2 Changing views of future demographic trends

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Introduction

Are population processes easy to predict? The relative inertia of population stocks suggests that this is the case. Indeed, errors in population forecasts five to ten years into the future are often smaller than the errors of economic forecasts over a similar period (Ascher, 1978). However, population flows are much harder to predict (Keilman, 1990), so in the long run, population processes are much more uncertain than generally recognized. Yet, many tasks of social policy, such as planning of schools and health care require information about the likely developments of population variables for twenty or thirty years into the future. Analyses of the sustainability of pension systems require that we take an even longer view, so the US Office of the Actuary routinely prepares forecasts seventy-five years into the future (Andrews and Beekman, 1987), for example.

One way the uncertainty in population variables manifests itself is through changing views, over time, of the demographic future. For instance, a forecast of a particular population made in 2000 may be different from one made ten years earlier. New data for the period 1990–2000, different interpretations of historical developments before 1990, refined techniques of analysis and prediction – all these shape different conditions for the forecast made in 2000, compared to the one made in 1990. As an example, consider Table 2.1. It shows UN forecasts of the 2050 old-age dependency ratio (OADR), i.e. the ratio of the elderly population (aged 65+) to the working age population (aged 20–64). We show forecasts that were made in 1994 (the so-called '1994 Revision'), and compare them with forecasts computed ten years later ('2004 Revision').

We see that the UN changed its view towards greater ageing in four of the five countries. Leaving out Germany, we find that the average increase in the forecasted OADR was 18 per cent over a decade! From the perspective of analysing the sustainability of pension systems, this is of major importance. Below we shall see that the UN has indeed become more optimistic concerning life expectancy. It so happens that life expectancy

Table 2.1. *Predictions of the old-age dependency ratio in 2050: selected countries.*

	1994 Revision	2004 Revision
Austria	0.517	0.599
Finland	0.402	0.504
France	0.471	0.524
Germany	0.585	0.550
Norway	0.385	0.453

predictions for Germany are also higher for the 2004 Revision than for the 1994 Revision. However, its effect on the German OADR is compensated by an increase in expected immigration levels, which primarily affects the population of working age.

It is not surprising that the UN has changed its views concerning population variables in European countries in 2050. After all, we cannot know the future with certainty, and updates are necessary. However, the changes from one forecast round to the next are far from random. Instead, they display rather *characteristic* patterns. Our purpose in this chapter is to document systematic changes that characterize population forecasts prepared by the UN and Eurostat. In the case of fertility and migration, there are also important differences between the two organizations. Moreover, we shall see that the changes are directly relevant for research on ageing, which frequently relies on official forecasts as a guide for what to expect.

Indicators such as the OADR in Table 2.1 summarize a population's age-structure. The age-structure can be deduced once one assumes certain levels for future fertility, mortality and international migration. We will analyse how the assumptions concerning these flows have changed. We consider a group of eighteen European countries. The group consists of the fifteen members of the European Union prior to the joining of the new member states in 2004 (i.e. Austria, Belgium, Denmark, Finland, France, Germany, Greece, Italy, Ireland, Luxembourg, the Netherlands, Portugal, Spain, Sweden and the United Kingdom) plus Iceland, Norway and Switzerland. Except for Switzerland, these countries made up the so-called European Economic Area, hence we call the area 'EEA+'.[1] These countries were also included in our own UPE forecasts,[2] with which we will make comparisons throughout.

The data used in this chapter stem partly from the World Population Prospects of 1994, 1996, 1998, 2000, 2002 and 2004, forecasted by the UN and partly from Eurostat forecasts. Cruijsen and Eding (1997), De Jong and Visser (1997), De Jong (1998) and Van Hoorn and De

Beer (1998) document the assumptions for the Eurostat forecasts of 1994, while Economic Policy Committee (2001) contains information about the Eurostat forecast of 1999. Eurostat's 2004-based forecast is described in Eurostat (2005) and Lanzieri (2006). The UPE website (www.stat.fi/tup/euupe/) gives information about the UPE forecasts.

After an introductory section on the cohort-component method of population forecasting, we will study UN forecasts prepared every second year between 1994 and 2004. Eurostat computes its forecasts less frequently, and we will use those with base years 1995, 1999 and 2004. An important finding is that the UN and Eurostat have systematically adjusted their views with respect to life expectancy and net migration towards higher levels. Yet, based on UPE work, we also explain why we believe that these levels still fall short of what one should expect.

Conventional and stochastic population forecasts based on the cohort-component method

The UN and Eurostat (and most statistical agencies) produce population forecasts using the cohort-component approach (Shryock and Siegel, 1976; Keilman and Cruijsen, 1992). In this method one starts from the observed population numbers broken down by age and sex, called the base population or jump-off population. The year for which this population is observed is the base year or jump-off year. The method predicts the numbers for future years by repeatedly applying assumed death rates for each combination of age and sex, and birth rates for women of childbearing age (e.g. 15–49). The simplest way to handle migration is to add to the projected survivors, for every year in the future, net migration numbers broken down by age and sex.

Stochastic (or probabilistic) forecasts are carried out similarly, but now future vital rates and numbers for net migration are considered as random variables that reflect the uncertainty of future population developments (e.g. Alho and Spencer, 2005). Their distribution can be specified in alternate ways. The scaled model of error, which we used in the UPE forecasts, assumes that the vital rates are normal in the log scale, and that net migration numbers are normal in the original scale. The normal distribution requires that one specify the mean of the distribution as a measure of location, and the standard deviation as a measure of spread (or scale) around the mean, to reflect forecast uncertainty. Below we give details about the mean values of the distributions of fertility and mortality rates, and net migration numbers. Alho, Cruijsen and Keilman (this volume, chap. 3) describe the scaled model in more detail and explain how the standard deviations around the means were specified using empirical data. Their appendix also provides a schematic comparison of conventional and stochastic forecasts.

Changes in forecast assumptions of the UN and Eurostat

A forecast for a given future year may change over subsequent forecast rounds either because of updates of the starting population, or because assumptions for the flows have been changed, or both. Consider the updates. Imagine a forecast for 2050 with base year 1994. Because of the recursive nature of the cohort-component bookkeeping, the forecast for 2050 also includes a forecast for 1996 as an intermediate step. However, an update with base year 1996 starts from a *known* population for 1996. This will generally be different from the *predicted* numbers for 1996 as computed in 1994. Even if assumptions concerning post-1996 fertility, mortality and migration were to remain unchanged, this would lead to a different forecast for the population in 2050. Thus, a comparison of subsequent forecasts of population size does not necessarily reflect changing views on flows only. However, by computing annual *growth rates* for future population size, as implied by the various forecast rounds, we can control for changes in the base data.

In this section, we examine the extent to which the UN and Eurostat have changed their views, over time, regarding the population growth rate, fertility, mortality and migration in population forecasts for European countries for the year 2050. We limit ourselves to the medium variant (UN terminology), or baseline scenario (Eurostat terminology), of each forecast, as it is generally considered to be the most plausible one. We also give point predictions from the UPE forecast.

Annual population growth

Figure 2.1 illustrates how the average annual growth rate to 2050 for the population in the EEA+ countries changed over subsequent forecast rounds. We see that until recently the UN and Eurostat expected *negative* population growth for the eighteen EEA+ countries to 2050. However, the 2004 forecasts of both organizations predict a small *positive* growth after jump-off time. In comparison, the UPE forecast expects even more growth, albeit at an annual rate not exceeding 1.8 per thousand.[3]

Fertility

We have examined the total fertility rate (TFR). The TFR for a certain year tells us how many children a woman would have on average

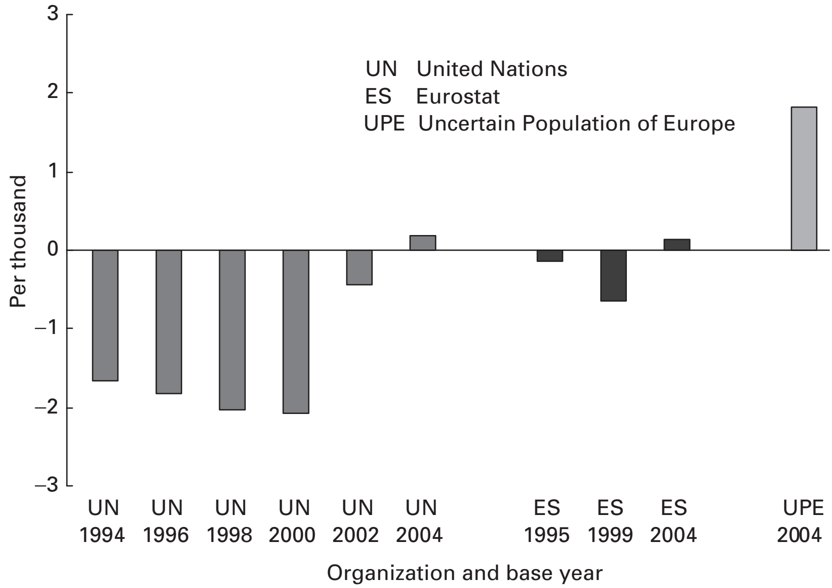


Figure 2.1. Forecasts of average annual rate of population growth in EEA+ countries to 2050. Averages across eighteen EEA+ countries (UN, UPE) and fifteen EU-15 countries (Eurostat).

if age-specific fertility rates in that year were constant for a long time. Figure 2.2 shows a decrease in the 2050 TFR over successive rounds of both the UN and Eurostat forecasts.[4] Table 2.2 gives country-specific values. The TFRs in the 1994 round and 1996 round of the UN are at or close to replacement level (2.1 children per woman) in 2050. Yet, Figure 2.1 indicated negative population growth for those forecasts. The reason is that the TFR was below replacement level in the starting years 1994 and 1996 (see Figure 2.3). Thus the interpolated path from the low 1994/1996 values to the 2050 value had several years with fertility below replacement. Table 2.2 also shows country-specific Eurostat numbers for 2049 (all three rounds) and the UPE point predictions for 2049. A comparison with Figure 2.3 shows that the UPE numbers (with average 1.66) and the most recent Eurostat numbers (with average 1.69) are reasonable extrapolations of historical fertility trends. The UN extrapolations seem high, particularly for Mediterranean and German-speaking populations.

The 1994 and 1996 Revisions of the UN forecasts assumed that countries with below-replacement fertility at jump-off time, would eventually experience an increase towards replacement level. This was the case

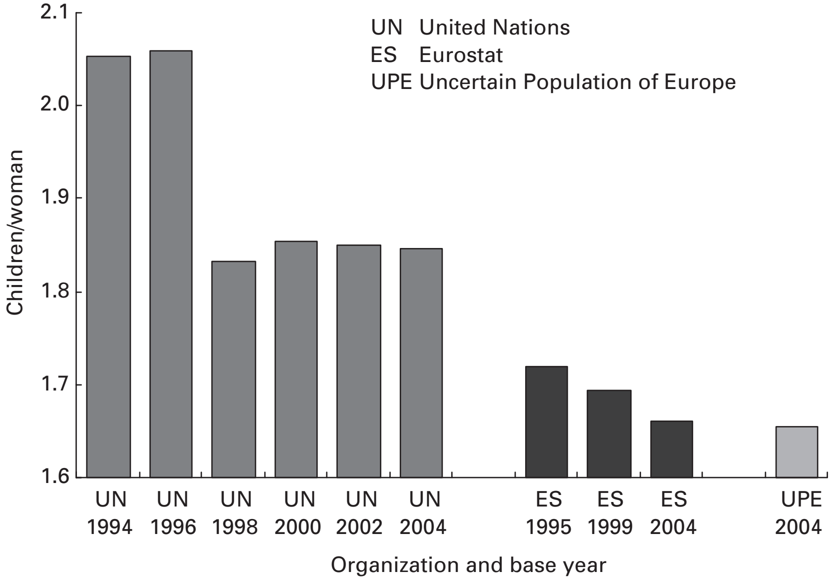


Figure 2.2. Total fertility rate assumptions in EEA+ countries, 2045–2049. Averages across eighteen EEA+ countries (UN, UPE) and fifteen EU-15 countries (Eurostat).

for all EEA+ countries except Iceland during the first half of the 1990s (Figure 2.3). Most of these countries were assumed to reach the replacement level in 2050 or earlier, but a few countries would reach it after 2050 (Table 2.2).

The earliest UN forecasts did not document reasons why particular future levels were chosen. Methodological sections in the projection reports outlined the extrapolation methods, but there was little or no interpretation of historical or future trends. Starting with the 1998 Revision the situation improved somewhat with the publication of an Analytical Report for each revision, but still few arguments are given for the assumptions.[5]

In the documentation of the 1994 and 1996 Revisions, the UN does not give reasons for the target level of 2.1 children per woman. Earlier forecasts (e.g. Revisions of 1973 and 1984) also assumed replacement-level fertility. Arguments in favour of this assumption include the belief that the demographic 'system' has an in-built tendency to maintain itself ('homeostasis'), and that sustained low fertility will inevitably lead to policy reactions (O'Neill *et al.*, 2001). However, there is no empirical evidence that the population in a low-fertility country necessarily returns

Table 2.2. *Country-specific predictions for the total fertility rate in 2050: UN, Eurostat and UPE forecasts.*

	UN Revision of . . .						Eurostat forecast of . . .			UPE
	1994	1996	1998	2000	2002	2004	1995	1999	2004	2004
Period	2040–50	2045–50	2040–50	2045–50	2045–50	2045–50	2049	2049	2049	2049
Austria	2.10	2.07	1.68	1.65	1.85	1.85	1.60	1.50	1.45	1.40
Belgium	2.10	2.10	1.86	1.82	1.85	1.85	1.80	1.80	1.70	1.80
Denmark	2.10	2.10	1.87	1.90	1.85	1.85	1.80	1.80	1.80	1.80
Finland	2.10	2.10	1.90	1.94	1.85	1.85	1.80	1.70	1.80	1.80
France	2.10	2.10	1.96	1.90	1.85	1.85	1.80	1.80	1.85	1.80
Germany	1.89	1.93	1.64	1.61	1.85	1.85	1.50	1.50	1.45	1.40
Greece	1.99	2.08	1.75	1.85	1.85	1.78	1.70	1.60	1.50	1.40
Iceland	2.10	2.10	1.90	2.10	1.85	1.85	2.10	–	–	1.80
Ireland	2.10	2.10	2.10	2.10	1.85	1.85	1.80	1.80	1.80	1.80
Italy	1.86	1.82	1.66	1.61	1.85	1.85	1.50	1.50	1.40	1.40
Luxembourg	2.10	2.10	1.78	1.90	1.85	1.85	1.80	1.80	1.80	1.80
Netherlands	2.10	2.10	1.86	1.81	1.85	1.85	1.80	1.80	1.75	1.80
Norway	2.10	2.10	1.98	2.07	1.85	1.85	1.90	–	–	1.80
Portugal	2.10	2.10	1.76	1.83	1.85	1.85	1.70	1.70	1.60	1.60
Spain	1.82	1.85	1.68	1.64	1.85	1.85	1.50	1.50	1.40	1.40
Sweden	2.10	2.10	1.99	2.01	1.85	1.85	1.90	1.80	1.85	1.80
Switzerland	2.10	2.10	1.72	1.72	1.85	1.85	–	–	–	1.40
United Kingdom	2.10	2.10	1.90	1.91	1.85	1.85	1.80	1.80	1.75	1.80
Average[1]	2.05	2.06	1.83	1.85	1.85	1.85	1.77	1.73	1.69	1.66
Standard deviation[1]	0.095	0.091	0.131	0.160	0	0.016	0.174	0.159	0.173	0.192

Note: [1] Averages and standard deviations across eighteen countries. In computing these summary measures for the Eurostat forecasts, we imputed UN values for Iceland, Norway and Switzerland.

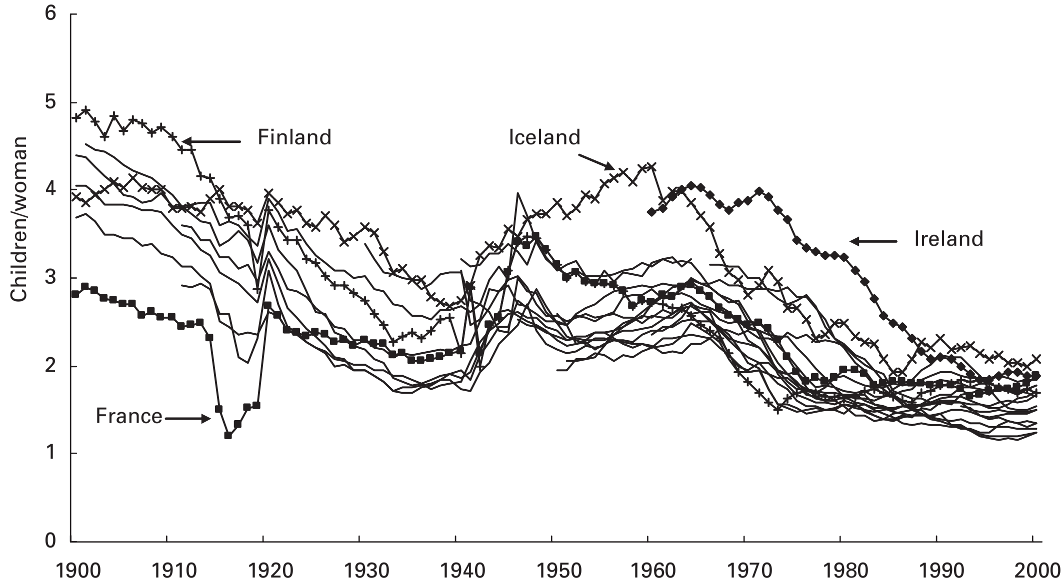


Figure 2.3. Total fertility rate in eighteen EEA+ countries, 1900–2000. (*Source:* Council of Europe, 2002.)

to replacement level. Moreover, policies that aim to promote high fertility involve substantial economic transfers, and they may have an effect only in the short run (Gauthier and Hatzius, 1997). Finally, the theories of childbearing behaviour point to a variety of reasons why individuals prefer fewer children (Van de Kaa, 1987). These include less adherence to strict norms; less religiosity and increased individual freedom on ethical issues; female education, which has led to women having greater economic independence and facilitates divorce; and more assertiveness in favour of symmetrical gender roles. Thus, lower fertility is thought to be the result of processes that cannot be reversed (such as modern contraception) or that we value for various reasons (such as women's emancipation). These theories of childbearing behaviour in low-fertility countries gained acceptance in the 1980s, but they had no impact on the UN for a decade or so. Starting with the 1998 Revision, the UN no longer assumed convergence towards replacement level.

Mortality

The most widely used measure of mortality is life expectancy: the number of years an individual could expect to live if age-specific death rates were to remain constant over a long period. We have examined life expectancy for men and women separately. Table 2.3 gives results by country, whereas Figure 2.4 plots average values (across countries) for the UN, Eurostat and UPE forecasts.

Between 1994 and 2004, the UN has become more optimistic regarding the life expectancy in EEA+ countries in 2050: on average, life expectancy predictions went up by 2.4 years for men and by 1.6 years for women; see Figure 2.4. To put these numbers into perspective: in the latter part of the twentieth century *actual* life expectancy has increased by roughly one to two years per decade in developed countries (National Research Council, 2000); see Figure 2.5. Record (or 'best practice') life expectancy has increased by 2.2 years per decade (Oeppen and Vaupel, 2002). Thus, the increases are only of the same order of magnitude as the actual improvement in 1994–2004. In consequence, the assumed levels remain lower than corresponding UPE figures. Note that the spread across the eighteen UN or the fifteen Eurostat countries for the 2004 forecasts is much larger than the spread in earlier forecasts, or that in the UPE forecast. One gets the impression that national (as opposed to average international) trends have been given a higher weight than before.

The notion of a maximum life expectancy seems to underlie UN forecasts for low-mortality countries. For instance, the 1994 Revision and

Table 2.3. *Country-specific predictions for life expectancy in 2050: UN, Eurostat and UPE forecasts.*

	UN Revision of . . .						Eurostat forecast of . . .			UPE
	1994	1996	1998	2000	2002	2004	1995	1999	2004	2004
Period	2040–50	2045–50	2040–50	2045–50	2045–50	2045–50	2049	2049	2049	2049
a. *Men*										
Austria	79.8	78.9	78.8	80.8	80.8	82.7	80.0	81.0	83.5	84.4
Belgium	79.8	79.1	78.9	81.1	81.1	81.1	80.0	80.5	82.3	84.2
Denmark	77.7	77.7	77.7	79.0	79.0	80.0	79.0	79.4	80.8	83.2
Finland	78.2	78.7	79.3	79.8	79.8	82.1	79.0	80.0	81.8	84.7
France	78.9	79.5	78.9	80.6	80.6	81.5	80.0	80.0	82.6	85.5
Germany	78.6	78.7	78.9	80.7	80.6	80.9	79.0	80.0	81.9	84.9
Greece	79.8	80.0	79.8	79.9	79.7	79.6	81.0	81.0	80.2	82.8
Iceland	80.4	81.6	81.0	80.8	81.2	84.3	82.0	–	–	85.9
Ireland	78.5	79.1	79.8	78.9	78.9	81.0	79.0	79.0	82.3	84.7
Italy	80.5	80.7	79.6	79.5	79.5	82.2	80.0	81.0	83.5	85.7
Luxembourg	78.3	78.7	78.7	80.0	80.8	80.8	80.0	80.0	81.5	85.2
Netherlands	79.4	79.7	79.3	79.6	79.6	80.6	80.0	80.0	80.2	82.5
Norway	78.1	78.7	80.5	80.8	80.8	82.7	81.0	–	–	83.7
Portugal	77.7	78.1	77.9	77.9	77.9	79.4	78.0	78.0	80.3	84.2
Spain	79.6	79.4	79.2	79.4	81.0	81.4	79.0	79.0	81.3	85.9
Sweden	81.0	81.3	81.1	82.1	82.1	83.4	82.0	82.0	83.3	84.7
Switzerland	79.5	79.8	79.7	79.9	79.9	82.8	–	–	–	85.3
United Kingdom	79.1	79.4	79.2	80.6	80.6	81.5	80.0	80.0	82.8	83.4
Average[1]	79.1	79.3	79.1	80.0	80.1	81.2	79.9	80.1	82.1	84.5
Standard deviation[1]	0.98	1.02	0.90	0.97	1.01	1.31	1.06	0.93	1.22	1.04

b. *Women*										
Austria	85.3	85.4	84.5	86.6	86.6	87.1	85.0	86.0	87.6	88.7
Belgium	85.6	85.0	84.8	86.7	86.7	86.7	85.0	85.5	88.2	88.3
Denmark	83.3	82.9	82.9	83.9	83.9	84.6	83.0	83.1	83.7	87.3
Finland	84.5	84.7	85.8	86.1	86.1	87.1	85.0	85.0	86.5	88.7
France	85.4	86.9	86.0	87.3	87.3	88.0	87.0	87.0	89.0	89.7
Germany	84.4	84.7	84.5	86.2	86.3	86.5	84.0	85.0	86.8	89.1
Greece	84.8	85.1	84.8	85.1	84.9	84.5	85.0	85.0	85.1	86.9
Iceland	85.4	85.5	85.4	85.5	85.7	87.8	87.0	–	–	89.9
Ireland	83.9	84.4	84.9	84.0	84.0	86.1	84.0	84.0	86.9	89.9
Italy	86.2	86.4	85.3	85.6	85.6	88.1	85.0	86.0	88.7	89.8
Luxembourg	85.4	84.7	84.5	85.5	86.5	86.5	85.0	85.0	86.6	89.4
Netherlands	85.0	85.1	84.9	84.9	84.9	85.8	85.0	85.0	83.6	86.4
Norway	83.9	84.1	86.4	86.7	86.7	87.2	85.0	–	–	87.9
Portugal	83.9	84.2	83.9	84.1	84.1	85.4	84.0	84.0	86.6	88.4
Spain	85.2	85.7	85.5	85.9	87.3	88.3	85.0	85.0	87.9	90.1
Sweden	86.5	85.9	85.7	87.1	87.1	87.6	86.0	86.0	86.5	88.7
Switzerland	85.7	86.0	85.8	86.0	86.0	88.3	–	–	–	89.4
United Kingdom	84.2	84.6	84.4	85.6	85.6	85.4	85.0	85.0	86.5	87.5
Average[1]	84.9	85.1	85.0	85.7	85.9	86.7	85.0	85.3	86.9	88.7
Standard deviation[1]	0.87	0.93	0.84	1.02	1.10	1.22	0.99	0.94	1.51	1.11

Note: [1] See Table 2.2, note 1.

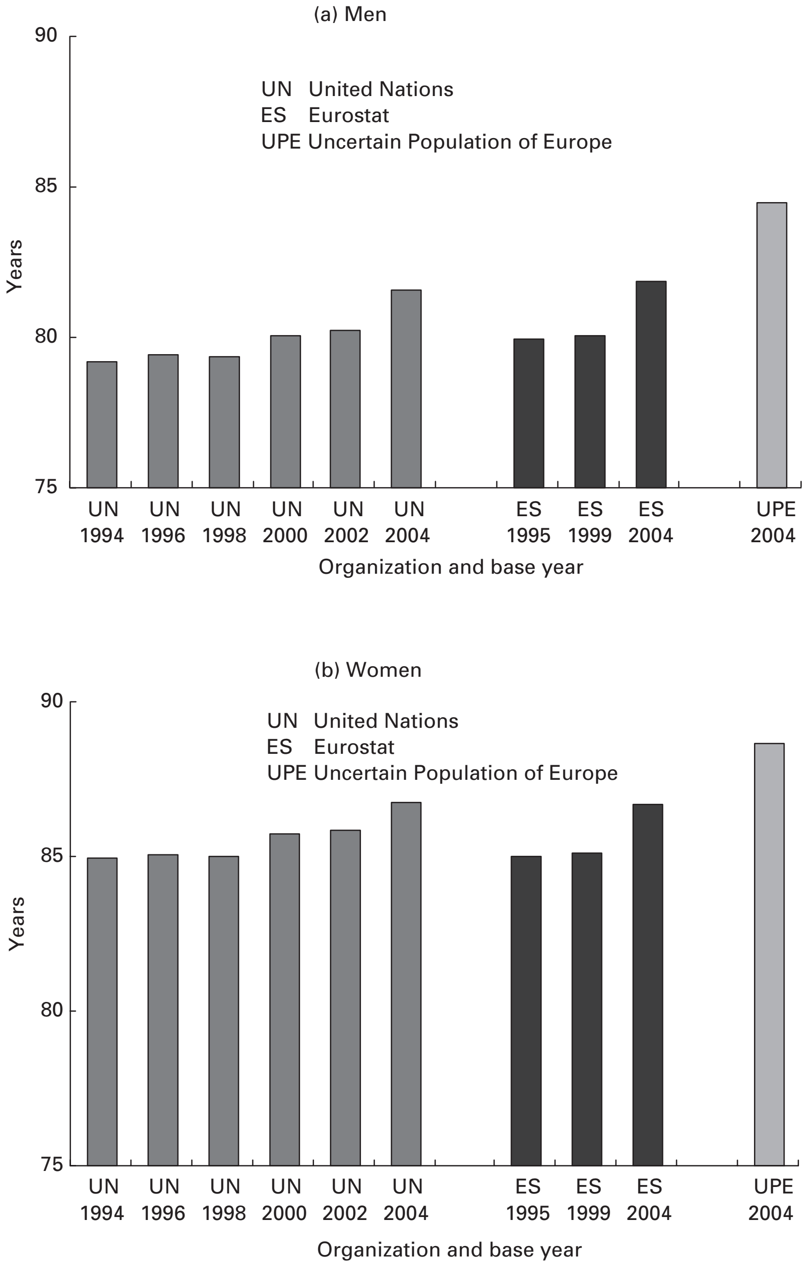
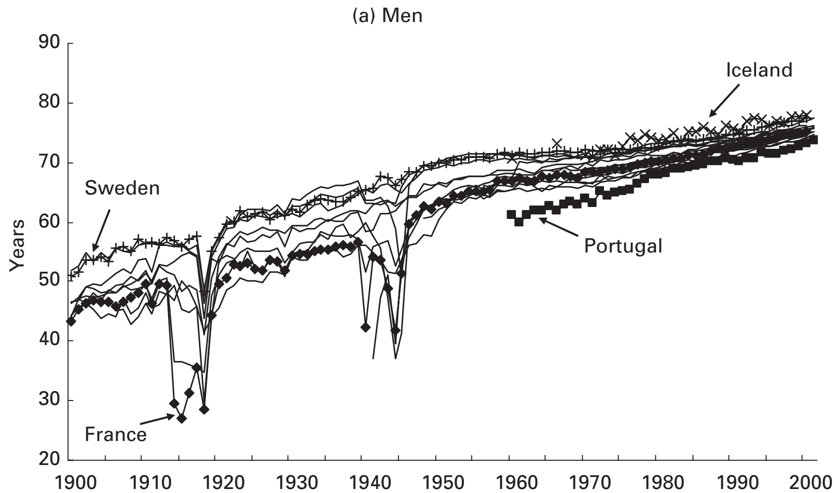


Figure 2.4. Life expectancy assumptions in EEA+ countries in the period 2045–2049. Averages across eighteen EEA+ countries (UN, UPE) and fifteen EU-15 countries (Eurostat).



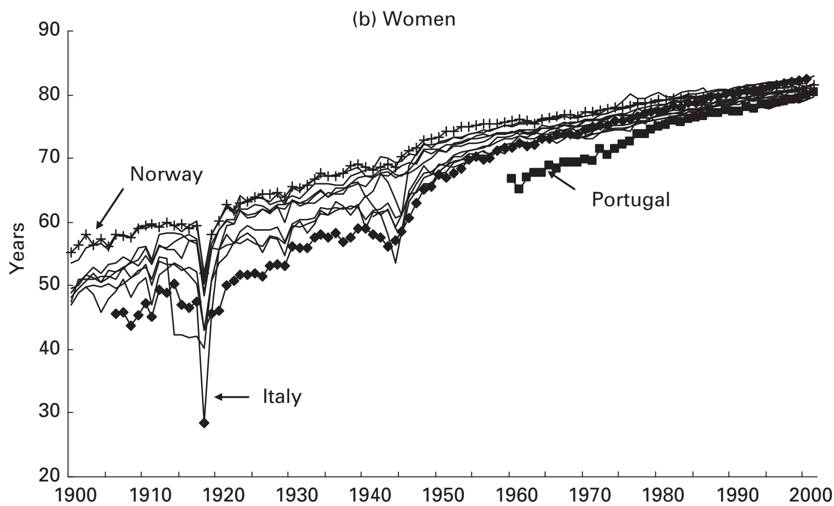


Figure 2.5. Life expectancy at birth in eighteen EEA+ countries, 1900–2000. (*Source:* Council of Europe, 2002.)

the 1996 Revision mention a maximum of 87.5 years for women and 82.5 years for men. Life tables used in the 2004 Revision assume a maximum life span of 92.5 years for women and 87.5 years for men. As countries approach the maximum values, the UN assumes that annual improvements in life expectancy become smaller.[6]

The UN has continuously adjusted the maximum life span upwards (National Research Council, 2000, p. 129). For instance, the 1973 Revision, with the year 2000 as the forecast horizon, uses 77.5 and 72.6 years, respectively. Men and women in Japan and Iceland had already attained these values in the early 1970s. The UN is not alone in using maximum life span values that have to be updated continuously (Oeppen and Vaupel, 2002). However, a panel of the US National Research Council (2000) carried out a broad assessment of UN mortality forecasts and concluded that the existence of a maximum life span is conceivable but that it is unlikely that the possible maximum would be reached within near decades.

Migration

Migration is analysed here in terms of the level of net immigration around 2050, expressed per thousand of the population in the year 2000.[7] Table 2.42.4 gives the assumed numbers by 2050 according to the UN Revisions of 1998 and later, the three Eurostat forecasts and the UPE forecast. Up to the 1996 Revision, the UN assumed that migration would be zero by 2050 in the countries concerned. The table also includes average net migration levels for the whole of the EEA+ countries. In addition, Figure 2.6 plots simple averages (across countries) of net migration per thousand of population.

Since the middle of the 1990s, both the UN and Eurostat have assumed ever higher levels of net migration to European countries around 2050. Large immigration flows into Germany dominate the pattern. Nevertheless, compared to the UPE assumptions, migration currently assumed by the UN and Eurostat seems low. The UN gives very little justification for the migration levels they select. For instance, the reports of the Revisions of 2000, 2002 and 2004 just state that ‘The future path of international migration is set on the basis of past international migration estimates and an assessment of the policy stance of countries with regards to future international migration.’

The UPE assumptions

Figures 2.2, 2.4 and 2.6 suggest that the UN has been somewhat reluctant to acknowledge new levels or trends for demographic developments.[8]

Table 2.4. *Country-specific predictions for net migration (per thousand of the population in 2000) in 2050: UN, Eurostat and UPE forecasts.*

	UN Revision of . . .				Eurostat forecast of . . .			UPE
	1998	2000	2002	2004	1995	1999	2004	2004
Period	2040–50	2045–50	2045–50	2045–50	2049	2049	2049	2049
Austria	0	0.62	1.75	2.50	2.78	2.48	2.51	3.5
Belgium	0	1.29	1.29	1.29	1.46	1.46	1.81	2
Denmark	0	1.91	1.91	2.30	1.88	1.88	1.24	2
Finland	0	0.78	0.78	1.57	0.97	0.97	1.17	1.5
France	0	0.69	1.29	1.03	0.84	0.84	0.99	1.5
Germany	2.45	2.20	2.58	2.45	2.44	2.44	2.18	3.5
Greece	0	1.91	2.86	3.34	2.36	2.36	3.29	4.5
Iceland	0	0	0	0	0.72	–	–	1.5
Ireland	0	2.77	2.77	5.54	−0.71	1.31	3.26	3.5
Italy	0	1.05	1.08	2.09	1.39	1.39	1.98	4.5
Luxembourg	0	9.83	9.83	9.83	4.58	4.58	6.35	6
Netherlands	0	1.94	1.94	1.94	2.21	2.21	1.96	3
Norway	0	2.30	2.30	2.76	1.79	–	–	3.5
Portugal	0	1.01	1.01	3.55	2.50	2.50	1.49	4.5
Spain	0	0.76	1.42	1.52	1.50	1.50	2.55	4.5
Sweden	1.14	1.14	1.14	2.27	2.26	2.26	2.42	3
Switzerland	0	0.56	0.56	1.12	–	–	–	3.5
United Kingdom	0	1.63	2.32	2.23	0.76	1.18	1.66	3.5
EEA+	0.56	1.40	1.81	2.06	–	–	–	3.38
Average[1]	0.20	1.80	2.05	2.63	1.75	1.71	2.15	3.31
Standard deviation[1]	0.62	2.13	2.10	2.15	1.14	1.04	1.34	1.25

Note: [1] See Table 2.2, note 1.

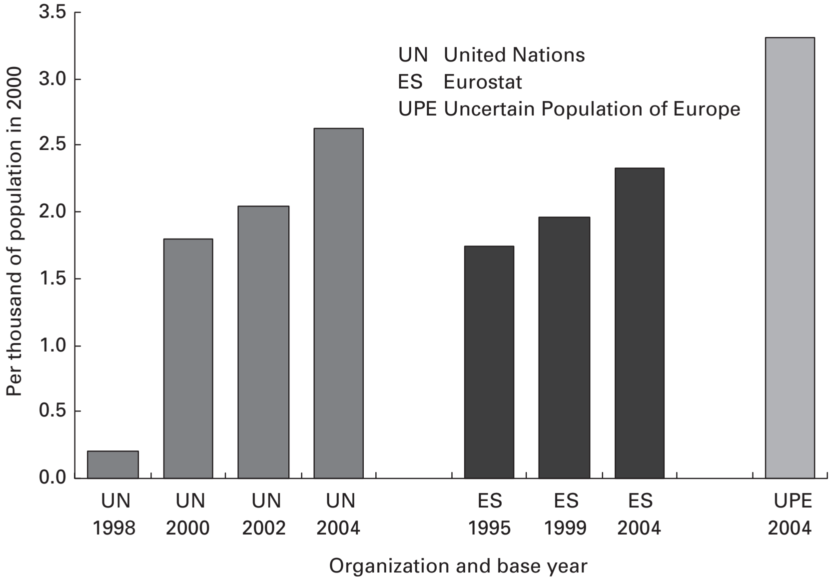


Figure 2.6. Net migration assumptions in EEA+ countries, 2045–2049. Averages across eighteen EEA+ countries (UN, UPE) and fifteen EU-15 countries (Eurostat).

This phenomenon is sometimes called 'assumption drag' (Ascher, 1978), and it has also been noted in demographic forecasts prepared by national statistical agencies (Keilman, 1990, 1997). For instance, the sharp decline in birth rates in the 1970s or improved life expectancies of men in the 1970s, after a period of stagnation, were only gradually accommodated in forecasts. To a degree, this is to be expected. We do not have behavioural models of sufficient explanatory power for predicting fertility, mortality or migration accurately. Therefore, we have to rely on long-term trends to an extent that might seem, in retrospect, too heavy. Moreover, examples of hasty changes and subsequent reversals also exist. These observations are a major motivation for considering forecast uncertainty seriously. However, if the same type of forecast error appears repeatedly, or the forecasts appear to be systematically *biased*, then corrections should be made.

In the UPE project, assumptions were derived from three sources:

1. time-series analyses of age-specific and total fertility; age- and sex-specific mortality and life expectancy; and net migration by age and sex, relative to total population size;
2. analyses of historical forecast errors for total fertility, life expectancies and net migration; and
3. interviews with experts on fertility, mortality and migration.

This section summarizes the UPE assumptions and provides motivation. We limit ourselves to point predictions of the predictive distributions. Alho, Cruijsen and Keilman (this volume, chap. 3) discuss uncertainty measures and predictive intervals. More information can also be found in Alders, Keilman and Cruijsen (2007) and the references therein, including the UPE website, www.stat.fi/tup/euupe/.

In practice, a starting point for specifying values for country-specific point predictions of the total fertility rate, the life expectancy at birth and the level of net migration was time-series analysis. Estimates obtained from the analyses were adjusted, sometimes considerably, to reflect expert views on whether current levels or current trends would persist. Below, we discuss qualitative considerations that were taken into account in this process.

Fertility

Past trends, contemporary levels and recent explanatory research indicate that there is a clear geographic division in fertility levels in Europe. Factors that are thought to have an impact on future fertility include:

- increased female education and female economic autonomy;
- rising consumption aspirations;
- increased investments in career development by both sexes;
- rising 'post-materialist' traits such as self-actualization, ethical autonomy, freedom of choice and tolerance of the non-conventional;
- a stronger focus on the quality of life with rising taste for leisure as well;
- a retreat from irreversible commitments and a desire for maintaining an 'open future';
- rising probabilities of separation and divorce, and hence a more cautious 'investment in identity'.

The Northern and Western EEA+ countries are experiencing levels of completed fertility rate (CFR) and total fertility rate (TFR) of about 1.8 children per woman, whereas the Mediterranean and German-speaking countries are at the historically low levels of around 1.4 children per woman. For the period 2003–2049, it was assumed that these clusters will remain essentially at their current levels (Table 2.2).

The Northern and Western cluster of countries comprises Belgium, Denmark, Finland, France, Iceland, Ireland, Luxembourg, the Netherlands, Norway, Sweden and the United Kingdom. The Mediterranean and German-speaking cluster consists of Austria, Germany, Greece, Italy, Spain and Switzerland. Portugal does not fall easily into either class. Its fertility is somewhere in the middle. The TFR in Portugal will rise to a level of 1.6 children per woman.

In addition to the factors mentioned above, it was pointed out to us that the Northern and Western countries were the first to postpone childbearing, and the first to recuperate. In the Mediterranean and German-speaking countries, there was also postponement but much less recuperation. In the latter countries, one-child families became quite popular, and we expect that this will persist on account of relatively weak childcare and housing facilities. Thus, postponement was not seen as a reason to alter the specification above.

Our specification is in line with the 2004 fertility forecast of Eurostat, but very different from the UN assumption of perfect convergence to a level of 1.85 children per woman. These are the simple correlation coefficients across countries of assumed TFR values by 2050 for the three organizations:

	UN 2004	Eurostat 2004	UPE 2004
UN 2004	1		
Eurostat 2004	0.255	1	
UPE 2004	0.333	0.969	1

Mortality

The assumptions for mortality were made in terms of age-specific mortality rates and their rate of decline. For each of the eighteen countries we assumed that the rate of decline starts from recent country-specific values, and changes linearly over time towards the common rate of decline, which is to occur by the year 2030. The eventual rate of decline was empirically estimated from data for Austria, Denmark, Finland, France, Germany, Italy, the Netherlands, Norway, Sweden, Switzerland and the United Kingdom during the latest thirty-year period observed. In some countries, the extrapolation procedure would imply diverging developments of male and female life expectancies. This is in contrast with observations in the last two or three decades. It seems plausible to assume that the gender gap in life expectancy will continue to decline as differences between men and women in life style (e.g. smoking) are becoming smaller. For this reason, we made a proportional adjustment such that the gender gap equals four years in the target year. In the case of Ireland, however, the gender gap was assumed to equal five years on account of strongly diverging trends in the recent past.

The basic assumption of ongoing international convergence means that in countries with an exceptionally fast rate of decline in the past, the rate of decline would be expected to slow down to some extent. In countries with a modest rate of improvement in the past, the decline would be expected to catch up. This takes into account the fact that recent developments differ strongly among the European countries. We saw no reason why they would reverse in the near future. On the other hand, it is hard to see why, in the long term, countries would diverge from each other and from the average European trend. These assumptions imply that especially for males the differences between countries are becoming smaller. In 2002, the difference between the lowest male life expectancy (Portugal) and the highest (Iceland) was about 4.7 years. This difference is assumed to decrease to 3.3 years (lowest for the Netherlands and highest for Spain). For females, differences are decreasing only slightly.

The resulting expected gains in life expectancy at birth for men during the period 2002–2049 vary between 6.5 (Netherlands) and well over 10 years (Luxembourg, Portugal and Spain). For women, slightly smaller improvements are expected, varying from 5.7 (Netherlands) to 9.6 (Ireland). Table 2.3 gives the resulting levels of the life expectancy in 2049. Alders, Keilman and Cruijsen (2007) note that the relative variation in life expectancies in 2049 is in line with international trends since the beginning of the twentieth century. In contrast, the UN and Eurostat assume a larger spread across countries in life expectancies in their more recent forecasts than in their earlier ones.

Compared to the UN and Eurostat forecasts, the UPE forecast assumes higher levels for life expectancy. This is primarily motivated by the fact that past forecasts of national statistical agencies in European countries have systematically underpredicted life expectancy. Life expectancies were too low by more than 2 years for European forecasts fifteen years ahead, and by 4.5 years twenty-five years ahead (Keilman 1997; Keilman and Pham 2004).

The disagreement between UPE assumptions for life expectancy in 2049 on the one hand, and corresponding UN and Eurostat assumptions on the other, is larger for men than for women. As a descriptive statistic, we give the simple correlations across countries:

	UN 2004	Eurostat 2004	UPE 2004	UN 2004	Eurostat 2004	UPE 2004
		Men			*Women*	
UN 2004	1			1		
Eurostat 2004	0.858	1		0.765	1	
UPE 2004	0.518	0.521	1	0.743	0.799	1

Migration

As to migration, the following principal factors are thought likely to influence migration developments in the coming fifty years:

- economic developments will induce fluctuations in the demand for labour and people will come from other EEA+ countries, but also from the outside to fill existing opportunities;
- the ageing of the EEA population will induce demand for labour, in particular in the health sector;
- developments in the South and East will put pressures on the gates of the wealthy EEA.

The starting point for the UPE point forecasts was a linear trend model. We detected a significant upward linear trend in net migration for many countries. However, it is very uncertain whether these rising trends will persist. For one thing, in many countries they would lead to high levels that have no precedent in history. Yet, the assumption of a break in the trend is equally problematic. As a compromise, values were sought between the linear trend and the current level. Eventually it was assumed that for the EEA+ countries as a whole, net migration per thousand of population in 2000, will rise to a level of around 3.5 in 2049. This is considerably less than the 5 per thousand according to the linear trend model, but higher than the current value of approximately 2.7. Next, we made long-term country-specific assumptions on net migration, that varied from 1.5 (Finland, France and Iceland) to 6 per thousand (Luxembourg); see Table 2.4.

As in the case of life expectancy, past official forecasts have systematically underpredicted levels of immigration in Europe. Net migration forecasts were too low, either because international migration was simply set to zero (the UN Revisions of 1994 and 1996) or because the levels assumed were too low. Also, similarly to life expectancy, the last row of Table 2.4 reflects a stronger belief in the convergence of levels of migration in the UPE forecast than in the most recent forecasts of UN or Eurostat.

Conclusions

Since the middle of the 1990s, the UN and Eurostat have changed their views about the likely demographic outlook in the eighteen countries of the EEA+ region. The surprise is that changes from one forecast round to the next display a very characteristic pattern. The UN and Eurostat have systematically adjusted their views on life expectancy and net migration towards higher levels. Moreover, since 1998 the UN no longer considers replacement-level fertility as the most probable long-term level, but it still assumes higher levels than Eurostat.

We have contrasted the UN and Eurostat forecasts with our own views that form the basis of the probabilistic UPE forecasts. On fertility we essentially agree with Eurostat, but the UN assumes convergence to a level that is about 10 per cent higher. However, the UPE assumptions on life expectancy and net migration are higher than those of the UN and Eurostat. This difference can be traced back to the realization that, in the past, official forecasts have been systematically too low for both life expectancy and net migration. However, a more detailed comparison between UPE assumptions and those of the UN and Eurostat is hampered by the lack of argument-based justifications for the assumptions of the latter two.

The high UPE assumptions for life expectancy and international migration imply larger working-age populations and larger numbers of the elderly than do the UN and Eurostat forecasts. Overall, UPE expects a monotonic increase in the population of EEA+ from the current level of 392 million to 427 million in 2050 (corresponding to an average annual growth rate of 0.2 per cent). In contrast, the 2004 Revision of the UN predicts a decline from 407 million in 2030 to 400 million in 2050. Eurostat predicts that the fifteen member countries of the former EU will have a population of 384 million in 2050, 7 per cent less than the UPE prediction for these countries.

How important are these differences? In Table 3.1 it is shown that the standard deviation of predictive distribution for the 2050 total populations in EEA+ countries is 15 per cent of the point forecast. However, as the countries are not perfectly correlated, the relative standard deviation for the EEA+ is smaller. Alho and Nikander (2004) present an 80 per cent prediction interval for the total population in 2050. Under a normal approximation one can deduce that the standard deviation for the EEA+ is about 8.4 per cent. Thus, the UN, Eurostat and UPE forecasts for the total population are within one standard deviation. The differences are non-trivial, but probably not qualitatively important in economic applications.

Yet, from the perspective of ageing research, the assumption of higher life expectancies (and, to a lesser extent, higher net migration) implies that the number of persons aged 65+ has fast become outdated in the official forecasts. For example, consider France, Germany and Italy in 2050. In the 1998 Revision, the UN expected populations of 15.28, 20.79 and 14.38 million, respectively. Six years later, in the 2004 Revision the expected populations were 17.11, 22.38 and 18.09 million, respectively. Corresponding median values (80 per cent prediction intervals in parentheses) from Alho and Nikander (2004) for France, Germany and Italy are 18.20 ([15.13, 21.13]), 25.03 ([20.26, 29.70]) and 19.29 ([15.54, 22.67]) million, respectively. Although the most recent revision is not radically different from the UPE medians, a forecast made six years earlier is so low that by current estimates the chance of such low values is only one in ten. Since economic analyses of the type considered in this volume are intended for strategic planning, they should not become outdated in five to ten years' time. Instead of concentrating on minor differences in forecasts made by different agencies at a given time, it seems more fruitful to recognize that they are all likely to be in error. This is the motivation for handling forecast uncertainty in probabilistic terms.

NOTES

1 For practical reasons, we excluded EEA-member Liechtenstein.
2 UPE stands for 'Uncertain Population of Europe'. This was an EU-funded research project that produced the first stochastic forecasts for all EEA+ countries.
3 The higher growth rate is partly explained by stronger population growth in France (2.6 per thousand in UPE; 0.9 according to the UN), in Spain (1.5 rather than −0.3 per thousand) and the UK (3.0 rather than 2.6 per thousand). There is also some effect caused by a *lower* starting population in the UPE forecasts, by 4.7 million. If the UPE forecast had started from the same population as the UN, the average growth rate to 2050 would have been 1.6 per thousand instead of 1.8.
4 These are simple averages across countries. When weighted with country-specific numbers for the 2050 population, the trend is similar but the values are between 0.3 and 0.6 children per woman lower.
5 At the time of writing (September 2006), there is still very little publicly available documentation for the 2004 Eurostat forecast.
6 Countries do not necessarily reach the maximum life expectancy by 2050. In fact, in the 2004 Revision, only Japanese women do so.
7 Numbers for the 2000 population in each country were taken from UN data. Using statistics from the Council of Europe or from Eurostat would have resulted in slightly different values. The patterns, however, would have been the same.
8 To a smaller extent, this is also the case for Eurostat.

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