

**UNITED NATIONS STATISTICAL COMMISSION  
and ECONOMIC COMMISSION FOR EUROPE**

**STATISTICAL OFFICE OF THE  
EUROPEAN UNION (EUROSTAT)**

**CONFERENCE OF EUROPEAN STATISTICIANS**

Joint Eurostat/UNECE Work Session on Demographic Projections  
(28-30 April 2010, Lisbon, Portugal)

**REPORT OF THE WORK SESSION  
ON DEMOGRAPHIC PROJECTIONS**

**I. INTRODUCTION**

**A. Participation**

1. The joint UNECE/Eurostat Work Session on Demographic Projections was held in Lisbon, Portugal, on 28-30 April 2010 at the invitation of Statistics Portugal. It was attended by participants from national statistical organisations, demographic research institutes, universities, and other institutions representing the following countries: Albania, Austria, Bosnia and Herzegovina, Canada, Cape Verde, Croatia, Czech Republic, Denmark, Finland, Germany, Israel, Italy, Japan, Latvia, Luxembourg, Montenegro, Norway, Poland, Portugal, Russian Federation, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey, United Kingdom and United States of America. The European Commission was represented by Eurostat, the Directorate General for Regional Policy and the Directorate General for Economic and Financial Affairs. The Organisation for Economic Cooperation and Development (OECD), the United Nations Population Division, the International Institute for Applied Systems Analysis (IIASA) and the Université catholique de Louvain (Belgium) were also represented.

**B. Organization of the meeting**

2. Ms. Alda de Caetano Carvalho, President of Statistics Portugal, Ms. Inna Šteinbuka, Director of Social and Information Society Statistics of Eurostat, and Paolo Valente, UNECE Statistical Division opened the meeting and welcomed the participants.

3. The agenda of the work session consisted of the following substantive topics:

- (a) Challenges and use of population projections;
- (b) Constructing assumptions for mortality: data, methods and analysis;
- (c) Constructing assumptions for fertility: data, methods and analysis;
- (d) Forecasting demographic components: fertility;
- (e) Forecasting demographic components: mortality;
- (f) Constructing assumptions for migration: data, methods and analysis;
- (g) Forecasting demographic components: migration;
- (h) Small population and sub-national population projections;
- (i) Beyond population projections by age and sex;
- (j) Stochastic techniques for demographic projections;
- (k) Stochastic national demographic projections;
- (l) Round-table discussion on "Is it necessary, and to what extent, to incorporate "feedback mechanisms" in demographic projections, in particular in population projections?"

4. Ms. Victoria Velkoff (United States) was elected as Chair of the meeting. The following participants acted as session organizers: Ms. Vanda Cunha (Portugal) for topic (a), Ms. Graziella Caselli (Italy) for topics (b) and (e), Ms. Maria Filomena Mendes (Portugal) for topics (c), (d) and (l), Mr. Michel Poulain (Université catholique de Louvain, Belgium) for topics (f) and (g), Mr. Joao Peixoto (Portugal) for topic (h), Mr. Jorge Miguel Bravo for topic (i), Ms. Jutta Gampe (Germany) for topics (j) and (k).

5. Keynote lectures were given by Mr. Ronald Hall, Director of the Directorate General for Regional Policy of the European Commission, on “Regional population change and cohesion policy”, and Ms. Maria Filomena Mendes, President of the Executive Board of the Portuguese Demographic Association, on “Demographic changes, demographic projections”.

## **II. SUMMARY OF DISCUSSION OF SUBSTANTIVE TOPICS**

### **A. Challenges and use of population projections**

6. Spain presented the strategy developed to monitor the important demographic changes taking place in the country. It is based on the preparation of monthly population nowcasts, annual short-term and triennial long-term population projections.

7. The Directorate General for Economic and Financial Affairs of the European Commission presented the main economic and budgetary implications of demographic changes in the long term in the European Union (EU) as a whole and at Member State level, based on Eurostat projections EUROPOP2008 and the 2009 Ageing Report. The policy options that could mitigate the effects of these changes were also addressed.

8. Portugal presented the main characteristics of the dynamics of the Portuguese population and discussed how the future evolution of the population structure by age, sex, and educational level could affect the average health status of the population.

9. In the discussion, it was noted that the average life-span of the population is changing, and this has various implications for population projections. On average, people start to work and have children later than in the past, and they are also in better health conditions at old ages. Therefore, it could be assumed that the retirement age may increase in the future from 65 to 70-75, which would have very important implications for population projections.

10. The issue of convergence or divergence of demographic behaviours in the different countries was also discussed. This issue has important methodological implications but is also politically sensitive, and is expected to be a topic of discussion for the next round of EU projections.

11. The participants discussed the need to conduct sensitivity tests for different assumptions and scenarios concerning the various components of the projections, such as mortality, fertility, migration, but also health care provision or other relevant factors.

### **B. Constructing assumptions for mortality: data, methods and analysis**

12. Sweden presented a method for mortality projections where rates are expressed as a function of age, period and cohort. This method takes advantage of the long time series of mortality rates available in Sweden from year 1861, which are used from both a period and a cohort perspective.

13. The Italian study looked at increasing longevity and decreasing gender mortality differentials from a cohort perspective, concluding that in Italy men seem to imitate female positive mortality models, while women do not seem to imitate the negative male behaviours, contrarily to what is happening in other countries.

14. Spain presented the results of studies conducted on advanced methods for computing life tables, at the national and sub-national level. At the national level, a method using observational data from on the date of occurrence of recorded death seems to be the most accurate. At the regional level a method that assumes uniform distribution of deaths over the year at each age within a given generation seems to be the most suitable.

15. The Portuguese presentation focused on the estimation of life expectancy for small population areas. The use of graduation methods in smoothing mortality data was presented as a feasible solution. The results of empirical testing using data from the Lisbon region show that the methodology is robust and can be used to construct life tables and estimate life expectancy.

16. In the discussion, reference was made to different results that may emerge when considering the life expectancy at birth or at adult ages like 50 or 60. Differences in life expectancy at 50 years could provide a lot of information in many countries. In Italy, no significant differences can be found when considering life expectancy at birth, 50 or 60 years of age.

17. It was noted that considering mortality for period and cohort at the same time, as in the approach presented by Sweden, may lead to result more complex to analyse. Italy favoured a linear approach based on cohorts, and it was suggested to consider also a non-linear approach.

18. The role of mortality at very old ages was discussed. Sweden reported that the mortality at old ages, above 80, do not affect significantly the projections. In Spain this is considered as a relevant issue given that the number of centenarians in the country has tripled since 1990.

19. Migration may affect mortality projections, especially in countries that experienced significant migrations flows. In Spain, for instance, the important immigration experienced influence exposure to risk and probability of dying. Projection models normally assume closed populations, and it could be interesting to look at the effect of migration actually experienced on the results.

20. In order to analyse mortality in small populations – around 10'000 – standard methods are not suitable and may lead to significant over-estimation of mortality. According to the experience of Portugal, for small populations parametric methods are preferable or relational models. Other possible solutions include using abridged life-tables (5 or 10 year age intervals) or aggregate data for long periods (i.e. 3 or 5 years).

### **C. Constructing assumptions for fertility: data, methods and analysis**

21. Sweden presented a study of recent trends in childlessness, which provides evidence against the assumption that childlessness will continue to increase in the future as a result of childbearing postponement. Decreasing levels of childlessness have been observed over the last few years in Sweden and the analysis of this recent trend may be interesting for other countries, as Sweden is often considered as a forerunner in demographic behaviour.

22. The presentation by Eurostat addressed the issue of fertility convergence across the Member States of the EU. A new indicator of relative convergence was used to assess the existence of convergence within the whole EU and the impact of the successive enlargements on the fertility trends in the new Member States.

23. Japan presented an analysis of the upturn in fertility observed over the last few years, after the Total Fertility Rate (TFR) reached its record low level at 1.26 in 2005. Similar trends have been observed in other countries with lowest-low fertility, e.g. Italy, Spain, some Central and Eastern European countries and other East Asian countries. In Japan, the recent upturn seems to be mainly due to an increase in late fertility.

24. In the discussion, it was noted that the analysis of fertility convergence within the EU was based on period data, rather than cohort data, mainly because of better availability of the first type of data. It would, however, be useful to expand the analysis to cohort fertility. Further studies are also planned to cover mortality convergence.

25. The impact of education level on fertility patterns was also discussed. Access to child-care may be an important factor to explain childlessness, but not in a country such as Sweden where everyone has access to a highly-developed child-care system. The possibility to get access to infecundity treatment is another factor that strongly depends on education level. In Sweden, it has been shown that the highly educated have better access to IVF treatments. Women's intention to have children according to education level should also be considered in fertility studies, as women with higher education want to have more children.

26. The importance of the tempo effect in explaining the fertility upturn in lowest-low fertility countries was highlighted, but it was noted that this effect may change in the future.

#### **D. Forecasting demographic components: fertility**

27. The UNPD presented the initial results of the probabilistic population projections carried out for the first time for all countries of the world. The main advantage of using a probabilistic model, rather than the deterministic approach used in the World Population Prospects, is that the uncertainty is derived from estimates based on empirical data, not expert opinion of uncertainty. But a major problem remains: no theory or model has yet been developed for future fertility trends in the countries that have reached sub-replacement fertility, which will soon represent more than 50% of the world population.

28. Japan showed how fertility projections can be used to analyse the period effect in past and current fertility trends.

29. Portugal presented an attempt to forecast births in Portugal using ARIMA models with regression variables allowing for seasonal effects. The number of marriages was used as regression factor, but it was noted that the number of births occurring outside marriages should also be taken into account.

30. The question of the advantage of using a seasonal model to forecast fertility was raised. There is a clear link between the seasonal patterns observed in the number of births and in the number of marriages. However, the model could be improved by using better data.

31. It was noted that the Bayesian model applied in the UN probabilistic population projections uses the whole range of empirical data available around the world. The fertility transition is well captured, but not what is outside the transition.

#### **E. Forecasting demographic components: mortality**

32. Japan presented the methodology adopted for the mortality projections in the country. The Lee-Carter (LC) model and a Linear Difference (LD) model were compared to examine whether it is more plausible to understand the recent Japanese mortality as a decline or shift. The results suggested that LD's performance is better than over LC's, and that shift is more strongly supported as recognition of the recent mortality improvement in Japan than decline.

33. The presentation by the University of Evora (Portugal) focused on the widely used Lee-Carter method for projecting mortality, and in particular on the asymptotic behaviour of mortality rates projected, considered unsatisfactory. A variant of the model was presented, in which mortality projections are bounded by a limit life table to which future mortality improvements converge over time.

34. A second presentation by the University of Evora and Statistics Portugal described the methodology used in the projection of the component mortality within the 2008 Portuguese Population Projections exercise. The methodology is based on a combination of extrapolative and expert-opinion based methods.

35. In the discussion, attention was paid to setting targets for future evolution of mortality in terms of life expectancy. Some participants observed that setting fixed targets is difficult and may limit the possibility of conducting sensibility testing, and suggested that dynamics targets could be considered. In Japan, no targets are set, but the projections are based on an extrapolation of the current trends.

36. It was noted that mortality improvements normally vary across different ages, and in general larger improvements can be expected at the ages where mortality is far from what can be considered the limits.

37. With regard to the mortality projections in Portugal, it was noted that the method adopted to smooth the estimates at older ages seems to result in an acceleration of mortality after age 80, and that alternative smoothing procedures could be adopted.

#### **F. Constructing assumptions for migration: data, methods and analysis**

38. The presentation discussed international migration data needed for national population projections, focussing on what data should be used and issues related to data availability, reliability and comparability. The effects on time series of changes in administrative rules or the data collection and production process were also discussed.

39. In the discussion, the variable to be used to identify migrants was discussed. The presentation recommended the use of citizenship, which is the most policy-relevant characteristic. However, some countries may prefer to choose other variables depending on the national context. For instance, in Norway the country of birth is considered preferable to the citizenship.

40. The effect of regularizations on time series was also discussed. It was noted that when regularizations are included in immigration figures it affect significantly the time series. In such cases it would be recommended to conduct a backward redistribution in order to smooth the time series.

#### **G. Forecasting demographic components: migration**

41. The presentation by the University of Southampton (United Kingdom) focused on the uncertainty of international migration predictions and their consequences for population projections. The limits of predictions were discussed, from the point of view of forecast users, and an interactive approach was proposed, based on an increased dialogue between forecasters and users.

42. Israel presented the work conducted to estimate the expected immigration of Jewish population to the country within the next decades, including size of flows, countries of origin, and possible demographic implications. For this an estimation of the Jewish population living abroad is produced. Future immigration to Israel is difficult to predict also because it will be largely affected by political and economic developments in Israel and the sending countries.

43. The presentation by Statistics Sweden described a model developed to estimate return immigration of Swedish-born persons for the projections “The Future Population of Sweden 2009-2060”. Information on immigration and emigration of Swedish-born persons for 1851-2007 has been used to estimate the population of Swedish-born persons abroad and its evolution. In the forecasting model, re-immigration of Swedish-born persons is based on the projection of the number of Swedish-born living abroad, combined with information on emigration flows of Swedish-born persons considering that the best predictor is the size of the emigration flow three years earlier.

44. In the Portuguese study, a Multi-Agent System is used to simulate social networks of migrants and analyse the impact of the structure of these networks in the flow of migrants. The model proposed uses information on immigrants in the United States extracted from the UPIMS database, focusing on selected countries of origin and variables. The study concluded that the agents that stay in the U.S. (and do not go away to their country of origin), have network connections that are weaker than those of other agents.

45. Norway presented a forecast of migration flows to and from the country made using an econometric model. This model estimates net immigration flows to Norway from the EEA as a function of the unemployment rate in Norway and the income level in the country relative to the average of OECD countries, adjusted for purchasing power differences. The estimation yields stable parameters and these are consequently used to forecast net immigration to Norway, based on forecasts of unemployment and level and relative income.

46. In the discussion, several aspects of the particular situation of Israel compared to other countries were touched. Restricting the analysis of immigration to the Jewish population depend on the fact that in principle only Jewish people can become permanent residents in the country. Future migration trends depend in this country (even more than in other countries) on the policies that will be adopted in various fields. For instance, in the 1990s the policy of accepting immigrants from countries of the former Soviet Union resulted in one million of immigrants in a relatively short period, and this was quite unexpected.

47. With regard to the migration estimates in Sweden, it was noted that Statistics Sweden produces projections for the officially registered population. Persons who live the country without de-registering (an issue that is common to virtually all countries) would not be reflected in these statistics. Even the best register-based statistical systems are not perfect, and include some errors.

#### **H. Small population and sub-national population projections**

48. The presentation by Slovakia argued that more attention should be given to sub-national forecasts within the EU, in view of the large regional disparities still observed within most countries. The integration of geographical approaches in regional projection models would greatly improve the quality of regional population forecasts.

49. The presentation by Portugal discussed the methodological challenges related to forecasting future population trends in small island states. Cape Verde, with less than half a million inhabitants living in 10 islands, was used as a case study presenting different population projections at national and regional (island) levels.

50. Austria presented the population projections carried out for 124 regions below NUTS-3 level. The results showed that Vienna should have the youngest population in the future due to positive net migration.

51. Spain presented the new population projections for Andalusia, its largest region in population size (8 million inhabitants). In view of the increasing importance of immigration, the place of birth has been introduced in the forecasting model. The results showed that the increase of the foreign-born population is likely to continue in the future, but the ageing process will also affect the immigrant population.

52. The issue of regional convergence or divergence was discussed. In a convergence scenario, the uncertainty lies in the level of TFR that should be reached by all regions: below replacement level (e.g. 1.6) or close to replacement level (e.g. 2.0) following the recent trends in Nordic countries? As in other European countries and regions, the fertility patterns in Andalusia are showing signs of convergence between the foreign-born and the population born in Spain.

53. It would be interesting to distinguish between first and second immigrant generations in the population projections for Andalusia. This will be done when the data are available.

54. It was noted that the population projections for Andalusia (carried out by the Statistical Institute of Andalusia) are completely independent from the national projections for Spain (carried out by the National Statistical Institute). The results are, however, very similar. The availability of population projections produced by many different organisations, e.g. UNPD, Eurostat, the national and regional statistical institutes, may be confusing for the users. Which results should be used? It was suggested that the users should select the projection and assumptions that best fit their needs.

55. The impact of the population age structure on future migration trends was discussed. Cape Verde has a young population and a very important diaspora, which means that the population projections should take into account the effect of the young age structure on future emigration.

## **I. Beyond population projections by age and sex**

56. The presentation by the IIASA examined to what extent the religiosity (i.e. religious intensity) of a population can affect its fertility patterns, population size and age structure. Cohort-component projections by religious affiliation and religious intensity were carried out for Austria, Germany and Spain. The main outcome is an increasing polarization, with growing numbers of both highly religious and secular persons.

57. Canada presented the Demosim micro-simulation model that allows to project a large number of characteristics, e.g. place of residence, generation status, place of birth, religious denomination, visible minority group, mother tongue, highest level of schooling, labour force participation, etc. The ethno-cultural diversity of the population is likely to increase in the future, in particular within the Canadian-born population, and to remain concentrated geographically.

58. Latvia presented forecasts of future student enrolment in higher education. Using the enrolment ratio method, three alternative scenarios were developed, which all project falling enrolment in the next 10 years with a decrease of 18-38% in the number of students. These results should lead to informed policy decisions, as they question the future sustainability of the very large number of higher education institutions (65 for 4 million inhabitants).

59. The presentation by the United States Census Bureau discussed the importance of race and ethnicity for the development of assumptions in their population projections and examined the impact of net international migration. With its younger age structure and higher fertility, the Hispanic population is likely to increase in the future, irrespective of immigration levels.

60. The correlation between religiosity and age was discussed. The IIASA study considers the effect of religious transition only for teenagers and young adults (15-29 years old), as empirical data and research have shown that transitions are most likely to occur in this age group.

61. The concepts of race and ethnicity in the United States were also discussed. The term "Hispanic" refers to persons who trace their origin or descent to Mexico, Puerto Rico, Cuba, Central and South America, and other Spanish cultures. The Hispanic population can be of any race. The U.S. Census Bureau has several experimental panels testing different ways of collecting information on race and Hispanic origin on the 2010 Census.

62. The new approaches to population forecasting presented and discussed in this session were considered interesting and innovative. However, there are a number of drawbacks in using more complicated projection models, including the possible lack of data availability and the need to make assumptions about future trends of non-demographic characteristics such as religiosity.

#### **J. Stochastic techniques for demographic projections**

63. The presentation by the University of Rome and Eurostat focused on the quantification of uncertainty in population forecasting. A mixed approach was presented which integrates deterministic projections within a stochastic framework, adopting a micro-simulation approach.

64. The Max Planck Institute for Demographic Research presented a stochastic mate-matching algorithm for continuous-time micro-simulation. The algorithm was tested using data on fertility and marriage behaviour of the contemporary Netherlands. The results were presented, and possible developments of the algorithm were discussed.

65. The University of Southampton presented an application of Bayesian time series models to obtain future population estimates with uncertainty for England and Wales. The advantages of predictive distributions from Bayesian forecasting models over those obtained using more traditional stochastic models were also discussed.

66. A second presentation by the Max Planck Institute was dedicated to an application of the MicMac-Software for population forecasting. The various steps for producing the projections were presented in detail, using as example data for Italy from the 2003 Family and Fertility survey and the EuroPop2004 projections.

67. In the discussion, the question was raised whether micro-simulation could also be used to model situations where an unbalanced sex-ratio among individuals of marriageable age (typically a higher number of males) would lead to an increase in marriage-related immigration.

68. It was also suggested that approaches used in organisational studies (firm collaboration or merges) could be useful to model compatibility measures of individuals in a marriage market.

69. The importance of incorporating expert opinions as prior information in a fully Bayesian approach was stressed. The proper translation of such expert knowledge into prior distributions for the parameters of the projection model was emphasized as an important research topic.

70. In the study of future health trajectories and their impact on mortality, it is of importance to investigate whether the sequence of health states or also the duration of the different states has an impact. It was discussed under which assumptions it is possible to use currently available micro-simulation tools to study such questions.

#### **K. Stochastic national demographic projections**

71. The Canadian study used a micro-simulation model to evaluate the impact of immigration and ethno-cultural diversity on the future composition of the Canadian labour force. The results were presented in terms of future labour force population, participation rates, proportion of immigrants in the labour force and other indicators.

72. The United Kingdom Office for National Statistics presented the provisional results of a stochastic forecasting model being developed for the United Kingdom. Uncertainty about future demographic behaviour is taken into account by expressing fertility, mortality and migration assumptions in terms of their assumed probability distributions. Three approaches for determining the probability distributions have been used.

73. In the discussion the issue was raised in how far demographic change will show feedback on the labour force participation rates in the different ethno-cultural groups. In particular, the impact of a rise in retirement age due to population aging was discussed. Also it was discussed in how far the projected increase of people,

who will hold at least a Bachelor degree, will be matched by a corresponding transformation of the labour market.

74. The question of subgroup projections for the United Kingdom was discussed. Even though not incorporated in the current presentation it is planned for the future. The correlation structure between projections of subgroups will need particular attention.

#### **L. Round table discussion on “Is it necessary, and to what extent, to incorporate "feedback mechanisms" in demographic projections, in particular in population projections?”**

75. In general, all panellists agreed that feedback mechanisms should be incorporated in demographic projections. This would provide a way to use existing knowledge and expertise from different fields related to demographic projections.

76. Feedback mechanisms are often already incorporated in population projection models, but this could be done more explicitly. For instance, the feedback effect of immigration (particularly from countries outside the European Union) on fertility and mortality should be taken into account in population projections. This would result in combining the fertility, mortality and migration components in a dynamic way.

77. Concerning the mechanisms that determine the evolution of mortality, lifestyles (i.e. smoking) , health care, and prevention are important. However, the population structure by education and social class is also important, and represents one of the factors behind the increase in life expectancy experienced in many countries.

78. In some cases there is a need for research and further knowledge about feedback mechanisms, like for the impact of the possible increase in retirement age. There is a need to increase the contribution from experts, in particular non-demographers, to the projection exercises. It was also noted that when feedback mechanisms are incorporated in population projections, the end results may be quite different from the initial expectations.

### **III. CONCLUSIONS**

79. The participants recommended that the next meeting take place in three years time (Spring 2013) to discuss the following topics:

- (a) Forecasting demographic components: Mortality (assumptions and methods);
- (b) Forecasting demographic components: Fertility (assumptions and methods);
- (c) Forecasting demographic components: Migration (assumptions and methods);
- (d) Small population and sub-national population projections;
- (e) Beyond population projections by age and sex;
- (f) Stochastic techniques for demographic projections;
- (g) The role of users of population projections;
- (h) New approaches for forecasting components of projections, including behavioural models;
- (i) Data quality;
- (j) Micro-simulations.

80. The participants expressed their great appreciation to Statistics Portugal for hosting this meeting and providing excellent facilities for their work.

### **IV. FURTHER INFORMATION**

81. All background documents and presentations for the meeting are available on the website of the UNECE Statistical Division.

### **V. ADOPTION OF THE REPORT**

82. The present report of the meeting was adopted during the closing session.