

Towards a better understanding of pension systems

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***Abstract:** Pension systems are vital components of every economic system. During the last two decades, population aging and financial insufficiencies in many countries forced governments, corporations and private pension schemes to conduct reform to sustain their pension systems.*

This paper investigates different Pay-as-you-go and funded pension schemes in order to provide a better understanding the dynamics and the structure behind a pension system. Fully funded and unfunded schemes are modeled in a generic form. Issues of stability, population dependency redistribution are discussed according to model structure and simulation results. System dynamics provides an efficient tool to understand the nature of each scheme.

Keywords: System Dynamics, Pension System, unfunded scheme, funded scheme, Pension Reform.

1. Introduction to pension systems

a. What is pension system?

Pension systems are vital components of every social security system all over the world. Objectives and general principles of pension systems around the world actually differ, but public pension system objectives' are to ensure that older people have a decent standard of living at retirement.

There can be two interpretations of this primary objective [1]:

- To ensure a basic living standard.(Adequacy objective)
- To ensure a reasonable standard of living in retirement relative to that position before retirement.(Insurance Objective)

As stated above, there are various degrees of emphasis on “adequacy” or “Insurance” objective.

b. Pension systems Taxonomy

Obviously there is no unique implementation for a pension system. Pension systems can be categorized in terms of three main dimensions. [1]

- How they are financed? (pay-as-you-go, fully funded, government budget or some combination)
- How they are managed?(earning related schemes, defined contribution schemes or some combination)
- How the system is managed?(private or public, centralized or decentralized management)

In Pay-as-you-go scheme contributions are paid by the currently employed population in the form of tax (social security tax). In the fully funded scheme, individuals save a constant fraction of their labor income in an individual account (usually) managed by private firms, which invests and accumulate these funds until retirement, when these funds are used a source of retirement income. [2]

As in case of many countries, the pension plan is financed by the government, corporations and the body of workers. For example in Iran the system is financed by 3% of government's contribution, 9% contribution's of the worker and 18% of corporation's contribution.

c. Variables that affect pension system

Pension systems are indeed, complex systems. Their complexities rely in demographic, economic, financial, political and social aspects of the countries they are implemented in. In this part we discuss the influence of different parameters -Both the past and future values- from different sectors on pension systems.

- Demographics and Labor Market factors
 - Population and average population growth
 - Population mortality and life expectancy
 - Workforce, working age, growth rate of workforce
 - Average income of the workforce
- Macroeconomic factors
 - Economic growth and GDP
Economic growth indirectly affect income growth factor. Which specify the input flow of the pension fund.
 - Macroeconomic stability (Interest rate, Inflation rate)
 - Pension scheme coverage
How much percent of the work force is covered by the pension scheme? Work force coverage is both a source of threat and opportunity. In case of PAYG schemes, extending work force coverage policies may reduce the financial deficit of the scheme in short run. By the way, in the long-run this policy may worsen the situation. As the number of workers needed to be more than retirees in each generation, when this policy is deployed, every future generation must have more workers than the previous

generation. This mean, the population should always be growing.

- Financial factors
 - Stock markets
 Stock market returns, affect the efficiency of pension scheme investments.

2. Model

a. PAYG system

In this part, we develop a model for PAYG System.

We start with the basic structure of the model, the workforce aging-chain. (Figure 1) "Average Time in labor market" is a time constant. In most countries, a worker usually works around 30 years in the labor market until he/she retires. This constant usually differs between genders.

"Life Expectancy - Avg rtmnt age" is indeed, the average years a person receives pension. Suppose a country in which life expectancy is 80 years and workers retire at 60. So $80-60=20$ is the average years a person receives pension.

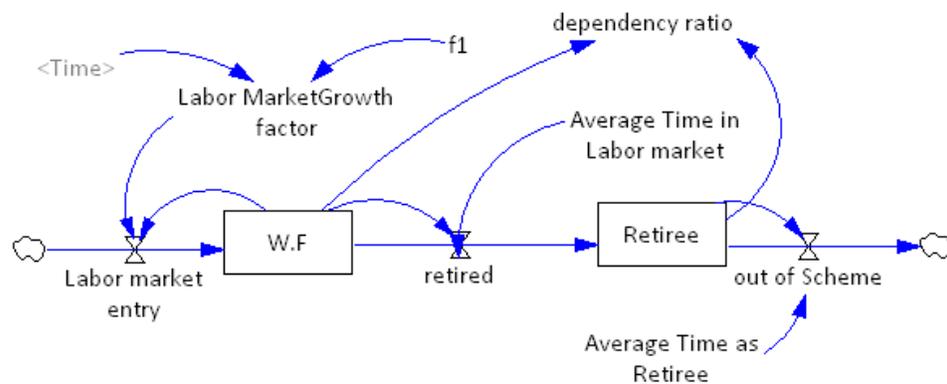


Figure 1 PAYG stock and flow structure (workforce)

Figure 2 illustrates the essence of PAYG structure, Taxes directly being paid to retirees.

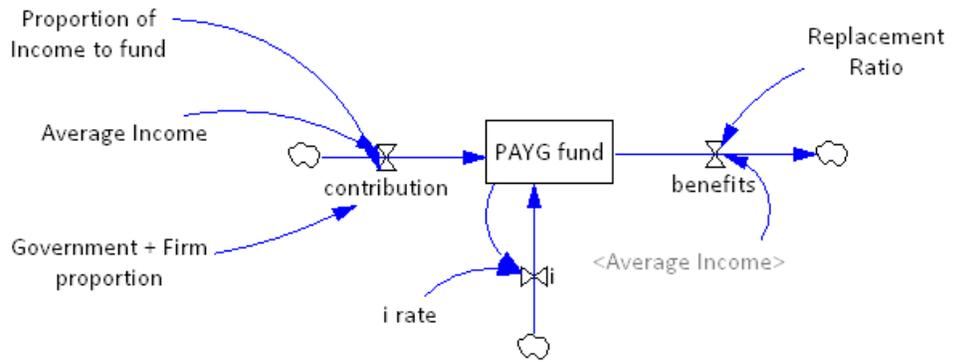


Figure 2-PAYG financial flow

Figure 3 illustrates the PAYG abstract model. "replacement rate" is a level of a laborer's wage to a retiree's pension.

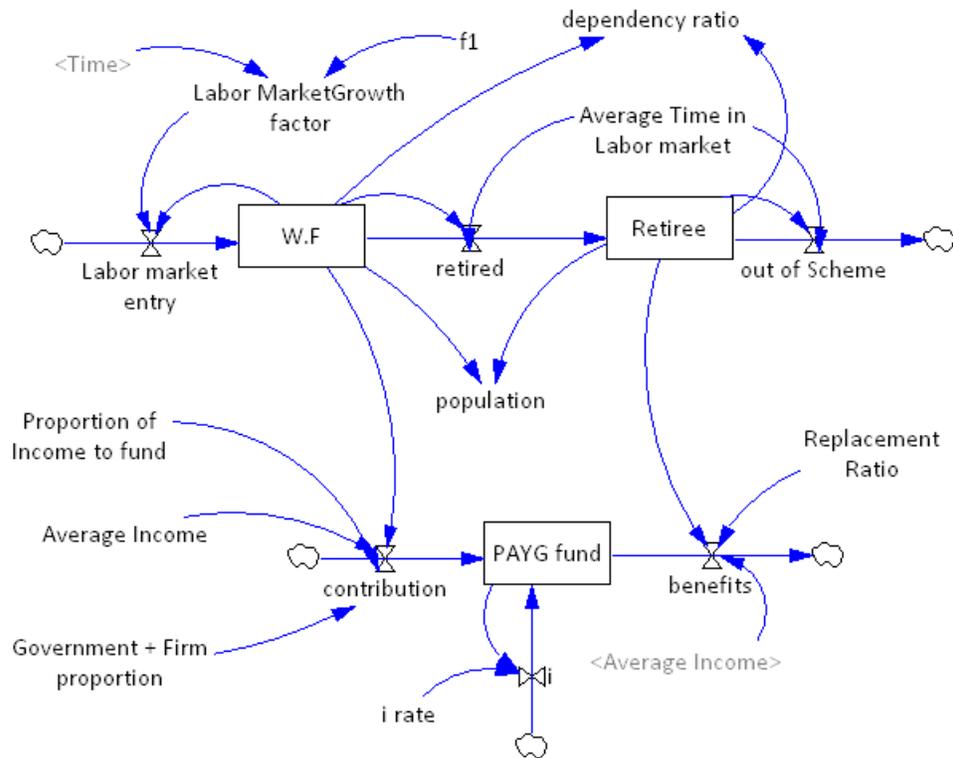


Figure 3-PAYG system stock and flow structure

b. Funded system

Funded scheme model does not differ with PAYG scheme so much, except of its financial structure.

In Funded scheme, every individual account is indeed an investment account. Accumulation of these individual accounts constituted a Pension Fund. This fund is managed (Invested) in the country (or abroad). At the retirement age, whole the accumulated fund a specific account plus its major fraction of return is used as source of pension for the owner of the account.

Figure 4 illustrates the funded scheme which is modeled by stock and flow diagram.

The challenge of modeling of funded scheme is relied in the level of aggregation. Differential equation models –as in system dynamics- are based on high levels of aggregation while funded scheme is conceptually disaggregated [6]. The challenge is handled through noting the fact that every individual saving's is going to be excluded from the Pension Fund after "average time as retiree". This solution is valid, when we assume that individuals equally participate in the plan.

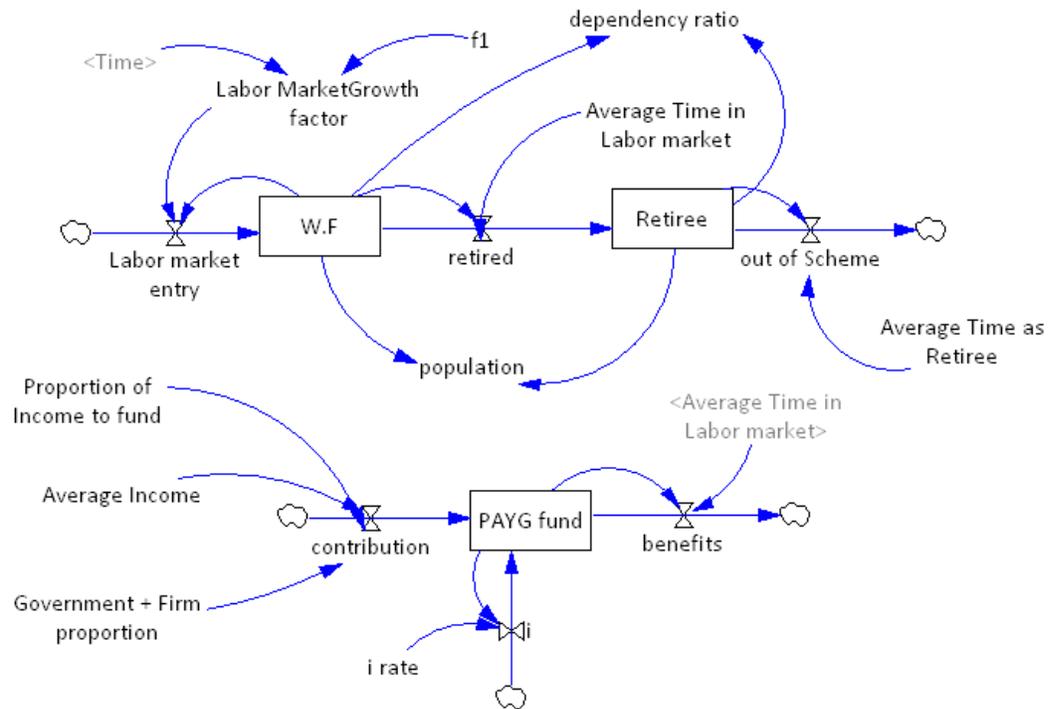


Figure 4 funded scheme stock and flow structure

3. Simulations

We assume that number of years an individual participated in the scheme is equal to the number of years she/he receives pension.

As it's stated in the literature of pension economics, PAYG schemes are unstable facing demographic fluctuations.

Generally, for the PAYG scheme to be stable, the labor market growth rate should be at the exact amount of $1/\text{Average Time in Labor market}$.

The financial structure is stable, when the every individual contributes for the same amount as she/he benefits. These insights are presented in the following Figures.

When the system is so-called mature, replacement rate should be equal to level of contribution. If the replacement rate exceeds this number, the system would collapse. Indeed "open-loop" PAYG system would certainly collapse in case of any fluctuation beyond system's threshold.

Replacement rate should not go above contribution rate, and $1/\text{Years as employee}$ should not drop below growth rate factor.

Figure 5 demonstrates the state of the system when it starts with no retirees and when it starts from equilibrium. It also captures the state of PAYG fund, when its parameters are not balanced (Replacement Rate= 0.5 instead of 0.3, which is the contribution rate).

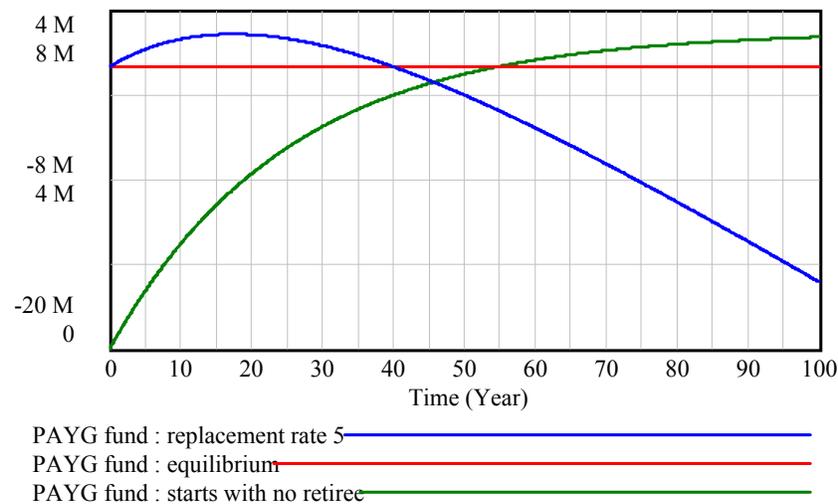


Figure 5 state of the system, with different conditions.

4. Conclusion

As it is stated in [1],[4] , there is a large pool of pension systems for countries from which to choose. Most countries follow a multi-pillar system which includes a PAYG and a funded pillar.

Obviously there is no best design; there is optimal design for a given situation of a country.

Open questions are, questions of transition between PAYG and Funded scheme and whether if there is an optimal PAYG design – “a closed loop PAYG”?

5. References

[1]. Robalino, D. (2005), Pensions in the Middle East and North Africa: Time for change. World Bank assessment.

- [2]. Cerda, R. A. (2007), The Chilean pension reform: A model to follow?, Journal of Policy Modeling.
- [3].Holzmann, R. (1998), A World Bank perspective on pension reform, World Bank Assessment.
- [4].Diamond, P. (2000), toward an optimal social security design. CePR working paper available at <http://cerp.unito.it>
- [5].March, C.L & Scovill, M. using System dynamics to model the social security system. NBER Workshop on Policy Analysis with Social Security Research Files, Social Security Administration, Office of Research, pages 459-469.
- [6].Rahmandad, Hazhir. Sterman, John (2008), Heterogeneity and Network structure in the Dynamics of Diffusion: Comparing agent-based and Differential Equation Models, Management Science Vol. 54(5), pp. 998-1014.

Note to referees: Work is still in progress.