WORKING PAPER

POPULATION FUTURES FOR EUROPE: AN ANALYSIS OF ALTERNATIVE SCENARIOS

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This paper is a revised and expanded version of remarks originally presented at a Task Force Meeting on the Impacts of New Technologies on the European Environment, held at IIASA 29 February–1 March 1988. We have benefited from the useful comments and questions raised during the workshop.

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Foreword

Population projections using arbitrary assumptions are made by many agencies, national and international, and there is no obvious need for one more set. But what distinguishes the projections of this Working Paper is the extremely wide range of assumptions in regard to births, deaths and migration with which the authors experimented. Moreover, they give a more explicit rationale for their assumptions than is commonly presented.

In effect the paper answers such questions as "What if we have a new baby boom, short but intense, comparable to that of the 1950s?" "What if mortality improves spectacularly, not only at the ages to which people have lived up to now, but far beyond those ages, say though discovery of a magic drug?" On the other hand they also ask "What happens if some vast epidemic, such as AIDS, ravages the population of Europe?"

Its imaginative assumptions are unlikely to be fulfilled, but none of them is impossible. This new set of perspectives goes beyond the more conventional projections that are currently in print in displaying what may happen in the future.

Nathan Keyfitz
Leader
Population Program

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POPULATION FUTURES FOR EUROPE: AN ANALYSIS OF ALTERNATIVE SCENARIOS

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1. Introduction

Population projections are an important product of demographic analysis, for several obvious reasons. Whether in planned or market economies, governmental officials, personnel directors, plant managers, educators, military leaders, and others all find it useful to "know" how many people there will be, and what the characteristics (age, sex, education levels, family status, and so on) of the population will be, in years to come.

Of particular concern is the delicate relationship between people and their physical and natural environments—as the numbers of people grow, so does the usage of resources and space, as well as the accumulation of by-products—often in the form of wastes—of that resource use. It is, in fact, a concern with future of population growth and its potential environmental consequences which motivates the present paper, which is part of a larger effort undertaken at IIASA in recent years, one focusing upon the future of Europe. Here we examine several alternative population-growth scenarios for Europe over the coming decades; we do not comment upon the environmental consequences of the alternative scenarios, but rather present them to the larger community of futures analysts.

The components of population dynamics are straightforward and few in number: births, deaths, and net migration. This is true whether we contemplate the regional, national, or global level, except that at the global level (under current transportation technology) net migration must be zero. If we add to these three components an additional category of information, namely the size and structure (according to age and sex) of an initial population, it is a straightforward exercise to compute a projection of the future population in any year. An overview of what has become a standard tool for population projection can be found in chapter 11 of Keyfitz (1982).

Despite the standardization of methods for population projection, projections remain a hazardous and error-ridden undertaking, and do so for the simple reason that it is impossible to correctly guess the future path of fertility, mortality, and net migration. It is

possible to make rather good guesses—especially for the near-term future and for components such as mortality rates, which have tended to show fairly regular trends over time. In recent years demographers have devoted some attention to the analysis of ex post errors in population projections, and have identified some factors associated with the relative size of the error; see for example Keyfitz (1982), Stoto (1983) and Land (1986). But correct guesses remain in the realm of the impossible.

In virtually all population projections it is the analyst's goal to calculate as closely as possible what time will reveal to be the actual path of the population. And, if not, this should be the goal, since the users of projections typically treat the numbers as answers to the question "what will happen?" Here, we attempt to answer a very different question, namely, "what *might* happen?" Our object is to anticipate what might be major demographic "surprises" of the coming decades, and then calculate what the population consequences of such surprises would be. Our attitude is that even unlikely surprises may nonetheless materialize, and that we should therefore contemplate a broad range of possible (if unlikely) alternative scenarios. There are of course an infinity of such alternatives; in what follows we confine ourselves to an exposition of five rather extreme alternative scenarios, representing major departures from recent mortality, fertility, and migration experience in Europe. For reasons of data availability, elaborated later, we omit from our analysis the European parts of the Soviet Union.

The outline of the paper is as follows: in the next section, we provide a context for the scenario analysis by describing the main demographic trends of postwar Europe; we consider mortality, fertility, and migration in turn. Section 3 describes our projection methodology, while Section 4 presents what might be labeled the "conventional wisdom" regarding Europe's future population. Section 5 presents our main findings, describing the assumptions underlying the alternative scenarios and presenting the corresponding calculations. A brief summary and discussion concludes the paper.

2. Demographic Trends in Postwar Europe

In order to set the stage for our scenario analysis, we present a brief survey of demographic developments in Europe, focusing upon the post-World War II period. The demographic trends and patterns exhibited during this period are important for two reasons: first, they have much to do with the composition of the present population of Europe, which in turn is the starting point for any population projection; and, second, it is only in the context of recent trends that the analyst can develop plausible assumptions regarding the future paths of the demographic parameters which serve as inputs into the projection.

In this section, we present an overview of mortality, fertility, and migration patterns.

Mortality. Age-specific mortality rates—for example, the number of deaths to men (or women) in a given age-group during the year, divided by the mid-year population in the given age and sex category—display a distinctive pattern. The pattern begins with rates which are somewhat high during the first year of life, but which drop off rapidly and remain low throughout childhood and into early adulthood, and then climb slowly, and later (around ages 50 and onward) progressively more rapidly. It is common to summarize mortality rates in a single, simple index, the expectation of life at birth. This is the average number of years that people would live if they experienced the given age-pattern of mortality rates throughout their lifetime.

Figure 1 displays life expectancies by sex for Europe, with actual data for 1950–1980, and the assumed path of life expectancy for 1985–2020. These data are used in the United Nations medium-variant population projection, discussed in more detail later. The two key features of Figure 1 are, first, the fact that women on average live longer than men and, second, the fact that the female-male differential has been widening. Moreover, the UN projections assume that the female-male differential will continue to widen throughout the projection period. According to the UN assumption, female life expectancy will be around 80 years by the year 2020, a level which has already been surpassed in Japan.

The sex-specific curves shown in Figure 1 mask considerable underlying diversity. One example of diversity is illustrated in Figure 2, which shows regional patterns of male life expectancy in Europe. According to this figure, in 1950 male life expectancy in Northern and Western Europe was several years greater than in Southern and Eastern Europe. But by 1970 male life expectancy in the southern region had risen to that of the western region; in the meantime male life expectancy stopped growing in Eastern Europe. In fact, detailed analyses of country data have shown that death rates of working-age men have actually declined in some countries; these declines would have translated into a ***reduction*** in overall life expectancy, had they not been offset by improvements in infant and childhood mortality [see, for Poland, Okolski (1985), and for Hungary, Carlson and Watson (1988)]. The corresponding region-specific curves for women (not shown) reveal a pattern which is similar to that found in Figure 2, though not so exaggerated.

While the age-pattern of mortality described before has remained fairly stable (except when upset by exogenous factors such as war), future mortality patterns could be quite different. It has been argued [especially by Fries (1980)] that future developments in adult mortality will cause the life-table—that is, the pattern of survivorship to specified ages—to become essentially *rectangular*. That is, there will be a tendency for

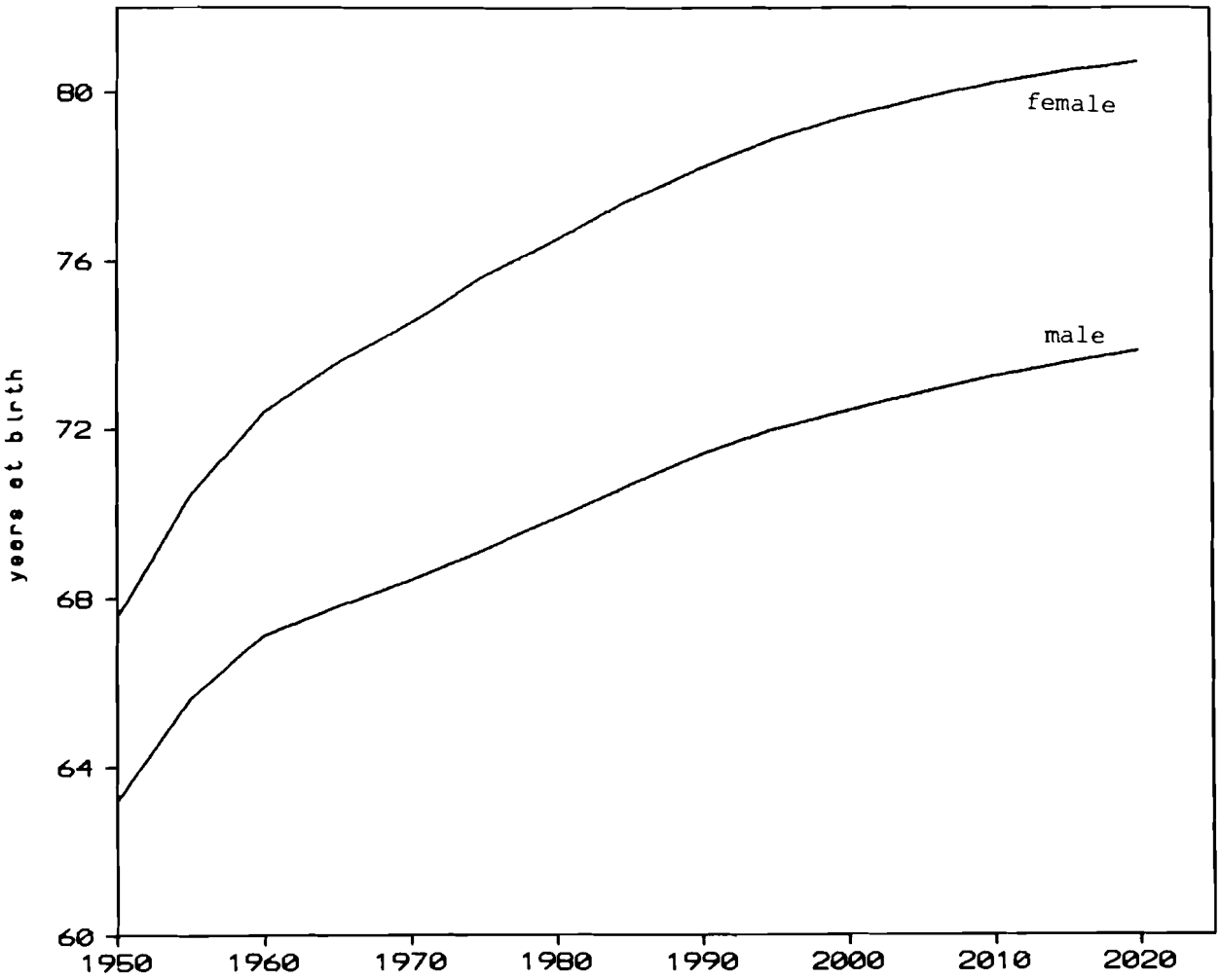

Figure 1. Life expectancy in Europe, by sex.

deaths to become concentrated at a theoretical maximum life span (of around 85 years), at which age most people will die. It has been argued that this progress is—and will be—due to improved personal health habits in combination with better medical care. Others, however, noting recent scientific advances in health care and medical research, have speculated that large and dramatic breakthroughs in mortality may emerge, raising the prospect of a "Methuselah society" in which large numbers of people live to unprecedently old ages [see, for example, Vaupel and Gowan (1985)].

In one of our scenarios we postulate developments in old-age mortality which combine elements of both the "fixed life-span" and the "Methuselah" viewpoints: we suppose that mortality after age 60 will drop dramatically and rapidly, in a way suggestive of sud-

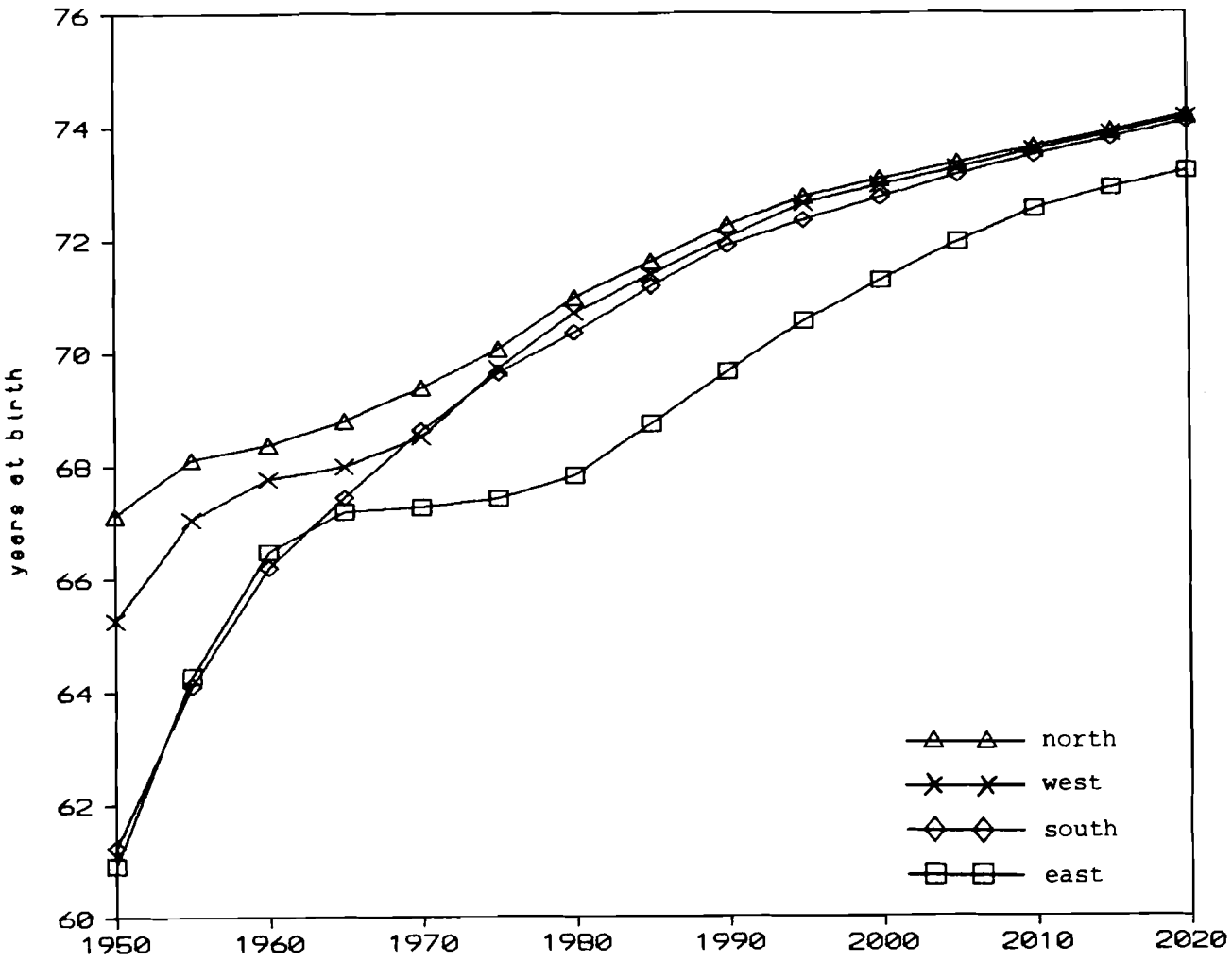

Figure 2. Male life expectancy in Europe, by region.

den technological breakthroughs, but that the span of human life will remain bounded above (at age 100).

Another recent development in mortality, still too early to be reflected in the published (and highly aggregated) data displayed in Figures 1–2, is the AIDS epidemic. The extent and ultimate consequences of AIDS remain largely unknown. In consequence, the literature contains a broad range of estimates and prognoses regarding the future path of the disease. We have picked from the literature one of many possible sets of assumptions regarding the dynamics of AIDS, and include this as one of our scenarios.

Fertility. During the last century all European populations experienced a fundamental change in their reproductive pattern. Demographers call this change the ***secular fertility transition***, which together with a substantial mortality decline constitutes the ***demographic transition***. This describes the fundamental change from a fertility pattern in which, for married couples, the number of children was virtually uncontrolled to a situation where couples more or less consciously determine the family size they want. Under the earlier regime, for married women the number of children was essentially a function of biological factors. Now, conscious planning together with the availability of efficient contraceptive methods makes personal family size desires the crucial variable.

The qualitative transition from "natural" to "controlled" fertility, which in most European populations took place early in this century, resulted as well in a significant change in the average number of children born to women over the course of their reproductive life. The total fertility rate (TFR) is a measure of the mean number of children born per woman as implied by observed age-specific period fertility rates. In most Western European countries the TFR declined from about 4–5 children per woman in 1900 to 2–3 children in the 1930s. In Southern and Eastern Europe the fertility transition took place somewhat later.

Figure 3 gives the trends in age-specific fertility rates for Finland from 1776 to 1984. In this figure one can clearly see the pre-modern fertility fluctuations at a high level, followed by a steep secular decline lasting until about 1940.

In most European countries the economic depression of the 1920s and 1930s was accompanied by very low fertility levels. The war which followed lead to considerable heterogeneity among the countries and particularly strong annual fluctuations in fertility. After the end of World War II all European countries showed an upsurge in the number of children, known as the postwar "baby boom". This phenomenon of strongly increasing fertility levels in almost every country was quite unexpected by demographers. In many countries we can identify two maxima, one right after the war and one in the early 1960s. The two examples given here (Figures 3 and 4) show two extremes in the timing of the baby boom.[1] In Finland the highest fertility levels were observed in 1947–1948, when the TFR reached almost 3.5 (equal to the level of 1916–1918) followed by a constant decline until recently. In the German Federal Republic fertility peaked in 1964 with a TFR of slightly above 2.5; for the 12 years from 1957 to 1969 it was at a level of above 2.2. After 1969 fertility in Western Germany had declined to levels somewhat under 1.4, where it now appears to have stabilized.

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[1]The sources for Figures 3 and 4 are Lutz (1987) and Lutz and Yashin (1987), respectively.

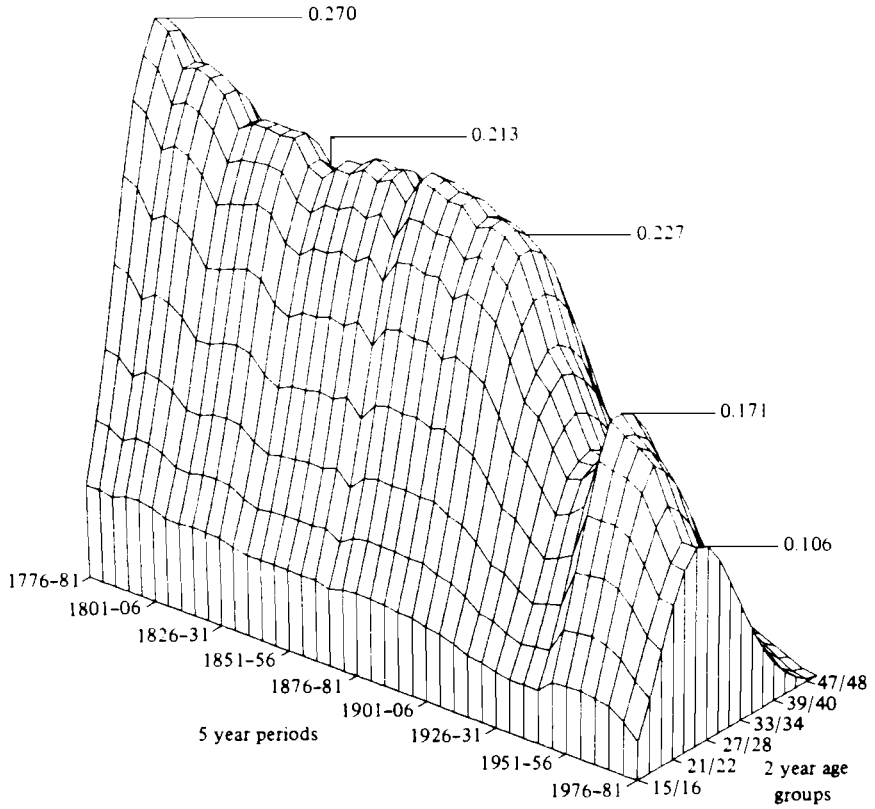

Figure 3. Age-specific fertility rates in Finland, 1776–1981.

What are the determinants of these trends in national fertility, and what can we know about future trends? Without going into the very extensive literature on fertility determinants, we will mention here only a few simple explanations. The secular fertility transition from uncontrolled to controlled fertility was largely accompanied by the transition from an agricultural rural society to a modern industrial society; children who represented additional help on the farm meant additional cost in an industrialized society. But equally important to these economic changes were probably cultural changes: people started to become more highly educated, to plan their life, and to change emphasis from the quantity to the quality of children. The postwar baby boom is now understood by demographers as being to a great extent a timing phenomenon. Women who had delayed births during the war had them later. Concurrently, younger women started their childbearing sooner than had previous cohorts. This compression of childbearing activity into a few years became the baby boom. The fact that during this period marriage in Western Europe had became almost universal, and the mean age at marriage had declined, also contributed significantly to the baby boom.

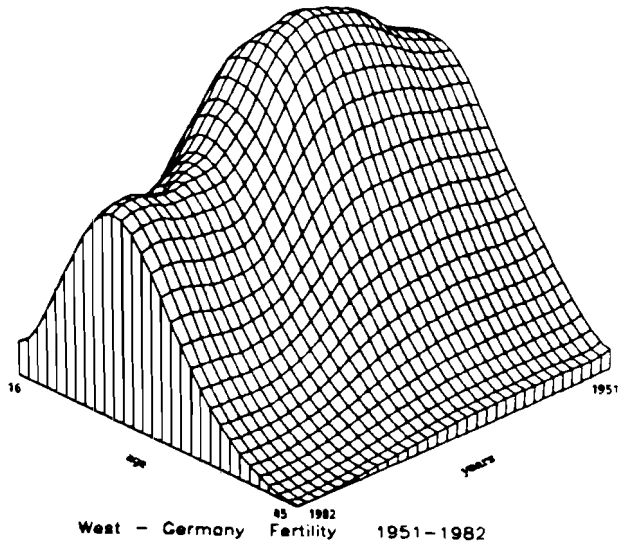

Figure 4. Fertility trends for the German Federal Republic.

More recently marriage has become less popular and also the number of children born within marriage has declined, on average, due to changes in the value pattern and structure of our modern society. The changing role of women in the family, in society, and in economic activity seems to be closely associated with this recent decline; but so also is a cultural shift from orientation towards the family to individualism, an observation sometimes called the "second demographic transition" (van de Kaa, 1987).

It is usually assumed that the marital fertility transition early in this century was an irreversible process; the irreversibility of the more recent changes remains unknown. For this reason we include two different fertility scenarios in our study, one assuming further steep fertility declines, and the other assuming the occurrence of another "baby boom".

Immigration. The pattern of immigration to Europe from year to year since World War II has not been uniform. After a century of being a large net exporter of people—to the New World—Europe gradually became a net importer of people since World War II. This shift occurred in different ways and at different times for various nations. In general, net immigration became positive earlier in West and North Europe. Partly, this was due to a large influx of people from South Europe in the 1950s and 1960s.

By the 1970s, perhaps as economic differences in Europe decreased, South European migration decreased. A large influx of workers and dependents from outside Europe continued. Nations with a colonial past experienced a large influx from their ex-colonies—for

example from Pakistan, India, and the West Indies to Great Britain; from the Maghreb and West Africa to France; and from Indonesia and Surinam to the Netherlands. Otherwise, large groups came to Europe from the South and West Mediterranean nations—notably from Morocco and Turkey. This second group initially formed the new immigrant category, "guest worker", meant to work in the "host country" for a few years and then return home. But many did not return, and instead brought their dependents after a few years, to remain permanently.

Presently, the influx of immigrants has decreased, as economic and social problems in Europe have led to an increasingly parsiminous distribution of new work permits. In those countries for which we had data, it appears that ongoing immigration consists mainly of dependents or non-workers. Presumably, unless new workers arrive, this immigration will also gradually dwindle. A new, presently small, group of immigrants are refugees. That the decreased immigration cannot be caused by decreased pressure in sending countries (as was the case for past pan-European immigration, and probably for South Europe in the seventies) is rather obvious. The pressure from developing countries to allow immigrants into Europe is more likely to increase than otherwise. As a concrete illustration of the historical trends reviewed here, Figure 5 is presented which shows the patterns of migration France from 1960 to 1984.

The absolute number of immigrants in the past decades appears large. Net migration to EEC countries was a bit under 500,000 annually from 1960 to 1976 (Statistical Office of the EC, 1977). But relative to the total population net immigration has generally been small. Available statistics indicate that during the peak years migration accounts for annual population increase of about 0.1 percent. One much higher figure—but still less than 0.5 percent—reflects a unique situation in the Netherlands when a mass exodus occurred from the colony Surinam the year before its independence. Moreover, in most of the period in question, net migration was much lower, equaling about 0.025–0.05 percent annual population increase.

Once arrived, the immigrant population can cause further increase due to natural growth. Espenshade (1987) and others note that the immigrant population often accounts for nearly all of a nation's natural growth. There are two reasons for this. The first is the age structure of the immigrant population. Immigrants are typically concentrated in the childbearing but low-mortality age group between 20 and 45; an example, illustrating the case of the German Democratic Republic in 1976, is given in Figure 6. Thus immigrants contribute substantially to fertility while contributing very little to mortality, and this alone will cause an immigrant population to grow relative to the native population.

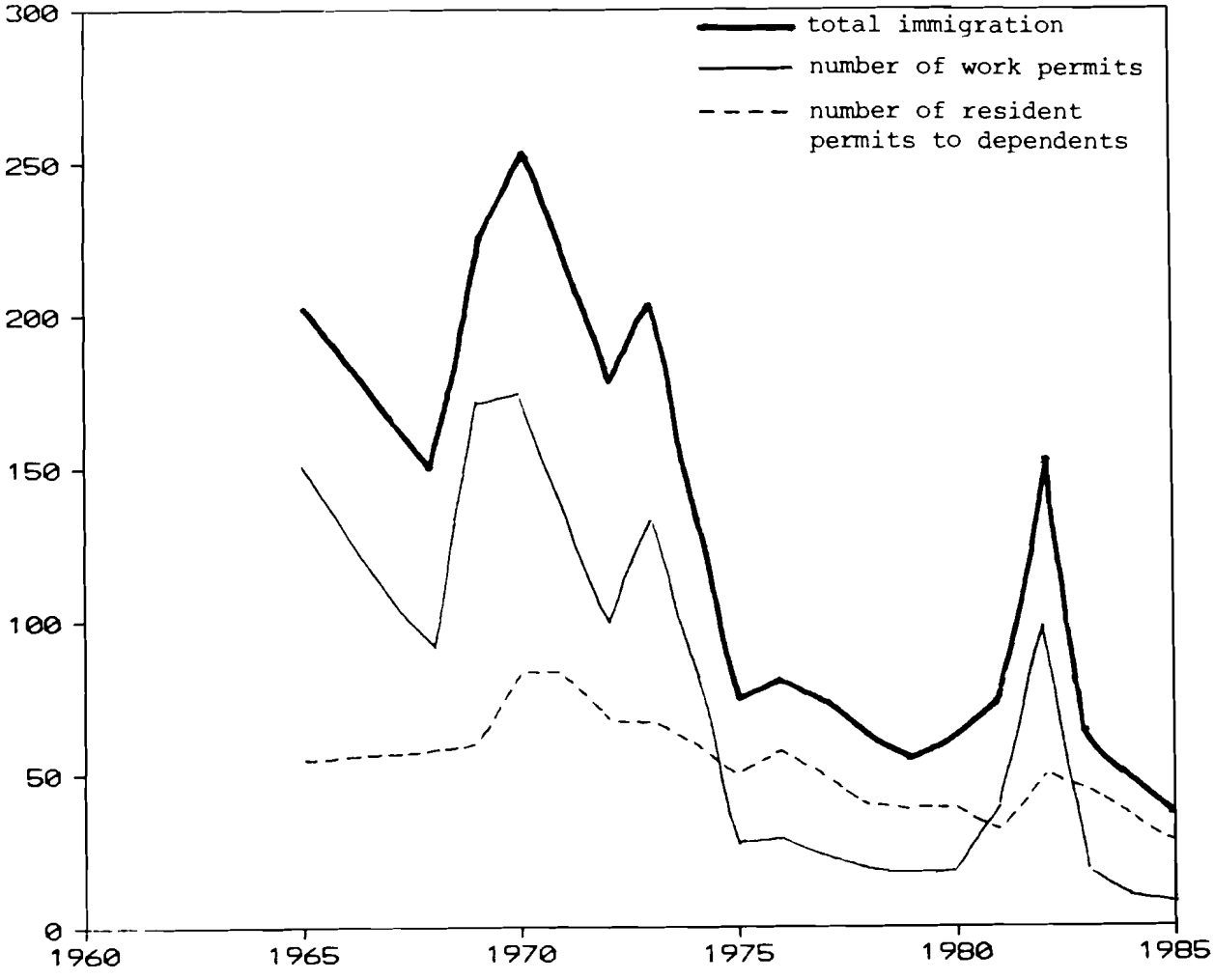

Figure 5. Immigration into France 1965–1985.
Source: Annuaires Statistiques.

The second reason is higher fertility in the immigrant than in the native population. While data on immigrant fertility in Europe are difficult to obtain, available examples—such as a TFR of 3.009 for foreign women in the Netherlands, compared to only 1.437 for Dutch women, both in 1984 (Frey and Lubinski, 1987)—indicate fertility levels which are considerably above that of the host population. Yet these high immigrant fertility levels tend to decline over time, becoming increasingly like those of the native population. In our scenario dealing with immigration, we assume that fertility differences between the immigrant and the host population vanish after 25 years.

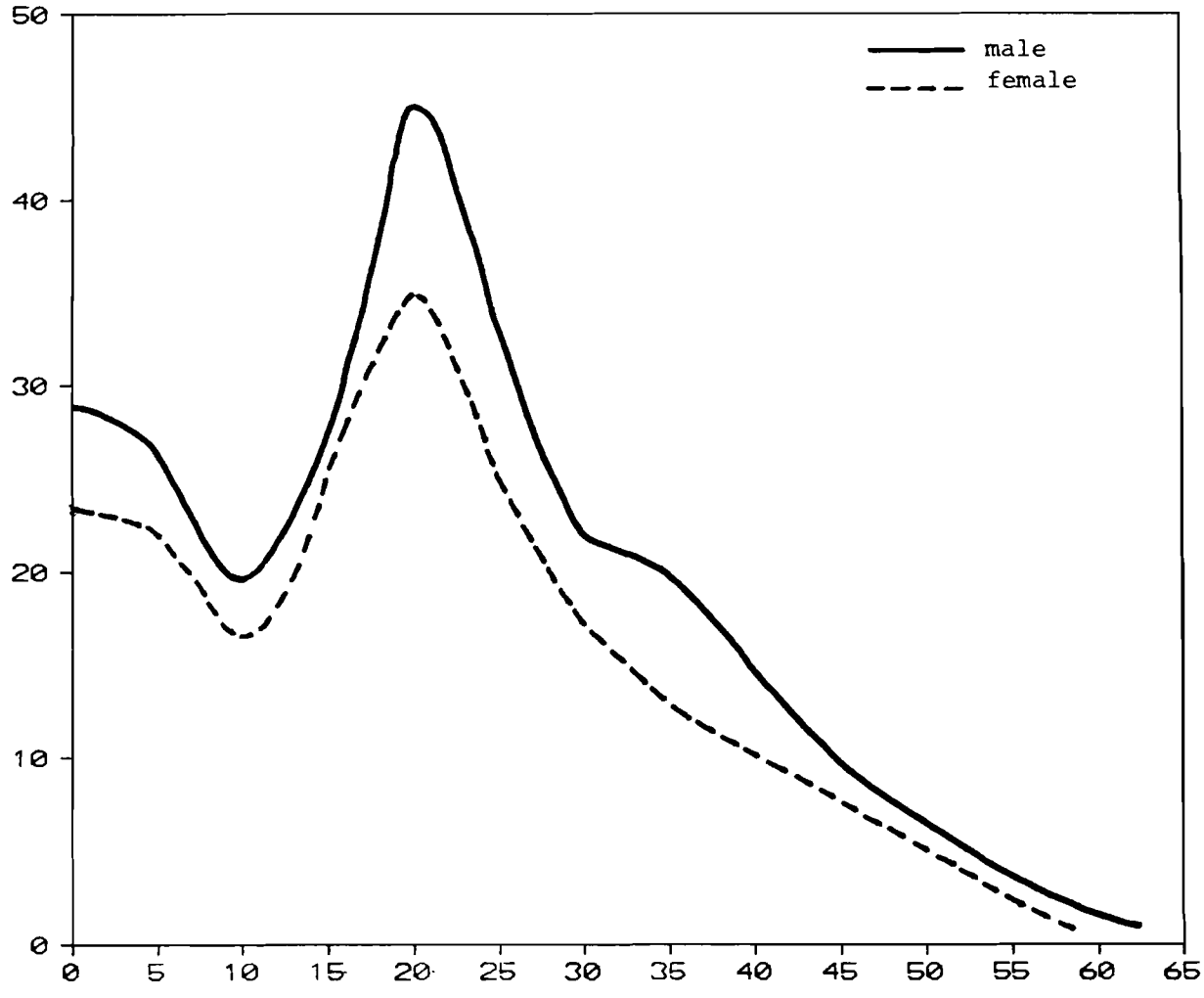

Figure 6. Age curve for migrants into the German Federal Republic in 1976.

3. Methods

As noted in the introduction, the methods of population projection are highly developed and fairly standardized. Our calculations use the usual components approach, in which the initial population is represented in terms of counts by 5–year age groups. The projection is carried out in 5–year calendar time units. In each time period, the proportion of each age group surviving until the next period is determined by the application of survival probabilities, which are in turn a function of age-specific mortality rates. Similarly, the number of newly-born people is determined by applying the appropriate age-specific fertility rates to women in the age groups for which childbearing is possible (generally, and, in particular, in our calculations, ages 15–49). The survivorship until the

end of the 5–year period of babies born during the period must also be determined. And, finally, net immigrants in each age-sex group must be added to the population.

Our calculations were obtained using the interactive microcomputer program called DIALOG, a full description of which can be found in Scherbov and Grechucha (1988). The DIALOG program is especially well-suited to the problem at hand, the examination of alternative scenarios. As noted above, the projection mathematics are based upon birth and death rates which are specific to each 5-year age group; the resulting schedule of rates is frequently called an "age-pattern" of mortality or fertility. Each pattern of rates can be summarized with a single index, such as the TFR for fertility, or life expectancy at birth, for mortality. Except as noted later, we specified our scenarios as trends in the respective indices, rather than in their individual age-specific components. The DIALOG program translates these assumptions into new patterns of birth or death rates by scaling up or down, as appropriate, the respective array of rates until the associated index agrees with the assumptions of the alternative scenario.

4. Europe's Future Population: The Conventional Wisdom

We have chosen to present, as a representative of the "conventional wisdom" regarding Europe's future population, the projections produced biannually by the United Nations' Population Division; we focus in particular on the 1986 edition of these projections (United Nations, 1986). Our choice is partly dictated by convenience, since the UN projections are available in machine-readable form and therefore very useful for analytic purposes. Moreover, the projections are presented not only by individual country but by region and continent, including all of Europe (excluding the part found in the USSR) as well as four subregions (North, East, South, and West Europe).

The UN produces three variant forms of its projections, a medium as well as low and high variants. These differ only in their assumption regarding fertility trends. We focus throughout on the medium variant, since, in the words of Keyfitz, "...[t]he interpretation of middle-variant projections as forecasts has been nearly universal among users" (1982: 196).

The essential ingredients of the UN projections are the initial population, and the assumed path of fertility and mortality rates. The mortality assumptions, summarized in the form of life expectancy at birth, were shown in Figure 1. The assumption regarding mortality is that life expectancy will continue to increase, by about 4 years, reaching 73.87 for men and 81.74 for women in 2020.

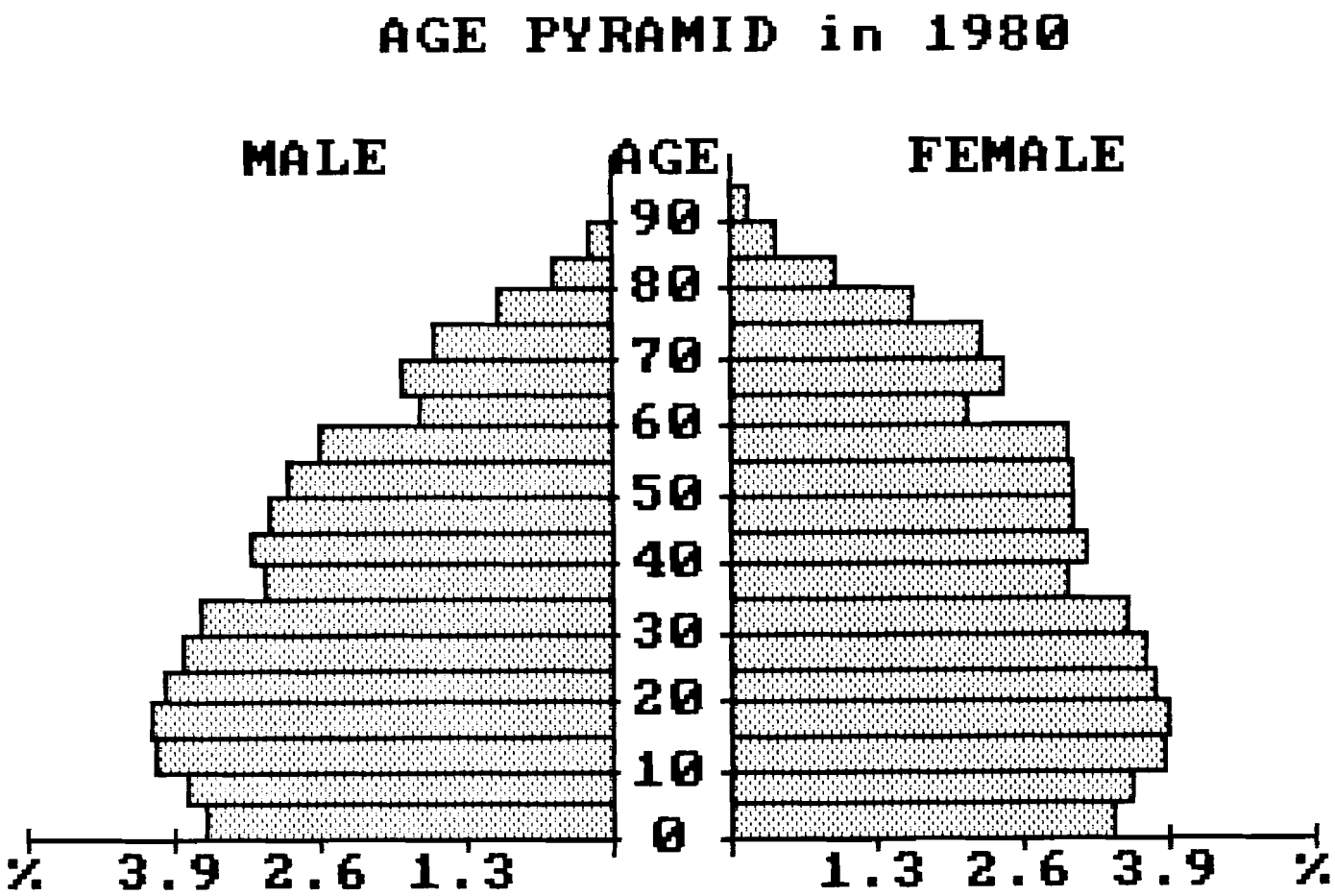

Figure 7. Age pyramid for Europe: 1980.

The remaining information is presented in Figures 7 and 8: Figure 7 depicts the starting population, in the form of an age-pyramid for 1980, while Figure 8 is a graph of the medium-variant assumptions regarding fertility (the TFR). Note that the UN projection embodies the assumption that fertility, which has been falling steadily and rather steeply since 1960, will in the immediate future reverse its downward trend, rising slowly from 1.825 (in 1980) to 2.045—almost the replacement level—by 2020.

We reproduced the UN medium-variant population projection for Europe using the DIALOG program, the results of which are shown in Figure 9. Although the UN's own projections go only until 2025, we continued the projection to 2050, using the assumption of no change in fertility or mortality after 2025. According to this projection, Europe's total population will rise gradually until 2030, at which time it will reach 526 million, which represents a 8.6 percent increase (or, a 0.16 percent annual growth rate) from the 1985

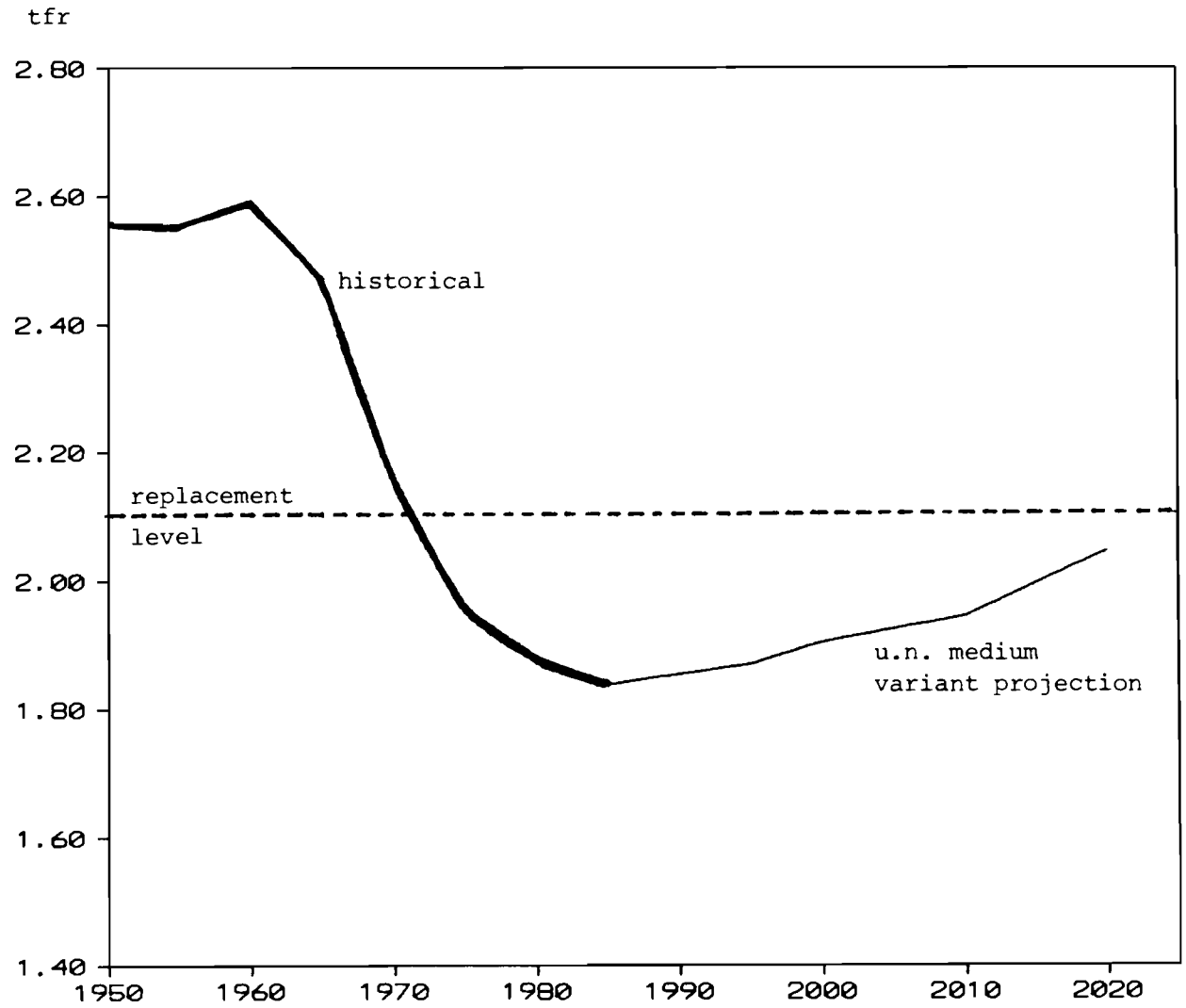

Figure 8. Total fertility rate for Europe: 1950–2020.

base of 485 million (recall that the European part of the Soviet Union is excluded from our analysis). Figure 9 also plots three broad age groups—those 0–19, those 20–64, and those 65 and older. The number of young people is projected to remain almost constant, while the working-age generation shrinks, and the elderly population grows dramatically, both in absolute numbers and in relative size.

Although we present the UN medium-variant projection as a representative of the "conventional wisdom", we must point out that the figures are not universally or uncritically accepted by students of population. The UN's medium-variant projection has in fact been termed a "bright future" (Macura and Malacic, 1987:20) mainly in view of its

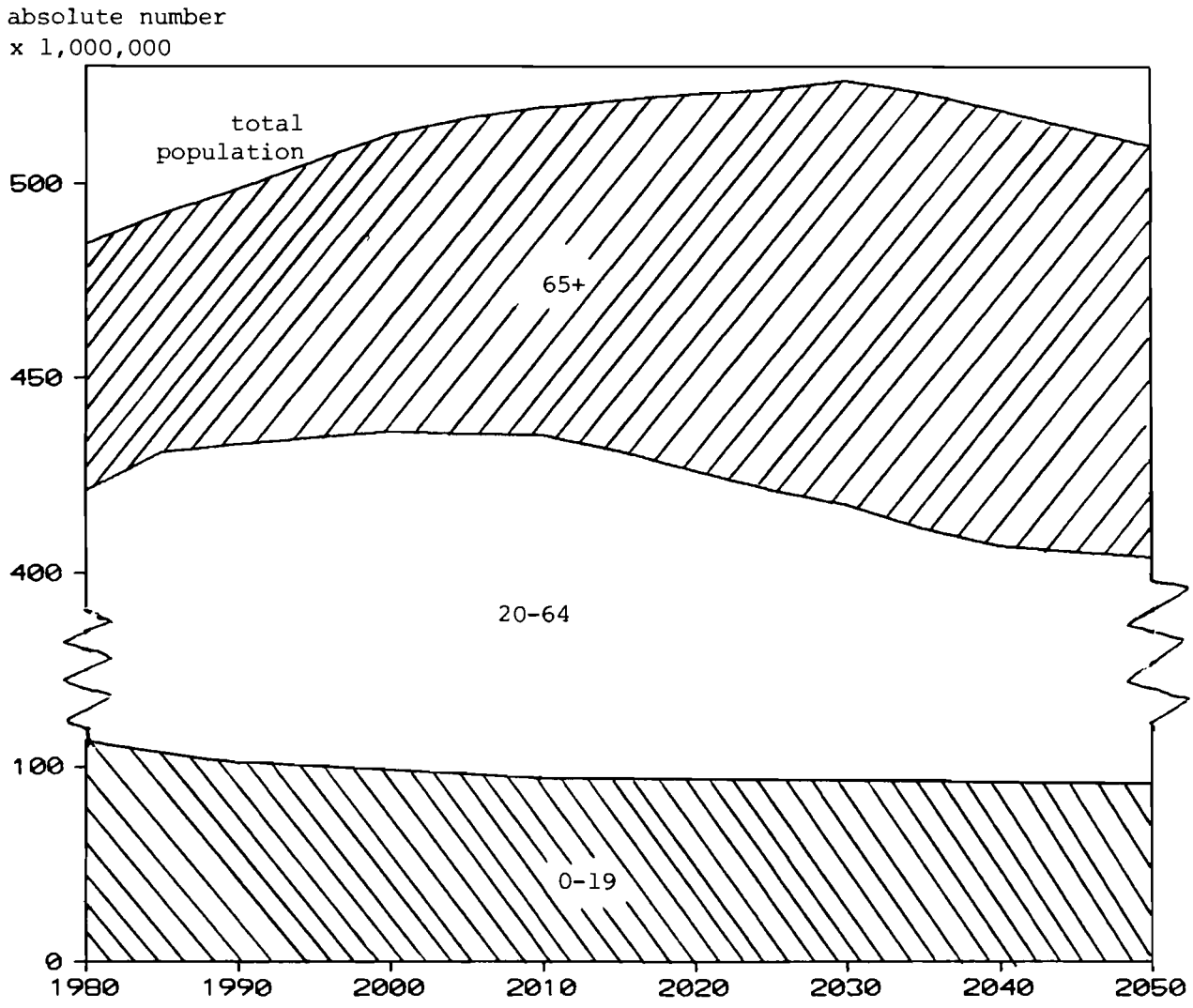

Figure 9. Projected European population, total and by age-group: UN medium-variant projection.

assumptions regarding the future path of fertility. There is no obvious reason to suppose that Europe's downward trend in fertility, a long-standing trend, will suddenly (and soon) reverse course, returning gradually to the replacement level. As we have already indicated, it is for this reason that we include as one of our illustrative scenarios a continued downward trend in Europe's TFR.

5. Europe's Future Population: Some Alternative Scenarios

Assumptions. Our alternative scenarios consider some extreme possibilities for each component of population growth. For fertility, we consider two possibilities, another "baby boom", larger than that of the postwar years, and (in our opinion, more realistically), a drop of fertility to the low levels currently observed in a few European countries. For mortality, also, we consider two possibilities; the first is a medical breakthrough (which we label, only partly in jest, a "magic drug") the effect of which is to reduce old-age death rates dramatically, and the second is a major epidemic—an extreme AIDS scenario. Finally, we examine the consequences of a major influx of immigrants, on a scale larger than experiences anywhere in Europe in the postwar years.

The specific assumptions underlying each alternative are given below.

(1) A new baby boom: the TFR starts to increase from 1.825 in 1990 to 2.776 in 2000, and decreases again to 1.825 by 2010. This would constitute a more dramatic, and more compressed, baby boom than that actually experienced in postwar Europe.

(2) Fertility decline: the TFR continues to decline in Europe, to an overall level of 1.4, a level already reached in some West European countries.

The assumptions for scenarios (1) and (2) are depicted in Figure 10.

(3) A "magic drug" is introduced on the market in 2000 which decreases mortality for those over 60 by 50 percent.

(4) A major epidemic: in order to represent a possible AIDS scenario, we note that while the present number of reported cases is about 6000 in Europe, the actual number of infections is assumed to be 40 times higher. It is assumed that the number of infections doubles annually, and that all of those infected die 10 years after infection, until half of the population aged 30–50 dies of AIDS. The other half is assumed to be immune and remains unaffected. These assumptions correspond roughly to the analysis presented by Platt (1987). Note that we apply the assumed mortality increases to both sexes.

The mortality assumptions used in scenarios 3 and 4 are shown graphically in Figure 11.

(5) A new wave of immigration: our last scenario postulates the occurrence of a turn-of-the-century burst of immigration larger than the one experienced in the sixties and seventies. From 1995 to 2004 there are one million immigrants annually. The age and sex structure is roughly historical: 55 percent male and 45 percent female, with age concentrated between 20 and 30. The immigrants' TFR is initially twice as high as the European rate, then declines gradually to the native level by 2025. Fig-

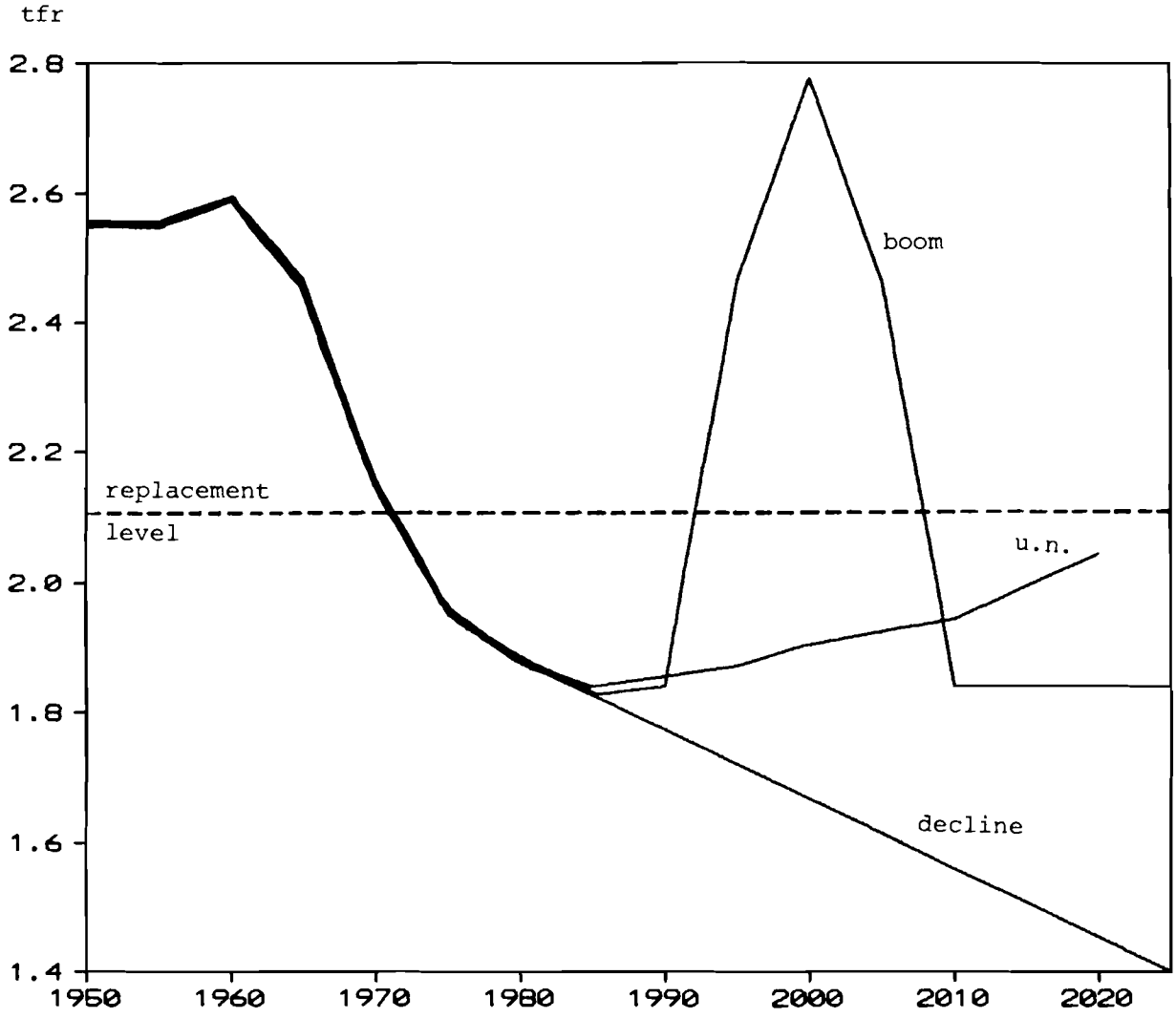

Figure 10. Total fertility rates for alternative scenarios: "baby boom", fertility decline, and UN medium variant.

ure 12 shows the net immigration into the EEC from 1960 to 1976 together with the assumed magnitude of the "new wave" immigration scenario.

The UN assumptions hold for those variables not included in the scenarios. Also, note that each scenario involves only a single set of alternative assumptions. We do not explore the consequences of *combinations* of different assumptions, but these would be, for the most part, additive. Thus the reader can readily determine the population that would result if, for example, both the low-fertility and the high-immigration scenarios were to materialize.

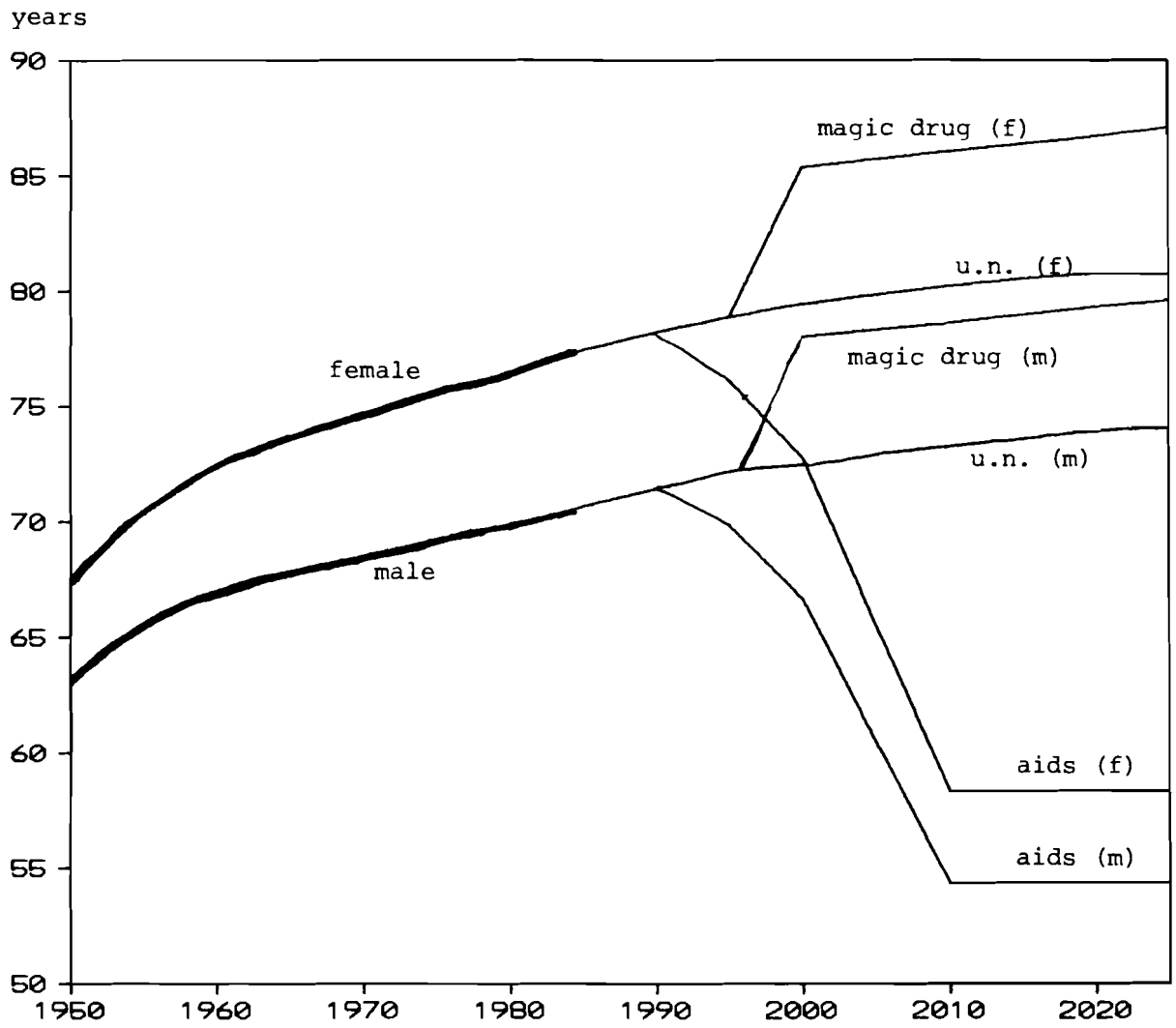

Figure 11. Life expectancy, by sex, for alternative scenarios: "magic drug", AIDS epidemic, and UN medium variant.

Results. The population paths implied by each of our alternative scenarios is pictured in Figures 13–15. In each, the UN medium-variant projection is also shown for purposes of comparison. In Figure 13, which shows the total population, we see that three of our scenarios—the baby boom, "magic drug" and new wave of immigration—imply more growth than does the UN projection, while the other two—fertility decline and AIDS—imply a sharp reduction in Europe's population. It is interesting to note that the three growth scenarios are, in effect, scenarios for upward shifts in the conventional-wisdom growth path, followed by population trajectories essentially parallel to the UN projection.

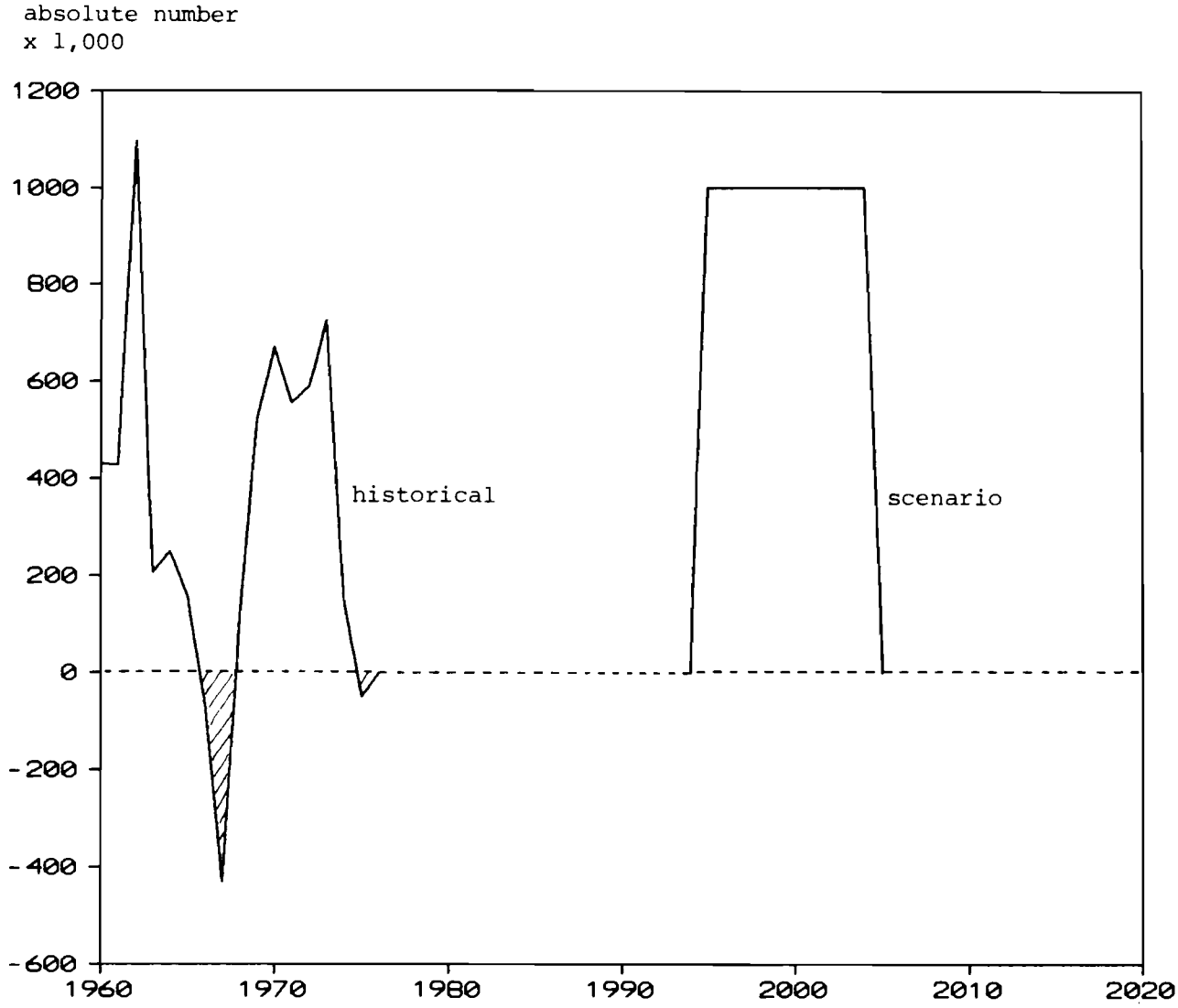

Figure 12. Immigration (in 1000s): 1960–1976 for EEC, and assumed volume for immigration scenario.

In contrast, the fertility-decline and the AIDS scenarios both imply a sharp departure from recent trends. In both cases, Europe's population peaks, at somewhat below 520 million, around 2000–2005, after which it shrinks at a rapid rate.

The age-composition of Europe's future population differs dramatically across alternative scenarios. Information on age structure is shown in Figures 14 and 15. Figure 14 shows the percentage of the population in the 15–64 age group; this is the group from which most of the labor force must be drawn. Under all the scenarios, this percentage will be at or near its peak in 1985–1990, and will decline thereafter. The decline is most

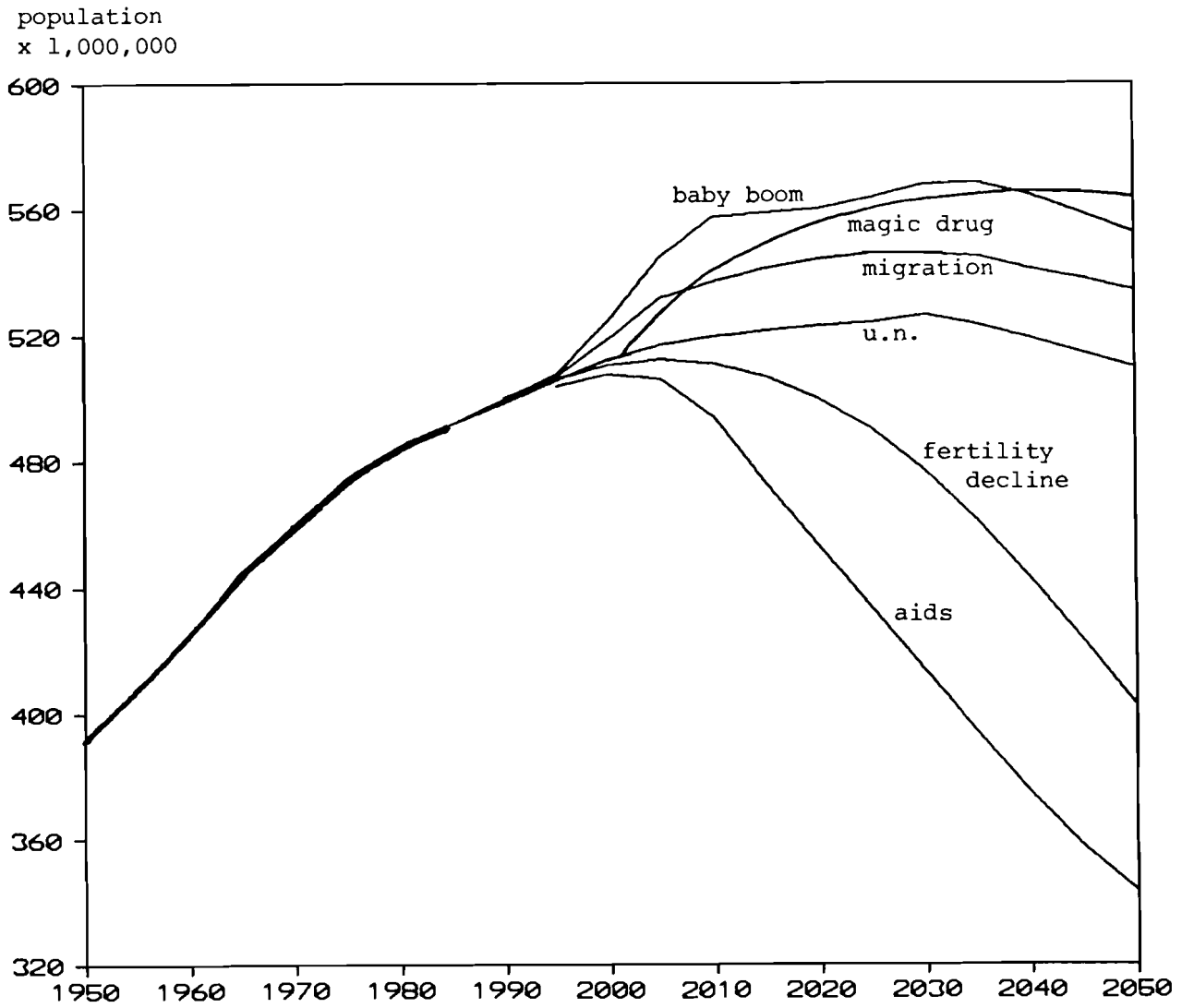

Figure 13. Projected European total population: six alternative scenarios.

precipitous for the "magic drug" scenario, where the percentage below 65 is pushed down by the massive growth of the over–65 population (see Figure 15). The "baby boom" and AIDS scenarios display more fluctuation, and more transitory changes, since in each case the underlying phenomenon occurs during a relatively compressed period of time.

Figure 15, which depicts the percentage of the population 65 and older, for the most part mirrors the curves shown for the working-age population in Figure 14. Both the fertility-decline and the "magic drug" scenarios imply dramatic growth in the percentage of the population elderly; in the first case, the cause is the failure of the population to add sufficient numbers of young people, and in the second case, the cause is a reduced tenden-

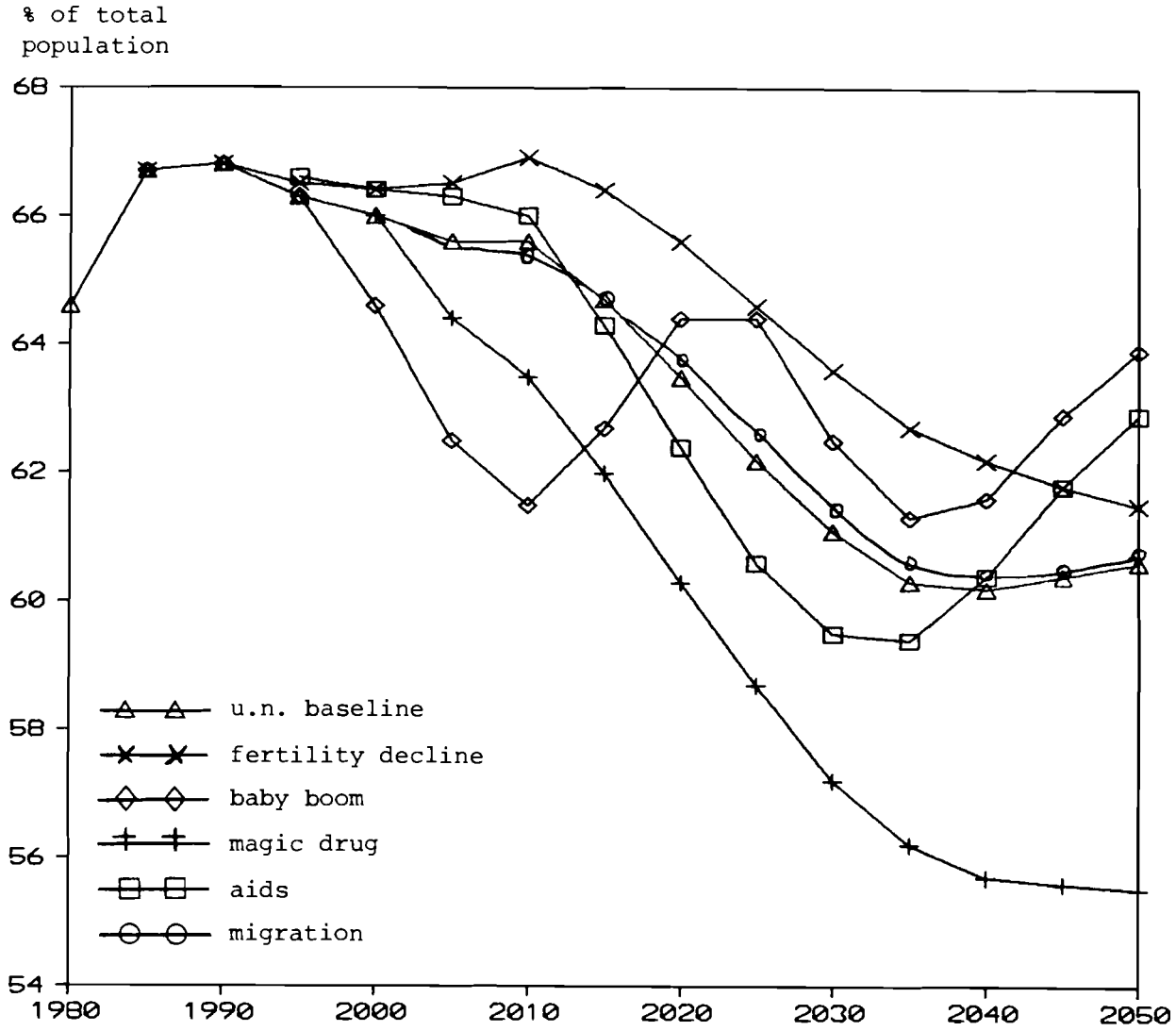

Figure 14. Percentage of projected population aged 15–64: six alternative scenarios.

cy for the older population to die off. Note that even under the conventional-wisdom projection the percentage of the population elderly is expected to rise a lot; our baby-boom and immigration scenarios do little to change this feature, while the magic drug and fertility-decline scenarios merely amplify it. Only under the AIDS scenario does the percentage elderly drop, and this it does during the years when those who died young from the disease would otherwise have entered the over–65 group.

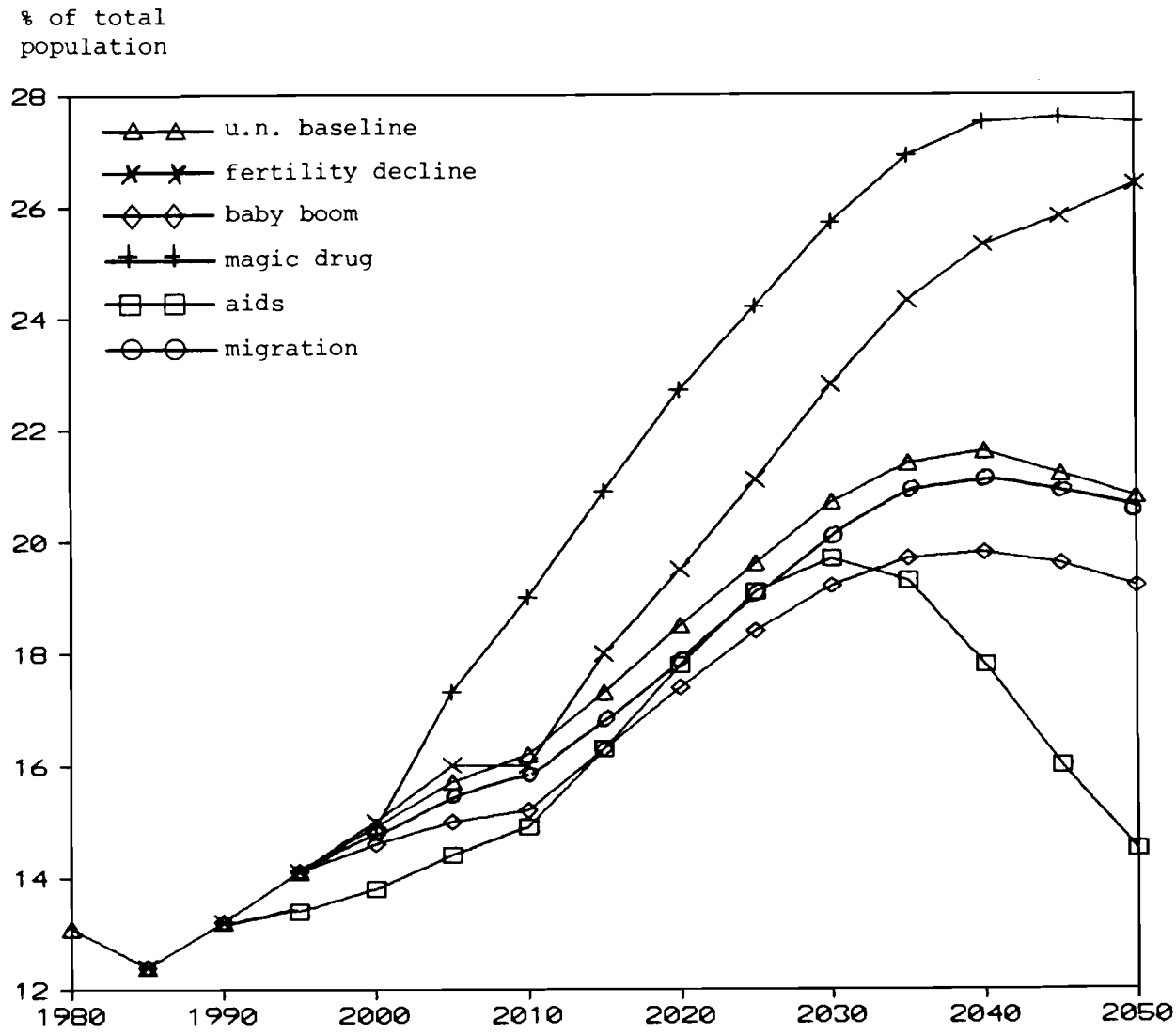

Figure 15. Percentage of projected population aged 65 and over: six alternative scenarios.

6. Summary and Discussion

This paper has discussed the possible path of Europe's population to the year 2050, employing an alternative-scenario approach. Our objective has been not to guess what the most likely path of population growth will be, but rather to identify a range of possible, albeit extreme or unlikely, paths of population development. We have addressed all of the basic elements of population dynamics: birth rates, death rates, and the net inflow of immigrants. A characteristic of all three elements historically has been the occurrence of unexpected events—"surprises"—especially in the area of fertility. We have no reason

to suppose that the future is without surprises, and have tried to anticipate some of them in our various scenarios.

Among the surprises—or reversals of trend—we have contemplated are: an end-of-century baby boom of unprecedented size; continued decline of fertility to a point at which Europe overall is well below replacement; a dramatic and rapid drop in old-age mortality rates; a worst-case AIDS scenario; and a new wave of immigration. Of these, the fertility-decline and the AIDS scenarios lead to the most dramatic results, in each case implying rapid shrinkage in the size of Europe's population after the year 2000, accompanied by pronounced changes in the age structure of the population. The other scenarios, and particularly the immigration scenario, depart rather little from the medium-variant projections produced by the United Nations.

Even though our scenarios are not meant to represent the actual, or even the likely, future, they can still be instructive about what the future may hold in store. And, equally importantly, the scenario analysis helps to identify what sorts of "surprises" would have large consequences, and what sorts would not. For example, even though we assumed immigration on an unprecedented scale, our high-immigration scenario led to only modest growth in Europe's population, beyond what would be expected on the basis of the conventional-wisdom view. Even a very large baby boom does not lead to an abrupt shift in the population growth path.

What does turn out to make a big difference in Europe's future is the fertility-reduction and the AIDS scenarios. In both cases, precipitous population decline begins to occur early in the next century. Yet we again point out that in our view, the fertility-decline scenario is more realistic than that assumed in the UN projections: we have merely assumed a continuation of the fertility trends of the last two decades, until all of Europe (on average) reaches a low level of fertility, a level which several countries have already reached (or gone below). Moreover, the AIDS scenario that we modeled, while not necessarily the "conventional wisdom", corresponds to assumptions and assertions being made in the existing literature.

Finally, it should be pointed out that whatever the future holds, it will include changes in fertility, mortality, and immigration simultaneously, not singly as in the scenarios we analyzed. As mentioned before, some of the changes would be additive—for example, the immigration results can simply be added to the fertility results, to obtain the population implications of the two assumptions together. Some of the changes, however, would not be additive. In particular, if an AIDS epidemic on the scale examined here were to materialize, it is quite possible that fertility rates would drop as well, as people adopted a more cautious attitude towards sexual activity. Our results indicate that such an interaction would only accelerate the implied shrinkage of the population.

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