Simulation of the Ecuadorian Social Security Institute Funds Sustainability Addressing Government Contribution to Retirement Pension in 2015

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Abstract*– The Ecuadorian Social Security Institute (IESS) operates on the principles of solidarity, obligatoriness, universality, equity, efficiency, sufficiency and subsidiary. However, its distribution system is easily affected by changes in demographic variables and the Government reduces the system volatility by subsidizing some liabilities. In April 2015, the Government announced a new reform which stopped a 40 % compulsory contribution to the social security retirement pensions. Some analysts affirm that the IESS cannot be sustained longer than 10 years with its current operational features. This study seeks from an impartial academic perspective to simulate the social security system using the system dynamics methodology including demographic and macroeconomic variables in order to determine the number of years that the IESS can operate. Because of this simulation, different policies were tested in order to get a correct path to funds sustainability. As a final conclusion to this model, In Ecuador, eliminating the subsidy in 2015 without changes in the IESS operations would reduce the funds until exhausting them in 2030. If the expense parameters per enrollee could vary as simulated in the Monte Carlo process showed in this paper, it is more likely that the funds run out between 2028 and 2039.

***Keywords*-- Social Security System, Social Security System, Sustainability, System dynamics modelling**

I. Introduction

The Ecuadorian Social Security Institute (IESS) was founded in September 1963. Since its origin, the organization and operation has been based on the principles of solidarity, obligatoriness, universality, equity, efficiency, sufficiency and subsidiarity, in order to protect the population against possible contingencies like sickness, unemployment, disability, and life events like maternity, senior age and death, as prescribed by the Social Security Law [1].

The IESS is a social consensus in which the citizens who could contribute more help to cover the costs of those who contribute less. The obligatoriness is established by the Ecuadorian law which enforces that all employees must be affiliated to the IESS; otherwise, the employer can be sued in the Ministry of Labor. Universality means that their affiliates can be from any industry and any hierarchy range. There is also the possibility of voluntary affiliation for freelance professionals and a special insurance for farm workers and their families. Equity is to provide the same quality services to all the members without prejudice, and the efficiency can be proved in their qualified professionals, a faster paperwork management, and satisfaction of the affiliates' necessities [1]. In this study, we will discuss about these last two principles: sufficiency and subsidiarity.

The social security benefits are financed by the employees' contributions, independent professionals' contributions, voluntary contributions and State contributions. The affiliation implies a contribution rate computed from the net salary, in which one part is assumed by the employer and the other by the employee. This contribution will vary depending on the activity and the sector in which the person works, being 20.5% to 41%, and is used to cover the following areas: 10% for disability insurance, retirement pensions and death compensations; 0.1% for the Organic Law on Disabilities; 5% for Health Insurance; 2% for workplace risk insurance; 2% for unemployment insurance; 0.4% for the Rural Social Security, and 3% for administrative costs [1].

The Ecuadorian National Institute of Statistics and Census reported a population of 16,250,167 inhabitants for 2015 [2]. The economically active population is approximately 7.3 million people. In recent years, the Government has sponsored labor reforms in which compulsory affiliation in the IESS for all workers was established for both private and public sector. In November 2014, 3,123,467 citizens were affiliated to the IESS, which is a significant growth of affiliates regarding historical data [3]. For this reason, the income of the IESS has been trending positive according to data from the IESS National Collection and Portfolio Management Office, as represented in Fig. 1.

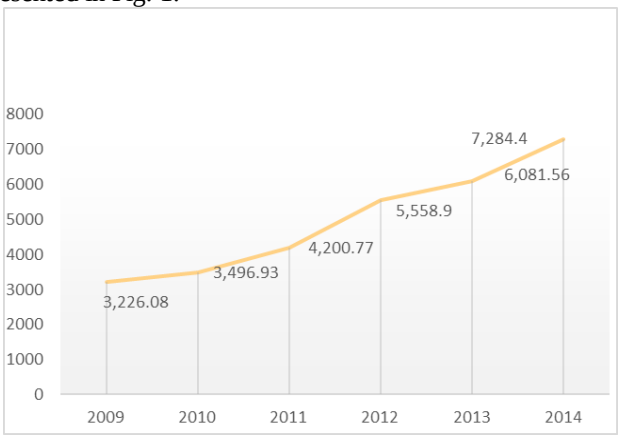

Fig. 1 IESS Income Evolution (USD$ Million).

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In April 2015, the Government announced a new reform which cut off the 40% compulsory contribution established in the article 237 of the Social Security Act [4]. Other national authorities brought up the principles of sufficiency and subsidiary because some analysts suggest the IESS current situation could not be sustained in a period longer than 10 years. On the other hand, the Government official position presented that the IESS can reach long-term sustainability with its current resources and that the population does not have to be worried about their retirement. This study, from an impartial academic perspective, looks forward to simulate the social security system operations to ensure the income of the retirees, health services, mortgage loans and other fields in which the IESS is crucial for the Ecuadorian economy.

The aim of this paper is to present a model, using the system dynamics technique, to observe the behavior of the IESS funds over the next 20 years, and determine the number of years that the IESS could operate with the current processes, perform a sensitivity analysis, and apply a non-deterministic process to estimate a range of sustainability duration. The authors will proceed to model a causal diagram, containing the variables interacting in the system, design a stock and flow chart to upload the system to the Vensim® software, simulate different scenarios, run games, and systematize the findings to provide recommendations to the IESS authorities.

The social security system is administrated as a public social system designed one hundred twenty years ago in Germany based on the principle of solidarity, in which the economically active population finances the benefits of senior citizens [5]. Nevertheless, this scheme is reliable for short-term periods because financing the social security with this framework is affected by changes in the demographic variables and the macroeconomic trends in the long run [6]. The flaws in the Latin American social security systems in which demographical changes have driven to the revaluation of their retirement pension policy [7]. The instability of a social security system is one of the crucial issues for the population, especially since many systems are facing sever crisis around the world [8].

An example regarding social security sustainability is the Ireland social security during the Celtic Tiger period. There was progress in terms of social welfare generosity of Ireland's social security system, nevertheless the Irish Government didn't search how to raise the revenues to finance these, so when the crisis came, Ireland's social security had to retrenchment [9]. For these reasons, it is necessary that countries take action about the financing means of the social security system.

The government of every country plays a key role in this issue, to get an efficient social assistance system is necessary a set of intergovernmental grant policies ensures the operation of the social welfare program and a good financial arrangement [10]. Governments around the world are considering alternative social security designs and the allocation and management of risks, one of this is the system based in a private scheme and an improvement of voluntary superannuation schemes, as Australia did it [11]. In Latin America, the first country to reform its system and partially privatize it was Chile in 1981 [12]. After this experience, Bolivia, El Salvador, Mexico, Argentina, Colombia, Peru, and others, took the Chilean model as a social security archetype.

On the other hand, countries like Brazil has maintained the public sector role as the main social security provider. It has been dedicated to create additional resources, and look for another alternatives for the sustainability of the social security, like postponing the retirement age, eliminating "seniority retirement", eliminating another multiple benefits and dissociating the minimum wage from the minimum benefit, the last one would have a larger impact in the long run [13].

After applying a system dynamics model, and analyzing the social security system problems, it was concluded that age-specific survival probabilities, a lower rate of population growth, and a reduction in the rate of labor productivity growth cause insufficient contributions to finance the social public system, so that the contributions of the active population cannot guarantee the financial resources demanded by the passive population An increase in the retirement age is necessary [14] [15]. For these reasons, in Chile, the contribution rate, total of contributors as a proportion of the labor force, is around 60%, meanwhile in countries such as Colombia, Mexico and Peru the contributors do not exceed 40% [16].

The sustainability of social security systems continues to be a global controversy issue, even more considering the current socio-economical conditions. Studying the Romanian case, the decreasing number of employees, from 8.1 million in 1990 to 4.7 million in 2010 struggling to afford a 36.3% contribution rate to maintain 5 million pensioners [8]. Similarly, countries who belong to the Organization for Economic Co-operation and Development (OECD) encounter these difficulties. According to a survey in Germany and Italy, people expected that the social security system will collapse in 10 to 15 years because the social security tax rates will not be sufficient to finance the outstanding pension benefits, especially for the large number of older adults [17].

The relevance of the social security pension resides the fulfillment of the human rights for older citizens, likewise, pensions can also be seen as investments in local economies and human capital development [18]. This is the main income for the elderly in urban China like in the rest of the word, there the majority of people aged 60 and over receive a pension [19]. Actually, old-age social security programs legally cover only 42 per cent of the world's working-age population and only 40 per cent of the worldwide population above the legal retirement age [6].

This paper aims to analyze the financial sustainability of the Ecuadorian Institute of Social Security applying system

dynamics, including the current subsidy removal over the retirement pensions. System dynamics is a versatile technique used in studies regarding this area. For instance, the fiscal financial dynamics applying system dynamics to analyze the economic development achieved due to oil exports income [20], a sustainable manufacturing process that involves interaction of multiple complex systems including those in manufacturing, environmental, financial, and social dimension [21], a sustainable finance model which links both the real economy to the financial system and money supply in the United States [22] are applications of this methodology among other areas of knowledge.

II. METHODOLOGY

In order to simulate the Ecuadorian social security system will be used different available information sources. Among which can be emphasized the consolidated budget reports IESS 2013, INEC reports, and reports of the Guayaquil Chamber of Commerce. The data used for the simulation from the year 2013 to 2033 and the details of the variables those build the system passed the modeling and unit's tests.

Jay W. Forrester, a professor of the Massachusetts Institute of Technology MIT, developed system dynamics during the mid-1950s. Based in his knowledge in engineering and management, he fostered this method to understand the dynamic behavior of business and social science topics. System dynamics was defined as a perspective and set of conceptual tools that enable us to understand the structure and dynamics of complex systems [23]. This rigorous modeling method builds a formal computer simulation to design more effective policies and organizations.

System dynamics is a method that decompose a complex social or behavioral system into its different components to analyze how they interact and, then, integrate them into a whole network that can be easily visualized and simulated [24]. It is based in two major principles. The first is that stocks, flows, and delays determine the system behavior and the second is bounded rationality which is to concentrate on the variables that are crucial to the problem and its context.

A great diversity of applications to this technique can be reviewed in physical, engineering, life, and social sciences. System dynamics was applied in a simulation model to evaluate Uganda´s power sector and its expected evolution over 80 years in terms of power supply and demand [25]. This methodology was also used to model and encourage macro and meso-level analysis of traffic safety policy [26]. It was applied for business portfolio simulation introducing dynamics into the static BCG model and identify its fatal flaws [27].

Another application on the economics and business research are illustrated in rural and social economic interaction [28], macro-micro modeling for field services [29], and for project management [30]. This methodology also can be fusion with other techniques like soft systems methodology to study social problems, for example the citizen insecurity problem in Argentina [31]

The models are represented by causal-loop diagrams. These are used to show relevant elements in the system and the relationships that exist between them [32]. A casual diagram involves three types of elements: level variables, flow variables and auxiliary variables. The level variables are those whose evolution is significant for the study of the system. Flow variables are those variables that determine variations in the level variables and characterize the actions taken in the system which are accumulated in the corresponding levels. Auxiliary variables represent how the flow variable is decomposed from the values taken by the levels; its purpose is to facilitate the valuation of the flow variables [33] [34] [35].

Sensitivity analysis is a useful tool for the analysis of system dynamic. This tool measures the impact of an infinitesimal parameter change on the behavior of the system, including derived functions of its output, and in this way analyze the results [36]. Manual sensitivity analysis requires changing the value of one or more constant and makes a simulation, change the value of the constant back and simulate again and repeat this action many times for a range of output values [37]. Therefore, sensitivity analysis can be applied in different fields, like in model reduction, and stability analysis, which is the application we chose for this research.

Monte-Carlo simulation, also known as Multivariate Sensitivity Simulation (MVSS), performs an automatic sensitivity analysis. A Monte-Carlo simulation replicates the results of a system to produce a sample of different random-process sample functions. Applying these functions, the study could generate hundreds or thousands of simulations with modified constants over a range of values, and then save the results to estimate a result interval. The reliability of this model is to consider an hypothesis analysis from this result with the real system.

III. SYSTEM DYNAMIC MODEL

The social security system is based on a demographic pyramid where young people contribute during their working life to finance the elderly. Fig. 2 illustrates this demographic behavior in Ecuador. There is a positive loop because a higher number of births is generated by the current adults.

After modeling the demographic loop, it is necessary to establish which are the main income sources and expenses for the IESS funds as in Fig. 3. Working adults contribute with their salary to the IESS, while the elderly receives a retirement pension proportional to their higher contributions during their labor life. Before 2015, 40% of these pensions was covered by the Government.

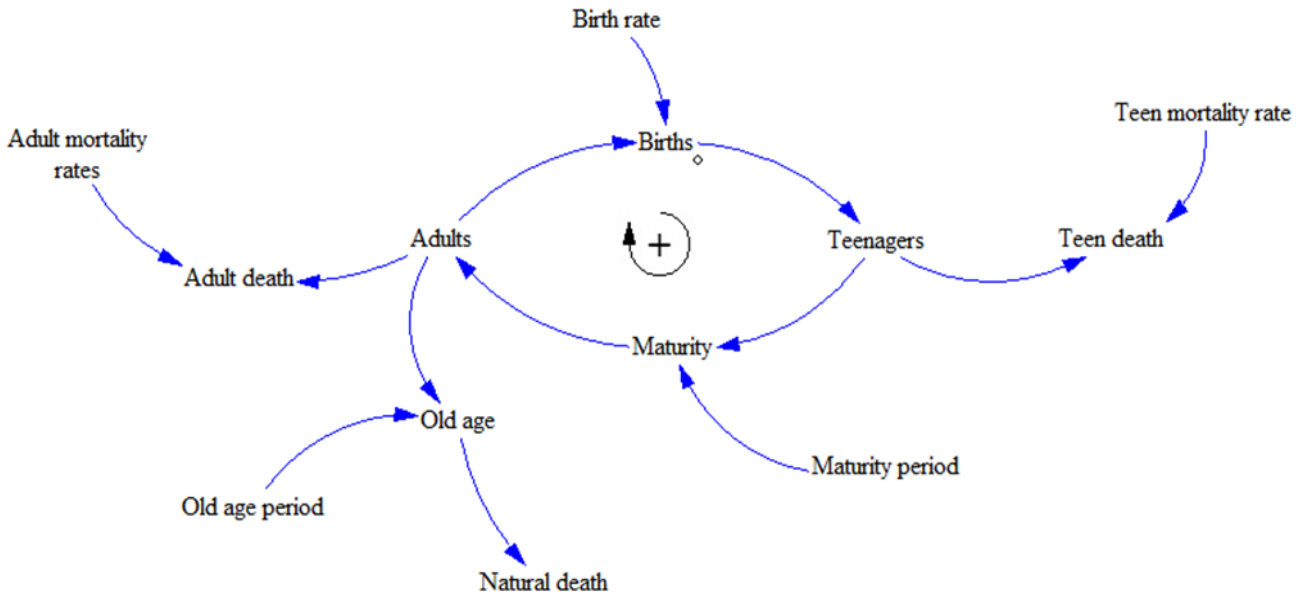

Fig. 2 Demographic behavior in Ecuador.

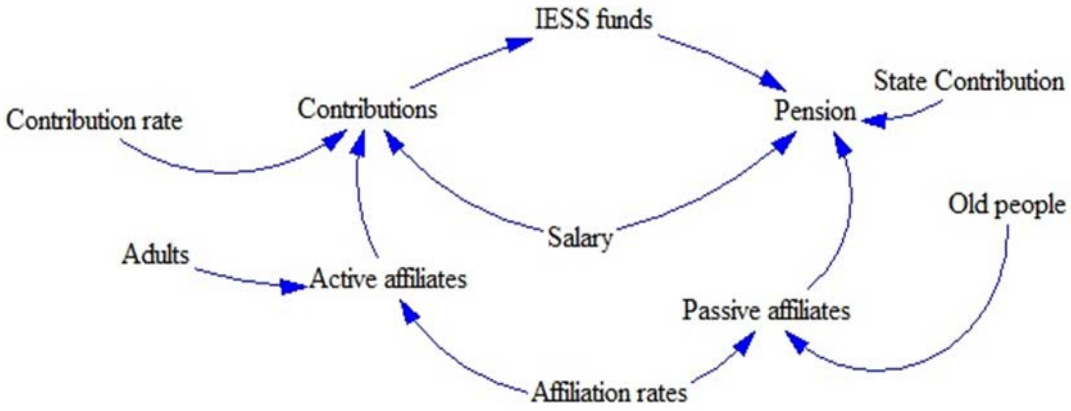

Fig. 3 IESS main income sources and expenses.

Besides the contributions from active members, the IESS also earns financial returns from the investments. These capital investments come from the contributions and includes bonds, stocks, investment funds, loans or and other types of credits extended to the affiliates. The process to invest and earn interests generates a positive loop in the system because a

Finally, in Fig. 5, we account other money outflows like operating cost, infrastructure investment, and other services for the citizens said health expenses as the most representative.

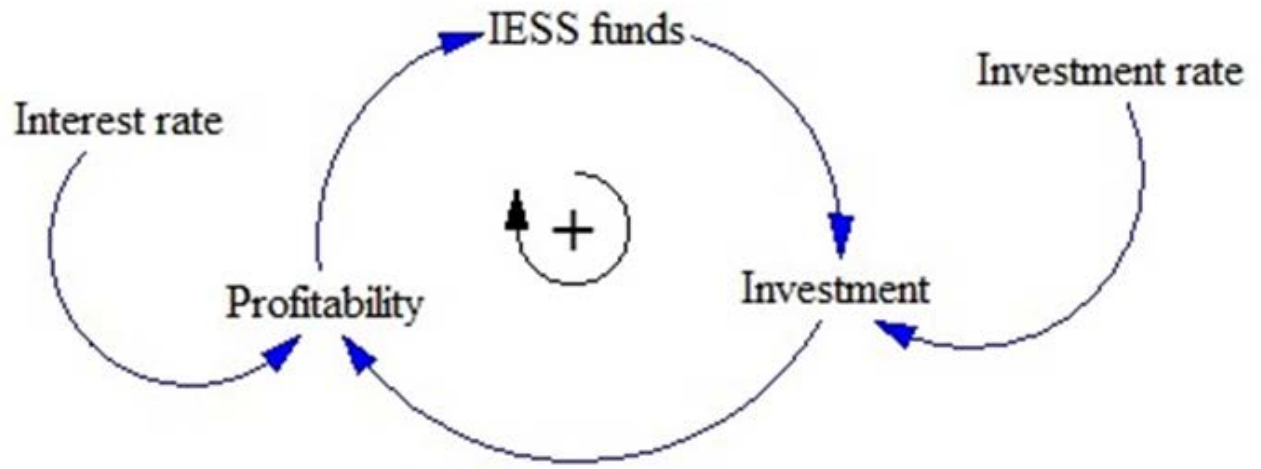

Fig. 4 IESS secondary income sources.

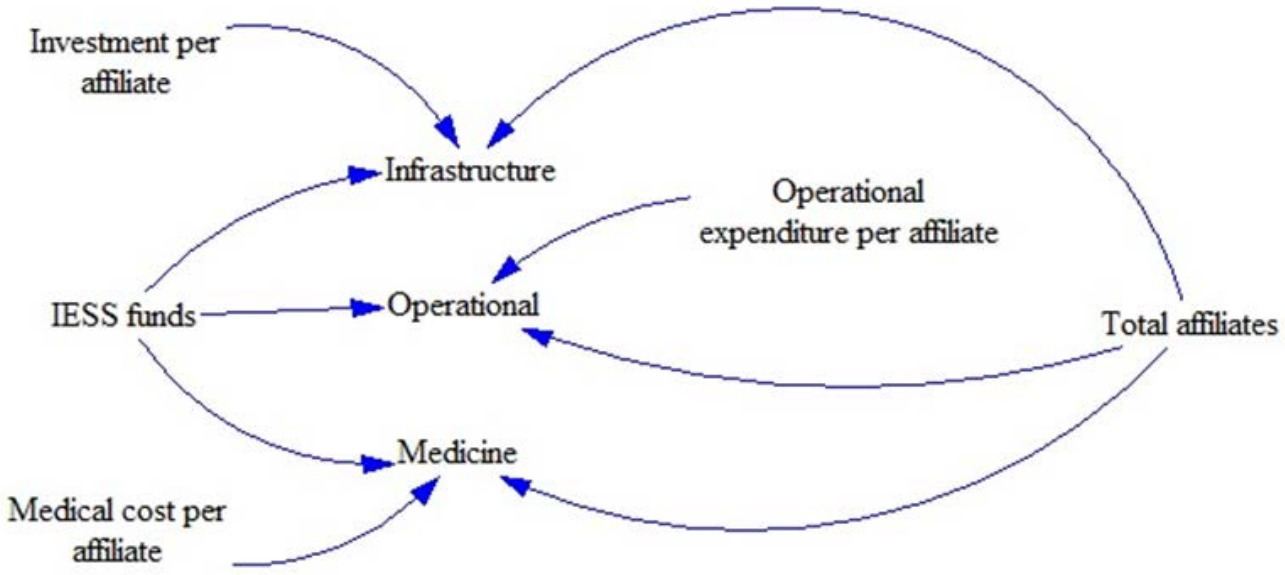

Fig. 5 IESS Other Expenses.

In order to model the causal diagram in an application, the authors developed a stock and flow chart to establish level, flow and auxiliary variables. The IESS stock and flow diagram is presented in Fig. 6.

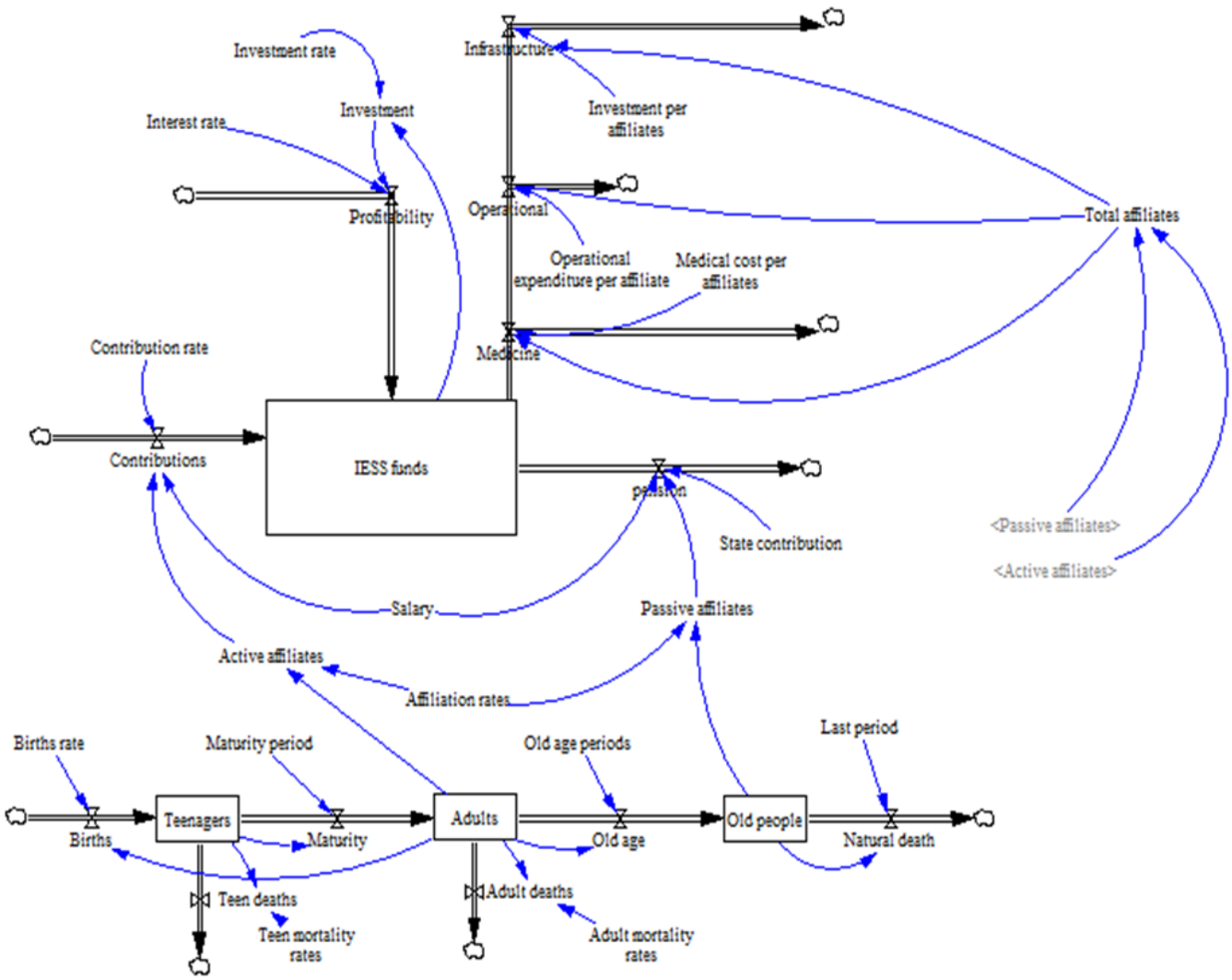

FIGURE 6. The IESS stock and flow diagram

IV. SIMULATION: SENSITIVITY ANALYSIS AND DISCUSSION

Analyzing IESS funds until 2033, the simulation shows that removing Government support leads to funds scarcity for 2030, 18 years after this measure, ceteris paribus. By contrast, in the scenery where Government does not withdraw the retirement support, IESS funds grow exponentially (see Fig. 7).

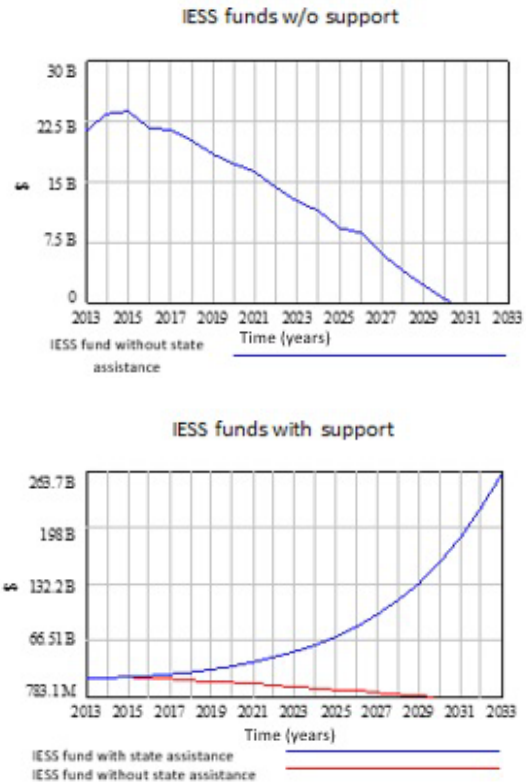

Fig. 7 IESS funds Simulation with and without Government support.

The Fig. 8 shows increasing 0.5% in the affiliate's contribution rate significantly improves IESS funds balance around 11 billion in the long term. On the other hand, deducing 0.5% in the affiliate's contribution rate reduces the fund availability by four years.

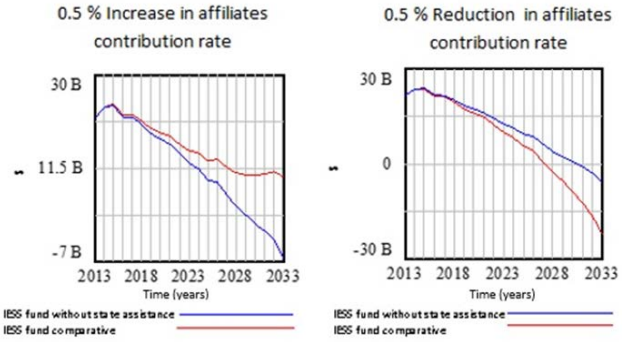

Fig. 8 IESS Funds: Affiliates Contribution Rate Sensibility.

The Fig. 9 shows that a 2% reduction in healthcare expenses per affiliates expands the funds duration for another decade, and if this reduction accounts for 4%, the funds stabilize in the long term around 11.5 billion. A similar behavior is expected for operating costs and infrastructure investment per affiliate.

The Fig. 10 illustrates that an increase or reduction in the birth rate does not have a significant impact on the IESS funds availability. Likewise, a change in mortality rate does not have a significant effect either. In contrast, changes in the retirement age have a relevant effect on the funds duration. Increasing two years to the retirement age would expand the funds duration up to a decade.

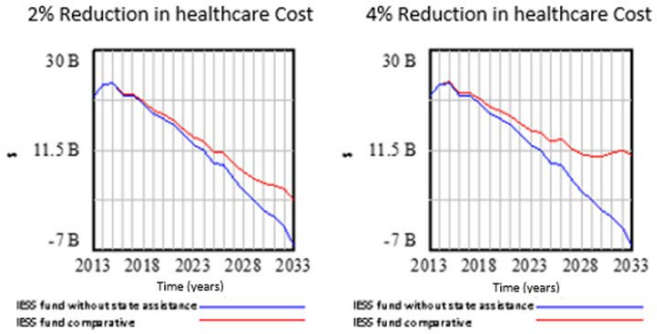

Fig. 9 IESS Funds: Healthcare Expenses Sensibility.

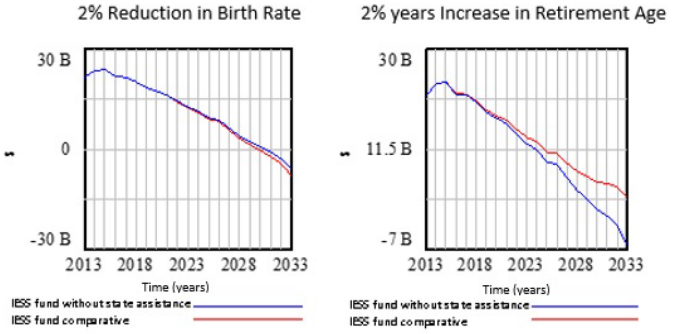

Fig. 10 IESS Funds: Birth Rate and Retirement Age Sensibility

The Fig. 11 shows that in our model, an increase in wages has a positive effect on the funds duration only when this increase is greater for active affiliates than for passive affiliates. Otherwise, this effect is negative. Similarly, an increase in the affiliation rate is positive only when the working affiliation rate is higher than the senior affiliation rate. Finally, increasing one year of the population life expectancy cuts the funds by five years.

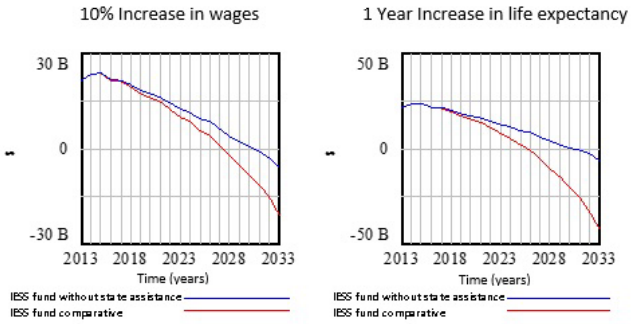

Fig. 11 IESS Funds: Healthcare Expenses Sensibility.

Running a simulation game in Vensim®, we can determine that the Government could help the IESS to build a sustainable financial position in the long run if they resume the 40% subsidy on retirement pensions for four years: 2018, 2019, 2023, and 2024. Through these interventions, the IESS funds will stabilize until 2025 and grow thereafter.

Using the Monte Carlo method to simulate 200 scenarios, some simulation auxiliary variables follow a uniform distribution with an upper bound 10% over and a lower bound 10% under the current value. These auxiliary variables are healthcare expenses, infrastructure investments and operating costs per affiliate. The results indicate under 50% of uncertainty that the funds will be insufficient between 2028 and 2039 (see Fig. 12 and Fig. 13).

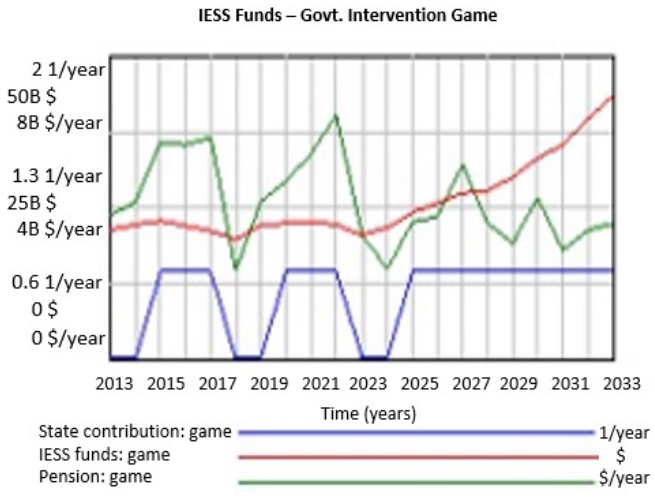

Fig. 12 Simulation Game.

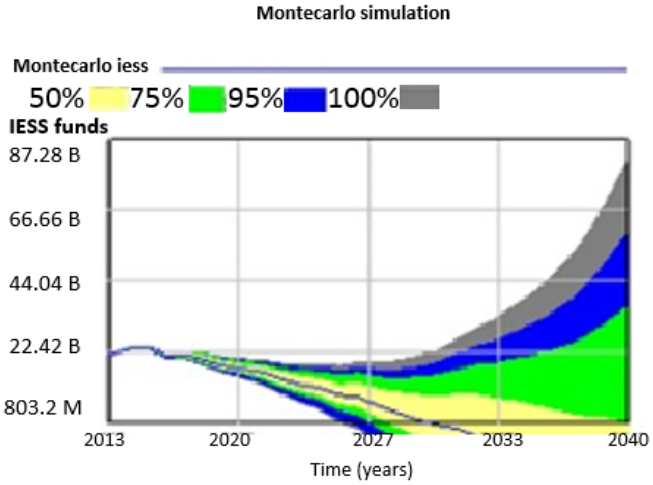

Fig. 13 Montecarlo Simulation.

VI. Conclusions

This paper presents a system to represent the fluctuations of the available funds of the Ecuadorian Social Security Institute IESS after the news about Government withdrawal of the subsidy of 40% on the retirement pensions applying the methodology of system dynamics and formalizing the model through Vensim® software.

The sustainability of social security systems is a matter of great importance, and controversy in countries around the world, because of the different forms of operation, financing and the changes existing in demographic variables, such as life expectancy, the rate of population growth, and the growth rate of labor productivity, making the system sensitive to economic shocks.

On the other hand, the elimination of the subsidy is a necessary step because if the subsidy is constant over the years, the IESS would begin to accumulate funds exponentially, and those resources could have been used by the Central Government to cover other needs of the population.

An increase of 0.5% of the contribution rate from active members would generate stability in the IESS funds during the study horizon and the increase in the retirement age in two years extends the duration of the funds by a decade but the generated social discontent and political cost associated would be a problem that the Government and the authorities of the IESS would have to face. Changes in the birth and mortality rate does not generate a greater effect on the duration of IESS funds, however, the one-year increase in life expectancy of the Ecuadorian population would reduce in five years the duration of the funds. Considering the current Government investments in healthcare, this scenario is very likely so the IESS should take urgent measures to guarantee its services sustainability.

IESS authorities should ensure that the rate of enrollment of active contributors exceeds that of passive contributors so that there is no negative impact on the funds. If the

Government wishes to contribute again to the pension subsidy, it can participate in the 2018, 2019, 2023 and 2024. After this intervention, the IESS will be able to maintain a trend of funds accumulation in the long run.

For further research and analysis on the issue, it is recommended to include a larger number of inner variables influencing the behavior and operations of the Ecuadorian Institute of Social Security to have a more precise simulation. It is also recommended to conduct a qualitative research making a deep interview with Government official and IESS executives, and review different new alternatives to feed IESS funds, as using the resources coming from oil exploitation in an area of Yasuni Park, or business net earnings distributed among employees.

Another recommendation is that further researches would focus in several simulation games to suggest the Government intervention in different years in more than one stage. The results could be robust if conducting a time series analysis but the information is hard to collect because of the lack of official information sources in Ecuador to complete an uninterrupted series.

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