T.C. DOGUS UNIVERSITY

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DEPARTMENT OF FINANCIAL ECONOMICS

RISK MANAGEMENT AND CAPITAL ADEQUACY OF ANNUITY PLANS IN TURKISH PRIVATE PENSION SYSTEM

PhD DISSERTATION

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SUPERVISOR

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Tezin Başlığı : Risk Management and Capital Adequacy of Annuity Plans in Turkish Private Pension System

Doğuş Üniversitesi Lisansüstü Eğitim-Öğretim ve Sınav Yönetmeliği'nin 44.Maddesi uyarınca yapılan değerlendirmeler sonunda;

☒ tezin kabul edilmesine   ☐ tezde düzeltme verilmesine   ☐ tezin reddedilmesine

oy birliği / ~~oy çokluğu~~ ile karar verilmiştir. Gereği için arz olunur.

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ABSTRACT

An annuity plan is an insurance product that insured make a lump sum payment or series of regular payments and, in return, obtains regular payments for a certain period of time in the future or whole life starting from a certain time. Annuity plans are generally preferred for retirement period. Employees want to convert a lump sum of money which they save up during their working life into guaranteed income for a time period or the rest of life.

Annuity Regulation came into effect on 01.04.2015 (Official Gazette No. 29313) in Turkish Insurance Sector. According to regulation, there were local restrictions for annuity plans such as guaranteed interest rate, mortality table, discount rate, required capital (RC) etc. Thus, annuity plans can be designed in real terms for the first time by the virtue of this regulation. Annuity plans are divided into two groups, one for participants under the age of 56 who leave Private Pension System (PPS) voluntarily before retirement and one for participants above the age of 56 who retire from PPS based on the regulation and technical principles are specified for both groups in the regulation.

Annuity plans have an important place in both PPS and insurance system for increasing insurance awareness, product range, customer loyalty and customer satisfaction. However, pension and life insurance companies face with challenges due to legal restrictions, economic and non-economic (like demographic etc.) uncertainties while preparing annuity plans.

This dissertation focuses on pension company's liability in case of selling annuity plans to participants over age 56 who retire from PPS under local regulation and an international regulation which is Solvency II directives. In addition, Solvency Capital Requirement (SCR) is calculated considering Turkish economic indicators. Various scenario analyses will be made based on economic and non-economic variables and results are utilized.

Keywords: Annuity, Solvency II, solvency capital requirement, economic indicators

ÖZET

Anüite planı, sigortalıya tek bir seferde toplu olarak ödeme yapan, ya da belirli bir süre boyunca yapılan düzenli ödemeler veya belirli bir zamandan başlayarak hayat boyunca ödenen düzenli ödemeler dizisi olan sigorta ürünüdür. Anüite planları genellikle emeklilik dönemlerinde tercih edilir. Çalışanlar, aktif çalışma dönemleri boyunca elde ettikleri birikimlerden oluşan toplam varlıklarını, emeklilik dönemlerinde geri kalan hayatları için garanti edilmiş bir gelire dönüştürmek isterler.

Yıllık Gelir Sigortası Yönetmeliği 01.04.2015 tarihinde (29313 sayılı Resmi Gazete) yürürlüğe girmiştir. Yönetmeliğe göre, anüite planlarında garanti edilen faiz oranı, mortalite tablosu, iskonto oranı, gerekli sermaye tutarı gibi kısıtlamalar bulunmaktadır. Bu nedenle annüite planları, bu yönetmelik sayesinde ilk kez gerçek anlamda tasarlanmıştır. Anüite planları 56 yaşından önceki ve 56 yaşından sonraki katılımcılara sunulmak üzere ikiye ayrılır ve her iki grup için de teknik esasları yönetmelikte belirtilmiştir.

Anüite planları, sigorta bilincini, ürün yelpazesini, müşteri sadakatini ve müşteri memnuniyetini arttırmak için hem bireysel emeklilik sisteminde hem de sigorta sisteminde önemli bir yere sahiptir. Ancak, emeklilik ve sigorta şirketleri anüite planlarını hazırlarken yasal kısıtlamalar, ekonomik ve ekonomik olmayan (demografik gibi) belirsizlikler nedeniyle zorluklarla karşı karşıya kalmaktadır.

Bu çalışma, emeklilik ve sigorta şirketlerinin bireysel emeklilik sisteminden emekli olan 56 yaş üstü katılımcılara anüite planı sunması durumunda şirkete getireceği yükümlülüğe yasal mevzuat ve uluslararası bir düzenleme olan sermaye yeterliliği (Solvency II) çerçevesinde odaklanmaktadır. Ayrıca, yükümlülük karşılama yeterliliği için gerekli sermaye tutarı Türkiye'nin ekonomik göstergeleri dikkate alınarak hesaplanacaktır. Ekonomik ve ekonomik olmayan değişkenlere dayalı çeşitli senaryo analizleri yapılacak ve sonuçlar değerlendirilecektir.

Anahtar kelimeler: Anüite, sermaye yeterliliği, gerekli sermaye, ekonomik göstergeler

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LIST OF ABBREVIATIONS

AES   : Auto Enrollment System

BSCR   : Basic Solvency Capital Requirement

CEIOPS   : Committee of European Insurance and Occupational Pensions
                Supervisors

CRO   : Chief Risk Officers

DCF   : Discounted Cash Flow

EIOPA   : European Insurance and Occupational Pensions Authority

EGM   : Pension Monitoring Center

GAO   : Guaranteed Annuity Option

IMF   : International Money Fund

MCR   : Minimum Capital Requirement

ORSA   : Own Risk and Solvency Assessment

PPS   : Private Pension System

QIS 5   : Quantity Impact Study 5

RC   : Required Capital

RFR   : Risk Free Rate

SCR   : Solvency Capital Requirement

SPK   : Capital Markets Board of Turkey

TRH 2010 : Turkish Mortality Table 2010

TRHA 2010 : Turkish Annuitant Mortality Table 2010

WHO   : World Health Organization

1. INTRODUCTION

Since the lifetime of a human is increasing, people need guaranteed lifetime income to supplement Social Security payments for a higher life standard during their retirement period. Because Social Security is only supposed to be a supplemental federal assistance according to a certain percentage of salary in active working life for the elderly in passive life. In other words, people's regularly income drops and thus people need alternatives for maintaining a similar standard of living as before retirement.

Poterba (1997) gives a general definition for annuity plans as; "Annuity plans comprised of accumulation phase and liquidation phase. During the accumulation phase, capital builds up; this capital is dispersed during the liquidation phase. In case of the single premium annuity, there is no accumulation period".

Annuity plans are generally preferred for retirement period. Because, they allow converting a lump sum of money into guaranteed income for a period of time or the rest of life. "Annuities are even more central in pension system. In fact, a retirement plan can be regarded as a system for purchasing deferred life annuity" (Bowers et al., 1997, p. 133). However, risk management of an annuity is difficult and has high risk. Because insurance companies face with challenges about annuity plans as legal restrictions, economic uncertainties and customer behaviours. Therefore, all of these uncertainties should be taken into account while designing annuity plans and profitability analyses. Therefore, pension and life insurance companies should make cash flow analyses of annuity plans for seeing future status.

The history of annuity plans dates back to ancient times and they are also one of the most popular life insurance products in developed countries which have an advanced insurance system. Marrion (2010) gives information about the history of the first annuity plan:

According to Marrion's (2010) study, there were contracts in the ancient times of Babylonians and Egyptians, where those contracts were guaranteeing periodical payments, but Marrion (2010) stated that the first true annuities were during the Roman period. The Roman Emperor was giving back most of the spoils of the war to the soldiers as a sign of fidelity. However, the Emperor changed this rule by only giving half of spoils

of the war tot the soldiers at the beginning and giving the remaining half to provide a pension for those soldiers upon retirement. This pension plan was a mandatory plan providing an income for life but no interest was earned on that plan, but on the other hand, this plan is viewed as the first annuity.

Then, annuity plans spread to countries such as Germany, France, England, US etc. Annuity plan's share in the insurance system changes depending on economic conditions, non-economic conditions, product's properties etc. throughout the years. When looking at history of insurance, there are some life companies that went bankrupt because of inaccurately designed annuity plans like guaranteed annuity plans. As an example, Equitable Life Insurance in U.K. admitted that it was insolvent in 2003. Its crisis stemmed from high guaranteed annuity rate. The company guaranteed minimum pension pay-outs and a bonus when the insured's policy matured. The demand for this product, which is very attractive for the customer, has been so much more. However, Equitable Life Insurance estimated high inflation and high interest rate but actual economic indicators were lower than its estimation. Therefore, this company was unable to fulfill its commitments. As a result, the company went through a crisis. This crisis affected about 800,000 policyholders who had an insurance contact from the company. Briefly, the cause of Equitable Life Crisis stems from guaranteed annuity options due to inaccurate estimation of the economic indicators. As Boyle and Hardy (2003) explained; the main challenges of guaranteed annuity options which are guarantees of annuity and mortality assumptions, effected the value of annuity product.

While looking at Turkish Insurance Market, life insurance is still not fully developed. Because insurance expenditures in Turkey are low compared to similar countries. However, positive developments such as increasing insurance awareness, digitalization in the insurance sector and the development of new business models will return to the insurance sector as growth occurs in the event of favourable economic conditions. In addition, there is no a real annuity plan offered to insureds yet. However, life insurance and pension companies can design annuity plans in real terms by using the Annuity Regulation which was put inforce as of 2015. General framework and restrictions of selling annuity plans are specified within this regulation and how life insurance and pension companies can offer annuity plans to their customers.

Starting from this point, this dissertation will be focusing on the forecast of life insurance or pension company's liability in case of selling annuity plans by considering local regulation and an international regulation as Solvency II directives. Various scenario analyses will be made based on economic and non-economic variables and results shall be put into use. This study is the one of the first studies in Turkish literature related with the private pension system's annuity plan solvency calculation.

The inspiration of this dissertation is Kochanski's study (2010). Kochanski's study focuses on unit-linked business and Solvency II. His study focuses on lapse risks for life insurance products. Moreover, solvency capital requirement for German unit-linked insurance product is calculated using an alternative model. The study finds out that market and lapse risk are the main risks of German unit-linked insurance product with guaranteed death benefits. Mortality and expense risks are insignificant because such type of the death benefits has no impact on the solvency capital requirement.

This dissertation is organized as follows: Part two summarizes literature review of valuation of annuity plans, specific studies, Solvency II calculation and evaluation of different calculation approaches in previous studies. Part three and part four explains PPS and annuity plan valuation respectively. Part five summarizes Solvency II calculation in practice. Recommendation for the assumptions used in Solvency II calculation according to Turkish economic conditions are given in Part six. A case study for annuity plan valuation including assumptions and RC cash flow figures are also given in Part six. Conclusion and ideas for further researches are given in Part seven. Appendices I-IX present the various scenario analyses of annuity plan valuation and RC cash flows. Appendix VIII and IX give the comparison of RC results. Forecasted figures of PPS, annuity plans and SCR examples for sub-risks are given in Appendix X.

2. LITERATURE REVIEW

Solvency II directives were published as at end of 2009 and since then there have been a lot of studies and discussions regarding it. On the other hand, annuities have an important role to get income during retirement and it is known that annuities have also different kinds of risks. For that reason, there are many studies about annuity modelling and Solvency II in the literature. Annuity type, economic assumptions (inflation etc.) and non-economic assumptions (mortality etc.) are the most important variables in annuity modelling and those variables are modelled by various approaches. Deterministic or stochastic methodology is used for modelling and alternative methods are also used depending on the data and assumptions.

Sample studies are summarized as below:

Ballotta, Esposito and Haberman (2006) developed a market consistent valuation for annuity reserve considering two main risks (the interest rate risk and the mortality risk).Annuity modelling is made by considering two alternative frameworks for interest rates based on the Cox-Ingersoll-Ross (CIR) (1985) model and the Heath-Jarrow-Morton (HJM) (1992)model and a modified version of the stochastic mortality model developed by Cox and Lin (2005).Among the different approaches, the results are compared with each other. An important conclusion of the analysis is the sensitivity of the annuity fair values and the risk margin to the underlying assumptions and choices made as part of calibration.

Ruez (2016) analyses the risk profile of the key financial risk drivers of equity returns, implied equity volatility and interest rates for annuity policies where those key financial drivers are used as variable with Guaranteed Lifetime Withdrawal Benefit (GLWB) riders. He computes the indicators for risk based capital requirement by analysing the effectiveness of different stylized hedging programs over a one-year time horizon. In addition, the impact of changing market environments - on risk profile, hedge effectiveness and capital requirements is analysed. This part is a kind of forward-looking analysis in the context of the mandatory Own Risk and Solvency Assessment (ORSA) under Solvency II. He found that, market environment causes potentially unhedged changes of the value of liabilities, and changed parameters also have a considerable

impact on risk measures and the change in capital requirements. At the same time, the impact of the level of interest rates has a direct effect on risk-based capital requirements. Since sensitivity of capital requirements to market parameters is not easily assessable, accurate numerical analyses is needed to have proper assessment of this risk.

Bernard and Tang (2016) designed a new annuity product that allows to better align the guarantees' market value and the corresponding hedging costs when the market environment is changing. They propose to link the issuer's income to the volatility index VIX and show that it is good for insurers as it allows for a better match in periods of high volatility between the hedging cost and the guarantees' values.

Gao et al (2017) developed a loss function for guaranteed annuity option (GAO). A decrement model is estimated in which death is the only decrement, and the interest and mortality risk factors are correlated. Monte-Carlo simulation is used for evaluating risk measures which are determined by moment-based density method. Bootstrap technique is utilized to assess the variability of risk measure estimates. Sensitivity analyses are made to compare the results. Two risk factors (interest and mortality) modelled by these equations: $dr_t = a(b - r_t)dt + \sigma dX_t$ and $d\mu_t = c\mu_t dt + \xi dY_t$. Also, Xt and Yt are Brownian motion and they are correlated. Impact of interest rate depends on the three parameters which are the mean-reverting rate a, mean level b, and volatility σ. According to results, a and b parameters have negative, c parameter has positive influence on risk measures. Impact of mortality rate is based on c and ξ parameters where c has negative and ξ has positive influence on risk measures. In fact, interest and mortality rates are negatively correlated; and the risk of GAO is reduced according to results.

Floreani (2013) analysed the Solvency II VaR-based capital requirement. This study shows that total risk measure such as the Value-at-Risk based metric used by regulators, is not a balanced solution between effectiveness and simplicity, but this is simply wrong and could lead to significant adverse side effects. This paper suggests and discusses some adjustments to the current Solvency II framework. For example, this paper suggests a different treatment between systematic and diversifiable risks. In other words, systematic risk capital requirements should be strengthened and in turn, diversifiable risk capital requirements should be weakened.

Bacinello et al. (2011) computed annuity plan values and fair fee rates under static and mixed valuation approaches via ordinary and least squares Monte Carlo methods. Then results are compared.

Mackenzie (2002) examined annuity in many aspects such as basic features of annuity market, regulatory framework and potential problems of annuity. His study gives a general information about annuity plans.

Mircea et al. (2014) developed some models for mortality rates using Lee-Carter and Renshaw-Haberman model. As regard forecasting mortality rates, they make some predictions for the Romanian population in the breakdown of gender and living area (urban and rural). In addition, their paper expands some models for the securitization of longevity bonds or loans for Romania.

Fung et al. (2014) examined the pricing and risk assessment of guaranteed life withdrawal benefits (GLWB) embedded in variable annuities. Their study demonstrates the significance of parameter risk, model risk and mortality risk. Their study shows that GLWB can be priced by two approaches based on tractable equity and stochastic mortality model. They study the effect of important financial and demographic variables which are interest rate, volatility of fund investment and mortality on the fair guaranteed fee rate charged by insurer. Their study shows that fair guaranteed fee rate is positively related with volatility of mortality and equity exposure of the investment account. However, fair guaranteed fee rate is negatively related with interest rate.

Boonen T.J. (2017) examines the consequences of a life annuity insurance company if the solvency II SCR are calibrated based on expected shortfall (ES) instead of value-at-risk (VaR). His study focuses on the risk modules of the SCR for the three-risk classes; equity risk, interest rate risk and longevity risk. He calibrates the SCR stress scenarios for equity risk, interest rate risk and longevity risk based on value-at-risk and expected shortfall. As a result, the comparison of SCR based on Value at Risk with SCR based on Expected Shortfall is given for a fictitious life annuity insurer.

Rae et al. (2018) reviewed Solvency II Pillar 1's market consistent valuation (including the risk margin and transitional measures) as well as the capital requirements (including internal models). The authors also analysed Pillars 2 and 3 in respect of the Own Risk and Solvency Assessment, liquidity and disclosure. They specified that

although Solvency II represents an improvement over Solvency I, there are still concerns around procyclicality and the market consistency principle for the assessment of the financial and solvency position.

3. PRIVATE PENSION SYSTEM

PPS is a special saving system that provides an additional income to individuals to maintain their living standards during retirement period by investing their savings which was made in active working period into pension funds. The objectives of PPS are as follow:

- Increase the level of welfare by providing additional income in retirement period;
- Supplement to the public social security system;
- Create long-term resources for the economy;
- Contribute to economic development;
- Increase employment.

Individual Pension Savings and Investment System Law came into force on 7 October 2001 and pension companies have been active since the beginning of the private pension system on 27 October 2003 in Turkey. Everyone who has completed 18 years of age can join the system.

PPS has two periods as accumulation period as active period and retirement period as passive period. Active period of the system is given within this section and passive period of retirement period, which can be called as annuity plans offered to the participants, will be given in the following section.

3.1. Properties of Turkish PPS

As mentioned above, PPS system started as at 2003 and since that time, some changes have come into force. The most recently update of the Regulation on the Individual Pension System come into force on 09.11.2012 (Official Gazette No. 28462). The procedures and principles on the participants' entry into the individual pension system, and on the rights and obligations of the individuals, pension companies and fund management companies is being governed by the Regulation on the Individual Pension System (2012).

Under Turkish PPS regulation, PPS consists of two periods: active (accumulation) period and passive (retirement) period. Active (accumulation) period is the time during

participant makes contribution payments to pension company until retirement. During active period, contribution payments are directed to the investments and the fund of the participant is monitored in individual account of the participant. Passive (retirement) period starts when the participant retires from PPS. At the beginning of passive period, retired has right to receive his fund amount (accumulations of his individual pension account and state contribution account) with different options. So, and he/she should choose one of options like lump-sum payment, programmed reimbursement (like a fixed financial payment), life annuity options, or he/she has also chance to distribute the total accumulated amount among these options (in other words, retired has right to choose these options at the same time with distributing his/her total accumulated amount within these options) (Regulation on the Individual Pension System, 2012).

Properties of Turkish PPS are:

- Based on voluntary participation and supplementary to the current public social security system;
- A defined contribution system (which means future benefits in retirement period is based on the contributions in active period and investment earnings);
- Each participant has their own pension fund accounts; in addition, each participant is able to have more than one pension fund account (e.g. one is able to have different pension fund accounts from the same insurance/pension company and/or from different insurance/pension companies).
- Aims to provide an extra income to the participants during their retirement period in proportion to their savings and the performance of the investment returns of their savings. Therefore, performance of the pension funds has an extensive role in retirement earnings;
- Participants have the right to switch their fund or pension plan, to transfer their accounts to any other pension company, to change their contribution payment amount and /or frequency of the contribution, to take a break for a while to the contribution payments, merge their pension accounts at retirement (if they have more than one pension fund account), and leave from the system at any time within the framework of regulation. However, the

savings under a contract cannot be transferred to another pension company for 2 years as of the date of entry into effect of the contract. This period is set at 1 year in the case of contracts are already transferred from another pension company.

- Pension funds are managed by asset management companies, which should have different entity;

- Pension companies are supervised and audited by the Undersecretariat of the Treasury, Capital Markets Board and Pension Monitoring Center with operations conducted by private pension companies.

As of 2013, participants benefit from state contribution at the rate of 25% of the amount of their contribution payment. To benefit from the state contribution, participants must be citizens of the Republic of Turkey even if they don't reside in Turkey.

The state contribution will be kept in a sub-account linked to the participant's private pension account in the settlement and custody bank Takasbank and evaluated in mutual funds to be identified by the Undersecretariat of the Treasury.

The total annual amount of state contribution for a participant could not be greater than 25% of the gross annual minimum wage for all different contracts of the participant. In the case of having multiple contracts and total state contribution of a participant is higher than the 25% of the gross annual minimum wage, then the state contribution will be calculated by taking into consideration the weights of the contributions paid under each contract and the total amount of state contribution will be divided among these contracts.

Participants have right to be retired after staying in the system at least 10 years and completing 56 years of age. These criteria are important as regards leaving the system in retiree status and getting maximum tax benefit and state contribution. It is always possible to leave the system by paying withholding tax. When participants retire, they can recover their savings in a lump sum; regular repayments; in a combination of lump sum plus pension or annuity.

If participants have multiple pension contracts from the same or different companies, the contract with the oldest date is taken into account as the date of entry into the system and all of his contracts' accounts are consolidated.

Since participant is able to withdraw from the system before their retirement, additional constraint to get the state contribution is defined. According to that constraint, a stepped arrangement is applied to become entitled to receive the state contribution in case of withdrawing the system before retirement and this is based on how long participants stay in the system which are given below:

- People who have stayed in the system for a minimum of 3 years would become entitled to receive 15% of the state contribution;
- People who have stayed in the system for a minimum of 6 years would become entitled to receive 35% of the state contribution;
- People who have stayed in the system for a minimum of 10 years would become entitled to receive 60% of the state contribution;
- People who completed 56 years of age after staying in the system for 10 years and people who leave the system because of death/disability would become entitled to receive for the entire amount of the state contribution including its gains.

In case of withdrawal of the participant or in case of being retired, participant is able to get their fund by subjecting a withholding tax deduction on the amount of return. Withholding tax deduction rates are;

- 5% for who are retired from the system or leave by compulsory reasons such as death, disability or dismissal,
- 10% for who stayed in system for ten years but leave before retirement age,
- 15% for who leave the system before ten years.

In addition to voluntary PPS, Auto Enrollment System (AES) is also defined with Individual Pension Savings and Investment System Law No. 4632, which entered into effect on January 1, 2017.Based on this new law, employers are obligated to enter their employees to the AES. Thereafter, employers should send to the system at least three percent of the premium-based earnings as contribution to the system both for the private and the public sector. Employees are allowed to stay in this system for as long as they

wish. Turkish citizens or Blue Card holders under age 45 and who work as a salaried employee in the public or private sectors are entering the system. (https://www.egm.org.tr/auto-enrollment-system-aes/what-is-aes/).

3.2. Summary of the Turkish Private Pension Market

By the end of 2018, 19 pension companies are operating in Turkish insurance market. As mentioned before since 2003 pension companies are operating and market statistics are already published by EGM periodically. In addition, Insurance and PPS annual report is published yearly and this report gives information about basic indicators of the PPS.

In this sub section, some of the statistics about the Turkish pension market is summarized for giving the general frame of PPS.

Table 3.1 General Overview of Turkish PPS

All amounts in TRY (000)

Years	Number of Participants	Pension Mutual Funds	State Contribution Funds	Total Contribution Amount	Number of Retired Participants
2003 YE	15,245			5,867	
2004 YE	314,257			288,326	
2005 YE	672,696			1,117,234	
2006 YE	1,073,650	3		2,592,509	
2007 YE	1,457,704	5		3,917,061	
2008 YE	1,745,354	6		5,467,696	368
2009 YE	1,987,940	9		7,102,008	1,898
2010 YE	2,281,478	12		9,515,230	2,848
2011 YE	2,641,843	14		12,393,689	3,838
2012 YE	3,128,130	20		16,177,758	5,404
2013 YE	4,153,055	25	1,151,766	21,921,860	7,577
2014 YE	5,092,871	35	3,019,076	28,346,503	15,350
2015 YE	6,038,432	43	5,020,000	37,119,096	27,745
2016 YE	6,627,025	53	7,438,180	44,363,956	44,350
2017 YE	6,922,615	68	10,141,205	52,539,176	63,877
2018 YE	6,875,886	77	11,318,856	58,290,203	89,141

Source: www.egm.org.tr

According to Table 3.1, there are 6.9 M participants with 76.6 B fund amount (including State Contribution Fund) as the end of 2018.
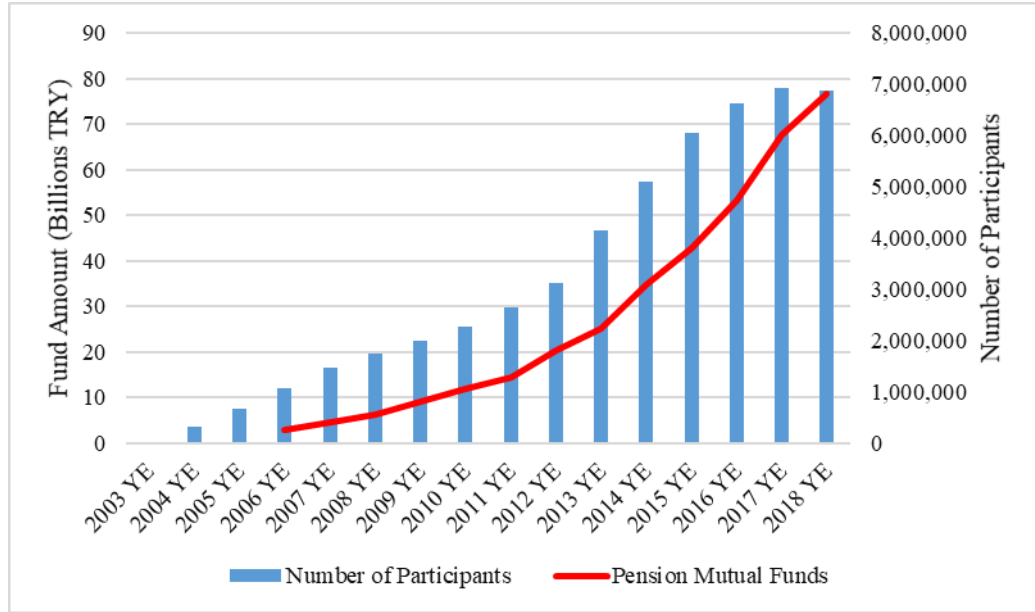
Figure 3.1 Number of Participants and Pension Mutual Funds by Years

As shown in Table 3.1 and Figure 3.1, both the number of participants and the amount of funds have increased significantly since beginning of the system due to tax advantages, performance of investment instruments and state contribution starting in 2012. However, PPS is affected by adverse economic conditions in 2018, number of participants decreased in 2018 compared to 2017. In addition, AES has an adverse impact on this decrease because some of participants who entered AES, withdrew from voluntary PPS.

Although the amount of fund in the system has increased rapidly, total pension fund investment as a percentage of GDP is still very low compared to other OECD countries. The comparison of OECD countries' ratio of private pension investment to GDP is summarized in Table 3.2. In addition, the comparison of selected other non-OECD countries' ratio of private pension investment to GDP is summarized in Table 3.3.

Table 3.2 Total Assets in Funded and Private Pension Arrangements for OECD
Countries, as a percentage of GDP, 2017

OECD Countries	Assets as a % of GDP
Denmark	208.41
Netherlands	184.15
Iceland	164.55
Canada	154.70
Switzerland	148.76
United States	145.27
Australia	130.17
United Kingdom	105.30
Sweden	90.20
Chile	72.04
Finland	60.49
Israel	59.03
Ireland	35.88
Korea	30.06
Japan	28.83
New Zealand	25.77
Estonia	17.54
Mexico	16.87
Latvia	13.81
Spain	13.57
Slovak Republic	11.74
Portugal	11.41
Norway	10.48
France	10.13
Poland	10.12
Italy	9.75
Czech Republic	8.83
Belgium	7.80
Lithuania	7.20
Slovenia	6.92
Germany	6.89
Austria	6.04
Hungary	5.94
Luxembourg	2.92
Turkey	**2.56**
Greece	0.75
Simple Average	**50.69**

Source: Pension Markets in Focus, 2018

As seen in the Table 3.2, Pension fund investments as a percentage of GDP is more
than 10% almost many OECD countries. Despite total pension fund investment as a
percentage of GDP for all the OECD economies is 50.7, Turkey's rate is 2.56 and it gets
behind the nearly vast majority of OECD countries.

Table 3.3 Total Assets in Funded and Private Pension Arrangements for Selected non-OECD Countries, as a percentage of GDP, 2017

Selected other non-OECD	Assets as a % of GDP
South Africa	95.30
Liechtenstein	86.90
Singapore	80.22
Hong Kong (China)	43.52
Malta	42.00
El Salvador	35.63
Uruguay	27.40
Kosovo	25.77
Colombia	25.28
Brazil	24.59
Peru	22.67
Bulgaria	12.92
Thailand	7.06
Russia	6.06
Romania	4.85
Indonesia	1.88
Egypt	1.74
Malaysia	0.32
Albania	0.11

Source: Pension Markets in Focus, 2018

As seen in Table 3.3, the size of pension funds compared to GDP varies widely across countries, ranging from 0.1% of GDP in Albania to 95.3% in South Africa.

Country	Value
Poland	14.5
United States	7.5
Australia	7.3
Israel	7.1
Greece	6.9
Finland	6.7
Weighted average	6.6
Switzerland	6.4
Ireland	6.3
Norway	6.1
Canada	5.7
Chile	5.6
Iceland	5.3
Hungary	4.7
Netherlands	4.5
Simple average	4.0
Denmark	3.9
Austria	3.7
Portugal	3.2
Japan	3.2
Belgium	3.1
France	3.1
Turkey	2.9
Slovenia	2.2
Spain	2.2
Germany	2.1
Italy	2.0
Korea	1.9
Mexico	1.5
Luxembourg	1.2
Latvia	0.8
Slovak Republic	0.4
Lithuania	0.3
Estonia	-0.1
Czech Republic	-1.8

Source: Pension Markets in Focus, 2018

Figure 3.2 Real Investment Rates of Return of Pension Assets, Net of Investment Expenses, 2017

Pension funds' real net investment rate of return is summarized in Figure 3.2. In the OECD area, pension funds achieved the highest returns in 2017 in Poland (14.5%), followed by U.S. (7.5%) and the Australia (7.3%). Comparing to other OECD countries, Turkey's real net investment rate of return is relatively low because of high inflation rate in 2017.

Pension fund asset allocation is given in Figure 3.3 for selected OECD countries for comparing investment preferences.
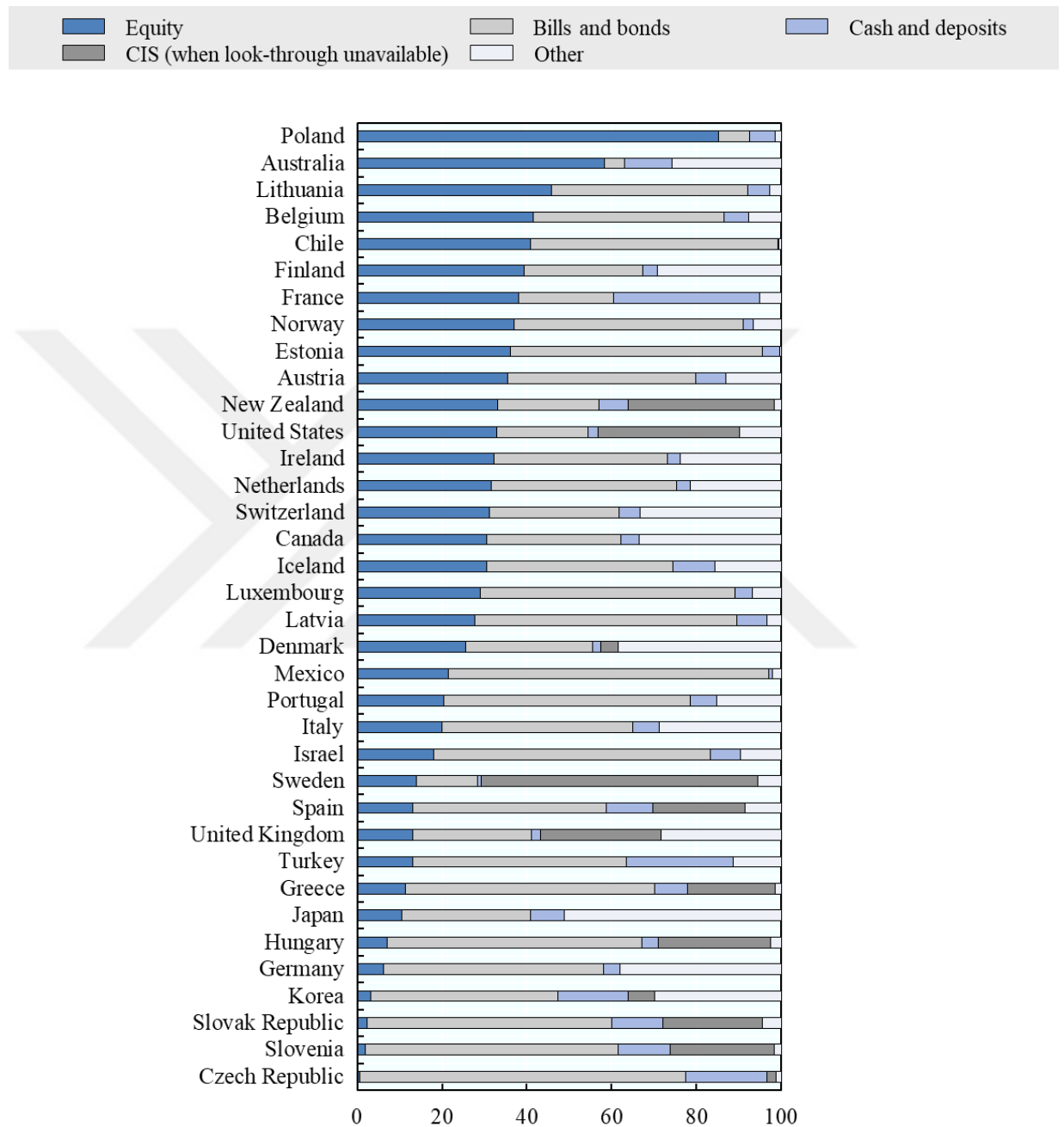
Source: Pension Markets in Figure, 2018

Figure 3.3 Allocation of Pension Assets in Selected Investment Categories, 2017

Despite the prolonged low interest rate environment, pension funds still hold a high share of their portfolios in bills and bonds in 2017. As seen in Figure 3.3, equities are mainly preferred for investment instrument in developed countries because of stable economic conditions.

When compared with OECD countries, it can be said that PPS in Turkey is below the level that it should be. So Turkish PPS is still open to development and PPS should spread to mass of the people.

It can be said that PPS made a good progress from the first year that came into force to the current position with regard to number of participants and fund size. The distribution of participant's fund amount on the basis of age and gender is given in Figure 3.4.
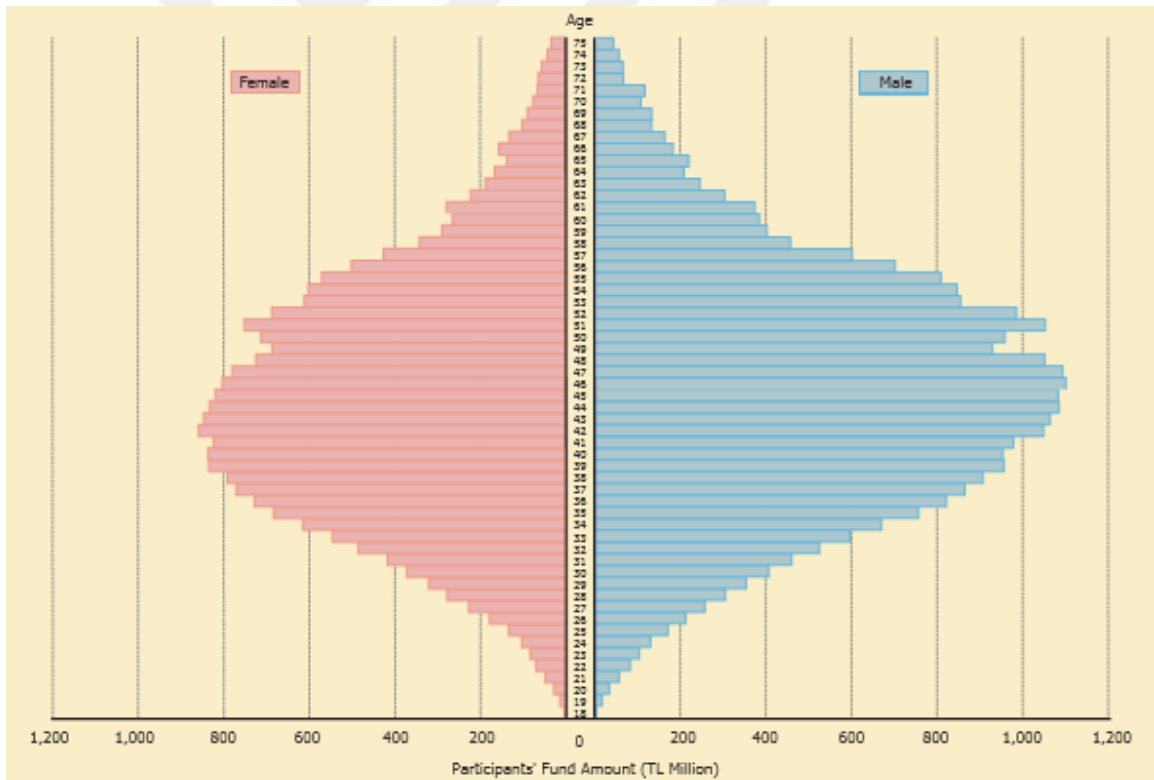
Source: Individual Pension System Progress Report, 2016, p.20

Figure 3.4 Accumulations of Participants according to Gender and Age

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Figure 3.4 indicates distribution of participants' fund amount in the breakdown of gender and age as of 2016 year-end. Average age of participants is 39.4 and weighted average is 45.5, which was calculated based on the total amount of pension funds owned by participants. 56% of the total amount of pension funds owned by male participants and 44% by females (Individual Pension System Progress Report, 2016).
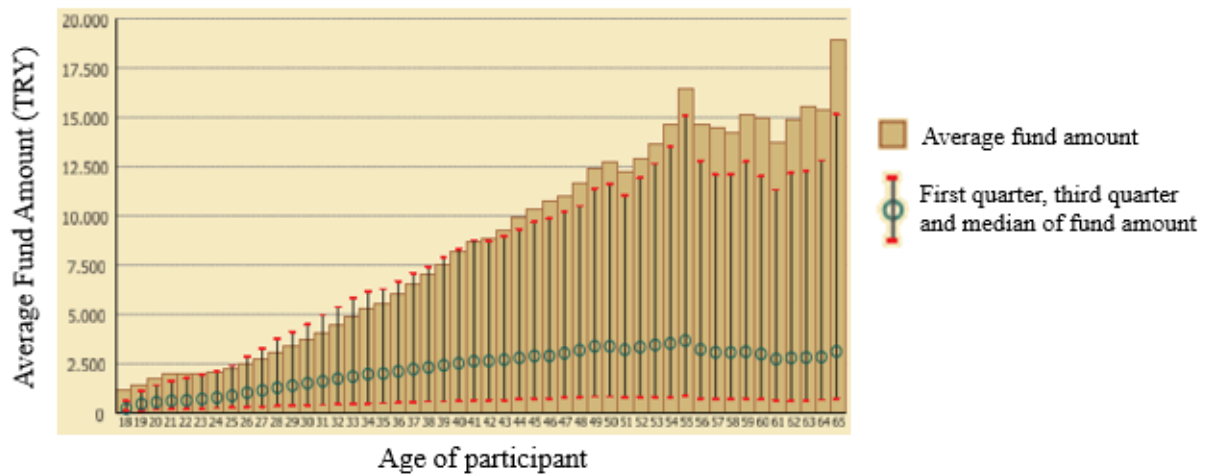
Source: Individual Pension System Progress Report, 2016, p.24

Figure 3.5 Average Fund Amount according to Age of Participants

Average fund amount of participants on an age basis without gender discrimination is given in Figure 3.5. In addition, first quarter, third quarter and median values for fund amount for each ages are given in the figure. Although range of fund amount is wide in respect of single ages, median values of fund amount for all ages are relatively close to each other.

When age and fund amount distribution are analysed, middle age participants have a great fund share. Probably, big outflow of funds will start, when they have right to be retired. Because of the fact that, companies should submit various products especially annuity plans for customer retention. More information about annuity plans will be given in the following section.

4. ANNUITY PLAN

A life annuity is an insurance contract between the insurer and the insured where the insurer (life insurance company) makes a series of future payments to the insured (annuitant) in exchange for the immediate payment of a lump sum (single premium annuity) or a series of regular payments (level premium annuity) at the date of inception of the annuity.

A whole life annuity guarantees a steady income until the annuitant's death. If the payments are made as at beginning of each year, equation 4.1 is used which is also called the annuity due, else if the payments are made as the end of each year equation 4.2 is used which called the annuity immediate.

$$\ddot{a}_x = E\left[\ddot{a}_{\overline{K+1|}}\right] = \sum_{k=0}^{w-k} v^k \, _kp_x \qquad , \text{k=0, 1, 2, 3, ...} \tag{4.1}$$

$$a_x = E\left[a_{\overline{K|}}\right] = \sum_{k=1}^{w-k} v^k \, _kp_x \, , \text{k=1, 2,3, ...} \tag{4.2}$$

Where;

x : annuitant age,

k : the curtate-future-lifetime of x,

w : limit/last age,

v : discount factor,

$_kp_x$: the probability that age x survives k years (the probability of a payment is made at time t).

There are two categories of annuity, which are fixed and variable annuity. A fixed annuity is an investment that provides a guarantee at least a minimum rate of investment return. A variable annuity provides irregular payments based on the performance of the

investment options. In addition, the success of variable annuities is due to tax incentives, introduced by governments to support private pension systems (Bacinello et al., 2011).

Annuity differs from traditional life insurance. Life insurance protects the insured's family if he dies, while annuities protect him as long as he lives. In this respect annuity is important for both insurer and insured. In terms of insurer, companies have to well-defined annuity plans for compensating of financial burden and make profit. On the other hand, from the perspective of the insured, it can be a good investment for its advantages such as; whole life income, investment management etc.

4.1 Annuity Valuation

As mentioned before, the insurer provides regular payments to annuitant for an unknown duration based principally upon the date of death of the annuitant. At this stage, the insurance contract will terminate and the remainder of the fund accumulated is forfeited unless there are other annuitants or beneficiaries in the contract. In other words, annuity is a longevity insurance, where the uncertainty of an individual's lifespan is transferred from the insured to insurer. Annuities have two periods:

- Accumulation period, when the insured pays premiums and accumulates them with interest and other gains (or losses) earned in the account (which is already given with 3rd section),
- Pay-out period, when the insurance company makes regular payments to the insured/insureds.

The methodologies used in valuation of reserves during those two phases are different. Based on Annuity Regulation (2015), accumulation phase is the period where an individual's (participant's) contributions are accumulated in a pension fund during his active life before retirement and details of this accumulation period of an individual (participant) is also given in section 6 of this dissertation. When that participant is retired, then total accumulated pension fund amount is used as a net single premium of an annuity plan. As a result, that net single premium of an annuity is used as a present value of the whole life annuity payments given in equation 4.1 and 4.2 and reserves are mainly based on interest rate and mortality table set by law (or by actuary's judgment). Note that during

the payout period; death, lapse, disability etc. are the decrements but in this study death and lapse are the only decrements which are also given with details in section 6.

Valuation of annuity plans are performed with at least two risk factors, the most important of these factors are the interest and mortality rates. In addition, these risk factors are also correlated. During annuity valuation, deterministic or stochastic models can be used for modelling. In this study, deterministic valuation is used and the correlation of mortality and interest rate is out of study. Steuten (2012), Browne et al. (2009), Cairn et al. (2008) and Bravo and Freitas (2017) used stochastic mortality models. Because longevity risk is the one of the most important risk for annuity and it has to be modelled to have a realistic annuity modelling. On the other hand, Cairn et al. (2008) specified that the development of a good and reliable model requires time and considerable patience: an initial analysis might suggest that a model is satisfactory, but further forensic investigation might reveal some pitfalls that need corrective work.

Annuity reserve calculation is made with the equation 4.3 below:

$$_tV = (_{t-1}V - P_{t-1)} \times (1 + i) \times \quad p_{x+t} \tag{4.3}$$

Where;

$_tV$: the reserve amount at t

P_t : Premium amount at t

x : annuitant age,

i : interest rate,

p_{x+t}: the probability that age x+t survives one year (the probability of a payment is made at time t).

Assumptions are the critical points of the reserving methods because they have an important effect on actuarial calculations such as annuity reserve calculation as mentioned in Ballotta, Esposito and Haberman (2006), Ruez (2016) and Mackenzie (2002) studies. In addition, assumptions are changed by many indicators such as economic conditions, demographic conditions, regulations, insurance company's managerial decisions, etc. Under such dynamic conditions, life insurance and pension

companies should measure the performance of their products' profitability continually. Namely, companies have to assess the value of their insurance contracts periodically. Because the financial burden of long-term products (such as annuities) spreads over an extended time period due to the fact that, data, projection method and assumptions which are used in projection are crucial for a realistic forecast.

In general, assumptions which are used in the valuation model can be mainly split into two categories: economic and non-economic assumptions. More information about the assumptions which are used in the study are given in the Section 6.2.1 and 6.2.2.

4.2 Annuity in Turkey

Annuity Regulation was inforce as at 2015 but before that life insurance companies were also providing simple whole life annuity products. Nevertheless, those products provided mainly as rider of saving products do not have significant or statistically meaningful amount. Even though, there are some annuity products sold in Turkey, those are not comparable with annuity regulation standards and those are not having enough information in market statistics.

5. SOLVENCY II

Solvency margin requirements in Europe are based on the Solvency II regime. Historically, Solvency II regime goes back to 1973 with the non-life directive, and thereafter continues with the life directive in 1979 and extends with the third life and non-life directives in 1992. (Poufinas and Tsitsika, 2018). Solvency I framework was launched as at 2002 where previous directives are aggregated. But Solvency I regime showed structural weaknesses where it was not risk sensitive and key risks, including market, credit and operational risks were not taken into account in capital requirements. Since Solvency I was not risk sensitive, following consequences are arisen.

• Solvency I framework does not lead to an accurate assessment of each insurer's risks, because of its simplistic approach,

• Solvency I does not ensure accurate and timely intervention by supervisors,

• Solvency I does not bring about an optimal allocation of capital,

(T. Poufinas, and Tsitsika, 2018).

The European Commission accepted Solvency II proposal in 2007, which was followed by a re-evaluated proposal in 2008. Parallel to those studies, starting from 2005 to 2010, Quantitative Impact Studies (QIS) studies took place to be able to assess the capital requirements of the insurance industry. Latest QIS study was performed as QIS5 in 2010 and impact of the Solvency II regime is mainly observed with this study where QIS5 study is also used as a reference for this dissertation.

Solvency I regime was not risk sensitive but, Solvency II is a risk based approach to capital adequacy regime and aims to establish risk management standards for the European insurance industry.

The underlying quantitative Solvency II is that insurers should hold an amount of capital that enables them to absorb unexpected losses and meet the obligations towards policy-holders at a high level of equitableness (Boonen, 2017).

Rae et al. (2018) give Solvency II's objectives and assess the outcome of the final regulations against its key objectives which include:

• improved protection of policyholders and beneficiaries;

- harmonization;

- effective risk management;

- financial stability.

Under Solvency II regulation, insurance companies can implement internal models to assess their risks. However, it is a fact that implementing such kind of internal model is costly and sophisticated.

European Commission published fifth Quantitative Impact Study (QIS 5) report for Solvency II on 14 March 2011, and that report is prepared with support of the Committee of Insurance and Occupational Pension Supervisors (CEIOPS). Scenario based standard model is established for approximating insurance companies' capital requirements with this report, and all insurance companies are allowed to use this scenario based standard model. Overall risk is segregated into several modules as market risk, operational risk, or life underwriting risk etc. in this model. Then, SCRs are computed separately for these modules. These SCRs are aggregated with pre-specified correlation matrices to allow for diversification effects (Börger, 2010).

Solvency II consists of the three pillars that are given in Figure 5.1.

SOLVENCY II

Pillar I. Quantitative	Pillar II. Quality	Pillar III. Reporting
• Balance sheet valuation • Solvency Capital Requirements (SCR) • Minimum Capital Requirements (MCR) • Standard formula • Internal model	• System of governance • Three lines of Defense • Own Risk and Solvency Assessment (ORSA)	• Solvency and Financial Condition Report (SFCR) • Report to Supervisor (RTS) • Quantitative Reporting Templates (QRT)

Figure 5.1 Solvency II-Three Pillar Structure

Pillar I – Quantitative: Calculation of capital reserves

It outlines a standard equation where insurance companies across the European Union have to use for the calculation of their capital reserves covering all types of risks.

Minimum capital requirements, which is to clarify that insurance companies' capitals are adequate according to their risk exposure, is indicated in Pillar I. Companies are able to use the standard formula or to create an internal model approach for calculating SCR. Before Solvency II, capital requirements of the insurance companies were based on the profit and loss accounting measures (premiums and claims) which was Solvency I. Contrary, Solvency II capital requirement is using the different stress scenarios related with the key risks, which are direct impact on balance sheet items like assets, liabilities etc. including consideration of operational risks. Therefore, Solvency II bring out balance sheet based standard (Dell'Atti et al., 2018).

Pillar II – Quality: Management of risks and governance

Pillar II comprises of the management of potential risks and system of governance.

Pillar III – Reporting and disclosure

Pillar III is related to reporting requirements of insurance companies based on the EIOPA.

A well-defined and rigorous review process regarding companies' solvency by supervisors, obligations of auditors and disclosures to managers, policyholders and investors is designed to provide a more modern and secure prudential regulatory system with the help of qualitative risk management requirements and minimum capital standards (Solvency II General Insurance, 2016).

The Solvency II balance sheet is summarized in Figure 5.2.
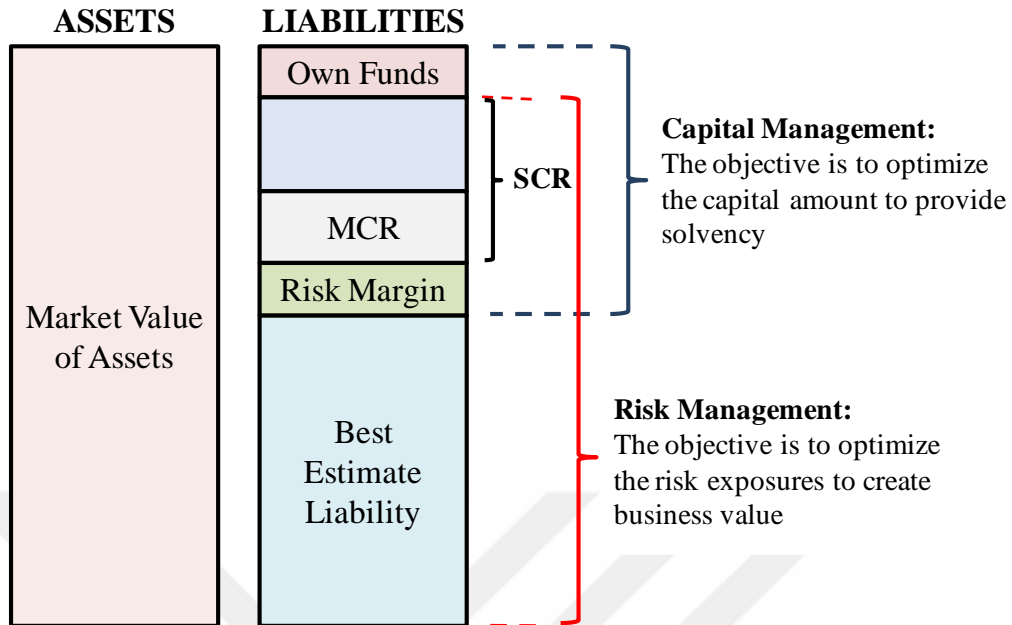
Figure 5.2 Solvency II balance sheet

Best Estimate Liability (BEL):

Best estimate liabilities are calculated via appropriate methods for each line of businesses. For life and pension businesses, best estimate cash flows are calculated and discounted with a discount factor under market consistent assumptions.

Risk Margin:

The risk margin reflects the cost of holding capital. For the liabilities, which cannot be matched perfectly, best estimate including the risk margin should equal the price required for transfer to willing buyer (SII, hot-topic 4). Risk margin is calculated company based approach considering market conditions. In addition, alternative approaches are performed for non-hedgeable risks.

Capital Requirement:

Total capital amount that insurance companies have to hold in order to have a 99.5% confidence level over a one-year time horizon is defined as SCR under Solvency II directives

Standard equation of SCR is following a modular approach and according to this modular approach, overall risk exposed risk of the insurance or reinsurance undertaking, is separated into sub-risks and in addition to this separation, some risk modules also divided into sub- sub risks. The capital requirement is determined for each separated sub-risk or sub-sub risk. To determine the capital requirement of overall risk, the capital requirement of sub-risk or sub-sub risk is aggregated by using correlation matrices (EIOPA,2014, p.7).

Another important term is the Minimum Capital Requirement (MCR). As already suggested by its name, MCR indicates the lowest level and strongest actions of the supervisor (auditor) performed if the capital level is below MCR, such as removing the insurer's authorization (Solvency II-General Insurance, 2016). MCR is lower than SCR and generally, it is equal to 25-45% of the SCR.

SCR is calculated using several risks and their correlation matrices under standard method or internal method in Pillar I.

SCR is calculated as the difference between the net asset value of the unstressed and stressed balance sheet figures for each individual risk. Capital amounts of these individual risks are aggregated using a correlation matrix of the risks. In addition, based on the insurance companies experience internal models can be used (Solvency II-General Insurance, 2016).

The SCR comprises the following risk charges based on standard equation:

- Operational risk,
- An adjustment, that may include the loss absorbing capacity of deferred taxes,
- Market risk
  - interest rate risk,
  - equity risk,
  - property risk,

- spread risk,

- currency risk,

- concentration risk,

- Non-life underwriting risk

  - premium reserve risk,

  - catastrophe risk

  - lapse risk,

- Life underwriting risk

  - mortality risk,

  - longevity risk,

  - disability/morbidity risk,

  - expenses risk,

  - revision risk,

  - catastrophe risk,

  - lapse risk,

- Health risk

  - health risk

  - catastrophe risk,

- Counterparty default risk,

- Intangible asset risk,

(Solvency II-General Insurance, 2016).

Each individual risk charges are aggregated together using the Equation5.1 and Equation 5.2.

$$SCR = BSCR + Adj + SCR_{op} \tag{5.1}$$

$$BSCR = \sqrt{\sum_{i,j} Corr_{i,j}\, SCR_i\, SCR_j} + SCR_{Intangible} \tag{5.2}$$

Where

SCR$_i$: Solvency capital requirement for I,

BSCR : Basic solvency capital requirement,

Adj   : Adjustment,

SCR_{op} : Solvency capital requirement for operational risks.

Correlation coefficients $Corr_{i,j}$ are taken from the following coefficient matrix:

Table 5.1 Correlation Matrix for SCR

	Market	**Default**	**Life**	**Health**	**Non-life**
Market	1				
Default	0.25	1			
Life	**0.25**	0.25	1		
Health	0.25	0.25	0.25	1	
Non-life	0.25	0.5	0	0	1

Source: QIS 5 Technical Specifications, p.96

As this study focus on annuity products, market and life underwriting risk modules are used for SCR calculation. Because health and non-life business is completely separated in Turkish market and those risks are not related with pension companies' risks.

5.1 SCR Market Risk Module

Market risk is derived from financial instruments' level or volatility of market prices (QIS5 Technical Specifications, 2009, p. 106). Measure of the market risk is based on the impact of movements in the level of financial variables like stock prices, interest rates, exchange rates etc.

Based on QIS 5 specifications the following variables are used for SCR$_{Market}$ and Equation 5.3 is used for calculation of SCR$_{Market}$.

- $SCR^{Up}_{interest\ rate}$:interest rate risk for the "up" shock,

- $SCR^{Down}_{interest\ rate}$:interest rate risk for the "down" shock,

- SCR$_{equity}$:equity risk,

- SCR$_{property}$: property risk,

- SCR$_{spread}$: spread risk,

- SCR$_{concentration}$: market risk concentration,

- SCR$_{currency}$: currency risk.

$$SCR_{Market} = \max \left(\begin{matrix} \sqrt{CorrUp_{i,j}\ SCR_{Up,i}\ SCR_{Up,j}}; \\ \sqrt{CorrDown_{i,j}\ SCR_{Down,i}\ SCR_{Down,j}} \end{matrix} \right) \qquad (5.3)$$

Where;

$CorrUp_{i,j}$: the entries of the correlation matrix CorrMktUP,

$SCR_{Up,i}$, $SCR_{Up,j}$: Capital requirements for the individual market risks under the interest rate up stress according to the rows and columns of the correlation matrix $CorrUp_{i,j}$,

$CorrDown_{i,j}$: the entries of the correlation matrix CorrMktDown,

$SCR_{Down,i} \times SCR_{Down,j}$: Capital requirements for the individual market risks under the interest rate down stress according to the rows and columns of the correlation matrix $CorrDown_{i,j}$.

The correlation matrices $CorrUp_{i,j}$ and $CorrDown_{i,j}$ are given in Table 5.2 and 5.3.

Table 5.2 Correlation Matrix for $CorrUp_{i,j}$

CorrUp	Interest Rate	Equity	Property	Spread	Currency	Concentration
Interest Rate	1					
Equity	0	1				
Property	0	0.75	1			
Spread	0	0.75	0.5	1		
Currency	0.25	0.25	0.25	0.25	1	
Concentration	0	0	0	0	0	1

Source: QIS 5 Technical Specifications, p.108

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Table 5.3 Correlation Matrix for $CorrDown_{i,j}$

CorrDown	Interest Rate	Equity	Property	Spread	Currency	Concentration
Interest Rate	1					
Equity	0.5	1				
Property	0.5	0.75	1			
Spread	0.5	0.75	0.5	1		
Currency	0.25	0.25	0.25	0.25	1	
Concentration	0	0	0	0	0	1

Source: QIS 5 Technical Specifications, p.108

5.2 SCR Life Risk Module

Life risk module covers the life underwriting risks. Life underwriting risks are mortality risk, longevity risk, disability/morbidity risk, lapse risk, expense risk, revision risk and catastrophe risk.

SCR life risk module can be calculated the same approach using Equation 5.4.

$$SCR_{life} = \sqrt{\sum_{i,j} Corr_{i,j} SCR_i SCR_j} \qquad (5.4)$$

where i and j denotes the sub-module i and j respectively, and "i,j" means that the sum of the different terms should cover all possible combinations of i and j. SCR_i and SCR_j are the sub-modules detailed by the following:

- $SCR_{mortality}$: mortality risk,
- $SCR_{longevity}$: longevity risk,
- $SCR_{disability}$: disability/morbidity risk,
- $SCR_{expense}$: life expense risk,
- $SCR_{revision}$: revision risk,
- SCR_{lapse} : lapse risk,
- SCR_{cat} : life catastrophe risk.

(Solvency II Directives, Article 105(3))

Correlation matrix of the life underwriting risk is given in Table 5.4.

Table 5.4 Life Underwriting Correlation Matrix

	Mortality	Longevity	Disability	Lapse	Expenses	Revision	Cat
Mortality	1						
Longevity	-0.25	1					
Disability	0.25	0	1				
Lapse	0	0.25	0	1			
Expenses	0.25	0.25	0.5	0.5	1		
Revision	0	0.25	0	0	0.5	1	
Cat	0.25	0	0.25	0.25	0.25	0	1

Source: QIS 5 Directives, p.148

Following the calculation of SCR and MCR under Pillar I, next step is performing Own Risk and Solvency Assessment (ORSA). The ORSA is the processes and procedures of a company where short term and long-term risks are identified, assessed, monitored, managed and reported. In addition to this, determination of the company's own funds necessary to guarantee overall solvency requirements are met at any time (Solvency II-General Insurance,2016).

Kortebein (2013) summarized main ORSA principles under Solvency II as follow;

- ORSA is the responsibility of the insurance company and should be monitored regularly,
- ORSA should cover all material risks of insurance company liabilities related with insurance contracts,
- ORSA should be based on adequate measurement and assessment processes,
- ORSA should consider the business plans and projections of the insurance company,
- ORSA policy should be integrated to the risk management policy of the company.

According to Pillar III, quarterly or annual Regular Supervisory Report (RSR) to be disclosed where details of the risk management processes, ORSA and results of the solvency calculation included within this report. This report should include the following information:

- Governance applied by the insurance company,
- Business of the insurance company,
- The valuation principles of the solvency purposes,
- Main risks of the insurance company,
- Risk management policy,
- Capital structure and management of the insurance company.

Insurance companies have to calculate market consistent liabilities for facing challenges under Solvency II. Reserve requirements for annuity products are highly scenario dependent. In addition, technical provisions and solvency capital requirements change over time depending on market conditions (inflation, interest rates, volatility, etc.) (Bernard and Tang, 2016).

In this study, SCR of annuity plan is calculated considering life underwriting and market risks. SCR_{life} is calculated as the change in liabilities in case of a longevity shock that assumes a permanent reduction of mortality rates (Böller, 2010). On the other hand, SCR_{market} is computed considering changes in main economic indicators as currency, interest rate, property etc. and their correlations.

6. METHODOLOGY AND APPLICATION

Since the objective of this dissertation is to analyse annuity plans in Turkey with regard to risk management and RC, forecasting models are established for annuity plan valuation in order to make a good risk management. In the first step, Turkish PPS figures are analysed. Because, Turkish PPS figures are used for the valuation and capital requirement of an annuity plan. As mentioned in the 3.1 and 4.1 parts of the study, both PPS and annuity plan consist of two periods which are accumulation and payment periods. In accordance with Annuity Regulation (2015), annuity plans will be offered to retirees who has an accumulated pension fund amount from PPS. Therefore, the accumulation period of the annuity plans consists of PPS' accumulation period, and those accumulation period's figures are considered and used for the valuation and capital requirement of an annuity plan.

A case study for PPS's accumulation period valuation, annuity plan valuation, assumptions used during these valuations and cash flows related with RC are presented within this section. PPS's figures are analysed based on gender and single age. In addition, in-force and new business (new participants) are separated for the analysis. Participants who stay in the system at least 10 years and complete 56 years of age are assumed to be retired, and number of retired participants and their fund amounts have been projected by years. Retired participants total accumulated pension fund amount is used as a net single premium of an annuity plan. Thus, pension product convert to a risk product. However, all pensioners will not choose annuity plan for their retirement period. Accordingly, an annuitant rate, indicates what percentage of participants who retire from the private pension system will receive an annuity, is defined for projected years and all calculations are done using these participant's data. Since pension product become a risk product with buying life annuity, it should be called insured instead of the participant. During the pay-out period; death, lapse, disability etc. are the decrements in general but in this study death and lapse rates are the only decrements which is also given with details in following sections. Later, annuity projection is done using economic (reel interest rate, technical interest and inflation) and non-economic (annuitant and lapse rate) assumptions. Actuarial liability is calculated with mathematical reserve for projected years based on gender and single age. Finally, SCR figures year by year for projection periods are

estimated using annuity valuation figures and local regulation and Solvency II directives. Detailed information is given in the following sections.

6.1. Data

Data analysis is the process of inspecting, cleaning, transforming, modelling and interpreting of data for providing homogeneous data to users. Firstly, PPS's data was analysed in the steps described below:
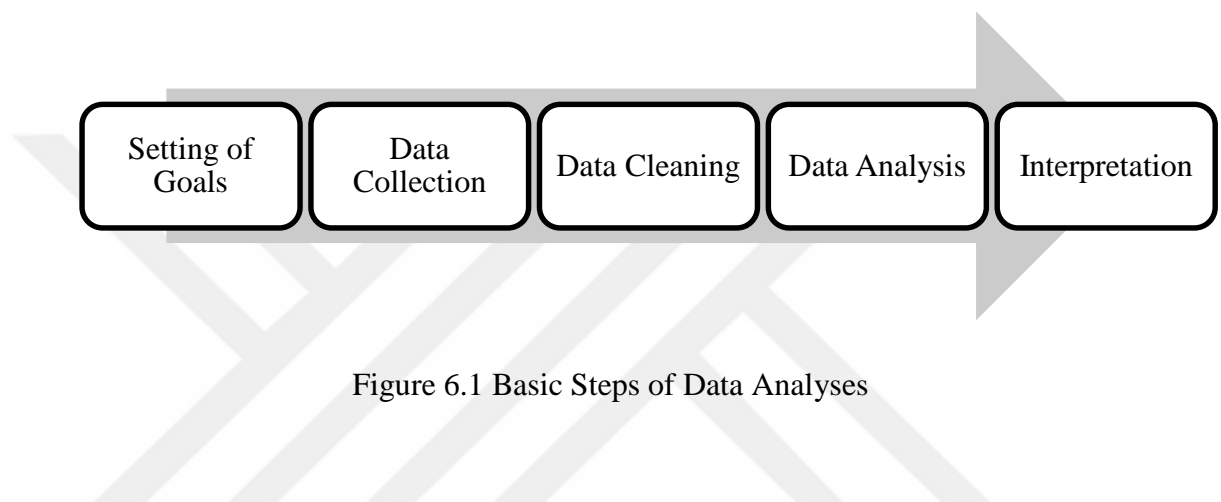
Figure 6.1 Basic Steps of Data Analyses

Setting of Goals: It is the one of the most important step of the data analysis. Comprehensible and measurable goals should be defined before data collection.

Data Collection: Data and variables are defined in accordance with the goals of the analysis.

Data Cleaning: This step is made for improving the data quality. Measuring the data quality, identifying the reliability of data sources, checking consistency and formation of the data are involved within this process.

Data Analysis: There are different methodologies to analyse the data, such as data mining, business intelligence, data visualization, or exploratory data analysis.

Interpretation: This step has paramount importance. Data analysis results should be interpreted meticulously and carefully. In addition, interpretation of the analysis should be consistent with the goal of the study.

This study examines pension company's liability in case of selling annuity plans. Annuity modelling is made in the breakdown of single age and gender due to increasing

the sensitivity of the study. In addition, this study is focus on annuity plans which are served to participants retire from PPS.

During PPS modelling phase, PPS's main indicators are examined to clarify defining required variables and data structure. Because, this data is used for annuity modelling and estimation figures. Data set for the following variables is provided as of 31.12.2016 by Pension Monitoring Center:

- Age,
- Gender,
- Entrance year to PPS,
- Entrance month to PPS,
- Number of participants,
- Number of contacts,
- Fund amount,
- Contribution amount,
- State contribution amount.

Secondly, data consistency is checked and data cleaning is made in order to coherent outputs. PPS's main figures which are number of participants and fund amount are modelled based on gender and single age for in-force and new business (new participants) using assumptions which are given in part 6.2. As mentioned above any participant who stayed in the system at least 10 years and complete 56 years of age are assumed to be retired. No possibility is allowed to extend the period of accumulation in this study. Starting with this assumption the following figures are forecasted for in-force and new business for projected years based on economic and non-economic assumptions:

- Number of participants,
- Number of withdrew participants,
- Participant's fund amount,
- Participant's state fund amount,
- Number of retired participants,
- Retired participant's fund amount,
- Retired participant's state fund amount.

Participant's average fund amount is calculated from the data provided by pension monitoring center, and data is used after data cleaning step. Average fund and average state fund by age groups both for female and male participants are calculated and given in Table 6.1. and 6.2. In addition, average monthly contribution amount, published in Individual Pension System Progress Report (2016), is used for modelling of both male and female participants' future savings. Because, these are published average regular contribution amounts and using these figures is giving more realistic estimations.

Table 6.1 PPS Summary Statistics for Female Participants

All amounts in TRY

Age Group	Av. Fund Amount	Av. State Fund Amount	Av. Monthly Contribution Amount
under 25	2,235	472	152
25-34	4,174	750	167
35-44	8,050	1,185	208
45-55	11,573	1,549	253
56+	15,293	1,803	293

Table 6.2 PPS Summary Statistics for Male Participants

All amounts in TRY

Age Group	Av. Fund Amount	Av. State Fund Amount	Av. Monthly Contribution Amount
under 25	1,702	367	152
25-34	3,151	570	167
35-44	6,391	948	208
45-55	11,267	1,375	253
56+	15,811	1,579	293

As seen in table 6.1 and 6.2, average figures are increasing while the ages are increasing and the time passed in the system is increasing.

While forecasting of contribution amount both for individuals contribution and state contribution, average contribution amount of individuals and accordingly state contribution amount are estimated year by year for projected period by using yearly inflation rates. In addition, state contribution is assumed to be continued as 25% of contribution amount for each projection year. In addition, two decrements (death and withdraw) are used for existing from PPS and the rates used for these assumptions are given in the following section 6.2.2.2 and 6.2.2.5.

In the meantime, assumption for paid up is also given in section 6.2.2.3 both female and male participants. Although there is not enough statistical information about paid up, rough assumption is used for the future periods for this rate.

After forecasting of PPS's figure, annuity modelling is done based on PPS's figures. Retired participants fund amount is considered as net single premium of annuitant in this study based on Annuity Regulation. Firstly, number of annuitants are calculated for the projected years with the assumption of annuitant rate which is defined differently for projection years. Since there is not enough data available, a low rate was determined with the assumption that the demand for annuity plans at retirement would be low. So, it is assumed that for the first three years is 1%, next two years is 2%, following two years is 3%, following two years is 4% and increased 1% for the following years (Assumption of annuitant rate is given in section 6.2.2.6). After calculating the number of annuitants, then their net single premium figures are forecasted by years using economic and non-economic assumptions based on gender and single age. As given in the section 4.1, during pay-out period death and lapse are the only decrements in this study and %5 is used for lapse rate and TRHA 2010 table is used for mortality forecasts. Duration of liabilities for annuity plan is estimated for mathematical reserve calculation where formula was given in the section 4.1. Since annuity plan is a risk product, the liability of this product is calculated by mathematical reserve. At the same time, cash flow of regular payments (income) are forecasted year by year for the projection period based on gender and single age to be able to get future outflows of pension company. Finally, those figures are used for SCR calculation.

6.2. Assumptions

Assumptions are very crucial inputs into a model. Because, there are many uncertainties in long-term and assumptions have a direct impact on the predictions.

Assumptions are separated by two main areas; economic and non-economic. Economic assumptions will impact the future expected economic indicators and calculations (premium, reserve, etc.). On the other hand, non-economic assumptions impact the timing and probability of live. Both assumptions impact the amount of the forecasted liability at any point in time.

Accordingly, economic and non-economic assumptions are defined in the purpose of PPS cash flow and annuity modelling. Number of participants and the amount of their funds with considering state contribution were projected year by year in terms of age and gender during PPS figures estimations. Because outputs of PPS's forecast are used as inputs for annuity modelling.

6.2.1. Economic assumptions

It is almost impossible to forecast accurate economic variables because of uncertainties of the market, but various sensitivity analyses should be made in order to see the effect of volatility of economic variables in the model. For example, Ruez (2016) found that, there is a highly positive correlation with market indicators and capital requirements. So, market indicators have a directly effect on risk-based capital requirements.

Economic assumptions are key point of modelling as they have a high level of correlation to each other. However, assumptions depend on expert judgement, company's experience and company' observed data, there is no standard for selecting assumptions. Therefore, assumptions could change from model to model or from company to company.

Most commonly used economic assumptions are given below:

- Inflation,
- Discount rate,
- Equity return,
- Property return,
- Fixed return,
- Government return,
- Tax rates.

The economic assumptions used in dissertation are explained below with details.

6.2.1.1. Inflation

Inflation rate is used for estimation of future expenses and for the renew of the policy terms, which are related to inflation, in case of need. Inflation rate is the vital parameter of annuity. Because annuities have to provide as much return as the inflation rate under Annuity Regulation (Article 13-3, 2015). Also, risk discount rate is calculated with inflation rate, used for the present value of cash flows.

Forecasting inflation rate in a long time period is very difficult such as Turkey due to the economic volatility. So, forecasts made by various institutions are examined. For example, Central Bank publishes inflation rate expectation survey which contains two-year inflation rate expectations periodically. However, this period is insufficient for making robust annuity modelling. Also in literature, inflation forecast studies are for short-term periods. As it mentioned before, annuity is a long-term insurance product and inflation rate is critical point of modelling and effects the whole valuation method.

Inflation forecast is made for two years generally in Turkey due to economic conditions. On the other hand, IMF's six-year inflation forecast is used in the study by virtue of longer period estimation than Central Bank. After 2024, inflation is taken at a fixed level at 12.40%. IMF's inflation forecast figures for Turkey are given in the Table 6.3.

Table 6.3 IMF's Inflation Forecast for Turkey

Years	2019	2020	2021	2022	2023	2024
Inflation Rate	17.50%	14.10%	13.40%	13.00%	13.00%	12.40%

Source: www.imf.org/en/Countries/TUR

6.2.1.2. Discount rate

Present value of the future profits are calculated with discount rate. Fixed discount rate is used for annuity plans under Turkish Regulation. This rate is around % 1.5-2. However, discount is determined by insurance companies considering insurance period, coverage and properties of the insurance product (Annuity Regulation, Article 10-1). Furthermore, the Undersecretary of Treasury can determine minimum and maximum bounds of discount rate (Annuity Regulation, Article 10-3).

As mentioned above, discount rate is used to calculate the net present value of a business as part of a discounted cash flow analysis. There are two types of approach for determining the discount rate. First, a constant discount rate could be used for all years under local regulation. Second, reel interest rate could be used for discounting.

Turkish Treasury Bonds investment return is provided from Bloomberg (www.bloomberg.com) and those rates are used for calculating the yearly risk free rate. In addition, Risk free rates are used as risk discount rate within this study.

6.2.1.3. Equity and property return

Equity return is the total return on common stock. It measures how well the company uses its invested equity.

The property return is the total return on investments in real estate.

A general assumption is made for these variables. It is assumed that equity return is 5% more than the treasury bond.

6.2.1.4. Fixed return

Fixed return is the yield on a corporate bond portfolio held by an insurance company. Fixed return is not used in this study because, all the pension funds are managed by an independent/autonomous fund management company which are subject to regulation of SPK (Capital Markets Board of Turkey) and since all the funds are managed by independent entities regulated by SPK, using this fixed rate of return for an insurance company (even fixed rate of return for an independent/autonomous fund management company) is not meaningful.

6.2.1.5. Government return

Typically, the yield on a 10-year bond offered by the local government or the 10-year swap rate (swap rates are commonly used as risk-free yields for modelling purposes). 10-year Treasury Bond's rate of return is used for government return.

6.2.1.6. Tax rates

In accordance with the Law No. 6802 on Expenditure Taxes, in any way whatever the content of the payment, if an insurance company gets any kind of amount cash or account and in favour of itself, then that money received by insurance company is subject to banking and insurance transactions tax (BITT). In general, BITT is 5% of the amount of received amount.

Tax revenue is an income to government and it changes in time. Tax rate is excluded from the study since contribution payments done by participants to their PPS account are not subject to specific BITT tax.

6.2.1.7. Summary of used economic assumptions

Based on the definitions given above, economic assumptions, which are used both PPS and annuity forecast year by year, are summarized in Table 6.4. After the first five years, the indicator figures have been fixed, since inflation is estimated at a maximum of 5 years in IMF's forecast.

Table 6.4 Economic Assumptions in Main Scenario

Year	CPI	Bond yield	Cash yield	Equity yield	Corporate bond yield	Commodity	TL RFR	IF Business- Av. Return- reel	New Business- Av. Return- reel
2017	11.92%	13.04%	12.54%	18.04%	14.04%	11.92%	13.04%	3.46%	4.80%
2018	20.30%	23.11%	22.61%	28.11%	24.11%	20.30%	23.11%	2.55%	6.42%
2019	17.50%	19.49%	18.99%	24.49%	20.49%	17.50%	19.49%	1.93%	5.57%
2020	14.10%	15.88%	15.38%	20.88%	16.88%	14.10%	15.88%	1.80%	5.31%
2021	13.40%	15.29%	14.79%	20.29%	16.29%	13.40%	15.29%	1.91%	5.36%
2022	13.00%	15.98%	15.48%	20.98%	16.98%	13.00%	15.98%	2.87%	6.39%
2023	13.00%	15.70%	15.20%	20.70%	16.70%	13.00%	15.70%	2.62%	6.07%
2024	12.40%	15.34%	14.84%	20.34%	16.34%	12.40%	15.34%	2.85%	6.25%
2025	12.40%	14.98%	14.48%	19.98%	15.98%	12.40%	14.98%	2.53%	5.85%
2026	12.40%	14.34%	13.84%	19.34%	15.34%	12.40%	14.34%	1.97%	5.17%
2027	12.40%	14.34%	13.84%	19.34%	15.34%	12.40%	14.34%	1.97%	5.12%
2028	12.40%	14.34%	13.84%	19.34%	15.34%	12.40%	14.34%	1.97%	5.07%
2029	12.40%	14.34%	13.84%	19.34%	15.34%	12.40%	14.34%	1.97%	5.02%
2030	12.40%	14.34%	13.84%	19.34%	15.34%	12.40%	14.34%	1.97%	4.97%
2031	12.40%	14.34%	13.84%	19.34%	15.34%	12.40%	14.34%	1.97%	4.92%
2032	12.40%	14.34%	13.84%	19.34%	15.34%	12.40%	14.34%	1.97%	4.87%
2033	12.40%	14.34%	13.84%	19.34%	15.34%	12.40%	14.34%	1.97%	4.82%
2034	12.40%	14.34%	13.84%	19.34%	15.34%	12.40%	14.34%	1.97%	4.77%
2035	12.40%	14.34%	13.84%	19.34%	15.34%	12.40%	14.34%	1.97%	4.72%
2036	12.40%	14.34%	13.84%	19.34%	15.34%	12.40%	14.34%	1.97%	4.67%
2037	12.40%	14.34%	13.84%	19.34%	15.34%	12.40%	14.34%	1.97%	4.62%

Economic assumptions used in the main scenario are given in Table 6.4. The following assumptions are made for investment returns based on returns of Turkish major banks and the advice of the finance department of a large insurance company;

Cash Yield = Bond Yield – 0,5%

Equity Yield = Bond Yield + 5%

Corporate Bond Yield = Bond Yield + 1%

Commodity = Inflation

In addition, average pension return is calculated by taking into consideration the investment instruments used in individual pensions and their weights in the portfolio for both in-force and new business.

In this study, economic assumption given in Table 6.4 is used in main scenario. Additionally, different economic assumptions used for the different scenarios are also given in Appendixes.

6.2.2. Non-economic assumptions

Other than economic assumptions, as fund allocation rate for PPS, lapse rate, paid up rate, costs (acquisition, maintenance, etc.), mortality table (for PPS and annuitant) etc. are non-economic assumptions of life insurance modelling generally. Non-economic assumptions change from study to study which are used in modelling.

6.2.2.1. Fund allocation rate for PPS

Since it is an open system, there will be new entries in the system during projected years. So, participants in PPS are divided into two groups: In force and new business. It is assumed that the investment preference of the new participants will be different from the existing participants. Because, new participants are assumed to have more risk appetite than in force participants and distribution of investment instruments differs between those two groups. Fund allocation assumption is made for in-force participants using recent years' fund allocation ratio and a general assumption is made for new participants with actuarial experience of one of the biggest pension company in Turkey. Fund allocation ratio is given for these two groups year by year in Table 6.5.

Table 6.5 Fund Allocation Ratio for PPS

Years	IF BUSINESS				NEW BUSINESS			
	Bills & Bonds	Cash & Deposits	Equities	Other	Bills & Bonds	Cash & Deposits	Equities	Other
2017	78%	12%	7%	3%	10%	12%	75%	3%
2018	78%	12%	7%	3%	11%	12%	74%	3%
2019	78%	12%	7%	3%	12%	12%	73%	3%
2020	78%	12%	7%	3%	13%	12%	72%	3%
2021	78%	12%	7%	3%	14%	12%	71%	3%
2022	78%	12%	7%	3%	15%	12%	70%	3%
2023	78%	12%	7%	3%	16%	12%	69%	3%
2024	78%	12%	7%	3%	17%	12%	68%	3%
2025	78%	12%	7%	3%	18%	12%	67%	3%
2026	78%	12%	7%	3%	19%	12%	66%	3%
2027	78%	12%	7%	3%	20%	12%	65%	3%
2028	78%	12%	7%	3%	21%	12%	64%	3%
2029	78%	12%	7%	3%	22%	12%	63%	3%
2030	78%	12%	7%	3%	23%	12%	62%	3%
2031	78%	12%	7%	3%	24%	12%	61%	3%
2032	78%	12%	7%	3%	25%	12%	60%	3%
2033	78%	12%	7%	3%	26%	12%	59%	3%
2034	78%	12%	7%	3%	27%	12%	58%	3%
2035	78%	12%	7%	3%	28%	12%	57%	3%
2036	78%	12%	7%	3%	29%	12%	56%	3%
2037	78%	12%	7%	3%	30%	12%	55%	3%

6.2.2.2. Lapse rate

Participants have right to withdraw from PPS at any time by paying withholding tax depending on the time passed in the system. There are not enough figures for forecasting withdrawal rate from published data. Since this assumption is needed for both in force and new business, a general assumption is done considering published data and actuarial aspects.

Withdrawal rate both for in-force and new business portfolios are assumed as 12% for the first five years, 10% for the next five years and 8% for the following five years and 5% for the remaining years. However, it should be noted that this assumption is used just for the accumulation period.

Lapse rate assumption is also used for annuity modelling which is the passive period and 5% is taken into account as lapse rate for future projection years in annuity modelling based on actuarial judgement.

6.2.2.3.Paid up rate

Participants have right to paid up in PPS at any time which means they have right to take break for a while to the contribution payments, and in this case they should pay a fixed amount of charge for taking break. There are not enough figures for forecasting paid up rate from published data. Because of this, an assumption should be used both for in force and new business. So, a general assumption is done considering published data and actuarial judgement.

Average 5% is used for forecasts, however 6%, 7% and 8% are used respectively for 2018-2020 years because of economic uncertainties for accumulation period.

There is no such an assumption in annuity modelling because annuity is an insurance product and paid-up is meaningless during annuity modelling.

6.2.2.4. Insurance costs

Insurance costs arise from insurance activities such as commissions, acquisition costs and general expenses for operational purposes, customers, fixed costs of the company etc. Expenses mainly split in two groups: Acquisition and maintenance costs.

Acquisition costs are direct expenses associated with selling and issuing new policies. When a new policy is sold, insurance companies have underwriting costs and policy issuance costs for each of new policy. In addition, insurance companies pay commissions to sales channels (agency, broker, etc.) which has the main share of the acquisition cost, could be very high in the first policy year.

Maintenance costs are directly related to the actual maintenance of policies like information technology (IT) requirements, general expenses of the operations, cost of fees during annuity payments etc.

We focus on acquisition cost and maintenance cost generally (an average amount is used) without going into a company's detailed expenses. Average cost per policy is used as 5 TRY based on a large life insurance company suggestion without any split of acquisition and maintenance.

6.2.2.5. Mortality table

Rate of deaths occurred in a population during time interval or survival of an individual starting from birth to any given age, is summarized within mortality tables which is also known as life tables. The probability of an individual's death before his next birthday, based on his age is the main statistics given with mortality tables.

There are several approaches for used mortality table which is one of the most important variables in modelling. As Mircea et al. (2014) develop age specific Romanian mortality rates for annuity market. Because the tendency of decrease of the mortality rates was persistent and therefore mortality prediction models were developed for country specific in the process of time. Apart from that approach, mortality tables are also used for modelling. However, the important point is using updated mortality table in accordance with the regulation for modelling.

TRH 2010 mortality table is used for the main scenario during accumulation period of PPS forecast due to regulation. However, World Health Organization (WHO) published Turkish mortality statistics and based on this study expected lifetime extends by two years in general on the average. Hence, TRH 2010 mortality rates are revised by considering WHO statistics and the results are given in scenario analysis in Appendixes.

TRHA 2010 mortality table, which is specific to annuitants, is also used for annuity modelling main scenario due to definition in regulation. Also, TRH 2010 and TRHA 2010 mortality rates are revised by considering WHO statistics and alternative mortality tables are used in scenario analysis which are explained in appendix. It should be noted that annuitant mortality level is lower than general mortality level of the population. Because, people who prefer annuity plans have a higher income level and longer life expectancy.

6.2.2.6. Annuitant rate

Annuitant rate indicates what percentage of participants who retire from the private pension system will receive an annuity. It is assumed that for the first three years is 1%, next two years is 2%, following two years is 3%, following two years is 4% and increased by 1% recursively for the upcoming years.

6.2.2.7.Other non-economic assumptions

Average yearly contribution amount increase: Inflation rate is used for this assumptions considering general approach in PPS.

6.3. Application

After forecasting of PPS figures, annuity projection is done using retired participants' figures.

Annuity is a long-term insurance product and mathematical reserve has to be calculated for covering future liabilities for each insured. Mathematical reserves are defined as the provision made by an insurer to cover liabilities arising under long-term insurance business.

Consider a sequence of amounts, payable at the beginning of each year as long as the annuitant is alive. Its actuarial present value is given in Equation 6.4.

$$\ddot{a}_x = P * \sum_{k=0}^{w-x} {}_kp_x \, (1+i)^{-k} \qquad\qquad (6.4)$$

where:

- P denotes yearly payment,
- x denotes the annuitant's age at annuity commencement,
- i is the interest rate used to calculate present values, and hence $(1+i)^{-1}$ is the annual discount factor
- ${}_kp_x$ denotes the probability for an individual age x of being alive at age x+k,
- ω is the limit /last age.

Equation6.5 is used for mathematical reserve calculation at time point t.

$$_t V = P * (1 + e_1) \dots (1 + e_t) * \ddot{a}_{x+t} \qquad (6.5)$$

where:

- t denotes time,
- e_i denotes yearly payment increase rate at year i

Since annuity payments should be increased annually by using inflation due to regulation of annuity.

Annuitant projection is done for single age with breakdown of gender and with the split of in-force and new business.PPS accumulated fund amount is used as net single premium (or present value of an annuity defined in equation 6.4) and retirement payments P is calculated again with the breakdown of gender and with the split of in-force and new business. Moreover, all those calculations are performed during projection years which means each cohorts' cash flows are projected. After projection of annuity plan including all cash flows and mathematical reserves, SCR is estimated based on the methodology and assumptions given in previous sub-sections.

Annuitant SCR calculation is done considering life and market risk modules. $SCR_{longevity}$ and $SCR_{expense}$ risk sub-modules and the reserve requirement for these liabilities are calculated under SCR_{life} module. In addition, life risk of SCR is based on the mortality, disability, lapse and longevity risks. Since this product is an annuity product, main risk is longevity risk from SCR point of view. Lapse is also modelled within annuity models but since lapse is not creating additional risk for the companies, it is not taken into account within SCR life risk module. Similarly, there is no guarantee given for the disability which means disability is not taken into account in modelling. As a result, $SCR_{mortality}$, $SCR_{disability}$ and SCR_{lapse} sub-risks are not required to calculate where $SCR_{mortality}$, $SCR_{disability}$, $SCR_{revision}$, SCR_{lapse} and $SCR_{life\ catastrophe}$ are kept out of the study.

Although the following risk correlation matrix given in part 5.1 is used, market risk and life underwriting risk are considered and other risk charges are not in the scope of the study.

Table 6.6 Solvency Risk Correlation Matrix

	Market	**Default**	**Life**	**Health**	**Non-life**
Market	1				
Default	0.25	1			
Life	**0.25**	0.25	1		
Health	0.25	0.25	0.25	1	
Non-life	0.25	0.5	0	0	1

(Solvency II Directives, 2009, Annex IV, p.2)

6.3.1. Solvency II market risk

The market risk module is defined with the equation 6.3 given below by Solvency II Directives.

$$SCR_{market} = \sqrt{\sum_{i,j} Corr_{i,j} \, SCR_i \, SCR_j} \qquad\qquad (6.6)$$

where SCR_i denotes the sub-module i and SCR_j denotes the sub-module j, and where "i,j" means that the sum of the different terms should cover all possible combinations of i and j. In the calculation, SCR_i and SCR_j are replaced by the following:

- $SCR_{interest\ rate}$ denotes the interest rate risk sub-module;

- SCR_{equity} denotes the equity risk sub-module;

- $SCR_{property}$ denotes the property risk sub-module;

- SCR_{spread} denotes the spread risk sub-module;

- $SCR_{concentration}$ denotes the market risk concentrations sub-module;

- $SCR_{currency}$ denotes the currency risk sub-module,

(Solvency II Directives, Article 105(5)).

Correlation matrix of the market risk which was defined in equation 6.6 is given below with Table 6.7 and Table 6.8. These tables also given in section 5.1.

Table 6.7 Correlation Matrix for$CorrUp_{i,j}$

CorrUp	Interest Rate	Equity	Property	Spread	Currency	Concentration
Interest Rate	**1**					
Equity	0	**1**				
Property	0	0.75	**1**			
Spread	0	0.75	0.5	**1**		
Currency	0.25	0.25	0.25	0.25	**1**	
Concentration	0	0	0	0	0	**1**

Source: QIS 5 Technical Specifications, p.108

Table 6.8 Correlation Matrix for$CorrDown_{i,j}$

CorrDown	Interest Rate	Equity	Property	Spread	Currency	Concentration
Interest Rate	**1**					
Equity	0.5	**1**				
Property	0.5	0.75	**1**			
Spread	0.5	0.75	0.5	**1**		
Currency	0.25	0.25	0.25	0.25	**1**	
Concentration	0	0	0	0	0	**1**

Source: QIS 5 Technical Specifications, p.108

SCR calculation is defined with interest rate, equity, property, spread, currency and concentration risks, but as mentioned below in Table 6.12, just interest rate, equity, property and currency risks are taken into account within this study. In addition, interest rate risk should be modelled with upward and downward shocks with different correlation matrix. Neverthless, for the sake of calculations which is already used as Lloyds's approach (2014), maximum of the upward and downward shocks is taken into account as interest rate risk capital requirement (SCR$_{InterestRate}$) and downwards correlation matrix is used.

Correlation coefficients for risk modules are given in Solvency II directives which are calculated as a result of long studies. As CEIOPS (2009) and CRO forum (2009) give advice with regards to the choice of the correlation parameters applied in the SCR standard equation to aggregate capital requirements. Starting from this point, it is aimed to suggest a proposal for market risk coefficient matrix for Turkey.

CEIOPS (2009) Consultation Paper No.74 aims to suggest a proposal with regards to the choice of the correlation parameters applied in the SCR standard equation to aggregate capital requirements on module and sub-module level as requested in Article 109(1c) of the Solvency II Level 1 text ("Level 1 text").

CEIOPS (2009) suggestion as correlation factors for market risk is given in Table 6.9.

Table 6.9 CEIOPS (2009) Suggestion of Correlation Factors for Market Risk

	Interest Rate	Equity	Property	Spread	Currency	Concentration
Interest Rate	1					
Equity	0.5	1				
Property	0.5	0.75	1			
Spread	0.5	0.75	0.75	1		
Currency	0.5	0.5	0.5	0.5	1	
Concentration	0.75	0.75	0.75	0.75	0.5	1

CEIOPS (2010) made further studies on correlation coefficient for life, non-life and market risk modules. Due to the fact that we focus on market risk, this part shall be examined deeply. CEIOPS use the following variables for performing risk coefficient matrix:

Equity: MSCI World Index,

Interest: UK 10 year swap rates,

FX: GBP / USD currency rates,

Property: A large portfolio of UK investment grade property (assessed monthly),

Spread: The spread to gilts on UK AA rated corporate bonds,

Concentration: A simulated set of variables with a relatively high correlation with Equities.

Their analysis is based on only 12 years of data. Because UK spreads (as for spreads in most other markets) does not exist for longer periods.

CEIOPS examines the setting of correlation parameters between specific pairs of sub risks in the market risk module. They use both linear correlation and also tail correlations.

Based on the analysis, CEIOPS (2010) proposal for correlation factors of market risk is given in Table 6.10.

Table 6.10 CEIOPS (2010) Suggestion of Correlation Factors for Market Risk

	Interest Rate	Equity	Property	Spread	Currency	Concentration
Interest Rate	1					
Equity	0.5/0	1				
Property	0.5/0	0.75	1			
Spread	0.5/0	0.75	0.5	1		
Currency	0.5	0.5	0.5	0.5	1	
Concentration	0.5	0.5	0.5	0.5	0.5	1

CRO Forum (2009) recommends to calibrate market risk correlation factors as well as a counterproposal for the correlation matrix of risk sub modules as suggested by CEIOPS (2009). They performed their analysis on correlation for market risks, they adopt principles for calibrating the correlations with a systematic analysis of all the available statistics rather than focus on one particular metric or observation period. In addition, they calculate both static and rolling correlations pairs of sub risks in the market risk module.

As well as CRO and CEIOPS studies, a proposal of market risk correlations considering Turkish economic variables is also given within this dissertation. Following variables for performing risk coefficient matrix are used for that reason:

Equity: BIST 100 Index

Interest: Turkey 2 year, 5 year and 10 year bond rates

FX: USD/TRY and EUR/TRY currency rates

Property: House price index

BIST 100 index measures the performance of the 100 stocks traded in Borsa Istanbul with the highest market value and transaction volume.

Bond rate is used as interest rate variable. 2 years, 5 years and 10 years bond rates are used for the analysis and results are compared. The data is provided between 28.01.2010-31.12.2018 on daily basis.

House price index from Central Bank (www.tcmb.gov.tr) is used for property data which is between 02.2010-10.2018 on monthly basis.

Spread and concentration variables are excluded from the study. Because we could not provide continuous data for a time period for Turkey.

Before calculating correlation coefficients, data is cleaned and prepared on monthly basis for all variables. The data is between 02.2010-10.2018 which comprised of 105 months (line), 7 variables (column). The variables are:

- 2 year bond yield,
- 5 year bond yield,
- 10 year bond yield,
- USD-TRY FX,
- EUR-TRY FX,
- Property (House price index),
- Equity (Bist 100 index).

CEIOPS, CRO Forum and our advice on market risk correlations for Turkey are compared below for pairs of sub risks.

6.3.1.1. Interest rate vs equity

Interest Rate risk is two-sided in nature; therefore, correlation is highly dependent on the Interest Rate position in the portfolio (duration).

CRO Forum recommends that for portfolios with short durations (which is the more common situation), a correlation of 0.5 seems to be appropriate; whereas for a portfolio with long duration a correlation of 0 would be appropriate (conservative assumption).

Linear correlation between BIST 100 Index and bond rates for two, five and ten years, is calculated within this study to understand the Turkish model. According to those calculations for Turkey, the correlation coefficients are found as 47% (two years bond vs equity (BIST 100)), 39% (five years bond vs equity) and 36% (ten years bond vs equity). This correlation is based on the data, as mentioned above in previous sub-section, starting from February 2010 to October 2018. In addition, same correlation is calculated with the data from February 2010 to December 2015 and correlation is found as -35% (two years bond vs equity), -55% (five years bond vs equity) and -63% (ten years bond vs equity).

In order to compare the Turkish results with CRO Forum and CEIOPS Suggestion, the correlation between ten years bond rate and BIST 100 Index is added in Figure 6.2.

INTEREST RATE vs EQUITY		
Static correlation		16% 49%
Rolling correlation	-29%	73%
CROF recommendation	0% (long dur.)	50% (short dur.)
QIS5	0% (upward)	50% (downword)
CEIOPS Advice		50%
Turkiye's static correlation	-63%	36%
Turkiye's rolling correlation		
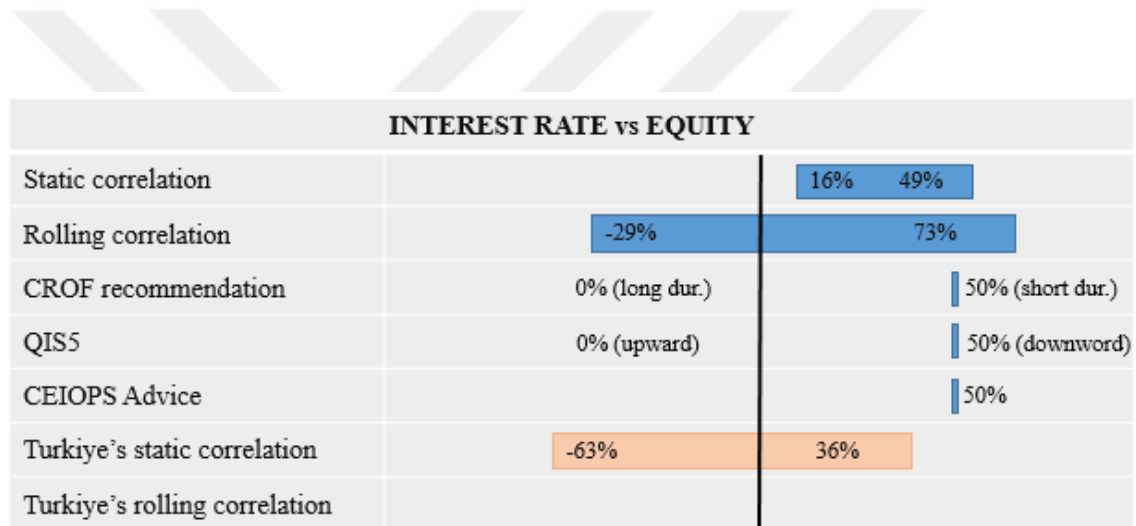
Figure 6.2 Suggestions for Interest Rate-Equity correlation coefficient

Rolling correlation and tail dependence of these variables are also performed. As seen in Figure 6.2, rolling correlation varies in a wide range due to the economic fluctuations. Eventually, 50% correlation coefficient is acceptable for interest rate vs equity under Turkish market conditions.

6.3.1.2. Property vs interest rate

PROPERTY vs INTEREST RATE		
Static correlation	-29%	56%
Rolling correlation		
CROF recommendation	25%	50%
QIS5	0% (upward)	50% (downword)
CEIOPS Advice		50%
Turkiye's static correlation	-57%	60%
Turkiye's rolling correlation		

Figure 6.3 Suggestions for Property-Interest rate correlation coefficient

For the comparison of property and interest rate, house price index is used from central bank is taken into account as mentioned in section 6.3.1 for property; and again 2 year, 5 year and 10 year bond rates are taken into account as interest rate during the calculation of correlation between property and interest in Turkish market. According to Turkish market calculations, the correlation coefficients are found as 68% (property vs 2 year bond), 62% (property vs 5 year bond) and 60% (property vs 10 year bond) based on the data starting from February 2010 to October 2018. In addition, correlation coefficients with the data starting from February 2010 to December 2015 are also analysed and they are found as 28% (2 year bond vs equity), 3% (5 year bond vs equity) and -11% (10 year bond vs equity).

Rolling correlation and tail dependence for these variables are also performed, but this correlation has a very wide range. As a result, correlation coefficient is 50% is acceptable for property vs interest rate under Turkish market conditions.

6.3.1.3.Property vs equity

PROPERTY vs EQUITY		
Static correlation	-37%	54%
Rolling correlation		
CROF recommendation	25%	50%
QIS5		75%
CEIOPS Advice		75%
Turkiye's static correlation	74%	85%
Turkiye's rolling correlation		

Figure 6.4 Suggestions for Property-Equity correlation coefficient

For the comparison of property and equity, house price index is used from central bank is taken into account as mentioned in section 6.3.1 for property; and BIST 100 index is taken into account as equity during the calculation of correlation between property and equity in Turkish market. According to Turkish market calculations, the correlation coefficient is found as 85% based on the data starting from February 2010 to October 2018. In addition, correlation coefficients with the data starting from February 2010 to December 2015 is found as 74%. Comparing to CRO Forum and CEIOPS suggestions at least 75% is acceptable for property vs equity under Turkish market conditions.
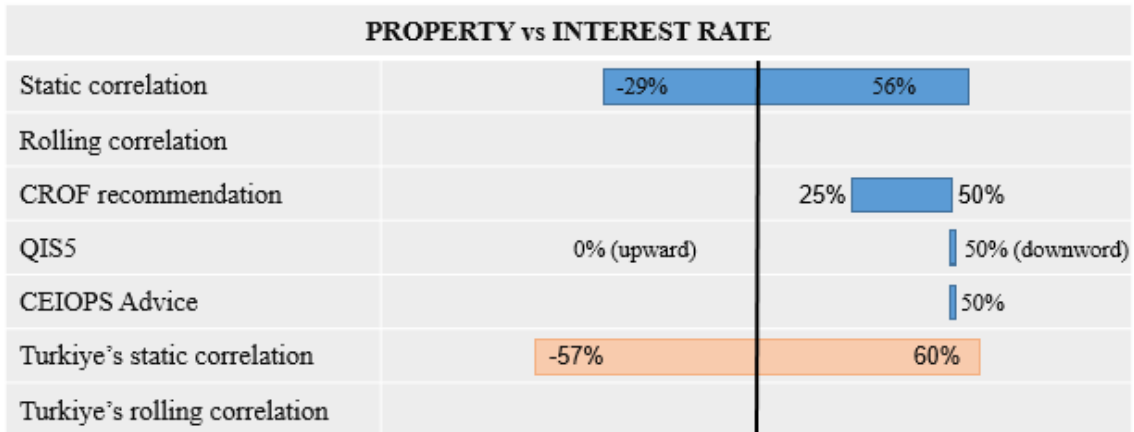
6.3.1.4. Property vs currency (FX)

Figure 6.5 Suggestions for Property-Currency correlation coefficient

For the comparison of property and currency, house price index is used from central bank is taken into account as mentioned in section 6.3.1 for property; and USD/TRY and EUR/TRY indexes are taken into account as currency during the calculation of correlation between property and currency in Turkish market. According to Turkish market calculations, the correlation coefficients are very volatile according to time period. The correlation coefficient is found as 94% (property vs TRY-USD) and 90% (property vs TRY-EUR). The rate is high compared to SII directives, CRO Forum and CEIOPS suggestions. Since this correlation is more than 50%, CEIOPS suggestion of 50% is assumed as acceptable for property vs currency under Turkish market conditions.

6.3.1.5.FX vs interest rate
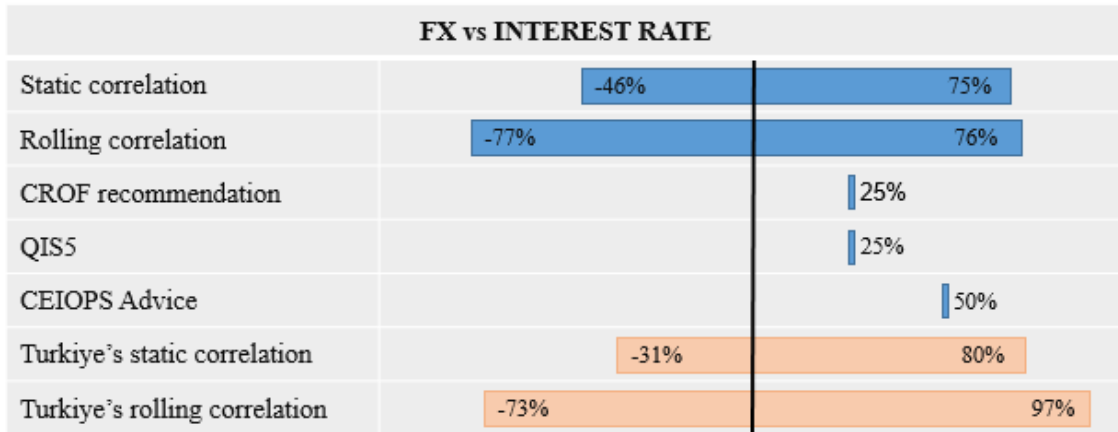
Figure 6.6 Suggestions for Exchange Rate-Interest Rate correlation coefficient

For the comparison of currency and interest rate, USD/TRY index is taken into account as currency as mentioned in section 6.3.1; and as used in previous analyses 2 year, 5 year and 10 year bond rates are taken into account as interest rate during the calculation of correlation between currency and interest in Turkish market. TRY-USD exchange rate and bond yield (two, five and ten year) correlation coefficient coefficients are summarized in the Table 6.11.

Table 6.11 TRY-USD Exchange Rate and Bond Yield Correlation Coefficients

	2 Year Bond Yield	5 Year Bond Yield	10 Year Bond Yield
USD-TRY FX	87%	83%	80%
EUR-TRY FX	90%	86%	84%

Those correlation coefficients given in Table 6.11 are relatively high compared to SII directives, CRO Forum and CEIOPS suggestions. Therefore, it should be more conservative using this correlation coefficient is more than 50% under Turkish market conditions.

6.3.1.6.FX vs equity
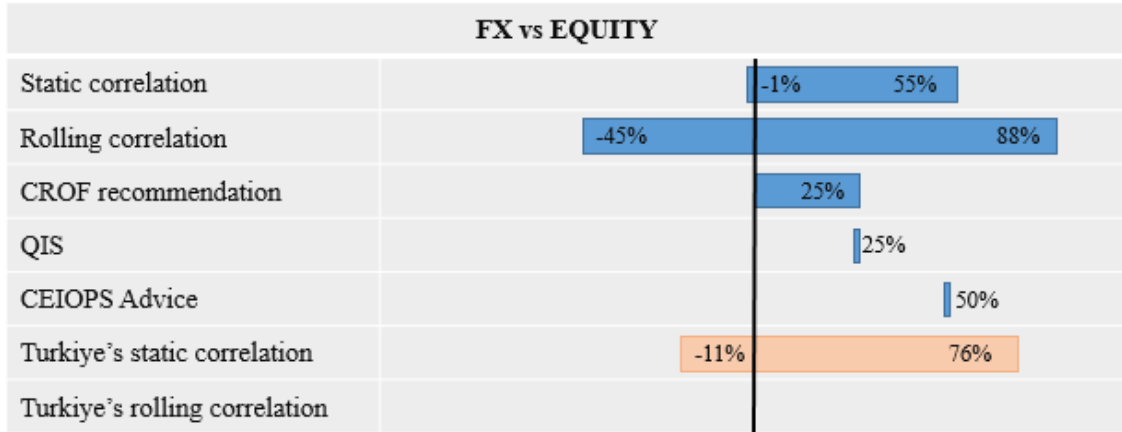
Figure 6.7 Suggestions for Exchange Rate-Equity correlation coefficient

For the comparison of currency and equity, USD/TRY and EUR/TRY indexes are taken into account as currency is taken into account as mentioned in section 6.3.1 for currency; and BIST 100 Index is taken into account as equity during the calculation of correlation between currency and equity in Turkish market. According to Turkish market calculations, the correlation coefficients are found as 66% (TRY-USD vs equity) and 72% (TRY-EUR vs equity). This rate is high compared to SII directives and CRO Forum suggestions. So, more than %25 is acceptable for fx vs equity under Turkish market conditions.

6.3.1.7.Summary of Turkish market correlations

As a summary, the proposal factors based on the estimated Turkish market figures are given in Table 6.12 below:

Table 6.12 Market Correlation Matrix Comparison

	Interest rate	Equity	Property	Currency
Interest rate	1			
Equity	CROF : 0.5/0 CP74 : 0.5 QIS4 : (0;+/-0.25) QIS5 : 0.5/0 Recom. For Turkiye : 0.5	1		
Property	CROF : [0.25;0.5] CP74 : 0.5 QIS4 : 0.5 QIS5 : 0.5/0 Recom. For Turkiye > 0.5	CROF : [0.25;0.5] CP74 : 0.75 QIS4 : 0.75 QIS5 : 0.75 Recom. For Turkiye > 0.75	1	
Currency	CROF : 0.25 CP74 : 0.5 QIS4 : 0.25 QIS5 : 0.25 Recom. For Turkiye > 0.25	CROF : [0;0.25] CP74 : 0.5 QIS4 : 0.25 QIS5 : 0.25 Recom. For Turkiye > 0.25	CROF : [0;0.25] CP74 : 0.5 QIS4 : 0.25 QIS5 : 0.25 Recom. For Turkiye > 0.25	1

The market correlation matrix in main scenario is given in Table 6.13 and suggested market correlation matrix for Turkey is given in Table 6.14.

Table 6.13 Used Market Correlation Matrix in Main Scenario

	Interest Rate	Equity	Property	Currency
Interest Rate	1			
Equity	0.5	1		
Property	0.5	0.75	1	
Currency	0.25	0.25	0.25	1

Table 6.14 Suggested Market Correlation Matrix for Turkey

	Interest Rate	Equity	Property	Currency
Interest Rate	1			
Equity	0.5	1		
Property	0.5	0.75	1	
Currency	0.5	0.5	0.5	1

6.3.2. Solvency II life risk

The underwriting life risk module is defined with the same approach as following equation 6.7, which is defined by Solvency II Directives:

$$SCR_{life} = \sqrt{\sum_{i,j} Corr_{i,j}\, SCR_i\, SCR_j} \qquad (6.7)$$

where SCRi denotes the sub-module i and SCRj denotes the sub-module j, and where "i,j" means that the sum of the different terms should cover all possible combinations of i and j. In the calculation, SCRi and SCRj are replaced by the following:

- $SCR_{mortality}$: mortality risk,

- $SCR_{longevity}$: longevity risk,

- $SCR_{disability}$: disability/morbidity,

- $SCR_{life\ expense}$: life expense risk,

- $SCR_{revision}$: revision risk,

- SCR_{lapse} : lapse risk,

- $SCR_{life\ catastrophe}$: life catastrophe risk,

(Solvency II Directives, Article 105(3)).

Correlation matrix of the life underwriting risk which was defined in equation (6.2) above is given below with Table 6.15.

Table 6.15 Life Underwriting Coefficient Matrix

	Mortality	Longevity	Disability	Lapse	Expenses	Revision	Cat
Mortality	1						
Longevity	-0.25	1					
Disability	0.25	0	1				
Lapse	0	0.25	0	1			
Expenses	0.25	0.25	0.5	0.5	1		
Revision	0	0.25	0	0	0.5	1	
Cat	0.25	0	0.25	0.25	0.25	0	1

Source: Solvency II-General Insurance, 2016

Calculation of SCR$_{longevity}$

As it is known life annuities guarantee to make recurring series of payments until death of the annuitant and if there is decrease in mortality rates, this will result with an increase in liabilities of the insurance company, which means an in increase in technical provisions. Similarly, for the products like pure endowments where insurance company guarantee to make a single payment in case of survival of the policyholder, this will also lead to an increase in technical provisions. Therefore, decrease in mortality rate is defined as longevity risk which is directly associated with the insurance liabilities.

Longevity risk will lead to a deviation in insurance liabilities. As explained above, if there is decrease in mortality rates, this will lead to an increase in number of survives and as a result, this will lead to an increase in technical provisions of the annuitants' mathematical reserves. On the contrary, if number of deaths is less than the expected for death liability, then payable amount would be less than the technical provisions held.

Based on QIS5 Technical Specification (2010) prepared by EIOPA, as explained n previous sections, capital requirement is defined as the change in net asset value (assets minus liabilities) following a permanent decrease in mortality rates.

The capital requirement of longevity risk is given the equation below:

$$SCR_{longevity} = (\Delta NAV | longevity\ shock) \qquad (6.8)$$

Where;

ΔNAV : The change in the net value of assets minus liabilities,

Longevity shock : Decreasing the mortality rates by 20% for each age and applying these mortality rates to each policy which is contingent on longevity risk.

Calculation of SCR$_{life\ expense}$

Variation in the expenses incurred in servicing insurance and reinsurance contracts is defined as expense risk.

Life expense can be calculated with the following equation (QIS5 Technical Specifications, 2010):

$$SCR_{life\ expense} = 0.1 * n * E + \left(\frac{1}{k} * ((1+k)^n - 1) - \frac{1}{i} * ((1+i)^n - 1) \right) * E \quad (6.9)$$

Where;

E : Expenses of the insurance company to serve life insurance liabilities during the last year,

n : Average duration in years during the run-off period of all risks,

i : Expected inflation rate,

k : Stressed inflation rate (i.e. i+1%).

6.3.3. Required capital under local regulation

Local regulator (Treasury) defined two methodologies for the calculation of capital requirement. Those two methodologies are interpreted below.

Methodology I under local regulation:

- Based on the liability where;
    - Changes in total net provisions (net of reinsurance) of mathematical reserves with a fixed rate (4%)
- Based on the risk where;
    - Risk is defined the possible future payments over the provisions (mathematical reserves) which means zero from theoretical point of view.

Methodology II under local regulation:

- Using the active risk with a fixed rate of risk (1% mainly since almost all of the active is assumed as related with the banks), where active risk is related with the investment instruments,
- Using the underwriting risk with a fixed rate of risk, where underwriting risk is related with the product type and distribution channel and where underwriting risk is used as fixed rate of 3.5% which is maximum rate of the different distribution channels for annuity products.

6.4. Summary of the Findings

With the help of assumptions of economic and non-economic given in section 6.2 PPS figures like number of contributors, total fund amount of those contributors and state contributions of those accounts are projected both for in-force and new business during projection years, and all those results are interpreted with the following tables of Table 6.16 and 6.17.

Table 6.16 PPS Figures-In Force Business

all amounts in TRY (000)

Years	Female - IF Business			Male - IF Business		
	Number of contributors	Total Fund Amount	Total State Contribution Fund	Number of contributors	Total Fund Amount	Total State Contribution Fund
2017	36,719	501,934	63,709	49,618	702,457	76,617
2018	33,030	644,912	84,945	45,119	910,812	108,437
2019	34,072	764,842	113,163	46,234	1,067,321	144,610
2020	32,190	859,974	134,848	44,183	1,193,968	177,622
2021	34,034	1,061,808	174,972	46,967	1,500,871	233,621
2022	33,988	1,259,872	217,839	46,492	1,744,041	288,695
2023	27,364	1,276,836	219,666	37,194	1,716,308	291,145
2024	24,268	1,336,290	238,155	33,323	1,810,828	319,130
2025	25,190	1,568,866	295,489	35,449	2,234,954	409,301
2026	25,045	1,816,323	349,952	35,591	2,548,794	489,476
2027	23,282	1,970,797	382,881	33,340	2,744,448	540,251
2028	22,266	2,167,499	427,285	32,034	2,975,804	606,844
2029	21,388	2,369,342	473,593	30,977	3,278,394	676,724
2030	20,910	2,610,762	532,063	30,228	3,590,461	759,686
2031	20,062	2,840,006	585,780	28,925	3,894,054	835,066
2032	17,924	2,894,334	599,810	25,514	3,927,126	845,139
2033	18,030	3,272,377	686,639	25,664	4,423,443	967,402
2034	18,320	3,695,487	792,159	26,197	5,068,005	1,122,634
2035	17,728	3,985,057	869,681	25,420	5,523,844	1,237,039
2036	17,546	4,412,571	975,823	24,818	6,068,401	1,370,435
2037	16,987	4,779,395	1,070,335	24,117	6,646,203	1,510,114

Table 6.17 PPS Figures-New Business

all amounts in TRY (000)

Years	Female - New Business			Male - New Business		
	Number of contributors	Total Fund Amount	Total State Contribution Fund	Number of contributors	Total Fund Amount	Total State Contribution Fund
2017	-	0	0	-	0	0
2018	-	0	0	-	0	0
2019	-	0	0	-	0	0
2020	-	0	0	-	0	0
2021	-	0	0	-	0	0
2022	-	0	0	-	0	0
2023	-	0	0	-	0	0
2024	-	0	0	-	0	0
2025	-	0	0	-	0	0
2026	-	0	0	-	0	0
2027	1,930	155,390	31,887	2,322	186,986	38,345
2028	3,792	353,919	72,799	4,686	437,796	89,996
2029	5,667	608,526	125,536	7,143	768,427	158,424
2030	7,521	925,748	191,693	9,617	1,186,688	245,559
2031	9,329	1,312,932	273,101	12,067	1,703,516	354,072
2032	11,065	1,776,785	370,976	14,460	2,330,738	486,255
2033	13,170	2,398,882	501,916	17,334	3,170,485	662,862
2034	15,405	3,179,298	666,033	20,368	4,222,032	883,856
2035	17,731	4,140,355	868,180	23,583	5,534,217	1,159,675
2036	20,211	5,337,097	1,119,909	26,977	7,160,433	1,501,550
2037	22,848	6,818,257	1,431,473	30,576	9,172,460	1,924,556

As seen in Table 6.17, since the participant who entered the system in 2017 would be able to retire in 2027 at the earliest, where forecasts of the new business starts from 2027.

Annuity plan figures are also estimated using PPS' estimated figures and using annuitant rate year by year. Annuity plan figures of number of annuitants, those annuitants total fund amount and related mathematical reserves year by year, are given with the following Table 6.18 and 6.19. All those figures are given with the split of in-force and new business which were already defined in PPS projections.

Table 6.18 Annuity Plan Figures-In Force Business

all amounts in TRY (000)

Years	Female - IF Business			Male - IF Business		
	Number of annuitant	Total Fund Amount including State Contribution	Total Mathematical Reserves	Number of annuitant	Total Fund Amount including State Contribution	Total Mathematical Reserves
2017	367	5,656	5,656	496	7,791	7,791
2018	330	7,299	13,618	451	10,192	18,829
2019	341	8,780	23,781	462	12,119	32,699
2020	644	19,896	45,723	884	27,432	62,661
2021	681	24,736	74,347	939	34,690	102,135
2022	1,020	44,331	124,697	1,395	60,982	170,512
2023	821	44,895	179,540	1,116	60,224	242,847
2024	971	62,978	255,744	1,333	85,198	343,703
2025	1,008	74,574	348,302	1,418	105,770	470,476
2026	1,252	108,314	480,088	1,780	151,913	650,037
2027	1,164	117,684	629,876	1,667	164,235	852,170
2028	1,336	155,687	825,935	1,922	214,959	1,114,219
2029	1,497	199,005	1,076,521	2,168	276,858	1,450,555
2030	1,673	251,426	1,394,240	2,418	348,012	1,874,767
2031	1,806	308,321	1,787,249	2,603	425,621	2,397,234
2032	1,792	349,414	2,243,195	2,551	477,226	2,995,394
2033	2,164	475,082	2,847,845	3,080	646,901	3,787,336
2034	2,565	628,271	3,639,981	3,668	866,689	4,836,283
2035	2,837	776,758	4,627,637	4,067	1,081,741	6,153,474
2036	3,158	969,911	5,864,223	4,467	1,338,990	7,791,208
2037	3,397	1,169,946	7,368,716	4,823	1,631,263	9,795,897

Table 6.19 Annuity Plan Figures-New Business

all amounts in TRY (000)

Years	Female - New Business			Male - New Business		
	Number of annuitant	Total Fund Amount including State Contribution	Total Mathematical Reserves	Number of annuitant	Total Fund Amount including State Contribution	Total Mathematical Reserves
2017	-	0	0	-	0	0
2018	-	0	0	-	0	0
2019	-	0	0	-	0	0
2020	-	0	0	-	0	0
2021	-	0	0	-	0	0
2022	-	0	0	-	0	0
2023	-	0	0	-	0	0
2024	-	0	0	-	0	0
2025	-	0	0	-	0	0
2026	-	0	0	-	0	0
2027	97	9,364	9,364	116	11,267	11,267
2028	228	25,603	36,065	281	31,668	44,157
2029	397	51,384	91,324	500	64,880	113,406
2030	602	89,395	189,687	769	114,580	238,185
2031	840	142,743	349,723	1,086	185,183	443,143
2032	1,106	214,776	594,574	1,446	281,699	759,339
2033	1,580	348,096	991,370	2,080	460,002	1,275,329
2034	2,157	538,346	1,609,064	2,852	714,824	2,081,748
2035	2,837	801,366	2,536,927	3,773	1,071,023	3,299,156
2036	3,638	1,162,261	3,894,269	4,856	1,559,157	5,084,492
2037	4,570	1,649,946	5,836,690	6,115	2,219,403	7,643,093

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As mentioned in section 6.3.3, Treasury has two approaches for RC(reqıired capital) which are Method I and Method II. So, companies have to calculate their RC with both of these two methods and reflect the highest amount to their financials. Based on these calculation approaches, RC figures of annuity plan where both of the defined two methodology and final amount that should be reflected to the financials under local regulation, are given in Table 6.20 for the projection years.

Table 6.20 RC under Local Regulation

all amounts in TRY (000)

Years	Treasury: Required Capital under Method I	Treasury: Required Capital under Method II	Treasury Required Capital
2017	538	332	538
2018	1,298	580	1,298
2019	2,259	872	2,259
2020	4,335	1,780	4,335
2021	7,059	2,631	7,059
2022	11,808	4,504	11,808
2023	16,895	5,795	16,895
2024	23,978	8,199	23,978
2025	32,751	10,798	32,751
2026	45,205	15,092	45,205
2027	60,107	19,146	60,107
2028	80,815	25,653	80,815
2029	109,272	34,283	109,272
2030	147,875	45,769	147,875
2031	199,094	60,565	199,094
2032	263,700	78,155	263,700
2033	356,075	105,647	356,075
2034	486,683	143,660	486,683
2035	664,688	193,358	664,688
2036	905,368	260,289	905,368
2037	1,225,776	347,392	1,225,776

Table 6.22 is interpreting the results of the RC of the Annuity plan's under Solvency II regulation using market correlation coefficient matrix given in Table 6.21 which is also explained in section 5.1.

Table 6.21 Used Market Correlation Matrix

	Interest Rate	Equity	Property	Currency
Interest Rate	1			
Equity	0.5	1		
Property	0.5	0.75	1	
Currency	0.25	0.25	0.25	1

Table 6.22 RC under Sovency II Regulation

all amounts in TRY (000)

Years	Assets	SCR Longevity	SCR Expense	SCR Life Risk	SCR Interest Rate	SCR Currency	SCR Property	SCR Equity	SCR Market Risk	SCR
2017	13,447	753	129	795	3,178	672	168	148	3,580	3,856
2018	32,447	1,846	891	2,241	7,185	1,622	406	357	8,166	8,992
2019	56,480	3,261	734	3,517	11,607	2,824	706	621	13,338	14,620
2020	108,385	6,292	658	6,487	21,063	5,419	1,355	1,192	24,420	26,788
2021	176,482	10,348	775	10,568	32,293	8,824	2,206	1,941	37,821	41,737
2022	295,209	17,392	1,006	17,670	50,848	14,760	3,690	3,247	60,206	66,849
2023	422,386	25,168	1,146	25,479	67,705	21,119	5,280	4,646	81,290	91,065
2024	599,448	36,041	1,206	36,361	89,754	29,972	7,493	6,594	109,309	123,523
2025	818,777	49,735	1,346	50,088	113,769	40,939	10,235	9,007	140,909	160,913
2026	1,130,125	69,114	1,545	69,516	145,307	56,506	14,127	12,431	183,411	211,771
2027	1,502,676	92,660	1,707	93,102	177,000	75,134	18,783	16,529	228,675	267,591
2028	2,020,376	125,222	1,943	125,721	215,891	101,019	25,255	22,224	286,950	340,858
2029	2,731,806	169,881	2,249	170,457	261,533	136,590	34,148	30,050	360,139	435,259
2030	3,696,879	230,433	2,630	231,105	310,866	184,844	46,211	40,666	448,531	553,551
2031	4,977,349	310,944	3,066	311,724	357,216	248,867	62,217	54,751	549,821	696,543
2032	6,592,503	413,225	3,505	414,116	389,941	329,625	82,406	72,518	657,215	859,945
2033	8,901,881	558,232	4,152	559,285	415,232	445,094	111,274	97,921	796,661	1,081,781
2034	12,167,075	762,309	5,017	763,579	418,243	608,354	152,088	133,838	974,873	1,380,444
2035	16,617,194	1,040,579	6,055	1,042,109	382,658	830,860	207,715	182,789	1,200,370	1,775,483
2036	22,634,193	1,417,106	7,286	1,418,945	293,180	1,131,710	282,927	248,976	1,495,742	2,304,742
2037	30,644,397	1,919,652	8,697	1,921,845	147,321	1,532,220	383,055	337,088	1,895,814	3,018,166

Comparison of RC results of local regulation and Sovency IIis given in Table 6.23 and Figure 6.7.

Table 6.23 Comparison of Teasury's RC and Solvency II SCR Results

all amounts in TRY (000)

Years	Treasury Required Capital	SCR
2017	538	3,856
2018	1,298	8,992
2019	2,259	14,620
2020	4,335	26,788
2021	7,059	41,737
2022	11,808	66,849
2023	16,895	91,065
2024	23,978	123,523
2025	32,751	160,913
2026	45,205	211,771
2027	60,107	267,591
2028	80,815	340,858
2029	109,272	435,259
2030	147,875	553,551
2031	199,094	696,543
2032	263,700	859,945
2033	356,075	1,081,781
2034	486,683	1,380,444
2035	664,688	1,775,483
2036	905,368	2,304,742
2037	1,225,776	3,018,166
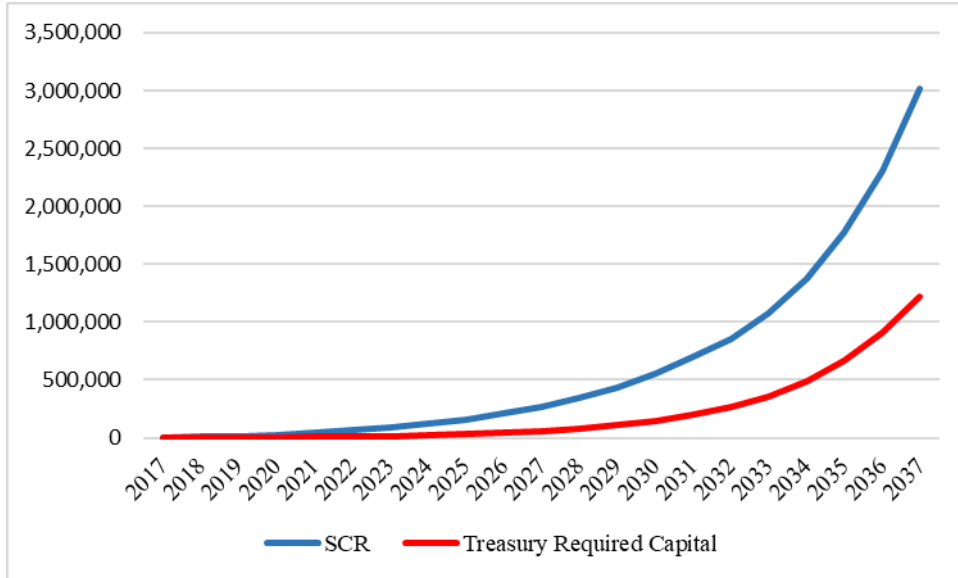
Figure 6.7 Comparison of Teasury's RC and Solvency II SCR Results

Comparison of the required capital results of local regulator Treasury and SCR are given with the Table 6.23 and Figure 6.7.

In case of using estimated market correlation matrix for Turkey is given in Table 6.24 (given in section 6.3.1.7), Solvency II SCR results are given in Table 6.25.In as much as market correlation matrix is not used under local regulation, local results will not change.

Table 6.24 Suggested Turkish Market Correlation Matrix

	Interest Rate	Equity	Property	Currency
Interest Rate	1			
Equity	0.5	1		
Property	0.5	0.75	1	
Currency	0.5	0.5	0.5	1

Table 6.25 RC under Solvency II Regulation

all amounts in TRY (000)

Years	Assets	SCR Longevity	SCR Expense	SCR Life Risk	SCR Interest Rate	SCR Currency	SCR Property	SCR Equity	SCR Market Risk	SCR
2017	13,447	753	129	795	3,178	672	168	148	3,740	4,014
2018	32,447	1,846	891	2,241	7,185	1,622	406	357	8,552	9,367
2019	56,480	3,261	734	3,517	11,607	2,824	706	621	14,006	15,270
2020	108,385	6,292	658	6,487	21,063	5,419	1,355	1,192	25,696	28,031
2021	176,482	10,348	775	10,568	32,293	8,824	2,206	1,941	39,890	43,746
2022	295,209	17,392	1,006	17,670	50,848	14,760	3,690	3,247	63,649	70,183
2023	422,386	25,168	1,146	25,479	67,705	21,119	5,280	4,646	86,185	95,786
2024	599,448	36,041	1,206	36,361	89,754	29,972	7,493	6,594	116,209	130,152
2025	818,777	49,735	1,346	50,088	113,769	40,939	10,235	9,007	150,260	169,853
2026	1,130,125	69,114	1,545	69,516	145,307	56,506	14,127	12,431	196,202	223,936
2027	1,502,676	92,660	1,707	93,102	177,000	75,134	18,783	16,529	245,495	283,485
2028	2,020,376	125,222	1,943	125,721	215,891	101,019	25,255	22,224	309,262	361,786
2029	2,731,806	169,881	2,249	170,457	261,533	136,590	34,148	30,050	389,803	462,844
2030	3,696,879	230,433	2,630	231,105	310,866	184,844	46,211	40,666	487,791	589,674
2031	4,977,349	310,944	3,066	311,724	357,216	248,867	62,217	54,751	601,089	743,079
2032	6,592,503	413,225	3,505	414,116	389,941	329,625	82,406	72,518	722,311	918,033
2033	8,901,881	558,232	4,152	559,285	415,232	445,094	111,274	97,921	879,564	1,154,295
2034	12,167,075	762,309	5,017	763,579	418,243	608,354	152,088	133,838	1,079,152	1,469,568
2035	16,617,194	1,040,579	6,055	1,042,109	382,658	830,860	207,715	182,789	1,327,435	1,881,420
2036	22,634,193	1,417,106	7,286	1,418,945	293,180	1,131,710	282,927	248,976	1,644,421	2,425,736
2037	30,644,397	1,919,652	8,697	1,921,845	147,321	1,532,220	383,055	337,088	2,063,658	3,152,013

As seen in Table 6.25, it can be said that the change of market correlation coefficients has not a high effect on the overall level of SCR results.

Comparison of the required capital results of local regulator Treasury, SCR and SCR calculated with suggested market correlation matrix are given with the Table 6.26 and Figure 6.8.

Table 6.26 Comparison of Teasury's RC and Solvency II SCR Results

all amounts in TRY (000)

Years	Treasury Required Capital	SCR (calculated with original market correlation matrix)	SCR (calculated with suggested market correlation matix)
2017	538	3,856	4,014
2018	1,298	8,992	9,367
2019	2,259	14,620	15,270
2020	4,335	26,788	28,031
2021	7,059	41,737	43,746
2022	11,808	66,849	70,183
2023	16,895	91,065	95,786
2024	23,978	123,523	130,152
2025	32,751	160,913	169,853
2026	45,205	211,771	223,936
2027	60,107	267,591	283,485
2028	80,815	340,858	361,786
2029	109,272	435,259	462,844
2030	147,875	553,551	589,674
2031	199,094	696,543	743,079
2032	263,700	859,945	918,033
2033	356,075	1,081,781	1,154,295
2034	486,683	1,380,444	1,469,568
2035	664,688	1,775,483	1,881,420
2036	905,368	2,304,742	2,425,736
2037	1,225,776	3,018,166	3,152,013
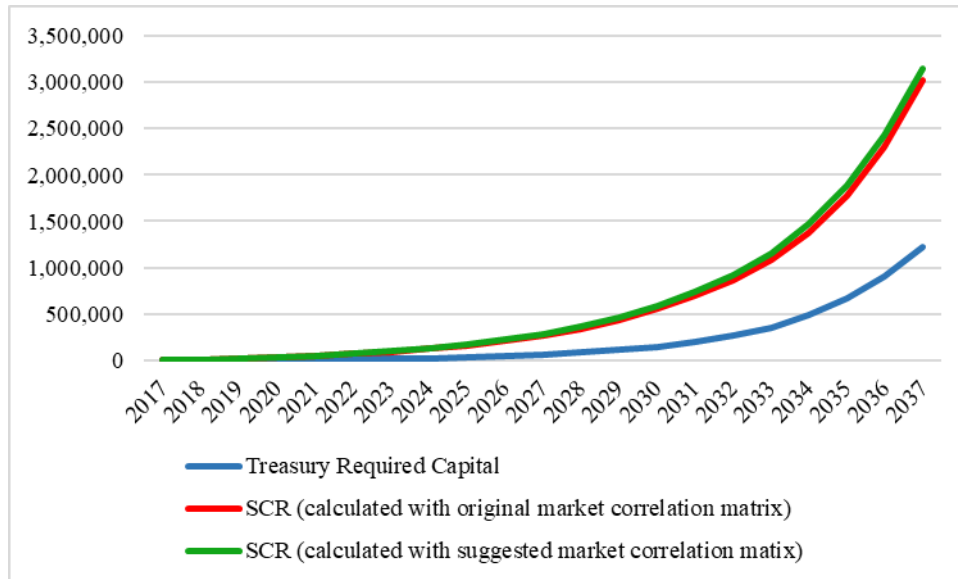
Figure 6.8 Comparison of Teasury's RC and Solvency II SCR Results

So, based on those results, during the first years of the projections the difference between local RC and SCR figures are proportionally higher than in the next years.

In the long term, due to increasing fund amount and increasing provisions (which already means increasing risk) both results are increase. Local RC is increasing proportionally much more than SCR figures. Although SCR results are higher than local RC results, the rate of increase is lower than Local RC result. The gap between local and Solvency II regime is related with the approach where local regulator is using standard and fixed rates for increasing risks without taking into account market / economic conditions. But SII regime is using the risk based approach while taking into account market/economic conditions. So, SII is resulting with higher capital requirement in long term.

To mention again, as seen in Table 6.26 and Figure 6.8, change of market correlation figures has not a high effect on SCR results.

In addition, the effect of market indicators on SCR is also examined and results are given in Appendixes.

7. CONCLUSION

A life annuity provides a series of future payments to an insured (annuitant) with an option of an immediate payment of a lump sum (single premium annuity) or a series of regular payments (level premium annuity) at the date of inception of the annuity plan. Insureds generally prefer annuity plans in order to maintain their active life's living standards in their passive life. So, annuity plans have an important life insurance product for both insurer and insureds in different aspects. In insurer's aspect, well defines annuity plans should provide to the insured's with an increasing product range, adequate income, customer loyalty etc. However, there is no annuity plan in real terms in Turkish insurance market yet.

As mentioned within this study, pension companies are not providing annuity plans especially with the new regulation of annuity published in 2015. Because new regulation is defining strict rules and definitions for an annuity plan which could result with a high risk and/or high capital requirement for the pension/insurance company. Starting from this point, this study examines the required capital of annuity plans in case of selling those plans by pension companies under local and Solvency II regulation.

Based on the Annuity regulation, annuity plans would be served to the participants who retired from PPS. Since, there is not enough statistics about contributors who left from the system voluntarily; the study is focusing on the participants who retire from PPS.

First of all, PPS's data is provided form EGM. The data set was based on single age and gender. The variables comprise of participant's age, gender, entrance year to PPS, entrance month to PPS, number of participants, number of contacts, fund amount, contribution amount and state contribution amount. After data cleaning and data analyses, the data is prepared for the purpose of modelling cash flow projections of PPS's figures again based on single age and gender. Because PPS's forecasted figures are also used as inputs for annuity modelling.

Modelling step comprises of three phases. Those steps given briefly as followed:

- PPS figures are modelled,
- Annuity modelling is done using the outputs of PPS's modelling,

- RC figures are modelled using outputs of annuitant modelling.

Before starting to the modelling economic and non-economic assumptions are defined to achieve more realistic results. Market indicators like inflation, interest rate, Treasury Bond rate, equity return etc. are analysed to be able to use them within this study as economic assumptions. At the same time, predictions of the figures of economic and non-economic assumptions are forecasted because annuity plan is a long-term product and all calculations/forecasts are done in long-term consideration.

Main indicators of PPS as number of participants, fund amount and state fund amount is projected year by year based on single age and gender, where all those projections are done with the split of in-force and new business. During PPS's modelling step, economic and non-economic assumptions are used to achieve more realistic results. And, all those figures are used as an input of annuity modelling.

As mentioned within this study, annuity is a long-term insurance product and mathematical reserve has to be calculated for covering future liabilities for each insured. Mathematical reserves are defined as the provision booked by an insurer to cover liabilities arising under long-term insurance business.

Annuitant projection is done for single age with the breakdown of gender and in-force and new business split.PPS accumulated fund amount is used as net single premium as mentioned above and future retirement payments are calculated again with the same split. In addition, all those calculations are performed during projection years which means each cohorts' cash flows are projected. After projection of annuity plan including all cash-flows and mathematical reserves, solvency capital requirement is estimated based on the local regulation and Solvency II regulation.

In Solvency II approach, there are two main risk modules which are life and market risk. Life risk of SCR is based on the mortality, disability, lapse, longevity and expense sub-risks; since this product is an annuity product, main risk is related with expense and longevity. So, just $SCR_{longevity}$ and $SCR_{expense}$ sub-modules and reserve requirement for these liabilities are calculated under SCR_{life} module within the study. Lapse is also modelled within annuity models but, since lapse is not creating additional risk for the companies, it is not taken into account within SCR life risk module within the study. Similarly, there is no guarantee given for the disability and as a result disability is not

taken into account in modelling. Finally, $SCR_{mortality}$, $SCR_{disability}$ and SCR_{lapse}sub-risks are not required to calculate.

Another risk module of SCR is market risk module. Market risk arises from the level or volatility of market prices of financial instruments and SCR_{market} is calculated considering market conditions. SCR_{market} calculation is defined with interest rate, equity, property, spread, currency and concentration risks, but interest rate, equity, property and currency risks are taken into account within this study. In addition, Turkish market indicators are analysed for suggesting new correlation coefficients for Turkey.

Afterwards, SCR figures are forecasted using SCR_{life} and SCR_{market} modules under Solvency II regulation.

Consequently, RC figures under local and Solvency II regulation are calculated and various scenario analyses are also calculated based on the given assumptions. Then all the results are compared. This study is one of the first studies in Turkish literature related with the private pension system's annuity plan solvency calculation.

Main output of the study is that during the first years of the projections the difference between local RC and SCR figures seems lower compared to long time period. In the long term, due to increasing fund amount and increasing provisions (which already means increasing risk) both results are increasing. Local RC is increasing in long term more and more compared to SCR figures. Although SCR results are higher than local RC results both for short term and long term, the rate of increase from short them to long term for SII is lower than Local RC result. The gap between local and Solvency II regime is related with the approach where local regulator is using standard and fixed rates for increasing risks without taking into account market / economic conditions. But SII regime is using the risk based approach while taking into account market/economic conditions. So, SII is resulting with higher capital requirement in both short and long term.

Second output of the study is changing market correlation figures has not a high effect on SCR results. Because, this matrix is not used in local RC calculation and consequently it has no impact on local RC figures.

Third output of the study is that mortality rates has an impact on the results of Solvency II regime while there is almost no impact on Local RC calculation.

Another output of the study is that RC figures are more sensitivity to market conditions in SCR rather than local regulation. In another words, market indicators have an impact on Solvency II SCR results while there is almost no impact local regulation RC results.

Since annuity plans are long-term products and guarantees a return at least inflation rate, insurance companies need long term treasury bond which fixed to inflation rate but on the other hand the longest treasury bond is 10-year currently. So it is fact that treasury bond with more than 10-year maturity would be needed.

The study contributes to the existing literature by proposing a model for annuity valuation for Turkey taking into account Turkish insurance market and economic conditions of Turkey.

The model provides a tool to evaluate the required capital of annuity plans based on economic and non-economic variables which are already used in this study. It is obvious that the model assumptions could be changed based on life insurance or pension company's perspective. It is necessary to underline that the model is a dynamic structure and new assumptions can be added for improving the model.

Finally, although the study focuses on annuity plans, the ideas mentioned here may be applied to all other products or line of businesses that insurance companies can serve to customers.

REFERENCES

Annuity Regulation. (2015). Official Gazette, 29313, 01.04.2015.

Bacinello, A.R., Millossovich, P., Olivieri, A., Pitacco, E. (2011). Variable annuities: A unifying valuation approach. Insurance: Mathematics and Economics 49, 285-297.

Ballotta, L.,Esposito, G., Haberman, S. (2006). Modelling the fair value of annuities contracts: the impact of interest rate risk and mortality risk. Actuarial Research Paper, 176.

Bernard, C., Tang, J. (2016). Variable annuities with fees tied to VIX.http://egrie2016.ucy.ac.cy/wp-content/uploads/2016/09/16_Bernard_2016-06-13-preliminary.pdf

Boonen, T.J. (2017). Solvency II solvency capital requirement for life insurance companies based on expected shortfall. Eur. Actuar. J. 7:405–434.

Bowers, N.L., Gerber, H.U., Hickman, J.C., Jones, D.A., Nesbitt, C.J. (1997). Actuarial Mathematics. The Society of Actuaries.

Boyle, P., Hardy, M. (2003). Guaranteed annuity options. ASTIN Bulletin, 33: 125- 152.

Börger, M. (2010). Deterministic shock vs.stochastic value-at-risk – an analysis of the solvency ii standard model approach to longevity risk. Blätter der DGVFM, Volume 31, Issue 2,pp 225–259.

Bravo, J.M., Freeitas, N.E.M. (2018). Valuation of longevity-linked life annuities. Insurance: Mathematics and Economics, 78, 212-229.

Browne, B. Duchassaing, J. Suter, F. (2009). Longevity: a 'simple' stochastic modelling of mortality. B.A.J. 15, Supplement, 249-265.

Cairn, A.J.G., Blake, D., Dowd, K. (2008). Modelling and management of mortality risk: a review. Scandinavian Actuarial Journal, (2-3), 79-113.

CEIOPS. (2009). Final CEIOPS' Advice for Level 2 Implementing Measures on Solvency II: Article 130 Calculation of the MCR. CEIOPS-DOC-47/09.

CEIOPS. (2010). CEIOPS' Advice for Level 2 Implementing Measures on Solvency II: SCR Standard Equation Article 111 (d) Correlations. CEIOPS-DOC-70/10.

Cox, J.C., Ingersoll, J.E, Ross, S.A., (1985). A theory of the term structure of interest rates. Econometrica, 53, 385-407.

Cox, S.H., Lin, Y., (2005). Securitization of mortality risks in life annuities. The Journal of Risk and Insurance,.72, 227-252.

CRO Forum. (2009). Calibration recommendation for the correlations in the Solvency II standard equation. CRO Forum –Correlations in Solvency II.

Dell'Atti, S., Labini, S.S., di Biase, P. (2018). The effects of Solvency II on corporate boards: a survey on Italian insurance companies. Corporate Ownership &Control,Volume 16, Issue 1.

Directive of The European Parliament and of the Council on the Taking-Up and Pursuit of the Business of Insurance and Reinsurance (Solvency II) (recast). (2009). Official Journal of the European Union.

EIOPA. (2010). QIS5 Technical Specifications. European Commission, Brussels.

EIOPA. (2014). The underlying assumptions in the standard equation for the Solvency capital requirement calculation. EIOPA-14-322.

Floreani, A. (2013). Risk measures and capital requirements: a critique of the Solvency II approach. The Geneva Papers, 38, (189–212).

Fung, C., F, Ignatieva, K., Sherris, M. (2014). Systematic mortality risk: An analysis of guaranteed lifetime withdrawal benefits in variable annuities. Insurance: Mathematics and Economics, 58, 103-115.

Gao, H., Mamon, R., Liu, X. (2017). Risk measurement of a guaranteed annuity option under a stochastic modelling framework. Mathematics and Computers in Simulation, 132, 100-119.

Heath, D. Jarrow, R.A., Morton, A. (1992). Bond pricing and the term structure of interest rates: a new methodology for contingent claims valuation. Econometrica, 60, 77–105.

Individual Pension Savings and Investment System Law. (2001). Official Gazette No. 24366, No. 4632, 07.04.2001.

Individual Pension System Progress Report 2016. (2017). Pension Monitoring Center.

Institute and Faculty of Actuaries, Papers and Reports (2016). Solvency II-General Insurance.Institute and Faculty of Actuaries.

Kochanski, M. (2010). Solvency capital requirement for German unit-linked insurance products. German Risk and Insurance review.

Kortebein, C. (2013). ORSA and SII: Challenges and Opportunities for the Industry. Casualty Loss Reserving Seminar.

Lloyd's. (2014). Solvency II Syndicate SCR for 2015 year of account. Lloyd's.

Lloyd's. (2014). Standart Formula and MCR Calculation Template. https://www.lloyds.com/~/media/files/the-market/operating-at-lloyds/solvency-ii/2014-guidance/scr-2015-yoa-submission-instructions-march-final.pdf?la=en., Date accessed: 05.02.2019

Mackenzie, G.A. (2002). The role of private sector annuities markets in an individual accounts reform of a public pension plan. IMF Working Paper, WP/02/161.

Marrion, J. (2010). A little annuity history. Advantage Compendium Ltd.

Mircea, I., Covrig, M., Serban, R. (2014). Some mathematical models for longevity risk in the annuity market and pension funds. Procedia Economics and Finance, 15, 115-122.

OECD. (2018). Pension Markets in Focus. OECD.

Poterba, J.M. (1997). The history of annuities in the United States. National Bureau of Economic Research, Working Paper 6001.

Poufinas, T. Panagiota, T. (2018). An Assessment of the Market Risk Solvency Capital Requirement Simplifications for Insurance Undertakings. Theoretical Economics Letters, 8, 2363-2387.

Rae, R. A., Barrett, A., Brooks, D., Chotai, M. A., Pelkiewicz, A. J. and Wang, C. (2018). A review of Solvency II: Has it met its objectives?. British Actuarial Journal, 23(4), 1-72.

Regulation on The Individual Pension System. (2012). Official Gazette, 28462, 09.11.2012.

Ruez, F. (2016). Variable annuities with guaranteed lifetime withdrawal benefits: an analysis of risk-based capital requirements. Mathematical Finance 18(4), 595 – 611.

The European Parliament. Solvency II Directives. (2009). The European Parliament.

Steuten, D. (2012). Stochastic mortality modelling and management of longevity risk with pricing and reserving applications to annuity products. (PhD Thesis). Address:https://duepublico2.uni-due.de/servlets/MCRFileNodeServlet/duepublico_ derivate_00032739/Steuten_Diss.pdf

http://apps.who.int/gho/data/node.country.country-TUR, Date accessed: 15.03.2019

https://www.egm.org.tr/auto-enrollment-system-aes/what-is-aes/, Date accessed: 20.05.2019

https://mort.soa.org/, Date accessed: 20.03.2019

www.bloomberg.com, Date accessed: 20.01.2019

www.egm.org.tr, Date accessed: 15.08.2018

www.imf.org/en/Countries/TUR, Date accessed: 25.04.2019

www.tcmb.gov.tr, Date accessed: 10.09.2018

Appendix I. RC results of annuity plan in Scenario 1

In case of using estimated market correlation coefficients is given in Table A.1, SCR results are given in Table A.2.It should be mentioned again; local RC results are not changed because of market correlation matrix is not used in local RC calculation.

Table A.1 Suggested Turkish Market Correlation Matrix

	Interest Rate	Equity	Property	Currency
Interest Rate	1			
Equity	0.5	1		
Property	0.5	0.8	1	
Currency	0.5	0.5	0.5	1

Table A.2 SII SCR Figures in Scenario 1

all amounts in TRY (000)

Years	Assets	SCR Longevity	SCR Expense	SCR Life Risk	SCR Interest Rate	SCR Currency	SCR Property	SCR Equity	SCR Market Risk	SCR
2017	13,447	753	129	795	3,178	672	168	148	3,741	4,014
2018	32,447	1,846	891	2,241	7,185	1,622	406	357	8,553	9,368
2019	56,480	3,261	734	3,517	11,607	2,824	706	621	14,008	15,272
2020	108,385	6,292	658	6,487	21,063	5,419	1,355	1,192	25,699	28,034
2021	176,482	10,348	775	10,568	32,293	8,824	2,206	1,941	39,895	43,751
2022	295,209	17,392	1,006	17,670	50,848	14,760	3,690	3,247	63,658	70,193
2023	422,386	25,168	1,146	25,479	67,705	21,119	5,280	4,646	86,199	95,800
2024	599,448	36,041	1,206	36,361	89,754	29,972	7,493	6,594	116,231	130,172
2025	818,777	49,735	1,346	50,088	113,769	40,939	10,235	9,007	150,290	169,882
2026	1,130,125	69,114	1,545	69,516	145,307	56,506	14,127	12,431	196,247	223,979
2027	1,502,676	92,660	1,707	93,102	177,000	75,134	18,783	16,529	245,559	283,545
2028	2,020,376	125,222	1,943	125,721	215,891	101,019	25,255	22,224	309,353	361,872
2029	2,731,806	169,881	2,249	170,457	261,533	136,590	34,148	30,050	389,934	462,967
2030	3,696,879	230,433	2,630	231,105	310,866	184,844	46,211	40,666	487,984	589,852
2031	4,977,349	310,944	3,066	311,724	357,216	248,867	62,217	54,751	601,372	743,338
2032	6,592,503	413,225	3,505	414,116	389,941	329,625	82,406	72,518	722,724	918,405
2033	8,901,881	558,232	4,152	559,285	415,232	445,094	111,274	97,921	880,184	1,154,842
2034	12,167,075	762,309	5,017	763,579	418,243	608,354	152,088	133,838	1,080,095	1,470,383
2035	16,617,194	1,040,579	6,055	1,042,109	382,658	830,860	207,715	182,789	1,328,864	1,882,627
2036	22,634,193	1,417,106	7,286	1,418,945	293,180	1,131,710	282,927	248,976	1,646,562	2,427,501
2037	30,644,397	1,919,652	8,697	1,921,845	147,321	1,532,220	383,055	337,088	2,066,784	3,154,537

Appendix II. RC results of annuity plan in Scenario 2

In case of the fact that assumed inflations increased by 1% for forecasted years, economic assumptions could be as following figures. Change in economic assumptions will impact both local RC and SCR results. Table A.3 and Table A.4 gives the RC figures in Scenario 2.

Table A.3 Treasury RC Results in Scenario 2

all amounts in TRY (000)

Years	Treasury: Required Capital under Method I	Treasury: Required Capital under Method II	Treasury Required Capital
2017	538	332	538
2018	1,301	581	1,301
2019	2,270	875	2,270
2020	4,351	1,780	4,351
2021	7,080	2,628	7,080
2022	11,829	4,494	11,829
2023	16,939	5,789	16,939
2024	24,060	8,196	24,060
2025	32,918	10,820	32,918
2026	45,520	15,152	45,520
2027	60,684	19,280	60,684
2028	81,824	25,910	81,824
2029	111,000	34,753	111,000
2030	150,810	46,602	150,810
2031	203,953	61,962	203,953
2032	271,436	80,359	271,436
2033	368,403	109,196	368,403
2034	506,326	149,362	506,326
2035	695,616	202,289	695,616
2036	953,392	274,069	953,392
2037	1,299,145	368,229	1,299,145

Table A.4 Solvency II SCR Results in Scenario 2

all amounts in TRY (000)

Years	Assets	SCR Longevity	SCR Expense	SCR Life Risk	SCR Interest Rate	SCR Currency	SCR Property	SCR Equity	SCR Market Risk	SCR
2017	13,447	856	129	897	3,086	672	168	148	3,490	3,815
2018	32,527	2,100	891	2,478	6,971	1,626	407	358	7,961	8,909
2019	56,760	3,714	865	4,019	11,263	2,838	709	624	13,014	14,549
2020	108,765	7,151	771	7,382	20,335	5,438	1,360	1,196	23,728	26,553
2021	176,998	11,744	905	12,002	31,055	8,850	2,212	1,947	36,646	41,314
2022	295,727	19,706	1,172	20,031	48,660	14,786	3,697	3,253	58,121	66,041
2023	423,469	28,507	1,330	28,868	64,651	21,173	5,293	4,658	78,409	90,073
2024	601,501	40,819	1,395	41,190	85,519	30,075	7,519	6,617	105,358	122,339
2025	822,955	56,363	1,553	56,771	108,245	41,148	10,287	9,053	135,853	159,797
2026	1,138,005	78,417	1,778	78,880	138,042	56,900	14,225	12,518	176,915	210,947
2027	1,517,094	105,314	1,961	105,822	168,024	75,855	18,964	16,688	220,939	267,773
2028	2,045,598	142,650	2,229	143,224	204,777	102,280	25,570	22,502	277,836	342,931
2029	2,775,005	194,085	2,580	194,746	247,934	138,750	34,688	30,525	349,770	440,821
2030	3,770,253	264,222	3,015	264,991	294,680	188,513	47,128	41,473	437,586	565,403
2031	5,098,835	358,007	3,514	358,901	338,675	254,942	63,735	56,087	539,715	718,995
2032	6,785,905	477,832	4,016	478,852	369,860	339,295	84,824	74,645	650,355	898,874
2033	9,210,087	648,709	4,758	649,915	393,991	460,504	115,126	101,311	796,324	1,146,863
2034	12,658,162	890,734	5,752	892,189	397,037	632,908	158,227	139,240	986,694	1,486,515
2035	17,390,388	1,222,982	6,945	1,224,736	363,573	869,519	217,380	191,294	1,232,394	1,942,538
2036	23,834,799	1,675,663	8,359	1,677,772	278,909	1,191,740	297,935	262,183	1,558,487	2,559,530
2037	32,478,618	2,284,128	9,977	2,286,643	140,448	1,623,931	405,983	357,265	2,001,966	3,394,922

Appendix III. RC results of annuity plan in Scenario 3

In case of the fact that assumed inflations decreased by 1% for forecasted years, economic assumptions could be as following figures. Change in economic assumptions will affect both local RC and SCR results. Table A.5 and table A.6 gives the RC figures in Scenario 3.

Table A.5 Treasury RC Results in Scenario 3

all amounts in TRY (000)

Years	Treasury: Required Capital under Method I	Treasury: Required Capital under Method II	Treasury Required Capital
2017	538	332	538
2018	1,295	579	1,295
2019	2,247	869	2,247
2020	4,319	1,780	4,319
2021	7,037	2,633	7,037
2022	11,786	4,514	11,786
2023	16,851	5,803	16,851
2024	23,898	8,204	23,898
2025	32,592	10,782	32,592
2026	44,912	15,046	44,912
2027	59,575	19,033	59,575
2028	79,892	25,434	79,892
2029	107,701	33,878	107,701
2030	145,214	45,040	145,214
2031	194,694	59,334	194,694
2032	256,703	76,203	256,703
2033	344,960	102,506	344,960
2034	469,035	138,614	469,035
2035	636,989	185,450	636,989
2036	862,493	248,097	862,493
2037	1,160,489	328,978	1,160,489

Table A.6 Solvency II SCR Results in Scenario 3

all amounts in TRY (000)

Years	Assets	SCR Longevity	SCR Expense	SCR Life Risk	SCR Interest Rate	SCR Currency	SCR Property	SCR Equity	SCR Market Risk	SCR
2017	13,447	661	129	705	3,258	672	168	148	3,658	3,895
2018	32,364	1,620	891	2,034	7,371	1,618	405	356	8,346	9,071
2019	56,186	2,860	622	3,075	11,904	2,809	702	618	13,617	14,691
2020	107,979	5,528	562	5,694	21,711	5,399	1,350	1,188	25,034	27,026
2021	175,929	9,105	665	9,294	33,414	8,796	2,199	1,935	38,886	42,180
2022	294,662	15,330	865	15,568	52,873	14,733	3,683	3,241	62,138	67,729
2023	421,284	22,194	989	22,461	70,556	21,064	5,266	4,634	83,986	92,203
2024	597,445	31,787	1,045	32,064	93,748	29,872	7,468	6,572	113,048	124,981
2025	814,798	43,844	1,170	44,151	119,018	40,740	10,185	8,963	145,737	162,499
2026	1,122,802	60,871	1,346	61,221	152,273	56,140	14,035	12,351	189,687	213,391
2027	1,489,363	81,484	1,490	81,869	185,658	74,468	18,617	16,383	236,222	268,651
2028	1,997,292	109,893	1,698	110,329	226,690	99,865	24,966	21,970	295,961	340,723
2029	2,692,534	148,698	1,967	149,202	274,836	134,627	33,657	29,618	370,559	432,688
2030	3,630,350	201,028	2,300	201,615	326,778	181,517	45,379	39,934	459,765	546,242
2031	4,867,351	270,229	2,682	270,912	375,521	243,368	60,842	53,541	560,593	680,877
2032	6,417,580	357,665	3,068	358,445	409,843	320,879	80,220	70,593	665,288	830,858
2033	8,624,003	480,945	3,633	481,866	436,380	431,200	107,800	94,864	799,085	1,031,144
2034	11,725,881	653,393	4,388	654,504	439,450	586,294	146,574	128,985	966,454	1,295,640
2035	15,924,714	887,004	5,294	888,343	401,808	796,236	199,059	175,172	1,173,617	1,639,457
2036	21,562,321	1,200,994	6,369	1,202,602	307,534	1,078,116	269,529	237,186	1,440,995	2,095,039
2037	29,012,232	1,617,201	7,602	1,619,118	154,238	1,450,612	362,653	319,135	1,801,822	2,706,804

Appendix IV. RC results of annuity plan in Scenario 4

In case of the fact that assumed inflations increased by 2% for forecasted years, economic assumptions could be as following figures. Change in economic assumptions will impact both local RC and SCR results. Table A.7 and Table A.8 gives the RC figures in Scenario 4.

Table A.7 Treasury RC Results in Scenario 4

all amounts in TRY (000)

Years	Treasury: Required Capital under Method I	Treasury: Required Capital under Method II	Treasury Required Capital
2017	538	332	538
2018	1,304	581	1,304
2019	2,281	878	2,281
2020	4,365	1,780	4,365
2021	7,099	2,626	7,099
2022	11,848	4,484	11,848
2023	16,980	5,783	16,980
2024	24,142	8,197	24,142
2025	33,090	10,847	33,090
2026	45,853	15,224	45,853
2027	61,298	19,434	61,298
2028	82,909	26,202	82,909
2029	112,873	35,284	112,873
2030	154,005	47,537	154,005
2031	209,260	63,524	209,260
2032	279,904	82,814	279,904
2033	381,953	113,157	381,953
2034	528,012	155,734	528,012
2035	729,896	212,283	729,896
2036	1,006,836	289,521	1,006,836
2037	1,381,126	391,651	1,381,126

Table A.8 Solvency II SCR Results in Scenario 4

all amounts in TRY (000)

Years	Assets	SCR Longevity	SCR Expense	SCR Life Risk	SCR Interest Rate	SCR Currency	SCR Property	SCR Equity	SCR Market Risk	SCR
2017	13,447	971	129	1,011	2,983	672	168	148	3,390	3,772
2018	32,601	2,385	891	2,747	6,732	1,630	408	359	7,730	8,827
2019	57,025	4,222	1,022	4,585	10,874	2,851	713	627	12,647	14,490
2020	109,118	8,113	906	8,386	19,531	5,456	1,364	1,200	22,964	26,343
2021	177,469	13,303	1,059	13,606	29,711	8,873	2,218	1,952	35,369	40,947
2022	296,201	22,289	1,368	22,669	46,328	14,810	3,703	3,258	55,903	65,366
2023	424,505	32,233	1,548	32,655	61,419	21,225	5,306	4,670	75,368	89,315
2024	603,558	46,158	1,617	46,588	81,075	30,178	7,544	6,639	101,228	121,555
2025	827,253	63,782	1,795	64,255	102,484	41,363	10,341	9,100	130,608	159,321
2026	1,146,322	88,862	2,052	89,397	130,519	57,316	14,329	12,610	170,247	211,153
2027	1,532,447	119,572	2,258	120,157	158,778	76,622	19,156	16,857	213,067	269,510
2028	2,072,723	162,376	2,564	163,036	193,393	103,636	25,909	22,800	268,670	347,370
2029	2,821,834	221,625	2,966	222,385	234,077	141,092	35,273	31,040	339,503	449,965
2030	3,850,132	302,896	3,465	303,781	278,250	192,507	48,127	42,351	426,985	582,627
2031	5,231,493	412,216	4,038	413,244	319,915	261,575	65,394	57,546	530,330	749,399
2032	6,997,604	552,716	4,613	553,887	349,595	349,880	87,470	76,974	644,765	949,251
2033	9,548,837	754,316	5,466	755,701	372,625	477,442	119,360	105,037	798,137	1,228,692
2034	13,200,305	1,041,760	6,611	1,043,432	375,772	660,015	165,004	145,203	1,002,007	1,617,261
2035	18,247,395	1,439,106	7,986	1,441,123	344,474	912,370	228,092	200,721	1,269,861	2,145,786
2036	25,170,893	1,984,332	9,613	1,986,757	264,646	1,258,545	314,636	276,880	1,629,603	2,867,337
2037	34,528,159	2,722,497	11,474	2,725,388	133,573	1,726,408	431,602	379,810	2,121,049	3,849,277

Appendix V. RC results of annuity plan in Scenario 5

In case of the fact that assumed bond yield increased by 1% for forecasted years, economic assumptions could be as following figures. Change in economic assumptions will affect both local RC and SCR results. Table A.9 and table A.10 gives the RC figures in Scenario 5.

Table A.9 Treasury RC Results in Scenario 5

all amounts in TRY (000)

Years	Treasury: Required Capital under Method I	Treasury: Required Capital under Method II	Treasury Required Capital
2017	538	332	538
2018	1,295	579	1,295
2019	2,251	870	2,251
2020	4,329	1,781	4,329
2021	7,068	2,641	7,068
2022	11,874	4,544	11,874
2023	17,041	5,864	17,041
2024	24,276	8,329	24,276
2025	33,277	11,004	33,277
2026	46,105	15,440	46,105
2027	61,503	19,642	61,503
2028	82,974	26,405	82,974
2029	112,559	35,394	112,559
2030	152,759	47,372	152,759
2031	206,194	62,829	206,194
2032	273,730	81,244	273,730
2033	370,488	110,072	370,488
2034	507,454	149,959	507,454
2035	694,291	202,147	694,291
2036	947,194	272,504	947,194
2037	1,284,261	364,155	1,284,261

Table A.10 Solvency II SCR Results in Scenario 5

all amounts in TRY (000)

Years	Assets	SCR Longevity	SCR Expense	SCR Life Risk	SCR Interest Rate	SCR Currency	SCR Property	SCR Equity	SCR Market Risk	SCR
2017	13,447	664	129	707	3,412	672	168	148	3,810	4,045
2018	32,370	1,626	891	2,040	7,757	1,618	405	356	8,723	9,442
2019	56,271	2,875	734	3,139	12,596	2,814	703	619	14,295	15,383
2020	108,219	5,560	658	5,760	22,993	5,411	1,353	1,190	26,290	28,286
2021	176,701	9,180	775	9,404	35,490	8,835	2,209	1,944	40,929	44,227
2022	296,852	15,503	1,006	15,784	56,321	14,843	3,711	3,265	65,556	71,163
2023	426,016	22,529	1,146	22,843	75,523	21,301	5,325	4,686	88,951	97,211
2024	606,896	32,415	1,206	32,737	100,836	30,345	7,586	6,676	120,213	132,252
2025	831,925	44,941	1,346	45,296	128,695	41,596	10,399	9,151	155,649	172,636
2026	1,152,634	62,735	1,545	63,139	165,512	57,632	14,408	12,679	203,448	227,597
2027	1,537,576	84,457	1,707	84,900	202,941	76,879	19,220	16,913	254,482	287,701
2028	2,074,358	114,591	1,943	115,092	249,203	103,718	25,929	22,818	320,218	366,351
2029	2,813,972	156,031	2,249	156,609	303,909	140,699	35,175	30,954	402,634	467,085
2030	3,818,987	212,324	2,630	212,997	363,591	190,949	47,737	42,009	501,622	591,958
2031	5,154,839	287,333	3,066	288,115	420,484	257,742	64,435	56,703	613,858	740,448
2032	6,843,251	382,901	3,505	383,793	461,900	342,163	85,541	75,276	730,675	906,309
2033	9,262,202	518,560	4,152	519,613	494,999	463,110	115,778	101,884	879,623	1,127,948
2034	12,686,346	709,638	5,017	710,909	501,743	634,317	158,579	139,550	1,065,454	1,421,022
2035	17,357,279	970,455	6,055	971,987	461,877	867,864	216,966	190,930	1,295,378	1,803,416
2036	23,679,858	1,323,821	7,286	1,325,661	355,992	1,183,993	295,998	260,478	1,593,099	2,313,287
2037	32,106,533	1,796,160	8,697	1,798,354	179,903	1,605,327	401,332	353,172	1,998,398	3,004,095

Appendix VI. RC results of annuity plan in Scenario 6

Turkey has similar demographic properties with Greece. Because of this, Hellenic Actuarial Society 2005 Annuity Products Table (EAE 2012 P) (https://mort.soa.org/) annuitant mortality table is also used in Scenario 4 for seeing the sensitivity of used mortality table. In addition, 25% mortality shock instead of %20 is applied for SCR longevity calculation for seeing the sensitivity of SCR longevity calculation to mortality rates.

Both local RC and SCR results are effected the change in mortality because of using mortality rates in calculation. However, the effect levels are different because the calculation approaches are different. Based on the used market correlation coefficient matrix and Hellenic Actuarial Society 2005 Annuity Products Table (EAE 2012 P) annuitant mortality table the RC figures are given in Table A.11 and Table A.12.

Table A.11 Treasury RC Results in Scenario 6

all amounts in TRY (000)

Years	Treasury: Required Capital under Method I	Treasury: Required Capital under Method II	Treasury Required Capital
2017	538	332	538
2018	1,299	580	1,299
2019	2,264	873	2,264
2020	4,347	1,783	4,347
2021	7,083	2,636	7,083
2022	11,852	4,515	11,852
2023	16,974	5,815	16,974
2024	24,108	8,231	24,108
2025	32,955	10,849	32,955
2026	45,513	15,169	45,513
2027	60,560	19,259	60,560
2028	81,464	25,815	81,464
2029	110,188	34,512	110,188
2030	149,154	46,088	149,154
2031	200,866	61,008	200,866
2032	266,140	78,765	266,140
2033	359,407	106,480	359,407
2034	491,220	144,795	491,220
2035	670,870	194,904	670,870
2036	913,795	262,396	913,795
2037	1,237,260	350,263	1,237,260

Table A.12 RC under Solvency II Regulation

all amounts in TRY (000)

Years	Assets	SCR Longevity	SCR Expense	SCR Life Risk	SCR Interest Rate	SCR Currency	SCR Property	SCR Equity	SCR Market Risk	SCR
2017	13,447	955	188	1,018	3,093	672	168	148	3,497	3,879
2018	32,482	2,344	1,480	3,068	6,990	1,624	406	357	7,977	9,235
2019	56,603	4,145	1,174	4,582	11,288	2,830	708	623	13,033	14,856
2020	108,666	8,000	999	8,307	20,464	5,433	1,358	1,195	23,850	27,145
2021	177,071	13,166	1,165	13,505	31,354	8,854	2,213	1,948	36,937	42,381
2022	296,311	22,140	1,502	22,562	49,326	14,816	3,704	3,259	58,783	68,027
2023	424,357	32,072	1,711	32,542	65,651	21,218	5,304	4,668	79,399	93,033
2024	602,699	45,966	1,784	46,444	86,990	30,135	7,534	6,630	106,804	126,667
2025	823,880	63,483	1,995	64,011	110,215	41,194	10,299	9,063	137,750	165,775
2026	1,137,816	88,279	2,294	88,881	140,685	56,891	14,223	12,516	179,385	219,204
2027	1,513,989	118,458	2,538	119,117	171,287	75,699	18,925	16,654	223,835	278,608
2028	2,036,598	160,199	2,889	160,945	208,798	101,830	25,457	22,403	281,126	357,153
2029	2,754,692	217,453	3,345	218,313	252,773	137,735	34,434	30,302	353,218	459,326
2030	3,728,843	295,099	3,910	296,101	300,245	186,442	46,611	41,017	440,566	589,067
2031	5,021,653	398,373	4,557	399,537	344,769	251,083	62,771	55,238	541,188	748,749
2032	6,653,507	529,683	5,205	531,008	376,114	332,675	83,169	73,189	648,781	935,490
2033	8,985,175	715,745	6,160	717,309	400,208	449,259	112,315	98,837	789,220	1,191,830
2034	12,280,504	977,480	7,439	979,366	402,789	614,025	153,506	135,086	969,890	1,541,033
2035	16,771,755	1,334,346	8,975	1,336,618	368,245	838,588	209,647	184,489	1,199,850	2,007,002
2036	22,844,882	1,817,269	10,792	1,819,997	281,947	1,142,244	285,561	251,294	1,501,849	2,633,367
2037	30,931,505	2,461,931	12,876	2,465,181	141,589	1,546,575	386,644	340,247	1,910,246	3,475,731

The comparison of RC figures of local and Solvency II is given in Table A.13 and figure A.1.

Table A.13 Comparison of Teasury's RC and Solvency II SCR Results

all amounts in TRY (000)

Years	Treasury Required Capital	SCR
2017	538	3,879
2018	1,299	9,235
2019	2,264	14,856
2020	4,347	27,145
2021	7,083	42,381
2022	11,852	68,027
2023	16,974	93,033
2024	24,108	126,667
2025	32,955	165,775
2026	45,513	219,204
2027	60,560	278,608
2028	81,464	357,153
2029	110,188	459,326
2030	149,154	589,067
2031	200,866	748,749
2032	266,140	935,490
2033	359,407	1,191,830
2034	491,220	1,541,033
2035	670,870	2,007,002
2036	913,795	2,633,367
2037	1,237,260	3,475,731
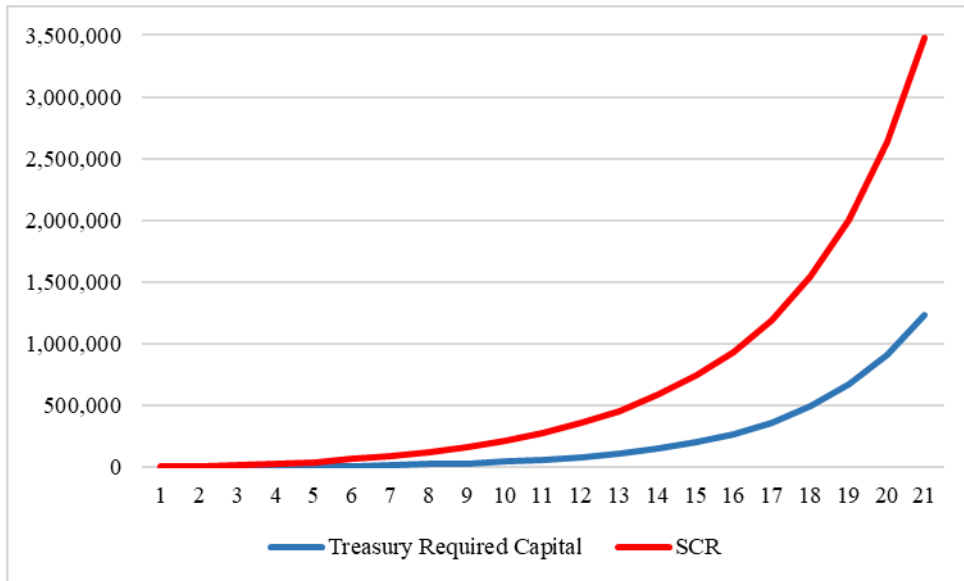
Figure A.1 Comparison of Teasury's RC and Solvency II SCR Results

As seen in Table A.14, Figure A.2 and Figure A.3, using Greece's annuitant table has arising effect on both local RC and SCR results. However, the effect of mortality on SCR is higher than local results. The comparison of local RC and SCR results using TRHA 2010 and Hellenic Actuarial Society 2005 Annuity Products Table (EAE 2012 P).

Table A.14 Comparison of local RC and SCR results using TRHA 2010 and Hellenic Actuarial Society 2005 Annuity Products Table (EAE 2012 P)

all amounts in TRY (000)

| Years	TRHA 2010		Hellenic Actuarial Society 2005 Pensions (EAE 2012 P) annuitant mortality table	
	Treasury Required Capital	SCR	Treasury Required Capital	SCR
2017	538	3,856	538	3,879
2018	1,298	8,992	1,299	9,235
2019	2,259	14,620	2,264	14,856
2020	4,335	26,788	4,347	27,145
2021	7,059	41,737	7,083	42,381
2022	11,808	66,849	11,852	68,027
2023	16,895	91,065	16,974	93,033
2024	23,978	123,523	24,108	126,667
2025	32,751	160,913	32,955	165,775
2026	45,205	211,771	45,513	219,204
2027	60,107	267,591	60,560	278,608
2028	80,815	340,858	81,464	357,153
2029	109,272	435,259	110,188	459,326
2030	147,875	553,551	149,154	589,067
2031	199,094	696,543	200,866	748,749
2032	263,700	859,945	266,140	935,490
2033	356,075	1,081,781	359,407	1,191,830
2034	486,683	1,380,444	491,220	1,541,033
2035	664,688	1,775,483	670,870	2,007,002
2036	905,368	2,304,742	913,795	2,633,367
2037	1,225,776	3,018,166	1,237,260	3,475,731
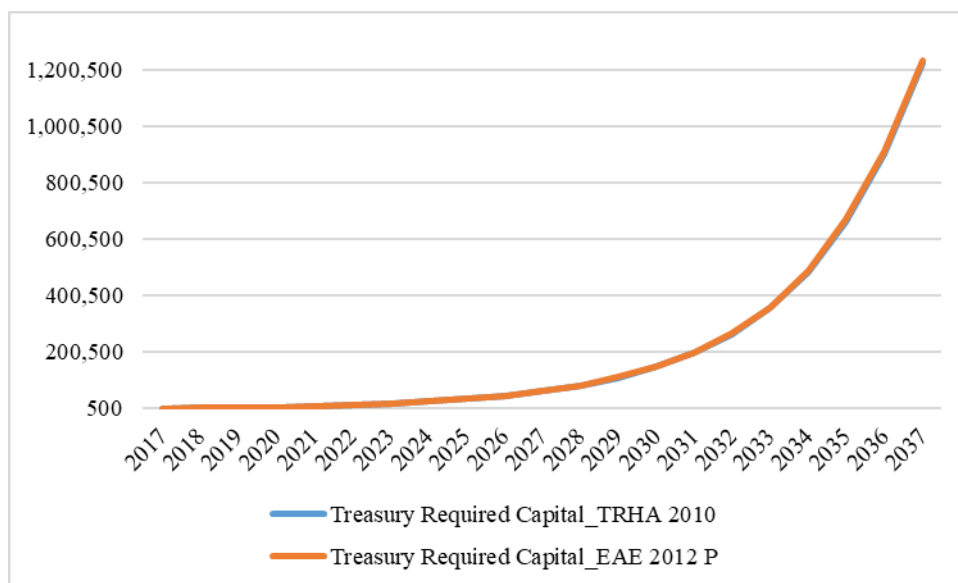
Figure A.2 Comparison of Teasury's RC Results based on mortality tables
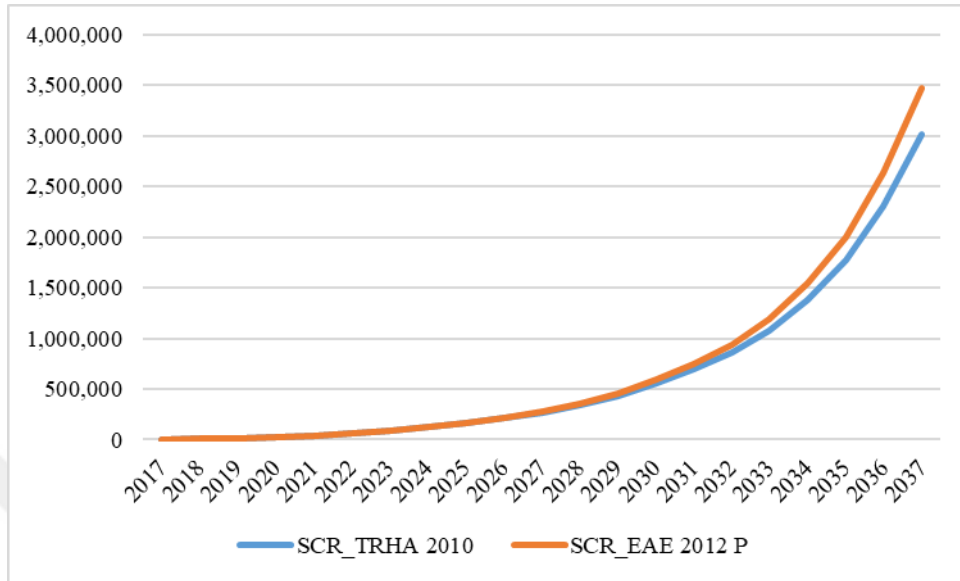

Figure A.3 Comparison of SCR Results based on mortality tables

Appendix VII. RC results of annuity plan in Scenario 7

In case of an 5% of improvement in mortality rates, change in mortality rates will affect both local RC and SCR results. In addition, 25% mortality shock instead of %20 is applied for SCR longevity calculation. Table A.11 and table A.12 gives the RC figures in Scenario 5.

Table A.15 Treasury RC Results in Scenario 7

all amounts in TRY (000)

Years	Treasury: Required Capital under Method I	Treasury: Required Capital under Method II	Treasury Required Capital
2017	538	332	538
2018	1,299	580	1,299
2019	2,261	873	2,261
2020	4,341	1,782	4,341
2021	7,072	2,634	7,072
2022	11,834	4,512	11,834
2023	16,940	5,808	16,940
2024	24,050	8,220	24,050
2025	32,864	10,830	32,864
2026	45,376	15,141	45,376
2027	60,358	19,215	60,358
2028	81,177	25,753	81,177
2029	109,790	34,425	109,790
2030	148,609	45,968	148,609
2031	200,121	60,842	200,121
2032	265,114	78,532	265,114
2033	358,028	106,168	358,028
2034	489,389	144,383	489,389
2035	668,428	194,352	668,428
2036	910,518	261,651	910,518
2037	1,232,829	349,248	1,232,829

Table A.16 RC under Solvency II Regulation

all amounts in TRY (000)

Years	Assets	SCR Longevity	SCR Expense	SCR Life Risk	SCR Interest Rate	SCR Currency	SCR Property	SCR Equity	SCR Market Risk	SCR
2017	13,447	957	138	1,000	3,156	672	168	148	3,558	3,930
2018	32,463	2,348	983	2,763	7,135	1,623	406	357	8,118	9,206
2019	56,535	4,151	802	4,420	11,527	2,827	707	622	13,263	14,992
2020	108,534	8,012	711	8,218	20,916	5,427	1,357	1,194	24,283	27,513
2021	176,804	13,183	835	13,416	32,068	8,840	2,210	1,945	37,616	42,980
2022	295,857	22,167	1,082	22,462	50,490	14,793	3,698	3,254	59,886	69,018
2023	423,497	32,097	1,233	32,427	67,230	21,175	5,294	4,658	80,878	94,361
2024	601,262	45,985	1,295	46,326	89,125	30,063	7,516	6,614	108,781	128,449
2025	821,590	63,489	1,446	63,866	112,973	41,080	10,270	9,037	140,268	168,027
2026	1,134,412	88,267	1,660	88,697	144,288	56,721	14,180	12,479	182,628	222,080
2027	1,508,938	118,395	1,834	118,867	175,756	75,447	18,862	16,598	227,780	282,047
2028	2,029,427	160,065	2,088	160,600	214,365	101,471	25,368	22,324	285,935	361,264
2029	2,744,747	217,226	2,417	217,843	259,665	137,237	34,309	30,192	359,020	464,172
2030	3,715,215	294,742	2,826	295,461	308,616	185,761	46,440	40,867	447,373	594,584
2031	5,003,026	397,829	3,295	398,665	354,588	250,151	62,538	55,033	548,777	754,638
2032	6,627,841	528,839	3,767	529,793	387,026	331,392	82,848	72,906	656,557	941,099
2033	8,950,697	714,544	4,462	715,673	412,061	447,535	111,884	98,458	796,721	1,196,682
2034	12,234,722	975,875	5,392	977,237	414,971	611,736	152,934	134,582	976,205	1,544,331
2035	16,710,691	1,332,228	6,508	1,333,870	379,595	835,535	208,884	183,818	1,203,716	2,007,721
2036	22,762,942	1,814,445	7,831	1,816,418	290,781	1,138,147	284,537	250,392	1,501,964	2,630,469
2037	30,820,725	2,458,120	9,347	2,460,474	146,090	1,541,036	385,259	339,028	1,905,747	3,468,476

Appendix VIII. Comparison of the Effect of Mortality Tables

Table A.17 RC Comparison in case of Using Different Mortality Tables

all amounts in TRY (000)

| Years	TRHA 2010		Hellenic Actuarial Society 2005 Annuity Products Table (EAE 2012 P)		% 5 improvement in mortality rates in TRH 2010 and TRHA 2010	
	Treasury Required Capital	SCR	Treasury Required Capital	SCR	Treasury Required Capital	SCR
2017	538	3,856	538	3,879	538	3,930
2018	1,298	8,992	1,299	9,235	1,299	9,206
2019	2,259	14,620	2,264	14,856	2,261	14,992
2020	4,335	26,788	4,347	27,145	4,341	27,513
2021	7,059	41,737	7,083	42,381	7,072	42,980
2022	11,808	66,849	11,852	68,027	11,834	69,018
2023	16,895	91,065	16,974	93,033	16,940	94,361
2024	23,978	123,523	24,108	126,667	24,050	128,449
2025	32,751	160,913	32,955	165,775	32,864	168,027
2026	45,205	211,771	45,513	219,204	45,376	222,080
2027	60,107	267,591	60,560	278,608	60,358	282,047
2028	80,815	340,858	81,464	357,153	81,177	361,264
2029	109,272	435,259	110,188	459,326	109,790	464,172
2030	147,875	553,551	149,154	589,067	148,609	594,584
2031	199,094	696,543	200,866	748,749	200,121	754,638
2032	263,700	859,945	266,140	935,490	265,114	941,099
2033	356,075	1,081,781	359,407	1,191,830	358,028	1,196,682
2034	486,683	1,380,444	491,220	1,541,033	489,389	1,544,331
2035	664,688	1,775,483	670,870	2,007,002	668,428	2,007,721
2036	905,368	2,304,742	913,795	2,633,367	910,518	2,630,469
2037	1,225,776	3,018,166	1,237,260	3,475,731	1,232,829	3,468,476
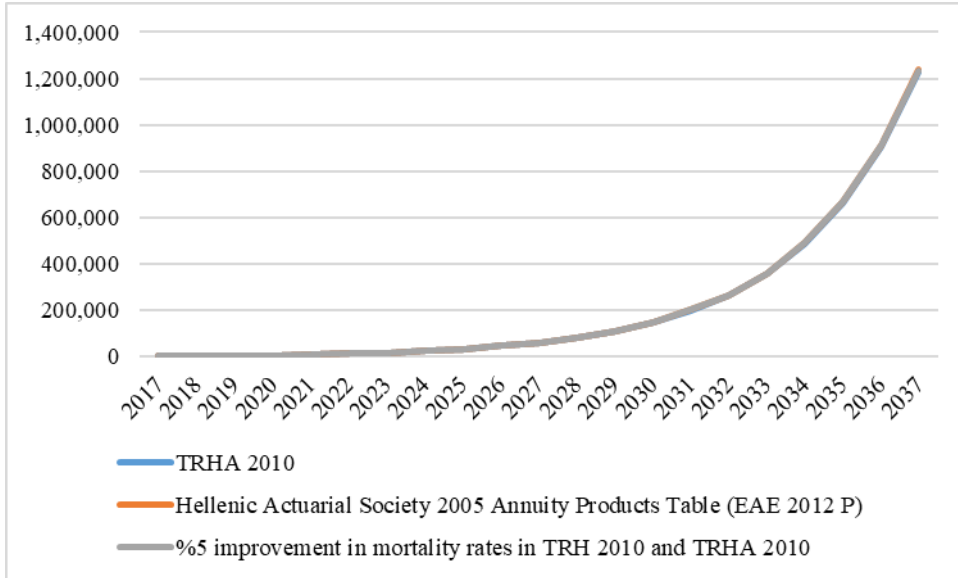
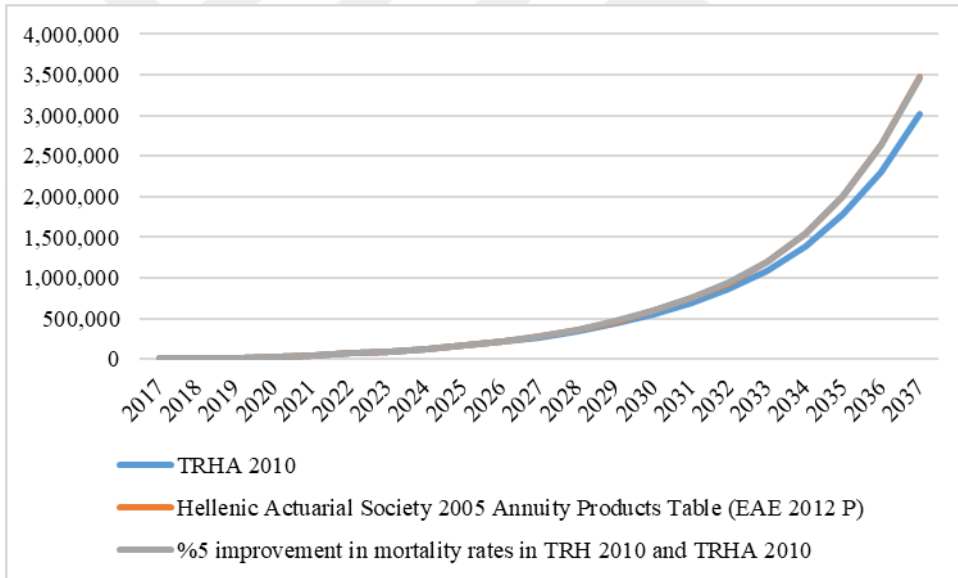Figure A.4 RC comparison under local regulation

Figure A.5 RC comparison under Solvency II regulation

Appendix IX. Comparison of the Effect of Economic Assumptions

Table A.18 RC Comparison in case of Using Different Economic Assumptions

all amounts in TRY (000)

| Years	Inflation+1%		Inflation-1%		Inflation+2%		Bond Yield+1%	
	Treasury Required Capital	SCR	Treasury Required Capital	SCR	Treasury Required Capital	SCR	Treasury Required Capital	SCR
2017	538	3,815	538	3,895	538	3,772	538	4,045
2018	1,301	8,909	1,295	9,071	1,304	8,827	1,295	9,442
2019	2,270	14,549	2,247	14,691	2,281	14,490	2,251	15,383
2020	4,351	26,553	4,319	27,026	4,365	26,343	4,329	28,286
2021	7,080	41,314	7,037	42,180	7,099	40,947	7,068	44,227
2022	11,829	66,041	11,786	67,729	11,848	65,366	11,874	71,163
2023	16,939	90,073	16,851	92,203	16,980	89,315	17,041	97,211
2024	24,060	122,339	23,898	124,981	24,142	121,555	24,276	132,252
2025	32,918	159,797	32,592	162,499	33,090	159,321	33,277	172,636
2026	45,520	210,947	44,912	213,391	45,853	211,153	46,105	227,597
2027	60,684	267,773	59,575	268,651	61,298	269,510	61,503	287,701
2028	81,824	342,931	79,892	340,723	82,909	347,370	82,974	366,351
2029	111,000	440,821	107,701	432,688	112,873	449,965	112,559	467,085
2030	150,810	565,403	145,214	546,242	154,005	582,627	152,759	591,958
2031	203,953	718,995	194,694	680,877	209,260	749,399	206,194	740,448
2032	271,436	898,874	256,703	830,858	279,904	949,251	273,730	906,309
2033	368,403	1,146,863	344,960	1,031,144	381,953	1,228,692	370,488	1,127,948
2034	506,326	1,486,515	469,035	1,295,640	528,012	1,617,261	507,454	1,421,022
2035	695,616	1,942,538	636,989	1,639,457	729,896	2,145,786	694,291	1,803,416
2036	953,392	2,559,530	862,493	2,095,039	1,006,836	2,867,337	947,194	2,313,287
2037	1,299,145	3,394,922	1,160,489	2,706,804	1,381,126	3,849,277	1,284,261	3,004,095
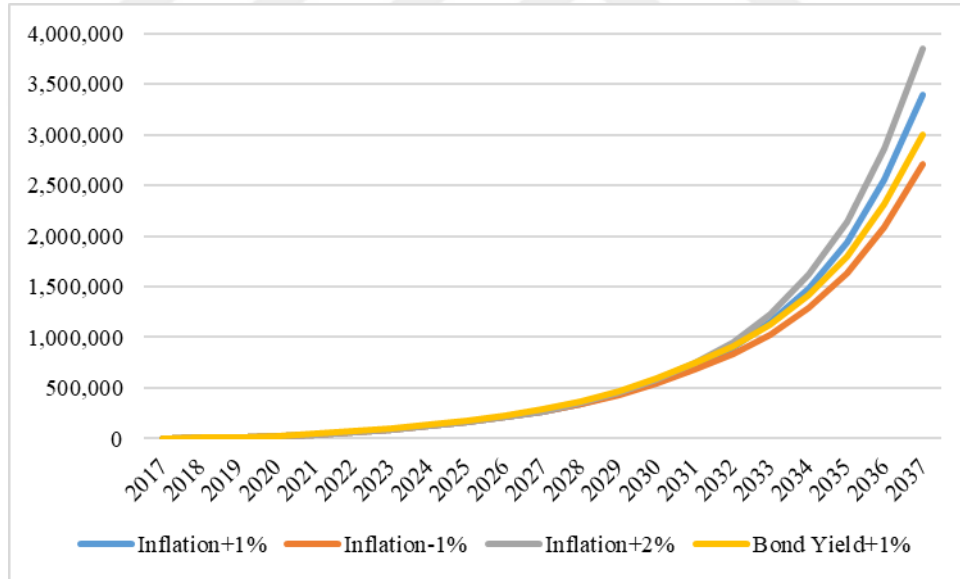
Figure A.6 RC comparison in case of using different mortality figures under Solvency II regulation

Appendix X. Forecasting of PPS', annuity plans' and Solvency II figures

As given in the previous sections, number of contribution and fund amount are forecasted for PPS using the following equations and sample forecasted figures are given in the tables below.

Number of contributors is forecasted with the equation A.1 below:

$$n_x = n_{x-1} - n_{x-1}\, q^w_{x-1} - n_{x-1}\, q^d_{x-1} \qquad (A.1)$$

Where;

n_x : number of contributors at age x

q^w_x : withdrawal rate at age x

q^d_x : death rate at age x

In addition, new business figures are forecasted using the same equation.

Forecasted figures of contributors are given in following tables in the breakdown gender and status (in force and new business).

Table A.19 Forecasted figures of female contributors (in force business)

Age	2017	2018	2019	2020	2021	2022	...	2033	2034	2035	2036	2037
18	2,916											
19	9,101	2,566										
20	14,608	8,007	2,257									
21	21,364	12,852	7,045	1,986								
22	29,574	18,795	11,307	6,198	1,747							
23	37,402	26,018	16,536	9,947	5,452	1,537						
24	44,074	32,904	22,889	14,547	8,751	4,797	...					
25	54,144	38,773	28,947	20,136	12,797	7,699	...					
26	65,893	47,631	34,109	25,465	17,714	11,258	...					
27	73,957	57,966	41,902	30,006	22,402	15,583	...					
28	81,805	65,059	50,992	36,860	26,396	19,707	...					
29	87,172	71,961	57,231	44,856	32,425	23,220	...					
30	91,615	76,680	63,300	50,342	39,458	28,522	...					
31	94,361	80,587	67,450	55,681	44,283	34,708	...					
32	99,648	83,001	70,886	59,330	48,978	38,952	...					
33	102,691	87,649	73,007	62,350	52,186	43,080	...					
34	106,522	90,322	77,092	64,213	54,840	45,900	...	566				
35	113,645	93,686	79,438	67,802	56,476	48,232	...	1,766	537			
36	111,414	99,947	82,393	69,863	59,630	49,668	...	2,833	1,677	510		
37	109,271	97,982	87,897	72,460	61,440	52,441	...	4,142	2,690	1,592	484	
38	104,833	96,091	86,164	77,295	63,720	54,030	...	5,731	3,932	2,554	1,511	460
⋮	⋮	⋮	⋮	⋮	⋮	⋮	...	⋮	⋮	⋮	⋮	⋮
51	65,729	51,738	44,859	45,525	44,254	40,221	...	21,669	19,287	17,657	16,271	14,632
52	57,734	57,655	45,383	39,349	39,933	38,818	...	21,190	20,524	18,268	16,724	15,411
53	47,882	50,625	50,556	39,795	34,504	35,016	...	20,723	20,064	19,433	17,297	15,835
54	44,421	41,968	44,372	44,311	34,879	30,242	...	19,818	19,614	18,990	18,393	16,371
55	37,723	38,913	36,764	38,870	38,816	30,554	...	19,374	18,748	18,555	17,964	17,400
56	36,719	33,030	34,072	32,190	34,034	33,988	...	18,030	18,320	17,728	17,546	16,987

Table A.20 Forecasted figures of male contributors (in force business)

Age	2017	2018	2019	2020	2021	2022	...	2033	2034	2035	2036	2037
18	4,586											
19	14,303	4,032										
20	22,908	12,575	3,545									
21	32,467	20,139	11,056	3,117								
22	47,576	28,541	17,704	9,719	2,740							
23	60,463	41,821	25,088	15,562	8,543	2,408						
24	71,788	53,148	36,761	22,053	13,679	7,509	...					
25	86,097	63,105	46,720	32,315	19,385	12,025	...					
26	99,822	75,686	55,474	41,070	28,407	17,041	...					
27	109,339	87,753	66,535	48,767	36,105	24,973	...					
28	118,061	96,119	77,143	58,491	42,871	31,739	...					
29	126,061	103,785	84,496	67,815	51,418	37,687	...					
30	132,918	110,813	91,231	74,276	59,612	45,199	...					
31	138,178	116,839	97,408	80,195	65,290	52,401	...					
32	144,443	121,462	102,704	85,623	70,493	57,392	...					
33	149,053	126,964	106,763	90,275	75,262	61,962	...					
34	154,474	131,007	111,593	93,838	79,346	66,150	...	880				
35	167,379	135,759	115,136	98,073	82,469	69,733	...	2,744	835			
36	164,751	147,092	119,305	101,181	86,186	72,474	...	4,393	2,603	792		
37	160,890	144,777	129,259	104,841	88,914	75,737	...	6,223	4,168	2,470	752	
38	156,376	141,371	127,213	113,578	92,122	78,127	...	9,115	5,904	3,954	2,343	713
⋮	⋮	⋮	⋮	⋮	⋮	⋮	...	⋮	⋮	⋮	⋮	⋮
51	91,759	71,760	62,851	65,362	64,157	58,755	...	31,204	27,330	25,027	23,019	20,900
52	81,057	80,238	62,750	54,959	57,155	56,101	...	30,567	29,470	25,811	23,637	21,740
53	66,632	70,831	70,115	54,833	48,026	49,944	...	29,689	28,850	27,815	24,361	22,309
54	60,872	58,171	61,837	61,212	47,870	41,927	...	28,677	27,997	27,206	26,230	22,973
55	51,799	53,080	50,724	53,921	53,376	41,742	...	27,838	27,013	26,373	25,628	24,708
56	49,618	45,119	46,234	44,183	46,967	46,492	...	25,664	26,197	25,420	24,818	24,117

Table A.21 Forecasted figures of female contributors (new business)

Age	2017	2018	2019	2020	2021	2022	...	2033	2034	2035	2036	2037
18	1,184	1,148	1,151	1,128	1,094	1,050	...	1,160	1,172	1,183	1,195	1,207
19	2,745	3,704	3,678	3,627	3,528	3,397	...	3,780	3,818	3,856	3,895	3,934
20	3,193	5,512	6,363	6,278	6,141	5,936	...	6,651	6,750	6,818	6,886	6,955
21	3,776	6,472	8,520	9,194	9,012	8,752	...	9,850	10,054	10,185	10,287	10,390
22	4,548	7,734	10,114	11,827	12,291	11,962	...	13,536	13,855	14,094	14,265	14,407
23	5,885	9,710	12,524	14,504	15,843	16,033	...	18,224	18,679	19,041	19,327	19,548
24	7,367	12,323	15,702	18,035	19,566	20,472	...	23,985	24,599	25,103	25,521	25,867
25	8,469	14,696	19,073	21,880	23,690	24,724	...	30,340	31,160	31,826	32,390	32,872
26	8,884	16,068	21,563	25,240	27,457	28,721	...	36,535	37,606	38,472	39,194	39,819
27	9,117	16,659	22,996	27,653	30,628	32,240	...	42,385	43,719	44,826	45,741	46,518
28	9,306	17,047	23,699	29,093	32,924	35,197	...	47,868	49,461	50,821	51,965	52,927
29	9,318	17,225	24,052	29,723	34,202	37,227	...	52,841	54,679	56,285	57,669	58,850
30	9,436	17,349	24,323	30,145	34,864	38,455	...	57,448	59,517	61,357	62,976	64,386
⋮	⋮	⋮	⋮	⋮	⋮	⋮	...	⋮	⋮	⋮	⋮	⋮
42	7,540	14,201	20,222	25,613	30,189	34,156	...	75,945	80,821	85,369	89,531	93,344
43	7,224	13,635	19,504	24,656	29,188	32,943	...	74,319	79,219	83,918	88,306	92,329
44	6,895	13,037	18,684	23,708	28,039	31,767	...	72,466	77,339	82,056	86,584	90,817
45	6,617	12,477	17,886	22,719	26,944	30,504	...	70,464	75,290	79,978	84,519	88,881
46	6,398	12,019	17,178	21,805	25,868	29,343	...	68,420	73,162	77,802	82,312	86,683

Table A.22 Forecasted figures of male contributors (new business)

Age	2017	2018	2019	2020	2021	2022	...	2033	2034	2035	2036	2037
18	4,362	4,231	4,240	4,155	4,030	3,869	...	4,274	4,316	4,360	4,403	4,447
19	4,329	8,034	7,928	7,851	7,653	7,383	...	8,258	8,341	8,424	8,508	8,593
20	5,358	9,003	12,272	12,074	11,853	11,481	...	12,891	13,141	13,272	13,405	13,539
21	8,403	12,861	16,082	18,792	18,378	17,874	...	20,121	20,551	20,871	21,080	21,290
22	9,851	16,942	20,881	23,521	25,621	24,893	...	28,205	28,844	29,350	29,752	30,050
23	11,126	19,452	25,707	28,952	30,955	32,390	...	36,852	37,778	38,494	39,085	39,579
24	12,298	21,709	29,051	34,310	36,812	38,118	...	45,906	47,143	48,143	48,946	49,631
25	12,873	23,297	31,595	37,799	42,054	43,777	...	54,692	56,305	57,607	58,684	59,576
26	13,173	24,094	33,284	40,322	45,399	48,653	...	62,957	64,943	66,604	67,971	69,127
27	13,529	24,703	34,330	42,146	47,947	51,910	...	70,785	73,140	75,159	76,870	78,305
28	13,753	25,234	35,084	43,279	49,757	54,348	...	78,058	80,791	83,162	85,216	86,979
29	13,900	25,573	35,692	44,081	50,889	56,069	...	84,753	87,838	90,569	92,958	95,048
30	14,109	25,904	36,193	44,814	51,785	57,247	...	90,995	94,396	97,464	100,196	102,606
⋮	⋮	⋮	⋮	⋮	⋮	⋮	...	⋮	⋮	⋮	⋮	⋮
42	10,648	20,220	28,856	36,544	43,296	49,049	...	110,589	117,794	124,709	131,235	137,362
43	10,037	19,084	27,507	34,894	41,357	46,914	...	107,609	114,766	121,695	128,350	134,637
44	9,391	17,918	25,877	33,087	39,302	44,627	...	104,177	111,271	118,146	124,806	131,208
45	8,686	16,664	24,162	30,975	37,052	42,184	...	100,296	107,282	114,087	120,686	127,083
46	7,942	15,321	22,333	28,754	34,502	39,539	...	95,991	102,837	109,531	116,055	122,385

PPS fund amount figures are forecasted by using number of contributors and their fund amounts as of 2016, average contribution amount of those contributors, which is based on age group, for the future period with the help of economic and non-economic assumptions, which are given in section six.

Table A.23 Forecasted figures of female fund amount (in force business)

Age	2017	2018	2019	2020	...	2035	2036	2037
18	4,256,958							
19	14,535,316	8,672,828						
20	28,939,587	28,360,127	12,901,125					
21	49,373,614	51,322,853	41,588,734	16,802,955				
22	70,474,272	82,351,399	72,702,358	53,790,653	...			
23	84,232,577	116,196,929	113,802,306	92,400,177	...			
24	103,692,456	141,885,967	159,787,050	142,751,142	...			
25	134,047,255	171,781,162	196,880,782	199,899,737	...			
26	179,334,235	214,551,536	234,456,792	245,874,557	...			
27	227,819,304	277,862,843	291,630,773	292,230,963	...			
28	278,450,351	339,316,875	372,085,861	362,665,049	...			
29	321,364,347	402,684,934	445,757,879	458,850,953	...			
30	373,213,027	454,588,989	521,100,675	543,663,662	...			
31	418,284,258	514,446,209	581,409,668	629,919,838	...			
32	485,796,544	564,915,626	648,655,090	697,856,899	...			
33	546,294,615	642,152,790	704,020,439	771,737,772	...			
34	615,839,863	708,980,965	790,180,472	831,446,869	...			
35	684,246,801	786,263,147	862,687,078	925,592,718	...			
36	728,668,572	866,976,641	948,473,703	1,004,976,705	...	76,371,517		
37	771,653,493	909,782,625	1,040,709,739	1,097,055,284	...	243,341,237	84,118,917	
38	792,012,350	951,197,564	1,081,557,578	1,199,694,082	...	403,737,832	267,592,831	92,358,735
⋮	⋮	⋮	⋮	⋮	...	⋮	⋮	⋮
51	752,172,148	823,916,981	897,441,056	1,068,939,365	...	3,556,038,655	3,682,989,150	3,726,180,858
52	688,067,415	873,763,091	926,804,526	988,580,835	...	3,773,381,923	3,875,329,335	4,010,810,718
53	611,923,106	795,572,458	986,974,274	1,019,066,583	...	4,075,522,446	4,104,110,020	4,212,514,312
54	602,211,640	702,239,694	895,337,228	1,088,419,159	...	4,077,154,448	4,426,464,371	4,452,623,940
55	571,162,357	686,877,140	785,650,696	984,429,864	...	4,078,373,383	4,419,367,893	4,795,447,084
56	501,933,605	644,911,670	764,841,536	859,973,917	...	3,985,057,011	4,412,570,938	4,779,395,110

Table A.24 Forecasted figures of male fund amount (in force business)

Age	2017	2018	2019	2020	...	2035	2036	2037
18	4,093,220							
19	17,532,596	11,232,717						
20	34,631,885	39,962,214	18,068,126					
21	57,761,824	70,776,865	61,400,468	24,372,075				
22	83,246,074	109,281,150	105,274,393	81,149,543	...			
23	104,576,110	158,685,495	158,391,836	137,027,751	...			
24	130,654,839	200,406,061	230,608,442	203,565,227	...			
25	171,488,861	244,665,383	291,785,944	296,779,814	...			
26	213,332,446	308,367,909	353,432,291	376,048,828	...			
27	258,328,068	372,540,992	439,208,688	453,627,806	...			
28	305,445,017	433,568,159	524,624,088	559,676,877	...			
29	354,408,048	495,570,450	600,787,949	664,580,697	...			
30	407,332,432	558,373,333	676,798,867	754,559,566	...			
31	461,359,798	623,545,606	752,607,005	843,354,248	...			
32	526,356,347	687,437,432	829,224,130	931,011,872	...			
33	597,252,027	764,185,813	902,224,523	1,017,982,341	...			
34	670,510,175	844,499,372	989,809,725	1,099,154,116	...			
35	757,488,183	928,466,272	1,078,651,869	1,196,449,361	...			
36	822,359,741	1,050,430,476	1,184,884,335	1,304,415,299	...	118,402,206		
37	865,804,885	1,113,309,155	1,329,327,584	1,420,054,568	...	381,693,916	130,407,683	
38	907,688,684	1,151,985,951	1,389,694,803	1,584,826,891	...	629,378,382	419,318,859	143,151,100
⋮	⋮	⋮	⋮	⋮	...	⋮	⋮	⋮
51	1,053,524,148	1,112,212,788	1,223,964,451	1,548,025,432	...	4,971,864,941	5,152,340,903	5,287,925,235
52	986,593,570	1,223,276,365	1,253,334,704	1,349,563,578	...	5,238,588,998	5,404,774,716	5,595,771,350
53	855,666,018	1,137,781,773	1,379,663,304	1,378,464,540	...	5,727,462,374	5,682,901,129	5,857,838,826
54	847,079,343	980,715,903	1,276,252,053	1,517,765,272	...	5,713,448,551	6,201,576,294	6,145,788,920
55	810,060,261	962,680,626	1,094,515,179	1,397,726,507	...	5,629,528,640	6,171,550,547	6,693,022,561
56	702,456,919	910,812,321	1,067,321,004	1,193,967,580	...	5,523,843,935	6,068,401,281	6,646,203,264

Table A.25 Forecasted figures of female fund amount (new business)

Age	2018	2019	2020	2021	...	2035	2036	2037
19	2,051,253	2,368,461	2,758,838	3,051,700	...	17,149,746	19,469,078	22,102,076
20	4,755,570	9,559,758	11,018,218	12,370,726	...	70,919,374	80,502,365	91,380,259
21	5,531,607	15,819,792	24,131,621	27,194,704	...	160,971,020	182,699,923	207,361,930
22	6,541,496	18,524,935	35,116,491	47,235,331	...	287,462,544	327,659,255	371,844,535
23	7,878,775	22,071,886	41,450,600	64,535,893	...	451,893,344	517,762,549	589,488,140
24	10,194,780	27,398,196	50,519,726	77,643,852	...	663,756,102	762,664,682	872,053,406
25	12,761,896	34,955,545	63,085,175	95,598,389	...	932,420,396	1,073,081,114	1,230,011,669
26	16,118,496	45,241,266	82,693,476	123,485,689	...	1,304,362,521	1,502,521,855	1,724,684,631
27	16,908,107	51,491,036	98,803,346	151,636,849	...	1,726,456,794	1,992,507,494	2,289,746,488
28	17,351,262	53,568,166	108,379,866	173,729,347	...	2,183,955,530	2,527,070,929	2,909,737,222
29	17,710,590	54,861,181	112,158,584	186,878,320	...	2,665,402,351	3,090,316,069	3,567,461,375
30	17,732,961	55,598,645	114,285,231	192,245,041	...	3,157,408,098	3,667,742,722	4,243,072,829
31	17,957,222	55,901,291	115,680,592	195,466,251	...	3,651,980,148	4,248,596,976	4,924,717,464
32	18,025,486	56,424,319	116,340,427	197,564,180	...	4,141,991,467	4,824,001,991	5,600,528,748
33	18,363,722	56,949,187	117,598,693	199,050,358	...	4,623,357,182	5,389,994,425	6,265,196,722
34	18,635,082	57,931,643	118,918,723	201,380,412	...	5,091,552,613	5,942,249,223	6,914,529,947
35	18,683,554	58,523,565	120,572,188	203,493,910	...	5,541,280,903	6,474,405,020	7,542,272,027
36	22,935,526	68,329,619	137,494,708	228,358,841	...	6,277,787,127	7,339,671,741	8,557,996,374
37	22,209,740	71,118,989	145,287,408	242,924,303	...	6,913,409,610	8,129,082,380	9,486,256,332
38	21,220,394	68,535,089	145,323,658	247,356,817	...	7,432,111,182	8,798,258,114	10,320,688,990
⋮	⋮	⋮	⋮	⋮	...	⋮	⋮	⋮
51	-	-	-	-	...	7,519,879,220	9,310,274,492	11,440,327,119
52	-	-	-	-	...	6,880,902,099	8,579,419,196	10,605,227,650
53	-	-	-	-	...	6,196,723,481	7,787,855,335	9,695,698,720
54	-	-	-	-	...	5,496,017,901	6,965,684,856	8,741,898,389
55	-	-	-	-	...	4,801,501,366	6,140,997,709	7,773,109,193
56	-	-	-	-	...	4,140,355,018	5,337,096,715	6,818,257,202

Table A.26 Forecasted figures of male fund amount (new business)

Age	2018	2019	2020	2021	...	2035	2036	2037
19	7,552,546	8,720,427	10,157,684	11,235,891	...	63,143,967	71,683,557	81,378,042
20	7,495,053	23,624,763	27,087,235	30,635,332	...	177,319,257	201,269,945	228,455,671
21	9,275,957	25,565,943	51,323,904	57,724,167	...	347,547,094	394,438,963	447,657,586
22	14,546,434	35,179,695	62,249,699	98,321,388	...	602,072,301	688,501,599	781,317,663
23	17,052,330	48,517,181	82,661,200	121,214,210	...	942,491,620	1,080,796,972	1,233,616,668
24	19,259,225	56,031,139	106,596,658	154,791,955	...	1,366,248,809	1,569,393,828	1,795,715,935
25	21,288,552	62,748,912	121,584,197	191,440,371	...	1,866,736,423	2,149,186,691	2,463,291,861
26	24,483,910	72,660,212	141,385,753	224,840,085	...	2,510,829,072	2,895,713,077	3,326,294,329
27	25,054,867	77,454,863	155,030,183	250,669,833	...	3,197,344,194	3,698,388,887	4,256,462,024
28	25,731,947	79,368,222	162,234,949	268,719,178	...	3,911,920,119	4,535,191,654	5,234,480,616
29	26,157,495	81,200,490	165,989,815	278,751,045	...	4,641,711,461	5,389,821,753	6,235,042,734
30	26,436,162	82,363,710	169,285,600	284,597,700	...	5,370,523,745	6,248,676,573	7,240,926,593
31	26,833,203	83,373,413	171,679,274	289,820,322	...	6,090,987,870	7,097,365,858	8,240,838,312
32	27,477,786	84,904,189	174,248,177	294,298,820	...	6,801,565,693	7,931,797,607	9,223,536,103
33	27,851,509	86,611,182	177,351,131	298,843,049	...	7,494,349,669	8,748,455,949	10,182,454,218
34	28,138,859	87,679,958	180,441,244	303,797,519	...	8,165,461,413	9,539,010,924	11,114,162,781
35	28,008,968	88,094,067	181,981,016	307,938,362	...	8,806,755,488	10,296,329,603	12,006,303,498
36	33,597,651	101,479,536	205,518,423	342,720,033	...	9,885,821,569	11,558,842,455	13,486,814,070
37	32,161,369	103,697,975	214,303,826	360,817,194	...	10,720,933,182	12,697,531,870	14,820,328,577
38	30,839,598	99,320,250	211,496,328	363,351,075	...	11,446,619,780	13,557,464,840	16,006,843,550
⋮	⋮	⋮	⋮	⋮	...	⋮	⋮	⋮
51	-	-	-	-	...	10,474,874,839	13,013,101,745	16,039,218,340
52	-	-	-	-	...	9,507,297,302	11,899,208,022	14,758,532,990
53	-	-	-	-	...	8,489,658,769	10,713,653,697	13,388,416,317
54	-	-	-	-	...	7,471,559,466	9,499,580,123	11,970,712,362
55	-	-	-	-	...	6,477,191,476	8,306,755,717	10,547,715,075
56	-	-	-	-	...	5,534,217,425	7,160,433,193	9,172,460,052

PPS state contribution fund amount figures are forecasted using number of contributors, their state contribution fund amounts as of 2016, contribution amount (%25 of this amount is assumed as state contribution) and economic and non-economic assumptions which are given in section six.

Table A.27 Forecasted figures of female state contribution fund amount (in force business)

Age	2017	2018	2019	2020	...	2035	2036	2037
18	593,673				...			
19	2,909,298	1,603,923			...			
20	6,081,181	5,967,438	2,516,493		...			
21	10,648,916	10,862,898	8,721,389	3,303,950	...			
22	15,432,195	17,484,216	15,157,273	11,089,217	...			
23	18,106,136	24,831,761	23,607,913	18,837,704	...			
24	21,226,112	30,119,845	33,246,492	28,840,933	...			
25	27,126,329	35,392,141	40,886,584	40,430,938	...			
26	35,989,094	46,382,556	49,683,118	51,416,609	...			
27	44,712,123	59,155,513	63,653,318	61,934,800	...			
28	53,200,927	70,324,271	79,907,016	78,431,597	...			
29	60,727,544	81,192,518	93,228,004	97,636,633	...			
30	68,321,038	90,190,101	106,189,380	112,756,698	...			
31	75,249,327	98,878,908	116,464,280	127,469,046	...			
32	84,626,373	106,282,571	126,088,860	138,794,217	...			
33	92,530,592	116,930,615	133,868,506	149,169,619	...			
34	100,722,494	125,336,929	145,594,442	157,218,282	...			
35	111,299,905	134,318,009	154,390,950	169,801,995	...			
36	115,352,870	157,965,008	174,552,745	188,812,642	...	16,851,836		
37	119,044,726	160,534,909	199,443,028	208,755,344	...	54,298,764	18,732,065	
38	119,795,912	162,815,225	200,628,364	234,545,188	...	89,593,281	60,106,325	20,713,607
⋮	⋮	⋮	⋮	⋮	...	⋮	⋮	⋮
51	102,960,449	121,405,877	143,327,027	182,813,877	...	812,895,221	847,943,720	862,818,034
52	91,878,339	133,206,926	144,978,044	162,662,302	...	855,588,221	886,558,953	924,039,732
53	79,168,583	118,272,299	159,629,282	164,484,299	...	924,008,192	931,013,628	963,958,758
54	76,453,810	100,737,211	141,276,446	181,474,013	...	913,310,090	1,003,350,401	1,010,160,670
55	68,623,669	96,127,974	119,465,914	160,230,623	...	901,674,996	989,957,896	1,086,475,630
56	63,709,062	84,945,450	113,163,295	134,847,630	...	869,681,168	975,822,777	1,070,334,753

Table A.28 Forecasted figures of fmale state contribution fund amount (in force business)

Age	2017	2018	2019	2020	...	2035	2036	2037
18	681,537				...			
19	3,591,968	2,291,396			...			
20	7,418,988	8,479,958	3,745,377		...			
21	12,123,557	15,095,918	12,882,199	4,999,597	...			
22	18,149,080	22,856,383	21,994,980	16,666,977	...			
23	22,974,153	33,840,201	32,487,715	27,912,382	...			
24	28,204,126	42,923,387	47,918,120	40,735,652	...			
25	35,746,216	51,807,619	60,824,517	59,972,863	...			
26	43,800,355	66,979,242	75,575,637	78,292,904	...			
27	51,195,285	79,800,481	95,010,554	95,970,419	...			
28	58,668,652	90,336,272	112,089,726	119,017,930	...			
29	66,493,849	100,623,066	125,412,878	139,720,785	...			
30	74,489,607	110,938,390	138,187,849	155,397,004	...			
31	82,912,437	120,952,921	150,699,253	170,269,725	...			
32	91,677,438	130,717,888	162,482,352	184,623,777	...			
33	101,205,790	141,191,719	173,393,160	197,870,297	...			
34	111,297,230	151,691,815	185,338,640	209,698,356	...			
35	124,959,541	163,022,093	196,632,766	222,836,421	...			
36	132,045,973	197,044,245	224,248,230	249,132,315	...	26,103,371		
37	135,944,887	202,169,218	261,354,352	276,500,963	...	83,995,405	29,004,443	
38	139,733,430	203,769,323	264,627,667	316,016,693	...	138,146,698	92,944,585	32,057,273
⋮	⋮	⋮	⋮	⋮	...	⋮	⋮	⋮
51	127,705,371	155,807,103	187,718,086	252,047,911	...	1,143,659,019	1,191,797,633	1,225,705,110
52	116,941,411	170,864,165	189,152,667	215,491,349	...	1,199,891,279	1,244,707,554	1,295,911,444
53	99,879,300	154,562,472	208,345,102	216,535,119	...	1,312,459,086	1,302,496,969	1,349,959,419
54	93,721,251	130,320,068	187,079,378	239,035,769	...	1,298,514,045	1,421,045,247	1,408,992,947
55	85,818,347	121,142,789	156,477,796	213,513,377	...	1,271,472,360	1,402,582,871	1,533,273,931
56	76,616,981	108,436,956	144,610,420	177,621,994	...	1,237,039,448	1,370,434,501	1,510,113,611

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Table A.29 Forecasted figures of female state contribution fund amount (new business)

Age	2018	2019	2020	2021	...	2035	2036	2037
19	431,828	478,710	533,939	563,863	...	3,610,347	4,098,610	4,652,906
20	1,001,134	1,948,332	2,151,308	2,308,139	...	14,929,836	16,947,232	19,237,229
21	1,164,501	3,234,855	4,761,514	5,131,709	...	33,887,284	38,461,607	43,653,401
22	1,377,096	3,787,699	6,957,097	9,008,040	...	60,515,870	68,977,977	78,279,748
23	1,658,611	4,512,522	8,210,159	12,358,307	...	95,131,191	108,997,773	124,097,223
24	2,146,161	5,599,548	10,000,943	14,856,806	...	139,731,546	160,553,426	183,581,548
25	2,686,571	7,145,189	12,484,936	18,280,766	...	196,289,299	225,900,617	258,936,995
26	3,393,179	9,244,241	16,356,862	23,583,667	...	274,588,377	316,303,970	363,072,659
27	3,559,394	10,533,771	19,575,285	29,015,581	...	363,444,906	419,452,555	482,025,808
28	3,652,673	10,959,755	21,502,868	33,321,439	...	459,754,133	531,984,886	612,541,676
29	3,728,302	11,224,521	22,256,358	35,897,267	...	561,104,140	650,554,385	751,000,112
30	3,732,992	11,376,329	22,681,307	36,939,883	...	664,676,095	772,108,298	893,222,917
31	3,780,190	11,437,621	22,959,714	37,564,572	...	768,787,773	894,383,155	1,036,715,070
32	3,794,551	11,545,054	23,089,878	37,971,159	...	871,920,169	1,015,510,410	1,178,978,675
33	3,865,733	11,651,604	23,339,034	38,253,173	...	973,161,037	1,134,636,353	1,318,895,123
34	3,922,827	11,852,720	23,598,929	38,698,794	...	1,071,540,796	1,250,798,363	1,455,562,671
35	3,932,991	11,974,341	23,928,872	39,103,675	...	1,165,978,476	1,362,640,300	1,587,612,426
36	4,828,021	13,956,414	27,210,050	43,719,711	...	1,320,748,457	1,544,549,787	1,801,246,229
37	4,675,216	14,553,492	28,796,313	46,553,736	...	1,454,306,862	1,710,455,882	1,996,415,139
38	4,466,911	14,025,422	28,856,233	47,507,881	...	1,563,265,948	1,851,074,715	2,171,795,458
⋮	⋮	⋮	⋮	⋮	...	⋮	⋮	⋮
51	-	-	-	-	...	1,579,018,310	1,955,957,619	2,404,617,068
52	-	-	-	-	...	1,444,546,916	1,801,980,324	2,228,452,012
53	-	-	-	-	...	1,300,647,710	1,635,392,992	2,036,868,638
54	-	-	-	-	...	1,153,283,887	1,462,448,340	1,836,132,433
55	-	-	-	-	...	1,007,223,714	1,288,988,124	1,632,325,556
56	-	-	-	-	...	868,180,306	1,119,909,088	1,431,472,680

Table A.30 Forecasted figures of male state contribution fund amount (new business)

Age	2018	2019	2020	2021	...	2035	2036	2037
19	1,589,776	1,762,308	1,965,544	2,075,603	...	13,291,511	15,089,054	17,129,698
20	1,577,660	4,833,681	5,310,912	5,741,700	...	37,324,648	42,366,125	48,088,559
21	1,952,502	5,225,435	10,174,493	10,947,415	...	73,155,938	83,026,309	94,228,411
22	3,061,843	7,182,101	12,303,380	18,804,141	...	126,730,114	144,922,607	164,459,447
23	3,589,274	9,918,689	16,342,235	23,135,091	...	198,383,234	227,494,866	259,661,595
24	4,053,788	11,456,763	21,118,150	29,585,913	...	287,577,649	330,337,052	377,974,932
25	4,480,955	12,831,691	24,096,339	36,683,919	...	392,923,489	452,375,574	518,490,600
26	5,153,571	14,850,641	27,997,652	43,047,872	...	528,497,629	609,510,837	700,142,734
27	5,273,766	15,844,751	30,731,738	48,044,750	...	673,001,763	778,465,544	895,933,108
28	5,416,282	16,235,906	32,187,407	51,576,624	...	823,412,279	954,603,466	1,101,795,416
29	5,505,836	16,611,441	32,933,257	53,545,036	...	977,024,457	1,134,492,665	1,312,401,521
30	5,564,456	16,849,729	33,590,240	54,673,007	...	1,130,428,630	1,315,268,894	1,524,125,212
31	5,648,009	17,055,875	34,065,548	55,682,133	...	1,282,074,749	1,493,904,393	1,734,590,668
32	5,783,679	17,368,301	34,572,572	56,540,011	...	1,431,571,169	1,669,538,701	1,941,432,618
33	5,862,305	17,718,204	35,187,804	57,409,094	...	1,577,153,766	1,841,361,333	2,143,266,459
34	5,922,720	17,936,886	35,803,496	58,362,468	...	1,718,084,491	2,007,519,644	2,339,299,982
35	5,895,283	18,022,478	36,111,850	59,167,833	...	1,852,646,749	2,166,589,845	2,526,833,040
36	7,071,509	20,725,947	40,670,476	65,613,457	...	2,079,219,806	2,431,902,102	2,838,115,008
37	6,769,161	21,217,983	42,475,439	69,151,017	...	2,254,596,144	2,671,023,960	3,118,369,624
38	6,490,853	20,321,738	41,989,856	69,786,511	...	2,406,848,732	2,851,617,122	3,367,549,588
⋮	⋮	⋮	⋮	⋮	...	⋮	⋮	⋮
51	-	-	-	-	...	2,198,575,306	2,732,744,952	3,369,920,603
52	-	-	-	-	...	1,995,017,231	2,498,150,669	3,099,842,762
53	-	-	-	-	...	1,781,043,808	2,248,723,494	2,811,331,412
54	-	-	-	-	...	1,566,984,213	1,993,411,010	2,513,047,629
55	-	-	-	-	...	1,357,918,614	1,742,581,660	2,213,765,584
56	-	-	-	-	...	1,159,675,395	1,501,549,596	1,924,556,011

Number of annuitant is forecasted with the equation A.2 below:

$$n_{57} = n_{57;retired} \, r_{annuitant} \tag{A.2}$$

$$n_x = n_{x-1} - n_{x-1} \, q^w_{x-1} - n_{x-1} \, q^d_{x-1} \, , \, x > 57 \tag{A.3}$$

Where;

n_{57} : number of annuitant at age 57

$n_{57;retired}$: number of retired contributors from PPS at age 57

$r_{annuitant}$: annuitant rate

n_x : number of contributors at age x

q^w_x : withdrawal rate at age x

q^d_x : death rate at age x

Table A.31 Forecasted figures of number of female annuitant (in force business)

Age	2017	2018	2019	2020	2021	2022	...	2033	2034	2035	2036	2037
57	367	330	341	644	681	1,020	...	2,164	2,565	2,837	3,158	3,397
58		348	313	323	610	645	...	1,699	2,051	2,431	2,688	2,993
59			330	297	306	578	...	1,621	1,609	1,943	2,303	2,547
60				312	281	290	...	1,422	1,535	1,524	1,840	2,181
61					295	266	...	1,205	1,346	1,453	1,442	1,741
62						280	...	1,017	1,140	1,274	1,375	1,365
63							...	838	962	1,078	1,204	1,300
64							...	852	792	909	1,019	1,138
⋮							...	...	...	...	...	...
72								138	143	270	285	427
73								144	129	133	252	267
74									134	121	125	235
75										125	112	116
76											116	104
77												107

Table A.32 Forecasted figures of number of male annuitant (in force business)

Age	2017	2018	2019	2020	2021	2022	...	2033	2034	2035	2036	2037
57	496	451	462	884	939	1,395	...	3,080	3,668	4,067	4,467	4,823
58		468	426	436	833	886	...	2,406	2,904	3,459	3,836	4,213
59			441	401	411	785	...	2,314	2,268	2,737	3,260	3,615
60				415	378	387	...	2,024	2,179	2,135	2,577	3,069
61					391	355	...	1,707	1,904	2,050	2,009	2,425
62						367	...	1,422	1,604	1,789	1,926	1,888
63							...	1,158	1,335	1,506	1,679	1,808
64							...	1,159	1,085	1,251	1,412	1,574
⋮							...	...	...	...	...	...
72								165	169	322	343	509
73								167	151	155	297	315
74									153	139	142	272
75										140	127	130
76											127	115
77												115

Table A.33 Forecasted figures of number of female annuitant (new business)

Age	2027	2028	2029	2030	...	2036	2037
57	97	228	397	602	…	3,638	4,570
58		91	216	376	…	2,689	3,448
59			87	204	…	1,936	2,547
60				82	…	1,344	1,834
61					…	890	1,272
62					…	639	842
63					…	433	604
64					…	270	409
65					…	146	255
66						59	138
67							55

Table A.34 Forecasted figures of number of male annuitant (new business)

Age	2027	2028	2029	2030	...	2036	2037
57	116	281	500	769	…	4,856	6,115
58		110	265	472	…	3,559	4,580
59			103	250	…	2,534	3,354
60				97	…	1,741	2,386
61					…	1,138	1,638
62					…	804	1,070
63					…	534	754
64					…	326	501
65					…	171	305
66						66	160
67							62

Capital requirement of market sub risks are calculated using annuitant's figures as given above. Mathematical reserve is calculated for annuitant portfolio and these figures are used for forecasting liability year by year where the equation of mathematical reserve is given in section 4.1.

As an example as at 2018 total asset was 32,447,382. It is assumed that 80% of the assets were in TL, 10% of USD and 10% EUR in this dissertation.

Based on the asset allocation assumption currency risk calculation for 2018 is given in Table A.35.

Table A.35 Solvency II – Currency risk calculation

Currency		Financial Investment Asset Exposures	All Other Asset Exposures	Total Assets (incl. all member balances)	Liability Exposures	Total NAV (incl. all member balances)	Basis SCR (incl. all member balances)
Turkish Lira	TRY	25,957,906	-	-	32,447,382	(32,447,382)	
Euro	EUR		3,244,738	3,244,738		3,244,738	811,185
United States Dollar	USD		3,244,738	3,244,738		3,244,738	811,185
Total		**25,957,906**	**6,489,476**	**6,489,476**	**32,447,382**	**(25,957,906)**	**1,622,369**

Capital requirement of interest rate risk figures as of 2018 is given in Table A.36. Assets, liabilities and surplus amounts are summarized in Table A.36.

Table A.36 Solvency II – Interest rate risk calculation

(including all member balances)	2018
Undiscounted	27,706,317,156
Assets - Discounted - Unshocked	22,713,168
Assets - Discounted - Upward Shock	22,713,168
Assets - Discounted - Downward Shock	22,713,168
Liabilities - Discounted - Unshocked	15,355,207
Liabilities - Discounted - Upward Shock	10,239,695
Liabilities - Discounted - Downward Shock	22,540,242
Surplus - Discounted - Unshocked	7,357,961
Surplus - Discounted - Upward Shock	12,473,472
Surplus - Discounted - Downward Shock	172,926
Impact on Surplus - Upward	5,115,512
Impact on Surplus - Downward	(7,185,035)
SCR interest rate	**7,185,035**

CURRICULUM VITAE

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