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Demographic and economic aspects of the pension system in Poland — a dynamic modelling approach

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Abstract

Demographic and economic aspects of the pension system in Poland — a dynamic modelling approach

The paper considers a hypothesis that some dynamic features of the Polish national and public pension system follow typical mental, generic and archetypal models, as a result of many demographic, macroeconomic, political and also global factors, particularly closed-loop feedback relations with delays and amplifications. There are some important messages in the paper for social insurance policies design, structures and management, the meaning of data mining and collection, and for model refinement with modelling approaches in a systems' thinking way. The shortcomings of national social insurance systems in dealing more effectively with upstream social insurance risk prevention in the population are systemic and include also a postulate to empower members of the population in order to involve them in their own, entrepreneurial downstream care. The paper contains a system dynamics (SD) point of view, as a method of macroscopic, continuous simulation modelling, to surface and explain some cycles and discrepancies between demography, policies, as well as the system's aspects of the national pension system. The conceptual, formal and simulation model presented in the paper, followed by some experiments' results, applies the SD method approach with causal loop diagrams (CLD) and stock-and-flow diagrams (SFD), displaying delays, amplifications and structure cycle dynamics in the national pension system. Further research should concentrate on the detailed analysis of additional modelling requirements in order to conduct more profound multi-factor experiments to forecast and evaluate contemporary national politics, and to test some new concepts in social insurance.

Introduction

The basic factors influencing an ageing population are the decline in the fertility and birth rate and increasing life expectancies. Generally, people are expected to live up to 74 years of age in the years 2045–2050, while in developed countries, life expectancy will rise to 82 years (according to data from *The Population Division of the United Nations Secretariat*, 2003). In a country like Poland, now being classified within developed countries, the population of people aged 60 and above in the total population was 15.7% in 1995, and is expected to increase to 23.6% by 2020 and is estimated to increase to 24.7% by 2025, while life expectancy for the ageing population increased to 73.6 years for males and 81.6 years for females in 2015 (*GUS Statistics*, 2016). In terms of coefficients of demographic age, work activity, work resource ageing, work resource load, "early pensioners" and generations replacement, even some forecasts for Poland seem to be more optimistic than for all EU countries (as averages), generally the process of an ageing population is a progressive process. These demographic trends are believed to exert pressure on the public pension system, as well as having a major impact on governmental social and economic policies. For these reasons, pensions have become one of the most important issues for policy makers, where in most countries pension spending is projected to grow substantially subject to the increased number of retirees. The ageing population also creates concern about the dynamic, and particularly sustainability, of the public pension systems.

Reforming any pension system in any country is not an easy task. The pressure of an ageing population means that the government needs to rebalance retirement income provision in ensuring the adequacy and the sustainability of the system. It involves a long-term policy in a situation of many uncertainties. Meanwhile, the examples of good practices from other countries can benefit policy makers in seeking to reform their own pension systems accordingly. Two basic types of retirement schemes or pension plans in the Polish national pension system are: an old version of DB and a new DC plan. The DC plan is a plan in which the contribution (premium) rate is fixed, but the retirement pension is variable. Contribution rates are usually a predetermined fraction of an employee's salary. Employers and employees make periodic contributions into individual accounts for employees. A formula specifies the amount of money that needs to be contributed to the plan, but does not specify the pension payouts. Although the contribution rate is known, the retirement pension will vary depending on the worker's age, earnings, contribution rate, investment return and normal retirement age. In the DB plan, as opposed to the DC plan, the retirement pension is known, but the contributions vary depending on the amount to fund it. An actuary determines the plan to produce the desired pension and specifies formulae for the pension to be paid out after retirement. It would take into account several factors, such as years of service, level of wages and others. The employer has the obligation of being a sponsor. The retirement pension would normally be an annuity type from retirement age to the date of death. In a DB plan, the monthly pension can be a replacement part of a final monthly salary. For example, an employee would enjoy a monthly retirement of a 50–60% replacement amount of a last drawn monthly salary, or a worker aged 65 may be entitled to a total retirement amount at the normal high estimated as ten years of earnings.

This research focuses exclusively on demographic and some selected macro-economic risks (particularly GNP growth and average salary level). Demographic risk is always defined as the increasing risk due to an ageing population, while salary risk refers to the salary growth affecting the premium payments and cost of providing pension benefits, as a social indemnity payment. There is an issue as to how the risk and pension system structure influences the functioning of the pension system. The complex phenomenon of demographic (particularly ageing structure and dynamics) and economic (particularly GNP and average individual salary) changes in a public (national) pension system performance involves numerous factors which are interconnected in different directions. Therefore, this study attempts to develop a dynamic generic and archetype (rather a synthetic one) pension system model with social policy design factors, which analyses pension expenditure as a result of some demographic and economic risk. Finally, after next-step calibrations of the model (with up-to-date precise statistics of the Polish pension system indicators) some short- and long-range forecasts and rough verifications of a "worst-case" scenario will be possible.

1. Theoretical framework of the research

Most countries are reforming their pension systems with the intention that the pension system will continuously and in a sustainable way function to provide pensions to retired people (Balcerowicz-Szkutnik and Szkutnik, 2010, 11–20). Poland also confronted the same phenomena when public pension system reform was developed in 1998 and implemented in 1999 (Iglicka, 2017, 1–4). Now, some pension system modifications are still being implemented (Matyjaszczyk, 2016, 61–76), such as contemporary changes in the second (OFE) pillar (e.g. premium decrease, new investments rules, new accounting procedures, voluntary access), consolidation of the first (ZUS) and second (OFE) pillar, decreasing and unifying the retirement age for males and females, development of new offers for the third pillar (e.g. *IKZE* investment), and development of a supplementary pension scheme (Jedynak, 2016, 34–48). In addition, some new political ideas and concepts are being discussed and suggested, such as: a "citizen retirement" pension system proposal (no premium and pensions financed by a central budget), a "repartition-alimentary" pension system proposal by the KoLiber organisation (pensions financed by central budget and a three-pillar system based on social "citizen retirement," pro-demographic bonus motivation benefits resulting from children alimentation, and capital investments), and a "pension savings account" (EKO) proposal by the Polish Financial Supervisory Commission (KNF) — as a governmental institution (a new third pillar based on individual and employer three-partition premium payment with some tax benefits), elimination of some professions' retirement privileges (e.g. retirement in the mining industry, agriculture, military-police-customs services, judicature), and differentiation of the pension system for males and females proposed by a popular party (PSL) — an agriculture political party (family status influence with an increase in premium-payment periods by non-premium-payment periods for females having children).

Due to demographic and economic changes and increasing pension expenditures, pension systems around the world (not only in Poland) are in a volatile condition. This is caused not only by many uncertainties or the inherent risk that affects the pension systems, but also by specific dynamic pension system features, mainly determined by the system's structure (as a result of the "structure drives behaviour" paradigm). The existence of risks and structure-specific features will also affect national pension system expenditure. Among the risks that national policy (politics) makers in public social insurance are exposed to, are demographic risk, economic growth risk, financial market risk, national budget as subsidy source risk (Bednarczyk and Raszewski, 2017, 13–19), salary risk, and, ironically, even "political risk" (in the context of subsequent parliamentary elections).

2. Research methodology

For research purposes, a dynamic, continuous simulation policy design model of the Polish public pension system is developed using the system dynamics (SD) method. This method, originated by J. W. Forrester (1961), belongs to the realm of systems thinking and macroscopic continuous simulation modelling methodologies. Risk analysis and a management approach by scenario testing is to be applied. The main focus of this modelling research is to analyse the pension system's dynamic features, particularly in terms of costs and expenditures as a result of demographic and economic factors. It also includes a proposal of pension system archetype (or generic) structure and assumptions used for the pension system expenditure forecasts. Cause-effect and causal-loop relationships (as influence and structure diagrams), quantitative SD models of these (as a set of mathematical differential equations translated into the Vensim PLE simulation modelling package notation and as a simulator interface), and some selected results of simulation and one- and multi-factor experiments are presented.

The SD method relies extensively on the system's structure (particularly feedback loops and delays) in order to analyse and explain how the system structure drives behaviour and leads to particular behavioural patterns. Even some formal methods are being developed for an analysis of the “structure–behaviour” relationship (e.g. loop polarity dominance, behavioural analysis for loop dominance, pathway participation metrics, graph theory measurements), yet practical analysis by simulation modelling and one- and multi-factor experimenting have largely been restricted to simple laboratory examples as guides to intuition. In social pension systems’ SD modelling and analysis practice, large-scale models with many loops are still analysed in a largely informal way, using trial-and-error simulation. Although this is not a weakness, any formal tool that might help identify important structures in the model as they affect a particular mode of behaviour could be of enormous utility, particularly in large models trying to map complexity relations in social systems (Pietroń, 2014, 301–320). System dynamics applied to pension system research can be interpreted as a systems thinking approach and a branch of management science, which deals with the dynamics and controllability of managed pension systems. SD method implementation in business and organisation systems’ modelling and analysis usually focuses and addresses the following basic research issues: circumstances in a system to use different policies in order to control its behaviour as time passes and circumstances change; the system’s policies design to become robust against change and the ability to create and exploit opportunities and avoid, or defend itself against, setbacks; information feedback structure design to ensure that effective policies become possible.

The basic viewpoint and associated methodologies of the SD approach require a definition of a “system.” A pension system is a collection of parts organised for a purpose, and this system may also fail to achieve its purpose. Knowledge acquisition, system activities, decision-making choices and learning consequences of choices need time — there are three delays in: data and information mining and acquisition to develop knowledge (basically national demographic and economic statistics), governmental and individual activities in making decisions (social insurance, economic acts and regulations made by parliament and government, individual personal life decisions made by individuals and employers), and experiencing the consequences of decisions in a pension system state.

For top management’s concern of pension system decision makers, policy designers and analysts, SD modelling with causality and feed-back paradigm is strongly recommended. The macro-scope SD modelling method in the social system also adopts a systems thinking concept and approach. A model helpful for understanding “global” (holistic and systemic) issues in pension system SD modelling, is the iceberg model (Fig. 1), often used in systems thinking and problem resolution. In SD modelling life-cycle stages, global issues can be looked at in some research and analytical layers, allowing successful system and process restructuring and improvements. The iceberg model is a systems thinking tool designed to help an individual or group discover the patterns of behaviour, supporting structures, and mental models that underlie a particular system event. If we apply the iceberg model to global issues, we could say that at the tip, above the water, are *events*, or things we see or hear about happening in the whole system. If we look just below the waterline, we often start to see *patterns*, or the recurrence of events. Finally, at the very base of the iceberg are the assumptions and worldviews that have created or sustained the structures that are in place. The important thing to understand is that in problem solving, the greatest leverage is in changing the structure. Like the different levels of an iceberg, deep beneath the patterns are the *underlying structures* or root causes that create or drive those patterns. The SD method in pension system modelling allows us to analyse a managed pension system so as to model the ways in which its information, action and consequences components interact to generate dynamic behaviour; diagnose the causes of faulty behaviour; tune its feedback loops to get better behaviour.

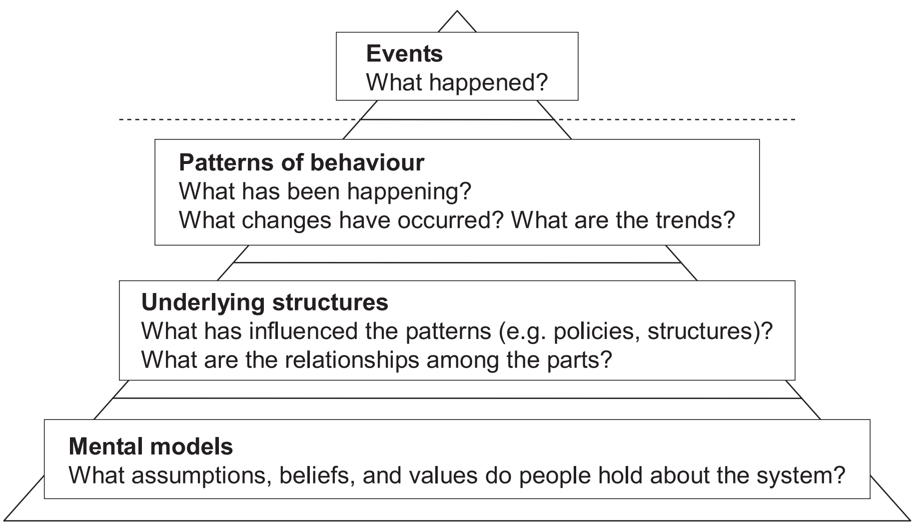


Figure 1. The systems thinking and SD approach to pension system modelling

Source: own work based on https://ecochallenge.org/iceberg-model/ (accessed: 5.12.2019).

The first stage in the SD application to pension system modelling is to recognise the problem and to find out which people care about it, and why. It is rare for the right answers to be found at this stage, and one of the attractive features of SD as a management-science methodology is that one is often led to re-examine the problem that one is attempting to solve. Secondly, and the first stage in SD as such, comes the description of the pension system by means of an influence diagram, sometimes referred to as a "causal loop diagram" (CLD) or "cause-effect diagram." This is a diagram of the forces at work in the system, which appear to be connected to the phenomena underlying people's concerns about it. Influence diagrams are constructed following well-established techniques — basically the "least-extension" technique. Having developed an initial diagram, attention moves to the third stage — "qualitative analysis." The term simply means looking closely at the influence diagram in the hope of understanding the problem better. This is, in practical SD, the most important stage, which often leads to significant results (sometimes it is the end of the modelling project). If qualitative analysis does not produce enough insight to solve the problem, work proceeds to the fourth stage, the construction of a simulation model. At this stage, we exploit the important property that the influence diagram can be drawn at different levels of aggregation. It is usually not even necessary to show every single detail because, if the influence diagram has been properly drawn, the simulation model can be written from it without a separate stage of flow-charting. The next stage (the fifth one) is where results based on quantitative analysis start to emerge. Initially, use is made of the insights from the bright ideas and pet theories from qualitative analysis. This stage represents exploratory modelling of the system's characteristic patterns of behaviour by laboratory experimenting with the aim of enhancing understanding and designing new polices and rules for the pension system.

Basically, the SD simulation modelling method is an approach used to study a nonlinear system and feedback control in engineering, economic, social and human sciences. With the aid of continuous computer simulation, supported by the iceberg model of systems thinking approach in collecting knowledge through the simulation runs, it is a powerful tool in understanding complex systems. SD is originally based on feedback control theory which includes both hard (quantitative) and soft (qualitative) approaches in analysing dynamic behaviours of the development and changes of a system. SD assists in improving the decision-making process and policy formation through its characteristics of incorporating all relevant cause-effect relationships as well as feedback loops in dynamic behaviour modes of systems. By developing a mathematical model as a set of differential equations solved by numerical integration (using basically the Euler integration method) and in a computer simulation environment, SD is capable of resolving a dynamic, interdependent, counter-intuitive and complex system such as the problem of investigating the impact of demographic and economic factors on public pension system expenditure.

The public pension system involves a long-range forecast horizon and political (mainly economic) consensus in social insurance policy design therefore, the risk management approach plays an important role in facing this problem — by absolving, resolving, solving and maybe finally dissolving it. Also, the complex phenomenon of demographic and economic volatility in a public pension system involves numerous factors which are interrelated. Due to these reasons, a problem such as analysing risks in a public pension system requires a technique that would deal with the complexity and allow the problem to be holistically viewed. As a consequence, an integration of risk management and a simulation modelling and experimenting methods in developing a public pension system expenditure model are needed, and to discover dynamic and macroscopic properties of such a system, the SD method is the most appropriate method in modelling and analysing the social insurance risk management problem in the Polish public pension system. In this research, the Polish public pension system is studied and modelled to analyse system expenditure due to basic demographic and ageing risks, economic GNP growth risk, average gross salary in economy risk. In Poland, the public pension system is also exposed to other risks, e.g. financial and investment risks, political risks in reaching a consensus of public pension system transformation and reform, and some risks concerning overdue liabilities from the past (old system liabilities in a new system). These risk factors are identified as basically time-dependent relationships, estimated on the base of time-series statistical data.

3. Pension system SD model design

3.1. A concept of a pension SD model

The SD method basic paradigm is that a system's behaviour depends on the underlying causal feedback structure, decision rules, amplifications and delays. CLDs and then stock-and-flow diagrams (SFD) are used to represent the cause-effect structure (open and closed relations as feedback loops) with delays in information and physical flows. The CLD basic concept of the pension system generic and archetype model, as a diagram, is presented in Figure 2.

Causal loop diagramming is a recommended part of the SD modelling stages in order to analyse the complex relationship that exists in a dynamic system. A causal loop is referred to as a closed influence diagram (or mathematically known as directed graphs) with polarity signs. A causal loop enlightens a dynamic process of a system in which the chain effects of a cause are traced, through a set of related variables, back to the initial cause. A causal loop is formed when a set of variables has been linked together in a connected path. There are two types of causal loop, namely "reinforcing loop" (indicated by the symbol R or plus sign) and "balancing loop" (indicated by the symbol B or minus sign). Balancing loops generally (and always for the 1st and 2nd order feedback loop) tend to stabilise the system while reinforcing loops always tend to destabilise the system. The loop is defined as positive (known as the reinforcing loop) when the number of negative relationships is even (or multiplication of polarity signs within the loop gives the plus sign), otherwise the loop is a negative one (known as the balancing loop). The causal loop is also represented by an arrow-headed line with the sign "+" which means that a change in the influencing variable produces a change of the target variable in the same direction, while the sign "–" means that a change in the influencing variable produces a change of the target variable in the opposite direction. The holistic summary analysis of causal loops relations is a helpful tool in predicting the impact of the desired factors in the system (even sometimes this is quite a difficult activity in complex feedback loop structures with many different polarities —

which feedback loop is a dominant structure?). The CLD of a simple generic public pension system model in this research consists of four parts (Fig. 3): CLD of population ageing sub-model, CLD of the public pension system central fund sub-model with basic incomes and expenditures, CLD of the economic growth sub-model with the influence of economic investments, and a CLD of the average salary estimation sub-model, as a base to calculate social insurance premium annuity and finally pension system liabilities.

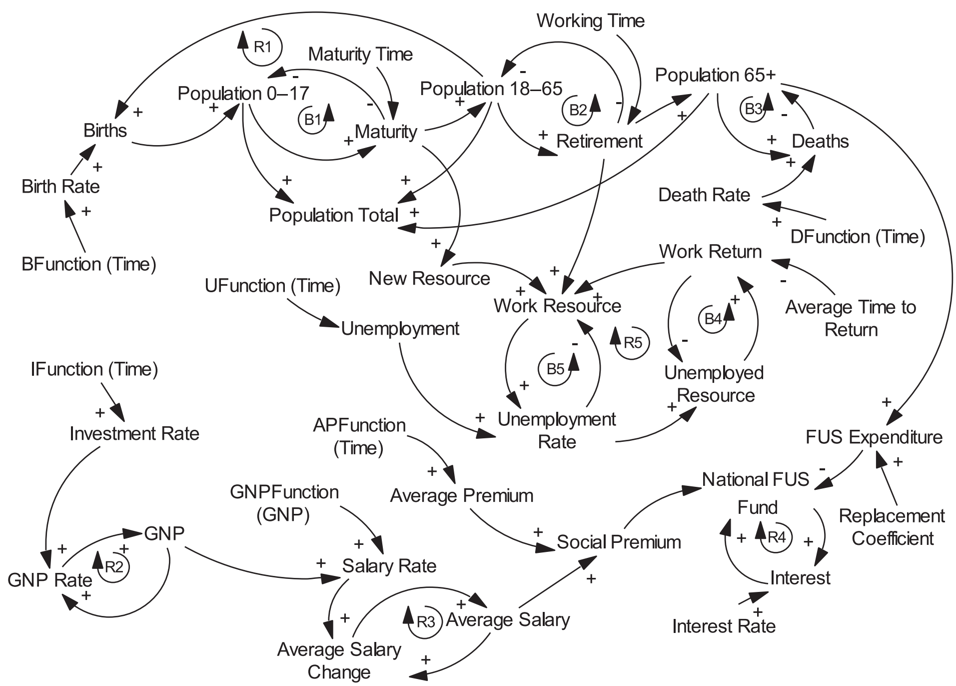


Figure 2. Causal loop diagram of the generic public pension system model

Source: own work.

The first part of the diagram maps the general population with ageing stages — population in the age between 0–18 years, economically active population in the age between 18–65 years, and retired population in the age above 65 (65+). This sub-model is a rather sensitive structure for birth and death rates, and in the model some statistics from the past are taken as multiplier time functions. However, in any SD model of a pension system, there is a typical problem with representation of the population where usually the population is broken down into yearly (sometimes into a longer time span) age groups (cohorts). In a continuous representation of the population system, individuals within population stocks (as integration levels) are not distinguished (macro-scope modelling), therefore they are mixed (blended) once they enter the level. This problem is to be resolved in more advanced versions of the proposed model with application of the "cohort blending" method described further (in: Eberlein and Thompson, 2013). The second part of the diagram is an essential modelling part of any public pension system — a central fund, which finances social insurance indemnity payment (basic expenditure), sourced by regular pension payments by the insured population, and some income from financial investments based on interest rates. In addition, this sub-model is rather a synthetic representation, without detailed structuring of types of financial sources, national budget donations, legal constraints, etc. The third part of the diagram maps an economic growth sub-model by GNP level as a result of two feedback loops (reinforcing and balancing loops) influenced by the investment ratio in the national economy. Also for this sub-model official GNP and investments rate official statistics from the past are taken as multiplier time functions. The fourth part of the diagram roughly describes the estimation of average salary level as a result of economic growth (measured by GNP) influence on salary payment by employers to employees. This relationship is also calibrated by using official statistics from the past to set multiplier GNP-related functions. As we can notice, the SD generic and synthetic model of public pension system, which is a result of risk factors' identification in this research, has five balancing (B) feedback loops and five reinforcing (R) feedback loops.

To summarise the description of the model's main assumptions, to simplify research and analysis in a systems thinking way (a focus on generic structures driving behaviours), the following "aggregative" assumptions are made in the model's development:

— All individuals are split up into tree cohorts, and each cohort is assumed to represent a homogeneous group by age, sex and professional status of individuals, and covers one year of observation.

— The age of individuals working and paying social premium is only in one active cohort of individuals aged between 18 and 65 years.

— One cohort of retirees is introduced. Its age structure is from retirement until death. Thus, this cohort is larger than one year and is a reversed value of the death rate.

— Individuals from the unemployed sector of the population always (after a delay) can find a job.

— The pension system is considered as a unified one for all groups of working individuals. It means that there is no specific professional group privilege and treatment, each working individual unit pays the same (on average) social premium to the FUS fund.

— Concerning the calibration of the main decision-making function of time factors, the estimation of the growth rates for births, investments, average premium in the pension system are given as time or other value functions (theoretical approximation of past statistics), with the possibility to test different scenarios for the pension system.

— Concerning the calibration of the main decision-making parameters or other system parameters and initial system states, this is done according to the current official data as initial states (replacement rate, populations, GNP, workforce, unemployment, FUS fund, average salary).

— A simulation step period covers a time span of 1 year and a simulation horizon (final time) is 100 years.

3.2. Pension system SD structure model and simulator

In this research, all factors presented in the CLD (Fig. 2) were translated into SFDs (Fig. 3) with application of the Vensim PLE software package in order to build the SD model of public pension system expenditure. The development of the SD model includes several types of variables such as stocks, flows, auxiliary variables, look-up functions, constants and connectors.

Stock, which is also known as level, acts as an accumulate (integration) reservoir of quantities (represented by a rectangle) and describes the state variable of the system. The increasing flow (inflow) and decreasing flow (outflow) of a stock are

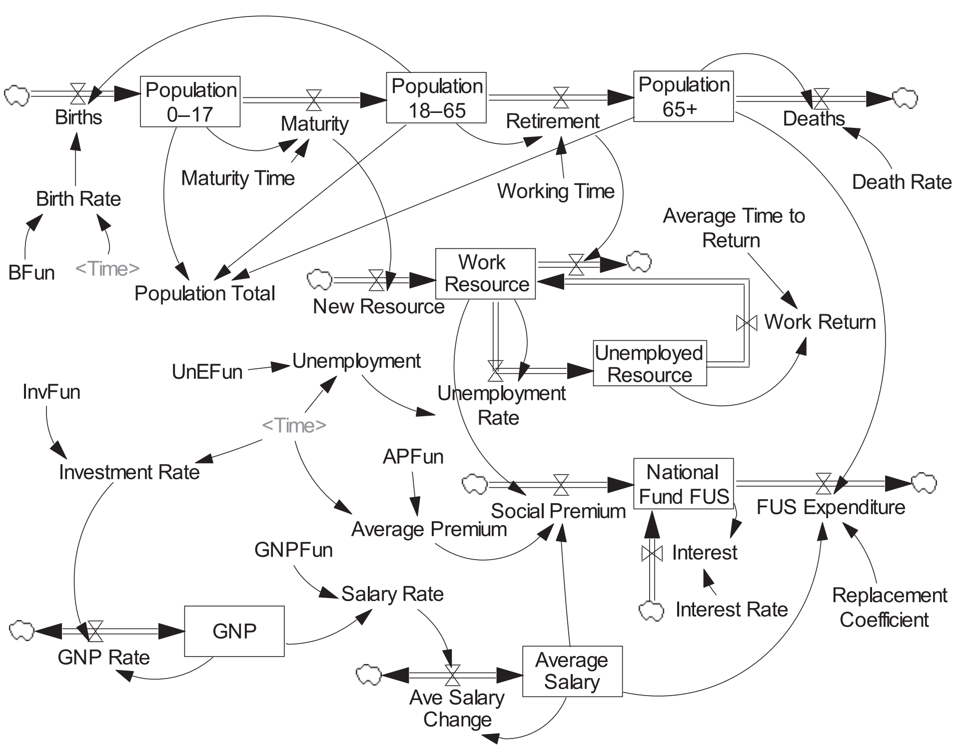


Figure 3. Stock-and-flow diagram of the generic public pension system model

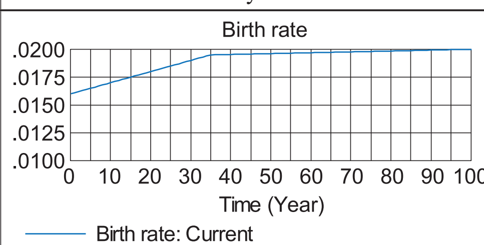
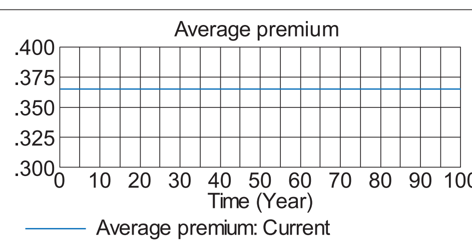
Source: own work.

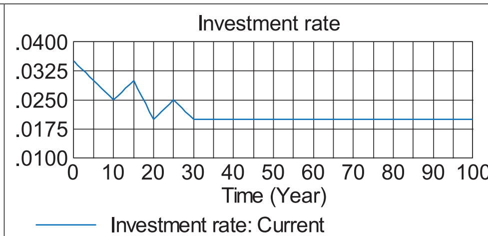
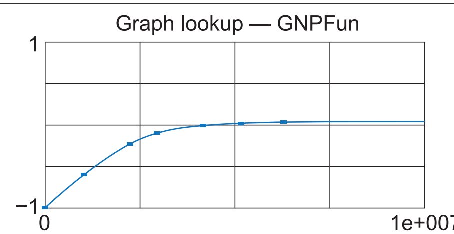
also known as rates (represented by a valve). The condition of the stock depends on the rates while the rates can be influenced by other factors affecting inflow or outflow, which are known as converters or auxiliaries (sometimes represented by a circle). Finally, the connector that represents cause-and-effect links within the model structure is represented by a single-line arrow with a polarity sign. The dynamic equations of the model refer to nonlinear relations between identified basic variables and data estimated with application of some empirical official statistics regarding public pension system indicators.

Calibrations of the model's main decision-making functions, parameters, and initial pension system states, for the basic model simulation scenario are presented in Table 1. The time unit for simulation and time parameters is a year [Year], the unit of population and unemployment groups is [10^3 of individuals], the unit of financial resources (e.g. FUS fund, GNP, average salary and premium, investments) is [mln zł].

Having developed the pension system SD model, a management flight simulator for user's interface to make experiments was also constructed, as a decision making tool for a pension system policymaker, or for an analyst to simulate interactively pension system behaviour after policy changes. In the control panel there is the possibility to set 19 simulation input data (functions, parameters, and initial stock states), particularly those directly controllable at the decision-making level: replacement coefficient, maturity and working time, interest rate, and also initial FUS fund. Any changes in policy made by the policy maker can be simulated by adjustments to these parameters in the management flight simulator. Results from these changes can be displayed in two forms — graph pad and numerical display.

Table 1. Function and parameter settings for model simulation with basic scenario

Function/Parameter	Value for 0–100 year time horizon
Birth rate time function	
Average premium time function of time	

Investment rate function of time	
Unemployment function of time	
Salary rate function of GNP	
Death rate for population 65+ parameter	0.05
Interest rate parameter	0.015
Replacement coefficient parameter	1
Maturity time parameter	18
Working time parameter	47
Average time to return to work parameter	1.5
Population 0–17 initial state	6,880
Population 18–65 initial state	22,540
Population 65+ initial state	7,763
Work resource initial state	23,000
Unemployment resource initial state	1,250
GNP initial state	$745{,}218 \cdot 10^6$
National fund FUS initial state	100,000
Average salary initial state	54

Source: own work.

3.3. Simulation results

The simulation experiments on the dynamic model, which was developed for research purposes to verify some common-sense opinions, have proved that the financial deficits in social insurance (FUS), particularly when the public pension system is in the current system's structure and under current constraints, are nearly certain. For laboratory experimenting, some rather unrealistic assumptions were made. As an example, the initial level of FUS was set to 100,000 million zł, which implies in reality a budget subsidy at this level. Indeed, currently running demographic processes for presumed birth, death, and unemployment rates, as time-dependent multiplier functions, allow us to forecast rather negative demographic and employment tendencies in Poland in a long-range time horizon (Fig. 4, Fig. 5).

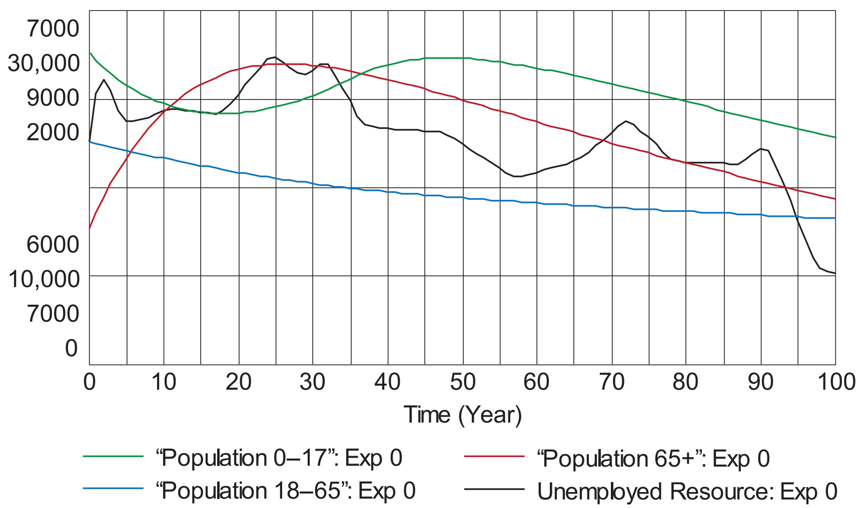


Figure 4. Population levels in basic (Exp 0) experiment

Source: own work.

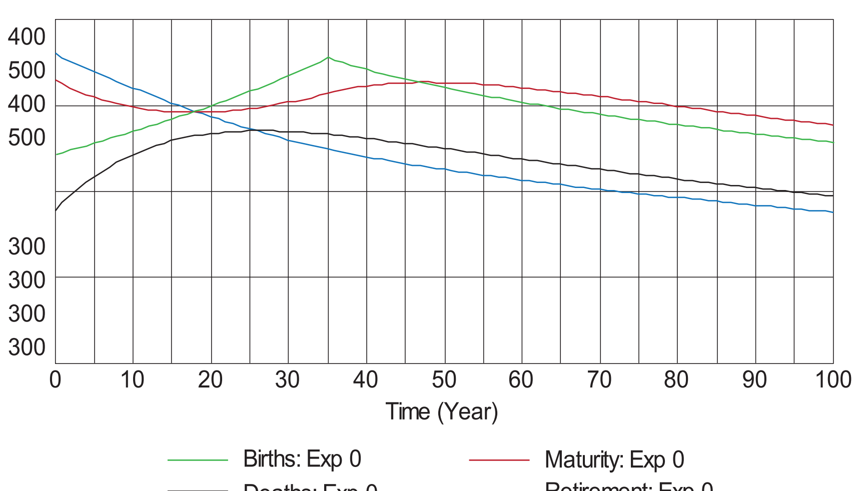


Figure 5. Population flows in basic (Exp 0) experiment

Source: own work.

In the financial system aspects of social insurance, an increase of premium annuity payment to the FUS fund (as a result of average salary increases in the economy) is not compensating FUS basic expenditure — payments of social indemnity for social insurance liabilities (Fig. 6). But it can be reasonable to search for some possible remedies in system structuring and tuning to avoid a rapid financial crisis. Some solutions can be found by an attempt to calibrate the system's parameters, for example a change of replacement coefficient from 1 (pension amount equal to

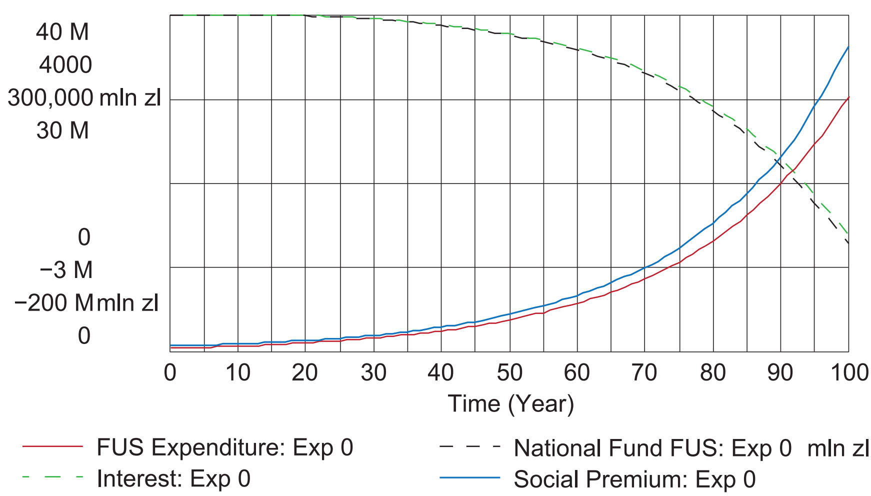


Figure 6. Financial levels in basic (Exp 0) experiment

Source: own work.

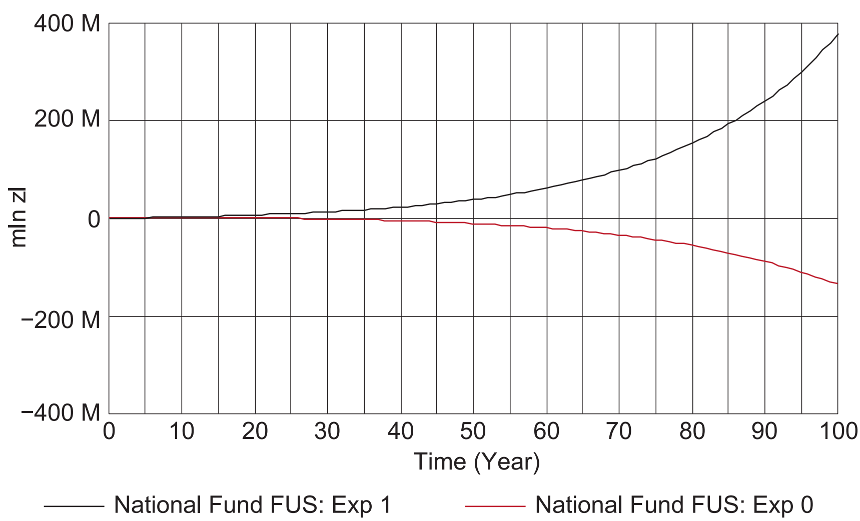


Figure 7. National FUS pension fund with a change of replacement coefficient from 1 (Exp 0 experiment) to 0.5 (Exp 1 experiment)

Source: own work.

100% of the last salary) to 0.5 (pension amount equal to 50% of the last salary). It is even possible in the model to find a break-even point for this parameter to allow sustainable growth of the FUS fund (Fig. 7).

Conclusions

This research paper discusses SD methodology and a generic public pension system dynamic model, which can be used in discussing and tuning the structure and dynamic properties of pension systems, and the first steps to analyse, test and design some proposals (as recommendations) for decision makers. The SD generic model of public pension system, presented in this research consists of four sub-models: ageing population, central pension fund with basic incomes and expenditures, economic growth with the influence of economic investments, and average salary estimation as a base to calculate social insurance premium annuity and finally the pension system liabilities. The first simulation experiments results have proved that for the relevance of representation and next practical application of this model, some multiplier and lookup functions must be recognised as very sensitive input data parameters — thus they must be calibrated on current real data bases. Basic dynamic behaviour of the system under consideration (as a complex system of five positive and five negative feedback loops) is that the system continuously in the long-range horizon tends to be in financial deficit and must be subsidised by external financial sources, but also some regulatory actions are possible — the dynamic system structure is to be transformed into more sustainable behaviour. Therefore, in the next and more extended research programme with simulation testing and results' analysis, some other effects of demographic and economic factors and risks on public pension system expenditure will be possible to be identified, and to formulate rough forecasts with scenarios for recommended structure changes in the Polish pension national system. In particular, studies to determine a feedback loop polarity dominance, behavioural aspects of feedback loop dominance, and pathway participation metrics are to be continued.

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