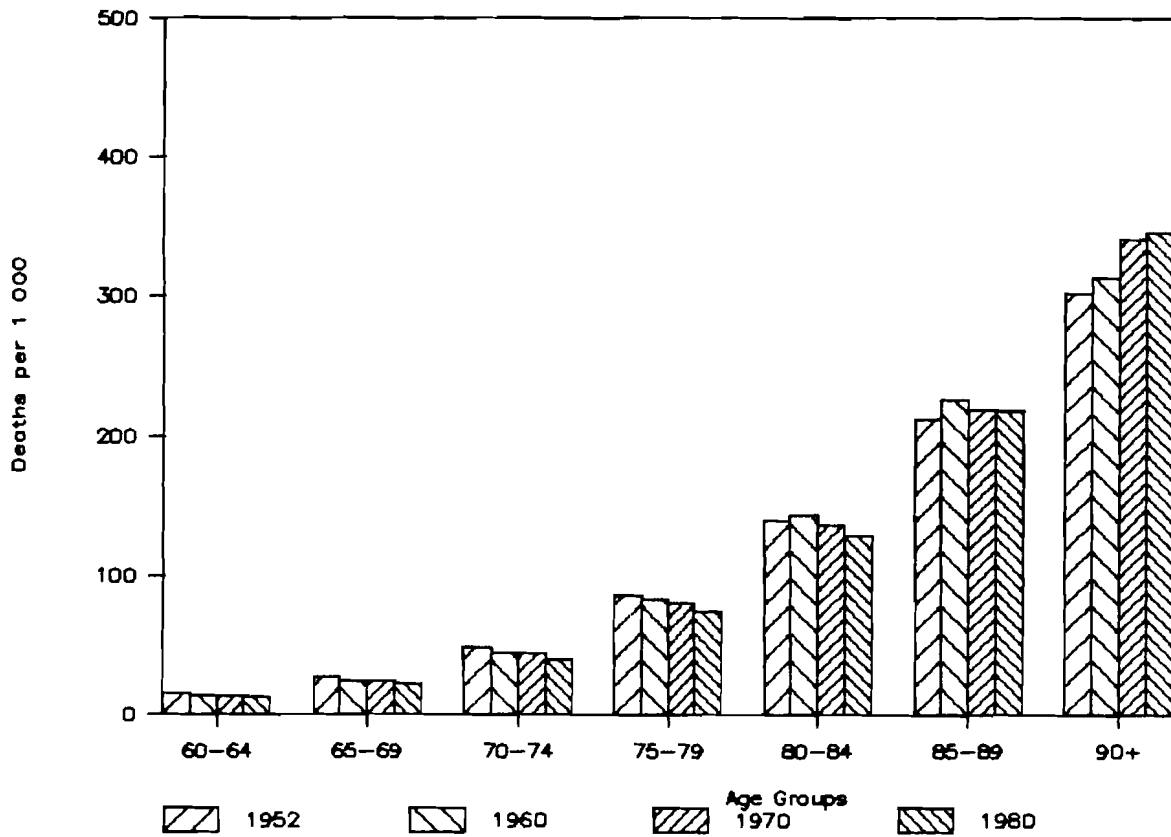
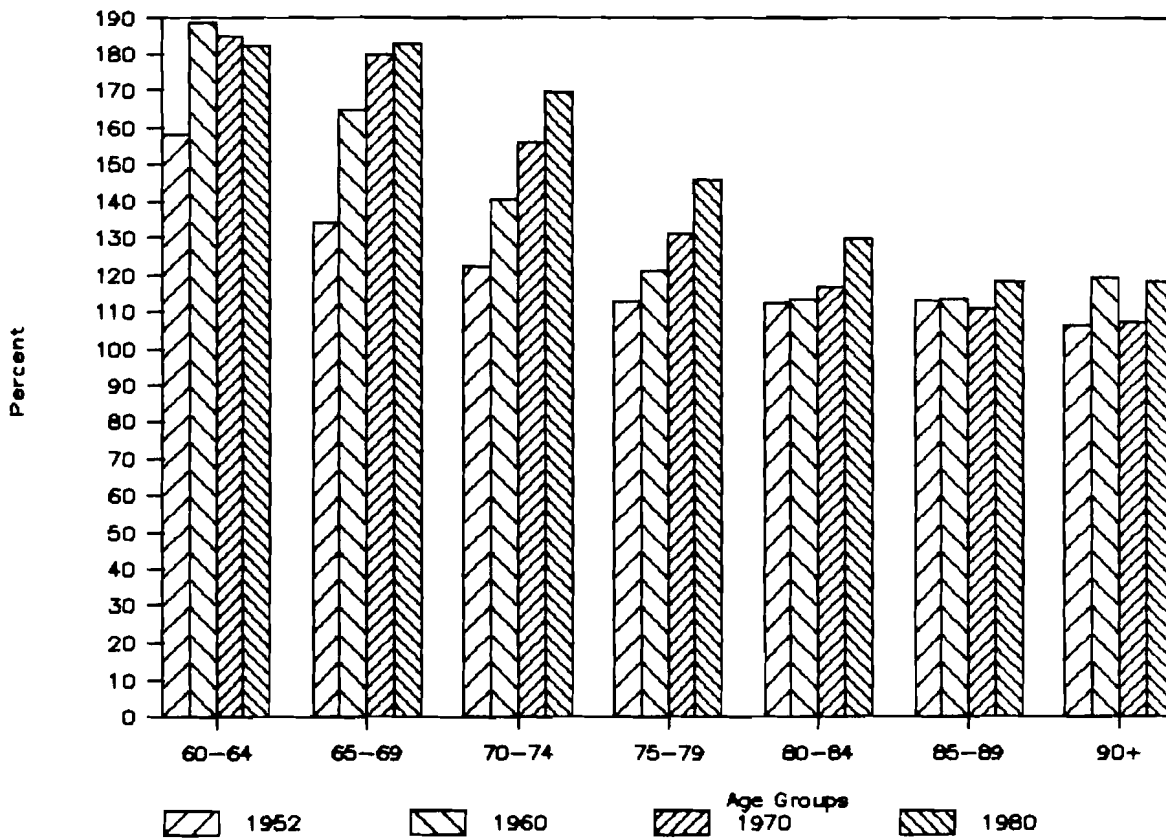


Figure 8. Sex differentials in mortality in the GDR, population aged 60 and over; male mortality as a percentage of female.



by even 5.5 years. As mentioned before, the increase in life expectancy is primarily due to a marked and sustained reduction in infant and child mortality. By contrast, life expectancy for males above age 30 or females older than 60 has remained almost constant or shows only little progress. The differentials between males and females have also grown in terms of life expectancy.

Table 9. Male age-specific mortality rates as a percentage of female age-specific mortality rates, 1952-1980.

| Age   | 1952  | 1955  | 1960  | 1965  | 1970  | 1975  | 1980  |
|-------|-------|-------|-------|-------|-------|-------|-------|
| Total | 118.8 | 119.1 | 117.5 | 114.7 | 103.6 | 97.9  | 93.9  |
| 0     | 125.2 | 128.0 | 129.6 | 129.6 | 125.5 | 114.3 | 133.3 |
| 1-4   | 117.4 | 110.0 | 126.7 | 136.4 | 125.0 | 114.3 | 133.3 |
| 5-9   | 142.9 | 160.0 | 150.0 | 150.0 | 166.7 | 166.7 | 133.3 |
| 10-14 | 180.0 | 150.0 | 166.7 | 166.7 | 166.7 | 166.7 | 200.0 |
| 15-19 | 144.4 | 183.3 | 260.0 | 200.0 | 220.0 | 300.0 | 240.0 |
| 20-24 | 142.9 | 177.8 | 200.0 | 266.7 | 250.0 | 300.0 | 233.3 |
| 25-29 | 126.7 | 130.8 | 180.0 | 200.0 | 228.6 | 216.7 | 233.3 |
| 30-34 | 105.3 | 112.5 | 150.0 | 154.5 | 177.8 | 200.0 | 228.6 |
| 35-39 | 119.2 | 115.0 | 122.2 | 137.5 | 164.3 | 169.2 | 176.9 |
| 40-44 | 125.0 | 124.1 | 137.5 | 133.3 | 168.2 | 185.0 | 194.7 |
| 45-49 | 137.0 | 142.1 | 142.1 | 140.0 | 147.2 | 177.4 | 196.8 |
| 50-54 | 158.5 | 153.4 | 160.7 | 158.5 | 167.3 | 172.5 | 190.2 |
| 55-59 | 162.1 | 170.9 | 184.5 | 179.0 | 182.9 | 183.1 | 189.9 |
| 60-64 | 158.2 | 161.3 | 188.3 | 185.7 | 184.8 | 185.4 | 182.3 |
| 65-69 | 134.3 | 146.7 | 164.7 | 175.0 | 179.5 | 181.0 | 182.4 |
| 70-74 | 122.2 | 128.2 | 140.2 | 148.8 | 156.0 | 163.8 | 169.6 |
| 75-79 | 112.5 | 114.1 | 121.1 | 128.4 | 131.3 | 141.0 | 145.9 |
| 80-84 | 112.2 | 113.8 | 113.2 | 119.4 | 116.8 | 122.1 | 129.8 |
| 85-89 | 112.9 | 111.5 | 113.4 | 114.4 | 110.7 | 113.0 | 118.2 |
| 90+   | 106.2 | 111.0 | 119.1 | 120.1 | 107.3 | 113.8 | 117.9 |

With respect to social factors mortality and life expectancy show only little differentiations. The differences between marital statuses are negligible at younger ages but increase slightly with age. Regional differentials in life expectancy are another socially induced phenomenon. Between the region with the highest and that with the lowest life expectancy for a newborn there is a difference of .9 years for males and of .72 years for females. With increasing age the differences diminish.

The general increase in life expectancy was accompanied by a significant change in the structure of causes of death. The major tendencies have existed already since the second half of the past century. The causes of death "infectious

diseases" and "tuberculosis" that were still significant in the years after World War II are today scarcely of any importance. By contrast, the "malignant neoplasms" have increased in weight up to the middle of the 1960s and since then they have stabilized on a relatively high level. The diseases of the heart and circulatory system have continuously had an increasing tendency as cause of death. They clearly mark the total character of the demographic process under consideration.

Summarizing the points made above it seems justifiable to assume stable mortality patterns for a mid-term projection period.

Table 10. Average life expectancy of newborns, 1955-1984.

| Year | Males | Females | Difference<br>(males - females) |
|------|-------|---------|---------------------------------|
| 1955 | 65.78 | 69.92   | -4.14                           |
| 1960 | 66.49 | 71.35   | -4.86                           |
| 1970 | 68.40 | 73.31   | -4.91                           |
| 1980 | 68.67 | 74.61   | -5.94                           |
| 1984 | 69.94 | 75.42   | -5.78                           |

## 2.3. Fertility

### 2.3.1. Past Trends

During the last four decades the GDR population has shown a relatively wide range of different fertility patterns. The annual number of live births fluctuated between 310.8 thousand (1951), 271.4 thousand (1958), 301.5 thousand (1963), 179.1 thousand (1974), and 245.1 thousand in 1980. In 1984 in the GDR 227.648 children were born. The Total Fertility Rate (TFR) in the past three decades was also characterized by great fluctuations. The highest values were observed in 1951 with 2.49 and in 1964 with 2.44, respectively. In 1974 a minimum was reached with a



TFR of only 1.54. Since the year 1971 the TFR has fallen below the replacement level. After the minimum of 1974 the total fertility rate recovered somewhat and in 1980 it reached a local peak at 1.94. The most recent figure for 1985 gives a TFR of 1.73.

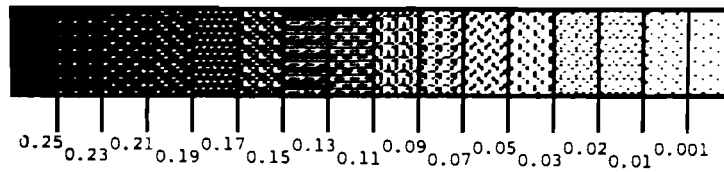
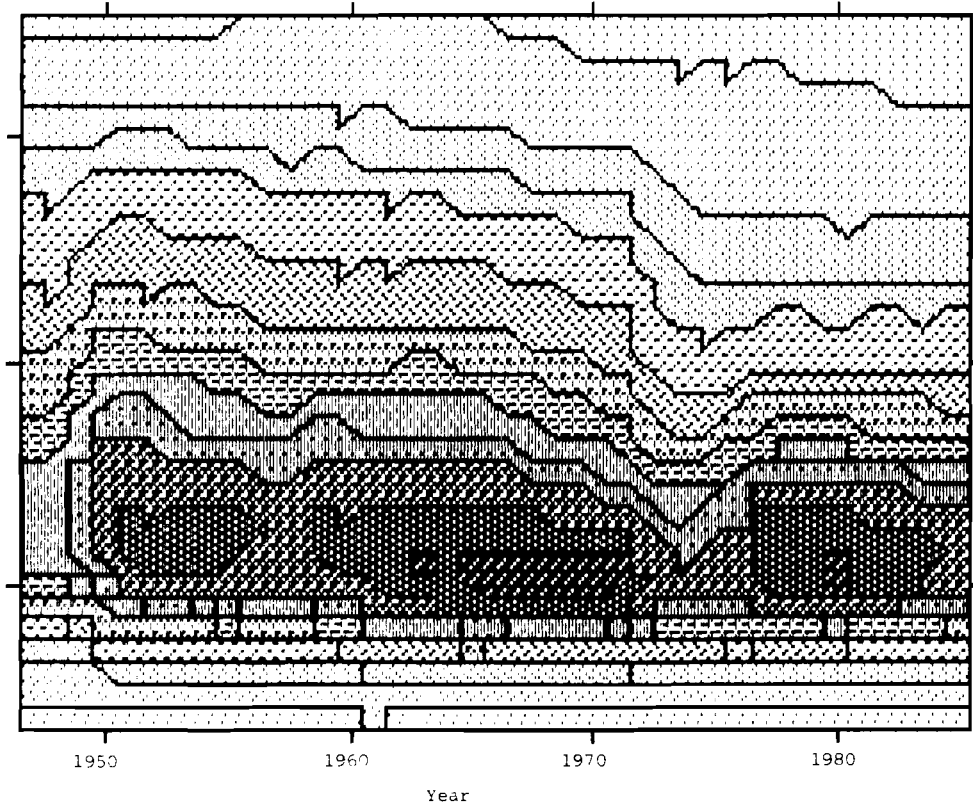
Figure 9. The period-TFR for the GDR, 1947-1985.



Because the total fertility rates summarizes the information from all age groups in one indicator, some information is lost when the analysis is restricted to the mean only. To avoid this shortcoming in Figure 10 we will present a shaded contour map of age-specific fertility rates (single years of age) over time (also single years). As described by Vaupel, Gambill, and Yashin (1987), such contour maps use the observer's geographical intuition and plot a 3-dimensional relationship on a plane like the map of a mountain, where dark shadings refer to high levels of fertility.

Immediately after World War II the women in all fertile age groups experienced an increase in age-specific fertility rates. This was, with some certainty, a compensation for the postponement of births during the period of war. The real

Figure 10. Shaded contour maps of trends in age-specific fertility rates, GDR, 1950-1985.



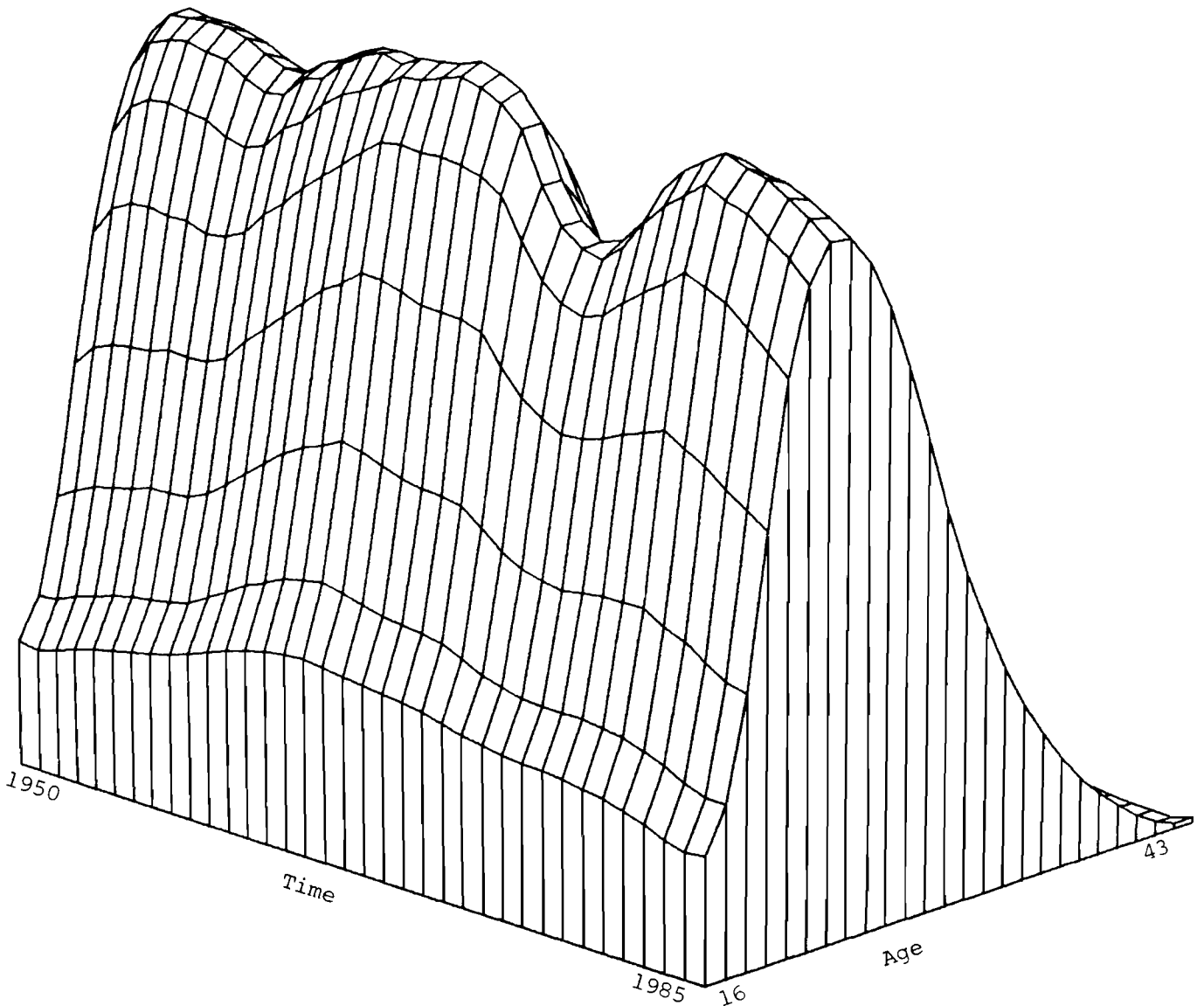
baby boom with its very significant increase in the level of fertility took place at the beginning of the 1960s. This phenomenon was strongest among younger women. At the same time the older age groups started to decrease their fertility continuously until the mid-1970s, so that the end of the high fertility period in the 1960s was caused mainly by the reduction of fertility in older ages. The resulting concentration of births in the age group between 20 and 30 also indicates the transition to a fertility regime where the two-child family dominates. We can also see the effects of the legalization of abortion at the beginning of the 1970s followed by a compensation period which was partly induced by a comprehensive program of socio-political measures. As a result the fertility level of most of the age groups seem to have become stable at a low level in the 1980s.

These trends have to be seen against the background of long-term and important changes in the demographic behavior of families, couples, and individuals which in turn are determined by changes in living conditions, value patterns and needs of the families as mentioned above. In order to understand the trends in fertility, identify its possible causes, and perhaps anticipate future trends, it is useful to look at real generations or cohorts and their life cycle. Moreover, a cohort perspective enables us to incorporate sociological and other findings in our explanations.

The 1981 GDR Census provided, for the first time, data of the birth history and the final parity distribution of women in the GDR. As a very interesting indicator of major changes in the procreation behavior, the Completed Fertility Rate (CFR) was calculated. The results shown in Figure 12 provide, besides others, another picture of the post-war baby boom in the GDR. But the most surprising result is that the secular trend of declining fertility cannot be seen at first and that generations born between 1910 and 1925 experienced a relatively low fertility level.

While women born between 1910 and 1920 reached a CFR which approaches replacement level, the fertility of women born between 1920 and 1925 fell markedly below this level. Obviously the latter cohorts were particularly affected by the immediate repercussions of World War II in their fertile life span. The cohorts born 1926 to 1940 (between 1971 and 1980 they left the fertile age) achieved a fertility rate significantly above replacement level. These are the generations of the post-war baby boom. It is remarkable that the 1932 cohort with a final number of 2.315 children per women shows one of the highest cohort fertilities of women born in this century. All the following cohorts have shown successively lower fertility rates.

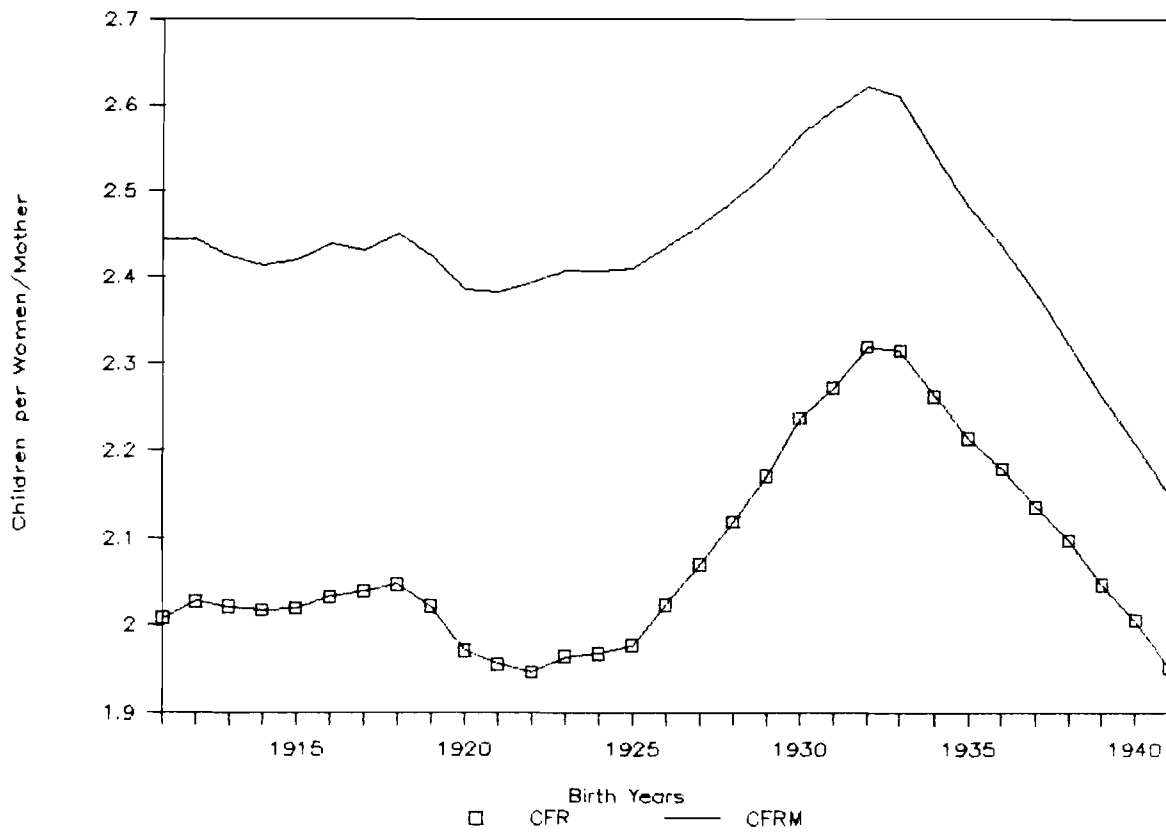
Figure 11. 3-D plot of age-specific fertility rates in the GDR, 1950-1985.



The data on final parity distributions enable us to calculate the Rate of Childlessness (RoCIn) of cohorts. This indicator, defined as the percentage of women without children, may be regarded as both a quantitative and a qualitative attribute of fertility.

In the GDR there has been a strong tendency towards a decreasing rate of childlessness. While the cohorts born before 1920 had rates of childlessness between 16% and 17% and the 1922 cohort even of 18.7%, the following cohorts decreased their childlessness significantly. In the 1932 cohort 11.5% of women

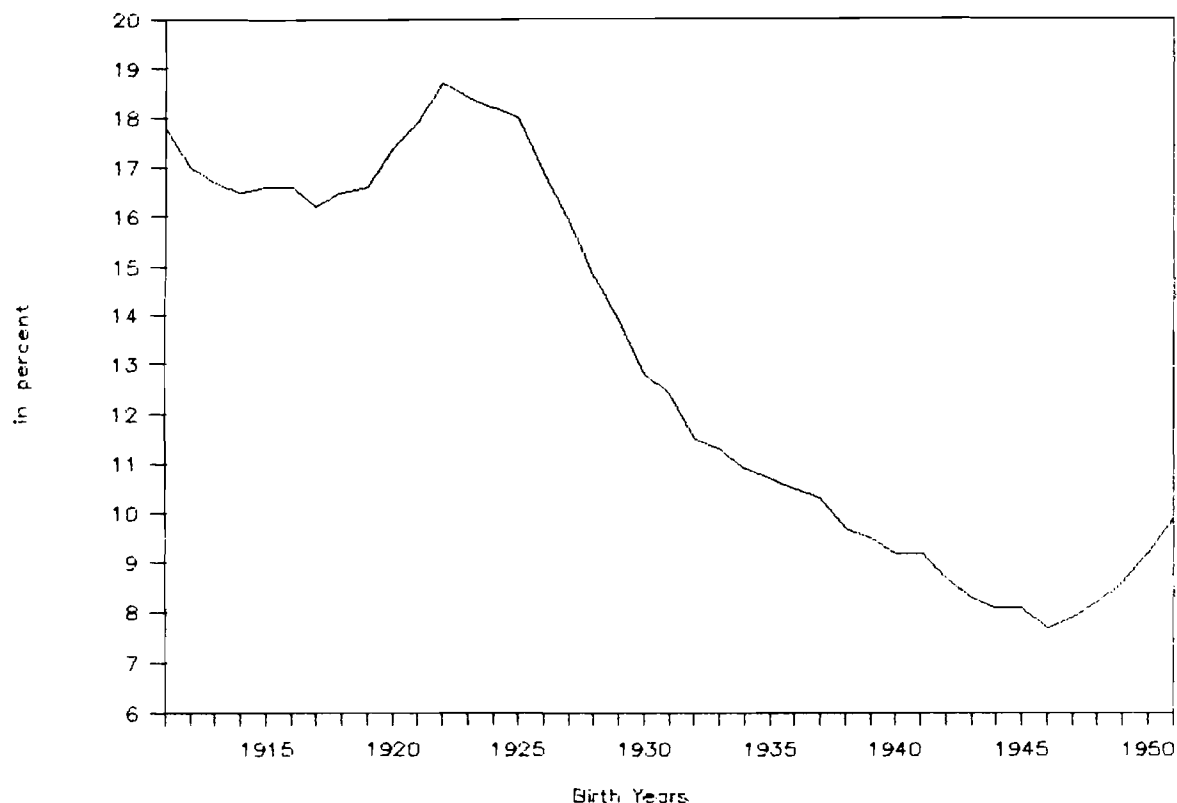
Figure 12. Cohort fertility in the GDR for women born 1910-1940. Source: Census 1981.



remained without children, for the cohort 1946 this percentage had already decreased to 7.7%. Note, that at the time of the 1981 Census, the cohorts born after 1936 had not yet completed their fertile life span.

Combining the information from the cohort fertility rate and the rate of childlessness yields another interesting result. To assess procreative behavior as well as to understand how society determines fertility, it is useful to calculate Completed Fertility Rates not only for all women of the same birth cohort (and still alive) but also for mothers only. This means to sort the childless women out of the population at risk, which yields the so-called Completed Fertility Rate of Mothers (CFRM). This identifies a special group of persons, who have to solve the problems of compatibility of motherhood and economic activity, for example (see also Figure 12). While the shape of the curve for completed fertility rate of mothers is similar to the trend of the average fertility (CFR), fluctuations before the post-war baby boom are significantly smaller, especially for cohorts which experienced parts of their fertile life span during World War II. A conclusion that could be drawn from

Figure 13. Rates of childlessness in the GDR for cohorts of women born 1910–1950. Source: Census 1981.



this is that the temporary reduction of CFR by some cohorts may have been caused by difficulties finding partners, because of the distorted age distributions and because of war activities which resulted in an increased childlessness for these cohorts.

On the other hand, for generations experiencing their fertile life span entirely after World War II that factor lost its importance. It seems that one of the reasons for an increasing RoCIn is the fact that more and more women give birth to a child irrespective of the stability of their relationships. Therefore, since the 1970s, the number and proportion of children born out of wedlock have increased significantly. This proportion amounts currently to about one third of all live births (34% in 1984). It has to be added, of course, that in the GDR unmarried mothers are not discriminated against and that special help is given to them by a set of specific social policy measures. Today the CFR, measuring an average phenomenon, and the CFRM, indicating an aspect of heterogeneity in the population, differ only slightly.

The finding is one of the most important results of the population policy and social policy which is aimed at making it possible for every woman to fulfill her desire to have one child or more children. As a result it has to be recognized that the tendency of lowering the average number of children per woman was accompanied by an increasing participation of women in procreation. Note, that during the same time period the female labor force participation rate also has increased.

### **2.3.2. Sociological Findings: Social Conditions, Value Patterns, and Needs**

The material living conditions and the general values prevailing in the society determine the reproductive behavior of social groups, families, and individuals. This is part of the way of life of the society which thus forms the socio-cultural framework for the reproduction of its population. The most essential social conditions underlying the current and future development of fertility in the GDR are the following:

- On the basis of economic growth, social security for every citizen has been ensured. Society guarantees the satisfaction of the basic needs for work, for adequate income, for education, leisure time and recreation, for medical and social care as well as for assistance in case of illness, accident, disablement.
- The status of the family and their way of living has been heavily influenced by important changes in the status of women in society and consequently in the family. Both sexes have equal rights in all spheres of society and personal life. In 1984 49.4% of the labor force was female. More than 91% of the female population capable of working either exercised their right to work, or were being prepared to work. The degree of employment of women up to the age of 50 does not show any essential differences as to age structure, not even in those age groups caring primarily for infants.

The integration of women into the labor force has been coupled with major changes in their level of education and training. In 1983 about 80% of working women had a completed vocational training.

- The two-generation family (core family) has been generally accepted and prevails in urban and rural environments. Birth, education, and care for children have remained one of the primary social values. The essential preconditions have been created by society making it possible for women both to care for several children and bring them up, and to be employed at the same time.

Thus in 1986 81% of children in the age up to three years were provided with a place in a *creches* (nursery), and in the age group three to six years more than 90% went to the kindergarten.

Nevertheless, the education and care for the children is a great requirement to be met by the life of the family. The compatibility between motherhood, family and professional employment has remained a problem for the majority of working women with children.

- The possibility of the woman and her partner to decide freely on the number of children as well as on the time of their birth has been implemented in the GDR. This is attained by a high level of family planning and the liberalization of abortion as well as by a far developed pro-natalistic social policy.

These material conditions and social values are main characteristics of the way of life of all social groups. But the various social strata exhibit also different conditions, traditions, and habits. This is the reason why value patterns arise in relation to the birth of children which are, by and large, rather uniform, yet at the same time different (Meyer and Wendt 1984). The central values are the following:

- family and partnership with children
- social relations within colleagues and friends
- professional attainments and development
- acquisition of cultural values.

The high priority assigned to the child is typical for all social groups. The general value patterns are oriented towards a 2-child family. It is self-evident that the expected number of children is always somewhat lower than that implied by the value patterns, because it comes as a demand to be considered in making the totality of needs compatible with each other. Sociological studies have shown the following:



Table 11. Expected number of children: percentage distribution, females.

| Number of children expected | Percentage |
|-----------------------------|------------|
| 0                           | 1.5        |
| 1                           | 19.9       |
| 1-2                         | 7.1        |
| 2                           | 53.0       |
| 2-3                         | 8.4        |
| 3                           | 7.6        |
| more than 3                 | 2.5        |

There is an average size of 1.9 per female. This means about 90% of replacement level.

The expected number of children is differentiated in the social strata. Sociological studies allow us to draw the following conclusions on the fertility trend for the next decade:

- Workers and employees will not substantially modify their expected number of children. This means that they will fulfill their desire for 1–2 children (1.8 children on an average), with those expressing a desire for three children (workers 7.7%, employees 7.6%) fulfilling it to a higher degree than in former times.
- The actual family size of farmers, who are still orientated towards several children, will probably be somewhere around the level of replacement. Sponsored by a number of socio-political measures more women than hitherto will comply with their desire for three children.
- More highly educated people will continue to pronounce a perceptibly higher desire for children than expressed by the number of their actually born children (1.7 children on an average).

### 2.3.3. Further Trends

The above outlined findings can be summarized in the following way: It may be expected that up to the turn of the century the average number of children per women will lie between 1.7 and 1.9 children. This corresponds to the actual needs and desires of young families (Winkler and Speigner 1986; Speigner 1987). This figure has also been obtained from a preliminary calculation based on incomplete cohort data and using some simple methods and assumptions. One approach was to

assume stable fertility rates for all women older than 30 years and estimate the completed fertility rates for corresponding cohorts.

This estimated trend in cohort fertility can be accompanied by fluctuations in the period fertility rates from year to year, having noticeable effects on the number of births. The absolute number of births up to the end of the twentieth century is, on the other hand, largely influenced by the fact that smaller cohorts of women will enter the fertile age groups.

Table 12. Number of women in fertile age span.

| Year | Number of women<br>in fertile age |
|------|-----------------------------------|
| 1982 | 100.0%                            |
| 1985 | 97.9%                             |
| 1990 | 95.6%                             |
| 2000 | 96.1%                             |
| 2010 | 89.1%                             |

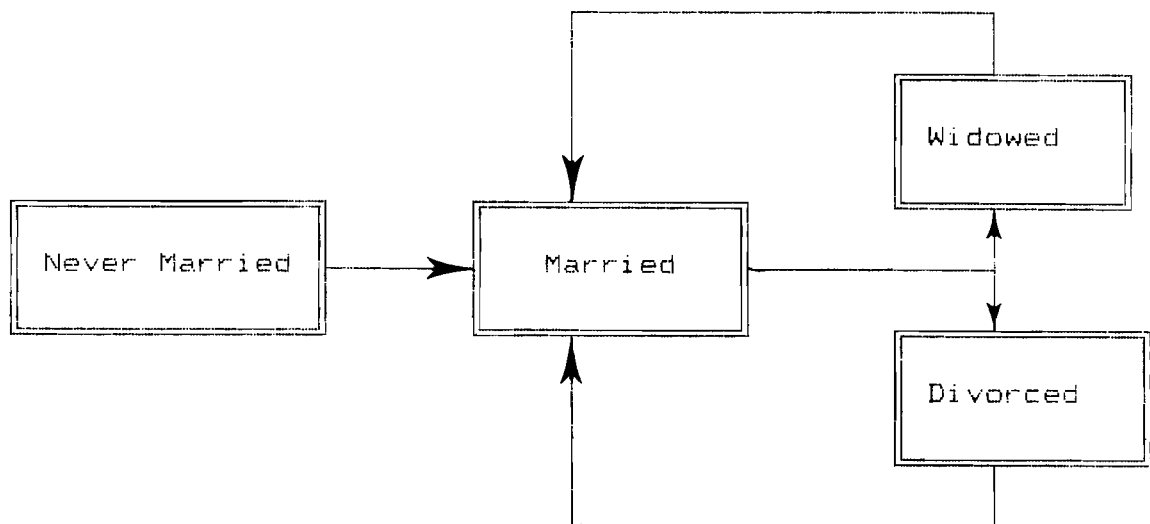
Under these circumstances the annual number of live births to be expected in the next 15 years will be clearly below those since the beginning of the 1980s.

### 3. SELECTED MULTI-STATE MODELS

#### 3.1. Aging and Changes in the Marital Status Distribution

Within the social process of aging the family, its formation and dissolution, its capacity for care for the aged, as well as its need for its own support is of special interest. One important aspect of this, the marital status distribution in the population had been mentioned before. The application of multi-state models for marital status changes is not new (Willekens et al. 1982; Espenshade 1984; Wijewickrema and Alli 1984; Lutz 1985b), but for the GDR it was first done under the collaborative research this paper refers to.

Figure 14. Transitions in the marital status life table used.



Our model was specified according to the four marital status categories distinguished in official vital statistics in the GDR: never married, married, widowed, and divorced. Figure 14 shows the transitions that are possible between the states mentioned above. The initial state for every individual is, of course, "never married". With respect to transitions from the never married status to the married status, the model is hierarchical. All other states can be left and re-entered. A fifth state, the absorbing state "death" can be entered from each state.

Since 1964 official statistics provide all initial events by marital status as well as the population by age, sex, and marital status. In this paper we refer to marital status life tables for the period 1975-1982, and a population projection (*status quo* assumption) until the year 2010.

Cohabitation, and other kinds of partner-related living arrangements, especially kinship patterns, are not covered by the model. This depends mainly on data availability. But, on the other hand, marital status can be seen as still the most important indicator for basic demographic features of the family, i.e. some aspects of lifestyle with long-term implications for individuals as well as for society. Furthermore one has to bear in mind that still the majority of population will become married in their lifetime, so one can assume that the model still covers a substantial part of the phenomenon.

### **3.1.1. Period Multi-State Tables**

In multi-state models it is possible to derive two different kinds of life table statistics: population-based and status-based indicators. Here we deal with the most common life table statistic--the life expectancy. Population-based measures refer to remaining lifetime in different states for an average member of the cohort, not taking into account the state an individual may have at a certain age. Status-based measures indicate the remaining life expectancy an individual may have at a certain age, given the current marital status of that person. Table 13 gives the life expectancy for men and women that are in different marital states at age 20.

For example, in 1977 never married males aged 20 have, on average, 50.53 years to live. From that, they are expected to continue to be 7.37 years never married, 38.60 years married, 2.04 years widowed, and 2.52 years divorced. A significantly different picture appears for males in 1977 who are also 20 years old, but already married, widowed, or divorced. First of all, there are only very slight differentials between marital statuses. If one considers that the figures for widowed persons at 20 are probably biased by the small number of individuals already widowed in the observed population, the differentials in life expectancy between never married, married, and divorced persons are less than one year. This holds true for the female population in 1977 as well as for the demographic patterns observed in 1982 (Table 14).

On the other hand, there are significant differences between male and female marriage patterns. The remaining life time in the never married status is much less for a 20-year-old never married female than for a male of the same age and status. The duration time in the state "married" for females (at age 20) is less than for males. This holds true for all statuses. A reason for this pattern is the higher life

Table 13. Life expectancy by sex and marital status, 1977.

| Marital status at age 20 | Remaining life time at status |         |         |          | Total |
|--------------------------|-------------------------------|---------|---------|----------|-------|
|                          | Never married                 | Married | Widowed | Divorced |       |
| <b>MALES</b>             |                               |         |         |          |       |
| Never married            | 7.37                          | 38.60   | 2.04    | 2.52     | 50.53 |
| Married                  | —                             | 45.54   | 2.19    | 3.32     | 51.05 |
| Widowed                  | —                             | 41.54   | 5.40    | 2.81     | 49.75 |
| Divorced                 | —                             | 39.88   | 2.15    | 8.36     | 50.39 |
| <b>FEMALES</b>           |                               |         |         |          |       |
| Never married            | 5.22                          | 36.78   | 9.08    | 5.30     | 56.38 |
| Married                  | —                             | 41.05   | 9.43    | 6.06     | 56.54 |
| Widowed                  | —                             | 31.87   | 18.36   | 4.43     | 54.66 |
| Divorced                 | —                             | 36.81   | 9.26    | 10.30    | 56.37 |

Table 14. Life expectancy by sex and marital status, 1982.

| Marital status at age 20 | Remaining life time at status |         |         |          | Total |
|--------------------------|-------------------------------|---------|---------|----------|-------|
|                          | Never married                 | Married | Widowed | Divorced |       |
| <b>MALES</b>             |                               |         |         |          |       |
| Never married            | 11.36                         | 33.07   | 1.88    | 3.49     | 49.80 |
| Married                  | —                             | 43.18   | 2.18    | 5.37     | 50.73 |
| Widowed                  | —                             | 34.79   | 7.36    | 3.75     | 45.90 |
| Divorced                 | —                             | 36.44   | 2.11    | 11.45    | 50.00 |
| <b>FEMALES</b>           |                               |         |         |          |       |
| Never married            | 9.87                          | 32.14   | 8.00    | 6.08     | 56.09 |
| Married                  | —                             | 39.36   | 8.93    | 8.16     | 56.45 |
| Widowed                  | —                             | 29.48   | 20.08   | 5.28     | 54.84 |
| Divorced                 | —                             | 32.72   | 8.46    | 14.99    | 56.17 |

expectancy of women and the lower chance of getting re-married after being divorced or widowed. In other words, females show a higher risk of staying in the status "divorced" or "widowed", respectively.

Even if one adjusts the differentials to the general sex differences in life expectancy, males spend a larger fraction of their life in the state "married" than women. For example, a married 20-year-old male under the demographic patterns of 1977 will spend 89.2% of his life--on an average--married, but a woman only 72.6% (85.1% and 69.7% in 1982, respectively). Between 1977 and 1982 significant changes in nuptiality patterns took place.

A general trend of postponing first marriage has been observed. As a result the remaining life time in the state "never married" for both 20-year-old males and females increased by about 4.0 years and 4.65 years, respectively. It may be added that in the same time the mean age at first marriage increased, but only slightly from 23.3 years to 23.7 years for males and from 21.4 to 21.6 years for females. From this we can see that the change was only in part due to an increase in the mean age of marriage; the other part was due to decreasing proportions ever marrying. Therefore the indicator mean age at first marriage seems to be much less sensitive to changes described as measures from the multi-state model presented here.

At the same time the duration time in state "divorced" increased for both sexes. The trend in the state "widowed" shows a somewhat different picture. The average duration time for "non-widowed" persons remained more or less stable for males and decreased for females, but increased for both sexes for individuals already widowed at age 20. In general, these findings indicate that 1982 patterns imply higher proportions widowed and divorced in the population than the 1977 pattern.

Consequently, the duration time in the state "married" decreased in general, and so did the fraction of lifetime spent in that state. This holds true regardless of the state the person occupies at age 20.

### **3.1.2. Marital Status Forecasts**

A *status quo* forecast for population by age, sex, and marital status has been prepared, taking the conditions of 1982 as the point of departure. The time horizon was chosen to be at 2010. Before presenting some results of forecast another methodological remark should be added. Notwithstanding the analytical power of a multi-state model, some methodological problems have remained. Especially for a marital status model the problem of managing the two-sex question remains unsolved. As most other demographic models the multi-state approach does not con-

sider a real two-sex population. Although it is possible to compute results for males and females in a compact way, the two sexes in fact do not interact. So it may happen that the number of married women and the number of married men do not coincide, as it must be in a real, closed population. But in the case we refer to, the bias arising from this appears to be minor and may be disregarded in view of the goal of this application. Even the initial population of 1982 shows a surplus of 15,960 more married women than married men. This is mainly a result of long-term implications of World War II, where some women whose men had disappeared during the war were still counted as married. With respect to the total numbers of both married males and females, this figure accounts for a share of .2%. As a result of the *status quo* forecast this percentage is reversed and there are more married men than women to be forecasted for the end of the time period considered (2010). The percentage of this "balancing error" turned out to be 3.7%. This may be considered--for a first step--as acceptable.

As an important component of population dynamics the marital status structure is expected to change further, even under the assumption of a *status quo* forecast.

Table 15. Marital status forecast: population over 18 years by sex and marital status (in percentages).

| Year           | Total | Never   |         |         |          |
|----------------|-------|---------|---------|---------|----------|
|                |       | Married | Married | Widowed | Divorced |
| <b>MALES</b>   |       |         |         |         |          |
| 1982           | 100   | 20.5    | 70.8    | 3.7     | 5.0      |
| 1990           | 100   | 21.0    | 69.2    | 3.3     | 6.5      |
| 2000           | 100   | 21.5    | 68.2    | 3.3     | 7.0      |
| 2010           | 100   | 22.5    | 66.8    | 3.7     | 7.0      |
| <b>FEMALES</b> |       |         |         |         |          |
| 1982           | 100   | 14.3    | 60.0    | 18.1    | 7.6      |
| 1990           | 100   | 14.5    | 60.3    | 16.1    | 9.1      |
| 2000           | 100   | 15.2    | 59.6    | 15.0    | 10.2     |
| 2010           | 100   | 15.6    | 58.4    | 15.2    | 10.8     |

The share of never married persons will increase for both sexes, from 20.5% (1982) to 22.5% (2010) for males and from 14.3% to 15.6% for females. However, this would only mean a slight increase in absolute numbers of never married persons because of the general demographic trend stressed above, which implies popula-

tion decline.

The tendency towards postponing first marriage becomes especially manifest in marital status distribution of the age group 25–29. The share of never married persons will fall for males from 26% (1981) to 35% (2010) and for women from 12% to 23%, respectively. The percentage of married persons will continue to fall: from 70.8% (1981) to 66.8% (2010) for male and from 60.4% to 58.4% for females. On the average the marital status "married" remains to determine the living arrangements and life cycle patterns of the majority of the population.

There will be an increasing share of divorced persons in the future. This applies less to males but more significantly to females.

In the following we will apply a sociological generation breakdown presenting results of the marital status forecast more explicitly.

The demographic processes in any population are the result of different types of demographic behavior. This behavior differs according to age and sex, i.e. the different age groups of males and females forming a population at a given time behave in a different manner. Therefore, demographic processes in a population occur in a generation-specific manner. The aging of the population may therefore be seen as the change of the relative weight of the different generations within the population.

This has repercussions on the social relationship between the generations. To find out how the process of aging of the population affects the society therefore requires to study

- the absolute size and the sex ratio of the generations of the population as well as its involvement in the demographic processes;
- how the demographic processes influence the economic and social processes in society.

In contrast to the definition of generations as usual in empirical demography, sociological generations are formed from members of age groups which

- can be assumed to have an equal position within both the economic reproduction and the social reproduction process of society,
- are characterized by typical and homogeneous demographic modes of behavior.



In order to operationalize these considerations a certain generation distance is to be assumed. In the GDR in 1984 65.4% of first children were borne by women in the age group 19 to 23 years. This pattern has been relatively stable for a long time. For this reason it is appropriate to use a demographic generation distance of about 20 years, or, put in another way, to establish a sociological generation from age groups of about 20 years.

It can be recognized with a simplified conclusion that in the GDR population there are four sociological generations which comprise the age groups in the following manner:

|                    |                     |
|--------------------|---------------------|
| first generation:  | 0 to 20 years old   |
| second generation: | 21 to 40 years old  |
| third generation:  | 41 to 60 years old  |
| fourth generation: | 61 years and older. |

The first generation is that of infancy and youth who neither participate actively in the reproduction of the population, nor in the working process of society. Only in the last age groups parts of this generation become demographically reproductive and assume economic tasks. This generation lives close to its parent's generation.

The second generation is the generation of the young working people, the learners (students), and of young parents. This generation behaves in a reproductive manner (some 90% of women become mothers) and is actively involved in the economic reproduction process. The members of this generation enter professional life with a high qualification and acquire a vocational position.

The third generation is the part of the population still in an age capable of working but no longer demographically reproductive. After the departure of one's children this generation enters the phase of post-parent companionship (empty nest). The continuous professional activities are typical for this generation. In the age groups from 40 to 50 years, more than 80% of women are employed, and in the age group from 55 to 60 years more than 70% are still working.

The fourth generation is the generation of old persons who will leave the working life in a longer process and will experience new aspects of their way of life. Life expectancy of 60-year-old men amounts to 15.7 years, that of women to 19.2 years (1984). In the first five years after entering retirement age there are still about 30% of men and women who are economically active.

The current nuptiality patterns yield very different results for the different generations. In the second generation the marital status structure is, of course, of special importance. The results of the forecast shows rather small changes for this group.

Table 16. Marital status forecast: second generation by sex and marital status (population 18–39 years) (in percentages).

| Year           | Total | Never   |         |         |          |
|----------------|-------|---------|---------|---------|----------|
|                |       | Married | Married | Widowed | Divorced |
| <b>MALES</b>   |       |         |         |         |          |
| 1982           | 100   | 40.2    | 54.5    | 0.1     | 5.2      |
| 1990           | 100   | 39.4    | 54.1    | 0.1     | 6.4      |
| 2000           | 100   | 41.8    | 51.9    | 0.1     | 6.2      |
| 2010           | 100   | 43.7    | 50.4    | 0.1     | 5.8      |
| <b>FEMALES</b> |       |         |         |         |          |
| 1982           | 100   | 26.9    | 65.5    | 0.5     | 7.1      |
| 1990           | 100   | 27.3    | 63.8    | 0.5     | 8.4      |
| 2000           | 100   | 31.0    | 60.4    | 0.5     | 8.1      |
| 2010           | 100   | 32.0    | 59.9    | 0.4     | 7.7      |

The share of married males will decrease by about 4 percentage points, the share of married females by about 6 percentage points. In a comparable amount the shares of persons never married increase. Even at the end of the period of forecast about 50% of males and about 60% of females will be married. Note, that the age group under consideration (18 to 39 years) includes all the primary family formation processes. Therefore the percentage of persons in the status "married" is, on an average, rather low.

In the third generation role and function of the family and therefore of marital status structure changed. This generation experiences the departure of their children and become mostly grandmothers or grandfathers. On the other hand, the care for their own parents will take more and more attention and effort.

The marital status structure of this generation is dominated by the great proportion of married persons. Even in 2010 about 77% of males and about 72% of females will be married. For both sexes the percentage of divorced and never married persons increases. It is noteworthy that especially the share of never married males increases significantly under the given assumptions. The reason for this is that the changes in nuptiality patterns after 1977 will become effective for the

Table 17. Marital status forecast: third generation by sex and marital status (population 40-59 years) (in percentages).

| Year           | Total | Never Married | Married | Widowed | Divorced |
|----------------|-------|---------------|---------|---------|----------|
| <b>MALES</b>   |       |               |         |         |          |
| 1982           | 100   | 4.1           | 88.2    | 1.3     | 6.4      |
| 1990           | 100   | 5.4           | 84.6    | 1.6     | 8.4      |
| 2000           | 100   | 9.1           | 79.8    | 1.4     | 9.7      |
| 2010           | 100   | 12.3          | 76.9    | 1.4     | 9.4      |
| <b>FEMALES</b> |       |               |         |         |          |
| 1982           | 100   | 6.4           | 77.8    | 6.6     | 9.2      |
| 1990           | 100   | 4.7           | 77.6    | 6.2     | 11.5     |
| 2000           | 100   | 5.9           | 75.0    | 5.4     | 13.7     |
| 2010           | 100   | 9.1           | 71.8    | 5.4     | 13.7     |

generation under consideration after the turn of the century.

In order to understand some of the basic changes which will take place in connection with the aging process, the marital status structure of the fourth generation deserves special attention. The aged people are often in the need of care, which is normally provided by spouses or relatives. In other words, single persons will need significantly more attention and care from the state and communities than married persons.

Table 18. Marital status forecast: fourth generation by sex and marital status (population 60+ years) (in percentages).

| Year           | Total | Never Married | Married | Widowed | Divorced |
|----------------|-------|---------------|---------|---------|----------|
| <b>MALES</b>   |       |               |         |         |          |
| 1982           | 100   | 1.8           | 79.0    | 17.0    | 2.2      |
| 1990           | 100   | 1.7           | 80.0    | 15.5    | 2.8      |
| 2000           | 100   | 2.9           | 80.0    | 12.2    | 4.3      |
| 2010           | 100   | 4.0           | 77.1    | 14.0    | 4.9      |
| <b>FEMALES</b> |       |               |         |         |          |
| 1982           | 100   | 7.0           | 33.8    | 52.7    | 6.5      |
| 1990           | 100   | 7.3           | 36.4    | 49.0    | 7.3      |
| 2000           | 100   | 5.9           | 42.1    | 43.1    | 8.9      |
| 2010           | 100   | 4.6           | 39.6    | 44.9    | 10.9     |

Table 18 shows that there is a sharp contrast in the living arrangements between males and females in the fourth generation. Because of the higher life expectancy of females and the higher remarriage frequencies of males in the past decades, the percentage of married females is, on an average, rather low. Only 34% to 42% of this age group will not have to live alone. In contrast, the overwhelming majority of aged males will be married.

### **3.2. Changes in the Spatial Population Distribution**

While the total population size will not change significantly during the period 1981–2011, the population trends are clearly different in the main regions of the GDR.

In order to analyze the spatial dimension of population change another forecast for the GDR was prepared that takes main regions into account. In line with a usual categorization into regions of the 15 GDR administrative districts, which was also used by some earlier IIASA studies (Mohs 1980; Scherbov and Usbeck 1983), the following breakdown was chosen (see Figure 15):

i NORTH

(Districts Rostock, Schwerin, Neubrandenburg)

Primarily an agrarian region with high concentration of agrarian production. Given the GDR average the North has the lowest density of population and a relatively young population. This is primarily due to the relatively high fertility. The demographic balance is positive with an excess of births over deaths of 3.8 per 1,000 of population (in 1984). The balance of migration is negative. Life expectancy of newborn boys in this region amounts to 68.38 years, of newborn girls to 74.49 years.

ii BERLIN

(Capital of GDR)

Municipal region with an above-average proportion of people working in non-producing spheres. This is above all due to the high concentration of administrative facilities. In addition, this region is also an important industrial center of the GDR. As to the development of living conditions, such as housing, medical and social care, cultural and educational facilities, Berlin lies far above the GDR average. Berlin shows both an excess of births over deaths and a substantial gain from migration. The life expectancy of newborn boys is 68.70 years, that of newborn girls 74.38 years.

iii MIDDLE

(Districts Magdeburg, Potsdam, Frankfurt, Cottbus)

In the context of industrial versus agricultural production this region has to be taken as a "mixed region". The region lies below the average with regard to population density. This region also has an excess of births over deaths. The balance of migration is slightly positive, with an altogether high number of immigration and outmigration. The life expectancy is 68.56 years for males and 74.55 for females.

iv SOUTH

(Districts Halle, Leipzig, Dresden, Karl-Marx-Stadt)

Predominated industrialized region, encompassing the traditional areas of heavy industry. In 1984 some 47.7% of the entire national industrial gross production and 41.2% of the population were concentrated in the South region. This correlates with an above-average population density and with a high proportion of the urban population. The demographic profile of this region is marked by a high percentage of old-age pensioners. The South region was the only region within the GDR with an excess of deaths. The migration balance is markedly negative. With 69.28 years for males and 75.10 years for females this region has, on an average, the highest life expectancy of all the regions.

v SOUTHWEST

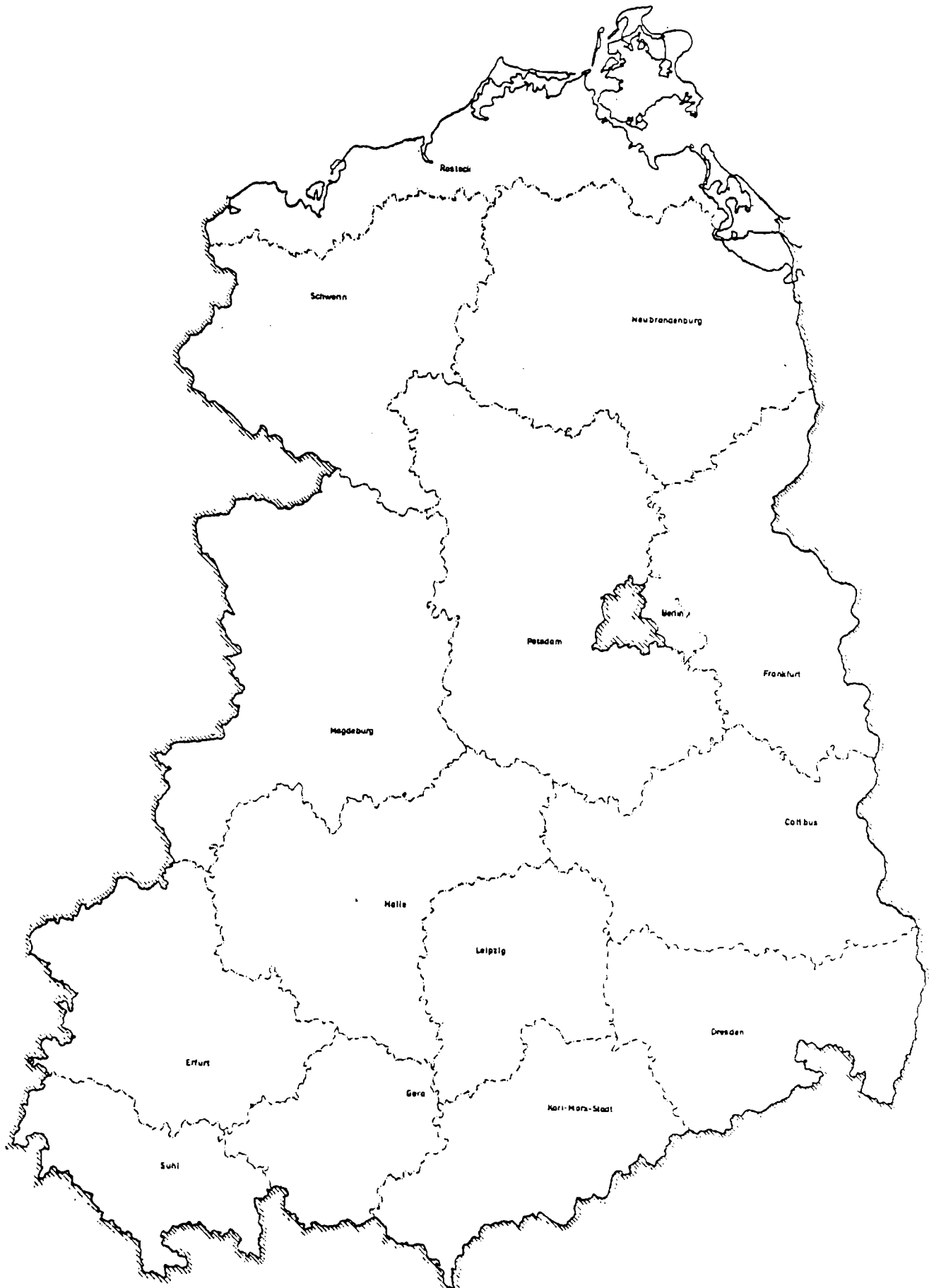
(Districts Erfurt, Gera Suhl)

Both an agricultural and industrial structured area. In terms of population density this region lies slightly above the GDR average. In 1984 there was an excess of births. The balance of migration is positive, the life expectancy of males was 69.17 years for males and 74.70 years for females.

This breakdown is based on important socio-economic and demographic criteria of these regions:

- The point of departure for a socio-economic characterization of the main regions is the existing territorial and economic basic structure. In the process of concentration of industrial production there is, as before, a "south-north-gradient" to be observed, although an important balance of the level of industrialization has already been reached due to economic policies. Despite the tendency of assimilation in the economy because of the relatively stable territorial concentration of agricultural production, the basic economic structure will not change greatly until the end of the time horizon chosen.

Figure 15. Map of GDR regional structure.



- A regionally different economic structure requires a specific way of distribution and redistribution of manpower within the economy and among the different economic sectors.
- As to socio-economic indicators reflecting the living conditions there are differences between the regions, although a positive trend is noticeable in all of them. Given these indicators, Berlin lies far above the GDR average. The still existing but decreasing socio-economic differences between the regions are one major reason for us to expect further migratory stems within the country that will, however, diminish in the future.

The population forecast calculated for population by five-year age groups, sex, and five main regions of the GDR has taken into account the mid-year population of 1981, the mortality patterns of 1981, an average fertility level for the period 1981-1984, and a medium migration estimation for the same period. The averaging of fertility and migration was done because the starting year of forecast already lies back some time. As to fertility an overall average TFR of 1.790 was assumed. Table 19 contrasts the TFR of the starting year with the TFR level chosen for the forecast.

Table 19. Fertility assumptions for regional population forecast.

| Region    | TFR for<br>forecast | TFR for<br>year 1981 |
|-----------|---------------------|----------------------|
| North     | 1.893               | 1.960                |
| Berlin    | 1.849               | 1.915                |
| Middle    | 1.797               | 1.861                |
| South     | 1.777               | 1.840                |
| Southwest | 1.781               | 1.845                |

For migration it was recommendable to assume a medium scope of 270,000 persons per annum crossing the borders of the smallest administrative units (counties). This number was then applied to age- and sex-specific migration patterns estimated by means of cubic spline interpolation from incomplete data. Status-based life table statistics have also been computed for the regional population forecast. Table 20 gives results for life expectancies by sex and region of residence for persons aged 20 years.

Table 20. Life expectancy by sex and region of residence, 1981.

| Region of residence at age 20 | Remaining life time at status |        |        |       |           |       |
|-------------------------------|-------------------------------|--------|--------|-------|-----------|-------|
|                               | North                         | Berlin | Middle | South | Southwest | Total |
| <b>MALES</b>                  |                               |        |        |       |           |       |
| North                         | 38.63                         | 2.40   | 4.39   | 3.35  | 1.25      | 50.01 |
| Berlin                        | 1.62                          | 36.42  | 8.23   | 3.04  | 1.09      | 50.40 |
| Middle                        | 1.66                          | 3.59   | 39.71  | 4.10  | 1.30      | 50.35 |
| South                         | 1.10                          | 1.48   | 3.16   | 43.37 | 1.88      | 50.98 |
| Southwest                     | 0.84                          | 1.30   | 2.08   | 3.77  | 42.86     | 50.84 |
| <b>FEMALES</b>                |                               |        |        |       |           |       |
| North                         | 44.20                         | 2.46   | 4.48   | 3.38  | 1.25      | 55.76 |
| Berlin                        | 1.58                          | 41.87  | 8.11   | 2.90  | 1.03      | 55.49 |
| Middle                        | 1.69                          | 3.68   | 45.09  | 4.13  | 1.29      | 55.88 |
| South                         | 1.09                          | 1.45   | 3.12   | 48.78 | 1.84      | 56.28 |
| Southwest                     | 0.84                          | 1.29   | 2.05   | 3.74  | 48.01     | 55.93 |

First, it should be noted that there are only little differences in life expectancies between the regions for 20-year-old males and females. It also becomes clear that the region of residence at age 20, i.e. at the age when people enter the second generation, determines the region of residence for the remaining lifetime to a large extent. At least 72% of the remaining lifetime will be spent in the current region of residence (e.g. males residing in Berlin). It should also be mentioned that migration in the GDR happens predominantly between neighboring regions.

The regions North, Middle, and Southwest follow essentially the average of the GDR, but, in contrast, the South and the capital Berlin deviate significantly from it. The region South will be characterized by a decline in population size and, consequently, in its share of total population (Table 21). In 2011 the number of people in that region will have declined to 89% of its number in 1981.

In contrast to all other regions the capital Berlin will show an increase in the number of people over the entire period. With a population of 1,158,000 people being counted in 1981, this number will increase by almost 30% within 30 years. In this figure any possible changes from changes in the migration policies could not be considered.

We also find that the future demographic development will be generally characterized by a marked decline of distortions in the sex ratio. In the wake of this trend any still existing differences in the sex ratio between main regions are



Table 21. Population forecast by regions: share of main regions on total population.

| Year | Total | North | Berlin | Middle | South | Southwest |
|------|-------|-------|--------|--------|-------|-----------|
| 1981 | 100   | 12.56 | 6.92   | 23.76  | 41.64 | 15.12     |
| 1991 | 100   | 12.69 | 7.74   | 24.06  | 40.29 | 15.22     |
| 2001 | 100   | 12.72 | 8.50   | 24.29  | 39.21 | 15.28     |
| 2011 | 100   | 12.68 | 9.20   | 25.50  | 38.30 | 15.32     |

currently balanced off. This leads to the fact that in 2011 in all regions of the GDR, with the exception of the South region, there will be more men alive than in 1981. By contrast, in all regions, except for Berlin, the number of women will decline in absolute and relative terms.

Table 22. Sex ratios by main regions and for total, 1981–2011.

| Region    | Year |      |      |      |
|-----------|------|------|------|------|
|           | 1981 | 1991 | 2001 | 2011 |
| North     | 109  | 105  | 103  | 102  |
| Berlin    | 116  | 109  | 104  | 103  |
| Middle    | 110  | 106  | 103  | 102  |
| South     | 115  | 110  | 106  | 104  |
| Southwest | 112  | 108  | 104  | 103  |
| Total     | 113  | 108  | 105  | 103  |

## CONCLUDING REMARKS

Despite some specific features that were discussed in this paper the aging process in the German Democratic Republic generally follows the pattern of most other central European countries. Like in most of these countries the graphical representation of the aging process (see Figures 16–21) is dominated by the strong birth cohorts that were born after World War II. Due to the relatively low levels of mortality these cohorts are expected to survive to old ages and at each age dominate the pattern of the age distribution. In the central European populations, where fertility declined sharply since the 1960s, these "baby-boom cohorts" will at each age of their life cycle represent the largest age group, be it at ages 5–9, 30–34, or even 70–74. To the left of this ridge crossing the 3-D graph from the back to front will be the small age groups produced by recent and expected fu-

ture fertility regimes. To the right is a rather uneven pattern that was produced by the strong fertility fluctuation during the first half of our century and the significant losses due to the two world wars.

Figure 16. Projected age structural changes, 1950–2025; All IIASA countries.

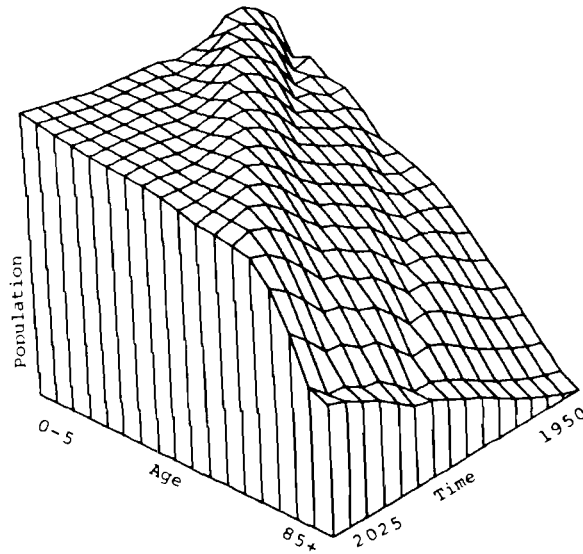
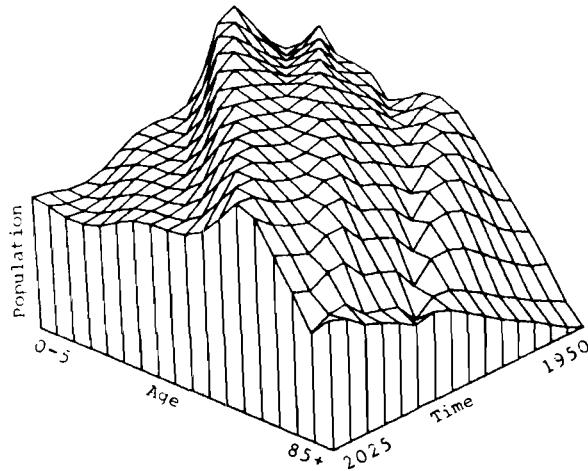


Figure 17. Projected age structural changes, 1950–2025; German Federal Republic.



This typical central European pattern of aging is different from that in the two largest industrialized nations of the world, the Soviet Union and the United States of America. For these two large countries on the aggregate national level a

Figure 18. Projected age structural changes, 1950–2025; United States.

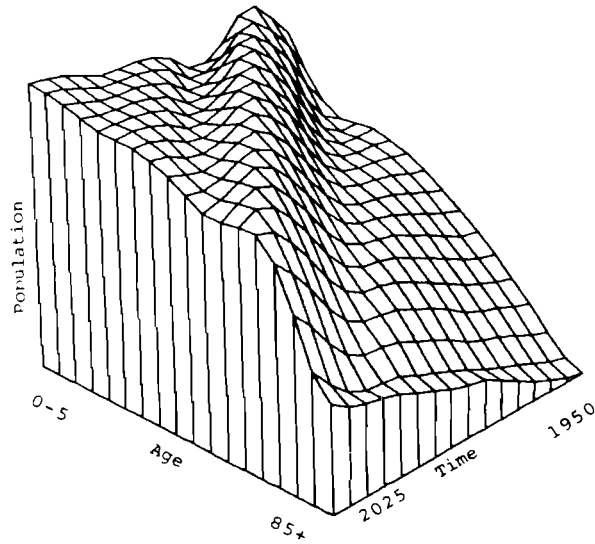
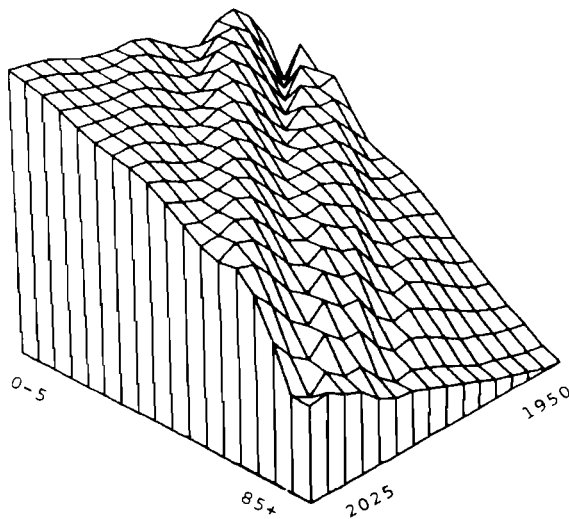


Figure 19. Projected age structural changes, 1950–2025; USSR.



baby boom is also visible but it is less dominant for the age structure in the first half of the next century because of higher levels of fertility since then. Both countries, however, seem to have substantial regional differentials, and especially in the Soviet Union the European Republics can be expected to come closer to the Central European pattern of aging.

Figure 20. Projected age structural changes, 1950–2025; Austria.

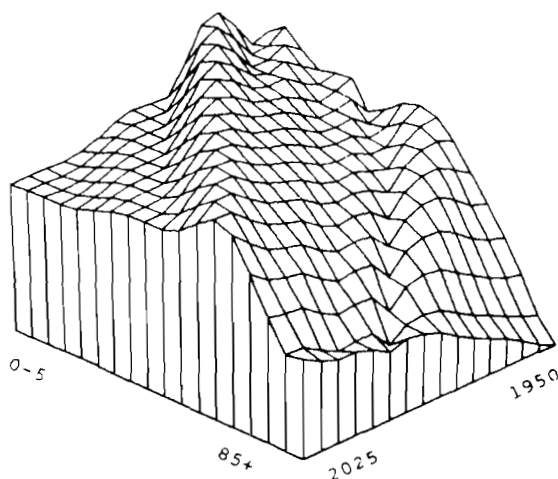
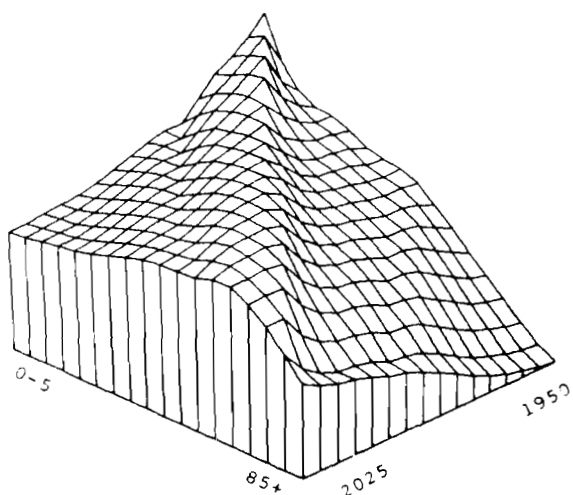


Figure 21. Projected age structural changes, 1950–2025; Finland.



This Central European pattern of aging, of which the German Democratic Republic is clearly a part and which is also similar to many northern and southern European countries, has a few typical problems that have already been mentioned in the case of the GDR. First of all the sex ratio is heavily distorted due to the wars and due to high sex differential in peacetime mortality. This has severe consequences on the marital status distribution of the population. There are many more women without a partner than men without a partner. This is not only true for widows who had lost their husband due to the higher female life expectancy and the the higher average age of men in marriage; it is also true for women who could not

find a partner due to the severely disturbed marriage market. Hence, speaking of the older segment of the population--called the fourth generation in this paper--is mainly speaking about women and especially women who have to live alone. Our multi-state projection model could demonstrate this quantitatively for the period up to 2010.

Another specific problem arising from the age structure that is characterized by a baby-boom and subsequent low fertility is that the severeness of the pension problem following the distorted age distribution is obscured by high proportions in the labor force and consequently low dependency ratios for quite a while. It is because of the combination of the strong cohorts that recently entered the labor force and the decreasing number of children that demographic dependency ratios actually fell significantly during recent years. In the GDR the total dependency ratio actually reached an all-time low in 1985. Nevertheless, it is necessary to understand the upcoming problem already today and consider measures to counteract the very dramatic future problems arising from the dependency ratios and in particular from old age dependency.

But such problems are clearly coming as a consequence of extended periods of low fertility. They will become very dramatic when the strong cohorts reach the age of retirement. Then all of a sudden there will be lots of pensioners having worked all of their life and expecting material security for their retirement; but, on the other hand, there will be only a few people in the active generations of the population to generate the resources that should pay for the retired people's pensions.

There is still some time ahead with relatively advantageous dependency ratios. This time should be used to develop creative new approaches to the pension problem. Unless there is an unexpected rapid improvement in productivity or an even more unexpected rapid increase in fertility levels, current structures of pensions and retirement can no longer be afforded by the national economy in the near future.

These problems are essentially the same for all countries that had the baby boom followed by very low fertility. Although in other countries the problem will arise earlier (e.g. in Finland because of the baby boom in the 1940s) and in some countries it will be more severe (e.g. in German Federal Republic because of lower fertility levels) the German Democratic Republic will also have to face this challenge arising from the population structure and questioning the current state of the "contract between the generations". The policy responses, however, may be

somewhat different in the various European countries and must be based on the specific national, social, and economic realities.

This paper on the specific case of aging in the GDR could only be selective in treating this broad subject. By no means is this the last word on this complex phenomenon that probably will attract even more attention in the future. In particular we had to restrict ourselves to demographic aspects and could not go into the field of social, economic, and political consequences. Even this demographic perspective has been limited. Possible important extensions of the demographic study of aging in the GDR include further analysis of the interaction between aging and the family, the role of kinship networks, and family support for the elderly. More could also be done on the analysis of mortality and assumption about future changes in longevity. Last, but not least, the process of aging is embedded in the process of changing value patterns that affect demographic factors at many levels (fertility, nuptiality, living arrangements, etc.). We have to ask how these values influence the aging process and what the impact of prevailing or anticipated demographic patterns on the value structure is.

## REFERENCES

- Espenshade, T.J. (1984) Marriage, Divorce, and Remarriage from Retrospective Data: A Multiregional Approach. *Multiregional Demography: Four Essays*. RR-84-2. Laxenburg, Austria: International Institute for Applied Systems Analysis.
- Just, P. (1983) *Two Program Packages for Deriving Multistate-Multiregion Life Table and Two-Sex (Female Dominant) Population Projections*. WP-83-10. Laxenburg, Austria: International Institute for Applied Systems Analysis.
- Keyfitz, N. (1980) Multistate Demography and Its Data: A Comment. *Essays in Multistate Mathematical Demography*. RR-80-10. Laxenburg, Austria: International Institute for Applied Systems Analysis.
- Kim, Y. (1983) *Regional Fertility Differentials in IIASA Nations*. CP-83-18. Laxenburg, Austria: International Institute for Applied Systems Analysis.
- Lutz, W. (1985a) On the Predictive Value of Fertility Studies. *Zeitschrift für Bevölkerungswissenschaft* 11(3):287-303.
- Lutz, W. (1985b) Heiraten, Scheidungen und Kinderzahl. Demografische Tafeln zum Familien-Lebenszyklus in Österreich. In: *Demografische Informationen 1985*, pp. 3-20.
- Lutz, W. (1986) *The Division of Labor for Society's Reproduction*. WP-81-19. Laxenburg, Austria: International Institute for Applied Systems Analysis.
- Meyer, D. and W. Speigner (1982) Bedürfnisse und Lebensbedingungen in der Entscheidung der Frau über ein drittes Kind. *Jahrbuch für Soziologie und Sozialpolitik 1982*, pp. 131-146. Berlin.
- Speigner, W. (1987) *Kind und Gesellschaft* (Child and Society). Berlin.
- Rogers, A. and F. Willekens (1978) *Spatial Population Analysis: Methods and Computer Programs*. RR-78-18. Laxenburg, Austria: International Institute for Applied Systems Analysis.
- Rogers, A. (1980) *Essays in Multistate Mathematical Demography*. RR-80-10. Laxenburg, Austria: International Institute for Applied Systems Analysis.
- Rogers, A. and P. Williams (1982) *A Framework for Multistate Demoeconomic Modeling and Projection, with an Illustrative Application*. WP-82-69. Laxenburg, Austria: International Institute for Applied Systems Analysis.

- Scherbov, S. and H. Usbeck (1983) *Simulation of Multiregional Population Change: An Application to the German Democratic Republic*. WP-83-6. Laxenburg, Austria: International Institute for Applied Systems Analysis.
- Vaupel, J.W., B.A. Gambill, and A.I. Yashin (1985) *Contour Maps of Population Surfaces*. Wp-85-47. Laxenburg, Austria: International Institute for Applied Systems Analysis.
- Willekens, F., I. Shah, J.M. Shah, and P. Ramachandran (1982) Multi State Analysis of Marital Status Life Tables: Theory and Application. *Population Studies* 36(1):129-144.
- Winkler, G. and W. Speigner (1986) Fertility Trends in the GDR and Their Effects on Age Structure. Berlin: Institute for Sociology and Social Policy. Paper presented at the Ad Hoc Group "Sociology of Population, XI World Congress of Sociology, New Delhi, India, August 1986.
- Bevölkerungstatistisches Jahrbuch der Deutschen Demokratischen Republik* (Statistical Yearbook on Population). Berlin: 1965-1980.
- Institute for Sociology and Social Policy (1984). *Demographic Processes and Population Policies in the German Democratic Republic 1970-1984*. Berlin: Academy of Sciences.
- Statistical Yearbooks of the German Democratic Republic, 1955-1985. Berlin.
- Volks-, Berufs-, Wohnraum- und Gebäudezählung am 31.12.1981 in der Deutschen Demokratischen Republik (GDR Census of 1981). Berlin.