Stochastic population forecast of Ireland: 2007-2057

Preliminary version

Abramowska-Kmon Anita
Warsaw School of Economics

Romanini Agnès
Università di Bari

Różańska Joanna
Vrije Universiteit Brussel

Steichen Elsa
Institut National d'Etudes Démographiques (INED) - Centre Maurice Halbwachs (CMH)

Abstract

This paper presents a stochastic population forecast of Ireland for the next fifty years, taking into account the great economic and demographic changes of the last decades. During the 1990s, Ireland has shown outstanding economic performances, attracting migrants in an unprecedented manner, especially after 2004. At the same time, the exceptional Irish fertility levelled off at 1.9 child per women and life expectancy rose steadily. Thus, uncertainty in future projection is high. Therefore, a stochastic population forecast will be conducted using cohort-component methods and deterministic jump-off population. The advantage of such forecast is that it produces probabilistic prediction intervals. The results show that the population will reach 7.6 millions in 2057, with a 75% growth and considerable migration effects during this period, a situation never faced by Ireland. Furthermore, population ageing will be a major challenge since the share of the elderly in total population will more than double.

Keywords: stochastic forecast, Ireland, old-age dependency ratio

I. Introduction

During the past two decades Ireland has experienced unprecedented changes both in its economic and demographic patterns. As for the economy, Ireland has gone through outstanding economic performances during the 1990s, becoming the so-called "Celtic Tiger", by reinventing its economy. It has resulted in the improvement of living standard, reduced unemployment rates and even in the labour force shortage. As a consequence, Ireland has become a destination country for thousands of migrants, especially after the enlargement of the European Union, changing by this a secular past of country of emigration to an immigration one. These changes have also affected the characteristics of the population. Irish families have been persistently larger than the European average and Ireland has never experienced such a dramatic fall in fertility below the replacement level as most countries from all parts of Europe. The other remarkable feature is that once Irish TFR fell below the replacement level it remained stable afterwards at the level of about 1.9. Nevertheless, the Irish population presents the fastest rates of increase in the European Union. Life expectancy is increasing and mortality rates are still declining. Though, the biggest impact is due to continuously high levels of immigration since mid-2000s, which are not expected to fall over a few next years (CSO, 2007).

These recent changes in the demographic pattern of the population have been taken into account by the various population projection made by the Central Statistics Office (CSO) of Ireland, which until very recently underestimated the impact of immigration in their projection. However, the method used by the CSO is a deterministic one based on three different scenarios - a low, a medium and a high - and does not allow to indicate any probability related to the different scenarios. Therefore, a stochastic population forecast will be conducted in this paper to face this issue, by using cohort-component methods and a deterministic jump-off population. Indeed, the advantage of such forecast is that it allows to assess the probability of its results since we express assumptions on the three components of the forecast - mortality, fertility and migration - and give the probability distribution to these parameters (Alho and Spencer, 2005 and Alders and De Beer, 2004). Thus, we are able to evaluate forecast results and deal with uncertainty by calculating prediction intervals. Further justification and trends in other countries, other projections estimations and theories that may help to understand possible population developments have been used in this paper.

In order to conduct the forecast and assess its uncertainty, 3000 simulation rounds have been executed in the Program for Error Propagation (PEP) (Yanulevskaya and Alho, 2005) using input files with parameters obtained beforehand in the BEGIN software (Alho and Mustonen, 2003). Both programs, BEGIN and PEP are based on scaled model for error (Li, 2007).

This paper will first introduce the assumptions envisaged for the life event of the population and discuss some basic notions on population forecast related to these assumptions. Then population forecast will be presented. Finally, we will discuss its effect on population ageing using the old age dependency ratio.

II. Data and assumptions

Dealing with uncertainty required us to make assumptions on fertility, mortality and migration levels. They were prepared mostly on the basis of time-series obtained from the Central Statistical Office of Ireland (CSO) and Eurostat.

A. Jump-off population

Detailed statistics regarding the population are available from the Central Office Statistics of Ireland. Furthermore, a census has been carried out in Ireland in 2006. This is a *de facto* population as the Irish census “accounts everybody who is in the country on Census Night. On this night everybody's details are entered on a census form, including people for example staying with friends or relatives, staying in a hotel, hospital, guesthouse or on board a vessel” (CSO). According to this census, the total population was 4,239,848 persons.

Nevertheless, as the CSO does neither provide most recent data, nor the age specific net migration, the jump-off population is based on data estimation for 1st January 2007 made by Eurostat according to the *de jure* definition.

B. Fertility

In order to forecast fertility, time series of three demographic fertility indicators were analysed:

1. Total Fertility Rate (TFR) that provides the general information about the expected number of children per woman based on current fertility patterns.

2. Mean Age at Childbearing for all the birth orders to assess the advancement of postponement of births and the effect of age at birth on fertility (even though these changes have rather limited impact on the forecasted population size).

3. Age-Specific Fertility Rates (ASFRs) – to investigate possible changes in the age-distribution of mothers over time and to explore the postponement of births pattern in detail, assess its development and character; this shall help to construct assumptions for the forecast.

The data used were obtained from Eurostat and Central Statistical Office of Ireland (CSO, 2004b, 2007, 2007c). Online databases were used complementarily with Vital Events publication from 2004 and the Statistical Yearbook for 2006 published by CSO (2007c) that allows covering a period of more than fifty years, 1955-2006. In case of the mean age of mothers by single age groups, annual data are available from 1985; earlier, between 1955 and 1985 numbers are given just every five years. As for the ASFRs, data are available by 5-years age-groups for the 1955-1960 period and by single year age-groups for the subsequent years.

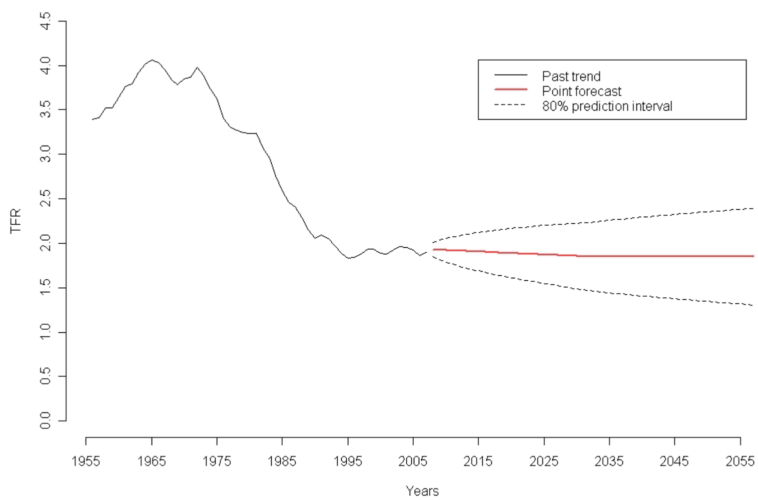
The final assumptions for the forecast were drawn upon three types of arguments: 1) based on data on Irish fertility and related topics data (marriage patterns, out-marital births, childlessness, divorce rates etc.), 2) comparable data for other countries and 3) taking into account fertility theories – to find out possible pathways for fertility in Ireland in the socio-economic and cultural context. Fertility trends in the UK and the Netherlands and to some extend France were of particular interest, though as identified by Fahey (2001) Ireland may rather follow the pathways of the US or New Zealand.

TFR in the baseline of forecast 2006 was 1.93 and the mean age of women at birth was almost 31 years old. This makes Ireland one of the fertility leaders in Europe. On the one hand, fertility seems to be very stable in Ireland: since mid-1980s TFR is around 2 with a slightly decreasing tendency and some little fluctuations in both directions (see Figure 1). On the other hand, changes in Ireland happened at a slower pace and later than in the other EU-12 countries. Indeed, TFR was 3.5-4 in the 1960s, still around 3 in the 1970s and always above 2 during the 1980s[1]. The minimum TFR of 1.84 was reached in 1995-1996 and afterwards it went up slightly and has remained since then around 1.9, at one of the highest levels in Europe.

[1] Quoted numbers come from the Central Statistical Office of Ireland (CSO) and Eurostat.

At the same time, the social climate and public policy have been changing in a direction consistent with European trends that may be associated with the Second Demographic Transition. As a consequence, legislation has been progressively modified. Contraception became accessible, right to divorce has been introduced in 1996, lone parent allowance in 1995 and topics such as abortion, new family models, and lone parenthood have become part of the social discourse, (McCarthy and Murphy-Lawless, 1997). Female employment rate has increased a lot recently reaching already the EU 2010 target of 60% in 2007 (CSO, 2007b).

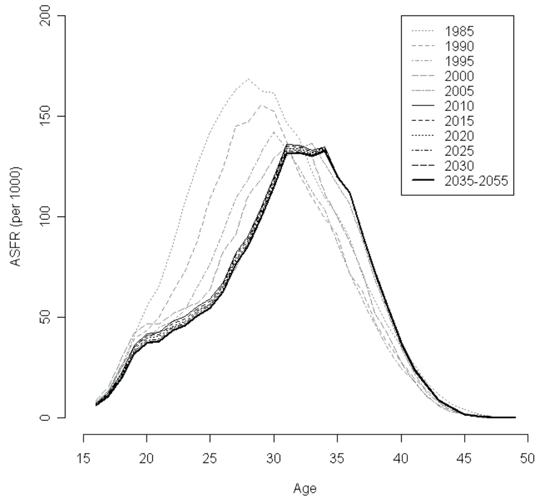
Figure 1: Period Total Fertility Rate, past and forecasted values



Source: CSO and own elaboration

Interestingly, the mean age at childbearing has been high in Ireland since long. This trend, visible across the whole 20th century, may be rooted in the Irish culture and Catholicism (Fahey, 2001). Traditionally the age at marriage was high as well. These numbers lowered in the era of baby-boom and nuclear families, in the second part of the 20th century. Simultaneously, out-marital births were very rare (3.7% in 1975) but marital fertility was high with a large proportion of fifth and higher births - one-third of all births in 1960, 15% in 1980 (Eurostat; McCarthy and Murphy-Lawless, 1997). It has changed in last decades but still differs when compared to countries with well-undergone Second Demographic Transition (Neyer, 2003, McCarthy and Murphy-Lawless, 1997).

Figure 2: Period Age Specific Fertility Rates, past and forecasted values



Source: CSO and own elaboration

As Ireland is expected to be still undergoing the transition and as the postponement may be delayed there, we made the assumption that in 25 years[2], the TFR will reach a level of 1.85 and the mean age at birth will increase slightly up to 31.5 (see Figure 2). As mentioned earlier, this is based on several conclusions drawn from the past trends, theories and experience of other countries. The direction of expected changes and their underlying factors will often work in the opposite direction leading to the limited "net" effect.

The main argumentation assumes:

a) on the one hand, factors resulting in the decrease number of births and their postponement:

- a further decline in higher order births;
- an increasing number of work-orientated women facing difficulties in coping with work and childbearing and childrearing in the situation of very limited governmental support;
- more women remaining childless (13% in 2006 according to the CSO).

b) on the other hand, factors that may preserve from the fall in TFR:

- still growing role of out-marital births;
- recuperation of already postponed births and births being postponed during the forecast time;
- traditionally strong position of family in the Irish culture;

[2] The 25 years period was chosen because the women currently entering the reproductive period will be reaching its end in 25 years.

- still higher intentions to have large families than European average - assumption based on the European Values Survey (Fahey, 2001).

It is thus difficult to predict precise fertility levels of subsequent generations, and especially since policy makers and demographers are now interested in little changes in fertility levels. In the developed countries differences in demographic profiles are now much smaller than they used to be even just 20-30 years ago. This is as well the reason why, after some efforts, it was decided not to apply ARIMA or any models that would provide the specification for the Irish fertility pathway. In fact, traditional time series models were criticised for its inadequacy for fertility trends (Alders *et al.*, 2007: 46(13)). In the "Uncertain Population of Europe" (UPE) project (2004) a more complex ARCH[3] model was used instead. It takes into account variability of TFR. This model was constructed for all the 18 countries (inc. Ireland) on the basis of data from countries that have vital statistics available back since mid-18th/end 19th century. Therefore, this European model has been applied for this forecast (default options in Begin and PEP). Recently the same model has been used for Poland (Matysiak and Nowok, 2007) and even for China (Li *et al*, 2007). Earlier similar approach was used by Alho (1998) in the forecast for Lithuania where the Finnish data provided the grounds. The other justification is that even if statistical methods are used, they need to be rooted in some assumptions.

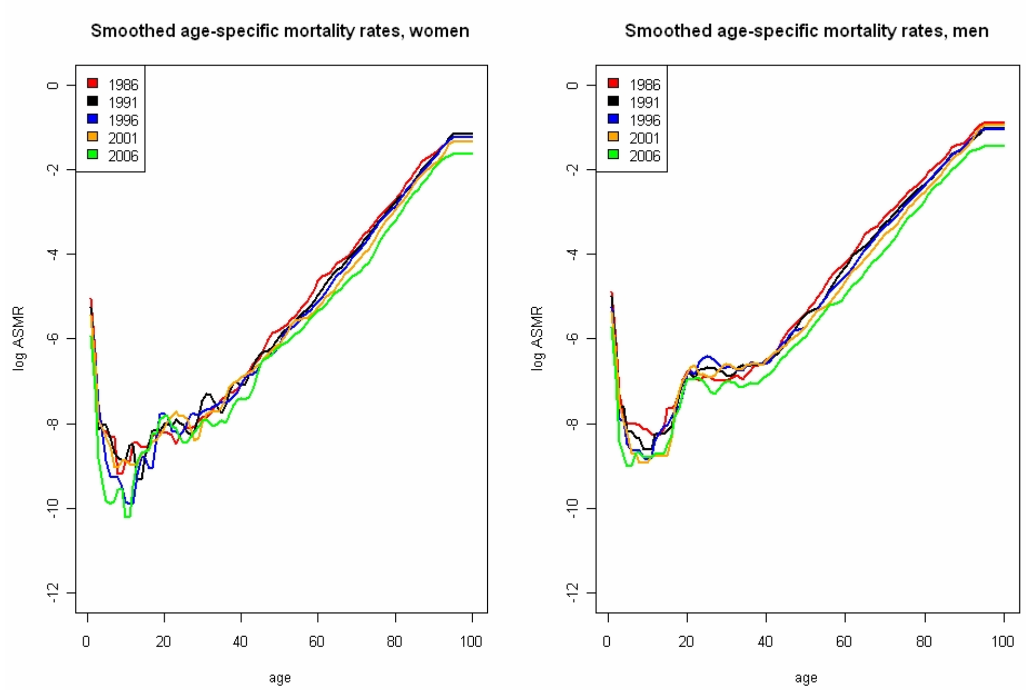
As noticed by Alders and De Beer (2004), it is inevitable in forecasting to avoid judgments though often it is not stated directly. Especially in case of fertility forecast, explanatory approach may be followed instead of extrapolating past terms. Indeed, it would be a mistake just to assume that past or current fertility patterns will continue. They serve the basis for future childbearing pathways but modelling one of the crucial life-events forms a real challenge and leaves always a big scope for uncertainty. For example, since once fertility levels fell down in Ireland from a TFR of 4 still in the 1960s to a TFR of 2 at the end of the 1980s, it is unrealistic that such a big change occurs again and for sure not in the period we forecasted and not from the current levels. Now, changes in TFR of 0.2-0.6 are of interest when European fertility is forecasted. A wider range of possible future TFR may be explored in case of extremes, e.g. lowest-low fertility countries but this does not apply to Ireland.

[3] The Autoregressive Conditional Heteroscedastic (ARCH), see above reference for further details (p. 13).

C. *Mortality*

The main source for analysing mortality was data on the number of deaths and life expectancy obtained from Eurostat. In particular, data on deaths and population by single age-group for each sex were available for the years 1985-2006. These data have been used for computing prospective age-specific mortality rates (ASMR) from the parallelograms of the Lexis diagram separately for males and females. In order to avoid the problems linked with the small number of deaths which occurred for certain ages for the Irish population, we smoothed the obtained ASMRs using running medians and moving averages. Moreover, due to large variability in the number of deaths at older ages and thus in old-age mortality rates, we decided to use ASMR at age 94 for ages 95 and above. The results are shown in Figure **3**. As we can see in last 20 years the ASMRs have significantly declined for almost all ages and both sexes. The only exceptions are mortality rates for the age group 15-24 – they have remained stable (males) or even have increased (females). Improvement in mortality has been mainly due to the declining mortality from circulatory diseases (Bennett *et al*., 2003).

Figure 3: Age-specific mortality rates, 1986-2006



Source: own elaborations based on Eurostat data

Generally this improvement in mortality has led to an increase in life expectancy from 70.7 in 1985 to 77.3 in 2006 for males and from 76.1 to 82.1 for females. In particular, during this period life expectancy increased on average by 0.33 per year for men and by 0.29 for women. It is worth mentioning that average increase in life expectancy in years 1926-1986 showed the opposite pattern: for females it was improving quicker than for males (0.31 versus 0.22 per year).

The mortality assumptions for this forecast were based mainly on the past trends. Until now demographers do not agree whether there is or not a limit in life expectancy (Oeppen and Vaupel, 2002). Thus, it was assumed that mortality rates will be improving for all ages, e.g. due to the further decline in mortality from main causes of deaths. This may be the effect of better standards of living and healthier life styles. For example, in case of circulatory diseases, the percentage of males smoking has already been reduced below 30% (Bennett *et al*., 2003).

In order to estimate possible rates of decline for mortality, we used the Lee and Carter model (Lee and Carter, 1992), which is a good method for predicting trends in mortality for all ages. The model is as follows:

$$\ln(\mu_{x,t}) = a_x + b_x k_t + \varepsilon_{x,t}$$

where $a_x = \ln(\overline{\mu}_x)$ is the average of logarithm of mortality rates for each age over time (observed trends), b_x is the rate of change in mortality for every age, k_t is an index of the general level of mortality at time t and $\varepsilon_{x,t}$ is an error term for information not captured in the model. In order to fit this model we used the Singular Value Decomposition (SVD) method with two additional restrictions: $\sum_t k_t = 0$ and $\sum_x b_x = 1$.

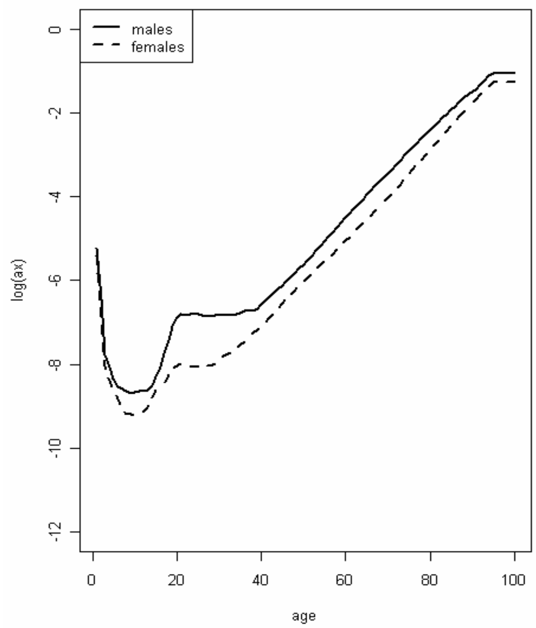
Moreover, as Lee and Carter (1992) proposed, we modelled the k_t parameter with a random walk with drift:

$$k_t = c + k_{t-1} + \varepsilon_t$$

where c is the drift term, and $\varepsilon_t \sim N(0, \sigma^2)$.

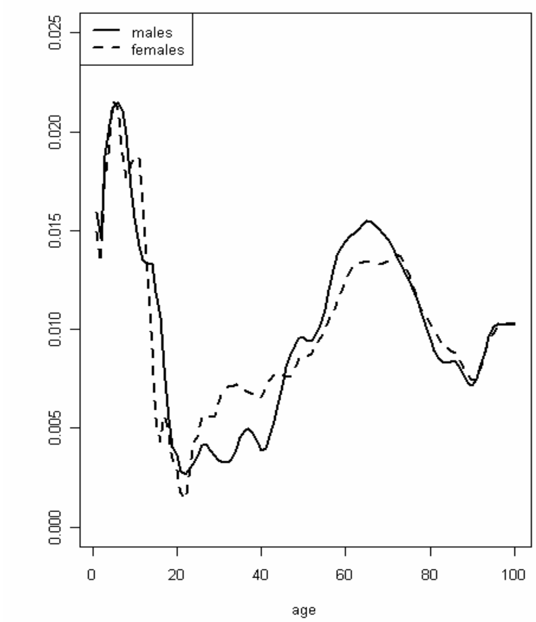
The results of the SVD are presented in the figures below. Figure 4 shows the average values of the log of age-specific mortality rates. The general pattern of mortality is similar to those observed in other developed countries. It reflects the differences in mortality between the two sexes. As it could be expected, the gap is the largest for young ages (20-30) linked with the differences in mortality due to accidents. Figure 5 presents the estimated b_x parameters, it shows the relative sensitivity of mortality rates to variation in k_t parameters. These results are in line with other findings concerning improvement in mortality (i.e. Torri and Vignoli, 2008). This stems mainly from the huge improvement in mortality at younger ages, and secondly at older ages. The Figure 6 presents estimated values of k_t parameters, which show a linear pattern.

Figure 4: Average of log of mortality rates for each age over time



Source: own elaborations

Figure 5: Smoothed rate of decline in ASMR



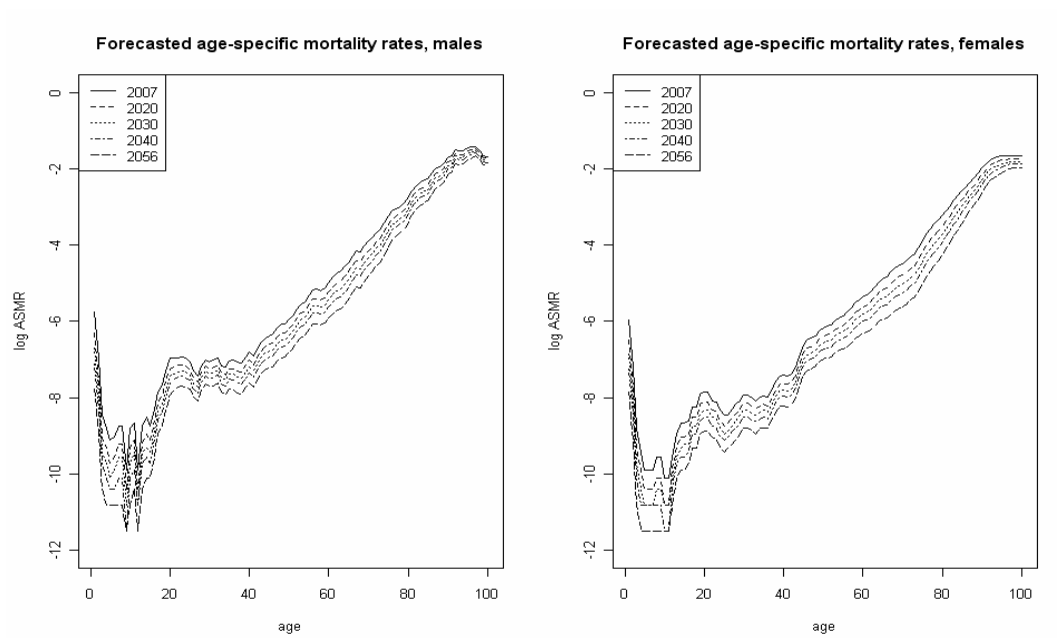
Source: own elaborations

Figure 6: Estimated parameters k_t

Source: Eurostat and own elaboration

The forecasted age-specific mortality rates are presented in Figure 7. They reflect the expected decline in mortality rates. Thus, on the basis of the forecasted ASMR, life expectancy has been estimated for all years of the forecast. As a result, it has been assumed that life expectancy will increase to 85.6 for men and to 91.2 for women in the next half century (Figure 8).

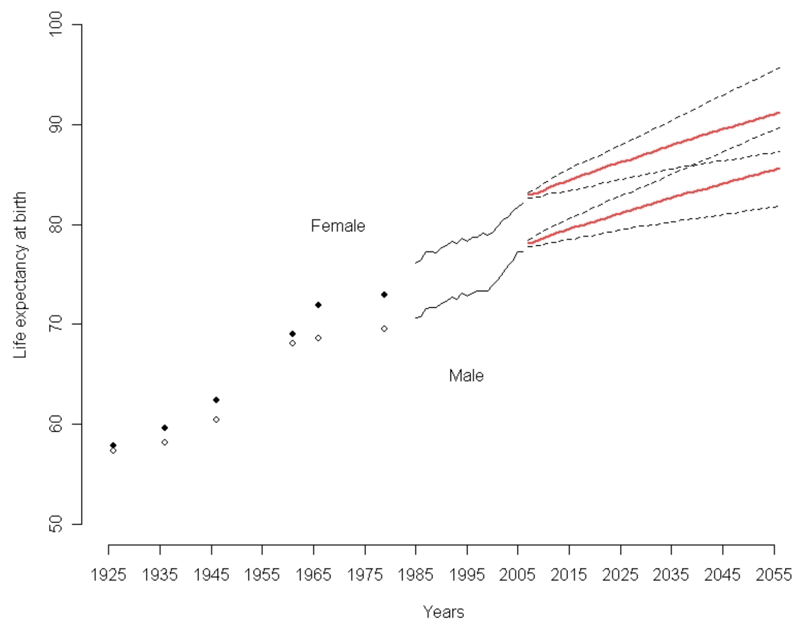
Figure 7: Forecasted age-specific mortality rates, 2007-2057



Source: own elaborations

As far as the assumptions about the uncertainty are concerned, we had to specify the parameters of the scaled model of error. According to Alho (1990) in a reasonable baseline forecast it can be assumed that future changes in mortality will follow the past trends, therefore we used the specification of the parameters proposed by Alho and Spencer (2005) – an average of selected European countries. Thus the parameters of the model were assumed to remain constant over time and be equal to k=0.05 and s=0.033; while cross-correlation across age was 0.95 and cross-correlation across sexes was 0.85. The Figure 8 displays the forecasted life expectancy with 80% confidence interval (81.8-89.7 for males in 2057 and 87.3-95.6 for females). As it can be observed the gap between male and female life expectancy will remain unchanged.

Figure 8: Life Expectancy at birth, past and forecasted values



Source: CSO before 1985, Eurostat from 1985 to 2007 and own elaboration

D. Net migration

After studying mortality and fertility, migration is the third component of the forecast. Firstly, the methods used to obtain the jump-off migration are described, as well as the sources of data. Then, the past trends and forecast assumptions will be presented.

Migration is implemented in the stochastic model using age-specific net migration flows. The Central Statistics Office of Ireland provides net migration flows only for wide age-groups (0-14; 15-

24; 25-44; 45-64; 65+). In order to obtain net migration flows for single years of age we used a residual method comparing the population on 1st January 2007 to the population on 1st January 2006 and taking into account the number of deaths which occurred during the year 2006[4]. Thus we an calculate the net migration flows for single years of age, M_x, using the following formula:

$$M_x^{06} = P_x^{07} - P_{x-1}^{06} + D_x^{06}$$

Whereas the deaths used in this formula are deaths by age reached during the year, *Eurostat* provides deaths by age at last birthday for Ireland in 2006. Consequently it is necessary to transform these numbers of deaths to use the formula. To do so, we assumed that the events are distributed uniformly in each parallelogram of the Lexis diagram except for the first age group. Indeed, the deaths occurring during the first year of life are not uniformly distributed: most of the infant deaths are concentrated in the first triangle of the Lexis diagram. Consequently we assumed that 80% of the infant deaths occur in the first triangle and 20% in the second one. Here are the formulas that we applied:

Net migration at age 0: $M_0^{06} = P_0^{07} - B^{06} + \frac{8}{10} D_0^{06}$

Net migration at age 1: $M_1^{06} = P_1^{07} - P_0^{06} + \left(\frac{2}{10} D_0^{06} + \frac{1}{2} D_1^{06} \right)$

Net migration at age x (with $2 \leq x \leq 98$): $M_x^{06} = P_x^{07} - P_{x-1}^{06} + \frac{1}{2}\left(D_{x-1}^{06} + D_x^{06} \right)$

Net migration at age 99+: $M_{99+}^{06} = P_{99+}^{07} - \left(P_{98}^{06} + P_{99+}^{06} \right) + \left(\frac{1}{2} D_{98}^{06} + D_{99+}^{06} \right)$

The curves of the density of net migrants by age have been smoothed for both sexes using a five years moving average. Some differences appear when comparing to the age structure provided by CSO, as shown in Table 1. The main discrepancy concerns males aged 25-44: our results underestimate them. The CSO estimations are based on several sources of information: the Quarterly National Household Survey, the Register of Electors, the Child Benefit Scheme, the number of visas granted, the number of work permit issued or renewed, the number of asylum applications… This multiplicity of migration sources attests for the reliability of their estimates. Therefore, we applied the age structure obtained for single year of age by the residual method to the number of net migrants (by wide age groups) provided by CSO.

[4] These data come from Eurostat.

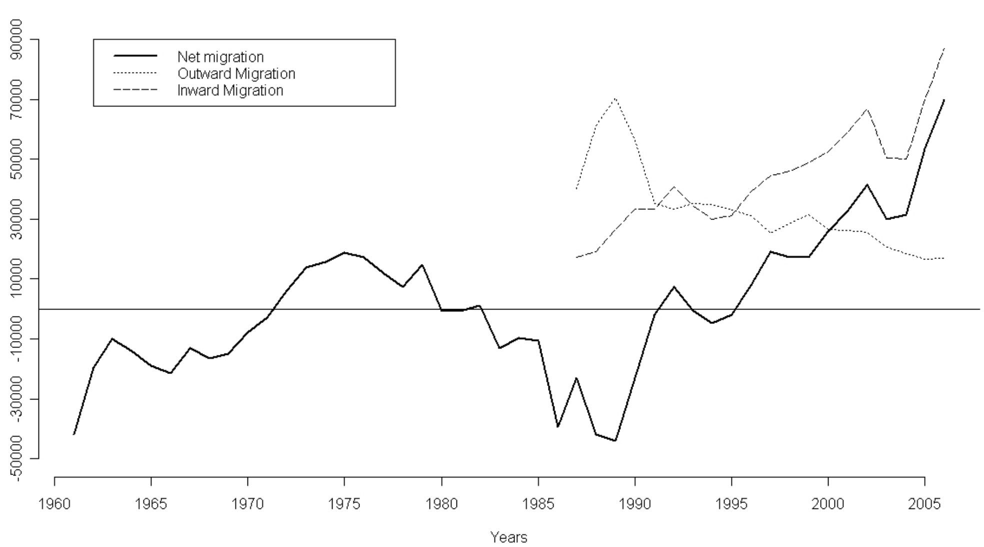
Table 1: Comparison between CSO values and residual method estimates

Age	CSO			Residual Method			Comparison (CSO - residual)		
	Males	Females	Total	Males	Females	Total	Males	Females	Total
0-14	4300	4700	8900	4459	4636	9095	-159	64	-195
15-24	8800	8300	17100	7775	9844	17618	1026	-1544	-518
25-44	23500	15400	39000	21275	16318	37593	2225	-918	1407
45-64	2500	1900	4300	2410	1758	4168	90	142	132
65+	200	300	600	307	174	470	-107	126	130
Total	**39300**	**30600**	**69900**	**36225**	**32730**	**68945**	**3075**	**-2130**	**955**

Source: CSO, Eurostat and own elaboration

Compared to the last century, international migration path has changed drastically. Ireland has been an emigration country for decades but recently the country started to attract many migrants as shown on Figure 9. After the Second World War, Ireland experiences a mass emigration period with 40.000 net migrants each year. After the mid-60s, emigration declines sharply due to a general improvement in economic opportunities until the early 70s when net migration became positive. During this decade, net migration remains positive. The 80s are characterised by a return to the post war negative levels mainly due to the entry of the baby-boom generation into an over-crowded labour market whose only choice was to leave the country.

Figure 9: Net migration in Ireland: 1961-2006



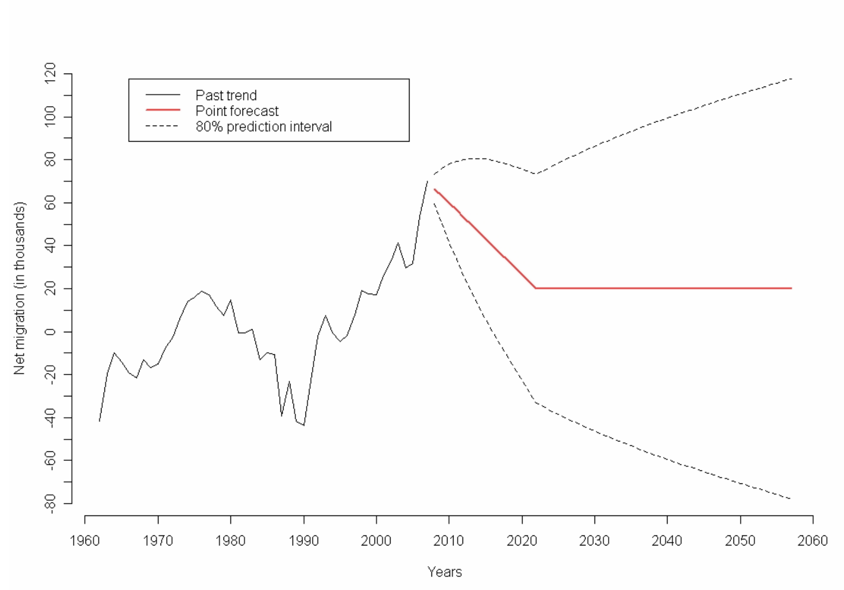
Source: Council of Europe before 1987 and CSO after 1987

After this period Ireland became a net-receiver country, following the trend showed by the other historical EU emigration countries. This is due to several factors: the very good economic performance of Ireland in the last decade of the 20th century, a combination of foreign direct investment, fiscal policy and structural funds yield to the emergence of a Celtic Tiger. This rapid economic growth led to a rise in living standards and wages. Furthermore, it induced a change in the labour market structure and created an unprecedented demand for workforce. The Irish state started on the one hand to encourage Irish emigrants to return and on the other hand to welcome immigrants to overcome the labour shortage. The turning point was reached in 2005, when Ireland decided to offer free access to the labour market for citizens of the ten new EU members. The dramatic increase in the inward migration flows reflects the magnitude of this measure: for the first time in its history, respectively 70 and 89.9 thousands immigrants crossed the borders in 2005 and 2006.

As for the future, it is unlikely that migration flows will continue at that level. First of all, the economy of Ireland and the society have to be prepared to absorb all the inward flows. Even though liberal measures were taken in the recent past, notably to allow the migrants to work in the public sector, less favourable measures were implemented in order to limit the right to citizenship. However, these measures are not part of an overall migration policy which will be soon formulated and seems to go towards the preference for a skill-based migration. For instance, the case of the two new EU member states - Romania and Bulgaria- can be stressed. The government decided to limit the access to the labour market for these new EU citizens, in order not to reiterate the experience of the massive Polish immigration after the 2004 EU enlargement.

Secondly, the improving economy of Eastern European countries will prevent from other mass migration in the future and will also favour a return migration. On the other hand, if the latent world economic crises will presumably hit the Irish economy as well, its solidity and growth rate - which is one of the highest of the EU zone – will allow the country to remain very attractive for foreign workers. Thus, Ireland is likely to continue to experience a continuing immigration for a long period of time. Nevertheless, the recent mass immigration of these last two years is unlikely to recur on the same scale. Therefore, we assume a slight decline in net migration for the next 15 years up to 20.000 net migrants, which will be considered as a stable value for the following 35 years until 2057. The choice of this ultimate value is supported by the ratio of total net migration at the end of the forecast over the population at the jump-off year. The UPE project estimates that this ratio should be equal to 4.5 per thousands in the countries which are supposed to experience an exceptional high level of net migration (Greece, Italy, Portugal and Spain) in the coming 50 years. The project started before the amazing inward migration flows of the recent years in Ireland which explains that this country has not been classified in this group. According to the recent trend, we expect Ireland to reach a ratio of 4.5, which corresponds to the number of about 20.000 net migrants (see Figure 10).

Figure 10: Net migration, past and forecasted values



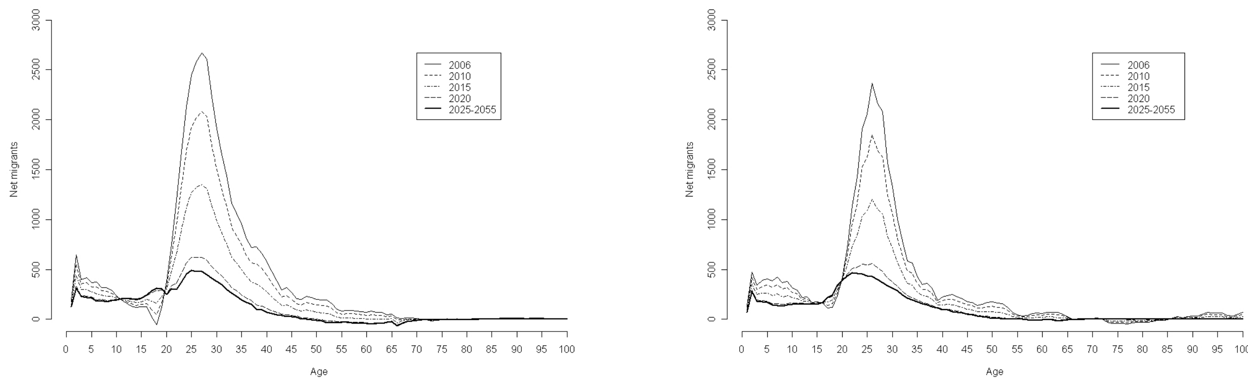
Source: Council of Europe before 1987, CSO from 1987 to 2007 and own elaboration

The age pattern of net migrants that we obtain by the residual method is close to the model migration schedules: a high concentration among young adults and a significant intensity at the beginning of life (Rogers 1986). Figure 11 shows that the density of net migrants was particularly high during the first years of life, followed by a decline reaching its lowest point around age 18. After a sharp increase to a peak at ages 25-26, the density of net migrants decreases dramatically until age 45 but then drops regularly to remain stable around a density of zero during the last years of life.

When comparing our estimations to the average EU pattern estimated in the UPE project (2004), we can notice that the maximum number of net migrants corresponds to slightly older migrants in Ireland (25-26 years) than the EU average (21-22 years). This difference is particularly striking for females. This is the reason why we assumed that the EU average age pattern will be reached by Ireland in 2057. The change over time in the number of net migrants by age is presented in Figure 11 for both sexes. Moreover, we also made the assumption that the sex ratio will vary from 56% of males and 44% of females in 2006 to an equal proportion in 2057. The estimation of the uncertainty is based on the default value implemented in BEGIN, i.e 5 for Ireland.

Figure 11: Net migrants by age and sex

Males **Females**



Source: CSO, Eurostat and own elaboration

III. Forecast results

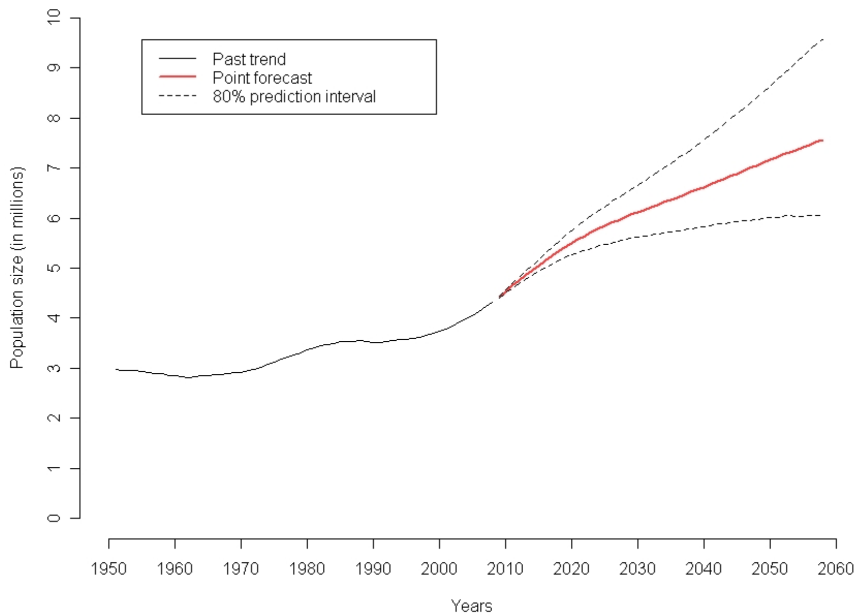
A. Total population

According to the stochastic forecast, the Irish population will reach 7.6 millions in half a century (median value, see Figure 12). This increase corresponds to a 75% growth during this period. In order to appreciate this change, we have to bear in mind, that because of emigration, Ireland never faced a similar situation before. During the 20th century the population grew by 31.6% (CSO), from 3.2 to 3.9 millions. Even if we take the lowest level of the century and the highest level reached in 2006 the growth does not exceed 50%.

Furthermore, the result of our forecast gives the higher population number than any other from the past forecasts for Ireland, both from the UN and the UPE Project. This is due to the fact that the forecasts were done before the massive immigration phenomenon of these last three years and therefore they did not assume such big flows of immigrants. The highest migration scenario used by the Irish CSO (2004) accounts for 30.000 migrants in the period 2002-2016 and ended with 15.000

in the period 2026-2036[5]. As we have already mentioned, migration was the major driver of the population growth in recent years and not the natural increase. Even if the number of migrants decreases, the impact of migration will remain important. The final population size obtained by the CSO was 5.8 millions, whereas we forecasted 7.2 millions in 2050. The same applies for the *Uncertain Population of Europe* projection (a median of 5.5 millions people in 2050).

Figure 12: Total population, past and forecasted values



Source: Eurostat and own elaboration

B. Age structure

Figure 13 shows the age structure of population on 1st January 2007, 2037 and 2057 with 80% prediction intervals. Nowadays, the Irish population is one of the youngest (in demographic sense) European countries. When we consider medians, the age-structure is changing in the forecasted period: the population is ageing due to the increasing number of elderly people. It seems that the driving force for population ageing is gain in life expectancy, especially for the older age-groups.

[5] As we said before, for our forecast we used 70.000 net migrants in 2007 and 20.000 in 2057.

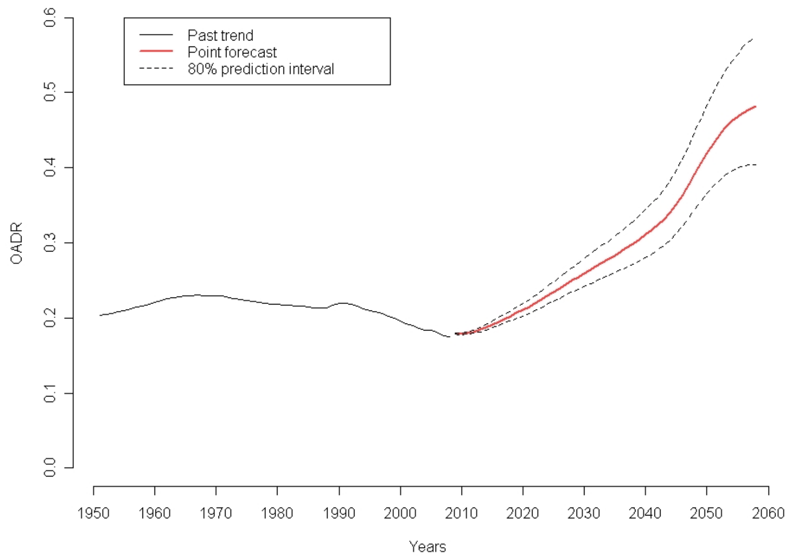
Figure 13: Future age structure of the population (ages 0-99), median and 80% prediction intervals

Source: Eurostat and own elaboration

According to the results of the forecast, it can be expected that Ireland, similarly to other European countries, will face the further advancement in the population ageing: the proportion of the elderly will rise from 11% in 2006 to 25% in 2057 (median value). It seems that another indicator – old-age dependency ratio (OADR) – reflects better this phenomenon. For this purpose we calculated OADR as a ratio of the number of people aged 65 years and more to the working age population (20-64 years)[6]. The results of the future OADR and its 80% confidence interval are presented in Figure 14. As we can see this indicator will increase significantly from 0.179 in 2007 to 0.482 in 2057 (median value). This fact reflects the increasing burden for the economically active population in the next 50 years, indeed the number of inactive elderly population will be more than 2.5 times bigger than nowadays.

[6] In our opinion due to the increase in the number of students and thus postponement in entry into the labour market it is assumed that working age population will consist of people aged 20-64. We are not taking into account the possible changes in the retirement age.

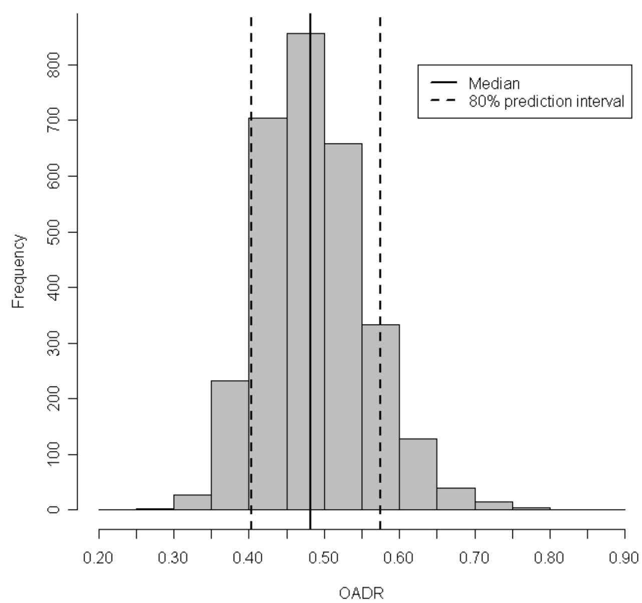
Figure 14: Old Age Dependency Ratio (OADR), past and forecasted values



Source: Eurostat and own elaboration

Figure 15 presents the distribution of possible outcomes of forecasted OADR in 2057. As visible, there is 80% probability that OADR will be in the range 0.40-0.55. To sum up, the obtained results confirmed that it is very plausible that Ireland will follow other European countries in terms of population ageing, but this process will be less advanced.

Figure 15: OADR, distribution of the possible outcomes in 2057



Source: own elaboration.

IV. Conclusion

Population forecasting is a real challenge because no one can predict the future. Though, the use of stochastic approach allows to build the prediction intervals for the future population size. Our results differ significantly from those of other projections. On the contrary to what was expected even just a few years ago, migration flows are still of a big importance for the population structure of Ireland. Therefore, here it has been assumed that migration will play a big role as well in the future. Even though, the Irish population will face the population aging resulting from the improvement in mortality. As a consequence, it is expected that the share of the elderly in total population will more than double between 2007 and 2057.

At the end, public policy may influence the future trends in population development in Ireland: regulation of immigration flows, introduction of special family policies, change of the retirement age, etc. However population ageing seems unavoidable. Moreover, it may be even more profound if, for instance, fertility declines or migration is limited.

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