

Sociophysics Simulations III: Retirement Demography

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Abstract. This third part of the lecture series deals with the question: Who will pay for your retirement? For Western Europe the answer may be “nobody”, but for Algeria the demography looks more promising.

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INTRODUCTION

During the last two centuries in peaceful rich countries, people lived on average longer and longer, while during the last few decades the number of children born per woman during her lifetime has sunken below the replacement rate of slightly above 2. Also in many poorer countries the number of births has fallen and the life expectancy increased. Thus the fear of overpopulation of our planet Earth has to be modified by fear of old-age poverty: In the year 2030 only those goods and services can be consumed by retired people which have been produced by working-age people. A million dollars of old-age savings can be halved by a ten-percent inflation rate over seven years, if not enough young people help me to live. This Econosociobiophysics problem is one of demography, not of money.

We present in an appendix details of the assumptions for our extrapolations into the future. In the next section we deal with conditions as are typical for Western Europe, to be followed by a section on the different problems of Algeria. More literature on ageing models, including one applied to our demography [1], is given in [2].

WESTERN EUROPE

Around 1970, the contraceptive pill reduced in the then two German states the average number of babies born by a woman during her lifetime below the replacement level of two, to about 1.4. Spain and Italy followed later but levelled at a lower plateau, while in France the number is higher, about 1.7 ten years ago and 1.9 in 2004: www.ined.fr. Life

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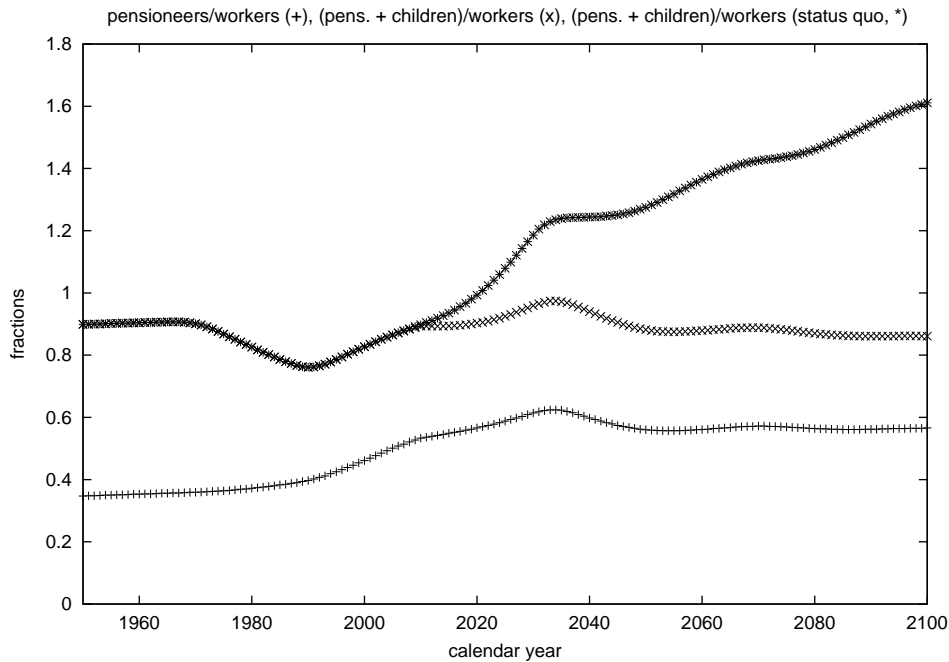


FIGURE 1. Ratio of number of pensioners to number of working age people (+) and ratio of number of pensioners plus number of children to working age people (x,*). The curves (+,x) take into account a net immigration of 0.38 percent per year and an increase of the average retirement age by half of the previous increase of the life expectancy. (Western Europe)

expectancy rises further though slower than during the first half of the 20th century. Thus if people retire at an age of about 62 years, and if around 2030 the strongest age cohort in Germany are the 70-year olds, problems lie ahead. Only in recent years were they discussed in general newspapers. As in science in general, we need open publications of extrapolation methods and results. Only if many different simulations are compared can we see to what extent they agree and thus may be relied upon.

The top curve in Fig.1 shows what happens if nothing is done: The average retirement age is 62 years, and immigration and emigration cancel each other. Then [3, 4, 5] the number of old people to be supported by working-age people will increase drastically, while the total population will decrease. We added here the number of children (up to age 20) to the pensioners since both groups are not fully "working" in the usual sense. For the middle curve we assumed a net immigration of 0.38 percent per year, starting now, and an increase of the retirement age by about half of the increase of the life expectancy. Thus for every year which medical progress gives us, about six month are given like a tax to the labour market, while the other six months are leisure time after retirement. Now the ratio and the population are more stable. If we do not count in the latter simulation the children (bottom curve), then the ratio of pensioners only to working age people is lower [5]. However, the reduction of the expenses for children is mainly an effect of the past, not of the future.

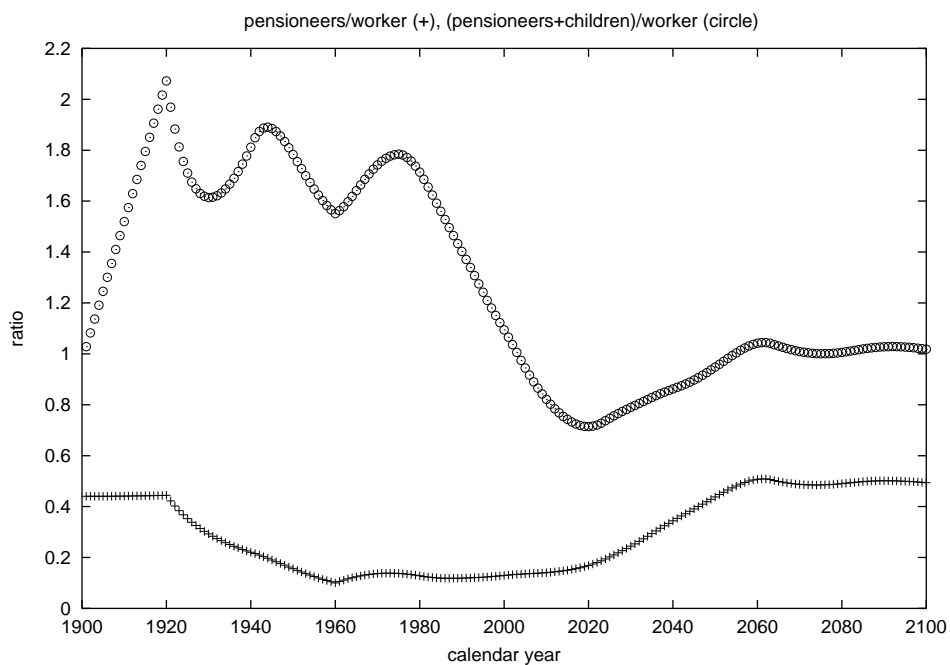


FIGURE 2. Ratio of number of pensioners to number of working age people (+) and ratio of number of pensioners plus number of children to working age people (x). (Algeria)

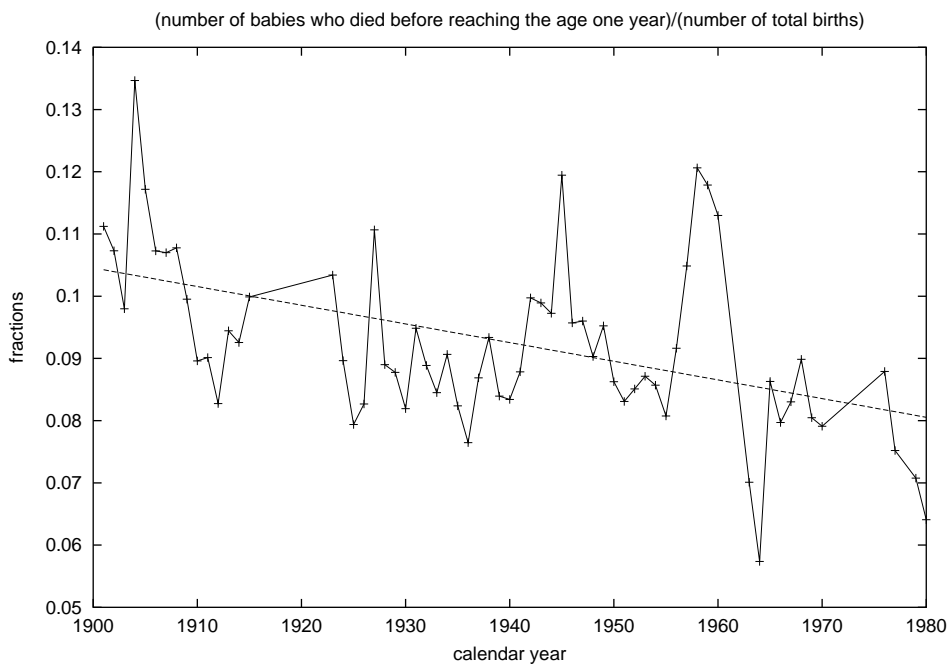


FIGURE 3. Ratio of number of babies died before reaching the age one year to number of total birth(+) (data of the National Office of the Statistics ONS Algeria) the fit line shows fractions increase of about 20 percent from 1980 until 1901.

ALGERIA

During the first half of the previous century, the fertility was very large in North Africa compared to Europe. It reached the value 8.1 during the seventies in Algeria because of a low average age of marriage in this country. Thirty years later, the average number of births per women (during her lifetime) becomes close to 2, whereas in France the fertility needed two centuries to pass from 6 in the middle of the 17th century to 2 in the 1930's. Algerian people are thus young.

Figure 2 shows that the number of children (up to age 20) added to the pensioners (the retirement age in Algeria is 60 years) obliged workers to support about two times their number until the year 2000. Sixty years afterwards the population will be older but the fractions remain constant (no fear of increasing). We assumed in Fig.2 the Gompertz slope b (see appendix) to increase with time from 0.07 in 1901 to 0.082 in 1971 and to remain constant thereafter. Only fertility data from 1950 on is available in Algeria. The fertility is constant with a mean value of 7.3 from 1950 to 1980 and then decreases abruptly til 2004 to reach a value 2.04; it is assumed to stay constant at this value thereafter. The sixty years period necessary to reach the steady state, corresponds to the age of retirement. In figure 3, we show that the ratio of the number of babies dying in their first year to the total number of births decreased by about 20 percent from 1901 to 1980. Thus, we made a correction on the fertility data (in fig.2) by reducing them by the number of children dying before they reach maturity. We noticed also that the greatest emigration rate of Algerian people was between 1950 and 1970 but remains weak compared to the rate of births and does not influence the population evolution. In our simulation we then neglected the emigration in such calculations. However, this simulation did not account the rate of unemployed which was very small during the period of socialism but reaches now 17 percent of population. However, the main prediction of Fig. 2 is an increase of the social load for old age by 400 percent starting from 2020, while that for children and old age combined will stabilize at the level around the year 2000.

SUMMARY

With rising life expectancies and falling births, the demographic problems of rich countries can be alleviated by controlled immigration and a moderate increase of the average retirement age. That policy requires that first the unemployment is reduced appreciably. For Algeria, on the other hand, emigration could not affect sensitively the evolution of pensioners, but their rate should be multiplied by a factor four after 15 years from now on which would create a real economic problem were it not offset by a reduction of the number of children.

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APPENDIX

According to the Azbel lectures at this seminar, in all different countries and centuries, the probability of humans to survive up to a fixed age is a universal function of the life expectancy; we do not have to apply this universality to yeast cells for the purpose of human demography. Thus we use Germany as typical Western European country, without taking into account the effects of World War II.

The mortality function $\mu = -d \ln S(a) / da$, where $S(a)$ is the number of survivors from birth to age a , is assumed to follow a Gompertz law for adults: $m \propto b \exp[(a - X)b]$ since the deviations at young age occur at such low mortalities that they are not relevant if we want to be accurate within a few percent. The deviations at old age [6] are not yet reliably established and may also be negligible as long as the fraction of centenarians among pensioners is very small.

The Gompertz slope b was assumed to increase linearly with time from 0.07 in 1821 to 0.093 in 1971 and to stay constant thereafter, in contrast to Bomsdorf [3] and Azbel [7] but in agreement with Yashin et al [8]; see also Wilmoth et al [9]. Instead, the characteristic age X was constant at 103 years until 1971 and then increased each year by 0.15 years to give a rising life expectancy. Also these deviations from universality are not yet established reliably. (Therefore we ignored the effect for Algeria, keeping $X = 103$ constant there.)

Babies are born by mothers of age 21 to 40 with age-independent probability. The average number of children born per women over her lifetime and reaching adult age is assumed to be $2.2 - 0.4 \tanh[(t - 1971)/3]$ recently. Immigrants are assumed to be 6 to 40 years old with equal probability, and their number per year equals a fraction $c = 0.38\%$ of the population, adjusted to give a constant total population.

After the year 2010, the retirement age is increased by 60 percent of the increase of life expectancy at birth to 73 in 2100 at a life expectancy then of 99 years; for the problem year 2030 these ages are 64 and 84 years.

The program is available from stauffer@thp.uni-koeln.de as `rente16.f`.

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