FINANCIAL SUSTAINABILTY OF SOCIAL SECURITY INSTITUTIONS IN THE PRESENCE OF AGING POPULATIONS

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Abstract

The purpose of this study is to build an experimental platform for scenario and policy analyses of social security institutions that deploy pay-as-you-go schemes as the financing method. To realize this aim, system dynamics methodology is utilized and a generic dynamic simulation model is constructed. Afterwards, the financial sustainability of the social security institution in Turkey, as a susceptible country for its aging population, is investigated via scenario and policy analyses. The results show that (i) irrespective of scenarios and policies, aging phenomenon is quite dominant and a serious threat to financial sustainability, (ii) informal sector plays a crucial role in the financial sustainability of social security systems, and (iii) a hybrid policy combining increase in retirement age, premiums and decrease in informal employment ratio seems to be the most promising one among the others. Future research involves modeling the fully funded scheme complementing this study to enable the public policy makers to compare and contrast the two financing methods comprehensively.

Key words: Social security, pay-as-you-go scheme, financial sustainability, population aging, informal sector, public policy simulation

1. INTRODUCTION

Today, developed and developing countries' populations are aging due to decreasing birth rates and increase in average life expectancies. It is an ongoing debate that aging phenomenon is going to lead those societies to a number of problems. One of the most serious of them looks like to hurt the social security beneficiaries under the coverage of pay-as-you-go (PAYG) schemes as the financing mechanism of their social security system. PAYG plans are widespread all over the world and basically, the contributions of the active working people are used to pay the pensions of previously contributed retirees and health expenditures of all insured persons. Thus, a sustainable PAYG scheme assumes a social contract such that each generation of workers pay for the pensions of the preceding working generation due to the fact that next generation, as they did, are going to pay for pensions of the current generation (Hemming 1998).

Due to population aging, the fraction of the young and working people is shrinking while the fraction of old and retired are increasing. This is troublesome for

PAYG schemes since active working persons finance the elders and the dependents. When it is thought that premium revenues are the most important source of income and the pension payments is a significant expenditure account of the social security institutions, increasing proportion of old population can result in huge budget deficits. The problem lies under the fact that, if the governments cannot raise enough revenues to finance these deficits of social security institutions via noninflationary policies, this will inevitably turn out to bring high inflation rates which is the nightmare of many countries today (Özgür 2008, Yüksel and Kocaman 2007).

From the above paragraphs, it is obvious that the sustainability of PAYG schemes is in question and hence, requires an analysis to probe the future of them. The social security systems are composed of interacting demographic and macroeconomic subsystems making their problems dynamically complex by the very nature of those elements (Börsch-Supan 1992). Hence, a realistic yet concise study is a must in order to be able to draw useful conclusions and insights from this dynamically complex problem.

In this study, a generic system dynamics model is built to investigate the fundamental dynamics of the financial sustainability of social security institutions in the presence of an aging population. Our motivation is to obtain an experimental platform for PAYG schemes to conduct scenario and policy analyses. In other words, the model represented in this paper can be used for any social security institution with PAYG scheme. There are some examples in the literature using SD to study social security institutions. However, to the best of our knowledge, a generic SD model is not present. Furthermore, some scenario and policy analyses are conducted for Turkey will be illustrated here as an example of the utilization of our model.

Turkey gives the impression of being among those susceptible countries with a decreasing birth rate. The old-age dependency ratio[1] is one of the most salient indicators that a PAYG system is in trouble (Cichon, et al. 2004). Figure 1.1 shows that the old-age dependency ratio of Turkey and it increases by approximately 45% in just 17 years. More dangerous than that, it exhibits an exponential growth. This alarms the increasing pension payments and decreasing premium revenues. Hence, the financial sustainability of the social security institution of Turkey will be probed in this paper via our generic model.

This paper will proceed as follows: Firstly, overview of the model will explain the important variables and definitions of the model. Secondly, the paper will continue with model description including dynamic nature of it, critical assumptions and technical details. After getting oriented to the model, several policies will be analyzed and compared. Lastly, conclusion and further research section will finish our discussion.

[1] It is the ratio of population over 65 years old to the population between 15-64 years old.

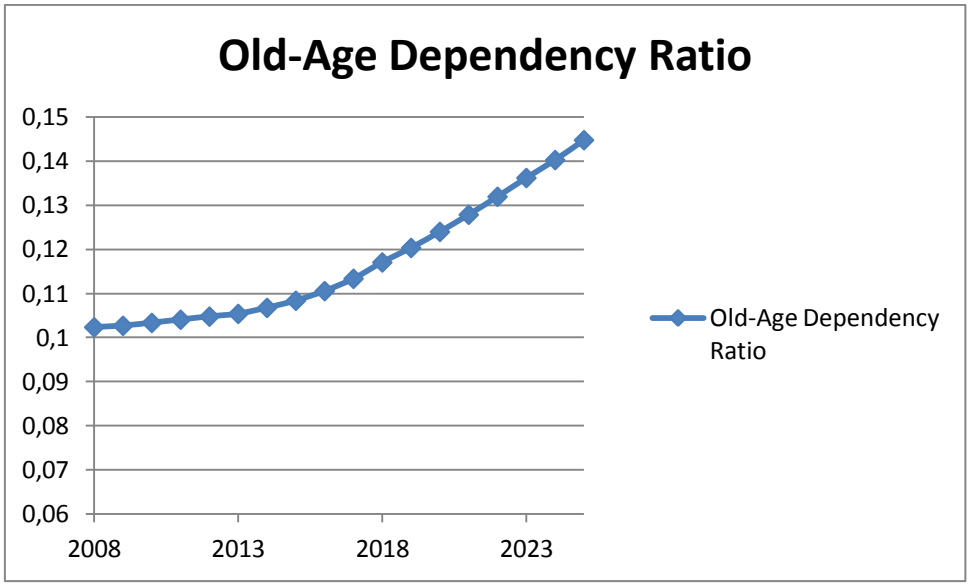

Figure 1.1: Old-age dependency ratio of Turkey calculated via Turkey Statistical Institute's population projections

2. OVERVIEW OF THE MODEL

The model consists of two sectors:

2.1. Population Sector

In this part, the population of Turkey and its age demographics are modeled. Population Sector is connected to Social Security Institution Sector with its "Increase in Employable Population" rate.

The nature of the problem requires us to deploy "the aging chains" (Sterman 2000). Certain age groups play distinct roles in the dynamics of social security institutions and some do not. Hence, having too many stocks as age groups is avoided. Consequently, two stocks are determined to be necessary and sufficient: The population between zero and fifteen years old stock is the population does not work hence does not pay premium. Moreover, it is our assumption that they are not fertile since their respective birth fraction is negligibly low. The population between fifteen and fifty years old stock is significant because it is assumed that the fertile age group of women is between fifteen and fifty years old. The motivation of these assumptions is to acquire a more calibrated model than one using crude birth rate for whole population which is more unrealistic. Moreover, population over fifteen years old can join the labor force.

2.2. Social Security Institution Sector

The relation between Population Sector and Social Security Institution Sector is that some fraction of the people joining the population between fifteen and fifty years old joins to the stock of Active Insured Persons which is the population who works and pays premium to social security institutions. That fraction is determined by Labor Force Ratio, Unemployment Ratio and Informal Employment Ratio that is the ratio of uninsured working population to whole working population. After retirement, Active Insured Persons join to Pensioners stock, the population who get pension from social security institutions. The children and some special status relatives of Active Insured

Persons and Pensioners are called Dependents who have health insurance financed by social security institutions.

An important point in the model is the presence of informal employment. It is a known fact that informal sector is present in almost each country (Schneider 2002). The significance of it in our study stems from the fact that the less the Informal Employment Ratio, the more Active Insured Persons and accordingly the more premium is paid. However, when Active Insured Persons increase, Health Care Expenditures also increase due to both increase in itself and increase in Dependents. Furthermore, after the retirement, those people will get pensions, a heavy burden on social security institution. Hence, the informal sector is an indispensible element of a social security institution, especially when the Informal Employment Ratio is not low in a country.

The focal point of our model is PAYG Cost Ratio and it is the ratio of the sum of Health Expenditures and Pension Payments to Premium Revenues. Actually, in social security literature, the denominator is the sum of the total insurable earnings of the registered workers. Then, PAYG Cost Ratio gives the desired contribution ratio for a social security institution to finance itself without any aid (Cichon, et al. 2004). However, in this study it will be used as described above and as an indicator of the financial situation of social security institution. Although it does not state the current budget deficit explicitly, it is a well-known fact that the less the PAYG Cost Ratio, the smaller the budget deficit is.

The simplified stock-flow diagram is in Figure 2.1. Here, the whole population sector is not present because from there, only Increase in Employable Population variable is necessary. The complete stock-flow diagram can be found in the Appendix.

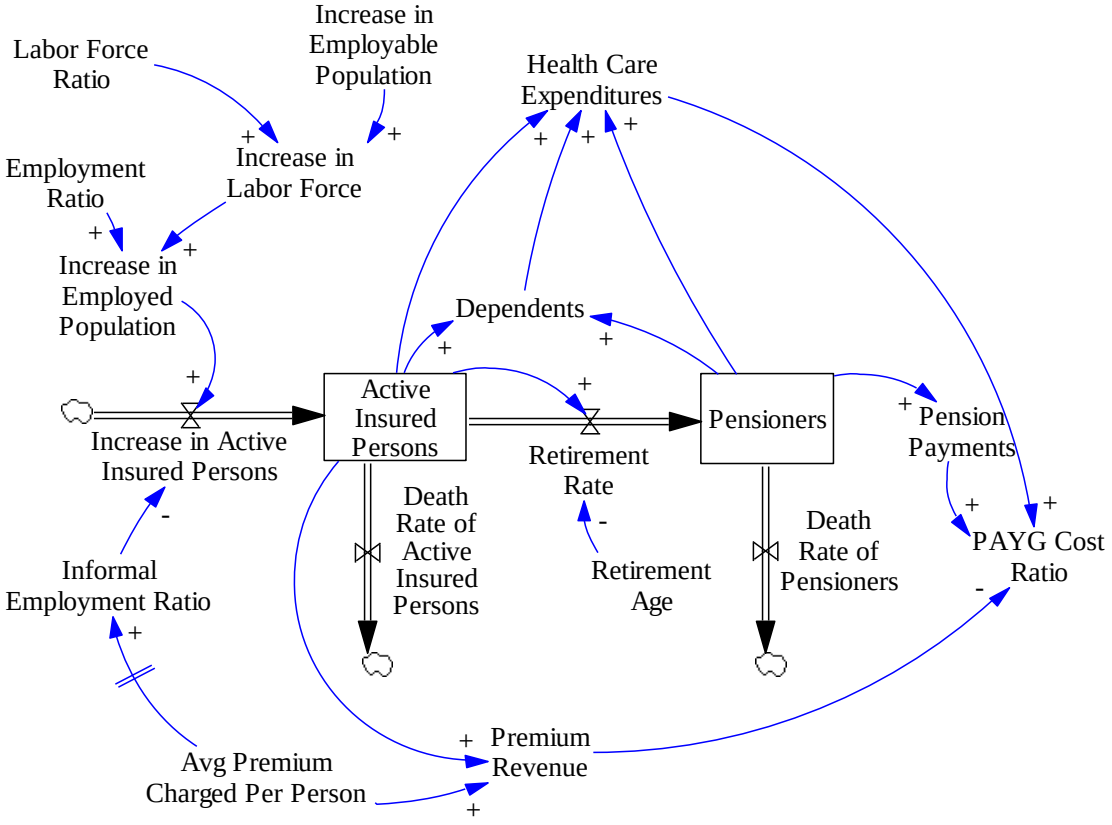

Figure 2.1: Simplified Stock-Flow Diagram

3. MODEL DESCRIPTION

One non-negligible reason of informal employment is the Premiums (Takim 2011, Cichon, et al. 2004, Adaman 2003). It is a cost on the employers and thus, not to pay that cost, some portion of employers provides employment without social security benefits. Hence, in our model, realistically, if the Average Premium Charged per Person is increased, then the Informal Employment Ratio also increases. However, a first order information delay of one and a half years is introduced due to the fact that it takes time for employers to react to the changes in the Average Premium Charged per Person. Of course, since it is not the only reason of the informal sector, for instance, income and salary taxes are also important reasons, the corresponding effect is formulated respectively, as it is seen in Figure 3.1.

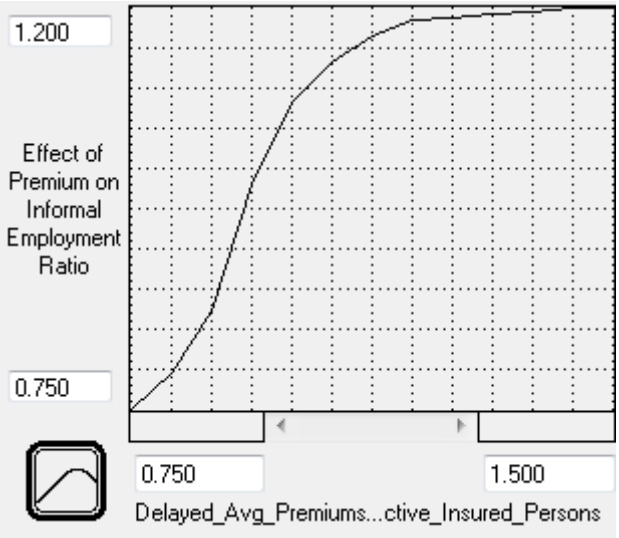

Figure 3.1: Graphical function of the effect of Premiums on Informal Employment Ratio

3.1. Critical Assumptions

It is assumed that Average Health Care Expenditure per person does not affect the birth and death fractions. That is of course unrealistic. Yet, putting this interaction into the model needs huge expertise and time. Hence, it is believed that this is beyond the scope of this study and also beyond the model boundary. For the same reason, birth and death fractions are also constant.

The Unemployment Ratio, the Labor Force Ratio and the Dependents Ratio are also taken as constants. There are so many other variables and systems that interact with those variables. Nevertheless, they are left out of the model boundary.

The Informal Employment Ratio is assumed to be effected only by the Average Premium Charged per person. However, the respective effect is designed keeping that in mind since it is not the only cause.

All the monetary variables used in this study are inflation free since it is seen that the increase rates of those are almost equal to the inflation rate.

The simulation runs for 30 years. It can be longer however, after many experiments; we see that 30 years is enough to observe the resulting behavior.

3.2. Parameter Estimation

In this part, how key parameters are estimated will be explained briefly. Moreover, the reasoning behind some crucial variables will be expressed in detail.

All the below mentioned data are obtained from Turkish Statistical Institute's and Turkish Social Security Institution's websites (Labor Force Statistics 2011, Consumer Price Index 2011, Social Security Institution 2012, Population Statistics and Projections 2008). The parameters of the model are the values of year 2008 since that is the latest available data.

To begin with, the birth rates are estimated from "Births by age group of mother" and "Mid-year population projections by age groups and sex" data. A weighted average of the age groups with respect to total population is taken to calculate birth fraction. Likewise, death fractions are also estimated with the same way as above. The reasoning behind this method is to have more precise results since the demographic information is crucial in this study.

Reference Average Premium Charged per Person is the respective value of year 2008. It is roughly estimated by ratio of the total premium revenues to total number of Active Insured Persons. Average Pension and Average Health Care Expenditure per person are also calculated in the same way as Average Premium Charged per Person is done. Moreover, Labor Force Ratio, Unemployment Ratio, Informal Employment Ratio and Dependents Ratio values are the values of year 2008.

Reference PAYG Cost Ratio is the average of PAYG Cost Ratios of years from 2004 to 2008. Because, during these periods the inflation is almost constant and before 2004, there was hyperinflation in Turkey.

3.3. Model Verification & Validation

During the modeling phase and after it has finished the model verification and direct model validation are conducted. Each equation in the model is tried with extreme values in order to assess direct validity of the model (Barlas 1996). These are done in isolation from the system and no problematic consequence is observed.

Afterwards, to perform indirect structural validation tests, special simulation runs which consists of extreme conditions testing model wide are deployed (Barlas 1996). All the tests are in tune with the expectations.

Conducting behavioral validity tests for this model is not possible since there does not exist enough real data as our simulation starts from year 2008.

3.4. Base Scenario

The model described in Figure 2.1 is run to obtain a benchmark. Note that there is no feedback in this scenario since another aim of this scenario is to show that the system is not sustainable. The observed behavior is presented in Figure 3.2. As it is seen, the PAYG Cost Ratio exhibits a negative exponential growth. Although the behavior seems mild, the estimated level of convergence is too high. In other words, the financial sustainability is in deep trouble. System Dependency Ratio[2] shows the same behavior as the PAYG Cost Ratio, claiming that the two are parallel indicators for financial sustainability of social security institutions.

[2] System Dependency Ratio is simply the ratio of pensioners to active insured persons.

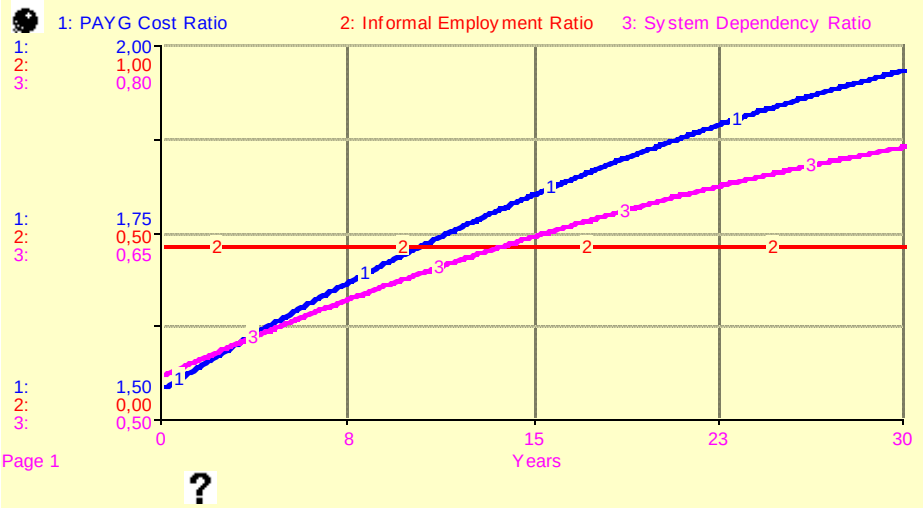

Figure 3.2: The PAYG Cost Ratio, Informal Employment Ratio and System Dependency Ratio in Base Scenario

4. POLICY ANALYSES

After constructing the model and being sure that it is both verified and validated, different policies become eligible to be tried out and analyzed. In this paper, three different policies will be investigated. However, as the main purpose of this study states, a policy maker is able to try different policies and scenarios on this generic infrastructure.

Each policy is studied in isolation from the others to assess the impacts of the policy without any bias. All policies will be activated after 5 years, assuming that intervening with such policies take serious amount of time to decide. Moreover, it is more salient to see the impact of each policy when it is implemented to the system running in its own course.

In all policies, the negative impacts of the aging population should definitely be taken into account while assessing and comparing the results. The focal point of our concern is the PAYG Cost Ratio which is the indicator of the financial sustainability of a social security institution. Although being another important indicator (Cichon, et al. 2004), System Dependency Ratio will not be under our observation. Because as it is observed in the base run, it is parallel to PAYG Cost Ratio. The Informal Employment Ratio will also be observed as a significant macroeconomic variable.

Firstly, Premium Back Up Policy will be analyzed. This will be followed by policies about Informal Employment Ratio and Retirement Age. Lastly, a hybrid policy that is a combination of the three will be studied. In the end, a comparison of each will take place.

4.1. Premium Back Up Policy

A well-known and suggested policy is to increase the contribution rates (Barr and Diamond 2008). The policy is as follows: if the PAYG Cost Ratio is above its reference value, social security institution increases the Average Premium Charged per Person to cover the deficit. On the other hand, if the PAYG Cost Ratio is below its reference value, the Average Premium Charged per Person is decreased since these are

nonprofit organizations. Due to the calculations of the exact ratio and making the corresponding changes in the Average Premium Charged per Person take time, a first order information delay of a year is introduced to the model. The corresponding effect function can be seen in Figure 4.1. Note that, the effect is also delayed by two years due to the fact that implementation of the policy takes time to decide.

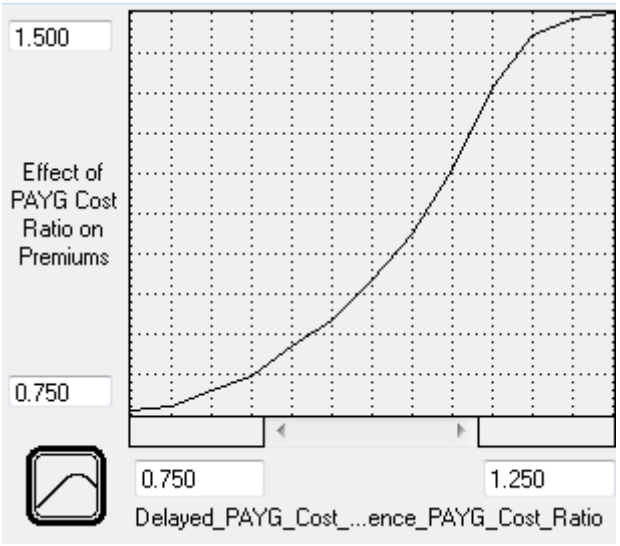

Figure 4.1: Graphical function of the effect of PAYG Cost Ratio on Premiums

Activating the above policy after 5 years, the problem turns out to be highly dynamically complex. As it is seen in Figure 4.2, the behavior is governed by four distinct feedback loops[3] where three of them are balancing and the other is reinforcing:

The reinforcing loop is called Increasing Active Insured Persons, R1. As the PAYG Cost Ratio increases, that would trigger the Informal Sector Ratio to increase and that would result in a negative effect on Active Insured Persons. That in turn, would lead to further increase in PAYG Cost Ratio, which is an undesirable but also unavoidable situation.

The first balancing loop is called Premium Back Up, B1. It tries to balance the increase of PAYG Cost Ratio which is the expected situation due to the notorious effects of aging populations. The second one is Declining Pensioners, B2. Increase in PAYG Cost Ratio has a negative effect on the number of Active Insured Persons. That would lead to a certain decrease in number of Pensioners which results in a reduction of Pension Payments. Lastly, Declining Insured Persons, B3, tries to balance the increase in PAYG Cost Ratio via a negative effect on total number of insured persons who are the sum of Active Insured Persons, Pensioners and Dependents. That would lead to a decrease in Health Expenditures.

Taking all those into consideration, without simulation, it is not trivial to find out which feedback loop is the dominant one. Moreover, the interactions between those and the delays make it harder to foresee the resulting behavior in the presence of aging populations. The resulting behavior is in Figure 4.3.

[3] There are also some other feedback loops. However, those have negligable importance compared to these four.

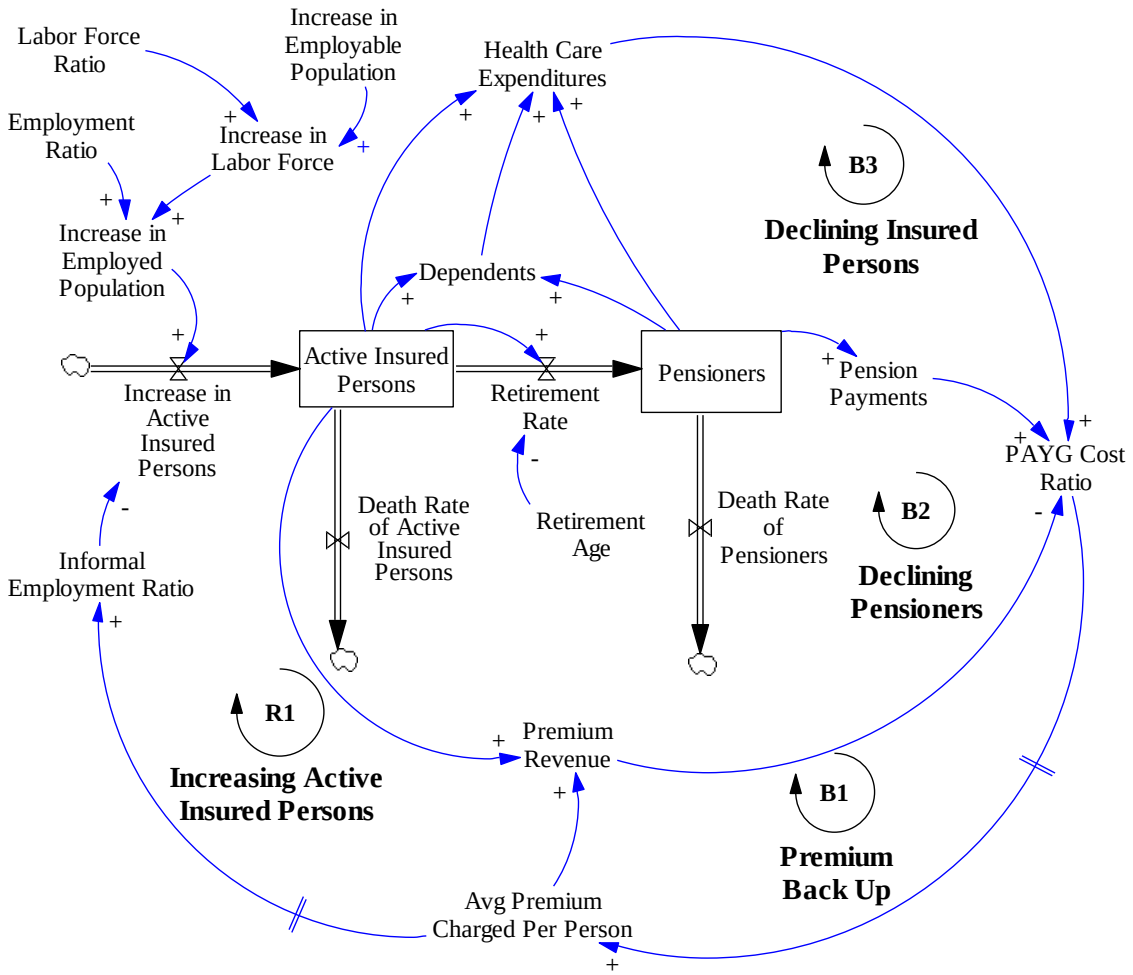

Figure 4.2: Simplified Stock-Flow Diagram when Premium Back Up Policy is active

Immediately after 5 years, with the policy implementation, a temporal relief occurs in PAYG Cost Ratio. This sudden reaction is due to the fact that this policy directly affects premium revenue which is the denominator of PAYG Cost Ratio. However, afterwards, it cannot resist to aging population and it starts increasing again. That is an example of policy resistance. Nevertheless, the increasing is not as aggressive as in the beginning. The improvement is quite significant signaling that this policy is promising.

Another expected result is observed in the Informal Employment Ratio. After the policy implementation, increase in Average Premium Charged per person led to an increase in Informal Employment Ratio showing a negative exponential growth. That increase is a very undesirable consequence for the whole economy. Moreover, this is an indicator of the unpleasant contributors.

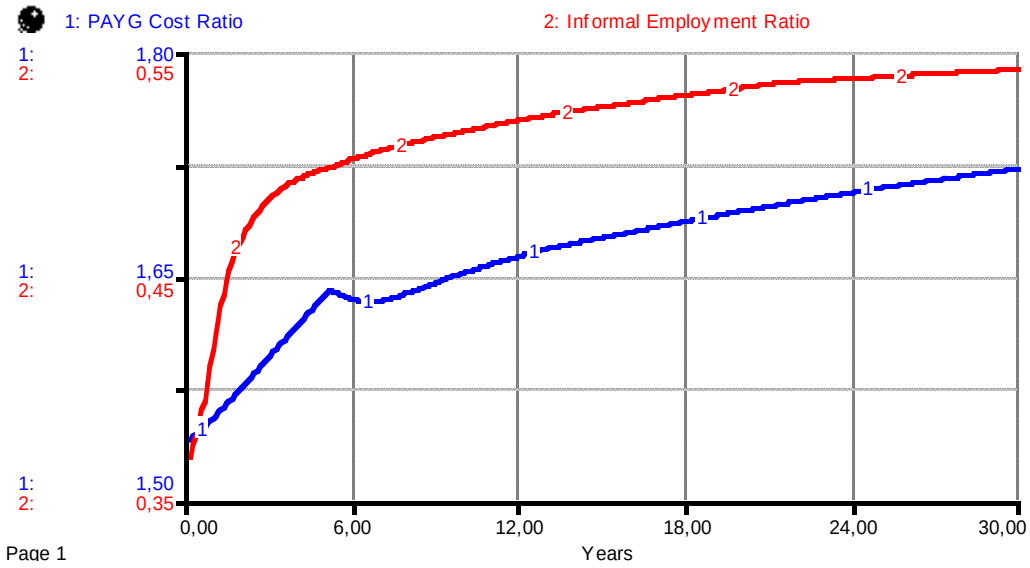

Figure 4.3: The PAYG Cost Ratio and Informal Employment Ratio under Premium Back Up Policy

4.2. Formal Employment Policy

An improvement in the Informal Employment Ratio leads to a positive effect on PAYG Cost Ratio (Adaman 2003). In this policy, it is supposed that the government has decided to decrease the illegal activities regarding to non-registered working conditions. This policy will be introduced to our model by changing the converter "Reference Informal Employment Ratio" to "Desired Informal Employment Ratio".

Desired Informal Employment Ratio is a function of time and after five years, the government begins to apply the policy and it is assumed that Desired Informal Employment Ratio will converge to lower value than the Reference Informal Employment Ratio in five years, as it is visible in Figure 4.4.

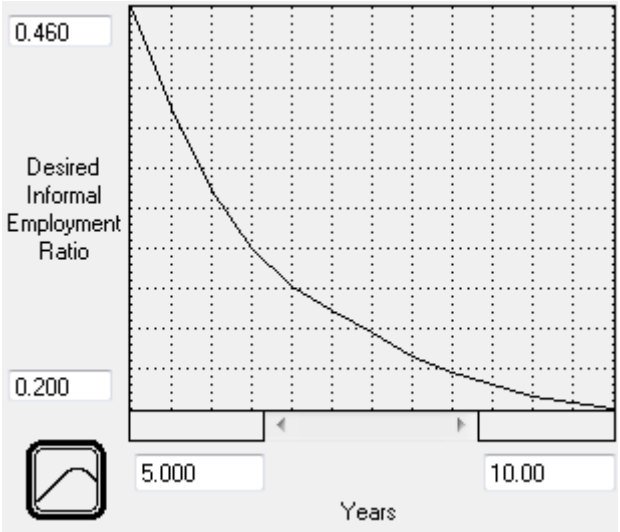

Figure 4.4: Desired Informal Employment Ratio

In Figure 4.5, it is seen that the policy could not change the behavior at all. The negative exponential growth is still present but the increasing pace has decreased significantly. That is a good sign that such a policy would yield improvement.

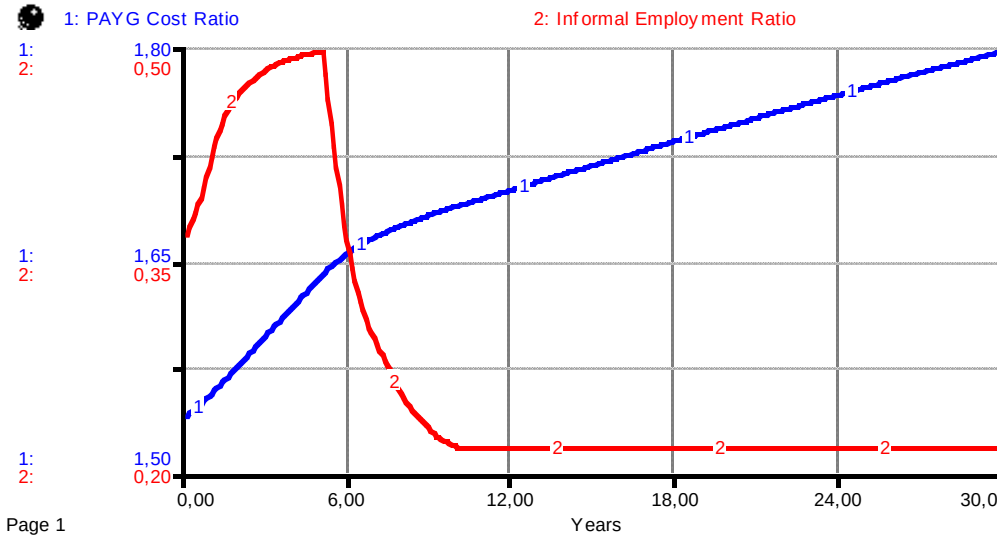

Figure 4.5: The PAYG Cost Ratio and Informal Employment Ratio under Formal Employment Policy

4.3. Increase in Retirement Age Policy

Increase in retirement age is one of the most popular policies in social security. Contributors are obviously against this kind of policies whereas it is of course proposed that this is a must for a social security institution to continue to serve its beneficiaries. Here, 5 years of increase is tried as a policy. After 5 years, the retirement age becomes 70. The results are in Figure 4.6.

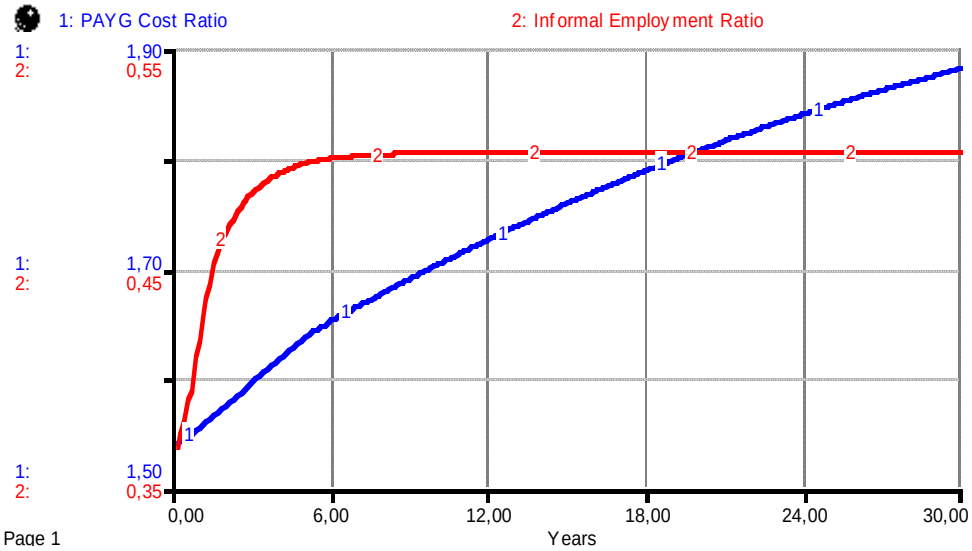

Figure 4.6: The PAYG Cost Ratio and Informal Employment Ratio under Retirement Age Policy

The increase in Retirement Age does not change the behaviors of the PAYG Cost Ratio. However, after the intervention, it gets better although it is not visible from Figure 4.5.

4.4. A Hybrid Policy

After conducting the three policy analyses, it is thought that a combination of these is also worth to be tried out to see that if there is a possibility of sustainability. A hybrid policy therefore is tested. The chosen new policy is the combination of all the three policies mentioned above. The resulting behavior is present in Figure 4.7.

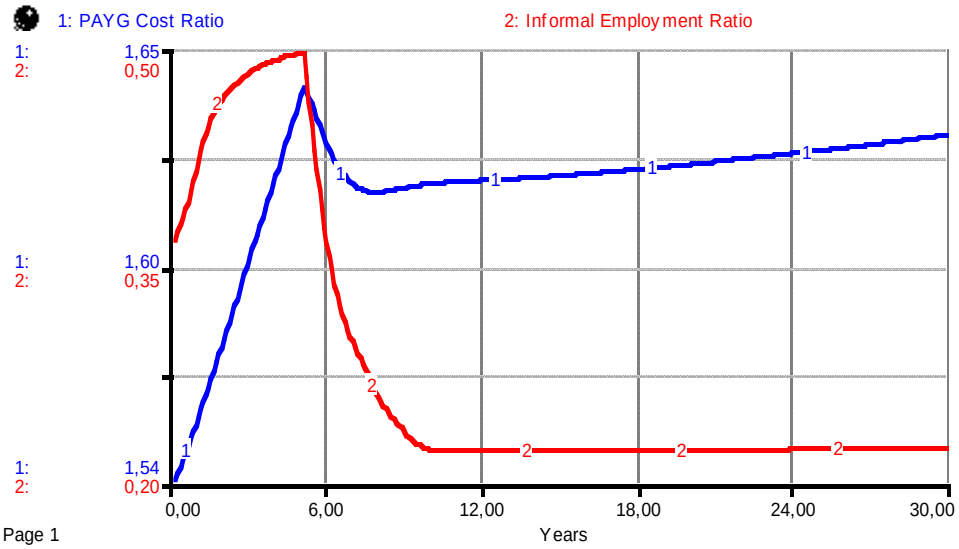

Figure 4.7: PAYG Cost Ratio and Informal Employment Ratio under Hybrid Policy

The combination of all three policies seems to promising. The behavior of PAYG Cost Ratio is the same as of Premium Back Up Policy. This also shows that it is the most dominant and effective policy among all three. Difference from Premium Back Up Policy is the final value of PAYG Cost Ratio.

Due to Premium Back Up Policy, Informal Employment Ratio starts to increase. However, it is compensated by Formal Employment Policy and brought down. It also has a slight tendency to increase in the long run, although it is not visible from Figure 4.7.

4.5. Comparison of the Policies

Here a comparison of the above policies will take place. Table 4.1 and Figure 4.8 summarize the results of the policy interventions.

Having the Base Scenario as a benchmark, Premium Back Up Policy seems to be the best except the hybrid policy. Furthermore, comparing the results of Hybrid Policy and Premium Back Up Policy, it is visible that in the implementation of Hybrid Policy, the behavior of PAYG Cost Ratio is mostly governed by Premium Back Up Policy. However, as an unpleasant side effect, there is a major increase in Informal Employment Ratio when Premium Back Up Policy is implemented. Taking that also into account Premium Back Up Policy has both advantages and drawbacks. However, Formal Employment and Retirement Age seem to be comprehensively beneficial policies since they both lead PAYG Cost Ratio and Informal Employment Ratio to decrease. However, these decreases are not satisfactory. Retirement Age seems to be the least effective one among all.

It should be noted that although the changes in the ratios are not huge, as time passes, the Total Premium Revenues, Health Care Expenditures and Pension Payments increase very much. Therefore, the budget deficit becomes larger.

Table 4.1 Comparison table for the policies

	Year	PAYG Cost Ratio	Informal Employment Ratio
Initial State	0	1.54	0.46
Base Scenario	30	1.97	0.46
Premium Back Up Policy	30	1.72	0.54
Formal Employment Policy	30	1.79	0.20
Retirement Age Policy	30	1.85	0.46
Hybrid Policy	30	1.63	0.22

Hybrid policy, on the other hand, is the best possible policy. It leads the PAYG Cost Ratio to the lowest among all. Moreover, that lowest value is not far away from the initial state. It also has the advantage of less Informal Employment Ratio. Of course, there are some side effects such as social unrest due to these policies, the effects of these policies on the macroeconomic variables and etc. nevertheless, these are beyond the scope of this study.

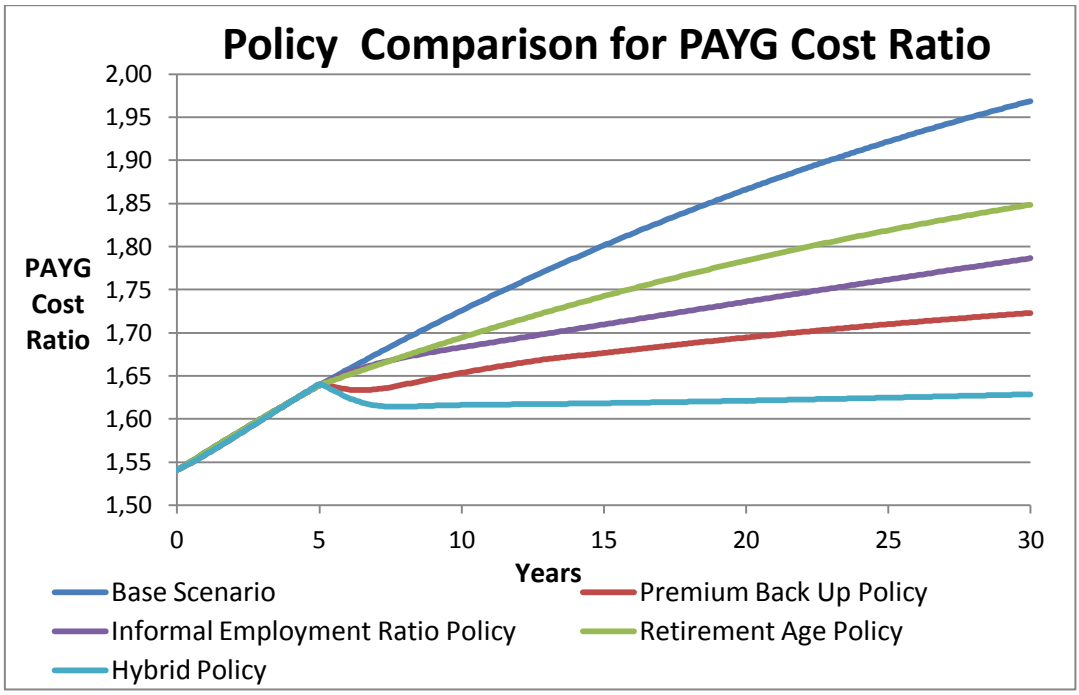

Figure 4.8: Comparative graph of PAYG Cost Ratio

5. CONCLUSION & FURTHER RESEARCH

The ultimate purpose of this study is to build an experimental platform for scenario and policy analyses of social security institutions that deploy PAYG schemes as the financing method. To realize this aim, system dynamics methodology is utilized and a generic SD model is constructed. Afterwards, the financial sustainability of the social security institution in Turkey, as a susceptible country for its aging population, is probed.

It is observed that aging population has an immense effect on the financial sustainability of the social security institutions. Although some policies are implemented, the PAYG Cost Ratio of the social security institution in Turkey is still increasing dangerously under each of these. From the policy analyses study, it is found out that increasing contributions and decreasing informal employment are the promising policies. Nevertheless, they are much more effective when they are implemented together since solely enforcing Premium Back Up Policy, although resulting in a significant decrease in PAYG Cost Ratio, lead the Informal Employment Ratio to increase. Increasing retirement age is found to be less effective than the other policies.

There is still room for further research and improvement in this study. The model presented in this paper can serve as an infrastructure to more sophisticated models. For example, Average Health Care Expenditure per person is a significant variable since it has an effect on both birth fraction and death fractions. Embedding such an interaction into the model brings important feedback loops into action. By means of that, the model becomes more realistic, in the cost of increasing complexity. More examples as such can be given.

Another opportunity is conducting behavioral validity tests with utilizing the past data. For the case of Turkey that will require significant amount of work on the data preparation side since there have been structural changes in social security system of Turkey. However, it is encouraged to benefit from our model via using the other countries' social security institutions data.

There is an ongoing debate about the sustainability of social security institutions and whether fully funded schemes, PAYG methods or a hybrid of them will be better for the public lies at the core of these discussions. The model presented in this paper can be utilized by the policy makers and that would enrich the discussions by elaborating more on PAYG schemes. Further research should be done to construct a similar model for fully funded schemes. That would complement our study and hopefully, aid to resolve some of the ongoing conflicts via providing useful insights about the financial sustainability of social security institutions.

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7. APPENDIX

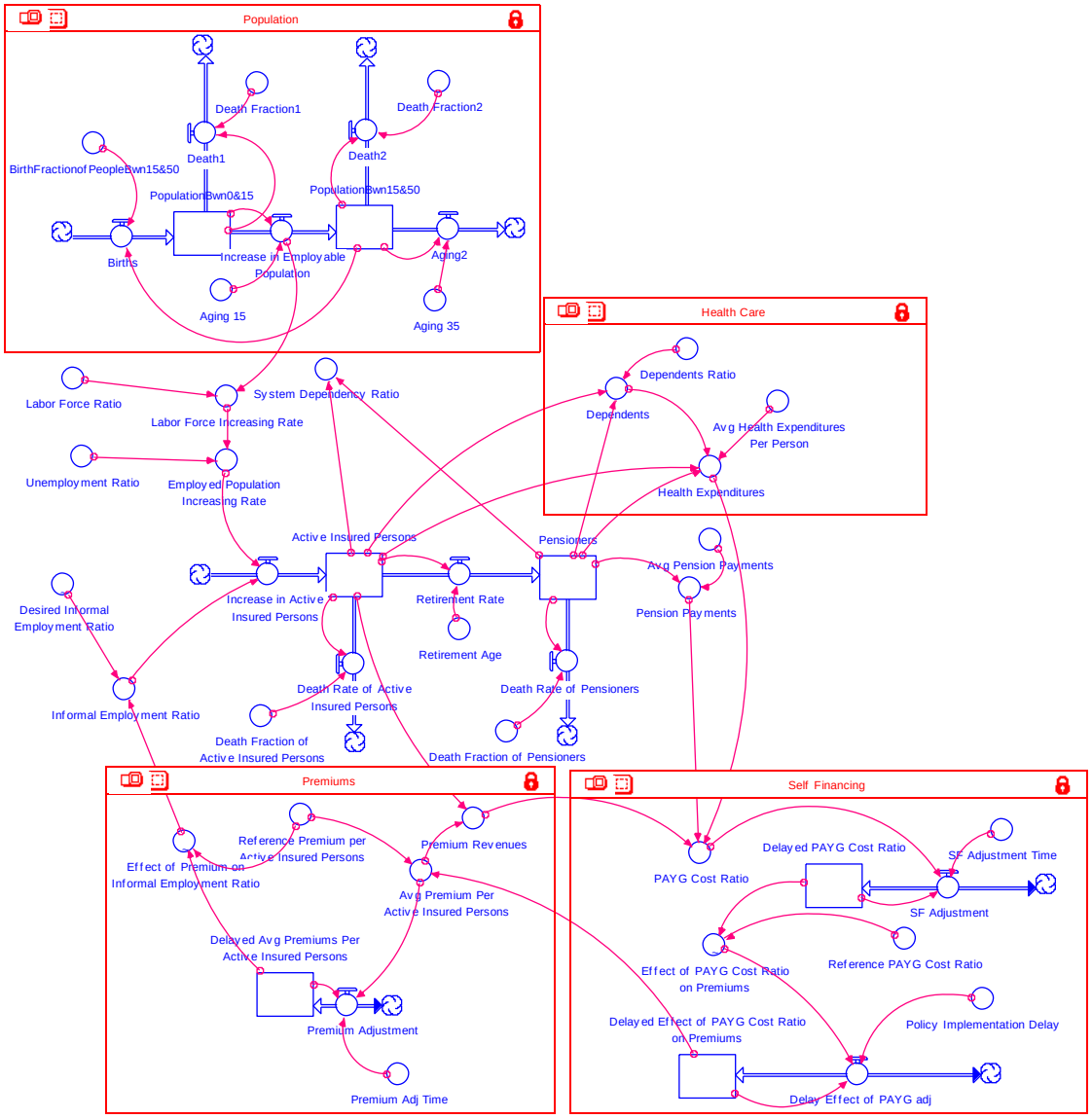

Figure 7.1: Complete Stock-Flow Diagram