New Challenges in Accounting and Finance

2019(2)1–10

Models of Analysis of the Social Security System's Financial Balance

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Received *12 May 2019* ***Accepted*** *05 July 2019*

ABSTRACT

The financial balance of each country's social security system is a concern for countries, professional groups, and individuals. If the first social security systems were based on the principle of social solidarity and objectively the financial resources collected from the active generations were sufficient to cover the risks of the social security branches, nowadays the supporters of this principle are fewer. An objective problem is also the achievement of the system maturity state that occurs after 60-70 years after the scheme's development that is almost after a period equal to a generation's age. For the projection of social security models, demographic, economic, fiscal and legislative variables are typically used. In this article, the researcher approached the social security models. Since between social security and demography there is a biunique relationship, the researcher presented econometric and OLG models.

Keywords: *Social Security, Pensions, OLG Models, Social Solidarity*

1. Introduction

The actuarial studies carried out by social security researchers have shown that a national social security system has three main stages: the introduction of the pension scheme, maturity and the steady state. If the early systems at the end of the nineteenth century and the beginning of the twentieth century were based on the principle of social solidarity, the evolution of the systems gave priority to the principle of contribution.

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There is an objectionable requirement to making changes to a pension scheme's parameters, so to reform it.

In the first phase of a pension scheme, a large number of generations contribute to the accumulation of funds and the number of beneficiaries is low. Annually, the labor force grows with another younger generation. The scheme is generous and the benefits are sufficient for old generations.

If the new generations are not of sufficient size to compensate for the size of generations that leave the active generation, respectively the workforce, then the pension scheme administrator is obliged to take steps to maintain a steady state between accumulation and distribution of resources. He has a financial balance and has the obligation to maintain it in balance.

Worldwide, at the end of the twentieth century reforms of pension systems began. Some states, brave enough, have introduced the system of individual accounts. The general trend is to maintain the social security system and the emergence of complementary systems, with a mandatory or optional private character. This diversification of pension schemes shows that the state confirms the existence of difficulties in managing financial resources. In a public social insurance system, the state has the role of Administrator.

In order to reestablish the financial balance of the pension scheme, we observe that the Administrator uses two options: increasing standard retirement ages and implicitly increasing standard contribution periods and, on the other hand, diversifying pension schemes by introducing the multi-pillar pension system.

Between demography and social security thee is a direct relationship because the main source of funding for the public pension system is the transfer of financial resources between generations, from generations currently active to generations active in the past and beneficiaries today. Although one of the general rules of funding in the social security system is the rule of intergenerational equity, it can not be permanently respected, because either the generations are not equal in size or in the economy there are not permanently produced equal quantities of goods to ensure a constant level of funds.

In Romania, in the years 1966-1970, there appeared generations that were "big" compared to previous generations, situations faced by other countries sooner or later. In this context, demographers and actuaries were interested in predicting the demographic potential of the country. The researcher also has this particular concern, in whose opinion it is very important to know the structure of generations by age groups.

The existence and appearance of large generations must not be a cause for concern for pension systems, and these briefly presented issues demonstrate that the modeling of social security systems is always necessary.

The types of models chosen by actuaries must include OLG models and econometric models. Solving this "problem" must begin with the reality that multiple generations coexist in a pension system.

The researcher proposed to answer the following questions:

1. To what extent can the financial equilibrium in a pension scheme be ensured by using OLG models?
2. Are high-dimensional generations a concern for pension systems?
To find answers I conducted a case study for the Social Security System in Romania.

Literature Review

From Maurice Allais (1947) to Samuleson (1958), orfrom Galenson (1949) to Edmund Phelps (1961), social security models were based on the overlapping generations concept.

The purely theoretical models designed by Allais and developed by Samuelson and Diamond have been put into practice since 1987, when the demographic boom has reopened the interest of researchers to create large-scale models with more generations.

Pieter Diamond (1965) built an OLG model with an aggregate production sector.

Paul Samuelson (1975) developed the Modigliani model to determine the optimum in a social security system based on the life cycle theory.

The redistribution of resources between generations has been studied by Aaron, H.J. (1966), Boadway (1989), Wildasin (1989), Verbon (1989), Diamond (1996), Corsetti, Schmidt-Hebbel (1997), Belan, Pestieu (1998), Altig, Auerbach, Kotlikoff, Smetters and Wallser (2001).

Auerbach and Kotlikoff, concerned about the numerical growth of generations born in the 1940s and 1950s, have extended the OLG models, including social security as a sector of the model. Auerbach and Kotlikoff (1987) used 55 life cycles' periods to simulate the model.

Miles (1999) has built many models to analyze the implications of changes in age profiles of populations, economies and fiscal policies. The study realized by Miles focused on analyzing the saving up rate on age groups in developed countries.

TuralayKenc and SerdarSayan (2001) have used the results of an OLG applied model in which they studied trade in a middle-income country at the beginning of the demographic transition period towards an aging population. They argued that trade and capital flows are channels of lower income countries through which they are importing the effects of an aging population. According to SerdarSayan(2002), the demographic transition started earlier in industrial countries than in developing countries, the share of the elderly population has reached critical, which has led to management problems in the public pension system. He pointed out that the low share of the working age population raises problems related to the diminishing of labor supply in the domestic market.

Sayan anticipated that the differing levels of consumption of older generations from the consumption of younger generations will have the effect of changing the saving up ratio from national income as well as changes in consumption patterns. Demographic developments will affect the economic growth patterns of highly industrialized countries' economies, as well as the allocation of labor resources worldwide. The "whitening" of richer nations as a repercussion of globalization is detrimental to them, but it is a serious phenomenon that leads to the deepening of poverty in the countries where the population exodus occurred.

Chicon (1999), Plamondon, Drouin, Binet, McGillivray, Bedard and Perez-Montas (2004) show that models will combine knowledge from the social, economic, demographic and actuarial spheres to develop long-term economic vision and transfers to the social systems which they called actuarial socio-economic models. They have demonstrated, using a stylized demographic model with generations of equal size, that pension systems can reach maturity. If the parameters of the pension system are not changed, the saturation state and the bankruptcy of the pension scheme can be reached. Thus, it follows that all pension systems need to be regularly reformed.

Poutvara and Marko Kőthenbűrger (2006) developed the idea of a Pareto-type optimization in the case of the redistribution of income between generations

In Romania, the preoccupation for the study of the 85 generations is illustrated by Carp (2012), which made a population's projection based on components until 2040, starting from the interest of studying and shaping the balance of social security system in Romania.

Anton-Carp and Carp C. (2009) analyzed the social insurance system in Romania.

Starting with 2012, Carp has designed an alternative pension model. This model is a benefits-correlation model, where the mandatory contribution period is 25 years and the emphasis is placed on the role of voluntary contributions and the application of the contribution test

Anghelache, Carp (2016) tackled the issue of voluntary contributions to the social security system. The same authors made econometric models for the analysis of the social security system in Romania.

Methodology and Data

To find answers to the research topic, we used actuarial methods and techniques, regression models, main components' method and OLG models.

The models of overlapping generations take into account the demographic factor, the secular trend of population's evolution, but also the long-term effects due to birth and mortality variations influenced by socio-economic circumstances. To answer some of these topics, without exhausting the multitude of solutions, we performed analyzes of historical and predicted data and made assessments. Historical statistical data was taken from the official specialized institutions.

The study was conducted on the Social Security System in Romania on the existing data for the period 1950-2018. For the years 2017-2018 we analyzed the simplified model with 3 sectors.

Using demographic data for the 1950-2018 period, we have estimated the 85 generations on the 2018-2035 time horizon, which are part of an 85-generation OLG model.

We used several methods to estimate the size of generations, including the main components' method for designing the total population.

For the design of new generations, we performed a laborious actuarial calculation that we made assuming the constancy of rates for each generation. For new generations, we used as initial data the mortality rates on the basis of which we determined the survival index and probability of survival. The number of people in a generation going to the next age depends on these rates. Forecasts have been made taking into account rates by age group.

In this study we pursued the analytical design of the population by age and gender. For this purpose we investigated a series of demographic indicators that are factors of influence.
The methods used were: the average growth method, the average annual growth rate method and the correlation method.

The correlation method has highlighted the link between the change in the total population and fertility rates, the gender-based mortality rate, birth rate, marriage number, divorce rate, emigrants and immigrants numbers.

As population evolution fluctuated with cyclical trends over time, using the Lewest Square method in the Ewies program and the adjusted series since 1992, the following regression model emerged:
P = c(1)* P(-1)+c(2)*P(-2)+c(3).
The model equation is:
Populatia=0.8401209244*Populatia(-1)+1.043613461e-008*Populatia(-2)+2.996895951
@IDENTITY POPULATIA = 0.8401209244 * POPULATIA(-1) + 1.043613461e-008 * POPULATIA(-2) + 2.996895951

Estimation settings: tol= 0.00010, derivs=fast numeric (linear)
POPULATIA=C(1)*POPULATIA(-1)+C(2)*POPULATIA(-2)+C(3)

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	0.840121	0.057888	14.51290	0.0000
C(2)	1.04E-08	2.10E-08	0.495949	0.6271
C(3)	2.996896	0.980360	3.056933	0.0080

R-squared	0.952394	Mean dependent var	16.94749
Adjusted R-squared	0.946046	S.D. dependent var	1.679075
S.E. of regression	0.390016	Akaike info criterion	1.105752
Sum squared resid	2.281682	Schwarz criterion	1.254147
Log likelihood	-6.951766	Durbin-Watson stat	1.771101

Any modeling in a pattern of overlapping generations can begin with the generations' projection.

Using the population projection components' method (analytical forecasting method), we considered the number of overlapping generations. The 0-year generation has the probability of 99.8236% to survive in the first year of life. Generations ranging from 1 year to 85 years were calculated on the basis of the formula:

$$P^{*}_{x+1} = P_x x p'_x$$

The regression model of the Children_0 years variable was obtained using the LS method, in which the independent variables are the total population and fertility rate.

For the rest of the generations, regression models were made on age groups and based on the idea that switching to a higher generation depends on the size of the previous and current generations and also on the mortality rates specific to the groups.

We consider the groups of young generations 0-4 years; 5-9 years old; 10-14 years old; 15-19 years and the Vector of Young Generations, whiletime isi..

For example, generation (V_{5-9}) has been dimensioned on the basis of a multivariate regression model, in which the dependent variable was (C_{5-9}), which represent the number of children aged from 5 to 9 years old. The independent variables are (C_{0-4}) from the year *(t-1),* (C_{5-9}) from the year *t* and mortality rates (r_{0-4}) from the year *t-1* and (r_{5-9}) from the year *t.*

The regression models for each generation were tested by applying appropriate econometric tests.

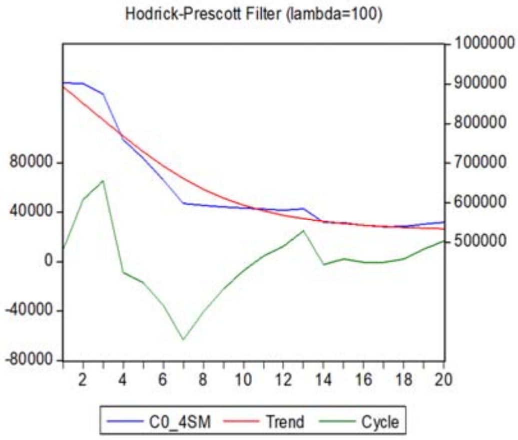


Figure 1: Generation of 0-4 years results

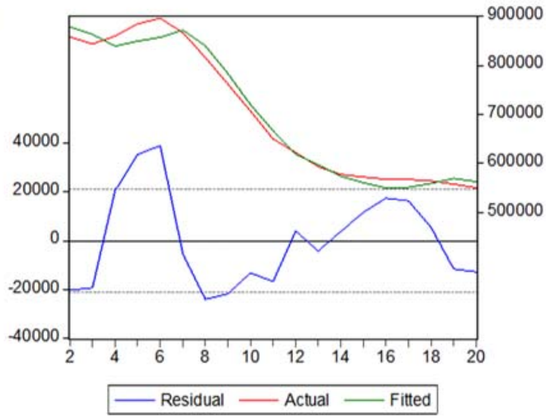


Figure 2: Generation of 5-9 years-results

Generations of 85 years old and over, for whom there are aggregate data published for all generations, were considered as having 85 years old. The probability of survival used was that of the 84-year-old generation, that is 83.2971%.

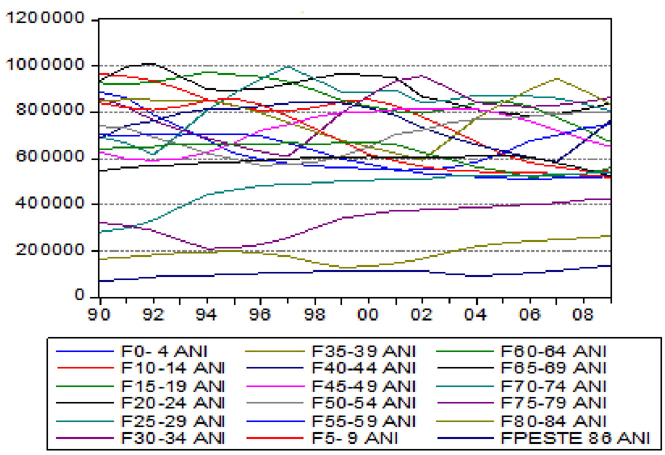


Figure 3: Generation of 0-85 years-women-results

The working hypothesis is that at the age of 100, each generation is extinguished.

The second hypothesis was that external migration is assimilated to the natural extinction of the generation. Over time, modeling problems are different for new or older generations.

The time horizon for which we made assessments was in the years 2030-2035, a period when it occurs the reaching of the retirement age of generations born in the period 1967-1968, of high dimensions.

The OLG Model with 3 Sectors

Any analysis of a social security system is based on studying the demographic evolution using an OLG model with at least three sectors: the population aged 0-19 years, the population aged between 20 and 64, the population older than 65 years. These sectors are components of a simplified OLG model. The 85 generations were grouped into the three components, taking into account the specific social security legislation: the young population; the employed population; the generations of pensioners.

On 01.01.2018, according to statistical data, the structure of the resident population in Romania was:Figure no.4- Population by age groups – Romania- 01.01.2018

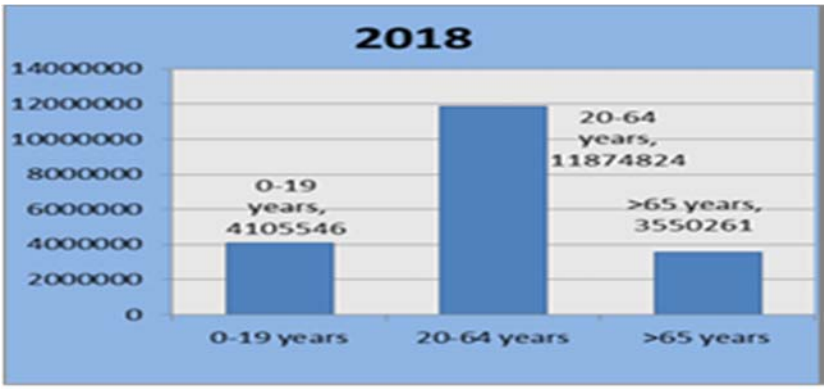


Figure 4: Population by age groups Romania 01.01.2018

It follows that the share of beneficiaries in the Social Security System is 18.17% of the total population existing on 01.01.2018 in Romania, while the population in the 20-64 age group has a weight of 60.80%.

The OLG Model with 85 Generations

Following the studies conducted and the application of the 85-generation prediction model, the following aspects resulted:

From the 1967-1968 generations, the largest generations, there were only 423,243 people in the 1967 generation and 425,412 people in the 1968 generation at the 2010 level. For these generations who will retire after 2030, there is still a question of finding the right benefits. Or, an OLG model does not involve direct correspondence between an active generation and an inactive generation, but between generational groups. From the graphic image shown in Figure no. 6 it can be seen that the generations 1982-1989 can coalesce for the future support of the generations 1967-1971, represented graphically in Figure no.5.

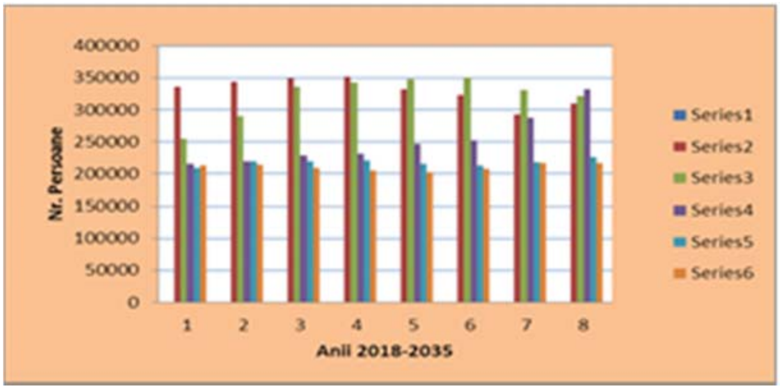
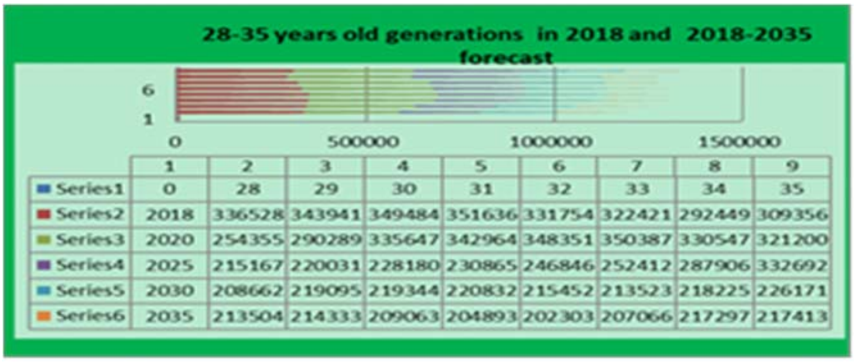


Figure 5: The generations of 1967-1971, projection realized by author

For generations 1967-1968, two generations born in 1982-1989 are needed to provide the necessary contributions. In the context of raising standard retirement ages, there is no longer the question of direct correspondence between two generations in one of the two sectors of an OLG model.



	1	2	3	4	5	6	7	8	9
Series1	0	28	29	30	31	32	33	34	35
Series2	2018	336528	343941	349484	351636	331754	322421	292449	309356
Series3	2020	254355	290289	335647	342964	348351	350387	330547	321200
Series4	2025	215167	220031	228180	230865	246846	252412	287906	332692
Series5	2030	208662	219095	219344	220832	215452	213523	218225	226171
Series6	2035	213504	214333	209063	204893	202303	207066	217297	217413

Figure 6: The generations of 1982-1989, projection realized by author

Conclusions

OLG models are increasingly needed it the analysis of social security system. The use of simplified model with 2 or 3 sectors can be done in the short term only to perform a concise analysis of the balance in a pension scheme.

Even though the presented analysis focused mainly on quantitative, generational dimensioning, the results are only part of comprehensive study.

Because social security schemes are designed on a long-term basis, the 85- generation OLG model becomes very necessary and useful.

When there is no direct correlation between generations in the last two sectors of a 3 segment OLG model, actuaries can find appropriate solutions.

Considering the idea that in the future the social security system is no longer sustainable is denied by the results of this study.

The fact that generations are of unequal size must not worry, but only be analytical elements of social security systems.

The OLG models are needed and current. Even if the "OLG model" term is not commonly used, structuring the population in the three major sectors is in fact a simplified model of this type.

In the view of the researcher, the use of 85-generations OLG models is necessary to ensure that the parameters of a pension scheme are kept for a longer time.

At present, benefits are projected into the social security system by taking into account the resident population. By applying international social security regulations it results that the non-resident population retains their social security rights in proportion to the period of activity in each country.

Respecting the principle of social solidarity implies that regardless of the numerical size of a generation, interests must converge to the same goal, which is the correct dimensioning of benefits in the social security system.

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