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FERTILITY AND MORTALITY SCENARIOS FOR 27 EUROPEAN COUNTRIES, 2002-2052

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Abstract: This paper summarises assumptions on future developments of fertility and mortality in 27 selected European countries in the period 2002-2052. The assumptions have been developed to serve as an input for the forecasts and simulations of population and labour force developments in Europe. The two demographic variables under study are presented in a context of their theoretical framework, as well as of their developments during the recent decades. On this basis, knowledge-based expectations for the future are made and subsequently quantified. The obtained scenarios are compared with the ones applied in the similar studies of national and international population projections and forecasts.

Keywords: fertility, mortality, population forecasts, Europe

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Contents

1. Introduction

This paper summarises assumptions on future developments of two components of natural population change, fertility and mortality, in 27 selected European countries in the period 2002-2052. The assumptions have been developed to serve as an input for the forecasts and simulations of population and labour force developments in Europe, prepared by the Central European Forum for Migration Research. The study has been conducted within the framework of the research project *Impact of international migration on population dynamics and labour force resources in Europe*, financed by the Foundation *Population, Migration, Environment* from Zurich. In geographic terms, the analysis covers 23 countries of the European Union (without Cyprus and Malta), two EFTA countries (Norway and Switzerland), as well as two accession countries (Bulgaria and Romania).

In two subsequent sections of this study, second and third, respectively, fertility and mortality are presented in a context of their theoretical framework, as well as of their developments in Europe during the recent decades. On this basis, knowledge-based expectations for the future are made and subsequently quantified. The demographic scenarios obtained in that way are compared with the ones applied in the similar studies of the national and worldwide (United Nations 2003) population projections. Results of the study, the natural change scenarios for 27 selected European countries, are summarised in brief in the final, fourth section of this paper.

Unlike in the case of many other population forecasts, the current study involves only one fertility and one mortality scenario, intended to reflect the most likely future developments of these demographic components of the population growth. In the majority of knowledge-based forecasts, multiple scenarios of all components are created, in order to capture the expected uncertainty of the future demographic developments. The main reason for renouncing that idea in the current study is that the forecasts and simulations, for which the assumptions are made, focus on the impact of international migration on population and labour force resources in Europe. Therefore, the forecasted fertility and mortality developments are designed to serve merely as a background (although an important one) for the analysis.

2. Fertility

2.1. Fertility trends in Europe: the second demographic transition

Already since the 1970s, there have been numerous efforts to explain the fertility decline in the developed countries. Several such attempts have been derived from the field of the theoretical economics. The first one (Easterlin 1975) is based on the relationship between fertility and 'relative' family income, i.e. actual earnings related to the level desired by the family. According to this hypothesis fertility decline is explained by the comparatively low future prospects of the relative income, especially when compared with the previous generations. The second concept ("New Home Economics", Becker 1991) is an example of applying the neo-classical consumer theory approach in family studies, with demand for children being treated as akin to the demand for durable goods. The drop in fertility in the developed countries is explained by the increasing 'opportunity costs' of having children, especially for contemporary women.

Within demography, a contemporary paradigm for setting the theoretical background for the analysis of many population processes, with a special focus on fertility, is based on the theory of the second demographic transition (Lesthaeghe, van de Kaa 1986, van de Kaa 1987). This theoretical framework stresses the role of changes in values and norms in the modern society, resulting in the adjustment of the demographic patterns and in particular of the fertility-related behaviour. These changes can be among others attributed to[1]:

a) individual autonomy in ethical, moral and political spheres,
b) related rejection of all forms of institutional control and authority,
c) increase in expressive values connected to the higher-order needs of self-fulfilment.

The most important components of demographic transition that resulted from the mentioned changes were: decline in fertility and in the number of marriages, postponement of marriage and childbearing and an increasing role of the informal unions (cohabitation) and extra-marital births. Thus, as it has been suggested by Okólski (2004), the crisis of the traditional family as an institution that followed the modernisation processes in the developed countries, can be seen as one of the major factors underlying the fertility decline. The changes started in Northern and Western Europe already in the late 1960s, extended in the 1980s to the Southern Europe, followed by the Central and Eastern part of the continent since the 1990s, i.e. after the fall of the Iron Curtain (Surkyn, Lesthaeghe 2004). Different schedules of the second transition for the particular groups of countries are clearly reflected in the time series of the Total Fertility Rates (TFR), measuring the average number of children per woman in a given period.

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[1] Quoted after: Surkyn, Lesthaeghe (2004: 47).

Without going into deeper discussion, it can be concluded that a synthesis of the presented demographic and economic theories of fertility provides quite complex explanation of the processes that have taken place in Europe since the late 1960s and continue up to date.

The forerunners of the second demographic transition in terms of fertility decline were Scandinavian countries (Denmark, Finland and Sweden) and Luxembourg, where the process started around 1965 and fertility fell to the below-replacement levels[2] already by 1970. With a delay of some years, the other countries of Northern and Western Europe followed this transition path. A particular situation was observed in German-speaking countries (Austria, Germany and Switzerland), where the TFR declined to the level of about 1.5 by the late 1970s and have remained almost constant since then. Exceptional circumstances were in place in Ireland, notorious for very conservative policies and attitudes towards the fertility and family issues, where the TFR dropped from the extremely high levels of about 4.0 in the early 1970s below the replacement level only in the 1990s.

A different picture of the second transition progress could be observed for the countries of Southern Europe. Italy, Portugal and Spain entered the process first, about 1985, two latter, however, starting from the significantly higher initial TFR values (about 2.8 as compared with 2.3 in Italy). Then, some five years later Greece and Slovenia[3] followed the path of fertility decline. Ultimately only in Portugal the TFR managed to stabilise around the level of 1.5, while in the remaining countries from this group fell below 1.3, level is considered as the threshold of the "lowest-low fertility" (Kohler et al. 2002).

In the post-socialist countries of Central and Eastern Europe, fertility levels were quite high until the changes of political and economic systems occurred in 1989. With the exception of Hungary and the Czech part of Czechoslovakia, TFR levels at the end of the 1980s were higher than 2.0. An interesting complex explanation of this phenomenon has been provided by Sobotka (2002), who introduced the concept of a "socialist greenhouse" – an artificial social and economic environment characteristic for the socialist countries. This institutional setting shaped the patterns of fertility and family formation by the means of various incentives and preferences for the young couples, as well as by ensuring a relatively stable and secure situation on the labour market. The socialist economic system, which allowed for a conciliation of high participation of women on the labour market with their traditional role in the family, together with the limited access to contraception, led to the relatively high fertility levels, especially at younger ages. A special case was Romania under the regime of Ceauşescu, where introducing the radical pronatalist policy and hardly any access to abortion

[2] In contemporary Europe the replacement level corresponds to the TFR of about 2.08, which under mortality conditions observed in the developed countries and with no international migration ensures the simple replacement of a generation of parents by a generation of children and thus a zero population growth.

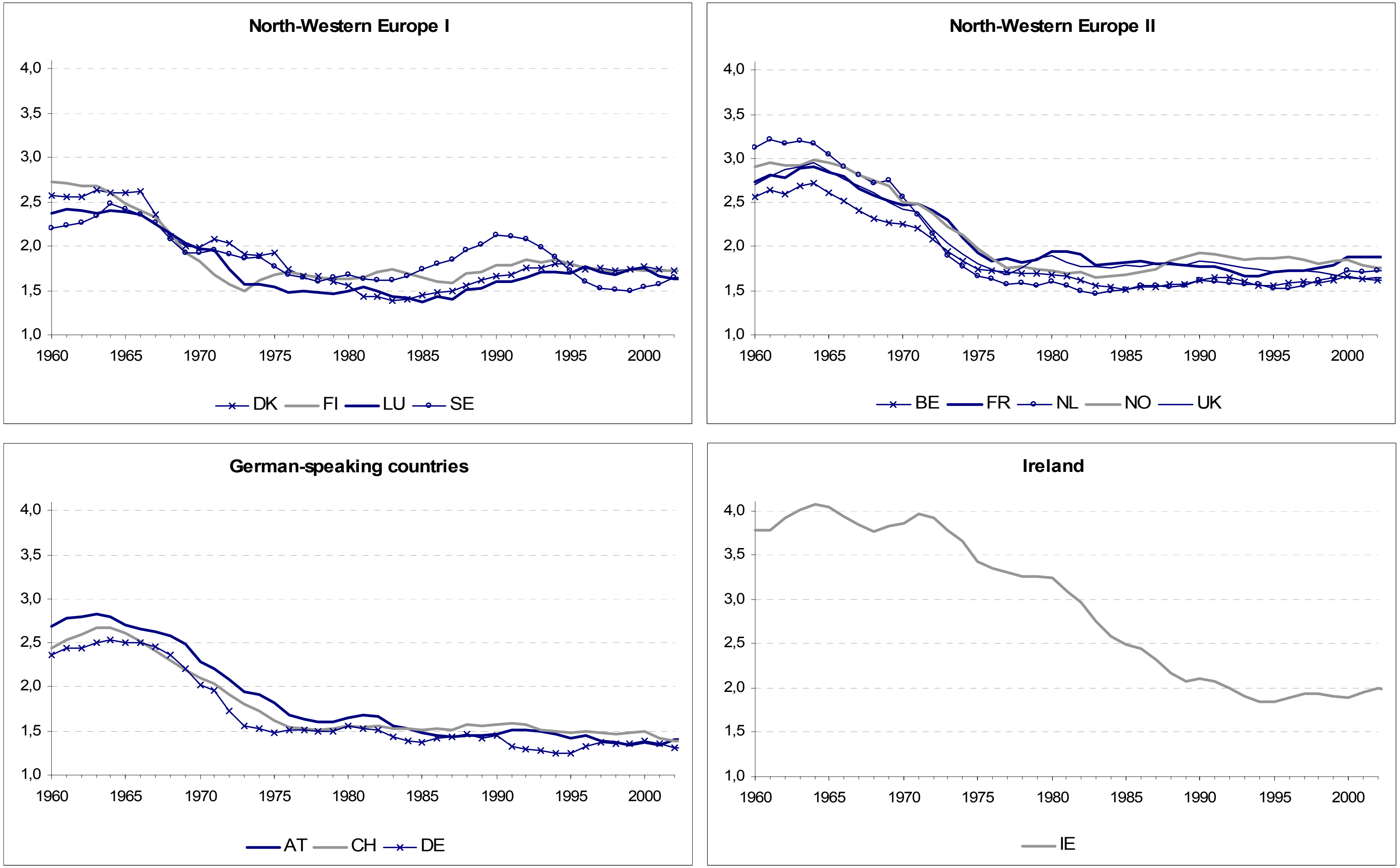
[3] It is worth noting that in terms of fertility changes, Slovenia can be rather seen as a Southern European country, than analysed together with the other post-socialist countries, firstly due to the relatively open character of Titoist socialism in the former Yugoslavia, and secondly to the high level of socio-economic development of Slovenia.

and contraception initially led to very high TFR values. These extreme peaks were, however, followed by the rapid fertility decline to the moderate levels that can be seen as reflecting rather the preferences of the families than the ones of the communist regime (Sobotka 2002).

Dissolution of the socialist system resulted in changes of values and norms regarding self-fulfilment, education, sexuality, contraception, consumption and many other areas of life. Transition to the market economy combined with the opportunities of higher earnings, but also with threats related to the insecure situation on the labour market also affected childbearing preferences of the families. Resulting demographic changes like postponement of family formation and childbearing, as well as an increasing age at motherhood and the increasing numbers of couples with only one or no children can be seen as direct factors influencing fertility decline (Okólski 2004). In that respect, it can be argued that the countries of Central and Eastern Europe follow the path of the second demographic transition with a certain delay towards Western Europe, yet at the greater pace (van de Kaa 2003). It has to be marked that the second demographic transition processes are more advanced in the countries that were successful in the economic transformation, thus in Central Europe. Adversely, in the South-Eastern European countries (Bulgaria and Romania), fertility decline can to a larger extent result from the unfavourable economic conditions than from the overall societal change, which is still postponed (Sobotka 2002). Summing up, it can be argued that in all formerly-socialist countries the modernisation processes are not completed yet, especially taking into the account the rural areas (Okólski 2004).

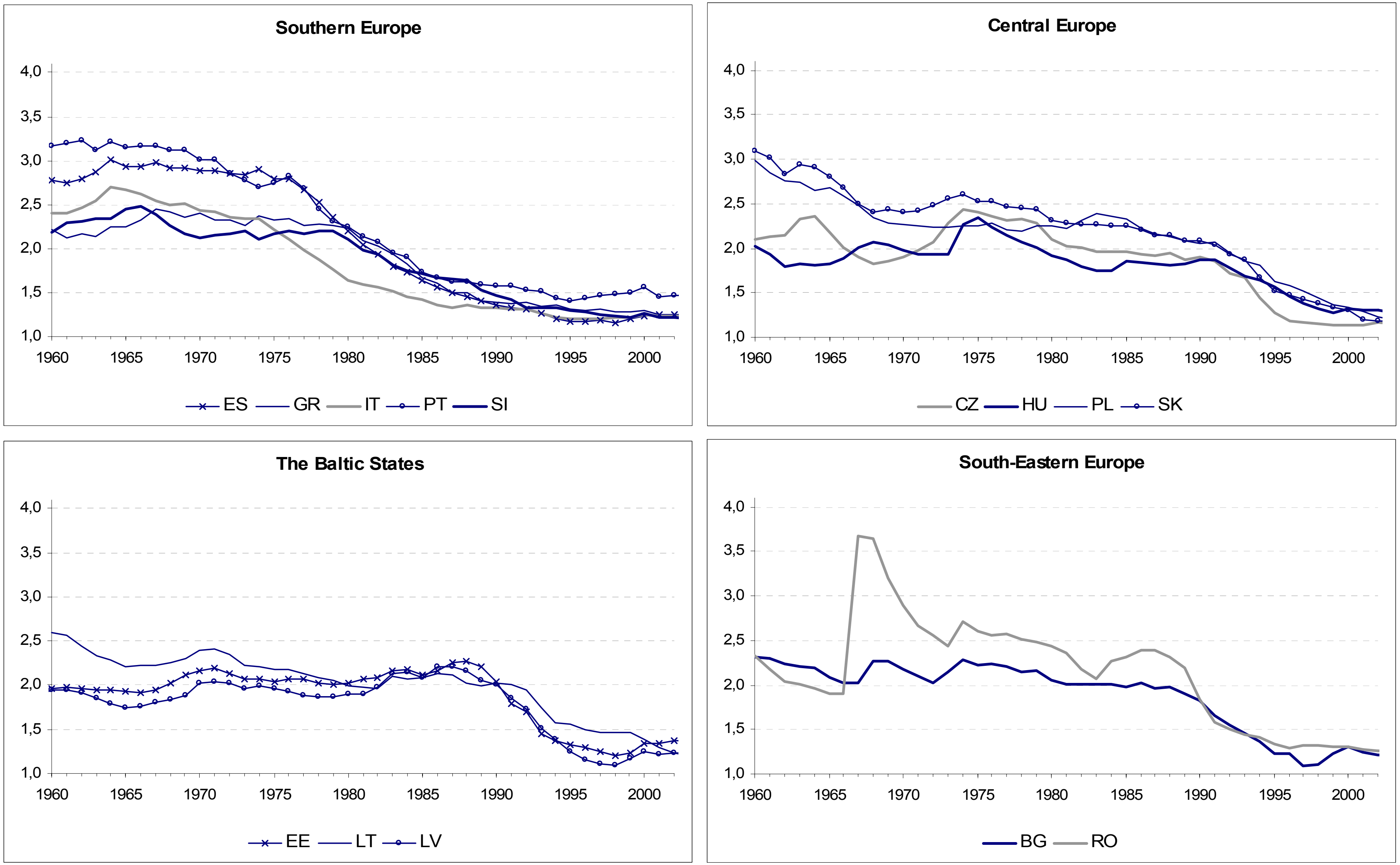
On the basis of the common fertility characteristics since 1960, a simple clustering of European countries according to the past and recent TFR developments can be made. An overview of fertility patterns for eight groups of countries is presented in Figure 1. The clustering is based on both the similar history of fertility changes, discussed earlier in this section, as well as the geographic and cultural proximity of the countries. The data come from the Council of Europe (2003) yearbook.

Figure 1. Observed period TFR values in eight groups of European countries, 1960-2002



Source: Council of Europe (2003), own computations

∞ **Figure 1. Observed period TFR values in eight groups of European countries, 1960-2002**



Source: Council of Europe (2003), own computations

As a result of the mentioned modernisation processes, more than a half of Europe's contemporary population lives in countries with the "lowest-low" fertility levels, with period TFR below 1.3 (Sobotka 2004). The exceptions are countries of North-Western Europe and Portugal, where the fertility decline was not as deep as in the remaining European countries.

2.2. Fertility scenario: a slow recovery

Both the demographic and economic theories may provide a useful background for setting the general framework of the future fertility scenario for Europe. It has to be, however, stressed that the precise assumptions, as always in population forecasting, are to a large extent judgemental, as a certain degree of subjectivism is always inevitable in this type of research (Lutz et al. 2000).

If we assume that a moderate yet stable economic growth will prevail in Europe for the forthcoming 50 years, combined with population ageing and related problems of the social security systems, then there will likely be some attempts from the population policy side to counterbalance fertility decline by introducing certain policy measures. There may be thus an indirect impact of economic growth on fertility that would act via institutional proxies, e.g. improved childcare systems, more equal division of rights and obligations with respect to childcare between both parents, or longer parental leaves. Such a scenario would be very much in line with the New Home Economics theory (Becker 1991), emphasizing the economic aspects of future fertility prospects. An example supporting this hypothesis are the highly developed Scandinavian countries, where the expensive institutional setting, including the factors mentioned above, seemingly contributed to the fertility increase in the 1990s. On the other hand, it is difficult to expect that the potential fertility recovery may be attributed solely to the economic improvement and decreasing opportunity costs of childbearing, given the nature and magnitude of the recent changes in the societal values (van de Kaa 2003).

At this moment it seems that the societal changes that have occurred in the developed countries since 1960s are durable and that return to the replacement-level fertility in the future can not be feasibly assumed, although of course the second demographic transition theory does not exclude the possibility of further changes in societal values. Nevertheless, there is no evidence that any policy measures can counterbalance the fertility decline in the light of strong individualisation processes that take place in Europe. The way fertility decline can be reversed can be seen through the commencement of perceiving childbearing as a way of self-realisation of the parents in a process that is likely to happen first in Western Europe, and only then, with a time delay in Central and Eastern part of the continent (van de Kaa 2003). At this point the economic and institutional setting mentioned in the previous paragraph may get involved, but only as an additional factor that influences the process, rather than the main determinant of the fertility trend. In any case, the size of expected recuperation of fertility levels in Europe has to be seen as relatively limited.

According to Bongaarts and Feeney (1998), in the analysis of fertility dynamics it is useful to distinguish two components that contribute to the overall change of period TFR: the *quantum* and *tempo* effects. The *quantum* component is defined as "the TFR that would have been observed in the absence of changes in the timing of childbearing during the period in which the TFR is measured. The *tempo* component equals the distortion that occurs due to timing changes" (Bongaarts, Feeney 1998: 272). In the context of the second demographic transition theory, one can expect the following changes with respect to the both components:

- the future changes in the timing of fertility (*tempo*) are likely to continue, with mean age of first childbearing slowly moving to the older age groups;
- in the nearest future, the fertility *quantum* is expected to stagnate in the Western European countries or even further decline in Central and Eastern Europe, and only afterwards commence a slight recovery.

Clustering of countries according to their recently observed fertility trends also to some extent reflects the patterns of cultural and structural social incompatibilities (Liefbroer, Corijn 1999) that influence fertility patterns. Cultural incompatibility is related to the stereotypes, values and norms determining the role of women in the society (traditional as opposed to modern), while the structural incompatibility to the possibilities of self-realisation of women especially on the labour market. The former one can be thus seen as more related to the second demographic transition concept, while the second one to the New Home Economics theory. Although these two types of incompatibilities are most often correlated, there are visible exceptions. The most relevant example is Italy where the structural possibilities are not utilised due to the relatively traditional cultural family values (Liefbroer, Corijn 1999: 52), resulting in the lowest labour force activity rates among the countries under study (International Labour Organization, 2003). On the other edge, the countries with the highest labour force participation of women are at the same time the ones with the highest fertility rates in Europe (Norway and Sweden). This is likely to a large extent due to the highly-developed institutional framework supporting the childbearing, as it has been mentioned previously. It would indirectly indicate that low levels of both types of incompatibilities make relatively good conditions for higher fertility in the contemporary society (Muszyńska 2003), yet still lower than the replacement level. An explanation would be that the countries with low levels of cultural and structural incompatibilities are relatively advanced in the process of the second demographic transition. Therefore, these countries are already on their way to the reversal of the declining fertility trends, which currently seems possible only in the favourable cultural and social environment, as suggested by van de Kaa (2003).

Together with the cultural and structural background, common fertility patterns observed in the past, as well as the geographic, historical and cultural proximity of countries allow for introducing a simple clustering of the European countries for the purpose of setting the fertility scenarios. The grouping proposed in this study is based on a simple qualitative analysis of the common features of the countries, and not on the formal clustering methods, in order to avoid unnecessary complication of the problem.

With regard to the Scandinavian frontrunners of the second demographic transition process (**Denmark**, **Finland**, **Norway** and **Sweden**), one can expect the relatively high recent TFR values (between 1.65 and 1.75 in 2002) to be quite good predictors of comparatively high fertility in the future. Very high levels of economic development and social welfare can likely contribute to the favourable environment for further fertility increase. Also both cultural and structural social incompatibilities regarding the role of women in the society and the institutional possibilities of reconciling work with family life remain in the Scandinavian countries at the low levels (Muszyńska 2003), what additionally supports the optimistic expectations with regard to the future fertility developments.

In **Belgium**, **Luxembourg** and the **United Kingdom**, the recent period TFR values of 1.62-1.64, stable or even slightly increasing, seem to indicate similar future fertility developments as in the case of Northern Europe, although perhaps to a slightly lesser extent. During the last 20 years, the TFR of the **Netherlands** observed an almost steady growth (with the exception of the first half of the 1990s) from the level of 1.47 in 1983 to 1.73 in 2002. Assuming a continuation of this tendency, one can expect this country to follow the Scandinavian fertility pattern rather then the one of its Benelux neighbours. An additional argument here is a relatively low level of cultural conflict resulting from the liberal attitudes prevailing in the Dutch society (Liefbroer, Corijn 1999).

Two other Western European countries (**France** and **Ireland**) are characterised by relatively high fertility levels in the recent years. For France the 2002 TFR level of 1.89 followed the period of a significant increase in the second half of the 1990s and stabilisation since 2000. For simplicity, one can assume that fertility in France will remain stable throughout the forecast period. In the case of Ireland, the rapid economic growth taking place in this country and the related modernisation of the society can, however, lead first to a further fertility decline and eventually to a moderate recovery.

In the case of German-speaking countries (**Austria**, **Germany** and **Switzerland**), the trends in period TFR values already indicate a stabilisation around the current levels of 1.30-1.40, with the history of more than 20 years at the levels around or below 1.50. For this reason, although one may expect fertility improvements in the future, their scope will likely be quite limited. The pertaining moderate levels of both cultural and structural incompatibilities in the societies (Muszyńska 2003) can be seen as additional factors limiting fertility recovery in the future, even despite very good economic performance.

In the countries of Southern Europe (**Greece**, **Italy**, **Slovenia**, **Spain**), the fertility decline was quite sharp (to the recent levels of 1.21-1.25) and it seems to be at least temporarily durable. Taking into the account certain factors limiting the future perspectives of fertility growth, one can expect the further fertility recovery only to a limited extent. Of a key importance here is the conflict between the traditional role of women and the modern societal values (Liefbroer, Corijn 1999), partially due to the relatively high levels of religiosity in these countries. An additional obstacle in reaching higher TFR levels in the countries of Southern Europe is the domination of the *quantum* effect, resulting in more families with no children or one child, rather than the postponed timing of fertility (Kohler et al. 2002).

The exceptional case among the Southern European countries is **Portugal**, where despite the historical, geographic and cultural proximity to the other countries from this group, especially to Spain, the fertility decline was not so dramatic and the TFR values eventually stabilised at the level slightly less than 1.50. For this reason, fertility scenario for Portugal should slightly differ from the ones for the other countries of Southern Europe, assuming higher TFR values.

Despite of the common history and presence of the "socialist greenhouse" effect, the countries of Central Europe can be divided into two subgroups, according to the level of influence of cultural and religious traditions (Sobotka 2002). In the **Czech Republic**, **Hungary** and **Latvia**, the societies are to a large extent secularised and can be seen as relatively advanced in the second demographic transition process. Therefore, in these countries a fertility stagnation can be expected rather than the further decline, followed by a moderate increase in the longer run. Additionally, the economic situation especially in the Czech Republic and Hungary is one of the best among the post-socialist countries and can provide positive background for the fertility recovery. The ultimate TFR target levels can be assumed as similar to the ones of the German-speaking part of Europe, considering the historically strong cultural ties of these countries either with either Germany or Austria. Moreover, in these countries the timing (*tempo*) effect seems to play the important role in determining the recent TFR decline. This indicates that to some extent the fertility processes are due to the postponement of childbearing and not only to the decreased number of children (Philipov and Kohler 2001, Sobotka 2002), what can constitute an additional argument for the future partial recuperation of fertility.

Conversely, the remaining countries from this cluster (**Lithuania**, **Poland** and the **Slovak Republic**), especially with respect to the traditional role of Roman Catholicism and its influence on the societal values, much more resemble the countries of Southern Europe (Sobotka 2002) For this reason, the high levels of both cultural and structural incompatibilities in these societies seems to delay advancement in the second demographic transition. One can therefore expect that there is still place for further fertility decline, especially in the short term. Nevertheless, it seems feasible to assume that these three countries will eventually follow Southern Europe in the process of moderate fertility recovery, yet with a certain time delay.

Estonia has to be seen as an exceptional case among the former socialist countries of Central Europe. In this Baltic state, the relatively low level of cultural conflict within the society (visible for example in the very high percentages of the consensual unions and extra-marital births) appears to be correlated with an increase of period TFR already in the second half of the 1990s to the level of 1.37 in 2002. Such low cultural incompatibility of the Estonian society, as well as cultural proximity to the Scandinavian countries allow for assuming higher future TFR values for Estonia than for the remaining Central European countries.

Finally, although the two South-Eastern European countries (**Bulgaria** and **Romania**) are characterised by similar historical and to some extent cultural features to the other post-socialist states, one can expect the fertility crisis to be even deeper and more long-lasting. A combination of traditionalist societal values and difficult economic conditions leaves space for further fertility decline, as these countries seemingly have not yet entered the process of the second demographic transition in full (van de Kaa 2003). For this reason, one can assume that fertility in Bulgaria and Romania may be even lower than in the neighbouring countries, especially that there were strong *quantum* effects of fertility decline in the countries like Bulgaria, due to the strong economic crisis in the early 1990s (Philipov and Kohler 2001).

For all the mentioned groups of countries the quantitative assumptions on fertility scenarios have to be set separately, taking into consideration the probable convergence of fertility trends within particular clusters.

2.3. Quantification of the assumptions

Methods derived for forecasting or projecting fertility are numerous: from stochastic (Keilman, Cruijsen 1992, Lee 1998, Alho 1998, Keilman 2001), through the conventional scenario-setting (United Nations 2003, most of the national projections) to the attempts to forecast future fertility on the basis of the expected or desired by couples number of births (Eurostat 1997). The applicability of the latter method to predicting fertility in Europe seems disputable, as the actual family size in the developed countries remains in most cases below the desired one (Bongaarts 2001, Voas 2003).

To get the most of the advantages of the stochastic and scenario-based forecasts, one can combine them, what should generally improve their performance (Gjaltema 2001). For this reason, the methodology of scenario-setting applied in this study is partially based on analysing past trends of the overall period TFR, their extrapolation for 10 years into the future and bridging the extrapolated figures with the judgmentally selected target values for 2052. The trend extrapolation for the initial 10 years of the forecast reflects the assumption of the stagnation or decline of the fertility *quantum* in the nearest future.

Assumptions on target TFR values have been chosen judgementally on the basis of the reasoning presented in Section 2.2, with an attempt to be as consistent as possible with the other similar studies (United Nations 2003 and the national projections). Methodology of setting the scenarios of period TFR for the particular countries applied in this study is therefore rather simplistic, without going into the details concerning the age structure of fertility or trends in cohort fertility rates. The reason for this simplification is that the geographical scope of the analysis is broad (27 European countries), and the relevant data are often incomplete or missing. Moreover, as it has been shown by van Imhoff (2001), there is no simple relationship between the period and cohort fertility measures allowing for deriving one from the other. Therefore, more complex assumptions underlying the fertility forecasts have been sacrificed for the sake of applying of a common methodology to all the countries under study.

For the purpose of the current analysis, nine clusters of countries have been identified, according to the common past TFR development patterns, as well as to the geographical and cultural proximity, as indicated in Section 2.2. The clusters and their specific target TFR values are assumed as shown in Table 1:

Table 1. Assumptions on target TFR values forecasted for 2052

No.	Cluster	Countries	Target TFR
1	South-Eastern Europe	Bulgaria, Romania	1.40
2	Southern Europe	Greece, Italy, Slovenia, Spain	1.50
3	German-speaking countries	Austria, Germany, Switzerland	1.50
4	Central Europe	Czech Republic, Hungary, Latvia, Lithuania, Poland, Slovak Republic	1.50
5	Estonia	Estonia	1.60
6	Portugal	Portugal	1.70
7	North-Western Europe (1)	Belgium, Luxembourg, United Kingdom	1.80
8	North-Western Europe (2)	Denmark, Finland, the Netherlands, Norway, Sweden	1.90
9	High-fertility countries	France, Ireland	1.90

Source: Own elaboration

For the majority of countries, the forecasted increase of period TFR values between 2002 and 2052 is expected to range between +0.1 and +0.3. The comparison of the assumptions on target TFR values for different projections and forecasts for 2050 (or for the latest available year, if the TFR was assumed to remain constant in the final period) is presented in Table 2.

Table 2. Comparison of target TFR assumptions for 2050: different projections/forecasts

Country	National	UN 2002	Current study *
AT	1,40	1,85	**1,50**
BE	1,70	1,85	**1,80**
BG	n.a.	1,85	**1,40**
CH	1,50	1,85	**1,50**
CZ	1,62	1,85	**1,50**
DE	1,40	1,85	**1,50**
DK	1,80	1,85	**1,90**
EE	1,77	1,85	**1,60**
ES	1,50	1,85	**1,50**
FI	1,77	1,85	**1,90**
FR	1,80	1,85	**1,90**
GR	n.a.	1,85	**1,50**
HU	1,90	1,85	**1,50**
IE	1,75	1,85	**1,90**
IT	1,43	1,85	**1,50**
LT	1,65	1,85	**1,50**
LU	1,80	1,85	**1,80**
LV	n.a.	1,85	**1,50**
NL	1,80	1,85	**1,90**
NO	1,80	1,85	**1,90**
PL	1,20	1,85	**1,50**
PT	1,70	1,85	**1,70**
RO	1,30	1,85	**1,40**
SE	1,85	1,85	**1,90**
SI	1,70	1,85	**1,50**
SK	1,70	1,85	**1,50**
UK	1,80	1,85	**1,80**

* Target values for 2052, n.a. – not available.

Sources: United Nations (2003), information on the national forecasts from the websites of the national statistical institutes and / or Eurostat.

From Table 2 it can be seen that the target TFR values assumed for the purpose of this study are in many cases quite close to the national ones. Only in some cases the assumed targets reflect somewhat more optimism with regard to the further developments of fertility in particular countries. As the assumptions of the United Nations (2003) do not differentiate between the countries and do not take into account the local specificities, they are in this case less useful as a reference.

TFR values for initial 10 years of the forecast (2003-2012) are derived from an exponential trend: $TFR_t = c + \exp(a \cdot t + b)$, estimated from the past data. The estimation method was Ordinary Least Squares with a constraint $TFR_{2002} = TFR_{2002}^{est}$, i.e. with the observed values for 2002 being equal their estimates from the trend. This solution ensured that that the initial forecast values derived from the trend are consistent with the most recent observations. The series used for trend extrapolation depended on the time when the fertility decline visibly started, and therefore were as follows:

- 1989-2002 for the formerly socialist countries except Slovenia;
- 1980-2002 for Greece and Slovenia;
- 1975-2002 for Italy, Portugal and Spain;
- 1965-2002 for the remaining European countries.

The data were taken from the Council of Europe (2003: Tables 3) yearbook, with the missing 2002 values for Greece and Italy assumed to be the same as in 2001. For all the countries, the fit of the exponential trend was very good, with p-values not exceeding 0,0005. Anyway, for three countries (Lithuania, Poland and the Slovak Republic) trend extrapolation led to the extreme fertility losses in the period 2003-2012. Therefore, in these cases an alternative scenario was assumed, with fertility drops declining by a third each year (i.e. with $TFR_t = TFR_{t-1} + 2/3 \cdot [TFR_{t-1} - TFR_{t-2}]$). This solution appeared to lead to the reasonable results, consistent with the qualitative expectations.

The values for 2012 and 2052 have been bridged using a polynomial (cubic) Hermite interpolation ensuring not only a smooth passage from the initial to target values, but also from the initial slope ($\alpha = \Delta TFR_{2012/2011}$) to the target one, set to 0 by default. The *TFR* values have been thus set to stabilise at their target levels by 2052. The matrix formula for the Hermite interpolation is[4]:

$$TFR_t = \mathbf{s}^\mathbf{T} \cdot \mathbf{H} \cdot \mathbf{b},$$

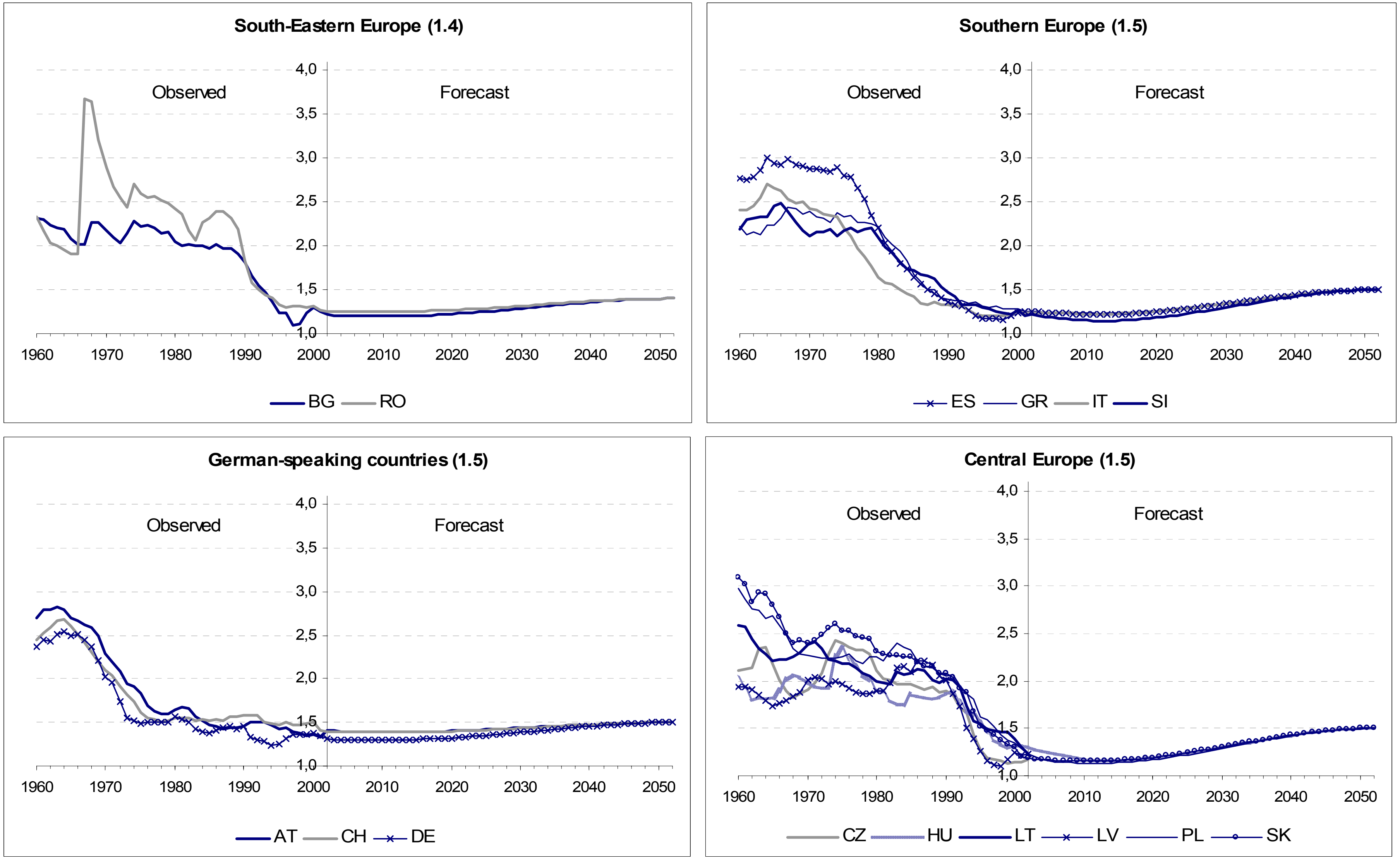
where $t = 2013 \ldots 2051$, $s = (t - 2012) / 40$, $\mathbf{s}^\mathbf{T} = [s^3 \;\; s^2 \;\; s \;\; 1]$, $\mathbf{b}^\mathbf{T} = [TFR_{2012} \;\; TFR_{2052} \;\; \alpha \;\; 0]$ and the Hermite coefficient matrix **H** is equal:

$$\mathbf{H} = \begin{vmatrix} 2 & -2 & 1 & 1 \\ -3 & 3 & -2 & -1 \\ 0 & 0 & 1 & 0 \\ 1 & 0 & 0 & 0 \end{vmatrix}$$

As a result, the complete TFR trajectories have been obtained in the particular clusters of countries, shown in Figure 2. Note that the thick and dashed lines denote respectively period fertility levels observed until 2002 and the ones forecasted for 2003-2052 for all European countries under study.

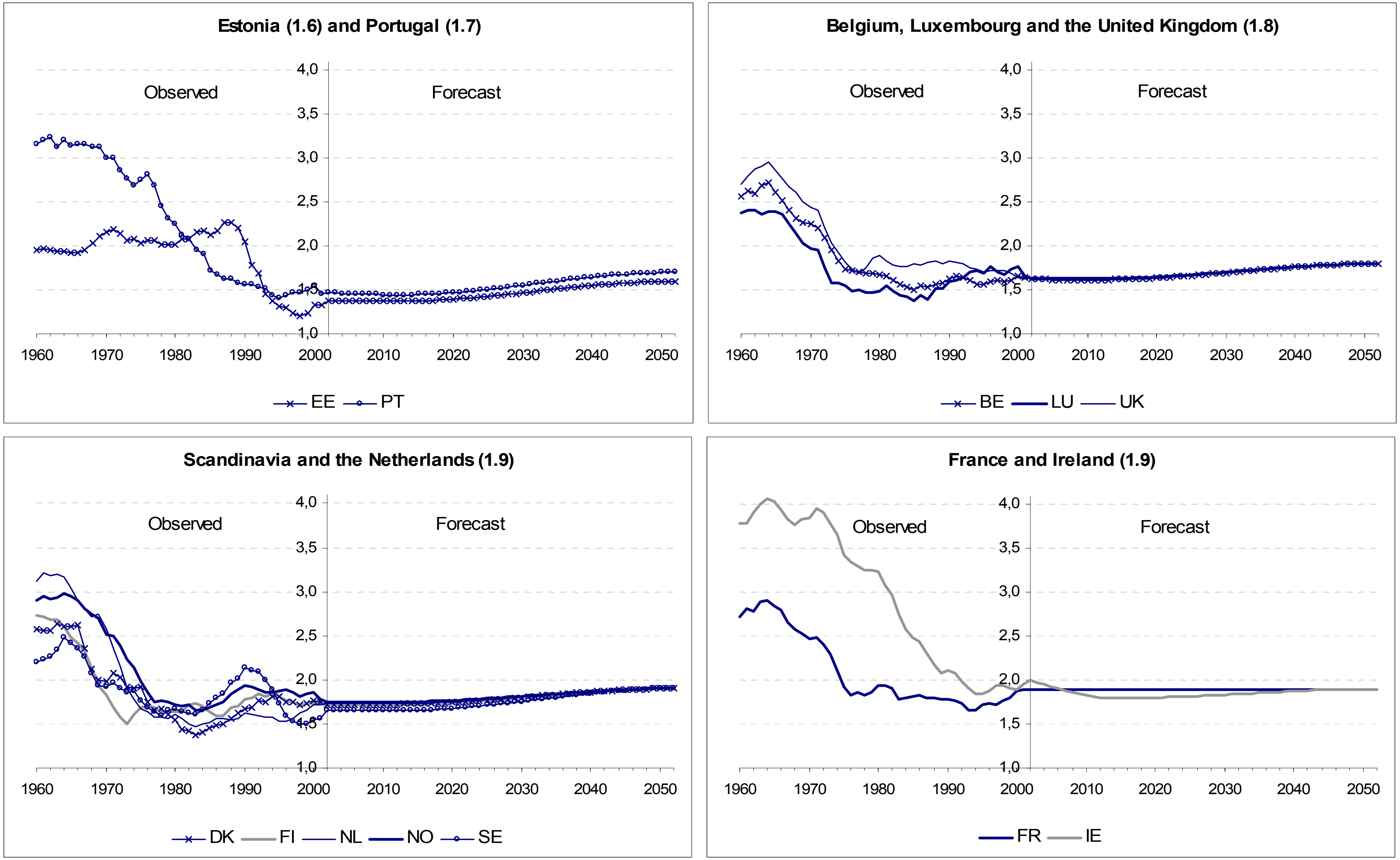
[4] The formula follows Weston (2002).

Figure 2. Observed and forecasted average TFR values in the clusters of countries (target values in brackets)



Source: Council of Europe (2003), own computations

Figure 2. Observed and forecasted average TFR values in the clusters of countries (target values in brackets)



Source: Council of Europe (2003), own computations

From Figure 2 it can be seen that although the forecast assumes a certain dose of optimism with regard to the slow increase in the number of children, in all cases the target values remain below the replacement level, i.e. about 2.08 child per woman. This reflects an assumption that the effects of the second demographic transition are long-lasting, although a slight upward shift from the lowest-low fertility levels is already visible by the end of the forecast period. This effect can also be interpreted within the framework of the 'second transition' paradigm, namely the ultimate increase in fertility may result from perceiving children and family life as the ways of self-realisation of the couples (van de Kaa 2003). The target values for 2052 can thus be interpreted within this paradigm as long-term stabilisation levels of the period TFR (and thus eventually also of the cohort-completed TFR), achieved at the ultimate stage of the second demographic transition. Any attempts to predict the changes in values, norms, attitudes and thus in the reproductive behaviour in the long run, beyond 2052, remain beyond the scope of the current study.

3. Mortality

3.1. Legacy of the past: East-West mortality gap in Europe

Similarly to the explanations of contemporary decline and postponement in fertility, also in the field of human mortality there have been attempts to create a unifying theory that would encompass the past and recent developments of health, longevity and prevalence of various diseases. An important endeavour was made by Omran (1971), who introduced the concept of the ‘epidemiologic transition’. In brief, his theory stresses the dominance of different types of diseases in various historical periods, with three stages of mortality developments being distinguished (Omran 1971: 516-521):

- domination of “pestilence and famine” approximately until the first half of the 19th century, with life expectancy at birth ranging between 20 and 40 years;
- “the age of receding pandemics” until the first half of the 20th century, with life expectancy steadily increasing to about 50 years and with the domination of infection diseases among causes of death;
- “the age of degenerative and man-made diseases” with a continuous mortality decline and a shift towards cardiovascular diseases, malignant neoplasms and external causes of death, as a result of medical and socio-economic improvements, as well as cultural changes in health-related behaviour.

The theory of epidemiologic transition was further elaborated, primarily by adding the fourth phase of delayed degenerative diseases (Olshansky and Ault 1986). During this phase, the developments in medicine and public health postpone the prevalence of the most important causes of death, most considerably the cardiovascular diseases. As a result, the increase in importance of mortality due to malignant neoplasms can be observed together with the declining impact of diseases of the circulatory system.

The theory of Omran had a strong impact on the way mortality issues are perceived among the epidemiologists, but also received a substantial amount of criticism from those, who considered the cultural, social and behavioural factors to be the primary determinants of the health and mortality in the modern world. As an alternative to the epidemiologic transition concept, the framework for the ‘health transition’ theory was proposed (Frenk et al. 1991, Caldwell 1993). Its key proposition is that in the modernising society, modern death risk factors begin to dominate over the traditional risks, what implies the concentration of mortality in older age groups, primarily due to the non-infectious diseases. A conclusion from this discussion is that, in general, it seems reasonable to include a synthesis of different explanations offered by various disciplines of science (biology, epidemiology, medicine, demography, psychology, etc.) in setting mortality scenarios, especially when requiring the inevitable dose of judgement (cf. Tabeau et al. 2001).

A comprehensive overview of socio-economic mortality determinants in Europe related both to epidemiologic and health transition theories has been provided recently by Spijker (2004), together with the empirical evaluation of impact of particular factors on health and mortality. Absolute and relative income levels, principal measures of economic development and social inequalities, have both proven to be significant factors of mortality decline. The only cases of death that were exceptions to this pattern were prostate and lung cancer in Western Europe, seen as the effect of ageing, and traffic accidents in Central and Eastern Europe, related to the increase in wealth and thus also motorisation. A significant impact on mortality decline has been also found in the case of the other socio-cultural and behavioural factors, like for example higher education or fruit and vegetable consumption. On the other hand, factors like the delayed effects of unemployment, risky lifestyles (smoking, excess alcohol consumption), as well as environment features, like air pollution, contributed to the increased mortality risk. Surprisingly, the impact of health care expenditures appeared to be of a little significance, but this can be attributed to the way it was measured. Apparently the effects of particular determinants were greatest in Central and Eastern European countries (Spijker 2004). This may result from the East-West mortality differences observed in Europe since the 1970s.

In Western Europe, in the second half of the 20th century a steady increase in life expectancy at birth for both sexes could be observed. White (2002) noted that this advance was typical for the high income countries, where linear trend in e_0 appeared to explain more of the variability of the phenomenon than the age-standardised death rates, either crude or logged. It has been also found that life expectancy changes were the result of both country-specific features, as well as a relative position of the country among all the countries under study with respect to mortality levels (White 2002). Research based on the application of the Lee-Carter mortality model (see further in Section 3.3) led to a similar conclusion on the basis of studying long-term trends, where linear mortality decline was observed among the most developed countries (Tuljapurkar et al. 2000). The main factors underlying the long-term mortality decline can be most likely attributed to institutional and technological factors (developments in medicine and health care, as suggested by Tuljapurkar et al., 2000), but also to the more hygienic living conditions and adopting healthy lifestyles by individuals (Olshansky and Ault 1986). Although there are cause-specific differences in mortality patterns between European countries (e.g. less deaths due to lug cancer in Northern Europe, more traffic accidents in Southern Europe, etc.), the overall mortality in all Western European countries remains on a similar level and a clear convergence of the trends can be observed (Spijker 2004: 101-106).

In the socialist countries of Central and Eastern Europe mortality decline until mid-1960s developed along the same lines as in Western Europe. This was mainly attributed to the successful reduction of mortality due to infectious diseases, corresponding to the beginning of the third stage of the epidemiologic transition. Afterwards, when the degenerative diseases started to prevail, Central and Eastern European countries failed to introduce the adequate health policy measures and implement new developments in medicine. On the contrary, the extensive and highly egalitarian socialist health care system was not able to cope with the degenerative diseases requiring highly-trained specialists, modern medical equipment and medicines, as well as expensive medical procedures (Rychtaříková 2002). There are also other explanations of the East-West mortality gap in Europe since the second half of the 1960s. An interesting view has been provided by Vallin and Meslé (2004), who suggested that additionally to the mentioned institutional drawbacks, the socialist system discouraged people from taking responsibility for their health through lifestyle and behavioural changes. This explanation would be very much in line with the theory of the health transition stressing the role of cultural, social and behavioural determinants of mortality.

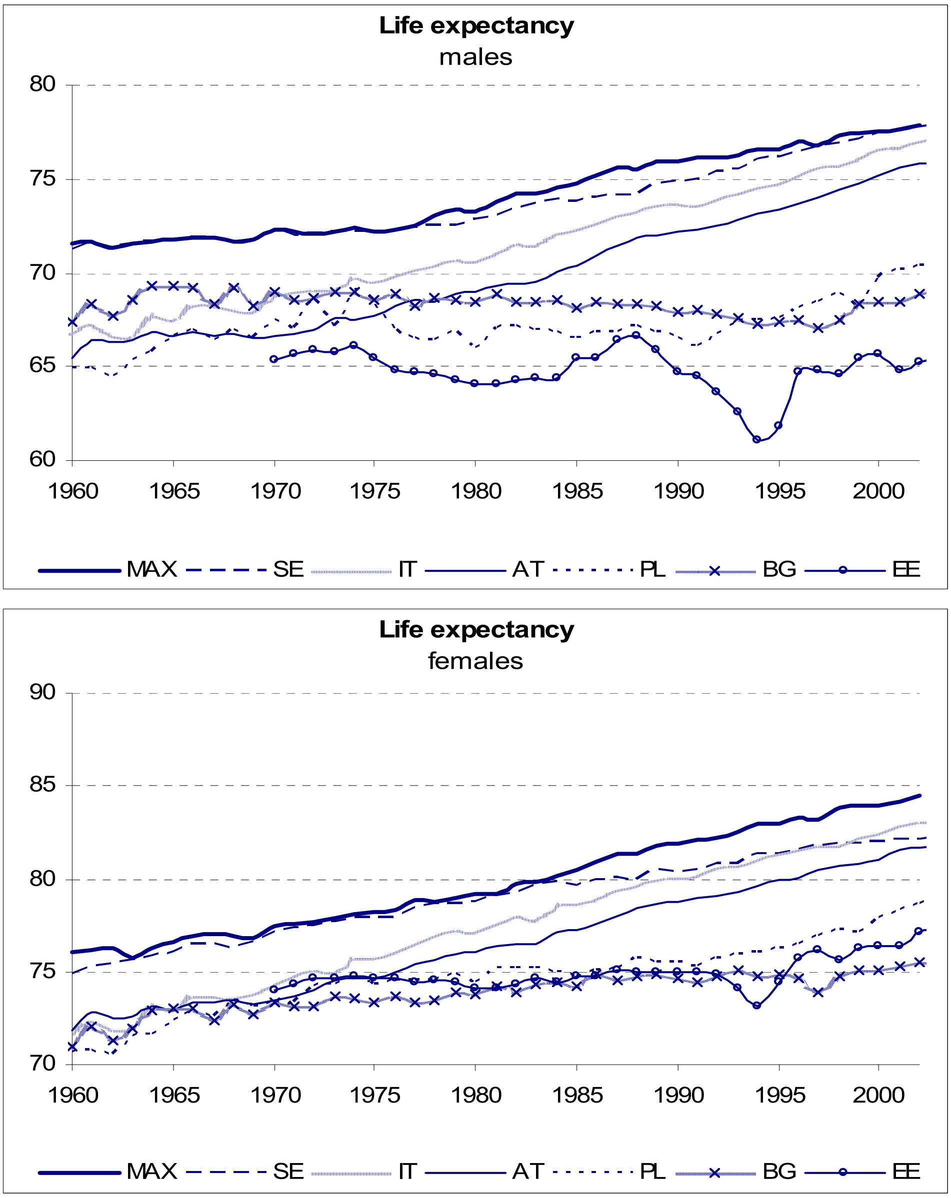
All the mentioned factors resulted in an increase in mortality due to cardiovascular diseases and external causes of death, which in turn caused stagnation or even slight decline in life expectancy (Okólski 1993, Meslé 2004a). A visible improvement in the period since 1965 was observed almost exclusively in successful prevention against infant and child mortality. On the other hand, the group most affected by mortality increase were the middle-aged men between 40 and 65 years of age. In this group the negative contribution of circulatory diseases, external causes of death and in some cases diseases of the digestive system to the life expectancy was most significant (Meslé 2004a).

The socio-economic transformation that took place in Central Europe in 1989 and in the former Soviet Union in 1991 caused a visible increase of mortality in all countries of the region, again mainly affecting the middle-aged males. This mortality crisis was deepest in the post-Soviet republics, thus also in the three Baltic States included in the current study. The reasons for the unfavourable changes can be sought in the economic crisis of the early 1990s, transformation of the labour market and the related social costs like unemployment and increasing poverty. Also the increasing uncertainty in everyday life, unhealthy living conditions and lifestyle, especially in the urban areas, as well as the crisis of the health care system likely contributed to the deterioration of mortality (Tabeau 1996). Negative transitional factors appeared to have an impact only for a couple of years. Recently, in all countries of Central and Eastern Europe being subject to the current study, a slow, yet sustainable recovery from the mortality crisis can be observed, with the post-Soviet countries still lagging behind, especially in terms of male mortality (Meslé 2004a).

A remedy for the unfavourable mortality developments in the former socialist countries can be seen in the improvement of the working and living conditions, together with the promotion of necessary changes in lifestyle. The latter includes nutrition habits, approach to work, as well as enhancing the importance of social factors, interpersonal relations and mental hygiene, and thus fits well in the framework of the health transition theory. Additionally, the organisational changes in the health care and social security systems seem necessary, as well as the further development of the institutions of the civil society (Tabeau et al. 1998). This observation is important for setting up the long-term mortality scenarios for the countries of Central and Eastern Europe.

A comparison of life expectancy developments in selected countries, chosen as typical for the different parts of Europe are presented in Figure 3. The countries shown on the graphs are: Sweden (Northern Europe), Italy (Southern Europe), Austria (Western Europe), Poland (Central Europe), Estonia (Baltic State) and Bulgaria (South-Eastern Europe). Additionally, a trend of the maximum e_0 in the developed countries value is presented. For males the maximum was observed either for one of the Scandinavian countries (Sweden, Norway) or Greece until 1979 and for Japan thereafter. In the case of females, the maximum e_0 values were observed in Norway until 1981 and since then for Japan[5].

Figure 3. Observed e_0 in six European countries and the maximum e_0 value, 1960-2002



Source: Council of Europe (2003), Eurostat / NewCronos

[5] The countries, for which the maximum life expectancy is observed differ slightly from the ones quoted by Oeppen and Vaupel (2002), likely due to the other source of data used in the latter study.

3.2. Mortality scenario: towards a common European pattern?

The question of limits of human longevity has always been a very controversial issue among demographers and epidemiologists. All theoretical limits to life expectancy that were set by scientists since the late 1920s have been subsequently surpassed by the real-life developments (Oeppen and Vaupel 2002). A modern example is the study of Olshansky et al. (1990), who set the ‘average biological limit to life’, thus the ultimate life expectancy level, at 85 years and the maximum at 120 years. On the other hand, Christensen and Vaupel (1996) argued that there is no evidence of genetic limits of life expectancy around 85 years. Their explanation is that only a quarter of the variation in the length of life in the developed countries can be attributed to the genetic factors. Therefore, there is still much left to improve in terms of human lifespan from the medical, behavioural and environmental side. Moreover, as it was shown by Oeppen and Vaupel (2002), the life expectancy limit of 85 years has been already surpassed by Japanese females aged 50+ in 1996. The important conclusion presented by Oeppen and Vaupel is that in the mortality scenarios for the developed countries, there is no need for assuming any artificial ‘ceiling’ life expectancy values.

Apart from the question of possible extension of human lifespan, there is still much uncertainty left with respect to the future changes in lifestyles, as well as in the environmental and institutional settings. An attempt to predict the future stages in the health transition has been made by Martens and Huynen (2003), who set three scenarios of mortality developments on the basis of a review of studies devoted to the expectations in different areas of life (social and policy issues, economy, technology, ecology, etc.). These three scenarios are as follows (Martens and Huynen 2003: 897-899):

- In the scenario of “emerging infectious diseases”, new infectious diseases will emerge (like it happened with AIDS in the 1980s) or the old ones reappear. This would cause a global mortality increase, strengthened by enhanced mobility, human behaviour and failures of the health care systems.
- In the scenario of “medical technology”, additional environmental and lifestyle risks will be compensated by the advances in medical technology, what would lead to the ultimately stable life expectancy, assuming constant economic growth.
- In the scenario of “sustained health”, investments in the public sector will eventually lead to the decrease in importance of lifestyle-related and environment-related diseases, and the mortality differences between different countries and regions will ultimately disappear.

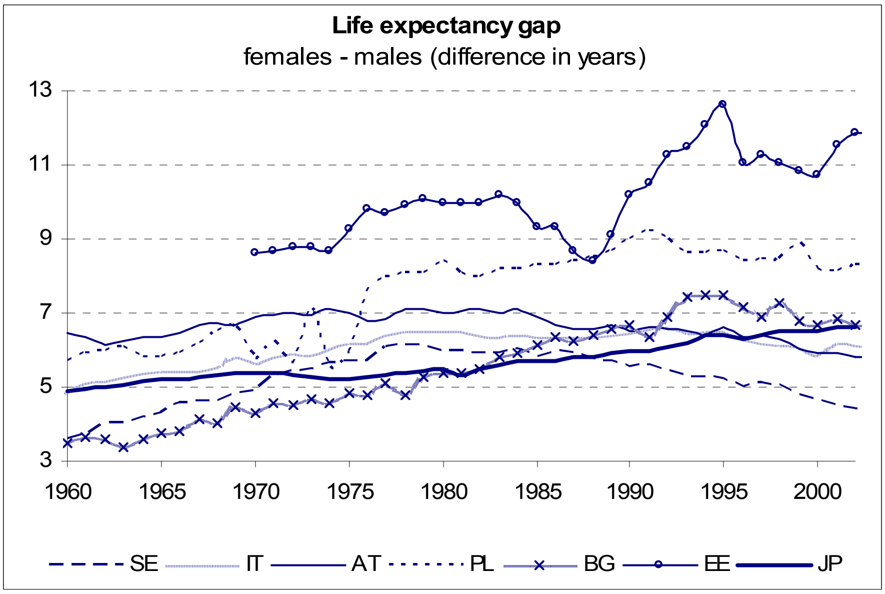
In this context, bearing in mind the historical developments of mortality in the developed countries and the remarks of Oeppen and Vaupel (2002), with a certain dose of optimism it can be reasonably assumed that the future baseline scenario of mortality developments in the regions like Europe may likely be the hybrid of all three pathways foreseen by Martens and Huynen (2003). More precisely, it would mean that although one cannot exclude the emergence of new infectious diseases, their impact on public health in the developed countries will likely be offset by technological, institutional and behavioural changes. In terms of the assumptions that would mean that the possible future evolution of mortality in the low-mortality countries including Western Europe would be more in line with the suggestions of Oeppen and Vaupel (2002) and Lee (2002) rather than of the official projections of United Nations (2003).

The countries of Central and Eastern Europe are likely to follow the path of the developed regions, although with a lag that is likely to be slowly diminishing over time. The most recent trends already indicate the upturn from the post-transformation crisis, both with respect to life expectancy, as well as to the age- and cause-of-death mortality profiles (Rychtaříková 2002, Meslé 2004a). Assuming sustained socio-economic developments in the future, one can expect both the health-related lifestyles, as well as the institutional setting, most notably the health care systems, to eventually catch up with the most advanced regions of the world.

With regard to the future life expectancy developments, it can be therefore assumed that the maximum level will continue to increase and there should be no fixed limits to it, following the argumentation of Oeppen and Vaupel (2002). For Western Europe, one can envisage a visible convergence of the trends, both to the maximum level and also within this group of countries. For Central and Eastern Europe, however, only a slow convergence towards the highest values can be reasonably assumed. This is both due to large initial disparities in comparison with most developed countries, as well as due to the social, economic and institutional drawbacks of this region, from which it will undoubtedly take many more years to recover.

Another issue that needs to be controlled in the mortality scenarios is the gender gap in life expectancy. Without going into deeper discussion, whether there is a biological lower limit to the excess male mortality, one can quote the recent findings of Luy (2004), who compared the whole German population with groups of Bavarian Catholic nuns and monks. According to Luy, although females showed similar survival patterns regardless of the group they belonged to, the life expectancy of monks was considerably higher than the one of males in the general population. The main conclusions from this study were that "improvements in men's survival conditions are lagging behind improvements among women and [the] biological factors cannot explain this development" (Luy 2004: 667). This seems to indicate that together with lifestyle changes among males there is still place for narrowing the mortality gap between genders, what was also suggested by Meslé (2004b), in line with the health transition theory. Recent trends in the life expectancy gender gap in selected European countries are presented in Figure 4.

Figure 4. Gender gap in e_0 in selected European countries and Japan, 1960-2002



Source: Council of Europe (2003), Eurostat / NewCronos

For the future, general decline of differences in life expectancy between males and females can be assumed for all the European countries, judging by the trends presented in Figure 3. Moreover, in contemporary Europe the difference in life expectancy between males and females seems to be already quite high, higher than it would be in the absence of negative behavioural factors among the male population (Luy 2004). The gap is especially wide in the Baltic States and to the smaller extent in South-Eastern Europe, where the impact of unhealthy lifestyles or unfavourable living conditions is especially strong. To achieve reduction of the gender gap in mortality, further improvements in the promotion of the healthy way of living among the male population have to be therefore assumed. The same can be envisaged for the difference in the longevity frontrunner country, Japan, yet after a short term continuation of the increasing trend of the gender gap and a period of stability at the relatively high levels. These assumptions on the gender gap need to be controlled in setting the quantitative mortality scenarios, together with the country-specific developments of the average lifespan.

3.3. Quantification of the assumptions

Mathematical modelling of human mortality has a long tradition, dating from the pioneering work of Gompertz (1825). Since then, many different models have been developed to serve as tools for explaining and forecasting mortality, authored mainly by the actuaries and demographers. Among the actuarial models, one may quote the classical Heligman-Pollard model (Heligman, Pollard 1980), as well as the Generalized Linear Model of Renshaw (1991). Among the demographic models for predicting mortality, the most important has been developed by Lee and Carter (1992). The model itself has many advantages, including simplicity of formulation and quite good *ex post* performance results (Lee and Miller 2000). Recently, Girosi and King (2004) proposed complex forecasting models incorporating the prior information, applying the theoretical framework of Bayesian statistics. Comprehensive overviews of the advances in mortality forecasting have been presented for example by Tabeau (2001), as well as by Girosi and King (2004).

Most of the mentioned models forecast the age-specific mortality rates using stochastic methods and therefore require detailed time series of input data. For the simplicity of scenario-setting, aimed to serve merely as the background for the forecasts and simulations of population and labour force developments with focus on international migration, the usage of the more advanced forecasting tools has been relinquished. We therefore allowed for more judgemental elements in the forecast in order to obtain one consistent mortality scenario for all European countries. The variable considered for the purpose of running the forecasting model is life expectancy at birth (e_0).

In order to set up life expectancy scenarios for particular countries, historical data series for the period 1960-2002 have been collected from the Council of Europe yearbook (2003: Tables 10), supplemented with the Eurostat data on life expectancy for Canada, the United States and Japan. The missing observations have been interpolated linearly. The historical series have been used to estimate the linear trends of the maximum life expectancy, following the proposition of Oeppen and Vaupel (2002). The trends for both sexes are characterised by a very good model fit, with the following characteristics:

- Males: $e_{0,t} = 0.1705\, t - 263.62$ $\quad t = 1960 \ldots 2002$
  $(0.0057) \quad (11.34)$ $\quad R^2 = 0.956, p \approx 0;$

- Females: $e_{0,t} = 0.2150\, t - 346.11$ $\quad t = 1960 \ldots 2002$
  $(0.0039) \quad (7.64)$ $\quad R^2 = 0.987, p \approx 0.$

High predicting accuracy of the linear model to the life expectancy series in the most developed countries the second half of the 20th century can be supported by the results obtained by Tuljapurkar et al. (2000), as well as Lee and Miller (2000), who used the modified methodology of Lee and Carter (1992). Therefore, in the current study, the estimated trends have been used to extrapolate maximum life expectancy until reaching the levels of 80 years for males and 85 years for females. Subsequently, the increase in maximum life expectancy was assumed to gradually slow down, thus reflecting a bit less optimism in comparison with the expectations of Oeppen and Vaupel (2002).

The linear increase of life expectancy during the first and second stages of the epidemiologic transition could be to a large extent attributed to the decline in infant and child mortality. However, given the diminishing returns from the infant mortality decline in the recent years, increasingly more life expectancy gains are due to the reduction of death rates at older ages

(Christensen and Vaupel 1996). Moreover, it has been shown that although the probability of death begins to increase after certain age, its growth is characterised by a decelerating pace (Horiuchi and Wilmoth 1998). Therefore, for the purpose of this study a simple solution is proposed, with a slight long-term reduction of forecasted life expectancy trend slopes, in order to fit the qualitative assumptions presented in Section 3.2.

In the case of males, the initial trend slope is assumed to be reduced by 20% after reaching the e_0 of 80 years. For females, after reaching the life expectancy of 85 years the following reduction pattern of the initial trend slope is proposed: by 20% for the period of seven years, by 40% for the subsequent ten years and by 60% for the remainder of the forecast horizon. This assumption is based on the empirical evidence of decelerating decrease in 85+ mortality among Western European women (Spijker 2004: 259-260). The differentiation with respect to the slope reduction between the sexes has been made, as the slow convergence of life expectancies for males and females was assumed as suggested in Section 3.2, while the initial trend slope for females greater than for the one for males would cause the exactly opposite effect.

The mortality scenario assumptions are operationalised in the following way: firstly, the following difference between life expectancy in 2002 in a given country (e_0) and the maximum one ($e_0^{(MAX)}$) is calculated: $d_{2002} = e_{0,\,2002} - e_{0,\,2002}^{(MAX)}$. In the subsequent years the difference between country-specific life expectancy and the maximum is assumed to diminish exponentially, according to the following formula:

$$d_t = d_{2002} \cdot \exp\,(c \cdot (t - 2002) / d_{2002}),$$

c being a constant equal 0.1 for males and 0.05 for females, reflecting the assumption of a slower convergence to the maximum life expectancy patterns for females. The formula assumes that the higher the initial difference between the life expectancy for a particular country and the maximum one, the slower the convergence, representing the impact of socio-economic, technological and lifestyle-related drawbacks in the health transition process.

For t = 2003 … 2052, the life expectancy forecasted for a particular country is calculated as: $e_{0,\,t} = e_{0,\,t}^{(MAX)} + d_t$. The final maximum life expectancy values for 2052 calculated in this way equal ca. 85 years for males and 90 years for females, which notably is in the former case higher and in the latter lower than the values forecasted by the UN for Japan within the same forecast horizon (83.7 and 92.5 years). The main reason of the difference is the assumption on ultimate convergence of the trends for both sexes. In all the countries, the gap between life expectancy of males and females is expected to decrease by 2052, the target gap ranging between 2.6 and 8.3 years, with the one for the maximum life expectancies equalling 5.1 years. Comparison of target life expectancies according to different projections and forecasts are presented in Table 3.

Table 3. Comparison of target e_0 assumptions for 2050: different projections/forecasts

Country	Males			Females		
	National	UN 2002	Current study	National	UN 2002	Current study
AT	82,0	80,8	**84,5**	87,0	86,6	**88,7**
BE	83,9	81,1	**84,2**	88,9	86,7	**88,2**
BG	n.a.	75,8	**79,4**	n.a.	81,6	**83,0**
CH	82,5	79,9	**84,7**	87,5	86,0	**89,6**
CZ	78,9	78,4	**82,2**	84,5	84,4	**86,1**
DE	81,1	80,6	**84,5**	86,6	86,3	**88,5**
DK	81,0	79,0	**84,1**	84,0	83,9	**86,8**
EE	75,9	75,8	**76,1**	81,4	82,7	**84,6**
ES	77,7	81,0	**84,5**	85,5	87,3	**89,6**
FI	82,4	79,8	**84,1**	86,4	86,1	**88,5**
FR	84,3	80,6	**84,4**	91,0	86,3	**89,5**
GR	83,0	79,7	**84,4**	86,9	84,9	**87,9**
HU	77,0	76,0	**79,0**	83,0	82,4	**84,2**
IE	*78,9*	78,9	**84,1**	*84,0*	84,0	**87,0**
IT	81,4	79,5	**84,7**	88,1	85,6	**89,6**
LT	72,5	76,0	**77,0**	83,4	82,9	**84,9**
LU	n.a.	80,8	**84,1**	n.a.	86,5	**88,5**
LV	n.a.	75,4	**75,7**	n.a.	82,6	**83,5**
NL	79,6	79,6	**84,6**	82,6	84,9	**87,9**
NO	84,2	80,8	**84,7**	88,1	86,7	**88,5**
PL	*80,6*	76,9	**80,8**	*85,4*	83,3	**86,0**
PT	79,0	77,9	**83,5**	84,7	84,1	**87,7**
RO	n.a.	74,4	**78,2**	n.a.	80,1	**82,3**
SE	83,6	82,1	**84,7**	86,2	87,1	**89,0**
SI	74,0	78,7	**82,7**	81,0	85,2	**87,7**
SK	77,1	76,5	**80,4**	84,0	82,7	**85,2**
UK	81,0	80,6	**84,6**	85,0	85,6	**87,7**

Italics – extrapolated target values for earlier years, n.a. – not available.

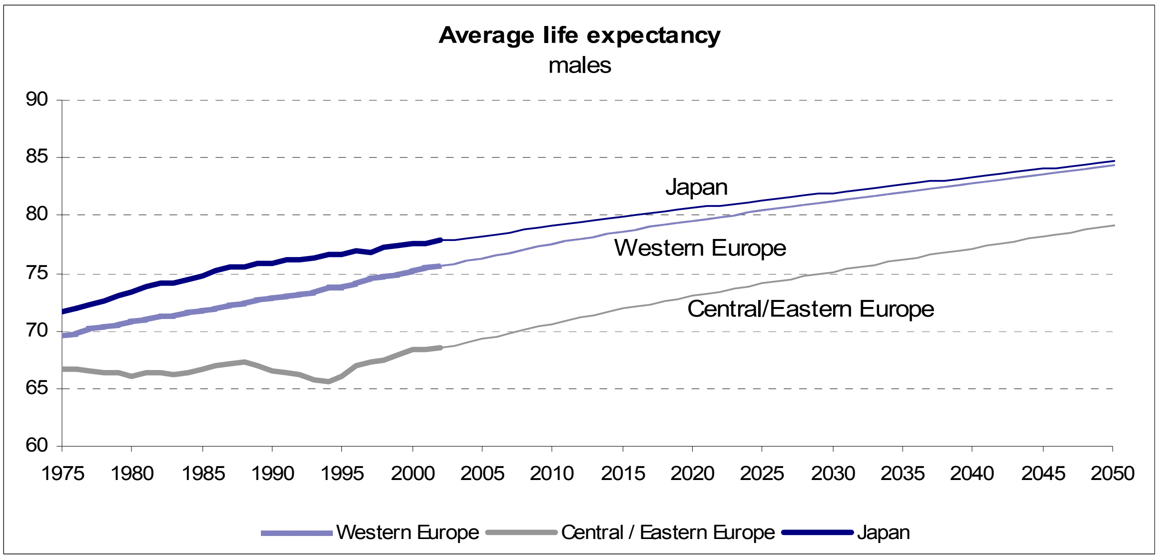
Sources: United Nations (2003), information on the national forecasts from the websites of the national statistical institutes and / or Eurostat.

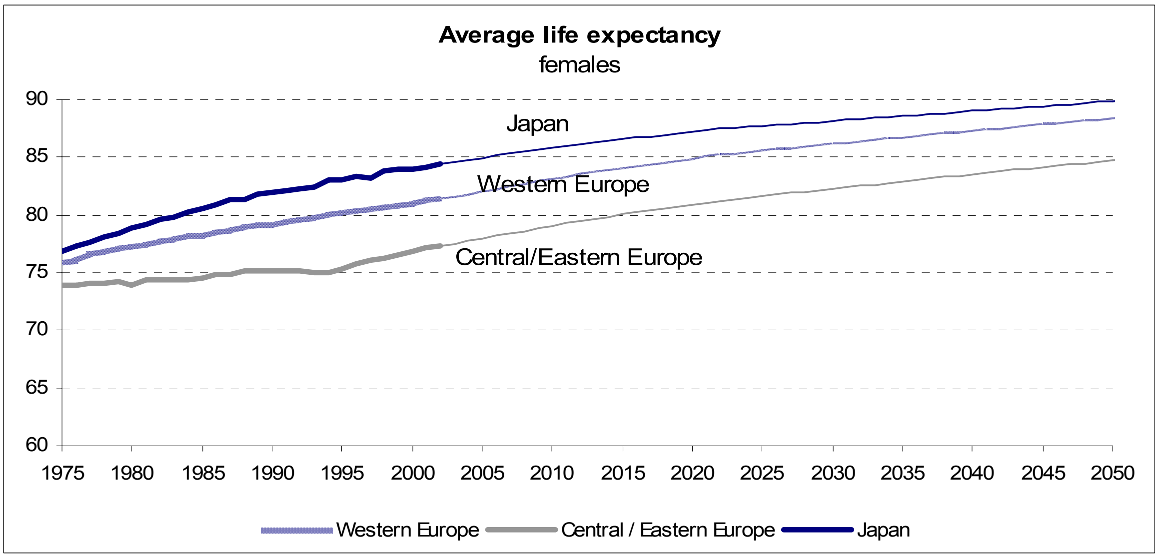
Summing up, in all the countries under study mortality improvements are assumed, resulting in an increase of life expectancy for both males and females. It is assumed, that mortality improvements until reaching the life expectancy of 70 years for males (75 for females) can be mainly attributed to the reduction of age-specific mortality rates in the age group 0–19, including the infant mortality. Life expectancy increase from 70 to 80 years for males (from 75 to 85 for females) is assumed to result from mortality reduction in all age groups. Above the levels of life expectancy at birth of 80 years for males and 85 for females, the improvements are assumed to result from decreasing mortality of the adult population (i.e. persons aged 20+), with the increasing contribution of life expectancy gains among the elderly population (cf. Christensen and Vaupel 1996). The outcome of the quantification of the forecast assumptions, i.e. the expected trajectories of life expectancy at birth for males and females, as well as the gap between them, are presented in Figure 5. For the simplicity of the picture, only the arithmetic averages of e_0 for Western Europe, Central and Eastern Europe, as well as for Japan (assumed maximum) are shown on the graphs.

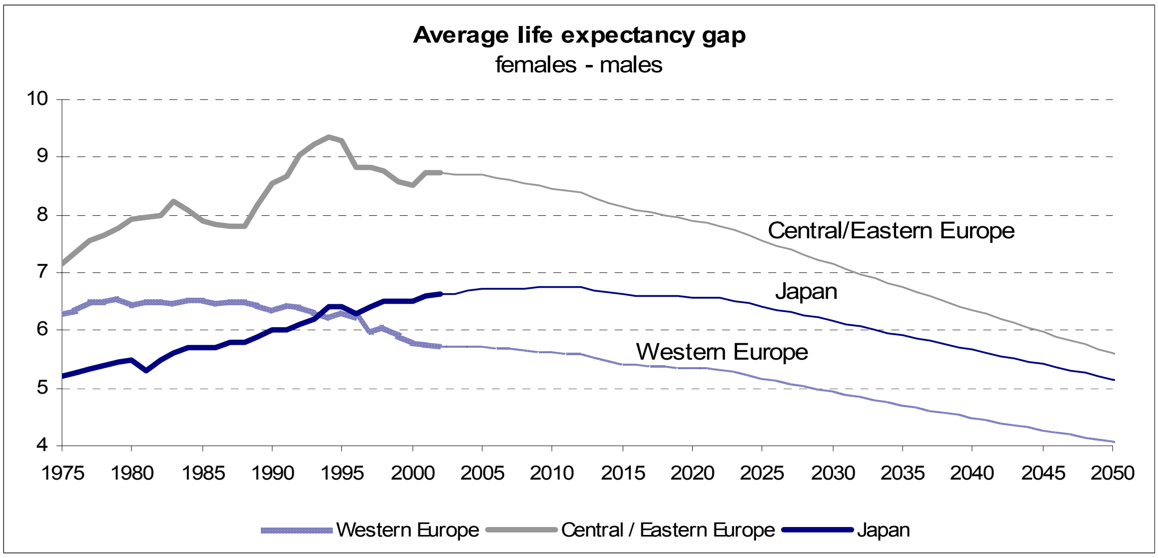
From Figure 5 it can be seen that although for the next 50 years a gradual increase of life expectancy for both sexes in all countries under study is expected, the East-West mortality gap is likely to prevail, albeit narrowing, throughout the forecast period. Judging by the slow mortality changes in the countries of Central and Eastern Europe in the period 1995-2002, filling the gap towards the Western countries can not be reasonably assumed to be an easy and immediate process. Therefore, the process of convergence of all European countries towards a common mortality pattern is expected to last longer than the 50-years forecast period. Nonetheless, the countries of Western Europe themselves are assumed to converge much faster to the levels close to the maximum life expectancy assumed for Japan, what can be especially anticipated in the case of males.

The comparison of assumptions of different forecasts shown in Table 3 suggests that the presented mortality scenario assumes slightly more optimism with regard to the future life expectancy improvements than it is the case with the national and international forecasts. This would be very much in line with the argumentation of Oeppen and Vaupel (2002), who showed that the majority of earlier forecasts underestimated life expectancy developments, which in reality proved to be higher than forecasted. Still, the maximum life expectancy values obtained in the current study for the end of the forecast horizon are slightly more conservative than the ones proposed by Oeppen and Vaupel (2002) or Tuljapurkar et al. (2000). Nevertheless, life expectancy patterns for various countries of Europe, presented in this study, are to a larger extent converging to a common model by the end of the forecast horizon than for example the ones prepared by the United Nations (2003). This follows the supposed further advances in the health transition process in all countries in Europe, taking into the account also the relation between mortality decline and the socio-economic development. With respect to the lifestyle changes, it can be envisaged that in the global modern era, values and norms influencing the health-related behaviour will spread relatively quickly among all European countries. Therefore, the cultural and behavioural factors are expected to lose significance in determining the East-West mortality gap much earlier than the ones related to the institutional and economic setting. Nevertheless, also the latter factors are implicitly assumed to ultimately converge to the common levels for the whole continent, again reflecting certain optimism with respect to the future developments of the societies.

Figure 5. Observed and forecasted e_0 values in Europe (arithmetic averages) and Japan







Sources: Council of Europe (2003), Eurostat / NewCronos, own computations.

4. Summary and conclusions

The long-term fertility and mortality scenarios for Europe presented in this paper have been developed with the aim of serving merely as an input for the forecasts and simulations of population and labour force resources in Europe for the coming half of the century. Focus of the whole research project, within the framework of which the scenarios were developed, was on the role of international migration as a component of population dynamics. For this reason, the assumptions on fertility and mortality presented in this paper are treated as the background picture. A complex study of demographic developments should additionally include several variants of future fertility and mortality scenarios, in order to incorporate uncertainty into the forecasts, as well as a detailed analysis of changes in the age and cohort patterns of the phenomena under study. In the current analysis these, otherwise important, additions have been omitted on purpose, in order to keep the demographic picture simple. Another reason for doing so, was to focus on the role of international migration in the subsequent parts of the research, for which the scenarios have been prepared. This issue, however, remains beyond the scope of the current paper.

Summing up the results presented in this study: the fertility scenarios assume a short-term continuation of past trends and a long-term slight increase of the total fertility rates. The target values for 2052 reflect to a large extent the current diversity of childbearing patterns across Europe, as well as the level of advancement of particular countries in the process of the second demographic transition. Thus, the assumed target TFR values vary significantly, from 1.4 for Bulgaria and Romania, and 1.5 for Central Europe, Southern Europe, as well as the German-speaking countries, to 1.8 – 1.9 for the wealthy countries of Northern Europe. Thus, there is a visible lack of convergence of fertility patterns reflected in the assumptions.

With regard to the mortality scenarios, the highest life expectancy values for the end of the forecast horizon are expected for the Western European countries, in particular for Switzerland, Italy, Spain, France, Scandinavian countries, Austria, Germany and the Benelux. The forecasted values for these countries are very close to the maximum ones assumed for 2052 for Japan, equalling ca. 85 years for males and 90 years for females. Among the European countries under study, the lowest values are envisaged for the Baltic States, Bulgaria and Romania. The minimum life expectancy for males, forecasted for 2052, is the one for Estonia (76 years), while for females – the one for Romania (80 years).

When interpreting the presented scenarios it is worth considering that within such a long forecast horizon, unpredictable changes of the factors underlying fertility and mortality phenomena may occur. In such cases, the future trajectories of demographic variables can be different from the ones presented in this paper. Hence, the proposed scenarios should be seen as the most likely future development patterns, assuming rather stable fertility and mortality paths and no revolutionary changes in the coming 50 years.

To conclude, the demographic differences between different parts of Europe are likely to slightly diminish, but by no means completely disappear within the timeframe of the analysis. Patterns for Northern Europe, with the highest fertility levels and longest life expectancy among the countries under study, will no doubt differ from the ones for Central and Eastern Europe, lagging behind not only in economic, but also in social and epidemiologic terms. Nevertheless, all European countries are certainly going to face problems resulting from the population ageing, some to a smaller and some to a greater extent. As mortality patterns are assumed to converge slowly in all countries under study, this is mainly the heterogeneity of fertility that is underlying the differences in the magnitude of population ageing. It can be expected that the current economic and cultural differences between countries, as well as the legacy of the past, visible especially in the case of post-socialist countries, are going to shape the diversity of demographic patterns in Europe for many more years to come.

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