Demographic and economic assumptions used in actuarial valuations of social security and pension schemes

An analysis of some recent valuations carried out by the ILO

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1. Introduction

The actuarial valuations of social security schemes should situate the scheme in the global context of the national social protection system and, therefore, in the demographic and economic context, in particular. Assumptions relative to demographic and economic condition are, therefore, established within this framework.

The International Actuarial Association (IAA) guidelines of actuarial practice for social security programs, which came into force on 1 January 2003, dedicate a paragraph to assumptions. This paragraph stipulates that assumptions must be realistic, explicit and should take account of internal and overall consistency. The internal guidelines for the actuarial analysis of a national social security pension scheme issued by the International Financial and Actuarial Service of the International Labour Office (ILO) emphasise the importance of the demographic and economic context in the setting of assumptions. These guidelines do not provide a quantitative indication. The choices of assumptions, therefore, are the responsibility of the actuary, who could be advised by an economist or a demographer.

Seven actuarial valuations recently undertaken by, or in collaboration with, the ILO are being reviewed (Aruba,1 Chile,2 Cyprus,3 Ghana,4 Luxembourg,5 Panama6 and Saint Lucia).7 The economic development and demographic situation of these countries vary significantly.


The objective of this analysis is to identify which quantitative choices are made in these valuations and to determine whether conclusions can be drawn from these choices. The main demographic and economic assumptions will, therefore, be detailed, compared and analysed. The objective is neither to present the context within which these assumptions were formulated nor to discuss the methodology since these valuations were undertaken using the ILO family models.

2.  Demographic assumptions

The major factors which influence population projections are fertility, mortality and migration. Assumptions on migration are not under review.

Numerous population projections are made by such diverse organizations as the National Statistics Institutes, Population Offices, and international organizations such as the Statistical Office of the European Communities (EUROSTAT) or the United Nations Organizations. The latter are of particular interest since the United Nations Population Division publishes statistics and projections for all the countries of the world using the same methodology and comparable assumptions. These projections frequently serve as a reference and their assumptions as a benchmark.

2.1. Fertility

The fertility assumptions are developed based on an analysis of the country's past trends and on assumptions and past trends in other countries. Only the projection assumptions relative to total fertility rates - are being compared; the specific context of how these assumptions were reached are not under review.
Graph 1. The fertility rates 2005-2050

Graph 1 illustrates the expected evolution of fertility rates between 2005 and 2050 in six of the seven valuations reviewed. In each case, the assumption is exogenous. The graph demonstrates that fertility rate values vary from country to country and that the evolutions in fertility rates follow different patterns.

**Chile**
It has been assumed that fertility will decline in Chile from the current rate of 2.38 children per woman to the replacement threshold of 2.1 children per woman, using a logistic regression, and thereafter to keep this rate constant until the end of the projection period. It has been assumed that the replacement threshold will be reached in 2021.

**Saint Lucia**
A similar assumption to Chile has been made for Saint Lucia. It has been assumed that the current rate of 2 children per woman will decline to 1.9 children per woman by 2021.

**Ghana**
A similar assumption has also been made for Ghana. It has been assumed that the current rate of 3.81 children per woman will decline to 2.1 children per woman by 2030.

**Aruba**
It has been assumed that, in Aruba, the current rate of 1.86 children per woman will be held constant throughout the entire projection.

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8 For all countries, the first years of projection are hidden and the graph starts with year 2005.

9 The actuarial valuation for Panama does not allow for a comparison of the demographic assumptions.
Luxembourg

The study for Luxembourg replicates the EUROSTAT fertility rate assumption, which sees the current replacement rate of 1.74 children per woman gradually increasing over different periods to reach a rate of 1.8 children per woman by 2022.

Cyprus

However, insofar as Cyprus is concerned, it has been assumed that fertility rates will decline from the current rate of 1.45 children per woman to 1.3 children per woman by 2017.

The assumptions vary significantly from one country to the next; however, several trends have emerged. Where countries have high fertility rates, the assumption is generally that there will be a relatively sharp decline in fertility rates over a relatively long period and that the rate will stabilise at the replacement rate of 2.1 children per woman. Where the current fertility rate is slightly above or slightly below the replacement rate of 2.1 children per woman and is still declining, the assumption is generally that the fertility rate will fall below 2.1 children per woman, again over a relatively prolonged period.

Where countries currently have a low fertility rate, the assumption is generally that fertility rates will either be held constant throughout the projection period or will increase. In fact, increases in fertility rates have been observed recently in a number of countries, particularly, European countries. This explains the assumption chosen for Luxembourg. However, a completely different assumption has been chosen for Cyprus.

Nevertheless, it is difficult to define the target value and the date it will be reached. In spite of mortality reduction, a low fertility rate over a sustained period indicates an irremediable decline of and an inevitable ageing of the population, which should encourage governments to act and to introduce conditions to improve the demographic situation. Therefore, assumptions which maintain low fertility rates over a sustained period should be applied with caution.

2.2. Mortality

Similarly to fertility rates, the assumptions for mortality are generally developed using an analysis of previous trends as well as the evolutions observed in other countries. Mortality is reviewed from life expectancy at birth. Only the assumptions are being compared; the specific context of how these assumptions were reached are not under review.
Graphs 2 and 3 illustrate the evolution of life expectancy at birth between 2005 and 2050 in five of the seven countries under review. The assumptions are, again, exogenous. The trend observed is one of increased life expectancy in all of the five countries.

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10 The actuarial valuation for Panama does not allow for a comparison of demographic assumptions. Ghana has been excluded because mortality rates in Ghana are significantly higher than in the other countries, thereby preventing a comparison.
**Luxembourg**
Between 2005 and 2050, male life expectancy will increase from 75.8 years to 80 years and female life expectancy from 81.6 years to 84.9 years, which is an increase in life expectancy of 4.2 years for men and 3.3 years for women. There is a sharp increase at the start of the projection period which then stabilises towards 2035.

**Chile**
Between 2005 and 2050, male life expectancy will increase from 73.4 years to 77.7 years and female life expectancy from 79.4 years to 84.2 years, which is an increase in life expectancy of 4.3 years for men and 4.8 years for women. The increase is maintained throughout the projection period and follows the United Nations’ assumptions under the medium variant projection.

**Saint Lucia**
Between 2005 and 2050, male life expectancy will increase from 72.6 years to 76.4 years and female life expectancy from 77.6 years to 81.4 years, which is an increase in life expectancy of 3.8 years for both men and women. The increase is maintained throughout the projection period and follows the United Nations’ assumptions under the medium variant projection.

**Aruba**
Between 2005 and 2050, male life expectancy will increase from 73.4 years to 78.3 years and female life expectancy from 78.6 years to 83.5 years, which is an increase in life expectancy of 4.9 years for both men and women. The increase is maintained throughout the projection period and follows the United Nations’ assumptions under the medium variant projection.

**Cyprus**
Between 2005 and 2050, male life expectancy will increase from 76.6 years to 79.3 years and female life expectancy from 81.5 years to 84.2 years, which is an increase in life expectancy of 2.7 years for both men and women. The increase is maintained throughout the projection period and follows the United Nations’ assumptions under the medium variant projection.

Unlike fertility assumptions, the assumptions on life expectancy are very similar. Moreover, it becomes apparent that differences in life expectancy between countries remain. In 45 years, life expectancy will increase by a minimum of 2.7 years and a maximum of 4.8 years. In three of the five countries, male and female life expectancy will increase at the same rate, which means that the difference (in years) will be held constant. In so far as Luxembourg is concerned, male life expectancy will rise sharply, thereby reducing the difference between male and female life expectancy by approximately 1 year. In Chile, however, the difference between male and female life expectancy, which in 2005 was already the most significant of all the countries, will continue to grow by approximately 0.5 years.

These assumptions are relatively classic assumptions. They assume a general decrease in mortality with different speeds and more or less equitable between men and women. Again, it is difficult to quantify this decrease. The projection for Luxembourg is the only projection which seems to assume a “limit” to the decrease in mortality, which appears to be relatively small when compared to the level already achieved. In fact, it has been assumed for all the projections that future life expectancy would increase at a significantly inferior path to the actual decrease in mortality over the past 45 to 50 years.

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**Florian Léger**
Again, there is a need for prudence when applying the assumptions formulated. It is important not to overestimate mortality in an actuarial analysis of a pension scheme.

3. Economic assumptions

While it may be natural for demographic projections to be long-term projections, the same cannot be held true for economic projections. It is also widely accepted that economic factors are generally more volatile than demographic factors. Moreover, the impact of the macro-economic framework on a social security scheme, if not properly taken into consideration in ancient actuarial valuations, is at least as important as the impact of demographic factors.

In order to undertake actuarial valuations, long-term economic projections must be made. These have been made by the seven valuations of this study. As in the paragraph relating to demographic assumptions, only the assumptions are being compared; the specific context of how these assumptions were reached are not under review. The assumptions discussed are all exogenous and are not the results of modelling. It should be noted that these are based on numerous studies, reflections, planning, etc. Three factors, only, have been studied: gross domestic product, productivity and inflation.

3.1. Gross Domestic Product (GDP)

Graph 4. *Real rate of growth in GDP, 2005-2050*

[Graph showing real rate of growth in GDP from 2005 to 2050 for different countries.]

Graph 4 repeats the assumptions made in the seven valuations. The trends observed indicate significant heterogeneity between the countries, both in the level of growth rates and in their evolution. Several countries (Panama, Luxembourg, Chile) have enjoyed strong economic growth over recent years, which explains why the projections assume relatively high rates of growth. At the same time, all the projections, with the exception of Luxembourg, assume weaker growth rates in 2050 than in 2005.

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Luxembourg
Luxembourg is the most straightforward of all the countries where a 4% growth rate has been assumed for the entire projection.

Panama
For Panama, the growth rate value has been assumed for 10-years periods. It is assumed that growth rates will be held constant during these periods. The same value has been assumed for the first two decades and will then decline for the final three decades.

Chile
It has been assumed that the current rate of growth in Chile will move towards a “target” value by the end of the first 15 years of projection. The values have been provided by the Ministry for Finance.

Ghana
It has been assumed that economic growth in Ghana is directly linked to the total demographic growth in the country. At the start of the projection, a 3% growth rate in GDP per capita has been assumed. This will decline linearly to 2.25% by 2020 and will be held constant until the end of the projection.

Saint Lucia
As far as Saint Lucia is concerned, three phases have been assumed. The first phase being from 2005 to 2010, where a constant growth rate of 2.5% has been assumed; the second phase being from 2010 to 2020, where growth will decline linearly to 2%; and the third phase being from 2020 to 2060, where growth will decline linearly to only 1%.

Aruba
It has been assumed that, in Aruba, economic growth will depend upon growth of the economically active population and of productivity, which explains the fluctuations in the trends observed in Graph 4.

Cyprus
Similarly to Aruba, it has been assumed that economic growth in Cyprus will depend upon growth of the economically active population and of productivity, but at a minimum annual rate of 3%.

Although there are similarities in the assumptions made for certain countries, significant differences, nevertheless, remain. Without wishing to call into question these assumptions, a one-percentage point differential throughout the 45 to 50 years of projection results in a 60% difference in development levels.

It has also been noted that the method used when making assumptions vary from country to country. In certain countries (Luxembourg, Panama and Saint Lucia), a direct assumption has been made whereas in other countries the assumption is linked to other factors (growth in the economically active population and in productivity in Aruba and Cyprus, population growth only in Ghana).
3.2. Productivity

Graph 5.  \textit{Growth rate of the productivity, 2005-2050}

Graph 5 illustrates the productivity assumptions used in each of the seven valuations. Relative homogeneity can be observed between the countries, at least in so far as the trends illustrated in the graph are concerned, since in five of the seven countries, it has been assumed that productivity will be held constant (or almost constant) throughout the projection. Only Chile and Ghana differ. However, the level of productivity differs significantly from one country to the next.

\textbf{Luxembourg}

For Luxembourg, it has been assumed that productivity will be held constant throughout the projection and the value retained is a function of the developments observed in productivity over the past seven years.

\textbf{Panama}

Similarly to the GDP projection, the projection for productivity in Panama has been assumed over 10-years periods. The value for each period is fixed in order to achieve a “target” unemployment rate; there is relatively little difference from one decade to the next.

\textbf{Chile}

The productivity growth rates for Chile have been provided directly by the Ministry for Finance.

\textbf{Ghana}

Productivity in Ghana is the result of growth in GDP and employment rates (assumed to be equal to the rate of growth of the economically active population).

\textbf{Saint Lucia}

It has been assumed that productivity in Saint Lucia will be held constant throughout the projection and that the rate of productivity will be 0.75% per annum.
Aruba
It has been assumed that productivity in Aruba will be constant throughout the projection and the rate of productivity will be 1% per annum.

Cyprus
It has been assumed that productivity in Cyprus will be constant from 2007 for the duration of the projection and that the rate of productivity will be 3% per annum.

Similarly to GDP, while the assumptions may be similar for certain countries, significant differences, nevertheless, have been observed. This can be explained by historic differences where continuity in a country’s performance has been assumed.

The differences can also be explained by the context of the review. An actuary undertaking an actuarial valuation of a pension scheme where benefits are index to inflation and not to salaries (which growth rates are generally assumed to be equal to productivity growth rates) will be inclined to take a conservative assumption and not overestimate growth in productivity in order not to underestimate the cost of the scheme.

3.3. Inflation

Graph 6. Inflation rates, 2005-2050

Graph 6 illustrates the inflation assumptions that have been retained in six of the seven valuations. Only Ghana has been excluded from the graph because it is the only country of the seven countries which has high inflation rates. As in productivity rates, there is significant homogeneity between the valuations since it has been assumed that inflation would remain constant for all the countries throughout the projection (with the exception of Aruba for the first decade). However, it can again be observed that inflation rates vary from country to country with a maximum inflation rate of almost double the minimum inflation rate.

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**Luxembourg**
Luxembourg has the lowest inflation rate (1.7) of the 6 countries, which is explained by both the historically low inflation rates in Luxembourg and the inflation rate policy of the European Central Bank.

**Panama**
Panama has fixed its inflation rate at 2% per year. This relatively low rate has been chosen in order not to underestimate the cost of the pension fund (whose pensions are not indexed).

**Chile**
Inflation has been fixed at 3% for Chile.

**Saint Lucia**
Inflation has been fixed at 2.5% for Saint Lucia.

**Aruba**
For Aruba, it has been assumed that inflation will decrease linearly from its present rate of 3.5% to a rate of 2.5%, after an initial period of ten years.

**Cyprus**
Inflation has been fixed at 3% for Cyprus.

As with GDP and productivity, differences have been observed between the inflation rates retained for the projections. This can certainly be explained by the differences in inflation rates previously observed for the six countries.

These differences can also be explained by the context in which the review is undertaken. An actuary undertaking an actuarial valuation of a long-term pension scheme where the benefits are not indexed will be inclined to choose a conservative assumption in order not to underestimate the cost of the scheme.

### 4. Conclusion

The review of the different actuarial valuations has enabled a comparison of certain demographic and economic assumptions. Even when a common methodology has been applied, differences in demographic and economic assumptions have been observed. The actuary retains control of the quantitative choice of the assumptions. Even if this appears to be a logical way forward, the question arises as to whether future standards or guidelines governing actuarial valuations of social security systems should consider the question of quantifying certain assumptions.

Finally, consideration should be given as to whether there should be greater integration of demographic and economic assumptions; in other words, should greater consideration be given to their interdependencies since, in the long term at least, the demographic situation of a country is closely linked to its economic situation.

This review has been limited to several factors only and it would, of course, be interesting to widen its scope to include a comparison of how the demographic and economic assumptions of the different scenarios presented within a study were arrived at. It would also be extremely interesting (and almost an obligation) to compare the different assumptions made for several successive valuations of the same scheme.

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