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The Role of the Population Projections for a Redefinition of the Portuguese Higher Education Institutional Network

Rui Dias, Universidade de Évora
Maria Filomena Mendes, Universidade de Évora
M. Graça Magalhães, Universidade de Évora
Paulo Infante, Universidade de Évora

THE ROLE OF THE POPULATION PROJECTIONS FOR A REDEFINITION OF THE PORTUGUESE HIGHER EDUCATION INSTITUTIONAL NETWORK

Preliminary Draft (Please do not quote)

Rui Dias[1], Maria Filomena Mendes[2], M. Graça Magalhães[3], Paulo Infante[4]

1 RuiDias666@gmail.com, Universidade de Évora, Portugal

2 mmendes@uevora.pt, CIDEHUS, Universidade de Évora, Portugal

3 mgraca.magalhaes@ine.pt, CIDEHUS, Universidade de Évora, Portugal

4 pinfante@uevora.pt, CIMA, Universidade de Évora, Portugal

ABSTRACT

Population projections can be used as a tool to provide information on possible scenarios of future population and, namely, to support decision-making processes in diverse socio-economic areas, such as, higher education institutional network planning, both in public and private sectors.

The dimension and the age and sex composition of future populations are influenced by mortality, fertility and migration trends. So, an accurate estimation of those future trends is crucial to evaluate how many inhabitants we will face in the future and simultaneously to prepare ourselves for their future needs. In a country like Portugal, affected by a severe economical and financial crisis, with a young population characterized by very low levels of education and qualification is fundamental to use population projections as a basis for higher education planning.

The main goal of this paper is to evaluate the possible changes in the younger population size in the coming years as a tool to (re)define and (re)design, geographically the higher education institutional network in Portugal.

For this purpose, we used the cohort-component method to project the Portuguese population from 2011 to 2036. For the evaluation of mortality future evolution we tested the performance, for the Portuguese case, of both the Lee-Carter (LC) method (1992) and the Booth-Maindonald-Smith (BMS) variant (2002), using data from the Human Mortality Database .Regarding the fertility projection, we used data from the Human

Fertility Database and applied the method proposed by Schmertmann (2003 & 2005), to model fertility rates by age. The complexity of migration flows, especially regarding its instability and the difficulties in addressing new forms of population mobility, supported the decision of include only a null migration scenario on this exercise.

Considering the relevance of the projection of the number (and sex composition) of the under 18 population, we centered the discussion on the impact of different estimates of the future mortality rates for the youngest. Alongside with the main results, we will focus also on the analysis of the outcomes of LC and BMS models, performing a sensitivity analysis. We will sustain the reasons to choose one of those models as well as the use of confidence intervals to design alternative scenarios.

Our findings will provide a range of reliable forecasts to support a more rational political decision contributing to an efficient and effective planning in what concerns higher education requirements adjusted to the future population.

KEYWORDS: Population Projections, Higher Education Institutional Network, time series analysis

1. INTRODUCTION

Population projections can be used as a tool to provide information on possible scenarios of future dimension and age and sex composition of population, and, therefore, to support decision-making processes in diverse socio-economic areas, such as, higher education institutional network planning, namely in a context of a country that, like Portugal, with a young population still characterized by very low levels of education.

Inserted in an extended research project, with the aim of a (re)definition of the Network for Higher Education in Portugal, the projection of the population in the near future that will be "at risk" of entering that grade level is crucial.

The main goal of this paper is to evaluate the possible changes in the younger population size in the coming years, based on the results of population projections, using the cohort-component method, by age and sex.

We will focus our scope on youth people, aged between 18 and 30 years of age, considering its sex and age distribution, in a time horizon of the next 25 years.

Over the last few years increasing attention has been given to the different methodologies to support demographic projections for specific purposes of prediction, well beyond the usual projections demographic statistics compiled by official organizations such as Eurostat or the United Nations (at European and global level), or by the statistical offices of each country (at national and regional levels).

In this paper, we will test the application of different methodologies to predict fertility and mortality, the main components responsible for the evolution trend of young people, as potential candidates to higher education at the considered time interval.

Despite the importance of migration component, once both levels of emigration and immigration are more significant in active young ages, at which may affect the prediction of the number of young people under the age of access to higher education, and influencing the number of births (however, in this case, the greatest effect will be noted only around 18 years later), we do not include the migration component in this study, namely due to its enormous volatility and the quite high level of difficulty to predict it in the long term.

The data used were provided by the Human Mortality Database, Human Fertility Database and the National Institute of Statistics of Portugal. The calculations were prepared using the software R.

2. METHODS

Deterministic projections usually performed using different scenarios to deal with uncertainty. More recently, probabilistic projections of population have been developed, with increasingly interest namely considering that it allows estimating a confidence interval associated with each outcome (Bongaarts & Bulatao, 2000).

The uncertainty in the results come not from the formal model but from the uncertainty in the data base whether the assumptions of evolution of components, being frequent use of different scenarios or variants, as a way of dealing with uncertainty. An alternative is to explicitly taken into account the uncertainty of the fertility, mortality and migration trends, and derive the probability distributions for the resulting size and age structure of the population projected (O'Neill, Balk, Brickman, & Ezra, 2001).

Thus, the complementary application of the most useful aspects of different methodologies, combining the scenario approach with probabilistic forecasts seems to be the most productive attitude (Goldstein, 2007; Sanderson *et al*, 2004).

2.1. Mortality Projection Method

In watt concern to mortality, the best known and most widely model used due to its better fit in terms of results, the probabilistic projection of mortality is undoubtedly the Lee-Carter model (Raftery et al. 2013).

It is an extrapolative model that projects into the future the trends of the historical data, according to the age patterns of mortality. As with all models, there are advantages and disadvantages associated with the method. However, from your initial article (1992) the Lee - Carter model has been the subject of study and application by different investigators, in different countries, namely, Lee & Nault (Canada, 1993), Lee & Rofman (Chile, 1994), Wilmoth (Japan, 1996), Figoli (Brazil, 1998), Coelho (Portugal, 2001), Booth, Smith & Maindonald (Australia, 2002),Tuljapurkar, Li & Boe (G7, 2000).

The main advantage highlighted by several authors is how the model combines a demographic model and a parsimonious time series model, thus obtaining intervals for probabilistic projections. The possibility to incorporate into the model relatively long historical data series, and also the fact that allow mortality rates progressively decrease exponentially over time, it is not necessary to set an upper limit arbitrary with respect to the life expectancy, are clearly considered advantages.

With regard to the disadvantages must be noted that being a model extrapolative it shares all the problems of similar models. The past structure and trends used in the model may not occur in the future, there may be profound changes at the structural, demographic or social levels that the model will not be able to consider, such as, possible advances in medicine, profound changes in the socio-economic context, lifestyle transformations or the appearance of new diseases that radically alter the past trend.

The Lee-Carter methodology is a bilinear model in the variables x (age) and t (calendar year). The model is defined as:

$$\ln(m_{x,t}) = a_x + b_x k_t + \varepsilon_{x,t} \quad (1)$$

Where $m_{x,t}$ is the observed central death rate at age x in year t; a_x is a set age-specific constants describing the general pattern of mortality by age, i.e. describes the average age-specific pattern of mortality; k_t is a time-trend index of general mortality level, i.e., describes temporal trends in the level of mortality; b_x is a set of age-specific constants describing the relative speed of change at each age, is a pattern of deviations from the age of profile as the k_t varies; $\varepsilon_{x,t}$ is the residue at age x and year t, the random error with zero mean and variance σ^2.

We have analyzed and modeled the evolution of mortality, based on historical mortality data from 1981 to 2009, separately for both sexes.

The model allows us to obtain the values projected by 2035. The mortality rates of the Portuguese population are represented in Figures 1, 2 and 3, by distinguishing between the total population, males and females. The estimates for mortality rates presented here are the central values for a confidence interval of 90%.

The trend shows a reduction in the rates at all ages, in particular as regards the younger ages, which means that a greater number of young people will survive till the older ages (Figure 1).

Notes that the expected gains in terms of reduced mortality in males will be substantial, but maintaining some comparatively higher values, for example, in the ages between 15 and 24 years of age, associated with a history of high mortality mainly due to road accidents (Figure 2).

In the case of females, the decline in mortality rates will also increase, although it is noteworthy that the starting levels are much lower compared to those recorded by males, at all ages.

Figure 1 – Mortality rates, total population, aged from 0 to 35, Portugal, 2010-2035

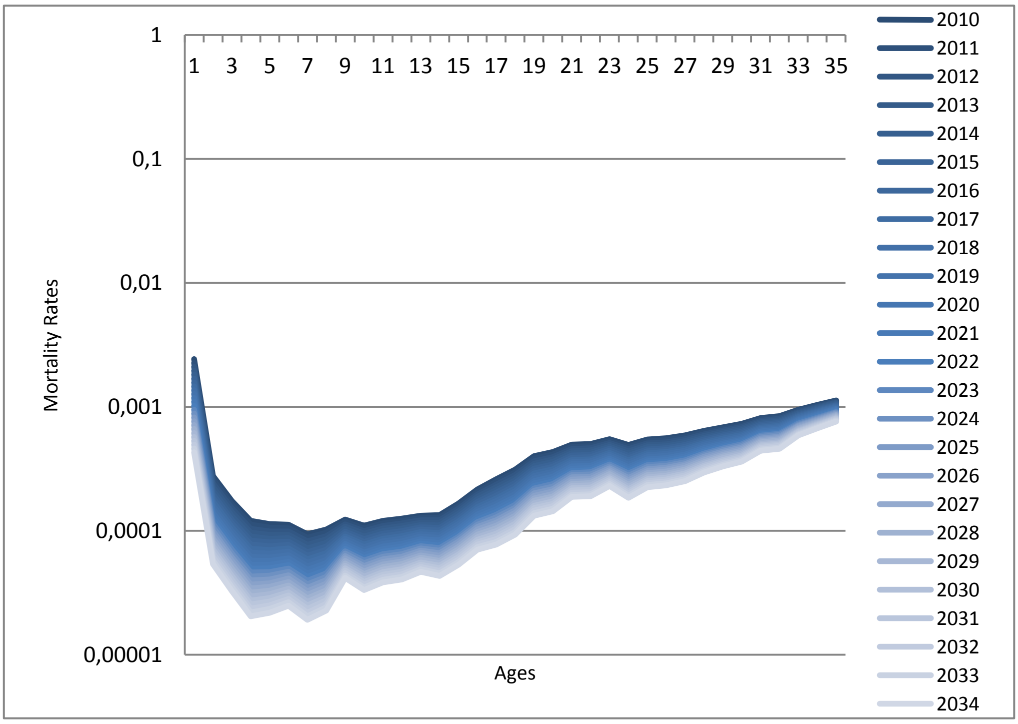


Figure 2 – Mortality rates, male population, aged from 0 to 35, Portugal, 2010-2035

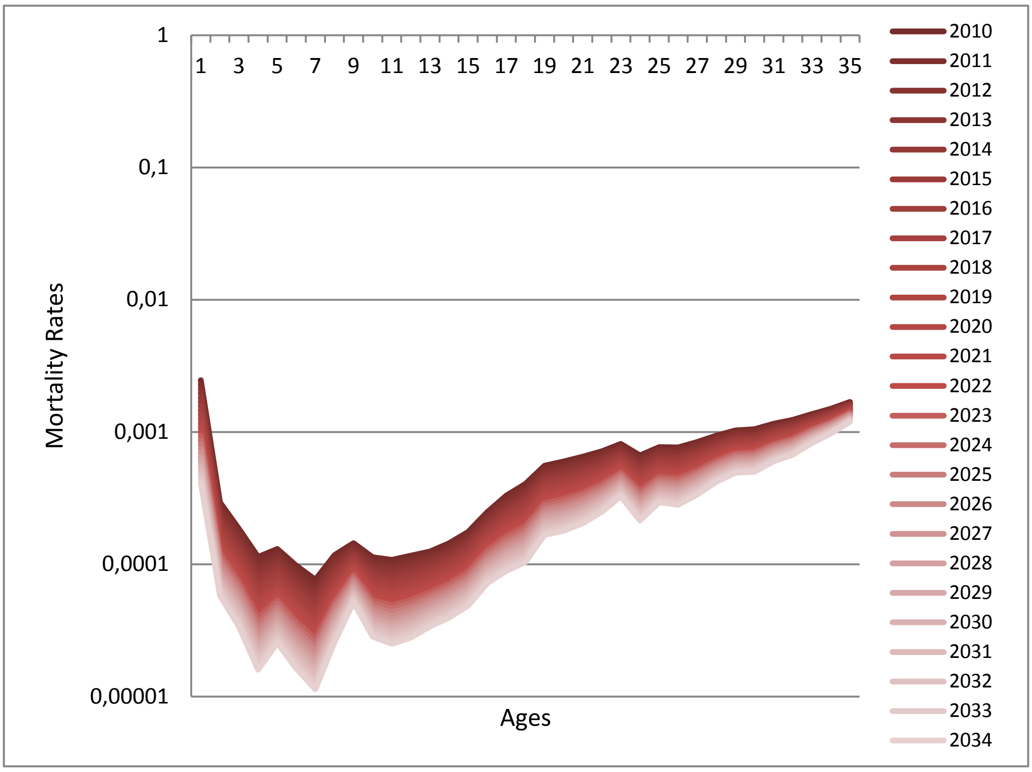
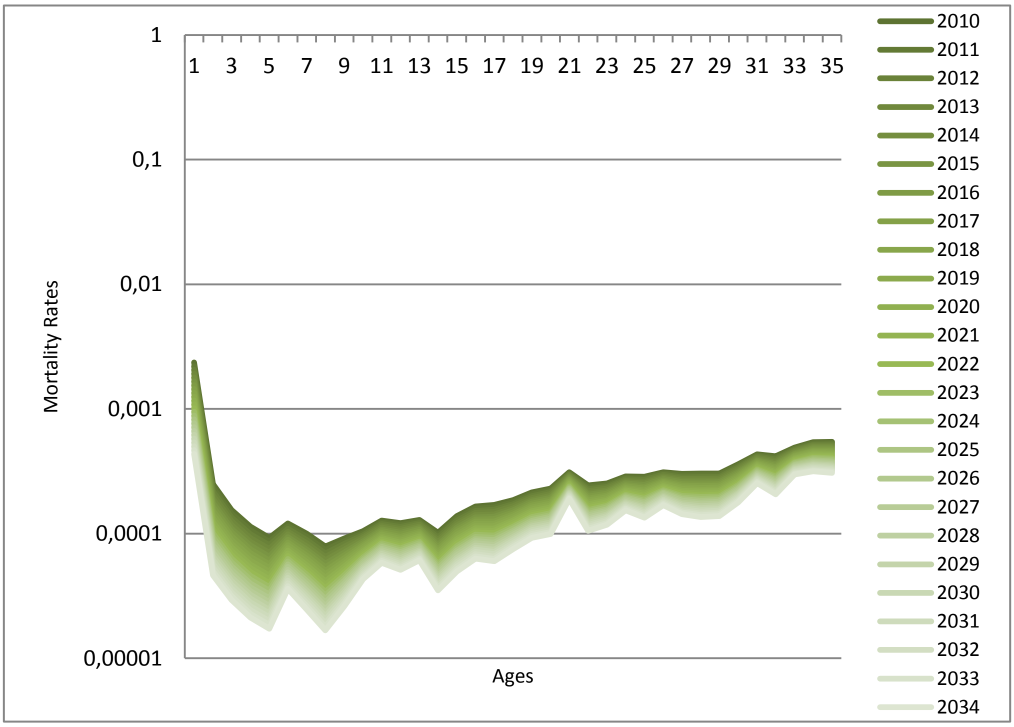


Figure 3 – Mortality rates, female population, aged from 0 to 35, Portugal, 2010-2035



2.2. Fertility Projection Method:

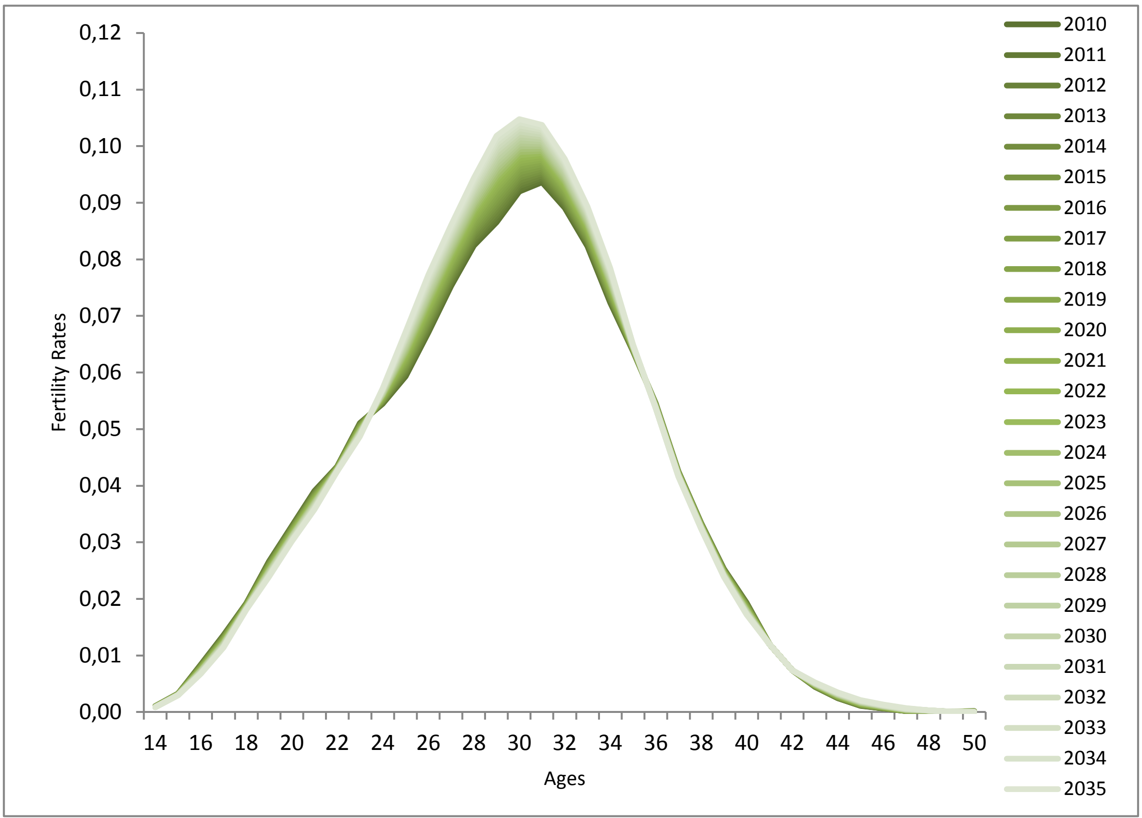
In the fertility component we opted to first establish the assumptions of possible evolution, in terms of expected developments in total fertility rate (TFR) and mean age at childbearing, based on the analysis of the recent trends in Portugal: the decrease in the number of children per women and the continuous increasing of the age of women at the birth of their children.

Three possible scenarios of evolution for the TFR are defined, as well as the evolution of the mean age at childbearing: (scenario 1) the maintenance of a very low fertility rate throughout the projection period, assuming a value of 1.3 children per woman in 2035; (scenario 2) the recovery of fertility levels in order to match the end of the period the amounts currently recorded nowadays, on average, in Europe, reaching 1.6 by 2035; and (scenario 3) an intermediate scenario that envisages a less significant increase in fertility, reaching a value of 1.45 children per woman by 2035. The mean age at childbearing will be around 30 years on average, decreasing slightly in the most optimistic scenario and prolonging the delay in the worst case.

For the estimation of the fertility rates by age, until the 2035 year we have applied the model proposed by Schmertmann (2003 and 2005), in order to meet the assumptions, proceeding thereafter to a linear interpolation between the values and the value of the projected estimates for the base year 2010. The model describes the curve composed of the fertility rates by age, between 15 and 49 years, using three parameters: α that represents the lowest age at which fertility rates take values above 0, P representing the age at which fertility rates are at their highest level, and H represents the lowest age after P in which the fertility rate drops to about half P. An additional parameter (R) is also used to obtain the level of fertility.

The distribution of fertility rates by age, over the next 25 years, according to the results for the scenario 2, may be represented as shown in Figure 4.

Figure 4 – Age specific fertility rates, Portugal, 2010-2035



Age specific fertility rates tend to increase slightly between 24 and 35 years of age, particularly between 28 and 32 years, but we do not anticipate a significant recovery of births postponed to ages above 37 years. However, the gradual decline in fertility observed in Portugal in recent decades conditioned inexorably the size of the generations that, either currently or in the coming decades, will reach the age to start a family and have children. Thus, even under a scenario of recovery of fertility without constraints caused by foreseeable emigration flows, the number of births in the future is likely to be lower for the simple fact that we have, year after year, fewer women at childbearing ages.

The estimation of the births in this projection exercise clearly shows that the consequences of fertility decline registered in our recent past will be reflected inevitably in the future; it is not possible to reverse its effects in the timeline of the coming decades.

3. RESULTS

The higher education institutions in Portugal has as prime candidates young people aged between 18 and 24 years of age, being the age of 18 the age with largest number of candidates. Therefore, we considered this target population on our study. However, given that we still consider a margin of recruitment at ages between 18 and 23, as well as in ages above 23 (due to the potential number of students attracted by after working courses), we analyzed not only individuals with the modal age 18, but also the people in the age groups between 18 and 24 and between 18 and 30.

The number of young people tends to decrease at all ages. However, depending on the initial population for each age or on the evolution of the corresponding probability of death, the variation has a greater or lesser extent; the variation in the number of births over past time may also be the cause of changes in *direction* variation (Table 1; results based on the application of both central scenarios for mortality and fertility).

Table No. 1 - Population by 2035, both sexes

Population by 2035, both sexes						
Age/Year	**2010**	**2015**	**2020**	**2025**	**2030**	**2035**
18	117131	107655	111397	105017	99470	89480
19	118450	108517	109278	108858	101131	91503
20	118573	106958	112470	108416	98847	93560
21	120226	110466	106628	111446	103989	95597
22	121072	113096	105960	113018	101852	97552
23	125624	116872	107462	111234	104892	99373
24	129238	118176	108312	109108	108720	101025
25	138346	118288	106746	112287	108270	98737
26	143429	119929	110240	106447	111289	103868
27	150230	120762	112855	105772	112851	101727
28	153051	125285	116608	107258	111057	104751
29	157705	128866	117888	108088	108917	108559
30	157967	137918	117975	106505	112069	108091

In addition to the results obtained by application of the central values, the estimated population on two other scenarios: (1) low mortality (relative to the lower limit of the confidence interval calculated for mortality rates at each age) with high fertility – TFR: 1.6; (2) higher mortality (upper limit of range) with the lowest level of fertility – TFR: 1.3.

The difference between the projected population values is almost nonexistent until 2028, due to the reduced effect of differences in mortality on population structure in young ages, in particular between 18 and 30 years old. After 2028 and until the end of the projection period, the differences increase among the different scenarios, mostly due to the impact of changes in fertility.

Projected values of the population aged 18 years old reflect, mainly, the past fertility trend in Portugal. Notice the values slightly higher than expected for the calendar years 2018 to 2021 as a result of the increased fertility occurred in 2000, as well as relatively high fertility rates until 2003.

The general trend of decline of 18 years old population becomes more evident from 2028, when the evolution of future fertility is crucial in calculating the size of the projected population. In fact, the population aged 18 years in the calendar years preceding 2028 are simply the expected survival of births already occurred by the year 2010. Considering this so called central scenario, it is expected that the size of the population of 18 years old will decline around 23.6%, between 2010 and 2035, 21.9% in the so called optimistic scenario and 25.8% in the so called pessimist scenario (Figure 5).

At the 18 to 24 age group, the downward trend remains (Figure 6): Although we can expect a slight increase in the population of these age group between 2020 and 2026, as an effect of a slight increase in fertility in Portugal between 1996 and 2002, in any of the scenarios these group could decline from about 20.4% to 22.8%, depending on the chosen scenario, optimistic or pessimistic; 21.4% on the central scenario.

For the wider group, composed of young people between 18 and 30 years old, the decline is also quite visible (Figure 7), with a reduction of more than 25% whatever the scenario (-26.1%, central scenario; -25.5%, optimistic scenario; -26.9%, pessimistic scenario).

Figure 5 - Population 18 year old, central, optimistic and pessimistic scenarios

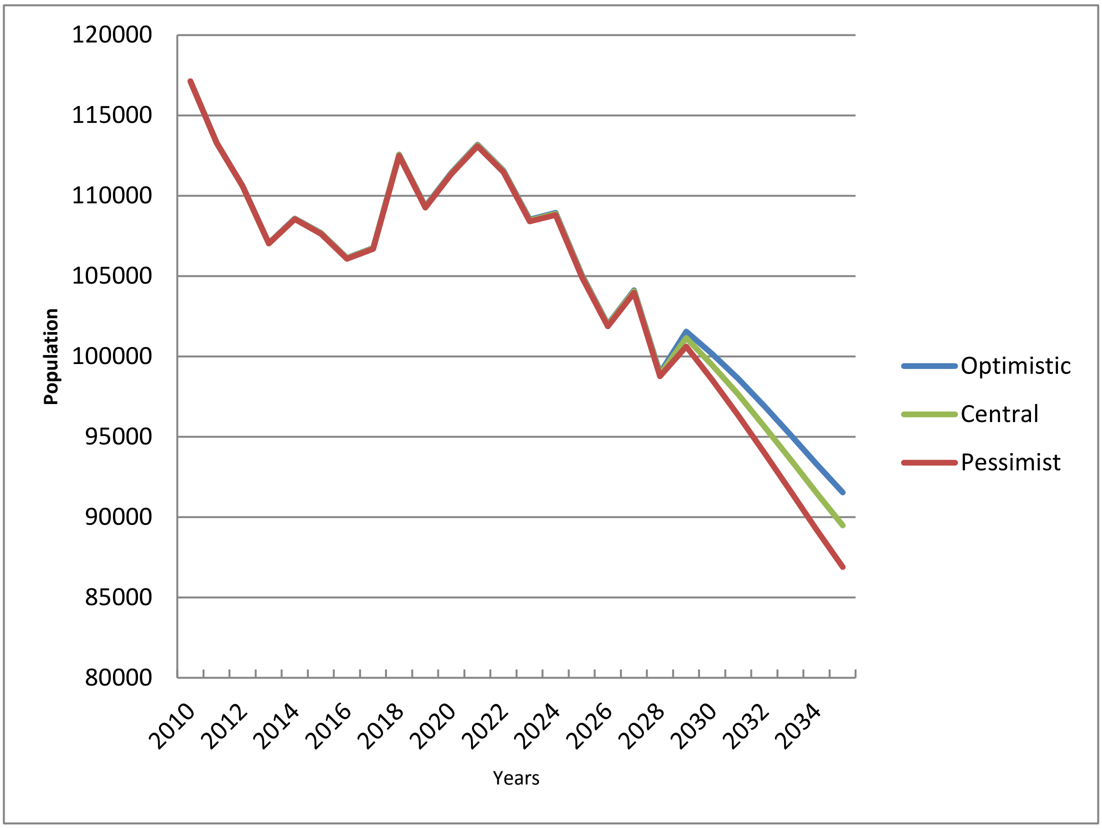


Figure 6 - Population 18-24 age groups, central, optimistic and pessimistic scenarios

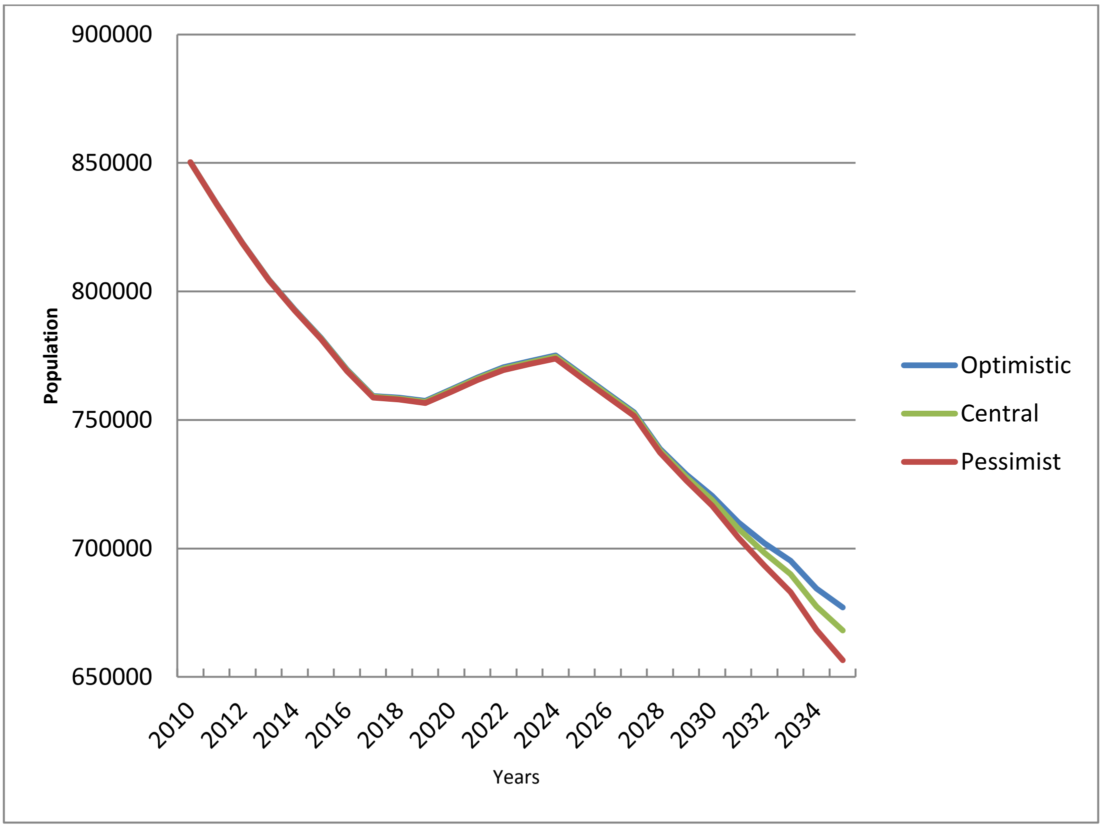
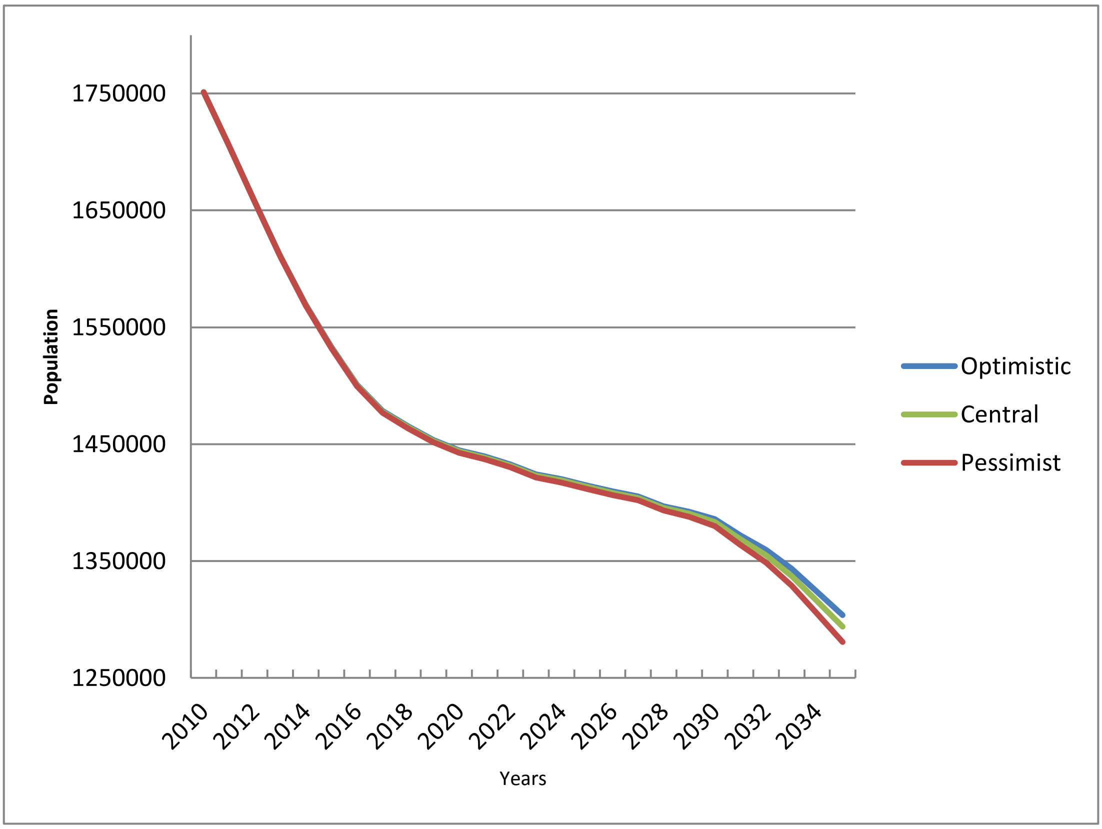


Figure 7 - Population 18-30 age groups, central, optimistic and pessimistic scenarios



4 CONCLUSIONS

The first conclusion to be drawn of the different results is that the number of young people in Portugal will decrease significantly in the next 25 years. Thus, the young population, base of student's recruitment will be reduced proportionately and the demand of higher education in Portugal will be strongly influenced by this trend.

Even considering impact factors with an opposite effect, such as: (1) possible changes in policies and incentives to attract students for higher education specific courses; (2) a broadening of the recruitment base, despite the reduction in the size of the youth population, due to the extension of compulsory education to 12 years and a possible rise on the secondary graduation rates that may cause an increase in the proportion of applicants to higher education, (3) a greater propensity of young people for chose universities and polytechnics in order to acquire a higher education; we can conclude that the demand for higher education in Portugal tend to decrease significantly in the years between 2010 and 2035, based on an expected loss of young population between 1/5 and more than a quarter of the population existing at the beginning of the current decade.

We believe that yet with a future change to (again) positive net migration would not be possible to reverse this trend of losing young population.

Moreover, there will be other factors that may act to decrease the absolute number of potential candidates, such as: (1) during periods of economic crisis the families decisions may be constrained and force to restrict the access of the most economically disadvantaged candidates; (2) highly concentrated supply of courses (and institutions) may discourage applications from young people belonging to the lower income classes who need to move from one region to another; (3) the emigration currently registered in Portugal may become responsible for a greater young ages depopulation.

In general, considering all factors, it appears that young people who most likely would have to apply to higher education in Portugal tend to decrease considerably in the coming years.

We believe that the conclusions which may be drawn on the basis of this exercise show that demographic projections are a fundamental tool for the process of resetting the network of higher education in Portugal, particularly when major changes are foreseen either in the size of the base of recruitment, either in entry strategies, and also the reorganization of the training supply.