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A SIMULATION-BASED DECISION-MAKING APPROACH TO EVALUATE THE RETURNS ON INVESTMENTS

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Abstract
The feasibility of Turkish Individual Pension System (IPS) for participants is empirically investigated under different scenarios determined based on its special conditions. Firstly, a system behaviour of the Turkish IPS is modelled by using system dynamics simulation method by taking into account the historical data of a pension company operating in Turkey. After that, all pension plans are evaluated under five "what-if" scenarios depending on the participant's age and the investment period that the deductions and the investment returns are directly related to these conditions. Secondly, the key performance metrics (i.e., net present value and profitability index) are measured to better understand which pension plans are suitable or not for participants. In conclusion, the IPS investment is not suitable for short-term investments, however, all pension plans are profitable in the medium-long term. In the long term, the IPS, particularly dynamic and aggressive funds, is determined as a very profitable investment tool for participants.
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Key Words: Simulation, System Dynamics, Engineering Economy, Decision Support System, Individual Pension System, Pension Plans

1. INTRODUCTION

The Individual Pension System (IPS) aims to enable people to make savings during their working life and obtain an additional income that will enable them to have a better quality of life during their retirement periods. The system works entirely on a voluntary basis [1].

Several important issues regarding the pension system cause some critical difficulties in the management of the economy and social security systems. For example, the increase in the population and the average life expectancy brings an increase in the number of retirees per working person [2]. This situation has weakened the sustainability of the pension management systems in social security systems that the income-expense balance is disturbed [3]. Increasing participation in the IPS offers important advantages to the country's economies, social security systems and participants. For example, small investments made by the participant throughout their working life will enable them to meet their living costs during retirement more comfortably and to have a higher quality of life. The long-term nature of the IPS process also provides the long-term financial resources to the economy. These resources directed to the investments provide employment increase [1].

The type of investment instruments should be in the portfolio before deciding to invest has always been the focus of attention for investors. In addition, one of the most important issues that investors are curious about is how much profit they will earn at the end of the investment period. Accordingly, several studies on financial issues have been carried out using operational research methods. One of the most common of these is portfolio optimization, for example, Cheong et al. [4], Yao et al. [5], Bubicz et al. [6] and Janekova et al. [7]. Fulton and Bastian [8] develop a multiperiod stochastic programming for optimization of diversified funds. Li et al. [9] is interested in portfolio optimization under minimax risk measure. Ahmadi-Javid and Fallah-Tafti [10] optimize portfolio using entropic value-at-risk. In addition, data mining techniques have been used for solving portfolio optimization problems by Almahdi and Yang

[11], Venturelli and Kondratyev [12], Soleymani and Paquet [13]. On the other hand, index and return estimations were carried out using artificial neural networks by Enke and Amornwattana [14] and Kim and Enke [15].

There exist a number of social studies related to individual pension system that are conducted by Chłoń-Domińczak [16], Ertugrul and Gebesoglu [17], and Babat et al. [18]. For example, Gokcen and Yalcin [19] investigate the performance of active pension funds in Turkish individual pension system. Moreno-Herrero et al. [20] analyse the approaches of Spanish households towards individual pension system in the possible future income changes. Ertugrul et al. [21] evaluate the efficiencies of policy changes on Turkish IPS by empirical modelling.

Simulation techniques are a powerful method in building twin of a system in computer environment to better understand system and capture the future behavioural expectations. Simulation has been widely used in several industries (i.e., manufacturing, healthcare services and Freile et al. [22] in supply chain management) however, it has been rarely applied to financial settings. In terms of modelling state pension system and/or social security system, a number of approaches has been developed including Monte Carlo simulation by Mielczarek [23] and Russo et al. [24]; system dynamics by Viehweger and Jagalski [25], and Pietroń [26]; agent-based modelling by Chen and Murata [27], Nair and Rodrigues [28] and Lychkina and Morozova [29].

System dynamics is a simulation method that allows us to better understand and analyse the structure and dynamics of the systems and allows to model the complexity of the systems in the computer environment, thus allowing to produce more effective policies related to the systems. Realistic systems are in a relationship with the dynamics that affect the system through positive or negative loops. These loops have relative strength with respect to each other and cause the system to have a nonlinear behaviour [30]. System dynamics has different advantages over other simulation methods. For example, Discrete Event Simulation (DES) and Monte Carlo Simulation (MCS) deal with discrete time [31], on the other hand, System Dynamics (SD) is interested in continuous systems. Moreover, DES models systems as discrete events, for example, in each passing time the entity (like a patient in a hospital) moves in different activities. That is, while DES is mostly used in queuing modelling problems (e.g., patient, customer, raw material entering the system and waiting in the queue), SD is used when modelling systems with a natural flow structure. On the other hand, ABS method is a new simulation method than others and consists of autonomous agents that interact with each other and their environment, acting according to a set of predefined rules. The disadvantages of the ABS method include the existing software is difficult to use, modelling and running is time consuming and cannot be better than SD [32]. Due to these reasons, system dynamics method is used to model the Turkish Individual Pension System in this study.

The core objectives and original contributions of the study are as follows:

1) Develop a system dynamics model for individual pension system in order to compare the performances of pension plans. The system dynamics approach is rarely used in finance and has not yet been developed for the Individual Pension System. This gap in the literature has been filled by this study and it will be able to direct future studies in this field.

2) Develop a hybrid approach by combining system dynamics simulation model and engineering economy methods to measure the key performance indicators (i.e., net present value and profitability index) for the purpose of the feasibility of individual pension plans.

3) Emphasizing the practical benefits of this study for the stakeholders of the individual pension system (i.e., participants, pension companies).

The remaining of the article is organized as follows: Section 2 provides greater detail about the Turkish Individual Pension System. Section 3 explains the simulation-based decision-making approach proposed in this study and Section 4 explains the system dynamics model

developed. In Section 5, the economic analysis of the investments made in the second stage of the study is carried out. Section 6 and 7 discusses the results and concludes the study, respectively.

2. TURKISH INDIVIDUAL PENSION SYSTEM

In the Turkish Individual Pension System, the participant is entitled to pension if the contribution is paid for at least 10 years and the participant is at least 56 years old or older. In case the participant who does not fulfil these conditions exits the system, the participant is exposed to some deductions (see Table I) from the total investment the participant made. On the other hand, the IPS has many financial advantages. All these cuts and opportunities vary depending on the participant's age and investment period [1]. The parameters related to cash flow in the Turkish IPS are explained in detail below.

Contribution is the amount paid by the participant to the pension company in certain periods. The state invests 30 % of each contribution amount to the relevant individual pension company on behalf of the participant as a State Contribution. The contribution paid by the participant and the state contribution are directed to investment separately. The upper limit of the annual state contribution is 30 % of the annual gross minimum wage. The annual gross minimum wage in Turkey is 42.930 Turkish Lira in 2021 [1]. At the end of the investment period, a certain proportion of the total savings obtained from the investment made with the state contribution is paid to the participant. These entitlement rates are shown in Table I. For example, if the participant has paid contributions for at least 10 years and is 56 years old or older, the participant is entitled to 100 % of the state contribution amount. In another example, if the participant pays less than 3 years, the participant deserves only 15 % of the state contribution.

Entrance Fee is paid as a certain percentage of the monthly gross minimum wage valid in the year the participant joins the IPS [1]. For example, if the participant pays the contributions for 60 months, 50 % of the monthly gross minimum wage is paid as entrance fee (see Table I).

Total Fund Management Fee Deduction is applied as a maximum 2 % deduction for each contribution. Fund Expense Fee Total is applied at certain rates over the fund net asset value to cover the fund-related expenses. For example, 1.09 % of the total fund net asset value are charged as the fund expense fee total in case of the pension plans regarding money market funds and 1.91 % for fixed income & index funds, 2.28 % for equity and managed funds and 0.36 % for state contribution funds [1].

Table I: The rates of the deductions [1].

Investment period (Month)	The age of the participant	The entitlement rate of the state contribution (%)	The rates of the total entrance fee applied to the monthly gross minimum wage (%)	The withholding tax rate at the end of the investment period (%)
0 – 36	–	0	75	15
37 – 72	–	15	50	15
73 – 119	–	35	25	15
120+	<56	60	0	10
120+	≥56	100	0	5

Withholding Tax is collected over the total savings of the participant at the end of the investment period. Withholding rates (see Table I) vary depending on the investment period [1]. A 15 % tax rate is applied when the contribution is paid less than 10 years. On the other hand, the participants, who have paid at least 10 years in the system and are 56 years old or over, only pay 5 % of the total savings as withholding tax. This situation proves an important economic advantage of the IPS.

3. THE PROPOSED SIMULATION-BASED DECISION-MAKING APPROACH

This study aims to develop a simulation-based decision-making approach combining system dynamics and engineering economy methods to evaluate and compare the pension investment plans in the Turkish Individual Pension System under different periods and conditions. First, the Turkish Individual Pension System has been modelled using the system dynamics approach. Five scenarios are developed based on the dynamics of the IPS such as the existing deductions, withholding tax advantages and the deserved state contribution rates. Second, the economic analysis of the investments has been carried out by using the engineering economy methods and accordingly, net present values and profitability indices are calculated.

The approach proposed in this study is shown in Fig. 1. First, the inputs used in the development of the system dynamics model were obtained. Data collection and analysis was carried out to capture variation and uncertainly, i.e., the monthly return of pension investment funds and the monthly return of state contribution fund. Data on important parameters of the system (i.e., withholding tax rates, deductions, investor information and other ratios) were obtained from the related pension company. Data regarding the crucial parameters of the system (i.e., withholding tax rates, deductions, investor information and other ratios) were obtained from the relevant pension company. The necessary inputs for the economic analysis were produced from the simulation model: Net amount paid to investor, total fund management fee deduction, deducted fund expense fee total and withholding tax amount. Engineering economy methods (i.e., net present value and profitability index) were preferred in order to analyse the profitability of the pension plans. To do this, the required inputs are cash flows, interest rate and investment period.

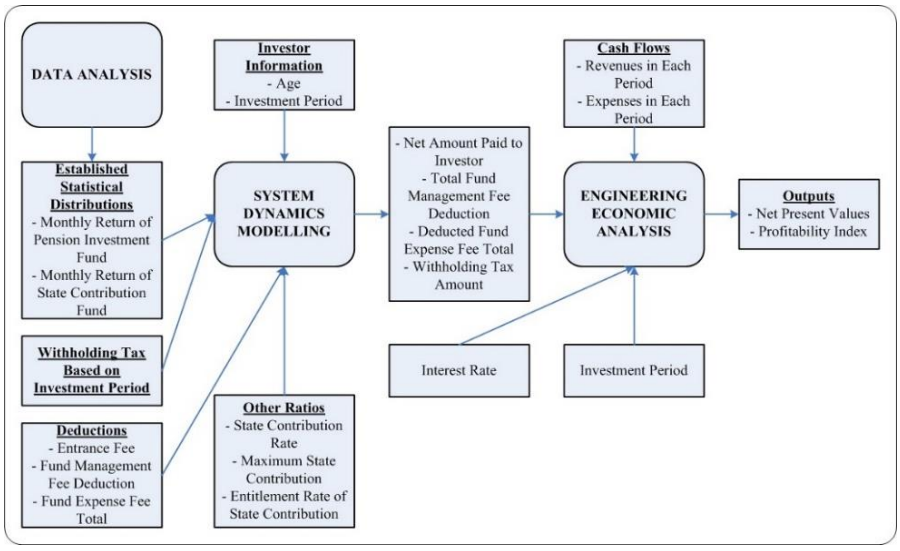

Figure 1: The proposed simulation-based decision-making approach.

4. SYSTEM DYNAMICS MODELLING

4.1 Model development process

The system dynamics modelling approach consists of two main stages in order to develop a simulation model: 1) Mapping the main cause-effect relationship between system elements using Causal Loop Diagram (CLD) and 2) Converting the CLD into a computer environment [30]. The model developed for the Turkish IPS (see Fig. 2) combines participant contribution payment, state contribution, monthly returns, total fund management fee deduction, fund

expense fee total, deserved state contribution amount at the end of the investment period, entrance fee deduction, withholding tax deduction and net amount to paid to the participant. During the model development phase, financial experts and individual investment consultants related to the IPS were constantly updated. The process of the development of the model continued until they validated the accuracy of the model logically and statistically.

The process of the IPS in the simulation model starts with the monthly contribution fee made by the participant. The monthly contribution fee entry depends on contribution amount and annual increase rate on contribution. Eq. (1) represents it as follows:

$$CFE_t = CA_t \times AIRC_t \tag{1}$$

where CFE_t: monthly contribution fee entry [Turkish Lira/month]; CA_t: contribution amount per month [Turkish Lira/month]; $AIRC_t$: annual increase rate on contribution [Turkish Lira/month]. In this stage, the fund management fee deduction over the contribution is applied by Eq. (2):

$$FMF_t = CFE_t \times FMFR_t \tag{2}$$

where FMF_t: Fund Management Fee Deduction per month [Turkish Lira/month]; $FMFR_t$: Fund Management Fee Deduction Rate [Turkish Lira/month].

After the fund management fee is deducted from the contribution, the contributions are directed to investment through the relevant pension plans. Pension plans are divided into four different groups according to their risk level: Conservative, Balanced, Dynamic and Aggressive. Savings is represented by the nonlinear function, see Eq. (3):

$$S_t = f(RIC_t + (CA_t - FMF_t) - FEFT_t) \tag{3}$$

where S_t: Saving per month [Turkish Lira/month]; RIC_t: monthly return of investor contribution [Turkish Lira/month]; $FEFT_t$: Fund Expense Fee Total of Investor Contribution per month [Turkish Lira/month].

Monthly state contribution entry depends on the participant contribution and maximum state contribution. The state contribution is paid as 30 % of the participant's contribution provided that it does not exceed 30 % of the annual gross minimum wage. It is represented by Eq. (4):

$$SC_t = MIN((SCR_t \times CFE_t), MSC_t) \tag{4}$$

where SC_t: Monthly state contribution per month [Turkish Lira/month]; SCR_t: State contribution rate [Turkish Lira/month]; MSC_t: Maximum state contribution per month [Turkish Lira/month].

Monthly fund expense fee total deduction is applied to cover fund-related expenses from both participant contribution and state contribution. At the end of the investment period, the total income from the participant's contributions and the revenues from the state contribution investment is summed. However, the amount of revenues from the state contribution investment are determined according to the entitlement rate (see Table I), so that it is depended on the investment period and the age of the participant. When the participant wants to leave the system, withholding tax is deducted at the rates specified in Table I. After the tax deduction, all the remaining savings are paid to the participant.

4.2 Data

The necessary data used in the study were obtained from an individual pension company operating in Turkey. The pension company offers participants a total of 18 pension plans. The following pension plans are divided into 4 groups according to their risk levels: Conservative Category (low risk): Money market (MM), Participant Standard (PP), Group Conservative (GC) and Private Sector Debt Instruments (PSDI); Balanced Category (medium risk): Bond (B), Group Bond (GB), Group Debt Instruments (GDI), Standard (S) and Debt Instruments (DI); Dynamic Category (medium-high risk): First Debt Instruments (FDI), Second Debt Instruments (SDI) and Developed Countries Flexible (DCF); and Aggressive Category (high risk): Gold (G), Group Equity (GE), Second Equity (SE), BRIC Plus, Equity Fund (EF) and Isbank

Subsidiaries Index (ISI). Data relevant to the pension plans have been collected and analysed for the period between 2015 and 2020. Each pension plan consists of various investment instruments at very different rates. For example, money market fund includes the following investment tools: government bonds and bills, stock market, time deposits, reverse repo, and financing bills.

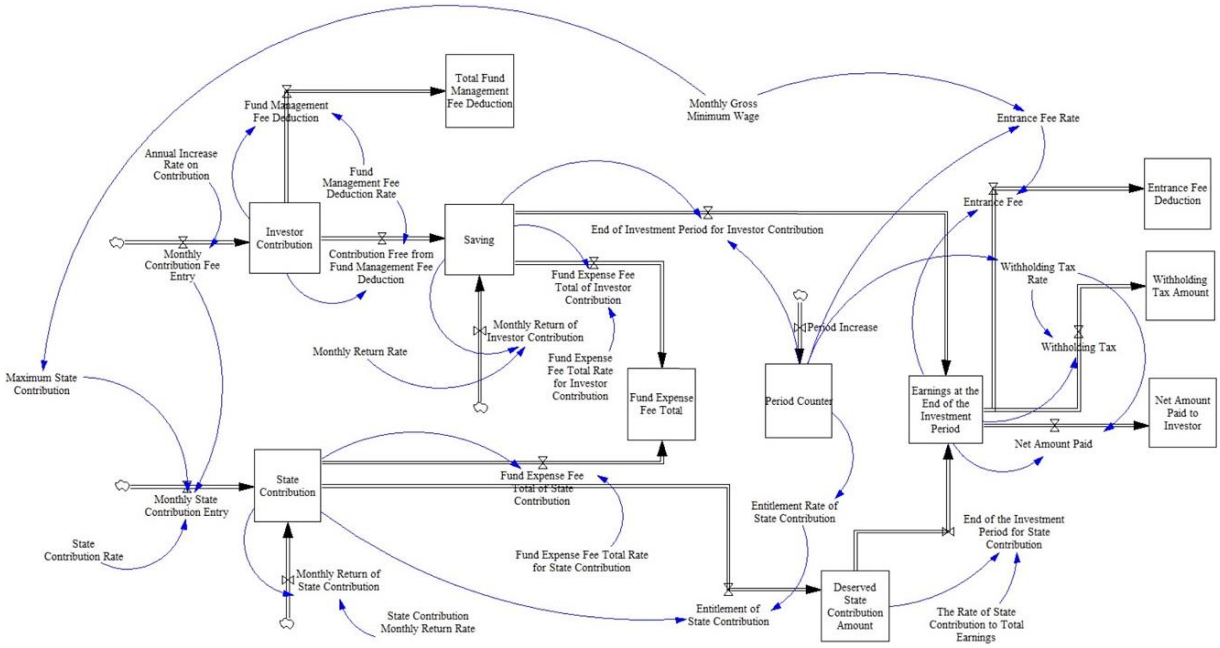

Figure 2: The simulation model.

4.3 Model parameters and validation

The simulation model was validated by using three validation methods. In the first step, the structure of the causal-loop diagram representing the Turkish Individual Pension System was verified by financial experts and individual investment consultants. In the second step, the accuracy of the equations embedded in the simulation model was checked. In addition, the expert opinion examined whether each component of the model was correct or not. Therefore, it was concluded that the model is compatible with the real world.

Finally, the results obtained were found to be consistent with the historical data. In addition, the model was tested for the critical components of the model in order to understand that the model will be able to produce accurate results and then, it produced acceptable results at the expected level. Table II gives the validation results for the money market pension fund with the 72-month simulation run. The simulation model generated the results very close to the past observation values. In addition, the model was validated for all other pension plans.

Table II: Validation test for the Money Market Pension Fund with the 72-month simulation run.

Outcome variables	Actual data	Simulation results	Differences	Percentage (%)
Fund Expense Fee Total (TL)	2,185.46	2,121.81	63.65	3.00
Deserved State Contribution Amount (TL)	1,746.06	1,661.36	84.70	5.10
Earnings at the End of the Investment (TL)	53,567.06	51,992.66	1574.40	3.03
Withholding Tax Amount (TL)	7,900.90	7,664.74	236.16	3.08
Net Amount Paid to Investor (TL)	44,771.78	43,433.54	1,338.24	3.08

4.4 Scenarios

In this study, five different scenarios (see Table III) have been developed by considering the situations that a participant may experience during the investment period regarding the special conditions of Turkish IP i.e., the participant's age and investment period. In this scenario analysis, it is assumed that the participant is 41 years old. Thus, five different scenarios can be developed for the same participant. It is also assumed that the participant makes regular payments during the participant stays in the Turkish IPS. The participant pays a monthly contribution of 500 TL. 30 % of this amount (i.e., 150 TL) is deposited by the state as state contribution to the participant's IPS account. The deduction rates applied by the relevant individual pension company are taken into account. In the first scenario, regular payments are made for 24 months, and the participant is 43 years old at the end of the investment. Therefore, the participant cannot benefit from the accumulated state contribution in any way. The participant must pay 75 % of the monthly gross minimum wage as entrance fee. 15 % withholding tax is applied to the amount remaining after deductions, and the remaining is paid to the participant. Information about Scenario 2, 3, 4 and 5 is included in Table III. These five scenarios are carried out for a total of 18 pension plans. In each pension plan, the fund expense fee total and the return rates of the participant contribution and the state contribution vary depending on the considered pension funds.

Table III: Scenarios in the study.

Scenarios	Investment period (month)	The age of the participant at the end of the investment period	Entitlement rate of the State contribution (%)	Entrance fee rate (%)	Withholding tax rate (%)
Scenario 1	24	43	0	75	15
Scenario 2	36	44	15	75	15
Scenario 3	72	47	30	50	15
Scenario 4	120	51	60	25	10
Scenario 5	180	56	100	0	5

4.5 Engineering economic analysis

Engineering economy consists of formulation, estimation and evaluation to calculate the values of the economic outputs of the alternatives for projects carried out with the aim of specific purposes and to decide their feasibilities [33].

Outputs produced by system dynamics modelling (i.e., net amount paid to investor, total fund management fee deduction, deducted fund expense fee total and withholding tax amount) are used as inputs in engineering economic analysis. Thus, the investment feasibility of individual pension plans in the investment maturities considered in the scenarios is investigated. Cash flows are composed of cash inflows and cash outflows. Cash inflows are as follows: The monthly contributions by the participant and accordingly the monthly state contributions paid by the state, and the returns obtained from the investments of the contributions. Cash outflows are fund management fee deducted monthly from participant contribution, fund expense fee total deducted monthly from the total fund amount, entrance fee and withholding tax deducted upon the exit from the IPS.

Net present value (*NPV*) and profitability index (*PI*) are two of key metrics among the methods of engineering economics. Net present value is the differences between the *NPV* of the incomes and the *NPV* of the costs at a project [3]. The formula for the single-payment present value is given by Eq. (5) as follows:

$$P = F(1+i)^{-n} \tag{5}$$

where *P* is present amount, *F* represents future amount, *i* is interest rate, and *n* means period [33]. The *NPV* of an investment is calculated by using Eq. (6) given below:

$$NPV = \sum_{n=1}^{t} \frac{F_n}{(1+i)^n} - \sum_{n=1}^{t} \frac{C_n}{(1+i)^n} \tag{6}$$

where *F* is income at period *n*, *C* represents cost at period *n*, *i* is interest rate, and *t* means period [34]. Profitability index (*PI*) is used to calculate and assess the profitableness of the projects. The formula is presented by Eq. (7) [33].

$$PI = \frac{Present\ Value\ of\ Net\ Cash\ Flow}{Present\ Value\ of\ Initial\ Investment} \tag{7}$$

The net present value method is used to compare the net returns of the pension plans in each scenario since the investment periods in the scenarios are different. The profitability index, on the other hand, is applied to evaluate the performances of the pension plans in amongst all scenarios and to select the most profitable pension plan.

5. RESULTS AND DISCUSSION

In this study, a system dynamic model is developed that simulates the behaviour of the Turkish Individual Pension System throughout the investment period, which has not been considered in the literature. After validating the model, the performance of pension plans of a company operating in the Turkish IPS under different scenarios is investigated. The scenarios are developed by taking into account the factors such as withholding tax, entitlement rate of the state contribution and entrance fee presented to the participants in the IPS. In case of preference by the participant, projections of each pension plan are produced in 5 different investment periods. For example, Fig. 3 shows the investment performance graphs of 18 pension plans in case of the contributions paid by the participant during the investment period with 180 months (i.e., Scenario 5).

The volatility of conservative pension funds remained low throughout the investment period. As an indicator of low risk level, their performance seems to increase slightly and exponentially. Group Conservative and Money Market funds clearly outperformed the other two funds after the 80th month. Balanced funds, like conservative funds, carry relatively less financial risk. The performance of the Group Debt Instruments fund and the Standard fund started to perform more successful compared to other funds after approximately 40 months and the 60 months, respectively. Other balanced funds, with the exception of the Group Debt Instruments fund, earned less than conservative funds. The Group Debt Instruments fund, on the other hand, stands out as the fund that can provide the most profit among the balanced funds. Dynamic funds are a lucrative investment instrument compared to both conservative and balanced funds. Dynamic funds experience a significant break after approximately 150 months and especially Developed Countries Flexible and First Debt Instruments funds have a sharp rise. Fund charts naturally show volatility as both dynamic and aggressive fund groups contain high risk. There are two important breaks in the performance graphs of aggressive funds. The first break occurs around the 70th month, and the second break takes place at the 150th month. Although BRIC Plus and Gold funds, in particular, showed themselves with their high performance in the first break, they clearly distinguish themselves from other aggressive funds in the second break. Isbank Subsidiaries Index and Second Equity, as well as Equity fund and Group Equity fund showed similar performance and did not have a preferable performance compared to Dynamic Pension Mutual Funds. In fact, Equity Fund and Group Equity fund earn less than conservative funds. The investment instruments that compose the Dynamic pension mutual funds may be better optimized. Breaks and sharp increases in the performance of pension mutual funds actually prove that the investment portfolio has grown like a snowball.

Small but regular contribution payments allow huge profits to be made after a certain investment maturity.

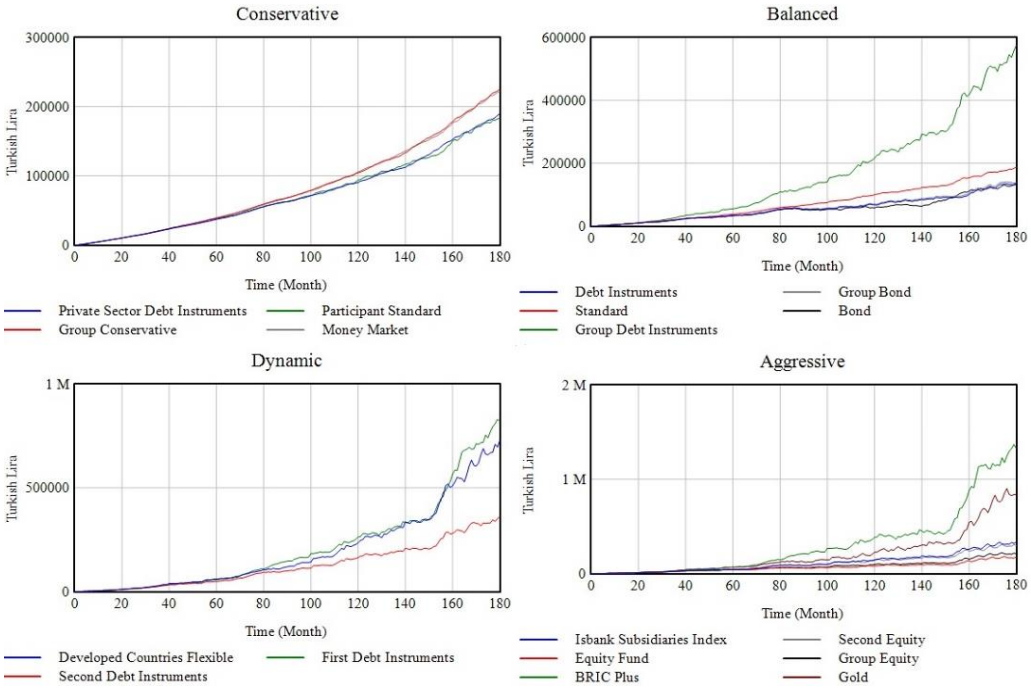

Figure 3: Graphs in groups for the investment performance of the pension mutual funds for 180-month investment period.

Table IV shows the net present values and profitability indices of pension plans for all scenarios. According to these results, in Scenario 1, all pension plans have *NPV*s less than zero and *PI*s less than one. It means no pension mutual plans is acceptable for investment. The possible reasons for this situation are as follows: 1) the tax is applied on the total income instead of profit, 2) the deductions (i.e., entrance fee, fund management fee and fund expense fee total), and 3) not being entitled the state contribution invested by the state. In scenario 2, the *NPV*s of funds (i.e., Equity Fund, Money Market fund to Debt Instruments fund excluding Group Debt Instruments in Table IV) are less than zero. In addition, a maximum profit of 36 % (with the Gold fund) is obtained proportionally. The present values of the income to be obtained in the medium, medium-long, and long investment terms (i.e., Scenarios 3, 4 and 5) are greater than zero and the investment is preferable. In addition, it is observed that as the investment period gets longer, the earn and the critical indicators (i.e., *NPV* and *PI*) grow more. The most important thing in this situation is that the rates of deductions in the long-term IPS investments are significantly low and the entitlement rate of state contribution valued in the investment is 100 %. These results show that the appropriate investment maturity in the IPS for the participants is greater than 72 months. First Debt Instruments, Gold and BRIC Plus funds become prominent in the 180-month investment period (Scenario 5), whereas Group Debt Instruments, First Debt Instruments, Developed Countries Flexible, Gold and BRIC Plus stood out in the 120-month investment period (Scenario 4). The followings can be also extracted from the results:

- Dynamic and aggressive funds with high risk are more suitable for investors who would like to earn more than inflation in the long term.
- Funds with a high level of risk are highly volatile in the beginning years of investment but consist of investment instruments that are considered to have higher returns in the long term.
- Conservative and Balanced funds are suitable for investors who have low interest rate risk and would like to protect their capital against inflation.

- Investors should prefer funds based on their willingness to take risks. Risk-averse investors can choose conservative and balanced funds.

Table IV: Net present values (TL) and profitability index values of the pension plans for all scenarios.

Pension plan	**Scenario 1**		**Scenario 2**		**Scenario 3**		**Scenario 4**		**Scenario 5**	
	NPV	*PI*	*NPV*	*PI*	*NPV*	*PI*	*NPV*	*PI*	*NPV*	*PI*
MM	-4533.99	0.60	-2248.74	0.84	6740.58	1.38	20902.95	2.10	41907.07	3.17
PS	-4570.45	0.60	-2279.40	0.84	5765.00	1.33	16796.27	1.89	32996.43	2.71
GC	-4610.70	0.59	-2286.17	0.84	6577.84	1.37	20445.97	2.08	42525.43	3.21
PSDI	-4708.84	0.59	-2683.39	0.81	5082.77	1.29	15560.15	1.82	34474.67	2.79
B	-4826.58	0.57	-2897.90	0.79	2423.65	1.14	4330.27	1.23	22243.67	2.15
GB	-4727.03	0.58	-2676.68	0.81	3286.34	1.19	8636.33	1.46	23277.07	2.21
GDI	-3449.44	0.70	1641.27	1.12	20796.31	2.18	59260.50	4.12	122094.17	7.33
S	-4640.98	0.59	-2106.46	0.85	6142.37	1.35	18792.70	1.99	33813.10	2.75
DI	-4765.74	0.58	-2762.00	0.80	2923.80	1.17	7777.50	1.41	21743.56	2.13
FDI	-3459.34	0.70	1667.20	1.12	23019.00	2.31	75494.38	4.98	178058.74	10.24
SDI	-3832.57	0.66	688.71	1.05	15730.36	1.89	41169.88	3.17	73525.38	4.81
DCF	-2955.66	0.74	3327.54	1.24	23266.82	2.32	65901.52	4.47	157156.12	9.15
G	-1945.92	0.83	4963.74	1.36	29103.04	2.65	63283.49	4.34	181842.60	10.43
GE	-3673.95	0.68	167.08	1.01	9248.56	1.53	18431.83	1.97	39172.77	3.03
SE	-3231.03	0.72	1323.24	1.09	12329.76	1.70	33672.49	2.77	59028.11	4.06
BRIC	-3008.14	0.74	4092.03	1.29	33425.16	2.90	118072.70	7.22	293399.90	16.22
EF	-3899.09	0.66	-386.66	0.97	7529.52	1.43	12494.64	1.66	31153.85	2.62
ISI	-3177.79	0.72	1466.10	1.10	12823.57	1.73	34862.32	2.84	67587.15	4.51

6. CONCLUSION

In this study, the functioning of the Turkish Individual Pension System is modelled using the system dynamics method. The data along with the monthly return rates of the investments made with the participant and the state contributions for the simulation model are obtained. In addition to these, other parameters were taken into consideration and the performance of the pension plans of the relevant IPS company is analysed under 5 different scenarios. Each scenario is run for a total of 18 pension plans. The scenarios are developed by taking into account the advantages and disadvantages offered to the participant, such as the existing deductions, tax advantages and the deserved state contribution rates in the Turkish IPS. After simulation modelling, the net present value and profitability indices of each pension plan are calculated. To do this, all cash flows in the system are analysed during the investment period and cash inflows and outflows are determined. As a result, it is observed that the IPS investment is not suitable for short-term investments, and on the other hand, all pension plans are profitable in the medium-long term. In the long term, the IPS is determined as a very profitable investment tool for investors.

In terms of practical implication, the simulation-based decision-making approach proposed in this study offers many advantages to the stakeholders of the individual pension system. For example, this approach can be used as a convincing tool for companies operating in the Turkish IPS to include potential investors into the system. Model outputs do not produce results regarding the profitability of the relevant company. However, an idea about the profitability of the company's pension plans can be obtained when the results generated from the simulation model are investigated. This may provide an opportunity to achieve higher company's profitability by optimizing the investment tools that compose the pension plans. In addition, participants who are already investing in the system will be able to decide more easily in which pension plans they can invest their portfolios. The study assumed that some parameters (i.e., contribution and monthly gross minimum wage) have constant values during the investment

period in the developed simulation model. Future research can be conducted by forecasting these parameters for the years taken into account in the scenarios.

The developed model actually covers the operational processes of the Turkish IPS. The model does not include any components related to inflation since it does not directly affect the operating procedures of this system. For example, an increase in inflation causes an increase in policy rates. This situation causes an increase in the rate of return in money markets. Therefore, it allows an increase in fund returns. Our model already selects monthly rates of return from the historical dataset randomly by using the theoretical distributions that fit the data pattern. Therefore, a fixed rate of return is not used. Of course, investors may have different behaviours in the face of inflation. However, by estimating inflation over the investment period, the model can be developed to be an inflation-based decision support system.

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